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# The Effects of Source Expertise and Trustworthiness on Recollection: The Case of Vaccine Misinformation

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**Data availability:** The data that support the findings of this study are openly available on Open Science Framework at https://osf.io/3zkmd/.

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**Abstract**

Designing effective communication strategies for correcting vaccines misinformation requires an understanding of how the target group might react to information from different sources. The present study examined whether erroneous inferences about vaccination could be effectively corrected by a perceived credible (i.e., expert or trustworthy) source. Two experiments are reported using a standard continued influence paradigm, each featuring two correction conditions on vaccine misinformation. Participants were presented with a story containing a piece of information that was later retracted by a perceived credible or not so credible source. Experiment 1 showed that providing a correction reduced participants' use of the original erroneous information, yet the overall reliance on misinformation did not significantly differ between the low- and high-expertise correction groups. Experiment 2 revealed that a correction from a high-trustworthy source decreased participants' reliance on misinformation when making inferences, nonetheless it did not positively affect the reported intent to vaccinate one's child. Overall, source trustworthiness was more relevant than source expertise.

*Keywords*: vaccine misinformation; source credibility; vaccination intent; belief updating

## Introduction

Despite being lauded as one of the greatest public health achievements of the 20th century, vaccines are losing public confidence (Larson et al. 2011), to the extent that some experts have described the problem as "a crisis of public confidence" (Black and Rappuoli 2010, p. 1) and a "vaccination backlash" (Shetty 2010, p. 970). Misinformation about vaccine safety and efficacy is just one of several challenges that immunization programs have to deal with. Scandals involving politicians, journalists and pseudo-scientists also make it difficult for communicators to set the record straight on vaccination (Myers and Pineda 2009).

It is difficult to replace misinformation with accurate facts because, even if individuals are presented with blatantly false information, they persist in biased reasoning and are highly resistant to correction attempts (Lewandowsky et al. 2012). In the case of vaccine misinformation, several psychological mechanisms render misinformation particularly "sticky" and/or pro-vaccination beliefs counter-intuitive (Miton and Mercier 2015). These include confirmation bias (the propensity to seek out information that confirms one's pre-existing beliefs about vaccination; Voinson et al. 2015), omission bias (the tendency to prefer a potentially harmful inaction – an act of omission, as in the case of non-vaccination – over a potentially less harmful act – an act of commission, as in the case of vaccination; Brown et al. 2010), or the feelings of "overconfidence" regarding one's own knowledge about a topic (Motta et al. 2018). In light of these complexities, corrective efforts can often be ineffective or even yield unintended and undesirable consequences (Cook and Lewandowsky 2011; Lewandowsky et al. 2012). For instance, pro-vaccination messages repeating the myth that vaccines cause autism in order to debunk it can actually strengthen familiarity with the misinformation, paradoxically increasing the likelihood that people will recall it and assume it to be true (Nyhan et al. 2014; Pluviano et al. 2017; Pluviano et al. 2019). However, while several studies indicate that the best strategy to counter vaccine misinformation is to emphasize the facts instead of drawing further attention to false information (e.g. Nyhan et al. 2014; Pluviano et al. 2017; Pluviano et al. 2019; Peter and Koch 2016), other recent accounts suggest that if a myth is not repeated when corrected, the associated lack of salience, conflict detection, and myth/correction co-activation may be equally or even more detrimental to belief updating than the boost of the myth's familiarity (Swire et al. 2017). Anyhow, any pro-vaccination campaign will fall short when it crafts messages only based on what it intends to promote, without addressing existing perceptions and individual scepticism about scientists (Larson 2018).

**The issue of credibility in experts and science**

Not all communications are equally persuasive; the perceived credibility of the source of information delivering the message is an important component of a sound pro-vaccination campaign (Guillory and Geraci 2013; Schmidt et al. 2016). Therefore, designing effective communication strategies for correcting vaccines misinformation requires an understanding of how the target group might react to different sources of information (Kumkale et al. 2010). One critical question concerns the credibility of different sources that inform people's vaccination decisions (Yaqub et al. 2014). Unfortunately, researchers and practitioners find it difficult to design effective pro-vaccination messages for two reasons. First, few principles of message persuasiveness derive from effective attempts to change anti-social or unhealthy attitudes and behaviours (Crano and Burgoon 2002; McNeill et al. 2017), while many refer to quite distant contexts such as advertising (e.g., Gotlieb and Sarel 2013; Nan 2013). Therefore, the pro-vaccination messages are not properly informed by relevant theory and previous research. Second, as mentioned above, the messages can backfire, yielding unintended and undesirable repercussions. The present study seeks to address the important yet neglected issue of the impact of source credibility on the efficacy of pro-vaccination messages.

Most theories of persuasion predict that highly credible sources produce more belief and attitude changes than less credible ones (Petty and Cacioppo 1986; Pornpitakpan 2004). The present study refers to the most common notion of credibility in psychology and communication research, which rests largely on perceptions of credibility of the information source as interpreted by the information receiver. This notion encompasses two core dimensions: *expertise*, namely the extent to which the communicator is perceived to be capable of making correct assertions, and *trustworthiness*, that is the willingness of the communicator to provide the assertions he or she considers most valid (Hovland et al. 1953). The expertise and trustworthiness dimensions may have differential weights in affecting belief and attitude change and assessing them in combination may obscure the complexity of the source evaluation (Pornpitakpan 2004). For example, Guillory and Geraci (2013) analysed the individual contribution of source trustworthiness and expertise in reducing political misinformation, revealing that source expertise was not sufficient to reduce erroneous inferences, while the trustworthiness of the source was the critical factor that led people to correct their inferences. However, they argued that the expertise of the source could be more relevant in other contexts, such as in medical decision making, and encouraged further studies to test this hypothesis.

As science communicators well know, communication is not just about logic and knowledge, but also about emotions. When it comes to sensitive topics such as vaccinations, credible experts like doctors or scientists may earn the audience's respect, but not necessarily their trust (Benegal 2018; Fiske and Dupree 2014). Public evaluations of expertise may indeed be independent from the source's technical knowledge or credentials and can be misled by emotions and gut feelings. For instance, one may trust a certain celebrity or a politician simply because he/she claims to have the public's best interest at heart, or rely on vaccines-hesitant parents thinking that no parent would ever do something bad for their child

(Archer 2014). Numerous studies on vaccine hesitancy in the US and UK (e.g., Freed et al. 2011; Marlow et al. 2007; Salmon et al. 2005) have found that distrust in the healthcare system may contribute to under-immunisation. The same worrying relationship exists in developing countries. For example, a recent study by Woskie and Fallah (2019) exposed how high rates of distrust in the health system contributed to recent Ebola epidemics, which demonstrates how medical distrust may affect universal health coverage.

Acknowledging that trust is pivotal in vaccination decision-making policies (Benin et al. 2006; Mills et al. 2005), the current study provides the first empirical examination of whether erroneous inferences about vaccination could be effectively corrected by a source perceived as credible (i.e., expert or trustworthy). In particular, we seek to evaluate the relative effects of source expertise and trustworthiness on people's ability to disregard misinformation and update their knowledge and memories, and to identify the subsequent effect of the source on people's stated intention to vaccinate their child.

**1. Norming**

A norming study was first conducted to identify high- and low-expert sources, and high- and low-trustworthy sources within the health context. A separate group of participants, who did not take part in the following experiments, was used. This group consisted of 15 students from the University of Edinburgh (4 males, 11 females, mean age 22.4 years, age range 18-33 years), who voluntarily participated in exchange for course credit. Participants read a fictitious story (see Experiment 1) where a piece of information is corrected towards the end of the story. After reading the story, they were given a list of sources of information and asked to imagine that the correction came from the source in question. They were asked to rate the expertise and trustworthiness of each source, using a Likert scale ranging from 1 (= "to little or no extent expert/trustworthy") to 5 (= "to a great extent expert/trustworthy").

Based on the means of participants' ratings, sources of health information were identified as low-credibility, neutral, and high-credibility. The inter-rater reliability was very high, the ICC (intraclass correlation coefficient) was .961 with a 95% confidence interval from .942 to .976 [$F(43, 602) = 29.346$, $p < .001$] (a report on the norming study is presented in File S1).

## 2. Experiment 1

Both experiments reported in this study used a standard continued influence paradigm (Johnson and Seifert 1994; Wilkes and Leatherbarrow 1988), whereby participants are presented with one piece of information at a time about an unfolding fictional event. The report typically contains a target piece of mistaken information that is later corrected. Participants' understanding of the event is then assessed with an open-ended questionnaire consisting of factual and inference questions. To evaluate whether the correction was effective, the number of clear references to the target piece of mistaken information in participants' responses is tallied.

Experiment 1 examined the individual's ability to disregard vaccine misinformation and adjust behaviour accordingly, when the correction is provided by a source of information deemed to be high or low in expertise.

### *2.1 Method*

*Participants.* Due to this being the first study to test the effects of source credibility in the vaccines context, no specific effect size estimate was available to guide *a priori* power analysis. However, in line with previous literature on source credibility (Guillory and Geraci 2013), we tested a total of N = 90 participants, all undergraduate students from the University of Edinburgh (25 men, , 65 women, mean age 18.91 years, age range 18-35 years), who participated on a voluntary basis and received course credit in exchange for their participation. Participants were tested individually. A quasi-random method of condition allocation was used whereby participants were assigned alternatively to 1 of 3 conditions, namely the *High-expertise Correction* condition, the *Low-expertise Correction* condition, or the *Baseline No-correction* condition (30 per condition). The study received ethical approval from the University of Edinburgh's Ethics Committee.

*Study design.* A between-subjects design was used with condition (two correction conditions and a baseline no-correction condition) as the independent variable, while the dependent variables were (a) the accuracy of recall (free-recall and fact-recall score), and most importantly, (b) the extent to which misinformation persists in one's memory (use of the original information to answer inference questions) and (c) the intention to vaccinate one's child (vaccination intent). For multiple comparisons between groups, Tukey's HSD correction method was applied. Significance was set at $p < .05$ for all analyses. Two principal hypotheses were formulated:

> *H1*: Participants will be less likely to use the original misinformation to answer inference questions when receiving a correction from a high-expert source than from a low-expert source.
>
> *H2*: Participants who rely more on misinformation will report a lower intention to vaccinate their own child.

Hypothesis 1 derived from the literature on source credibility effects showing that highly credible sources have proven to be more persuasive than less credible sources (Hovland et al. 1953; Pornpitakpan 2004). Furthermore, as suggested in a recent study by Jennings and Russel (2019), individuals who are convinced that the source delivering the corrective information is credible will spend more time and energy considering that information and will be more likely to incorporate it when forming later judgments and decisions and developing attitudinal dispositions. Hypothesis 2 was based upon recent studies showing the ineffectiveness of efforts to combat health misinformation and to increase intent to vaccinate a future child (Nyhan and Reifler 2015; Nyhan et al. 2014; Pluviano et al. 2017; Pluviano et al. 2019).

### *2.2 Procedure*

Participants read a fictitious story about a child developing ADHD (attention deficit hyperactivity disorder) after receiving the vaccine against "*Brainpox*" (the full story is presented in File S2), described as a serious illness. This story contained a critical piece of information – a rumour claiming a link between this vaccine and ADHD. In the two correction conditions, the *High-* and *Low-expertise Correction* conditions, a message specifically asserted that this rumour was incorrect. In the baseline no-correction condition, this information was not corrected. For both correction conditions, participants received the correction from one of the sources of information as identified during the norming study (a report on the norming study is presented in File S1).

For Experiment 1, in the *High-expertise Correction* condition the correction came from "*Websites from doctor groups like the British Association of General Paediatrics*" as a source with a high level of expertise (M = 4.07, SD = .88), while in the *Low-expertise Correction* condition the correction came from "*Celebrities*" as a source with a low level of expertise (M = 1.33, SD = .62). The high- and low-expert source of information did not differ regarding their degree of trustworthiness t(14) = 1.848, p = .086, (M = 2.73, SD = .7 and M = 2.06, SD = .97, respectively).

After reading the story, all participants were exposed to a rehearsal-preventing distractor task lasting 2 minutes, during which they were asked to count backwards by 3. Then, they were given a *free-recall test*, in which they were asked to write everything they remembered reading in the story as accurately as possible. After, participants completed a questionnaire (the questionnaire is presented in File S3) including specific questions about the story. The first eight questions (*fact-recall questions*) were designed so that participants could answer them by recalling the literal content of the story, while the following eight (*inference questions*) were designed so that participants could answer them by making their own judgments, claims, or predictions about the elements presented in the stories, not just to recall them (as in the free-recall and fact questions). Inferential questions are of the utmost importance because they may show the ongoing impact of misinformation on people's memory, even after clear retractions. For example, when people make inferences regarding the causal chain leading up to an event (e.g., the onset of a disease), misinformation (e.g., the false claim of a connection between the vaccine and the disease, that is later corrected) is often relied upon, even when people accurately remember its retraction (Ecker et al. 2014). After the inference questions, just for the participants in the correction conditions, there was a retraction-awareness question controlling for insufficient encoding, asking what was the message given by the source providing the correction. Finally, participants rated how likely they would be to give the vaccine against the illness at hand to their own child on a Likert scale ranging from 1 (= "*very unlikely*") to 6 (= "*very likely*").

### *2.3 Results*

*Coding procedure.* A scorer checked all the participants' answers to the retraction-awareness question in order to only include data for those who correctly answered this question, therefore ensuring that results did not reflect differences in participants' ability to recall the retraction statement. All participants recalled the purpose of the message from the source of the correction. Free recall, factual questions, and inference questions were scored by different pairs of judges blind to condition allocation and acting independently. Inter-rater reliability was high ($r$ = .93, .88, .90, respectively).

The free recall test was scored using "*idea units*". Each idea unit corresponded to one of the 14 messages in the story. An idea unit was recorded as being recalled and received a score of 1 if the participant reproduced all or substantial part of its content; otherwise it was scored as absent and received a score of 0. The highest possible individual score was therefore 14.

Factual questions were scored 1 for correct responses and 0 for incorrect responses. Responses containing partially correct information were given a score of 0.5. Since 8 factual recall questions were presented, the maximum possible score was 8.

Inference questions were scored 0 or 1. Responses wherein participants mentioned ADHD but indicated any disbelief in the vaccine causing ADHD were not scored as 1. Using a strict scoring system, any uncontroverted belief in the vaccine causing ADHD was considered a reference to the original and incorrect information and was scored as 1, while 0 was assigned to all "other" responses, including comments about the benefits of vaccines or worries over their safety but not the use of the original and incorrect information (the alleged link between the vaccine and ADHD). For example, for question no. 9 "How do you think the baby's body responded to the vaccine?", answers receiving a score of 1 were: "The baby has seemed to develop ADHD from this vaccine because it has altered his brain" or "I think that the diagnosis of this child is caused by the vaccination", while answers receiving a score of 0 were "[The baby's body responded] in the way that was expected" or "His immune system had to learn to fight off the tiny sample of the disease contained in the vaccine. This is what caused him to feel uneasy for a short while". Since 8 inference questions were presented, the maximum score achievable was 8. Means and standard deviations for Experiment 1 are presented in Table 1.

--------------- Insert Table 1 approximately here ---------------

*Accuracy of recall.* Results from the free recall test revealed that participants' overall recall performance did not differ across conditions, $F(2, 87) = .478$, $p = .622$. Likewise, there was no difference in participants' ability to answer factual questions across conditions, $F(2, 87) = 1.734$, $p = .183$.

*Inferential reasoning.* Participants' responses to inference questions were influenced by condition, $F(2, 87) = 4.058$, $p = .021$, $\eta^2 = .085$. Multiple comparisons using Tukey's HSD test were conducted. Data are reported as mean differences and standard errors. Results showed that participants in the *Baseline No-correction* condition were more likely to refer to the original incorrect information to answer inference questions in comparison to the *High-expertise* ($M = 1$, $SE = .41$, $p = .045$) and *Low-expertise Correction* ($M = 1.03$, $SE = .41$, $p = .037$) conditions. A non-parametric analysis was performed to demonstrate stability of the effects. Results from a Kruskal-Wallis H test demonstrated a statistically significant difference in inference scores among the three groups, $\chi^2(2) = 8.132$, $p = .017$. Pairwise comparisons were performed using Dunn's procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented. This post hoc analysis revealed statistically significant differences in inference scores between the *Baseline No-correction* (mean rank = 56.1) and *Low-expertise Correction* (mean rank = 40.68) ($p = .05$) groups and between the *Baseline No-correction* and *High-expertise Correction* (mean rank = 39.72) ($p = .033$) groups, but not between the *Low-* and *High-expertise Correction* groups.

*Vaccination intent.* Even though there was no effect of condition on vaccination intentions, $F(2, 87) = 1.476$, $p = .234$, there was a significant negative correlation between reference to the original incorrect information across conditions and vaccination intention, $r = -.561$, $p < .01$, showing that the more participants used misinformation to answer inference questions, the less likely they were to state an intention to vaccinate their children.

### *2.4 Discussion*

The hypothesis that source expertise affected the participants' use of the original misinformation to address inference questions was not fully supported, as the overall reference to misinformation did not differ across the two correction groups. There was evidence of a continued influence effect of misinformation on the reported intention of vaccinate one's child. Having investigated hypotheses related to the effects of source expertise, our next experiment turns to the question of source trustworthiness.

## 3. Experiment 2

Experiment 2 examined the individual's ability to disregard misinformation and adjust behaviour accordingly, when the correction is provided by a source of information deemed to be high or low in trustworthiness.

### *3.1 Method*

*Participants.* In line with previous similar studies (Guillory and Geraci 2013) we tested 90 participants. We have to disclose that, mirroring the study by Guillory and Geracy (2013), our original research design included two experiments, each featuring two correction conditions (Experiment 1 – on the role of expertise: *High-expertise Correction* condition and *Low-expertise Correction* condition; Experiment 2 – on the role of trustworthiness: *High-trustworthiness Correction* condition and *Low-trustworthiness Correction* condition). As with Guillory and Geracy (2013), the experimental conditions in both experiments were compared against a single *Baseline No-correction* condition. However, following a Reviewer's comment that the same control data should not be used for both experiments, we recruited new participants to be used as controls for Experiment 2. The analyses reported here are based on the new control data. Participants involved in this experiment were undergraduates (32 men, 58 women, mean age 19.43 years, age range 17-26 years) from the University of Edinburgh who participated in exchange for course credit. As in Experiment 1, participants were assigned to 1 of the 3 conditions, namely the *High-trustworthiness Correction* condition, the *Low-trustworthiness Correction* condition, or the *Baseline No-correction* condition (30 per condition). None took part in Experiment 1.

*Study design.* The study design was the same as in Experiment 1. Two principal hypotheses were formulated:

*H1*: Participants will be less likely to use the original misinformation to answer inference questions when receiving a correction from a high-trustworthiness source than from a low-trustworthiness source.

*H2*: Participants who rely more on misinformation will report a lower intention to vaccinate their own child.

### *3.2 Procedure*

Study materials and procedure mirrored those in Experiment 1 with one exception: in the *High-trustworthiness Correction* condition the correction came from "*Family and friends*" as a source of information with a high level of trustworthiness (M = 3.13, SD = 1.06), while in the *Low-trustworthiness Correction* condition the correction came from "*Television programs*" as a source with a low level of trustworthiness (M = 1.47, SD = .64). Expertise of the high-trustworthy (M = 2.13, SD = .83) and low-trustworthy (M = 2.13, SD = .62) source was held constant across the two correction conditions (a report on the norming study is presented in File S1).

### *3.3 Results*

*Coding procedure.* The coding procedure was identical to that in Experiment 1. A scorer checked all of the participants' answers to the retraction-awareness question. All of the participants recalled the content of the correction statement. Significance was set at $p < .05$ for all analyses. Inter-rater reliability for free recall, factual questions, and inference questions as assessed by different pairs of judges blind to condition allocation was found to be high ($r = .87, .93, .91$, respectively). Means and standard deviations for Experiment 2 are presented in Table 2.

-------------- Insert Table 2 approximately here --------------

*Accuracy of recall*. As in Experiment 1, results from the free recall test showed that the overall recall performance did not differ across conditions, $F(2, 87) = 2.216$, $p = .115$. Likewise, there was no difference in participants' ability to recall factual questions across conditions, $F(2, 87) = .489$, $p = .615$.

*Inferential reasoning.* Participants' responses to inference questions were influenced by condition, $F(2, 87) = 9.319$, $p < .001$, $\eta^2 = .176$. Multiple comparisons using Tukey's HSD test were carried out. Data are reported as mean differences and standard errors. Results showed that participants in the *High-trustworthiness Correction* condition were less likely to refer to the original incorrect information to answer inference questions in comparison to the *Low-trustworthiness Correction* condition ($M = -1.2$, $SE = .36$, $p = .003$) and the *Baseline No-correction* condition ($M = -1.43$, $SE = .3$, $p < .001$). Use of the original information to answer inference questions did not differ across the *Low-trustworthiness Correction* condition and the *Baseline No-correction* condition, $F < 1$. A non-parametric analysis was performed to demonstrate stability of the effects. Results from a Kruskal-Wallis H test demonstrated a statistically significant difference in inference scores among the three groups,

$\chi^2(2) = 18.745$, $p < .001$. Pairwise comparisons were performed using Dunn's procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented. This post hoc analysis revealed statistically significant differences in inference scores between the *Baseline No-correction* (mean rank = 53.43) and *High-trustworthiness Correction* (mean rank = 29.42) ($p = .001$) groups and between the *High-* and *Low-trustworthiness Correction* (mean rank = 53.65) ($p < .001$) groups, but not between the *Baseline No-correction* and *Low-trustworthiness Correction* groups.

*Vaccination intent.* Analogous to Experiment 1, even though there was no effect of condition on vaccination intentions, F(2, 87) = 1.088, $p = .341$, there was a significant negative correlation between reference to the original incorrect information across conditions and vaccination intention, $r = -.358$, $p < .01$. This suggests that the more participants used misinformation to answer inference questions, the less likely they were to report that they would vaccinate their children.

### *3.4 Discussion*

The pattern of results replicated those of Experiment 1, as there was no difference in participants' free recall or responses to factual questions across conditions. Furthermore, there was evidence of a continued influence effect of misinformation on the reported intention to vaccinate one own's child. However, a correction received from a high-trustworthy source reduced participants' reliance on misinformation.

## 4. General Discussion

Trust in vaccines is an important element of public health programs (Benin et al. 2006; Mills et al. 2005). In two experiments, we manipulated the credibility of the source of a correction to evaluate the differential impact of source expertise (Experiment 1) and trustworthiness (Experiment 2) on the persistence of vaccine misinformation.

Results from Experiment 1 suggest that simply providing a correction reduced participants' use of the original information, as participants in both correction conditions were less likely to continue using the original incorrect information to answer inference questions compared to participants in the baseline no-correction condition. However, our first hypothesis was not confirmed because the overall reference to misinformation did not differ across the two correction groups; indeed, when the correction in the story came from a more expert (but not more trustworthy) source, participants were just as likely to rely on erroneous information when making inferences about the story as those who received a correction from a less expert source. The null effect of the expertise of the source is noteworthy because it suggests that people may struggle to assess information quality and credibility, which is corroborated by the current lack of public trust in experts and science. Supporting the first hypothesis laid out for Experiment 2, participants were able to reduce their use of the original incorrect information when the correction came from a highly trustworthy source. This was confirmed by the fact that the use of the original information to answer inference questions did not differ across participants exposed to a low-trustworthy correction or to no correction at all. Thus, this finding suggests that source trustworthiness (and not expertise) is crucial in reducing people's reliance on misinformation.

Some studies corroborate our conclusion that source trustworthiness is more important than source expertise in reducing misconceptions; therefore, corrections of misinformation should come from a trusted source (Trembath et al. 2016). In a cross-cultural experiment evaluating different combinations of high and low expertise and high and low trustworthiness, McGinnies and Ward (1980) found that a trustworthy source was more persuasive regardless of whether it was expert or not. A recent study by Swire and colleagues

(2017) corroborates the view that people use sources of information they believe trustworthy, though not necessarily expert, to guide their evaluation of what is true or false and do not necessarily insist on veracity as a prerequisite for supporting a particular viewpoint.

Both experiments reported here supported our prediction that the continued influence of misinformation would be negatively associated with vaccination intention, so that those who continued to rely on invalidated information were also less likely to state an intention to vaccinate their own child. The corrections we provided, regardless of their degree of credibility, did not positively affect the reported intent to vaccinate one's child. The null effect concerning vaccination intention is not surprising and is consistent with the paucity of significant findings of pro-vaccination interventions on vaccine uptake (Jarrett et al. 2015; Nyhan et al. 2014; Pluviano et al. 2017; Pluviano et al. 2019). This null effect may be also partly explained by the role that "belief perseverance" may play during information processing: when confronted with new information that contradicts one's own beliefs, people can unexpectedly hold on even more to their initial beliefs (Anderson et al. 1980; Kunda 1990). In fact, one of the most potent backfire effects of corrective information strategies occurs with topics that align with people's "worldviews" (Cook and Lewandowsky 2011; Hartman and Newmark 2012; Lewandowsky et al. 2017; Miller et al. 2016). There is some research demonstrating that people with strong attitudes and misbeliefs about vaccination may readily discredit information about the safety and effectiveness of a vaccine if this information is framed in a way that clashes with their pre-existing worldviews (Kahan et al. 2010; Rossen et al. 2016). However, much research remains to be done to ascertain whether vaccine misinformation correlates with actual uptake and to what extent deeply-held beliefs could be affected by a correction perceived to come from a trustworthy source. For example, vaccine-hesitant individuals could be more easily persuaded by a message coming from a slightly less vaccine-hesitant individual who they perceive as trustworthy (Miton and Mercier

2015). Furthermore, it would be valuable to establish whether, when confronted with a novel vaccine (for instance, a possible vaccine against Zika virus), people might base their intentions to use it on beliefs about other vaccines (such as the misbelief that MMR causes autism). Recent studies have reported the possibility of dangerous spill-over effects from misbeliefs about one vaccine on intention to use another (Ophir and Jamieson 2018).

Besides prior beliefs, the variability of the effects of corrections could also be due to other individual characteristics, such as sense of identity, adherence to social norms, and past vaccination behaviours (Betsch et al. 2015). In light of the call for greater emphasis on tailoring communication around recipient characteristics (Durantini et al. 2006; Kumkale et al. 2010), future studies should address the effects of these variables. Furthermore, as people are more likely to trust advice from experts from their own ingroup, practitioners might consider employing a spokesperson from the target community to deliver the desired message. Also framing messages so that they are congruent with the worldview of the target group might be beneficial (MacFarlane et al. in press; Wang and Scheinbaum 2018).

Our findings must be interpreted in light of some limitations. Firstly, even though our sample size was in line with previous research (Guillory and Geraci 2013), recruiting a greater sample could have allowed us to more clearly show that the null effects we observed were not due to lack of power. Furthermore, the sample size of the norming study was quite limited and, collapsing across all the sources, the correlation between participants' ratings on the sources' expertise and trustworthiness was high ($r = .79$, $p < .01$). However, the sources we selected are frequently reported to be trusted by parents for vaccine-safety information, including, among others, websites by doctor groups, or family and friends. Nonetheless, it should be noted that levels of trust in specific sources of vaccine-safety information may vary significantly by gender and groups (Freed et al. 2011). Future research should consider this aspect when creating different, tailored strategies. Further experimental investigations are also needed to estimate people's beliefs before delivering informative materials about vaccines. Another potential limitation of our study relates to the source "family and friends" we selected in Experiment 2. Though rather unlikely, we cannot exclude the possibility that participants, when evaluating the credibility of this source, considered their own family and friends rather than those of the mother presented in the story, which could have influenced the results. Furthermore, our sample consisted of university students who have usually not been exposed to real decision making about vaccinating their children; this may limit the generalizability of our results. Also, overall inference scores were relatively low, showing that even in the no-correction condition, participants did not much rely on misinformation in answering inference questions. Likewise, the overall vaccination intentions were quite high, suggesting that our sample was biased towards those with more positive views of vaccines. Another limitation pertains to the use of fictional narratives in the current experiments. A growing literature points to the beneficial use of narratives as educational tools to communicate science to laypeople (e.g., Dahlstrom, 2014; Prins, Avraamidou, & Goedhart, 2017; Ritchie, Tomas, & Tones, 2011). As highlighted by a recent review by Fadlallah and colleagues (2019), the benefits related to employing narratives to impact health policy-making are manifold: narratives are easily understandable and so can facilitate information processing; they have been demonstrated to be both memorable and persuasive; they can add value and emotional appeal to the information provided; and, finally, people can relate to narratives regardless of their level of literacy, expertise or culture. However, our findings could still not apply to real-world communications in a straightforward manner. Future studies might usefully compare narrative communication with other techniques resembling the ones used in real-world immunization programs. Finally, our study design allowed the investigation of main effects only. Given the wide array of variables that are associated with source credibility, interaction effects are of interest "because some of them can dramatically affect the superiority of a high-credibility source such that a low credibility source turns out to be more influential" (Pornpitakpan 2004, p. 266-267). Therefore future research could look into possible relationships between source credibility and other factors that have not yet been thoroughly investigated, such as implicit-explicit refutation as well as recipients' personality traits.

In conclusion, the present study adds to the growing literature demonstrating the persistence of misinformation in memory, showing how difficult effective correction can be. In the specific case of health information, our research showed that corrections are effective as long as they come from a perceived trustworthy source. This finding is noteworthy to better comprehend the loss of public confidence in science and experts.

## Compliance with Ethical Standards

**Conflict of Interest**: The authors declare that they have no conflict of interest.

**Ethical approval**: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent**: Informed consent was obtained from all individual participants included in the study.

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**Supporting Information**

File S1. Norming study

File S2. The story of Sylvia and her child

File S3. Questionnaire items

Table 1. *Means and Standard Deviations for the experimental conditions in Experiment 1*

| | High-expertise Correction (n = 30) | Low-expertise Correction (n = 30) | Baseline No-correction (n = 30) |
|---|---|---|---|
| *Outcome* | *M (SD)* | *M (SD)* | *M (SD)* |
| Free-recall accuracy | 10.33 (1.81) | 10.47 (1.48) | 10.03 (1.96) |
| Factual questions | 6.33 (1.13) | 6.83 (.9) | 6.48 (1.15) |
| Inference questions | 1.17 (1.7) | 1.13 (1.33) | 2.17 (1.72) |
| Vaccination intent | 5.03 (1.16) | 5.13 (1.28) | 4.57 (1.61) |

*Note*. Means and standard deviations of free-recall accuracy rates (out of a maximum of 14), factual and inference questions' scores (out of a maximum of 8; higher means indicate a greater reliance on misinformation), and vaccination intent (measured on a Likert scale ranging from 1 = "very unlikely" to 6 = "very likely") for the *High-* and *Low-expertise Correction* conditions and the *Baseline No-correction* condition.

Table 2. *Means and Standard Deviations for the experimental conditions in Experiment 2*

| | High-trustworthiness Correction (n = 30) | Low-trustworthiness Correction (n = 30) | Baseline No-correction (n = 30) |
|---|---|---|---|
| *Outcome* | *M (SD)* | *M (SD)* | *M (SD)* |
| Free-recall accuracy | 10.4 (1.87) | 9.93 (1.8) | 9.47 (1.46) |
| Factual questions | 6.67 (.94) | 6.7 (.83) | 6.47 (1.17) |
| Inference questions | .5 (1.04) | 1.7 (1.18) | 1.93 (1.8) |
| Vaccination intent | 5.4 (.93) | 5 (1.36) | 5.03 (1.16) |

*Note*. Means and standard deviations of free recall accuracy rates (out of a maximum of 14), factual and inference questions' scores (out of a maximum of 8; higher means indicate a greater reliance on misinformation), and vaccination intent (measured on a Likert scale ranging from 1 = "very unlikely" to 6 = "very likely") for the *High-* and *Low-trustworthiness Correction* conditions and the *Baseline No-correction* condition.