Authority brings responsibility: feedback from experts promotes an overweighting of health-related pseudoscientific beliefs

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Abstract

The popularity and spread of health-related pseudoscientific practices is a worldwide problem. Despite being counteracted by competent agents of our societies, their prevalence and spread are still growing. Current research has focused on identifying which characteristics make us more likely to hold beliefs in favor of pseudoscience. However, how we hold these beliefs despite all the available information against them is a question that remains unanswered. We here aimed to assess if the development of health-related pseudoscience beliefs could be driven by a positive bias in belief updating. Additionally, we aimed to explore whether this bias could be exacerbated depending on source credibility. In this study, participants (N = 116 adult university students) underwent a belief updating task where they offered their agreement with various health-related pseudoscientific statements before and after receiving supporting and discrediting feedback from (a) experts (doctors) (b) peers or (c) a random number generator. Our results suggest that when receiving feedback from experts (but not from peers or random feedback) participants preferentially integrated supporting relative to discrediting information about health-related pseudoscientific proposals. We discuss the implications of this biased belief updating pattern on health-related pseudoscience research and suggest new strategies for intervention focused on increasing awareness, training, and consensus among healthcare practitioners.

Keywords: Pseudoscience, Belief updating, Healthcare practices, Feedback, Unwarranted beliefs, Misinformation.

Introduction

Alongside the relentless growth in scientific advances, we are experiencing an increase of disciplines that mimic the characteristics that render science trustworthy: pseudosciences (Hansson, 2021). Far from being innocuous, their infiltration and proliferation capacity in the societal tissue has terrible consequences. A great example of the impact of these practices comes from health-related pseudosciences, which produce unjustified investments of public money (Cattaneo & Corbellini, 2014), dangerous interference with medical treatments (Tascilar et al., 2006), and have been associated with a number of deaths in recent years (Hotez, 2021). Motivated by the need to understand this phenomenon, a body of correlational studies is growing. To date, the results of this research suggest that there are a variety of cognitive correlates for pseudoscience endorsement mainly rooted in cognitive biases (Bensley et al., 2020). These beliefs have been associated with well-known phenomena such as illusions of causality (Torres et al., 2020), jump-to-conclusions (Rodríguez-Ferreiro & Barberia, 2021), probabilistic reasoning biases (Šrol, 2021); and self-reported measures of intuitive and analytic cognitive styles (García-Arch et al., 2022; Šrol, 2021). Unfortunately, correlational studies fail to account for how pseudoscientific beliefs emerge in the population and therefore remain limited in informing of effective strategies to ameliorate them in society. To counteract their proliferation, we need to further our understanding of how these beliefs develop, which requires us to understand how we deal with pseudoscientific information we receive from our environment.

Information on health-related pseudoscience is easily accessible (Poulose, 2021). Through TV and social media, we are all exposed to an endless stream of

information with few restrictions. Indeed, the popularity of low-value healthcare practices has been partly attributed to the increased availability of information on the internet and the influence of our peers (Walker et al., 2017). Of even greater concern, health-related pseudoscience may sometimes be promoted by some of those who should be the standard-bearers of health sciences; namely, healthcare professionals. Current evidence suggests that a considerable proportion of physicians have at some point recommended the use of non-evidence-based treatments (Piñeiro Pérez et al., 2022; Posadzki et al., 2013). Studies also suggest that some practitioners recommend such treatments without even having received formal instruction in them (Posadzki et al., 2013; Winslow & Shapiro, 2002), and that such recommendations are often based on their personal beliefs (Winslow & Shapiro, 2002). This lack of rigorousness might become a serious problem considering the asymmetry between practitioners and patients. Healthcare professionals are the custodians of some of the most valuable knowledge for human beings: potential causes and remedies for adverse medical conditions. As such, they represent a strong source of authority, power, and trust that significantly influences patients' decision-making (Bartoš et al., 2022; Mccullough, 1999). Therefore, as much as healthcare professionals can improve the acceptance of evidence-based interventions, they may also promote pseudoscience endorsement, which may hinder efforts to reduce the proliferation of these practices.

In the face of the growth and danger of health-related pseudoscience, numerous initiatives have emerged to combat them. Health professionals have discredited many of these practices and criticized their promoters (Cattaneo & Corbellini, 2014); governments and scientific societies have launched campaigns (Caulfield, 2020; Piñeiro Pérez et al., 2022); and private companies have helped to curb the spread of

misinformation (Sharevski et al., 2022). Unfortunately, pseudoscientific practices are still highly prevalent nowadays, and how health-related pseudoscience beliefs are growing despite being actively counteracted by competent and trustworthy agents of our society is a question that remains unanswered.

Evidence from experimental psychology suggests that we can hold a belief and seek confirming information for it as long as it has a positive impact on our feelings or we believe it is useful for us, i.e., if it brings us some benefit, real or perceived (Bromberg-Martin & Sharot, 2020; Sharot & Sunstein, 2020). However, what benefit is there for us in believing in the effectiveness of pseudoscientific treatments? An intuitive reason might be that they give us hope and increase our sense of control (Evans et al., 2007; Truant et al., 2013), just as evidence-based treatments do. We want to believe that if we are trapped in some medical condition there will be a treatment that will release us from it (Vidal et al., 2013). Therefore, any information in favour of the effectiveness of a proposed cure is potentially desirable, even if it comes from a pseudoscience (Galbraith et al., 2018; Verhoef et al., 2005). Indeed, it has been argued that optimism about the effectiveness of an intervention can lead governments to promote pseudoscientific or poorly supported empirical practices, even when there is opposing evidence against them (Cattaneo & Corbellini, 2014).

From a rational point of view, disregarding opposing evidence on a pseudoscientific treatment just because we want to believe in its effectiveness would be suboptimal. However, when forming and updating our beliefs we tend to under-weigh undesirable relative to desirable information (i.e., we prefer “good news”; Sharot & Garrett, 2016), It has been suggested that this tendency is motivated by the need to modulate psychological factors such as perceived control, perceived vulnerability, stress, or

anxiety (Klein & Helweg-Larsen, 2010; Moutsiana et al., 2013; Sharot et al., 2012). Interestingly, all these factors have been suggested to be part of people's psychological reactions to several medical conditions, from which pseudoscientific treatments are supposed to protect us (Singh et al., 2005). This places beliefs in health-related pseudoscience in the range of beliefs more likely to show a positively biased belief updating. Although this possibility has never been studied experimentally, there is evidence that supports this notion. For example, some patients tend to accept pseudoscientific treatments and avoid information that may discredit them (Shih et al., 2009). Moreover, a recent study revealed that having received supporting health-related pseudoscientific information is a positive predictor of participants' pseudoscience beliefs, whereas receiving discrediting information showed null predictive capacity (García-Arch et al., 2022). This evidence highlights the importance of studying how health-related pseudoscience beliefs are updated after receiving supporting and discrediting information.

We here aimed to assess if the development of health-related pseudoscience beliefs could be driven by a positive bias in belief updating. Additionally, we aimed to explore whether this bias could be exacerbated depending on source credibility. In our study, participants were asked to make subjective judgments about the effectiveness of various health-related pseudoscientific proposals before and after receiving pseudo-random supporting (desirable) and discrediting (undesirable) feedback. Participants were divided into three groups where they were instructed to be receiving feedback from (1) experts (doctors), (2) peers (other participants), or (3) a random number generator. We hypothesized that participants would adjust their opinions more in the direction of supporting (relative to discrediting) feedback coming from an allegedly

meaningful source (i.e., from experts and other peers) but not when received from a non-meaningful one (i.e., a random number generator).

Methods

The dataset analysed during the current study is available at the Open Science Framework [https://osf.io/mnywk/?view_only=25f34bb9ef2e45838eecb922d65ec480]

Participants

The required sample size for the present study was determined by a power analysis conducted in G*Power (Erdfelder et al., 2009). Prior related research has found large effect sizes for the positive bias ($\eta^2 > .1$) (see, Kappes & Sharot, 2019), which require a sample size of n = 20 for an acceptable power of 80% in a repeated measures testing between conditions. However, the assessment of our hypothesis relied on an interaction effect (the positive bias should emerge only in the *Experts* and *Peers* groups). We therefore decided to conduct a power analysis for the interaction of between(groups)-within(conditions) factors. We assumed a rather conservative small to moderate interaction effect of $\eta^2 = .03$. Power analysis estimated that for an acceptable power of 80% we would need at least 81 participants. The sample of participants that participated in our study was 137 (undergraduate students, 70.07% women, $M_{age} = 20.85$, $SD_{age} = 3.74$, 95% CI[20.21, 21.49]).

Participants were randomly divided into 3 groups based on 3 different experimental conditions. Participants in *Experts* group (n = 45) were told they were receiving feedback from experts. Those in *Peers* group (n = 47) were presented with feedback allegedly coming from other participants in the experiment, and those in *Random* group (n = 45) were told they would receive random feedback. Prior to analysing the

data, we applied two exclusion criteria. Following previous literature (Kappes & Sharot, 2017), the first exclusion criterion was based on scores on the Beck Depression Inventory (BDI-II) (Sanz et al., 2003). Thirteen participants (9.48% of the total sample) with moderate or severe depressive symptoms ($BDI_{score} > 18$) were excluded (6 in *Experts*, 5 in *Peers*, 2 in *Random*). Participants (n = 8; 3 in *Experts*, 1 in *Peers*, 4 in *Random*) who did not complete at least 80% of the trials of the experimental task were also excluded from further analysis. Thus, the final sample included 116 participants ($n_{Experts} = 36$, $n_{Peers} = 41$, $n_{Random} = 39$). All participants provided written informed consent. Participants received course credit for their participation. The study was reviewed and approved by the University of Barcelona's Bioethics Commission (IRB00003099).

Procedure

Stimuli

Stimuli consisted of a set of 30 pseudoscientific statements related to health improvements, health interventions, and prevention of health problems (e.g., "*Chiropractic (treatment of the musculoskeletal system) can improve our immune system*", "*Natural remedies, such as Bach flower remedies, help overcome emotional imbalances*", "*Massage on the circulatory system (lymphatic drainage) can help to improve the body's defences"*, see Table 1, *Supplementary Materials*). These stimuli were extracted from validated questionnaires (Fasce & Picó, 2019; García-Arch et al., 2022; Torres et al., 2020) and complemented with new items based on an official list of pseudoscientific interventions recently published by the Spanish government (https://www.conprueba.es/).

Experimental task.

The experimental procedure followed the general lines of a well-known experimental belief updating task that has been widely used and adapted to study the processing of different feedback types (Korn et al., 2012; Sharot & Garrett, 2016). In each trial, participants read a pseudoscientific claim displayed on the screen. They then had 5 seconds to provide a rating (first rating) on their level of agreement with the provided statement on a scale from 1 (indicating absolute disagreement) to 100 (indicating absolute agreement). Pseudoscientific claims were presented in random order. After a fixation cross (1 second), participants were shown, for 4 seconds, what they believed to be (a) the average ratings of 8 experts on the same claim (Group *Experts*) (b) the average ratings given by other participants in the experiment on the same claim (Group *Peers*) or (c) a random number (Group *Random*) (see *Supplementary Materials*, for the original and translated instructions). This process was repeated for all 30 pseudoscientific statements, with a fixation cross (1 second) after every trial. After completing this process for every pseudoscientific claim, participants again provided their beliefs' ratings on each statement (second rating). The experimental procedure is outlined in Figure 1.

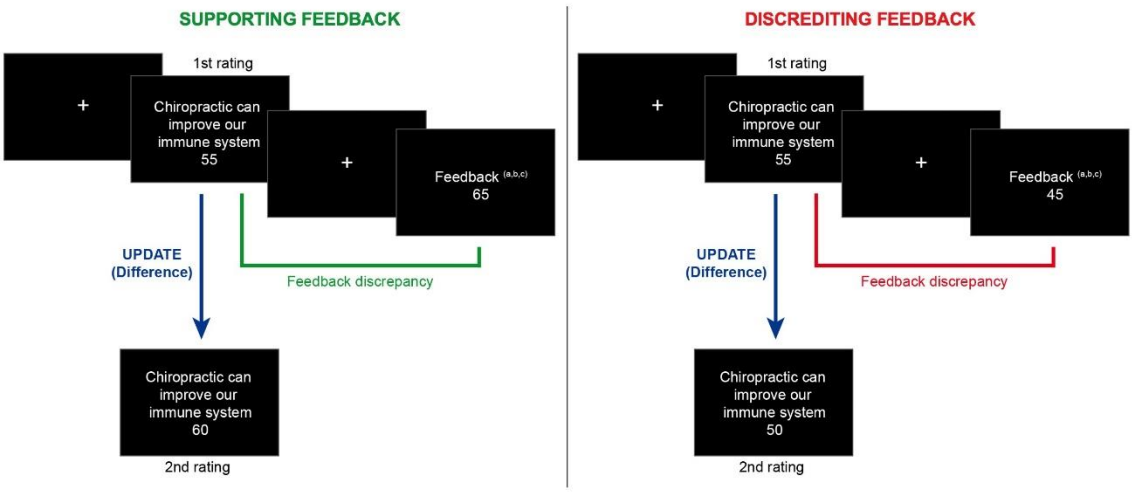

Figure 1. **Belief updating task**. (Left) Example of a supporting (desirable) feedback trial – participants' initial rating is lower than the feedback received. In each trial, participants had to provide an initial judgement responding to a general question ("How much do you believe the following statement is true from 1 to 100?"). Feedback indices ([a,b,c]) represent differences in the statements presented depending on feedback group ([a], Experts) "On average, experts believe that this statement is true from 1 to 100 per cent: "; ([b], Peers) "On average, other participants of the experiment believe that this statement is true from 1 to 100 per cent: "; ([c], Random) "the random number for this trial is: ". In green, feedback discrepancy represents the difference between participants' initial rating and the feedback received. In blue, update (dependent variable) is represented as the difference between first and second assessment (see, Experimental task, for details). (Right) Example of a discrediting (undesirable) feedback trial – participants' initial rating is higher than the feedback received. In red, feedback discrepancy represents the (discrediting) difference between participants' initial rating and the feedback received.

The target measure of this task is the difference between the first and the second rating (i.e., update). Updating scores were computed as follows: if participants received supporting feedback (the feedback received was higher than participants' rating) update was computed as the difference between the second and the first rating [rating 2 (post feedback) – rating 1 (pre feedback)]. If participants received discrediting feedback (the feedback received was lower than participants' rating) update was computed as the difference between the first and the second rating [rating 1 (pre feedback) – rating 2 (post feedback)]. As in previous studies, we also computed a variable aimed to capture the difference between one's own first rating and the feedback received, namely feedback discrepancy (Korn et al., 2012).

To control for potential confounds, we introduced complementary measures as covariates, such as familiarity (how familiar each statement was, on a scale from 1 to 4), memory accuracy (computed as the average difference between participants' memory of the feedback received for each statement and the actual feedback, in absolute value) and prior experience (participants had to answer whether they had put into practice themselves or through a professional or acquaintance any of the pseudoscientific proposals presented to them, through a dichotomous response: Yes or No). The selection of covariates was based on prior studies (Korn et al., 2012; Sharot et al., 2012). At the end of the experiment, after collecting participants' data on the covariates and BDI-II, they were informed that the feedback received was in fact pseudo-random and that all claims presented were considered pseudo-scientific proposals.

Feedback generation

As in previous studies (Korn et al., 2012), feedback was pseudo-randomly generated by a random number generator. To create the feedback conditions (supporting and discrediting), the random number generator was restricted to evenly generate higher (supporting; 50%) and lower (discrediting; 50%) scores than participants' ratings. We restricted the maximum absolute difference between feedback and participants' ratings to 40 (out of 99).

Results

In this research, we hypothesized that participants from *Experts* and *Peers* groups would exhibit a positively biased belief updating in the task, that is, participants' beliefs would adjust more to supporting than to discrediting feedback. To test this hypothesis, we conducted a 3 (Group: "Experts", "Peers" and "Random") by 2 (Feedback Condition: "Supporting", "Discrediting") Repeated Measures Analysis of Variance (RM ANOVA). Update (belief pre/post change) was set as the dependent variable, and Group, Feedback Condition and the interaction between the two were entered as between and within subjects' factors respectively. Post-hoc contrasts were Bonferroni corrected.

Results from the RM ANOVA including all covariates (Feedback Discrepancy, Familiarity, participants' Initial beliefs, Prior experience and Memory accuracy) revealed a significant main effect of Group, $F(2,220) = 13.14$, $p < .001$, $\eta_p^2 = .11$, a non-significant main effect of Feedback Condition $F(2,220) = .92$, $p = .3391$, $\eta_p^2 = .004$, and a significant interaction between Group and Feedback Condition $F(2,220) = 8.26$, $p < .001$, $\eta_p^2 = .07$ (Figure 2). Results obtained without the inclusion of the mentioned covariates yielded similar results [Group: $F(2,225) = 13.10$, $p < .001$, $\eta_p^2 =$

.1; Feedback: $F(2,225) = .921$, $p = .3392$, $\eta_p^2 = .004$; Group by Feedback Condition interaction: $F(2,225) = 8.24$, $p < .001$, $\eta_p^2 = .07$].

To scrutinize the results obtained, we then tested whether the interaction effect remained significant when restricting the analysis to *Experts* vs. *Peers* (contrast 1), *Experts* vs. *Random* (contrast 2) and *Peers* vs. *Random* (contrast 3). All contrasts were Bonferroni corrected. Results of contrast 1 showed a significant main effect of Group, $F(1,144) = 11.83$, $p = .0082$, $\eta_p^2 = .08$, a non-significant main effect of Feedback Condition $F(1,144) = .041$, $p = 1$, $\eta^2 = .0002$, and a significant interaction between Group and Feedback Condition, $F(2,144) = 11.29$, $p = .00891$, $\eta_p^2 = .07$. Results of contrast 2 showed a significant main effect of Group, $F(1,140) = 25.73$, $p < .001$, $\eta_p^2 = .16$, a non-significant main effect of Feedback Condition $F(1,140) = .32$, $p = 1$, $\eta_p^2 = .002$, and a significant interaction between Group and Feedback Condition, $F(2,140) = 12.37$, $p = .0045$, $\eta_p^2 = .08$. Results of contrast 3 showed a non-significant main effect of Group, $F(1,151) = 2.42$, $p = .360$, $\eta_p^2 = .02$, a significant main effect of Feedback Condition $F(1,150) = 9.78$, $p = .018$, $\eta_p^2 = .06$, and a non-significant interaction, $F(1,151) = .03$, $p = 1$, $\eta_p^2 = .002$. Subsequent post-hoc analyses revealed that participants updated their beliefs significantly more after receiving supporting than discrediting feedback in the *Experts* group, $F(1,64) = 7.41$, $p = .02433$, $\eta_p^2 = .1$ (Supporting feedback: M = 10.235, SD = 7.183, 95% CI[7.804, 12.665], Discrediting feedback: M = 5.041, SD = 8.946, 95% CI[2.013, 8.067]). However, no significant differences in updates between feedback conditions were found neither in the *Peers* group, $F(1,74) = 5.14$ $p = .0792$, $\eta_p^2 = .06$ (Supporting feedback: M = 1.002, SD = 8.121, 95% CI[-1.561, 3.565], Discrediting feedback: M = 5.068, SD = 7.658, 95% CI[2.651, 7.481]) nor in the *Random* group $F(1,70) = 4.61$, $p = .105$, $\eta^2 = .06$ (Supporting feedback: M = 10.235, SD = 7.183, 95% CI[7.804, 12.665], Discrediting

feedback: M = -.578, SD = 6.959, 95% CI[-2.834, 1.678]) (Figure 2). Overall, these results revealed that Supporting feedback produced grater updates than Discrediting feedback only in the *Experts* group.

Control analysis

In what follows, we provide additional statistical assessment that differences between groups were not partially driven by differences in nuisance variables such as familiarity, memory accuracy of the ratings and prior experience to pseudoscientific statements. Firstly, we tested whether feedback discrepancies were not systematically biased between feedback conditions and across groups. Results showed that feedback discrepancies did not significantly differ neither across groups $F(2,225) = .31$, $p = .732$, $\eta_p^2 = .002$, nor across feedback conditions, $F(2,225) = .23$, $p = .628$, $\eta_p^2 = .001$, and the Group x Feedback interaction was not significant, $F(2,225) = 1.084$, $p = .3401$, $\eta^2 = .01$. The same analysis was conducted for Familiarity ratings [Group $F(2,225) = 2.90$, $p = .0577$, $\eta_p^2 = .03$, Feedback Condition $F(2,225) = .033$, $p = .855$, $\eta_p^2 = .0001$, Group by Feedback Condition interaction $F(2,225) = .36$, $p = .699$, $\eta^2 = .003$], Memory accuracy [Group $F(2,225) = .502$, $p = .605$, $\eta_p^2 = .004$., Feedback Condition $F(2,225) = 1.69$, $p = .194$, $\eta_p^2 = .007$, Group by Feedback Condition interaction $F(2,225) = 2.46$, $p = .087$, $\eta_p^2 = .02$] and Prior experience [Group $F(2,225) = 1.34$, $p = .263$, $\eta_p^2 = .01$., Feedback Condition $F(2,225) = .0002$, $p = .999$, $\eta_p^2 < .001$ Group x Feedback Condition interaction $F(2,225) < .001$, $p = .999$, $\eta^2 = <.001$] with similar results.

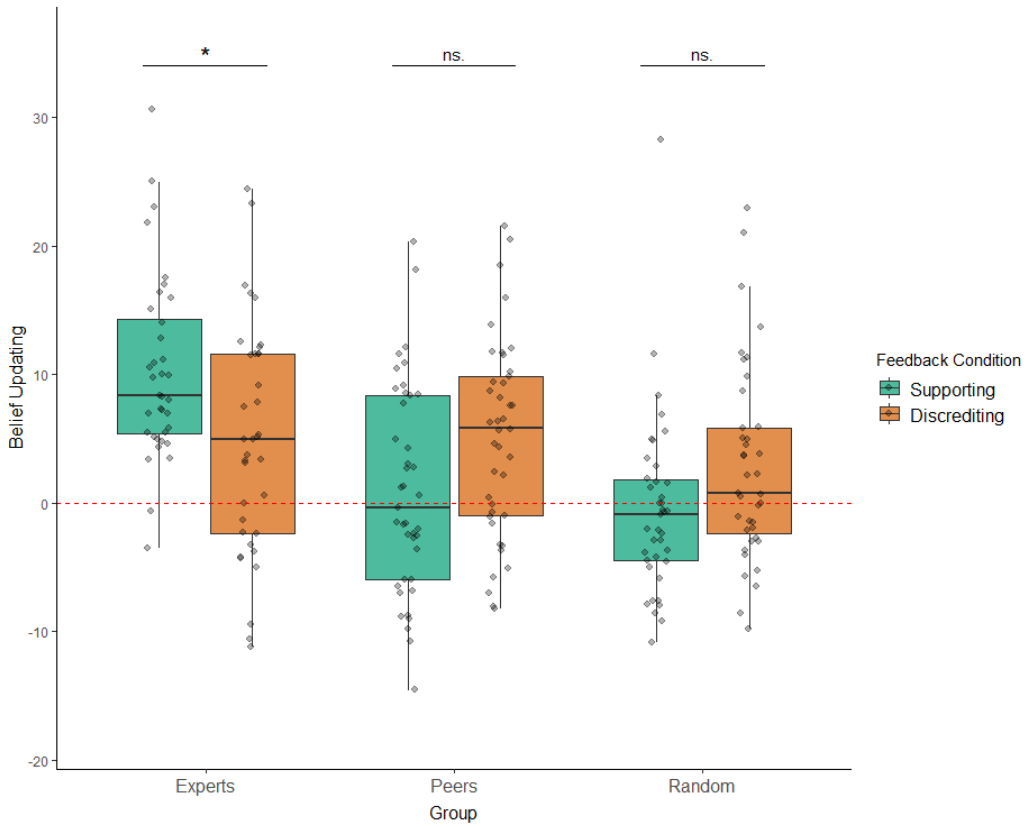

Figure 2. **Differences in average belief updating between groups (x-axis) and conditions (colours)**. Dashed red line denotes “no update” (0). Jittered points represent individual averages. Colour-blind friendly palette. Statistical significance codes: *p <.05 (Bonferroni corrected).

Discussion

The aim of the present study was to assess if the development of health-related pseudoscience beliefs could be explained by a positive bias in belief updating. To this end, we conducted an experiment in which participants received both supporting (desirable) and discrediting (undesirable) information regarding various health-related pseudoscience proposals. We included three different sources of information: experts (doctors), peers (other participants) and a random number generator. We found that only participants who received feedback from experts incorporated more supporting

(relative to discrediting) information into their health-related pseudoscientific beliefs. These findings indicate that experts' feedback can trigger a positive bias in belief updating that may critically contribute to the acceptance of health-related pseudoscience.

To the best of our knowledge, this is the first study to experimentally investigate whether the updating of pseudoscientific beliefs is positively biased after receiving supporting and discrediting information from different sources of information. Our results go beyond the identification of which individuals are most likely to show greater adherence to pseudoscience (García-Arch et al., 2022; Rodríguez-Ferreiro & Barberia, 2021; Šrol, 2021; Torres et al., 2020), and suggest that supporting and discrediting information provided by expert practitioners is differently weighted by the non-professional population. Specifically, our work indicates that when receiving feedback from experts about pseudoscientific treatments, people underweight discrediting relative to supporting information. That is, when receiving experts' feedback about the effectiveness of dubious healthcare-related proposals, we prefer "good news". These findings are consistent with the proposal that valenced beliefs are updated in a valence-dependent manner (Eil et al., 2010; Sharot & Garret, 2016), which has been linked to the need to preserve personal well-being (Klein & Helweg-Larsen, 2010; Moutsiana et al., 2013; Sharot et al., 2012). This phenomenon may help understand why, despite scientists' and institutions' efforts to discredit harmful non-scientific practices, the resistance, spread, and reach of pseudoscience still manage to influence policies and state funding (Cattaneo & Corbellini, 2014).

Intriguingly, we found a positive bias in belief updating in the group of participants that received feedback from experts but not in the one receiving feedback from

peers. A plausible interpretation of this finding, in the context of this study, is that participants may have considered the feedback provided by peers not relevant enough to trigger meaningful belief updating. Our results provide some evidence in favour of this suggestion, given that contrasts between *Peers* and *Random* groups yielded similar results. This is not completely surprising given that peers, unlike expert practitioners, are unlikely to have deep and meaningful knowledge of the targeted beliefs of this study (Mccullough, 1999), contrary to what happens with beliefs related to one's own personal identity, where peers' feedback is fundamental to self-concept updating (Korn et al., 2012). Indeed, recent work suggests that when seeking information, we first estimate what this information will reveal to us and then compute its expected value in terms of its impact on our cognition, affect and actions (Kelly & Sharot, 2021). The lack of authority and knowledge of peers in this context may reduce the expected impact of this information, making it irrelevant.

Unexpectedly, however, we found a main effect of valence when comparing the results of the groups of participants that were told feedback proceeded from other peers or was generated randomly by an algorithm. This finding may indicate that participants in these two groups tended to update their beliefs to a greater extent when receiving feedback that discredited rather than supported their initial judgment. However, these results should be taken with caution because a subsequent post-hoc comparison for each group of the degree of update as a function of type of feedback did not reach statistical significance. This speaks to the possibility that even non-meaningful discrediting feedback could make participants reassess their beliefs when re-exposed to pseudoscientific statements, resulting in a tendency to decrease them.

The results obtained in the *Experts* group suggest that positively biased belief updating could be an underlying cognitive mechanism for the acceptance of health-related pseudoscience, emphasising the relevance of the source of information. More generally, they also inform of the potential dangers of providing non-scientific information in a situation with strongly unbalanced roles in terms of power and knowledge, even when discrediting evidence is available. Importantly, although mass social transmission of misinformation is a fact (Poulose, 2021), our findings suggest that the information we receive from supposedly reliable agents may be the key trigger or main accelerator of beliefs in health-related pseudoscience. A recent work has suggested that in the general population, there is an overestimation of the proportion of physicians who do not adhere to scientifically supported practices (Bartoš et al., 2022). This study also suggests that such beliefs can be intervened upon to encourage evidence-based treatment choices. Our results complement these findings by suggesting that neutralising practitioners' propagation of non-scientific advice may be crucial to reducing the population’s beliefs about doctors’ pseudoscience acceptance, and pseudoscience acceptance in itself. The current situation regarding the spread and acceptance of health-related pseudoscience is worrying and out of control (Cattaneo & Corbellini, 2014; Piñeiro et al., 2022; Poulose, 2021). Our study suggests that our positive biases are awaiting the arrival of ‘reliable’ sources of information to contribute to their acceptance. This suggests that countermeasures aimed at the development of critical thinking in the general population (Wilson, 2018) need to be complemented with new strategies to ensure comprehensive and updated training of health professionals. Curbing the spread of pseudoscience requires a shared endeavour. As non-professionals, we should bear in mind that being inexperienced in a field does not exempt us from being able to

evaluate the sources of information that help us make decisions, nor does it preclude us from being aware of our own biases. As professionals, we should be aware of the consequences of our work, especially when derailing from deontological principles. Just as our ignorance does not exempt us from duty, our authority brings responsibility.

Limitations

Our results suggest that participants do not show a positive bias in their belief updating after receiving feedback from their peers, and we have argued that peers' feedback may not be relevant enough to update the targeted beliefs due to their lack of knowledge or authority. However, we cannot rule out the possibility of obtaining a different result if other sources of feedback from the participants' social life were included, such as known peers, friends or family members, who might be not only more relevant but also more authoritative depending on their role in participants' lives. On the other hand, this study was carried out on a sample composed of university students. Although this highlights the fact that individuals with higher levels of academic training are also susceptible to the described effect when receiving feedback from experts, it has been suggested that university students are less likely to accept pseudoscience (Garcia-Arch et al., 2020). The increased knowledge and development of analytical strategies provided by university education might limit the possibility of exhibiting a positive bias in the updating of pseudoscientific beliefs when receiving feedback from peers. Future research should extend these results to the general population.

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Supplementary Materials

Table 1. List of pseudoscientific statements and descriptive statistics of participants' initial belief ratings (means and standard deviations).

Item	M	SD
Through reflexology (manipulation of energy channels through the soles of the feet) medical problems such as migraine can be treated.	36.97	32.09
Some autoimmune diseases can be treated with substances from bees (honey, propolis, etc.).	42.81	28.99
By controlling the energy of the mind we can influence physical conditions (psychic healing).	40.51	33.02
By manipulating specific pressure points on the body, physical and psychological ailments can be treated.	54.30	31.70
Various diseases can be treated by analysis of iris colour and administration of certain amino acids.	29.13	29.93
By applying certain minerals to the skin, inflammation of a particular area can be reduced.	39.58	28.89
Changing the way we write (graphotherapy) can help to treat emotional problems.	23.35	26.64
Orange juice is an effective remedy for fighting cold viruses.	42.23	31.42
A positive and optimistic attitude towards life helps to prevent cancer.	34.49	32.85
Intestinal lavage with water and other compounds (hydrocolonotherapy) helps to treat problems such as irritable bowel syndrome.	46.01	28.58
Hot stone massage can help eliminate toxins and boost the body's metabolism.	36.10	29.37
Massage on the circulatory system (lymphatic drainage) can help to improve the body's defences.	50.70	30.72
The use of vitamin-based supplements helps prevent fractures as we grow older.	48.34	29.04
Treatment with plants with psychotropic properties helps to cure medical ailments.	53.95	29.65
Through the use of energy (reiki), people have been cured of physical illnesses.	30.29	29.21
In some cases, being exposed to magnetic fields is positive for health.	23.59	26.00
Finding the emotional source of a problem can influence the state of physical health.	72.97	20.38
There are therapies based on the use of the sea (thalassotherapy) capable of preventing and improving different medical conditions.	40.91	28.30
Oxygen-based therapies are capable of treating degenerative diseases.	40.85	30.89
There are therapies based on the rebalancing of internal energy that can improve the state of health.	40.68	33.24

The removal of metals from the body by means of substances that bind to them improves atherosclerosis.	33.54	25.66
Improving relationships with our environment can have an impact on the recovery from lung conditions.	43.12	30.40
Osteopathy is able to induce the body to heal itself by manipulating muscles and bones.	42.50	33.06
Chiropractic (treatment of the musculoskeletal system) can improve our immune system.	44.78	28.08
With natural teas and/or infusions, the same symptoms can be treated as with conventional medicines.	23.05	27.17
Detox diets or therapies are effective in eliminating toxic substances from the body.	45.16	31.94
Eating an alkaline diet (based on pH control) can prevent serious diseases.	49.98	30.34
Homeopathic remedies are effective as complements in the treatment of some diseases.	36.73	28.98
The superficial insertion of needles into specific parts of the body can be used to treat pain problems.	54.77	30.29
Natural remedies, such as Bach flower remedies, help overcome emotional imbalances.	31.64	28.69

Feedback instructions:

Experts

(Original): Después de cada valoración que proporcione sobre su grado de acuerdo con cada una de las afirmaciones, se le presentará una nueva información. Esta información es la media de las valoraciones que 6 expertos han realizado sobre su grado de acuerdo con las mismas afirmaciones que se le presentarán. Los expertos que han participado en este estudio han sido: 3 médicos de familia, 1 traumatólogo y 2 médicos residentes.

(Translated): After each rating you provide regarding your agreement with each of the statements, you will be presented with new information. This information is the average of the evaluations that 6 experts have made regarding their degree of agreement with the same statements that will be presented to you. The experts involved in this study were: 3 family doctors, 3 traumatologist and 2 resident doctors.

Peers

(Original): Después de cada valoración que proporcione sobre su grado de acuerdo con cada una de las afirmaciones, se le presentará una nueva información. Esta información es la media de las valoraciones que 8 participantes que ya han participado y completado este estudio han hecho sobre las mismas afirmaciones que se le presentarán a usted.

(Translated): After each rating you provide regarding your agreement with each of the statements, you will be presented with new information. This information is the average of the ratings that 8 participants who have already participated and completed this study have made on the same statements that will be presented to you.

Random

(Original): Después de cada valoración que proporcione sobre su grado de acuerdo con cada una de las afirmaciones, se le presentará una nueva información. Esta información es sólo un número que el programa elegirá al azar.

(Translated): After each rating you provide regarding your agreement with each of the statements, you will be presented with new information. This information is just a number that the program will randomly choose.