Naïve Beliefs About Intervening on Causes and Symptoms in the Health Domain

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Abstract

In two experiments we tested people's naïve beliefs about where interventions act in real-world causal systems. We provided people with a description of a novel health condition that could be treated by two different treatments, a medication and a lifestyle modification. Participants judged a medication as acting on the symptoms of a disorder instead of the cause of the disorder, while a lifestyle modification was seen as acting on both the cause and the symptoms of a health condition (Experiment 1). These results held despite participants rating both treatments as effective. Providing information about the specific causal mechanism by which a treatment could work did not increase beliefs about a medication's ability to target the cause of a disorder (Experiment 2). Implications for understanding of everyday causal interventions and health treatments is discussed.

Keywords: causal reasoning; interventions; health care reasoning.

Introduction

Understanding the causal systems of the world gives us the ability to control our environment. For example, understanding the causal link between a light switch and illumination allows us to turn on said lights when desired. In order to understand these causal systems, people represent causal models of the world (Waldmann, Holyoak, & Fratianne, 1995). Part of the power of a causal model is that it suggests where in a system needs to be acted upon in order to alter that system (e.g., Hagmayer, Sloman, Lagnado, & Waldmann, 2007; Kushnir & Gopnik, 2005; Park & Sloman, 2013; Schulz, Gopnik, & Glymour, 2007). For example, imagine the nodes in the top of Figure 1 represent chest congestion (C) and sinus irritation (S). If a learner understands that C causes S, then preventing C from occurring, (i.e., performing an intervention on C), would also prevent S from occurring, represented by the gray shading in the bottom left of Figure 1. However, an intervention on S would prevent only S from occurring because it is only an effect of C (bottom right of Figure 1). As such, understanding the relationship between congestion and sinus irritation allows the person experiencing these symptoms to intervene on the causal system to alleviate the symptoms.

Previous research has suggested that when people are interested in effecting change in a causal system, they focus interventions on the root causes of their causal models (Hagmayer & Sloman, 2009). For example, when attempting to reduce an environmental risk, people endorsed actions that targeted the cause of the risk (e.g., targeting a company responsible for gas pollution in order to reduce it; Böhm & Pfister, 2000). Similar results have been shown in the health domain. Mental health clinicians rated interventions that treated features that were more causal as more effective (de Kwaadsteniet, Hagmayer, Krol, & Witteman, 2010; see also Ahn, Proctor & Flanagan, 2009). More generally, people have shown a preference for treatments that work on causes (Yopchick & Kim, 2009). In short, people seem to believe that the best intervention is one that works on the root cause of the causal system.

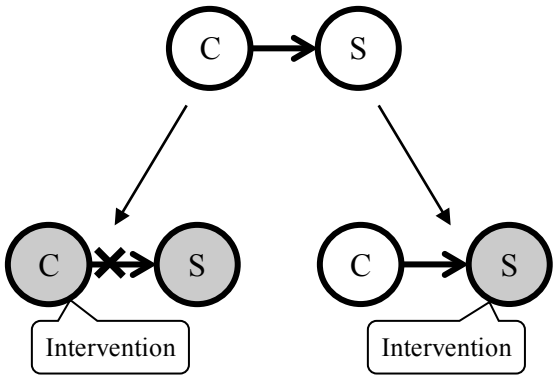

Figure 1: Possible interventions on a causal system.

Though people may hold that ideal interventions work on root causes, they may believe that real-world interventions often work on only the effects of an underlying cause. For example, a number of interventions can be implemented to address problems caused by cold weather (e.g., spraying saline solution on roads, using antifreeze) but none are able to actually act on cold weather, the root cause of the problems. This sets up an interesting tension: while people may prefer interventions that work on root causes they may have a wealth of experience dealing with interventions that only work on the effects of a causal system. Where does this leave people in their thinking about causal interventions? That is, when given limited information about a causal intervention, do people believe it works on the root cause of a system as an ideal intervention would, or only on the effects of that underlying cause?

In this set of experiments, we explored people's naïve beliefs about causal interventions. To guide this exploration, we chose to focus on beliefs within a domain where intervening on a causal system would be extremely familiar to participants: health. The treatment and management of

health conditions is an exercise in causal interventions. We can represent a health condition as the simple causal graph in the top of Figure 1, where C represents the cause and S the symptoms of the disorder. Importantly, we can easily think of example health interventions that work on the root cause or just the effects of those causes. Imagine that C represents a bacterium that was causing the symptoms of an infection. Taking an antibiotic would intervene on the root cause C itself, killing the bacteria and thereby ending the symptoms of the infection (bottom left of Figure 1). Alternatively, imagine that C represents the cold virus and S the symptoms of a cold. Taking over-the-counter cold medicine works by intervening on S and has no effect on C (bottom right of Figure 1). Given that we can think of both types of interventions, we can then ask, do people assume that interventions (i.e., treatments) tend to work on C or work on S in the health domain?

Influences on Beliefs about Intervention Targets

We can make several predictions of where people may tend to think interactions work in causal health systems. Given that people prefer interventions that work on causes, people may assume that for an intervention to be effective, it must work on a cause. As such, we would predict that people should think effective treatments are targeting root causes of health conditions.

This basic prediction may be moderated by other factors. For one, different types of treatments may intervene in different places in a causal model. For example, a lifestyle modification (e.g., reducing stress) may be thought to target a different location in the causal structure than a medication. Likewise, it is possible that where treatments are thought to act may differ depending on the type of health condition in question. Mental disorders have less well-established causal etiologies compared to medical disorders (Marsh & Ahn, 2012). People may be less likely to believe that a treatment can work on these unknown causes, resulting in treatments for mental disorders being seen as less likely to target root causes of the disorder. However, it is also possible that people believe that a mental disorder treatment acts on some root cause, even if it is unclear what that cause is. In this case, we would expect similar targeting judgments for mental and medical disorders. In short, it is not immediately obvious exactly how people should inherently think about how health care interventions work on a causal system.

Overview of Experiments

In the following set of experiments, we tested people's beliefs about where health treatments intervene. We provided participants with a novel health condition described as having two possible treatments. In this first pass of examining beliefs about health interventions, we described both as being effective treatments of the condition. To measure the influence of treatment type, we told people that the two effective treatments represented a medication and a lifestyle modification. We also manipulated whether the novel disorder was described as a mental or a medical condition in order to determine the influence of disorder type on intervention beliefs.

We asked participants to judge the extent to which each treatment worked on the cause of the disorder and the symptoms of the disorder. Our goal was to measure people's folk beliefs about where effective treatments intervene in a causal system of disease. In Experiment 1, we provided a first test of this question. In Experiment 2, we provided causal pathways by which the treatments work to see if this influenced judgments of where treatments intervene in disorder causal systems.

Experiment 1

In Experiment 1, participants were asked to rate the extent to which a medication and a lifestyle modification targeted the root cause and the symptoms of a health condition. Both treatments were described as effective. If people believe that effective treatments work by intervening on the root causes of health conditions, then we would expect high target ratings for both the cause and the symptoms because of the causal relationship between cause and symptoms of the disorder. Alternatively, if participants believe that treatments work by only addressing the symptoms of health conditions, then we would expect targeting ratings to be high for the symptoms judgment alone.

Methods

Participants Sixty participants recruited through Amazon's Mechanical Turk participated for payment.

Materials and Procedure Participants were presented with a scenario that described a novel health disorder called sorpraxia. In the medical condition, participants (n=30) read that sorpraxia was a medical disorder, characterized by respiratory problems. In the mental condition, participants read that sorpraxia was a mental disorder, characterized by mood regulation problems. All participants then read that a person had been diagnosed with the disorder and was told that it could be treated with a medication or a lifestyle modification, and that both of the treatments were effective.

After reading the disorder description, participants were randomly presented with one of the treatments (e.g., lifestyle modification) and asked to rate "To what extent does this [treatment] target changing the root cause of the disorder?", as well as, "To what extent does this [treatment] target changing the symptoms of this disorder?", on a sliding scale of 0 (not at all) to 100 (completely). Participants then rated how effective the treatment was on a sliding scale of 0 (not at all effective) to 100 (completely effective). After completing these three ratings, participants then made these ratings for the other treatment. Finally, participants answered a series of questions concerning their beliefs about mental and medical disorders in general. They were asked to rate for each disorder type in general how effective they believed medication and lifestyle modifications to be on a scale of 0 (not at all effective) to 100 (completely effective), as well as how curable and

severe they generally believed mental and medical disorders to be.

Participants were randomly assigned to the medical and mental conditions. The order of which treatment a participant rated first and the order of the two targeting questions was randomized for each participant. The order of the final set of global health disorders questions was randomized for each participant. All participants completed the experiment at their own pace through the Qualtrics Survey Software environment.

Results

Our analyses focused on determining whether our two different interventions, medication or lifestyle changes, target the root cause or just the symptoms of disorders. We submitted participant ratings to a 2 (intervention: medication vs. lifestyle change; within) x 2 (target: cause vs. symptoms; within) x 2 (disorder type: medical vs. mental; between) mixed ANOVA. There were no main effect or interactions involving disorder type that reached significance, *p*s > .45, indicating the ability of an intervention to work on different targets did not differ depending on whether the disorder was instantiated as a medical or mental disorder. We found a main effect of intervention, $F(1, 58) = 8.94$, $p = .004$, $\eta_p^2 = .13$. This main effect reflected that participants rated lifestyle changes (*M*=71.42) as overall more able to target anything than medication (*M*=63.72). We also found a main effect of target, $F(1, 58) = 61.91$, $p < .001$, $\eta_p^2 = .52$, representing that symptoms (*M*=77.36) were more likely to be thought to be targeted than causes (*M*=57.78). These two main effects should be interpreted in light of a significant interaction, $F(1, 58) = 21.68$, $p < .001$, $\eta_p^2 = .27$.

To explore the interaction of intervention and target, we conducted simple effect analyses comparing the mean targeting judgment averaged across disorder types for causes versus symptoms within each of the intervention types. Figure 2 shows the mean targeting judgments averaged across the disorder type manipulation. Participants rated medication as significantly less likely to target a cause than the symptoms of a disorder, $F(1, 58) = 60.25$, $p < .001$, $\eta_p^2 = .51$. However, lifestyle changes were rated as equally likely to target the cause as the symptoms of a disorder, $p = .99$. Splitting this data another way, a root cause was seen to be much more likely to be targeted by a lifestyle change than a medication, $F(1, 58) = 22.96$, $p < .001$, $\eta_p^2 = .28$. In reverse, symptoms were judged to be more likely to be targeted by a medication than by a lifestyle change, $F(1, 58) = 8.68$, $p = .005$, $\eta_p^2 = .13$.

A remaining question from this data is whether the believed effectiveness of these interventions depended on what they were believed to target. To answer this question, we first analyzed ratings for how effective medication and lifestyle changes would be for treating the artificial disorder (see Figure 3). We conducted a 2 (intervention: medication vs. lifestyle change; within) x 2 (disorder type: medical vs. mental; between) mixed ANOVA. There was no main effect of intervention, $p = .46$. The lack of a main effect of intervention indicates that participants did not judge medication or lifestyle changes as overall more effective. The main effect of disorder type was significant, $F(1, 58) = 5.51$, $p = .022$, $\eta_p^2 = .087$, in that when the disorder was instantiated as a medical disorder it was seen as more likely to receive an effective treatment (*M*=82.05) than when it was described as a mental disorder (*M*=70.88). The interaction was not significant, $p = .74$.

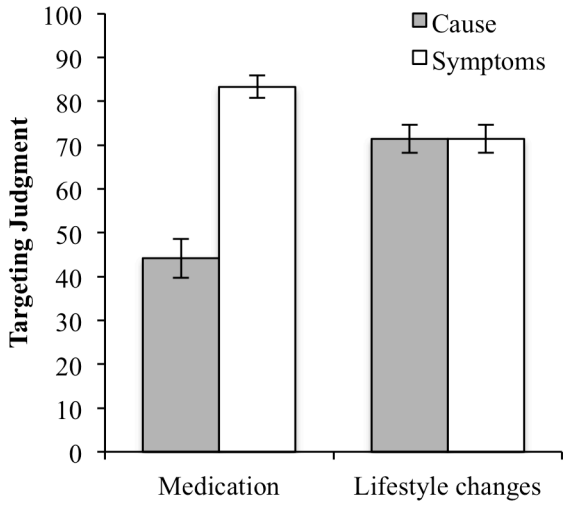

Figure 2: Mean targeting judgments for Experiment 1.

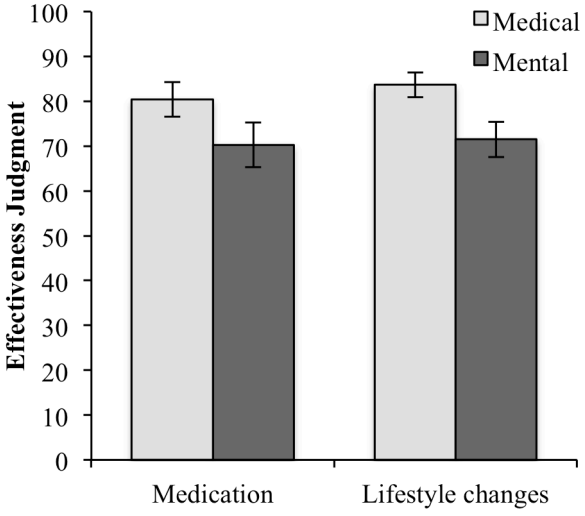

Figure 3: Mean effectiveness judgments for specific disorder of Experiment 1.

Parallel to these judgments, participants showed domain differences in estimating the effectiveness of treatments when thinking about health conditions more generally. A 2 (intervention: medication vs. lifestyle change) x 2 (disorder type: medical vs. mental) within-subjects ANOVA found a main effect of disorder type, $F(1, 59) = 11.92$, $p = .001$, η_p^2

= .17, reflecting that medical disorders (M=69.38) were rated as more likely to be effectively treated than mental disorders (M=62.05). The main effect of intervention and the interaction were not significant, ps > .84.

Discussion

Our results suggest that people do not necessarily believe that all effective treatments target the root cause of a disorder. Specifically, we found that medications were believed to be more likely to target the symptoms of a health condition than the root cause. Lifestyle modifications, on the other hand, were equally likely to target causes as symptoms. In a causal model of causes and symptoms as see in Figure 1, these findings suggest that people believe medications work on symptoms alone (right side of Figure 1) and lifestyle modifications work on root causes, in turn causing a reduction in symptoms as well (left side of Figure 1).

One possible explanation for our results is that people could not think of a mechanism by which a medication could work on the root cause of a health condition. That is, when people think about the mechanism of medications, they may think of examples like cold medicines instead of examples like antibiotics that work on root causes. If participants could have more easily thought of a way a medicine could have worked on the root cause of the condition, they may have increased their targeting judgments for causes. In Experiment 2, we provide participants with specific information about the causal mechanism of action for each treatment to test whether this modifies judgments related to target causes.

Experiment 2

In Experiment 2, we added a description of the mechanism by which a medication could act on the specific medical and mental disorder described. If adding this additional information allows participants to think of ways in which a root cause could be targeted, then we would expect ratings for the cause to increase to levels similar to the symptoms ratings. In other words, we would expect the medication ratings to look more like the lifestyle modification ratings in Experiment 1. However, if the inability to think of a plausible way in which medications target the root cause was not a factor in the results of Experiment 1, then we would not expect to see such a change. To provide a comparison, we also provided specific mechanism information for the lifestyle modifications. If participants were already thinking of a mechanism by which the lifestyle change acts comparable to what we provided, then this addition should not make a difference in ratings.

Methods

Participants Sixty participants recruited through Amazon's Mechanical Turk participated for payment.

Materials and Procedure Participants were randomly assigned to the medical (n=30) or mental condition that described the new disease sorpraxia as in Experiment 1. However, we gave participants specific causal mechanisms through which change was implemented by the medication (e.g., "works by reducing airway inflammation" for the medical version and "works by reducing brain chemistry imbalance" for the mental version) and the lifestyle modification (e.g., "works by reducing exposure to airborne allergens" for the medical version and "works by reducing exposure to stressful situations" for the mental version). Participants then completed the same ratings as in Study 1. In addition, at the end of the experiment participants rated how plausible they believed the mechanisms we provided to be on a scale of -3 (extremely implausible) to 3 (extremely plausible). They were also presented with statements which described the mechanisms as either causing the disorder (e.g., exposure to stressful situations causes mood regulation problems) or worsening the symptoms of the disorder (e.g., exposure to stressful situations worsens mood regulation problems but does not cause them) and asked to rate their agreement with these statements on a scale from -3 (strongly disagree) to 3 (strongly agree). Finally, participants rated how specific they believed medications and lifestyle modifications to be as treatments of health issues (i.e., treatments can work by generally improving a person's health or by specifically targeting a certain disorder) on a scale of 0 (extremely general) to 100 (extremely specific). All participants completed the experiment at their own pace through the Qualtrics Survey Software environment.

Results

Before exploring whether the cause ratings changed in this experiment, we first examined whether participants thought the mechanisms we described were plausible causes of the described health conditions. We analyzed participants' ratings for how plausible it was that our mechanism of action was related to the described condition (e.g., airway inflammation and respiratory problems). Using one-sample t-tests comparing ratings to the mid-point of the scale (i.e., 0) allowed us to test whether our mechanisms were significantly plausibly related to the given conditions. All of our mechanisms were rated as very plausible and significantly above zero: airborne allergy exposure for medical condition (M=2.17), $t(59) = 13.00$, $p < .001$; airway inflammation for medical condition (M=2.33), $t(59) = 16.43$, $p < .001$; stress exposure reduction for mental condition (M=2.07), $t(59) = 13.28$, $p < .001$; brain chemistry imbalance for mental condition (M=2.23), $t(59) = 14.98$, $p < .001$. We also checked to see if participants thought that the thing each treatment was targeting (e.g., stress, airway inflammation) was plausibly a cause of its corresponding health condition (e.g., mood regulation issues, respiratory problems). Again, one-sample t-tests comparing against 0 allowed us to assess whether people significantly agree that this treatment targeted the cause. For all of our proposed mechanisms, people significantly agreed that our mechanism could be a cause of the given disorder: airborne

allergy exposure for medical condition (M=1.52), $t(59)$ = 10.56, $p < .001$; airway inflammation for medical condition (M=1.17), $t(59)$ = 6.18, $p < .001$; stress exposure reduction for mental condition (M=1.12), $t(59)$ = 6.22, $p < .001$; brain chemistry imbalance for mental condition (M=1.62), $t(59)$ = 11.17, $p < .001$. In short, these ratings support the idea that our described treatment mechanisms could believably be thought to target the cause of the type of health conditions in question.

We next moved on to our main question of interest: does providing a specific mechanism by which a treatment could work increase belief in the treatment targeting the root cause of the disorder? We submitted participants' ratings to the same 2 (intervention) x 2 (target) x 2 (disorder type) mixed ANOVA as in Experiment 1. As found previously, there was no main effect or interaction with disorder type, ps > .31, indicating that the type of disorder did not differentially influence treatment ratings. We found a main effect of intervention, $F(1, 58) = 9.88$, $p = .003$, $\eta_p^2 = .15$, reflecting that participants rated lifestyle changes (M=67.63) as a more potent intervention overall than medication (M=60.48). We also found a main effect of target, $F(1, 58) = 26.21$, $p < .001$, $\eta_p^2 = .31$, representing that symptoms (M=71.75) were more likely to be thought to be targeted than causes (M=56.37). The interaction did not reach significance, $F(1, 58) = 2.58$, $p = .11$, $\eta_p^2 = .043$. The three-way interaction was also not significant, $p = .57$. Figure 4 depicts mean target effectiveness ratings averaged across disorder type as in Figure 2.

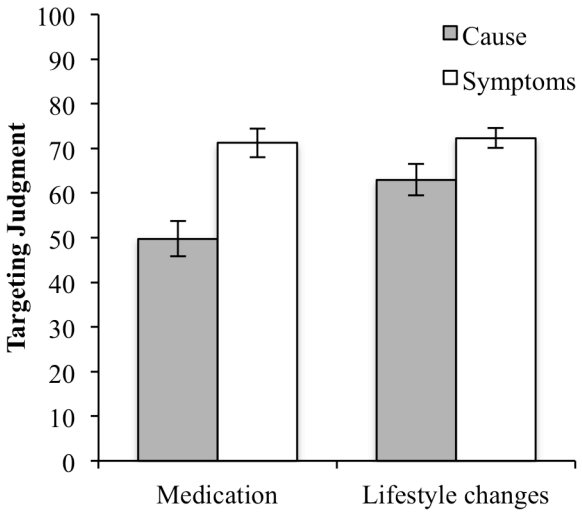

Figure 4: Mean targeting judgments for Experiment 2.

To mirror the data presentation of Experiment 1, we conducted simple effect analyses that collapsed across the disorder type variable to compare the mean targeting judgment for causes versus symptoms within each of the intervention types. As in Experiment 1, participants rated medication as significantly less likely to target a cause than the symptoms of a disorder, $F(1, 58) = 14.59$, $p < .001$, $\eta_p^2 = .20$. However, unlike Experiment 1, lifestyle modifications were rated as also significantly less likely to target the cause than the symptoms of a disorder, $F(1, 58) = 5.85$, $p = .019$, $\eta_p^2 = .092$. Splitting this data another way, a root cause was seen to be more likely to be targeted by a lifestyle modification than a medication, $F(1, 58) = 6.10$, $p = .016$, $\eta_p^2 = .095$. Symptoms were judged to be equally likely to be targeted by a medication and a lifestyle change, $p = .73$.

As in Experiment 1, we explored the ratings participants provided for how effective the described medication and lifestyle modifications would be for treating the artificial disorder. Figure 5 shows this data split by the disorder type dimension. We conducted a 2 (intervention) x 2 (disorder type) mixed ANOVA. There was a main effect of intervention, $F(1, 58) = 4.47$, $p = .039$, $\eta_p^2 = .072$. This main effect reflected that participants judged the lifestyle modifications (M=69.77) as overall more effective than medication (M=63.15). The main effect of domain was marginal, $F(1, 58) = 3.34$, $p = .073$, $\eta_p^2 = .054$, reflecting the same trend as in Experiment 1 that when the disorder was instantiated as a medical disorder it was seen as more likely to receive an effective intervention (M=71.30) than when it was described as a mental disorder (M=61.62). There was not a significant interaction, p =.43.

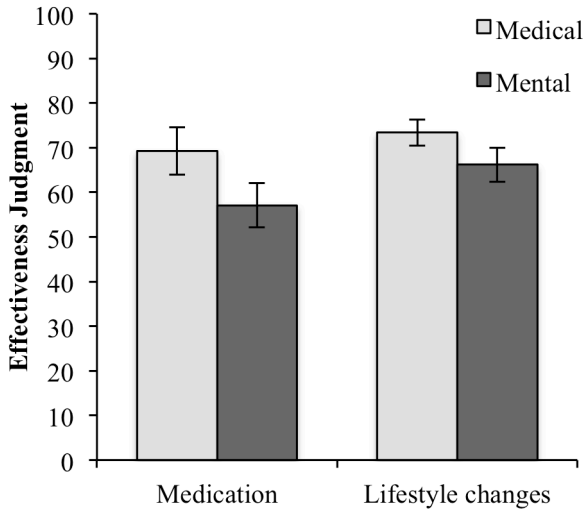

Figure 5: Mean effectiveness judgments for Experiment 2.

As in Experiment 1, we had asked participants for their more general estimates of the effectiveness of medication and lifestyle modifications when thinking about health conditions more generally. We analyzed these ratings with a 2 (intervention) x 2 (disorder type) within-subjects ANOVA. There was a main effect of disorder type, $F(1, 59) = 11.92$, $p = .001$, $\eta_p^2 = .17$, reflecting higher effectiveness ratings for medical disorders (M=69.38) than mental disorders (M=62.05). The main effect of intervention and the interaction were not significant, ps > .42, as in Experiment 1.

Discussion

In this experiment we added information about the causal mechanism by which treatments work to determine if this information increased ratings of how effective the treatments were at treating the root cause of the disorder. We did not find that targeting judgments for causes increased for our two treatments. Rather, we found that the same difference between cause and symptoms was found for medications, and now lifestyle modifications were seen as less likely to target causes than symptoms. These findings were obtained despite the fact that treatments were described as acting upon factors that participants rated as likely causes of the health conditions in question.

Finding that our causal mechanism information did not increase cause targeting ratings fits with previous findings that suggest explaining causal mechanisms can interfere with understanding. For example, Fernbach et al. (2013) showed that explaining the causal mechanism of a political issue decreased perceived understanding of the issue and extremity of views held about the issue. More generally, people believe they understand much more about causal mechanisms in the world than they actually do (Rozenblit & Keil, 2002). In our experiment, explaining how the lifestyle modification could have worked may have suggested to people how little they understood about how such treatments work on root causes in the first place. As a result, they rated the treatment as less likely to work through this mechanism they did not understand. If this is the underlying force in our effects, it is an interesting case of where outside instruction on a causal mechanism dispels an illusion of understanding.

General Discussion

In this set of two experiments we measured people's beliefs about where treatments intervene in a health causal system. While theories of causal models and previous research within health decision making has suggested the importance people see in intervening on root causes (e.g., Yopchick & Kim, 2009), our results suggest that people may hold treatment-specific beliefs about where interventions actually occurs. Within our disorder context people did not endorse medications as intervening on causes but still endorsed them as effective treatments. Highlighting causal mechanisms by which treatments could work on a root cause did not increase cause target judgments and instead reduced these judgments for lifestyle modifications.

People believe that different types of treatments can work on different parts of the causal system but still be equally effective. This suggests that people are able to navigate the tension between ideal causal interventions and real world treatments: even "non-ideal" interventions can still be effective. These results have important implications for thinking about treatment decisions within the health care setting. For instance, people may believe that a patient will need to be on a medication for life because this medication never actually removes the cause of the problem (e.g., someone taking an antidepressant can never stop taking it without symptoms returning). In summary, we have provided a first look into how people believe interventions work in a real-world causal system. It is the avenue of future research to explore how these naïve beliefs manifest in other domains.

Acknowledgments

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