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Countering demand for ineffective health remedies: Do consumers respond to risks, lack of benefits, or both?

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Countering demand for ineffective health remedies: Do consumers respond to risks, lack of benefits, or both?

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ABSTRACT

Objective: We tested whether targeting the illusion of causality and/or misperceptions about health risks had the potential to reduce consumer demand for an ineffective health remedy (multivitamin supplements).
Design: We adopted a 2 (contingency information: no/yes) × 2 (fear appeal: no/yes) factorial design, with willingness-to-pay as the dependent variable. The contingency information specified, in table format, the number of people reporting a benefit vs. no benefit from both multivitamins and placebo, plus a causal explanation for lack of efficacy over placebo. The fear appeal involved a summary of clinical-trial results that indicated multivitamins can cause health harms. The control condition received only irrelevant information.
Main outcome measure: Experimental auctions measured people's willingness-to-pay for multivitamins. Experiment 1 ($N = 260$) elicited hypothetical willingness-to-pay online. Experiment 2 ($N = 207$) elicited incentivised willingness-to-pay in the laboratory.
Results: Compared to a control group, we found independent effects of contingency information (-22%) and the fear appeal (-32%) on willingness-to-pay. The combination of both interventions had the greatest impact (-50%) on willingness-to-pay.
Conclusion: We found evidence that consumer choices are influenced by both perceptions of efficacy and risk. The combination of both elements can provide additive effects that appear superior to either approach alone.

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health psychology; health communication; fear appeal; risk estimation; complementary and alternative medicine (CAM)

Ineffective health remedies

The consumption of ineffective health remedies—remedies that are untested, or found to be ineffective, or even harmful—causes extensive and persistent harms to individuals. Harms include side-effects, financial costs, interactions with conventional medications, and opportunity costs of delays in getting critical diagnoses and effective treatment (U.S. Food & Drug Administration [FDA], 2019; Macfarlane et al., 2020). An example of such a remedy is multivitamin supplementation (hereafter, 'multivitamins')

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for healthy individuals, which extensive clinical testing has shown to be ineffective (Bjelakovic et al., 2012; Guallar et al., 2013; Jenkins et al., 2018) and potentially harmful (Mursu et al., 2011). Evidence-based interventions are thus needed to protect consumers from misleading claims about such remedies.

One approach to designing evidence-based interventions is to target the psychological mechanisms that drive demand for health remedies (Macfarlane et al., 2020). The perception that multivitamins are beneficial (i.e., the perception of efficacy), for example, is often driven by a mechanism known as the illusion of causality, which occurs when people perceive a causal relationship between an action (e.g., consuming a multivitamin) and a subsequent but unrelated outcome (e.g., feeling healthy).

One recent study (Macfarlane et al., 2018b) showed that a novel way to overcome the illusion of causality is to communicate clinical trial outcomes in a simplified contingency table—a table showing the number of people reporting a benefit vs. no benefit from taking a treatment (e.g., a multivitamin) or a placebo—in combination with an alternative causal explanation why a treatment did not cause a benefit over placebo. This contingency-information intervention is thought to work through two mechanisms. First, it communicates simplified clinical results—using small, cognitively-manageable frequencies rather than complex probabilities—showing the lack of benefits for a product (e.g., 3 out of 4 people experienced the same benefit from taking a multivitamin as from taking a placebo sugar pill). Communicating simplified clinical results is important because when people are given complex proportions, they tend to misinterpret the results through several cognitive biases such as denominator neglect (i.e., when probability estimates are skewed by disproportional attention to absolute numbers over the actual proportion) or availability bias (i.e., the tendency to believe that examples that come readily to mind are representative of reality; see Gigerenzer et al., 2007; Slovic et al., 2007; Yamagishi, 1997). Second, the contingency intervention fills the mental gap left by debunking a previously held belief (e.g., "supplements boost the immune system'; see Ecker, Lewandowsky, & Tang, 2010) by providing an explanation for the lack of benefits (e.g., 'most modern diets provide ample vitamins for the body to maintain healthy function'). Whilst this previous study found promising results of the contingency information intervention using an experimental auction—namely a 23% reduction in willingness-to-pay for a multivitamin product—the study needs to be replicated to have confidence that the effect is robust.

One aim of the present study was thus to replicate our previous finding. We also aimed to test whether the contingency intervention could be strengthened by concurrently targeting another psychological driver of consumer demand, namely the belief that alternative, or 'natural', health remedies are harmless. This perception drives demand through two key mechanisms. First, a perceived lack of harm encourages people to experiment more frequently with a remedy (to obtain a desired outcome, such as recovering from a cold), which strengthens the illusion of causality by repeatedly reaffirming the association of the action (consuming a remedy) with a subsequent unrelated outcome (feeling healthy). Second, a perceived lack of harm can increase people's belief that a product is also beneficial through an 'affect heuristic' (Finucane, Alhakami, Slovic, & Johnson, 2000)— whereby people tend to judge risks and benefits as negatively correlated even when the nature of the benefits is both distinctively and qualitatively different from the nature of the risks (see Alhakami & Slovic, 1994; Fischhoff et al., 1978; Slovic et al., 2007). While this heuristic enables us to make quick judgements, it also leaves us vulnerable to manipulation, especially when there is less opportunity for analytical deliberation. For example, if an antibiotic is portrayed as low in risk, this contributes to the perception that it is also high in benefit, and vice versa. Equally, if cancer screening is portrayed as low in benefit, this contributes to the perception that it is also high in risk, and vice-versa (Ghanouni et al., 2017). In other words, evaluations of risks and benefits tend to be causally determined, meaning that the perception of one attribute can be influenced by manipulating information about the other (Finucane et al., 2000). Therefore, if a remedy is portrayed as having no benefits and also potential harms then both factors should work in the same direction to reduce people's perception of overall value.

This prediction challenges the often-assumed dichotomy that health communications should only be framed around either benefits or harms. In other words, much research has advocated for either negative or positive messages (Akl et al., 2011; Gallagher & Updegraff, 2012; Jung & Villegas, 2011; Kok et al., 2018; O'Keefe & Jensen, 2008; Riet et al., 2008). However, as others have argued (Kidd, Bekessy, & Garrard, 2019; McAfee & Connell, 2019; Peters et al., 2018), to change complex behaviour, a more sophisticated approach may be needed that acknowledges the relevance of both frames and the balance between them depending on context.

Thus, in two experiments we sought to test whether augmenting the contingency intervention (countering the perception of efficacy) with a fear-inducing intervention communicating information about potential harms would yield a reduction in willingness-to-pay for multivitamins greater than that observed for the contingency intervention alone (while also assessing the fear appeal's individual effect). Such fear appeals—persuasive messages that depict a personally relevant and significant threat and outline a feasible recommendation to avoid the harm; see Witte, 1994—have been used in previous research to instigate behaviour change (for a review, see Tannenbaum et al., 2015).

We made two key predictions. First, consistent with our earlier study, we expected a main effect of contingency information, with stated willingness-to-pay lower in the presence versus absence of simplified contingency information (i.e., we expected the contingency information to reduce bid amounts; Hypothesis 1). Second, and new to the current study, we expected a main effect of fear appeal, with willingness-to-pay lower with versus without a fear-inducing message (i.e., we expected the fear appeal to reduce bid amounts; Hypothesis 2). We had two additional research questions: first, whether there would be an interaction between the contingency information and the fear-appeal interventions, and second, whether the effects of the two interventions differed significantly from each other (i.e., which intervention had the greatest impact on bid amounts).

Method

This research was conducted in accordance with recommendations for obtaining quality evidence from behavioural interventions (Dombrowski et al., 2007). In particular, the intervention was designed with a theoretical basis, tested via a randomised controlled trial, and reported with due regard to accepted CONSORT standards of reporting for randomised controlled trials (Boutron et al., 2008). Ethics approval to conduct both experiments was granted by the Human Ethics Office of the University of Western Australia in accordance with the requirements of the Australian National Statement on Ethical Conduct in Human Research (NHMRC, 2007).

Experiment 1

Participants

A sample of 260 online U.S.-based participants was recruited via Amazon's Mechanical Turk (MTurk)—an online labor market in which employers pay users for completing short tasks known as Human Intelligence Tasks (HITs)[1]. Sample size was informed by an a-priori power analysis (G*Power 3; Faul et al., 2007) that suggested a minimum sample size of 180 to detect a medium-sized effect (f = .25) with α = .05, 1 - β = .80. Participants were paid at a rate of US $7.25/hour pro rata (US federal minimum wage). Two key eligibility criteria were also set to ensure quality data (Peer et al., 2014), namely a HIT-approval rate of greater than 97% and the requirement to have previously completed at least 5,000 HITs.

Several a-priori exclusion criteria were applied to remove careless responders (Oppenheimer et al., 2009). Participants were excluded who (i) gave non-differentiated answers to every question in a survey block (Hamby & Taylor, 2016); (ii) completed a survey block in less than the allocated minimum reading time (i.e., $>$ 600 words per minute; Carver, 1985); or (iii) responded erratically, with overly inconsistent responses between pairs of equivalent questions (i.e., an odd/even threshold of $>$ 2 Likert points apart; Curran, 2016). Responses from a further 7 participants were removed due to a system error (no condition was attributed to these participants). Final sample size was thus $N = 179$ (90 females, 89 males; age $M = 40.76$, $SD = 11.47$)[2].

Design

The experiment adopted a 2 (contingency information: no/yes) × 2 (fear appeal: no/yes) between-participants design, with bid amount (willingness-to-pay) as the dependent variable. Participants were randomly allocated to one of the four intervention conditions subject to the constraint of equal cell numbers.

Predictors and materials

We measured three potential predictors of willingness-to-pay by asking participants (1): whether they had taken multivitamins in the past, and if so, to estimate their previous usage frequency on an eight-point scale (1 = not in the past few years, 8 = every day); (2) to rate their belief in the effectiveness of the routine consumption of multivitamins for maintaining general health (hereafter, 'efficacy-belief'), using a 5-point scale (1 = not effective at all, 5 = extremely effective; a sixth point was included in the scale so that participants could respond 'I don't know'); and (3) to estimate their current state of health using a 4-point scale (1 = 'Fine, healthy', 4 = 'Sick, exhausted'; as people may only consider using multivitamins when they feel unwell).

A fourth predictor of willingness-to-pay was participants' general attitudes toward health supplements and alternative medicines (as prior beliefs can moderate responses to health messaging; Myers, 2014). General attitudes were assessed using an 18-item questionnaire. Each item consisted of a statement relating to a motivation for consuming alternative health products (e.g., 'Vitamins are natural, and supplements are therefore safe' or 'Vitamin supplements are only useful if a person has a specific deficiency'). Participants were asked to rate how much they agreed with each statement using a 5-point Likert scale (1 = *strongly disagree*; 5 = *strongly agree*). A composite score was calculated for each participant, which indicated their general attitude towards health supplements and alternative medicines (hereafter, 'general-attitude'). To measure response consistency, each item was paired with a reverse-phrased statement of similar meaning (i.e., 9 pairs of items). The order of items in the general-attitude scale was randomised to control for order effects. The full general-attitude scale can be found in (Macfarlane et al., 2018a).

Willingness-to-pay

To assess willingness-to-pay, data were collected using a variation of the Becker-Degroot-Marschak auction mechanism (Becker et al., 1964; Thrasher et al., 2011). Participants were asked to participate in a hypothetical auction and imagine they had been given $5. In the auction, participants were given an opportunity to place a hypothetical bid on a tube of effervescent multivitamin tablets. Participants were shown a plain-packaged picture of the product and a general text about the product (e.g., '… comes in a small tube of 10 tablets …'). Participants were asked to place a hypothetical bid for only the amount that reflected how much they were willing to pay for that product. Participants were told that this was different to other auctions in that they could only bid once, and that it was in their best interest to bid the amount they were willing to pay for the product. Participants were required to enter their bid amount b in cents, with $b \in (0, 500)$. They knew that this amount would be compared against a random number $r \in (0, 500)$ drawn from a uniform distribution, and that if $b \geq r$, they would win the auction and would purchase the product for amount b but keep $500 - b$ of their endowment; otherwise they would lose the auction but would keep the full hypothetical endowment. Prior to the auction, participants were given the chance to participate in multiple hypothetical practice auctions to ensure they understood how the auction worked. To mitigate against hypothetical bias, we employed two established bias-reduction techniques (Penn & Hu, 2018), namely 'cheap-talk'—asking participants to behave as they would if the auction was real (Cummings & Taylor, 1999) and consequentiality—reminding participants that the results of this study would have implications for significant public-health issues.

Self-efficacy

As the impact of fear appeals has been hypothesised to depend in part on a person's self-efficacy (Cooper et al., 2014: Peters et al., 2018)—the perceived capacity to alter

Contingency information

	😀	😐
Multivitamin 3	3	1
Sugar pill	3	1

"The first row labelled "Multivitamin" shows that for every 4 people who took a multivitamin,
- *3 reported experiencing a health benefit;*
- *1 reported not experiencing any health benefit.*

The second row labelled "Sugar Pill" shows that for every 4 people who took a sugar pill,
- *3 reported experiencing a health benefit;*
- *1 reported not experiencing any health benefit.*

So, 3 out of 4 people experienced the same health benefit after taking a multivitamin as after taking a sugar pill. Therefore, the clinical evidence clearly shows that, for the general population, there is no health benefit from taking multivitamin supplements.

This is because, unless a person has a specific medical deficiency, most modern diets provide ample vitamins for the body to maintain healthy function."

Fear appeal

"After decades of extensive clinical trials from numerous research labs, it has been found that multivitamins can cause significant harm. Data from 79 clinical trials involving a total of over 330,000 participants have shown that several commonly used dietary supplements resulted in an increased risk of death for adults compared to placebo. The supplements linked to increased mortality included: multivitamins, Vitamin A, Vitamin E, Vitamin C, Vitamin B6, beta-carotene, folic acid, and iron, amongst several other minerals.

If you use multivitamin supplements, like the people in these clinical studies, then your risk of death is increased compared to people who do not.

These findings are reflected in the official position of medical agencies around the world. For example, the UK National Health Service (NHS) has acknowledged that taking vitamin supplements can be harmful but assures consumers that "most people don't need to take vitamin supplements and are able to get all the vitamins and minerals they need by eating a healthy, balanced diet."

Figure 1. Summary of the information provided to participants in the two treatment conditions. In the contingency table, the number below the smiling face represents the relative frequency of people who reported experiencing a health benefit, and the number below the sullen face represents the relative frequency of people who did not report experiencing a benefit.

one's behaviour—we also assessed self-efficacy by asking participants to estimate their 'ability to maintain a healthy vitamin intake without vitamin supplementation (e.g., through your diet)' on a 3-point scale (1 = *Terrible – I need vitamin supplements*; 3 = *Excellent, I do not need vitamin supplements*).

Interventions

The *control* condition provided irrelevant information about the multivitamin product on offer: 'Product A, which you will soon bid on, is available to purchase from various retail outlets.' The control also provided a basic refutation regarding the general efficacy of multivitamins: 'However, there is currently insufficient clinical evidence to support a recommendation for or against the use of multivitamins and mineral supplements for the general population.' The basic refutation was based on a tentative 'diplomatic' type of refutation commonly used in real-world attempts to debunk claims about ineffective health products. In this case, it was adapted from a statement published on the National Institute of Health (NIH) website (NIH, 2016).

The *contingency* condition provided participants with summarised information about the clinical outcomes of previous randomised controlled trials that have found multivitamins not to provide any health benefits (see Figure 1). This intervention consisted of three information components: (i) a contingency table, (ii) an explanation of the table, and (iii) a scientific causal explanation of the overall outcome. It was designed to help consumers overcome the illusion of causality and has been recently shown to reduce willingness-to-pay for multivitamins (see MacFarlane et al., 2018b).

The *fear-appeal* condition provided participants with information about the summarised results of several randomised controlled trials (Bjelakovic et al., 2012; Mursu et al., 2011) that suggest multivitamin supplementation can cause health harms (see Figure 1). The critical elements of this condition were based on a systematic review of fear appeals by Tannenbaum et al. (2015), who argued that in order to be effective, fear appeals need to (i) depict high health severity, (ii) depict high susceptibility of the target audience, and (iii) include a self-efficacy manipulation that assures the audience of their ability to avoid the stated harm.

The *combined* condition provided participants with the materials from the contingency condition followed by the materials from the fear-appeal condition. The combined condition was therefore designed to inform consumers that multivitamin supplementation not only provides no health benefit but may also cause significant health harms.

Future health purchases

To assess whether the interventions' effects might generalise towards helping participants make better health purchases in the future, participants were asked to rate the importance of 15 health-related factors using a 5-point scale (1 = *not important at all;* 5 = *extremely important*). These questions were designed to evaluate the impact of the interventions on participants' valuation of key information required to assess product safety and efficacy. The critical item was 'the number of people who did, and did not, experience a benefit when taking a sugar pill' (hereafter, 'placebo comparison')—this is because it measures participants' ability to recognise that comparing a treatment's benefit against placebo is crucial to assessing its efficacy. The remaining items were distractors (e.g., 'Advertising claims', 'Strength of active ingredients', and 'Experience of people I know'). Item order was randomised.

Procedure

The experiment was executed using Qualtrics survey software. Participants were initially given an information sheet and provided informed consent. Participants then responded to questions on demographics, multivitamin consumption, and the general-attitude scale. Participants were then shown the information about the multivitamin product before being introduced to the auction. Next, participants indicated their willingness-to-pay for the multivitamin product. After the auction, participants responded to questions regarding their future health purchases and their estimated self-efficacy. At the conclusion of the experiment, participants were shown the results of their hypothetical bidding. Finally, participants were fully debriefed.

Results

The general-attitude scale was found to have very good internal consistency reliability (Cronbach's $\alpha = .91$). Associations between willingness-to-pay and the four predictors were analysed via Spearman's correlation coefficient. For estimated usage, we

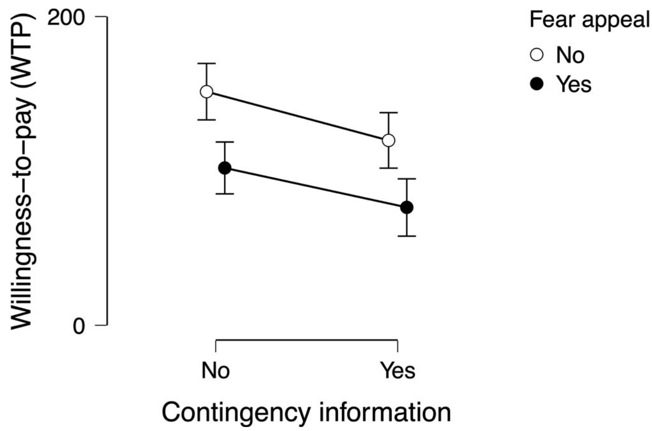

Figure 2. Willingness-to-pay across conditions in Experiment 1. Error bars indicate standard error.

excluded participants who reported having never previously taken multivitamins. For estimated efficacy belief, we excluded participants who responded, 'I don't know'. Willingness-to-pay was positively associated with estimated usage of multivitamins, $n = 165$, $r_s = .17$, $p = .02$; efficacy belief, $n = 176$, $r_s = .35$, $p < .001$; and general-attitudes, $n = 179$, $r_s = .34$, $p < .001$, indicating that participants with more frequent usage, higher efficacy belief, and more favourable attitudes toward health supplements had significantly higher willingness-to-pay for the multivitamin product. The control predictor of current health state was not correlated with willingness-to-pay, $n = 179$, $r_s = .02$, $p = .80$.

We conducted a 2 (contingency information: no/yes) × 2 (fear appeal: no/yes) analysis of covariance (ANVOCA) with stated willingness-to-pay as the dependent variable, and general-attitude as the covariate. This analysis confirmed that participants general-attitude was significantly related to their willingness-to-pay, $F(1, 174) = 26.37$, $p < .001$. There was a marginally significant main effect of contingency information, with willingness-to-pay lower when contingency information was provided, $F(1, 174) = 3.2$, $p = .076$, $\omega^2 = .01$. There was a significant main effect of fear appeal, with willingness-to-pay lower when a fear appeal was provided, $F(1, 174) = 13.13$, $p < .001$, $\omega^2 = .056$. There was no significant interaction, $F < 1$. Figure 2 shows the interaction plot for Experiment 1.

To determine whether self-efficacy levels varied across conditions, we conducted an ANCOVA with self-efficacy as the dependent variable, condition as the fixed factor, and general-attitude as the covariate. We found that general attitudes were negatively correlated with self-efficacy, $F(1, 174) = 34.37$, $p < .001$. This indicated that participants with more favourable attitudes toward health supplements tended to report lower self-efficacy. We also found that self-efficacy did not vary across conditions, $M = 2.18$, $F = 1.17$, $p = .33$. We also assessed whether participants' ratings of the importance of a placebo comparison (critical to making informed future health purchases) was higher for that half of the sample that received the contingency-condition ($Mdn = 3$) compared to the half that did not ($Mdn = 3$). As the data were ordinal, we used a two-tailed Mann-Whitney U test, but found the difference to be non-significant, $U = 3611$, $p = .25$.

Discussion

The aim of this study was to evaluate the separate impacts of contingency information and a fear appeal on willingness-to-pay for an ineffective health remedy. Consistent with our previous study (MacFarlane et al., 2018b) , three factors predicted greater willingness-to-pay for the multivitamin product: (i) more frequent estimated usage, (ii) higher efficacy belief, and (iii) a higher general-attitude. We found that when we isolated the effect of the contingency information on willingness-to-pay, its influence was only marginally significant (Hypothesis I). This result thus failed to provide strong support for our previous finding that communicating a simplified contingency table can help reduce consumer demand for an ineffective health remedy. When we isolated the effect of the fear appeal, its influence on willingness-to-pay was statistically significant (Hypothesis II). This novel result shows that communicating information about the potential health risks of consuming an ineffective health remedy can have a measurable impact on consumer demand. The absence of a significant interaction between the two conditions indicates that contingency information and fear appeal have independent and additive effects.

We found that participants with more favourable attitudes toward health supplements reported lower self-efficacy (their ability to maintain a healthy vitamin intake without vitamin supplementation). This provides support for the importance of boosting people's self-efficacy, and hence for including an efficacy-enhancing message (the message most modern diets provide ample vitamins).

We did not find evidence that the placebo comparison was rated as more important by participants exposed to the contingency information. In contrast to our previous study, this suggests the intervention may not always generalise towards increasing consumers' awareness of the importance of clinical evidence when making health purchases.

One potential limitation of Experiment 1 is that participants' auction bids had no real financial consequences. Despite our bias-reduction strategies, this may have contributed to a hypothetical bias, whereby some participants may have taken the auction less seriously than they would have with real financial incentives (Loomis, 2011). This, in turn, may have weakened the effect of the contingency-information intervention. Accordingly, to validate the results, we sought to replicate the experiment using real money and a real multivitamin product.

Experiment 2

Our second experiment aimed to evaluate the impact of the contingency information and fear appeal interventions when participants' choices had real financial consequences. Thus, the basic design and methodology was identical to Experiment 1, but Experiment 2 was conducted in the laboratory, and bidding was incentivised—we gave participants AU$5 to place real bids for a multivitamin product that they would purchase if their bid was successful. We expected that incentivizing the experiment would lead participants to more carefully consider their willingness-to-pay for the multivitamin product. Furthermore, by improving the ecological validity of the experiment, we envisioned that variation in the bid amounts would more accurately reflect the impact of the treatment conditions on consumer demand.

We also sought to empirically test whether the effects on willingness-to-pay were comparable between the hypothetical and the incentivised versions of the experiment. We hoped this analysis would provide evidence of the viability of conducting consumer intervention research online.

Participants

A total of 207 undergraduate students from the University of Western Australia took part in the experiment in exchange for course credit. One participant was excluded for failing to wait for instructions prior to starting the experiment. Two data sets were excluded due to system error that failed to allocate an intervention condition. The a-priori exclusion criteria were identical to Experiment 1. Six respondents were excluded for rushing and thus the final sample size was $N = 198$ (134 females, 64 males, 1 other; age $M = 20.87$, $SD = 5.94$).

Predictors and materials

The same predictors and materials were used as in Experiment 1, except for a minor change to the self-efficacy measure. To obtain a more refined estimate of participant self-efficacy—their perceived ability to maintain a healthy vitamin intake without supplementation—we increased the response measure from a 3-point to a 5-point scale.

Procedure

Experiment 2 was conducted in a computerised laboratory (http://bel-uwa.github.io). In each session, between one and six participants completed the experiment concurrently. Upon entering the laboratory, the general procedure was explained to participants. During this explanation, participants were shown open money tins containing the cash endowments. The experimenter followed a set verbal protocol to make clear that (i) participants would receive real money and/or the multivitamin product at the end of the experiment, depending on the outcome of the auction, and that (ii) the results of the survey were important for research so participants should take their time and respond as honestly as possible. Participants then completed the experiment on one of six computer terminals, separated by privacy blinds. At the conclusion of the experiment, participants received either the full cash endowment or their purchased multivitamin product and the change left over from their cash endowment, before being fully debriefed.

Results

The general-attitude scale was found to have good internal consistency reliability (Cronbach's $\alpha = .792$). Analysis of Spearman's correlation coefficient showed that willingness-to-pay was positively associated with efficacy belief, $n = 184$, $r_s = .31$, $p < .001$,

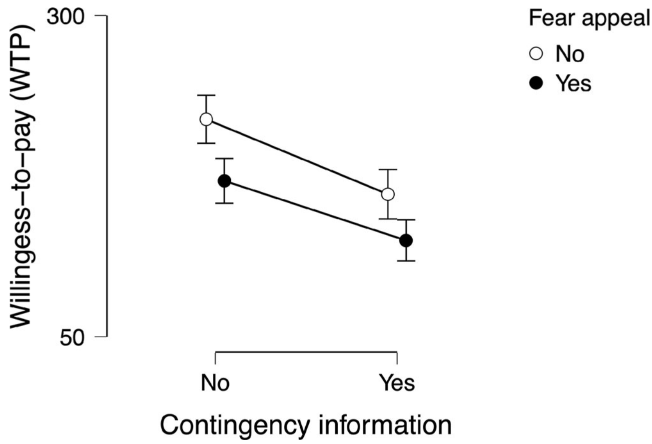

Figure 3. Willingness-to-pay across conditions in Experiment 2. Error bars indicate standard error.

and general-attitude, $n = 198$, $rs = .24$, $p < .001$. However, we did not detect a significant association between willingness-to-pay and estimated usage of multivitamins, $n = 125$, $r_s = .14$, $p = .11$ The control predictor of current health state was not correlated with willingness-to-pay, $n = 198$, $r_s = .002$, $p = .98$.

We ran the same two-way ANCOVA as in Experiment 1, which confirmed again that general-attitude was significantly related to willingness-to-pay, $F(1, 193) = 11.15$, $p < .001$. After controlling for the effects of general-attitude, there was a significant main effect of contingency information, with willingness-to-pay lower if contingency information was provided, $F(1, 193) = 7.36$, $p < .01$, $\omega^2 = .03$. There was also a significant main effect of fear appeal, with willingness-to-pay lower if a fear appeal was provided, $F(1, 193) = 4.48$, $p = .036$, $\omega^2 = .016$. There was no significant interaction, $F < 1$. Figure 3 shows the interaction plot for Experiment 2. In contrast to Experiment 1, we found that participants' rating of placebo comparison information was significantly higher for that half of the sample that received the contingency information ($Mdn = 4$) compared to the half that did not ($Mdn = 3$), $U = 3933.50$, $p = .025$. This indicated that the full-contingency condition increased participants' valuation of placebo-information, which is critical for making rational consumer decisions regarding health products.

We ran the same ANCOVA to assess whether self-efficacy varied across conditions. We again found that general attitudes were negatively correlated with self-efficacy, $F(1, 191) = 17.60$, $p < .001$. As with Experiment 1, this indicated that participants with more favourable attitudes toward health supplements tended to report lower self-efficacy. We again also found that self-efficacy did not vary across conditions, $M = 3.85$, $F < 1$, $p = .50$.

Discussion

The results of Experiment 2 were similar to Experiment 1 but provided more evidence of the predicted impact of both interventions. Participants' willingness-to-pay for the multivitamin product was significantly reduced by both the contingency intervention (Hypothesis I) and the fear-appeal intervention (Hypothesis II). There was again no evidence of a significant interaction between the contingency-information and fear-appeal manipulations.

The results of this incentivised study were generally consistent with the findings of our previous incentivised study (MacFarlane et al., 2018b), namely that employing a simplified contingency table with simple frequencies can help people overcome the illusion of causality, and thus effectively counter demand for ineffective health remedies.

In contrast to Experiment 1, we did find evidence that the placebo comparison was rated as more important by participants exposed to the contingency information. This supports the finding from our previous study (MacFarlane et al., 2018b) demonstrating that the contingency intervention increases consumers' awareness of the importance of clinical evidence when making health purchases.

Conjoint Bayesian analysis

To obtain a clearer picture of the robustness of the evidence for each intervention, we pooled the data of both experiments ($N = 536$)[3] and analysed the results with Bayesian inference using JASP (Version 0.10.2). Bayesian inference involves the comparison of explanatory models that do or do not contain an effect of interest in order to quantify evidence strength (either for the presence or the absence of an effect) as data accumulates (JASP Team, 2019; Rouder et al., 2017; Wagenmakers et al., 2018). Evidence strength is often expressed as a Bayes Factor (BF_{10}), which is the ratio of the probability of observing the data given a hypothesis (H_1) over the probability of the data given the null (H_0). For example, $BF_{10} = 2$ would indicate that data are twice as likely under H_1 than H_0,which is considered 'anecdotal' evidence (evidence in favour of H_1 is considered 'moderate' if $3 < BF_{10} < 10$, 'strong' if BF_{10} $10 < 30$, and 'very strong' if $BF_{10} > 30$; for further reading, see Berger & Berry, 1988; Wagenmakers, 2007; Wagenmakers et al., 2018).

We conducted a 2 (contingency information: no/yes) × 2 (fear appeal: no/yes) × 2 (bidding type: hypothetical vs. incentivised) Bayesian ANCOVA with willingness-to-pay as the dependent variable, and general-attitude as the covariate. We assessed the strength of the evidence against the null model for 37 potential models.[4]4

In addition to selecting the best-fitting model (the model with the greatest BF_{10}), we tested whether condition effects were comparable across the two bidding types by assessing the evidence in favour of an interaction between the treatment factors and bidding type. To reduce the risk of drawing misleading conclusions about the best model, given the large number of potential models, we also conducted an analysis of effects for variables and interactions. This analysis retained model-selection uncertainty by averaging the conclusions from each candidate model as weighted by that model's posterior plausibility (Wagenmakers et al., 2018). Planned comparisons were then used to assess each hypothesis by means of Bayesian *t*-test, as outlined in Wagenmakers et al. (2018). The Cauchy prior width was set to its JASP default, $r = 0.707$.

Results

All models received strong evidence in comparison to the null model (see supplemental materials, Table S1). The best-fitting model included all four main effects (i.e., contingency information, fear appeal, bidding type, and general-attitude; $BF_{10} = 2.98 \times 1014$). The effect of bidding type arose because hypothetical bids were lower on average in Experiment 1 than incentivized bids in Experiment 2. A comparison of the best model with the next-strongest model that included an interaction between a treatment factor (namely, fear appeal) and bidding type ($BF_{10} = 1.28 \times 1014$) yielded 2.4-to-1 evidence against including the interaction. The analysis of effects revealed further evidence against the inclusion of interactions between treatment factors and bidding type (see supplemental materials, Table S2). Thus, although participants who made hypothetical bids exhibited a reduced willingness-to-pay for the multivitamin product compared to participants whose bids were incentivized, the impact of condition was comparable for both bidding types (see supplemental materials, Figure S2). The average reduction in willingness-to-pay was calculated using the output of the model-averaged posterior summary. Planned comparisons yielded strong evidence ($BF_{10} = 13.11$) for an effect of the contingency information—an average reduction in willingness-to-pay of 22.02%, as well as very-strong evidence ($BF_{10} = 43{,}534$) for an effect of the fear appeal—an average reduction in willingness-to-pay of 31.61% (see supplemental materials Figure S2). The interventions had the greatest effect in the combined condition—an average reduction in willingness-to-pay of 50.23%.

General discussion

This study reported two experiments that sought to investigate the separate and joint effects of contingency information and fear appeals on consumers' willingness-to-pay for an ineffective health remedy—multivitamins for maintaining general health. Using a hypothetical auction, Experiment 1 showed that a fear appeal reliably reduced willingness-to-pay, while the impact of the contingency intervention was only marginally significant. Using an incentivised auction, Experiment 2 showed that both interventions significantly reduced willingness-to-pay. Neither experiment found evidence of an interaction between the contingency-information and fear-appeal manipulations, suggesting that both interventions have independent and additive effects. Our conjoint Bayesian analysis of the two experiments yielded strong evidence in support of our two hypotheses, namely that both the contingency intervention and the fear appeal independently reduced willingness-to-pay for multivitamins (by 22% and 32%, respectively). These results suggest that the best strategy to reduce demand for ineffective health remedies would thus be to deploy both interventions concurrently, which reduced willingness-to-pay by 50%.

We also found that, although participants who made hypothetical bids exhibited lower willingness-to-pay than participants whose bids were incentivised, the impact of the experimental manipulations on willingness-to-pay was comparable for both bidding types (see Figures 2 and 3). This suggests that hypothetical scenarios may provide a useful methodology to estimate and assess intervention effects on consumer demand in situations where using incentivised auctions may be impractical or unethical, such as when a product is known to cause significant harm (e.g., colloidal silver).

The present study provides additional evidence for the utility of a novel contingency-information intervention (see MacFarlane et al., 2018b), which in this case served to counter the misconception that vitamin supplementation is essential for maintaining general health. Moreover, our results provide evidence in favour of the use of fear appeals in health communications; in this case, the fear appeal countered the misconception that vitamin supplementation poses no risks to health. We note that our fear appeal included an efficacy-enhancing message (namely, highlighting that most modern diets provide ample vitamins) to assure participants that by doing the recommended behaviour (i.e., stop consuming multivitamins) they would avoid harm (i.e., vitamin deficiency). The finding in both experiments that participants with more favourable attitudes toward health supplements tended to report lower self-efficacy, supported the importance of including this message. Nevertheless, the benefits of a fear appeal may be limited to situations in which consumers are able to stop engaging in a behaviour. Our results do not provide evidence in favour of fear appeals in situations where action is required (e.g., to make healthy food choices) or where self-efficacy may be low (e.g., when a consumer is addicted to cigarettes; Peters et al., 2018). Thus, future research should test the effects of contingency-information and fear-appeal interventions on demand for more challenging products (e.g., fast food or cigarettes).

The fact that the combination of contingency and fear interventions was most effective constitutes experimental evidence that perceived benefits and perceived risks of a product can provide separate pathways to influencing consumer demand for irrational products. The absence of an interaction between the two factors was somewhat of a surprise—if perception of one attribute can be influenced by manipulating information about the other (Finucane et al., 2000), one might expect the combination of both treatments to be more than just additive. However, the observed result was still consistent with our expectations, namely that both factors would complement each other in driving an overall assessment that a low-benefit/high-risk remedy is not worth consuming (Alhakami & Slovic, 1994). Our findings therefore suggest that communicators seeking to dissuade consumers from purchasing harmful health remedies should aim to counter two distinct psychological drivers—perceived benefits and lack of risks—underlying consumer demand for health remedies. This factorial approach represents a departure from the often-assumed dichotomy (highlighted in debates about effectiveness of fear appeals vs. positive messaging; e.g., Akl et al., 2011; Gallagher & Updegraff, 2012; Kok et al., 2018) that health communicators must choose between framing public messages as either promoting health benefits or reducing health risks.

In support of our previous study (MacFarlane et al., 2018b), we found evidence in Experiment 2 (but not in Experiment 1) that the contingency intervention increased participants' valuation of placebo information, which is critical for making rational consumer decisions regarding health products. The reasons for this discrepancy are unclear, and we prefer not to speculate about them. Future research should investigate whether repeated exposure to contingency information and/or more explicit exposure of logical fallacies (Cook et al., 2017) could help consumers to be more vigilant in seeking critical clinical information when making judgments about the efficacy of novel health remedies.

More generally, we argue that our results highlight the considerable importance of crafting interventions using insights from psychology (MacFarlane et al., 2020*)*. Future research should consider targeting other emotional drivers of consumer demand; for example, one promising avenue may be to compare the impact of fear appeals to appeals that aim to elicit pathogen disgust—thus averting threat by means of avoiding contamination due to repulsion (Collymore & McDermott, 2016; Huang et al., 2017). For example, disgust communications to dissuade consumers from purchasing ineffective remedies could be crafted by drawing on recent research showing widespread adulteration (e.g., with undeclared plant and animal DNA) in the alternative-remedy industry (Coghlan et al., 2015; Rocha et al., 2016).

Conclusion

The present study provides evidence that consumer choices are influenced by both perceptions of efficacy and risk. We have provided further evidence that countering the illusion of causality and providing a valid causal explanation for why a health remedy is ineffective can reduce consumer demand for products that have been shown to have no health benefit. We have also provided evidence that this intervention can be considerably strengthened by augmenting it with information about known health risks. Our results challenge the often-assumed dichotomy that health communication messages need to either address benefits or harms; instead our results suggest that the combination of both can provide additive effects that may be superior to either approach alone. This research demonstrates that testing combinations of psychologically-informed interventions can provide health authorities with an iterative approach to developing more effective levers to reduce demand for ineffective health remedies.

Notes

1. The experiment was first run with a separate sample of online participants ($N = 164$). However, due to random chance, a key covariate differed across treatment conditions, which violated the assumption of homogeneity of regression slopes (see supplemental material Figure S1), meaning that the regression analysis of main effects would have been inaccurate. Consequently, we re-ran the experiment with a second sample, and report this second run here. The initial sample was, however, included in a joint Bayesian analysis of all available data across both experiments; this analysis is presented after Experiment 2.
2. In the first iteration of the experiment, $n = 6$ respondents were excluded due to rushing and $n = 2$ due to non-differentiating responses, giving a final sample size of $N = 156$ (74 females, 82 males; age $M = 38.51$, $SD = 12.17$).
3. Participants from both sub-samples of Experiment 1 were included. Due to regression to the mean, the significant differences in participants' general-attitude between conditions observed in the first sub-sample of Experiment 1 were averaged out by the addition of more participants. Thus, data from the first sub-sample could be included in the pooled data without the data violating the assumption of homogeneity of regression slopes.
4. The 37 models included a model for each individual main effect of the covariate and the independent variables; a model for each possible combination of these variables; and a model for each of these combinations with each possible combination of interactions between the relevant independent variables.

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