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Illusions of causality at the heart of pseudoscience

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Illusions of causality at the heart of pseudoscience

Abstract

Pseudoscience, superstitions and quackery are serious problems that threaten public health and in which too many variables are involved. Psychology, however, has much to say about them, as it is the illusory perceptions of causality of so many people that needs to be understood. The proposal we put forward is that these illusions arise from the normal functioning of the cognitive system when trying to associate causes and effects. Thus, we propose to apply basic research and theories on causal learning to reduce the impact of pseudoscience. We review the literature on the illusion of control and the causal learning traditions, and then present an experiment as an illustration of how this approach can provide fruitful ideas to reduce pseudoscientific thinking. The experiment first illustrates the development of a quackery illusion through the testimony of fictitious patients who report feeling better. Two different predictions arising from the causal learning and illusion of control domains are then proven effective in reducing this illusion. One is showing the testimony of people who feel better without having followed the treatment. The other is asking participants to think in causal terms rather than in terms of effectiveness.

The “Keep libel laws out of science” campaign was launched on June 4th, 2009, in the UK. Simon Singh, a science writer who alerted the public about the lack of evidence supporting chiropractic treatments, was sued for libel by the British Chiropractic Association (Sense about Science, 2009). Similar examples can be found in almost any country. In Spain, another science writer, Luis Alfonso Gámez, was also sued after he alerted the public on the lack of evidence supporting the claims of a popular pseudoscientist (Gámez, 2007). In the United States 54% of the population believes in psychic healing and 36% believe in telepathy (Newport & Strausberg, 2001). In Europe the statistics are not too different. According to the Special Eurobarometer on Science and Technology (European Commission, 2005), and just to mention a few examples, a high percentage of Europeans consider homeopathy (34%) and horoscopes (13%) to be good science. Moreover, “the past decade has witnessed acceleration both in consumer interest in and use of CAM [complementary and alternative medicine] practices and/or products. Surveys indicate that those with the most serious and debilitating medical conditions, such as cancer, chronic pain, and HIV, tend to be the most frequent users of CAM practices” (White House Commission on Complementary and Alternative Medicine Policy, 2002, p. 15). The latest USA presidential campaign has also been frequently cited as an example of how superstitious beliefs of all types are still happily alive and promoted in our western societies (e.g., Katz, 2008). On another, quite dramatic example, Science Magazine recently alerted about the increase in “stem cell tourism”, which consists of traveling to another country in the hope of finding a stem cell-based treatment for a disease when such a treatment has not yet been approved in one’s own country (Kiatpongsan & Sipp, 2009). This being the current state of affairs it is not easy to counteract the power and credibility of pseudoscience.

As preoccupied and active as many governmental and skeptical organizations are in their fight against pseudoscience, quackery, superstitions and related problems, their efforts in making the public understand the scientific facts required to make good and informed decisions are not always as effective as they should be. Pseudoscience can be defined as any belief or practice that pretends to be scientific but lacks supporting evidence. Quackery is a particular type of pseudoscience that refers to medical treatments. Superstitions are irrational beliefs that normally involve cause-effect relations that are not real, as those often found in pseudoscience and quackery. These are a serious matter of public health and educational policy in which too many variables are involved. Psychology, however, has much to say about them, as it is the illusory perceptions of causality and effectiveness of so many people that needs to be understood. One obvious route for research that many have already explored consists on investigating the psychological differences between believers and nonbelievers in pseudoscience and the paranormal, under the assumption that some type of flawed intelligence or other, related problems, are responsible for these beliefs. This approach, however, has not yielded consistent results (see Wiseman & Watt, 2006, for a review).

We suggest a different route. The proposal we put forward is that systematic cognitive illusions that occur in most people when exposed to certain situations are at the basis of pseudoscience beliefs. Systematic errors, illusions, and biases can be generated (and thus reduced as well) in the psychological laboratory and are the result of the normal functioning of our cognitive system as it relates with the world and extracts information from it (see López, Cobos, Caño, & Shanks, 1998, for an excellent review of biases in the causal learning domain). The main benefit from encompassing this approach is that much of what is already known from rigorous laboratory studies on causal and contingency judgments can be fruitfully incorporated into programs designed to reduce the impact of pseudoscience in society.

To this aim, we will first review laboratory studies both on the illusions of control and on the more general topic of causal learning in normal individuals, in order to show that these research lines provide convergent evidence and interesting suggestions that can help understand the illusions responsible for pseudoscientific thinking. A very simple experiment will then be reported as an example of how predictions arising from those laboratory traditions can be used to reduce the illusions and to design effective programs to combat pseudoscience.

Understanding the illusion

The most frequently used index of the contingency between two events is ΔP, which is the difference between the probability of the outcome when the potential cause is present, $p(O|C)$, and the probability of the outcome when the cause is absent, $p(O|\neg C)$ (Jenkins & Ward, 1965). When the outcome occurs with the same probability in the presence and in the absence of the potential cause, this difference is zero. It means that there is no causal relation between them. Any subjective judgment that differs significantly from zero can be taken as evidence of an illusory perception of causality.

There are two main lines of laboratory research that are highly relevant to the pseudoscience domain. One of them, the superstition and illusion of control literature, is an applied research line and is clearly and directly related to pseudoscience. The other one is the more theoretically-oriented area of contingency learning (e.g., causal and predictive learning and judgments, inferences, and reasoning). These two research traditions are quite complementary. The first one is concerned with how people perceive that their own behavior controls the (uncontrollable) outcomes. The second one is concerned with more general issues on how people attribute causes (and predictors) to effects in a broader sense, independently of whether the potential cause or predictor is the participant's behavior or an external event, and regardless of whether the outcome can or cannot be predicted or controlled. We suggest that information from both these research lines can be profitably integrated to combat pseudoscience.

Research on the illusion of control and superstitious behaviour has long been conducted in the psychology laboratory. Since the seminal publications of Langer (1975) on the illusion of control, or even Skinner's (1948) article on superstition in the pigeon, many studies have shown that people (and, arguably, other animals as well) trying to obtain a desired outcome that occurs independently of their behavior tend to believe that they are causing the outcome (e.g., Alloy & Abramson, 1979; Matute, 1994; 1996; Rudski, Lischner, & Albert, 1999; Ono, 1987; Pronin, Wegner, McCarthy & Rodriguez, 2006; Vyse, 1997; Wortman, 1975; Wright, 1962). These effects are known to be particularly strong when the desired outcome occurs frequently (e.g., Allan & Jenkins, 1983; Alloy & Abramson, 1979; Matute, 1995; Hannah & Beneteau, 2009; Msetfi, Murphy, & Simpson, 2007; Msetfi, Murphy, Simpson, & Kornbrot, 2005; Vallée-Tourangeau, Murphy, & Baker, 2005; Vazquez, 1987). This means that, when applied to a real life event, such as, for instance, a chronic health or pain problem, conditions that are particularly vulnerable to an illusory perception of causality are those in which there are spontaneous and frequent, though uncontrollable, occurrences of a desired outcome (e.g., remissions of crises or of pain, such as is known to occur, for instance, in people suffering from back pain). It is therefore not surprising to find out that one third of those suffering from back pain choose chiropractors to treat them, or that chiropractors provide 40% of primary care for back pain (White House Commission on Complementary and Alternative Medicine Policy, 2002).

It is a bit surprising that the illusion of control research has not been more extensively applied to the study of pseudoscience. One reason for this might be that many of the initial studies of the illusion concluded that personal involvement of the participant was needed for the illusion to occur and that a need to protect self-esteem was its most plausible explanation (e.g., Alloy, Abramson & Kossman, 1985; Alloy & Clements, 1992). However, many pseudoscience illusions are known to occur under conditions in which the participant is not personally involved. Simply listening to the testimony of others, reading a book about alternative medicine, or attending a course on extrasensory perception may be enough to develop the belief. Recent experiments have also shown that illusions of control occur in situations in which self-esteem is not at risk, as when participants ask another person to roll the dice for them (Wohl & Enzel, 2009), or even in situations in which participants are mere observers (Pronin et al., 2006). Thus, the initial assumption that personal involvement and protection of self-esteem were a key determinant of the illusion is not clear. Several theories have been published that propose more cognitive explanations, in line with those proposed in the more general framework of causal learning and judgment (e.g., Matute, 1996; Pronin et al., 2006).

The other research line that we need to consider seriously is the more general and theoretically-oriented area of causal and contingency learning (see Shanks, 2007, 2010, for excellent reviews). Within this line of research, illusory perceptions of causality and illusory correlations are also reported, though, interestingly, accurate detection of causality is frequently reported as well. There are, of course, many differences among the details with which the different theories in this area explain how the cognitive system produces the illusions, but what is important for our present purposes is that they all explain these illusions in the same way they explain the general process of accurate detection of causal relationships (e.g., Baker, Vallée-Tourangeau & Murphy, 2000; Blanco, Matute, & Vadillo, 2009; Chapman & Chapman, 1967; Fiedler, Freytag & Meiser, 2009; Hannah & Beneteau, 2009; Msetfi et al., 2007; Matute, 1996; Pronin et al, 2006; Piaget & Inhelder, 1951; Smedslund, 1963; Vallée-Tourangeau et al., 2005; Wasserman, Kao, Van Hamme, Katagari, & Young, 1996). Illusions are not unusual, nor are they the result of personality differences or of individual deficits in the cognitive system. Common to all these theories is the assumption that, given certain conditions, illusions should occur systematically even in emotionally neutral situations.

For this reason, in the experiment we report below we will use a setting in which the participant is a mere observer and the response is performed by a fictitious agent that is trying to obtain a desired outcome (and therefore, responding at a high rate) and obtaining the (uncontrollable) outcome at a high rate too. We will use this vicarious scenario, as an analogue to what happens in many cases of pseudoscience and quackery in which beliefs are acquired through books, miraculous advertisement, or the testimony of others, rather than direct experience. The experiment aims to illustrate how these two areas of research can be integrated to provide fruitful ideas and suggestions to combat pseudoscience.

Reducing the illusion

Reducing these illusions in real life is not simple. As mentioned above, these illusions are particularly strong when the participant is eagerly trying to obtain the outcome and it occurs with high frequency. This outcome frequency effect has also been confirmed in situations in which the potential cause is an external event rather than the participant's behavior, which shows this is a very robust effect (Allan, Siegel & Tangen, 2005; Buehner, Cheng, & Clifford, 2003; Wasserman et al., 1996; White, 2003b). Unfortunately, in natural uncontrollable situations, the frequency of the outcome is a critical variable that, by definition, remains out of control. This means that it is necessary to explore the potential of other factors that might also help reduce the illusions while the probability of the outcome remains naturally high. In the experiment below we assess the potential impact of some of those other factors, as an example of what can be expected from the application of causal learning research to the problem of pseudoscience.

According to all theories of causal and contingency learning we are aware of, reducing the probability with which the cue occurs is another factor that should reduce the illusion. This result, however, has not been as clearly established as the outcome-frequency effect. On the one hand, there are a few studies reporting that when the cue is the participant's own behavior it is possible to reduce the illusion when participants respond less frequently, presumably because in this way they become exposed also to information on what happens when they do not respond (e.g., Blanco et al., 2009; Hannah & Beneteau, 2009; Matute, 1996). Moreover, computer simulations of this process have shown that when the probability of the outcome is high, even a very simple artificial associative learning system develops the illusion of control if the system is responding at high rate (Matute, Vadillo, Blanco, & Musca, 2007). However, this cue-frequency effect has been reported in just a few empirical studies that used an external event as the potential cause (Kutzner, Freytag, Vogel, & Fiedler, 2008**;** Perales, Catena, Shanks, & González, 2005; Wasserman et al., 1996; White, 2003b), its magnitude has been modest, and there have been several confounds that do not allow to conclude that the effect has been firmly established (see Hannah & Beneteau, 2009; Perales & Shanks, 2007). For this reason, we thought it especially interesting to test the effect of the frequency of the potential cause, as it is one of the many predictions that could be extracted from this domain that could shed more new light not only in the applied setting of how to reduce pseudoscience but also on theoretical issues not yet entirely solved in the experimental causal learning tradition. Presumably, causal illusions should be reduced as participants become exposed to more cases in which the target cause is absent and the outcome still occurs. This result, if obtained, should allow us not only to show how knowledge derived from causal learning studies can be applied to the problem of pseudoscience but should also allow us to provide additional evidence on a prediction that has not been sufficiently tested.

An additional variable that has been shown to strongly influence the results of causal learning studies is the wording of the assessment question. Sometimes people seem to overestimate a causal relation, but it has been shown that the way the assessment question is worded does have a profound impact in the results of these experiments (Collins & Shanks, 2006; Crocker, 1982; Gredebäck, Winman, & Juslin, 2000; Matute, Arcediano, & Miller, 1996; Matute, Vegas & De Marez, 2002; Vadillo & Matute, 2007; Vadillo, Miller, & Matute, 2005; Perales & Shanks, 2008; White, 2003a). Imagine a practitioner that is using a treatment in which 90% of the patients report feeling better upon its completion. If a new patient comes in and we ask this practitioner to *predict* the chances that the patient will feel better by the end of the treatment, this person should honestly and accurately predict that the chances are 90%. If we ask about the effectiveness rate for this treatment, the practitioner may as well say 90% (note that this question is a bit vague, it does not necessarily force causal thinking and some people may interpret it as analogous to the predictive question above). But now imagine that we ask a clear causal question, that is, we ask whether there is any *causal* relation between the treatment and the recovery. In response to this last question, this person should compare the probability that patients will recover after following the treatment, with the probability that patients that are not following the treatment will recover as well. And let us imagine that this second probability is also 90%. In this case, the answer to this latest question should be zero, as the treatment and the recovery are independent events.

Thus, the way in which we word our question and the type of thinking we request from our participants should affect the type of information they consider and the type of response they give. To our knowledge, however, all the studies that have explored the illusion of control and related illusions have used questions that are not causal but have to do, instead, with the degree of control that the participant believes to have exerted over the outcome, or with how effective they believe their behavior has been (e.g., Alloy & Abramson, 1979; Blanco et al., 2009; Hannah & Beneteau, 2009; Matute, 1995; 1996; Msetfi et al., 2007). Likewise, those studies exploring the overestimation of contingencies between external events in described (not experienced) situations have often used predictive questions (e.g., Fiedler et al., 2009). There are good reasons to believe that wording the questions explicitly in causal terms should reduce the illusion, as causal judgments are generally much more sensitive to the actual contingencies than other types of judgments (e.g., Gredebäck et al., 2000; Vadillo & Matute, 2007; Vadillo et al., 2005). We will thus manipulate the wording of the assessment question, in addition to the probability of the cue, to reduce the illusions.

Overview of the experiment

The purpose of this experiment was twofold. First, to reproduce the development of a quackery belief in a vicarious setting in which participants acquire the illusion though advertisement or through the testimony of people who followed a treatment and felt better. Second, and most importantly, we will try to reduce the illusion by two complementary manipulations. One is exposing participants to vicarious information on what happened to patients who did not follow the treatment. The other one is asking participants a causal question so that they are prompted to think in causal terms.

We constructed a situation in which 80% of the fictitious patients reported feeling better (i.e., $p(O) = .80$), and this probability was identical for patients having taken the treatment as for those having not. Therefore evidence presented to the participants implied that there was no causal relation between following the treatment and feeling better. The critical difference between the two groups used in this experiment was the probability that the cause was present, that is, the number of patients who had taken the treatment. For Group High p(C) this probability was .80. For Group Low p(C) it was .20. In addition, participants were presented with two different assessment questions, one was worded in causal terms; the other one focused on effectiveness. The effectiveness wording was chosen as an adaptation of the question that is normally used in the illusion of control experiments (see above). The causal question was the one normally used in the causal learning domain. As previously discussed, this latest one should produce less biased judgments.

Method

Participants

Participants were 108 Internet users who visited our virtual laboratory (www.labpsico.com). In agreement with ethical guidelines for human research through the Internet (Frankel & Siang, 1999) we did not register any data that could compromise participants' privacy: They all were anonymous and voluntary. Although there is a possibility of getting noisy data over the Internet, an increasing body of research is showing that results obtained through the Internet are very similar to those in the traditional laboratory (Gosling, Vazire, Srivastava, & John, 2004; Kraut, Olson, Banaji, Bruckman, Cohen, & Couper, 2004; Reips, 2001). Most importantly, a previous study has already shown that the illusion of control effect is very similar in Internet users and laboratory participants (Matute, Vadillo, Vegas, & Blanco, 2007). The computer program randomly assigned each participant to each of the two experimental conditions. 52 participants were assigned to Group High p(C) and 56 to Group Low p(C).

Procedure and Design

The experiment used an adaptation of the allergy task (e.g., Vadillo & Matute, 2007; Wasserman, 1990). Participants were asked to imagine being a medical doctor who was using a new medicine, Batatrim (i.e., target cause), which might cure painful crises produced by a fictitious disease called Lindsay Syndrome. Then, participants were exposed to the records of 100 fictitious patients suffering from these crises, one per trial. In each trial, participants saw three panels. In the upper one, participants were told whether the patient had taken the medicine (cause present or absent). In the second panel, participants were asked whether they believed that the patient would feel better. Responses to this question were given by clicking on one of two bottoms, "Yes" or "No". The purpose of this question was to keep participants' attention. The third and lower panel of each trial appeared immediately after participants gave their response. It showed whether the fictitious patient was feeling better (i.e., effect present or absent). In Group High p(C), 80 out of the

100 patients had followed the treatment and 20 had not. In Group Low p(C), 20 patients had followed the treatment and 80 had not. In both cases 80% of the patients who took the medicine, and 80% of those who did not, reported feeling better. The different types of trials were presented in pseudorandom order.

The wording of the assessment question was manipulated within participants. After all 100 training trials had been completed the last screen comprised two horizontal panels, each one presenting one question and a rating scale. The questions, translated from Spanish, were as follows: *To what extent do you think that Batatrim was the cause of the healings from the crises in the patients you have seen*? (Causal question), and *To what extent do you think that Batatrim was effective in healing the crises of the patients you have seen?* (Effectiveness question). Note that the Causal question is more clearly asking participants to think in causal terms: it acknowledges that, yes, there have been healings, but we are asking about their cause. The Effectiveness question, however, is more similar to the questions people ask themselves in everyday life when they wish to know if a treatment is effective, but this question is also quite ambiguous. Some participants might find it difficult to answer that the treatment was not effective when indeed they observed that many patients felt better after taking Batatrim. The order in which these two questions appeared in the upper or lower panel of the screen was counterbalanced. The answers were given by clicking on a 0-100 scale, anchored at 0 (*definitely NOT*) and 100 (*definitely YES*). Given that the actual contingency between the medicine and the healings was set to zero for both groups, any realistic and objective judgment should not depart from this value.

Results

Mean judgments of causality and of effectiveness are shown in Figure 1 for both groups. The figure suggests that illusions were produced in all cases, and also that both causal and effectiveness judgments were higher in Group High p(C) than in Group Low p(C). Thus, as we expected, reducing the frequency with which the participant is exposed to the potential cause is an efficient means to reduce these illusions. The figure also shows a higher judgment for questions of effectiveness than for causal questions. This suggests that, as expected, asking people to think about the actual causes of the outcome is also an efficient means to reduce the illusion.

The existence of illusions would be confirmed if the participants' judgments were significantly greater than the normative value of zero which corresponds to the scheduled cue-outcome contingency. T-tests confirmed that the participants' judgments were significantly greater than zero in all cases, lowest $t(55) = 8.73$, all ps < .001, lowest $d = 1.16$. The results further confirmed that the manipulations used in this experiment were able to significantly reduce the strength of the illusions. An analysis of variance showed a main effect of the frequency with which the potential cause was presented, $F(1, 106) = 31.01$, $p < .001$, $\eta_p^2 = .226$, as well as a main effect of the type of assessment question, $F(1, 106) = 18.716$, $p < .001$, $\eta_p^2 = .150$. No interaction was observed. Further analyses (conducted with Bonferroni corrections for multiple comparisons, $\alpha/4 = .0125$) confirmed that the difference between the High p(C) and Low p(C) groups was significant for causal judgments, $t(106) = 5.264$, $p < .001$, $d = 1.02$, as well as for judgments of effectiveness, $t(106) = 4.886$, $p < .001$, $d = 0.95$. In addition, judgments of effectiveness were significantly higher than causal judgments both in Group High p(C), $t(51) = 3.042$, $p < .005$, $d = 0.35$, and in Group Low p(C), $t(55) = 3.115$, $p < .005$, $d = 0.35$.

Discussion

The present research aimed at illustrating how the integration of the experimental areas of the illusion of control and contingency learning can illuminate the efforts of governmental, educational, and skeptical organizations in reducing the impact of pseudoscience in society. According to our proposal the illusions that take place in pseudoscience are the result of the normal and well adapted mind, which systematically produces illusions when exposed to certain conditions. This is important because one of the things that believers in pseudoscience complain most is that academic science often treats them as fools, or even some times as liars. Our research shows that these illusions develop in most people. Thus, the illusions can be predicted (and reduced as well) if we understand the conditions in which our cognitive system tends to err in associating causes to effects and in assessing contingent relations. Indeed, our research shows that changing those conditions is sufficient to reduce the illusions. Thus, basic studies on how people detect causal relations can be fruitfully used to guide and suggest public programs and successful interventions to reduce the impact of pseudoscience.

The present results also demonstrate that pseudoscientific beliefs can be acquired vicariously, through the mere exposure to advertisement or to the testimony of others. Voluntary and personal involvement is not necessary. This is something that could be inferred by looking at the high incidence of pseudoscience in our society, but to our knowledge, had not been shown before. The good news is that the results also show that good vicarious strategies, programs and advertisements can also be highly effective in reducing the illusions. This is important because given that we normally cannot convince people to reduce their use of pseudoscience and superstitious rituals, one thing we can do is to show them, through advertisement or any other means, vicarious evidence by which they can learn equally well that some of the causal relation that they infer are illusory.

Another practical result that we observed was that asking participants a causal question did reduce the illusion. If we were to look for the particular process that gives rise to this result, the present experiment does not allow us to discriminate between several competing possibilities such as, for instance, whether this effect takes place at the acquisition or at the response stage. We have addressed this issue in several previous reports and, in general, we could content that the effect is normally at the response (reasoning), rather than at the acquisition stage (Matute, et al., 1996; Matute et al., 2002; Vadillo et al., 2005; Vadillo & Matute, 2007). In any case, this was not the purpose of the previous experiment. What is important to note here is that previous research on the causal learning tradition, and its integration with the illusion of control tradition, allowed the (correct) prediction that the causal question should produce a lower illusion than the effectiveness question. The greater sensitivity of causal judgments to the actual contingencies than predictive judgments had already been shown in contingency learning studies (e.g., Gredebäck et al., 2000; Vadillo & Matute, 2007). However, causal and effectiveness judgments had never been compared against each other, as they came from different research lines. Thus, the present study integrates previous results from the areas of causal judgments and of judgments of control and effectiveness and shows that the causal question prompts people to make a more accurate use of the actual contingency information than the effectiveness question, which produces stronger illusions. Quite possibly, the effectiveness question is the one that is most frequently used by lay peoples' day-to-day inquires about the efficacy of medical treatments, and pseudoscientific claims in general, but it should be noted that it is probably a misleading question. Stating that a treatment is not effective when all the people who we know that have followed it feel better makes no much sense. However, if we were asked whether the treatment is the real cause of the recovery of those patients, we would have to look for alternative potential causes (even hidden causes). This process forces participants to consider all the evidence available, something that they do not always do and that other questions may not require.

The other result that we observed also arose from the integration of those two research lines. The illusion was attenuated when participants were exposed to fictitious patients reporting that they had not taken the treatment (and still felt better). This cue-density effect was predicted by contingency learning theories. However, as noted in the Introduction, there were very few studies in that area that had shown the effect in a trial-by-trial experienced situation in which the potential cause was an external event, and there had been several confounds that did not allow to conclude that this effect had been firmly established (see Hannah & Beneteau, 2009; Perales & Shanks, 2007). However, demonstrations of the effect could be found in the illusion of control literature, where it had been shown that participants being more highly involved with the task developed stronger illusions. Participants trying harder to obtain the desired events were responding more frequently, which means that they were exposed to a greater frequency of the cue (Blanco et al., 2009; Matute, 1996). If this happens in an uncontrollable situation in which the outcome occurs frequently (as is the case in most situations producing illusions), response-outcome coincidences are guaranteed. And it is well known that these coincidences between a cue (defined as an antecedent event that can either be a cause, a predictor, or any other event occurring prior to the outcome) and an outcome strengthen the perception of contingency between the two variables (e.g., Kao & Wasserman, 1993), the perception of causality and/or prediction between them (e.g., Shanks & Dickinson, 1987), as well as the resultant behavior (e.g., Skinner, 1948; Vyse, 1997). Thus, if we apply the predictions from causal learning literature to the study of the illusion of control, it seems that one reason why the illusion of control occurs more often when the participants are personally involved is that in those cases they are exposed to a greater number of coincidences between the cue (in this case their own behavior) and the outcome. The integration of these two research areas allowed, once again, the correct prediction that reducing the frequency of the cue or response (in this case, taking the medicine) should suffice to reduce the illusion even in vicarious settings.

It is important to note that the strategies that we used to reduce the illusions are equivalent to teaching participants scientific methods, which should always be an effective way to reduce superstitions (Díaz-Vilela & Álvarez, 2004; Morier & Keeports, 1994). However, our research shows a much simpler way in which participants can be helped to perceive the actual contingencies and that can be easily implemented in TV advertising, news, and programs: Simply showing participants the actual proportion of patients that felt better without following the target treatment helps them detect the absence of contingency by themselves. This should counteract the effect of all those miracle-products advertisements that focus their strategies on presenting confirmatory cases. Presenting only partial and only confirmatory evidence to citizens could be treated as equivalent to lying, as it has now been shown that this strategy does produce illusions in most people.

Although a good knowledge of scientific methods is always desirable, one problem of such a strategy is that it requires, first, to convince people that science is something they should pursue (something quite difficult in pseudoscience circles of influence), and second, perhaps even more difficult, to convince people to use control conditions, to reduce the frequency with which they attempt to obtain the desired event, so that they can learn that it occurs equally often when they do nothing. Thus, providing people with the cognitive resources to be able to decide by themselves whether there is a contingency, and asking them to think in causal terms might be a first step, easy and economical, that should reach a larger number of people than more complex programs. Quite possibly, if people could learn by themselves what types of illusions are to be expected in which conditions and they were also given means by which those illusions could be fought, they certainly would be better equipped to detect their own illusions and to reduce their impact. Our research proves that developing evidence-based educational programs should be effective in helping people detect and reduce their own illusions.

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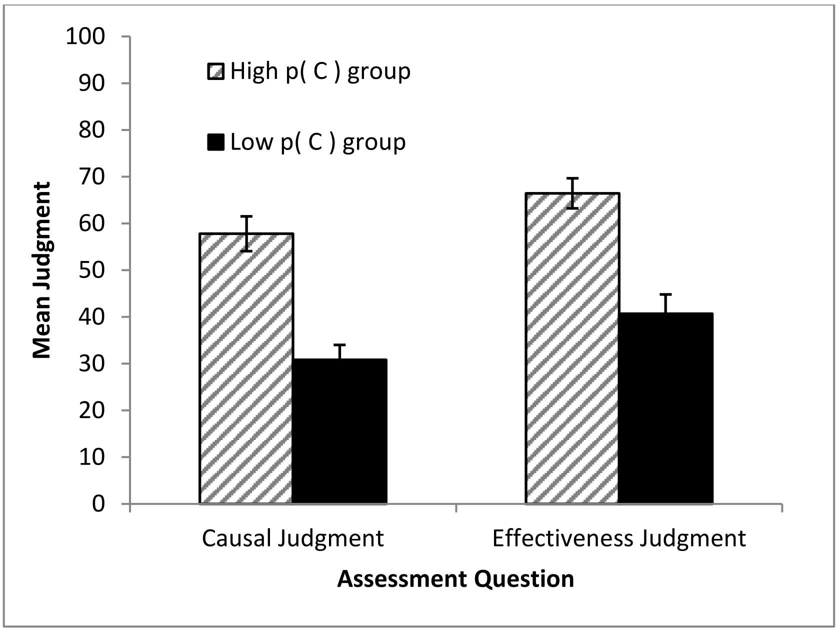
Figure Captions

Figure 1. Mean causal and effectiveness judgments for the fictitious treatment in participants with a high or low probability of observing patients that had taken the treatment. Error bars denote the standard error of the mean.


100
90
80
70
60
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40
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20
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0
High p(C) group
Low p(C) group
Mean Judgment
Causal Judgment
Effectiveness Judgment
Assessment Question

Figure #1