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Citation for published version:
Pluviano, S, Watt, C, Ragazzini, G & Della Sala, S 2019, 'Parents' beliefs in misinformation about vaccines are strengthened by pro-vaccine campaigns', *Cognitive Processing*, vol. 20, no. 3, pp. 325-331. https://doi.org/10.1007/s10339-019-00919-w

Digital Object Identifier (DOI):
10.1007/s10339-019-00919-w

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Cognitive Processing

Publisher Rights Statement:
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Download date: 12. Oct. 2024

Parents' Beliefs in Misinformation about Vaccines are Strengthened by Pro-vaccine Campaigns

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Abstract

The main objective of this study was to determine whether one of the most commonly employed pro-vaccination strategies based on the "myths vs. fact" format can be considered an effective tool to counter vaccines misinformation. 60 parents were randomly presented with either a control message or a booklet confronting some common myths about vaccines with a number of facts. Beliefs in the autism/vaccines link and in vaccines side effects, along with intention to vaccinate one's child, were evaluated both immediately after the intervention and after a 7-day delay to reveal possible backfire effects. Data provided support for the existence of backfire effects associated with the use of the myths vs. fact format, with parents in this condition having stronger vaccine misconceptions over time compared with participants in the control condition. The myths vs. fact strategy proved to be ineffective. Efforts to counter vaccine misinformation should take into account the many variables that affect the parents' decision-making.

Introduction

Although vaccines are recognized by health authorities and the medical community as an important tool for reducing the incidence of life-threatening diseases, their acceptance among the general population is quite variable (Barrows et al. 2015; Shrivastava et al. 2016). According to recent World Health Organisation estimates (WHO 2018a), 1.5 million children die every year because of diseases that could have been prevented by vaccines. Like other European countries, Italy has recorded a dangerous decrease in childhood vaccination coverage rates, resulting in a widespread measles epidemic in 2017 (WHO 2018b). In an attempt to prevent other outbreaks of potentially fatal diseases across the country, in July 2017 the Italian parliament made vaccinations compulsory for all children up to 16 years of age (Mantovani et al. 2018). Whether mandatory vaccination is the best way to improve vaccine uptake rates remains debated (Editorial 2018). However, ironically many parents no longer perceive a threat from a number of vaccine-preventable diseases, hold misconceptions about the safety of vaccines, and often decide against immunization because they are not confident in medical, public health, and government advice on vaccines (Lewandowsky et al. 2017; Myers and Pineda 2009; Salmon et al. 2005; Smailbegovic et al. 2003).

Research on how people respond to corrections of misinformation has painted a rather pessimistic picture where the most salient misconceptions appear to be widely held, easily spread, and difficult to correct (Cook and Lewandowsky 2011; Cook et al. 2015; Myers and Pineda 2009; Nyhan and Reifler 2012). This is true also for vaccines misinformation. It has been shown in an online study by Nyhan, Reifler, Richey and Freed (2014) and in Pluviano, Watt and Della Sala's (2017) previous laboratory experiment with university students that campaigns intended to correct misinformation about vaccines are likely to have little or no effect or even backfire by entrenching anti-vaccination beliefs.

These difficulties in belief updating account for some of the uncertainty of immunization providers about how best to communicate with parents. One of the most commonly employed strategies used to debunk myths relies on the use of the "myths vs. facts" format, which is based on the idea of reiterating myths and then discrediting them with a number of facts (Yeh and Jewell 2015). To illustrate, the myth is usually presented in form of a highlighted statement (e.g., "There is a link between the measles, mumps, and rubella (MMR) shot and autism"), followed by a longer passage that contrasts it with scientific data about the actual situation (e.g., "Scientists have carefully studied the MMR shot. None has found a link between autism and the MMR shot"). In many cases, myths and facts are identified by clear labels or are directly followed by short claims such as "False!" and "True!", respectively (Peter and Koch 2016).

A key problem with this technique is that repeating myths might contribute to increasing their acceptance due to their perceived familiarity. Several studies suggest, in fact, that people are more swayed when they hear an opinion more than once, confounding its familiarity with its validity (Dechêne et al. 2010; Weaver et al. 2007). The familiarity boost associated with this type of correction can be so counterproductive that it may cause a "familiarity backfire effect", such that the correction inadvertently increases individuals' beliefs in the very myth it is aiming to debunk (Cook and Lewandowsky 2011; Lewandowsky et al. 2012; Swire et al. 2017). A number of studies have reported that myths are often misremembered as facts over time, corroborating the idea that campaigns using the myths vs. facts format may do more harm than good toward positive health behaviour (Nyhan et al. 2014; Peter and Koch 2016; Pluviano et al. 2017; Skurnik et al. 2005).

However, another theoretical framework that focuses on the salience of the misinformation during the correction suggests that repeating misinformation in the course of a retraction could facilitate memory updating. According to the co-activation hypothesis

advanced by Kendeou and O'Brien (2014), refutation texts that directly state a belief incorrectly held by the reader and then refute that belief elicit the activation of both the erroneous and new information – the necessary first step in the knowledge revision process (Kendeou et al. 2014). Consistent with this view, Pashler, Kang and Mozer (2003) found that reviewing erroneous information actually improves storage of new information. Similarly, according to Stadtler, Scharrer, Brummernhenrich and Bromme (2013), as well as Putnam, Wahlheim and Jacoby (2014), the detection of conflicting information, which is arguably more likely to occur if the correction explicitly refers to both the invalidated information and the new correct information, is beneficial for memory updating. Indeed, a study by Ecker, Hogan and Lewandowsky (2017) found that an explicit reminder or repetition of misinformation in the course of its retraction effectively reduces people's reliance on misinformation because it makes both the falsity of the misinformation and the conflict between the outdated and updated event representations salient. Finally, in the specific context of health misinformation, a study by Cameron and colleagues (2013) revealed that people exposed to facts, myths, and evidence to counteract those myths may gain more knowledge regarding a specific health topic and have a better recall accuracy than those merely presented with factual information.

Therefore, we face a conundrum: while some accounts indicate that the best strategy to counter vaccine misinformation is to emphasize the facts instead of drawing further attention to false information to avoid a familiarity backfire effect, other 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).

Systematic reviews on the strategies for reducing vaccine hesitancy concluded that there is no convincing evidence to support one intervention over the other (Dubé et al. 2015; Sadaf et al. 2013). Acknowledging the need to identify the best ways to convince hesitant parents in an age of internet-fed misinformation, the current study aims to determine whether the myths vs. facts format can be considered an effective tool to counter vaccines misinformation. Practical implications stemming from our previous research on vaccine decision-making (Pluviano et al. 2017) were somewhat limited, or at least tentative, because we tested university students who are not typically involved with the decision to vaccinate their child. Instead, acknowledging that parental choice to decline childhood vaccinations is widely recognised as an important factor in suboptimal uptake (Brown et al. 2010; Tickner et al. 2006), the current study tests parents, rather than university students.

Methods

Participants

A total of 60 Italian parents attending pediatricians' surgeries and nurseries in three Italian Regions were recruited for participation in the current study. Participants were divided into two groups, and randomly assigned half to the control group (5 males and 25 females, average age M = 38.06, SD = 4.55 years) and half to the experimental group (2 males and 28 females; average age M = 32.2, SD = 5.52 years). The control group was given the condition "No Myths vs. Facts Correction"; the experimental group the condition "Myths vs. Facts Correction". 41 participants had a high school education, while 19 had an academic degree. Both participants and researchers were blind to condition allocation. The study received ethical approval from the University of Edinburgh's ethic panel. Written informed consent was obtained from each participant.

Questionnaires

All participants in the study completed two questionnaires, which have been used in previous studies (all intervention materials are presented in File S1) (Nyhan et al. 2014; Pluviano et al. 2017). The first one was a preliminary survey aimed at assessing participants' baseline beliefs and attitudes towards vaccines. It consisted of 8 items covering common stances from both the pro- (e.g., "Getting vaccines is a good way to protect my future child(ren) from disease") and the anti-vaccination side (e.g., "Some vaccines cause autism in healthy children"). Participants were asked to indicate their degree of agreement to each statement on a 5-point Likert scale, ranging from 1 (= strongly disagree) to 5 (= strongly agree). The second questionnaire was a post-manipulation survey that assessed whether and how participants' beliefs and attitudes toward vaccines changed compared to the baseline measure. It consisted of three items. The first item ("Some vaccines cause autism in healthy children") evaluated general misconceptions about vaccines causing autism on a 5-point Likert scale, ranging from 1 (= strongly disagree) to 5 (= strongly agree). The second item ("Children vaccinated against measles, mumps, and rubella will suffer serious side effects") investigated beliefs about vaccine side effects on a 6-point Likert scale, ranging from 1 (= very unlikely) to 6 (= very likely). Lastly, the third item asked participants to evaluate how likely they would be to give the MMR vaccine to their child on a 6-point Likert scale, ranging from 1 (= very unlikely) to 6 (= very likely). This post-manipulation survey was given twice, immediately after the intervention and after a 7-day delay to evaluate the longevity and robustness of the observed effects.

Conditions

The control group (condition: *No Myths vs. Facts Correction*) read some tips to help prevent medical errors and get safer healthcare, drawn from the AHRQ's (Agency for

Healthcare Research and Quality) website. The experimental group (condition: *Myths vs. Facts Correction*) participants received a booklet confronting 10 "myths" with a number of "facts". Each page of the leaflet contrasted a popular erroneous belief about vaccination with established evidence intended at decreasing the acceptance of that myth. The text for this intervention, which was taken nearly verbatim from the WHO's (World Health Organization) website, was displayed in a columnar format, with the "myth" and "fact" headings on each column to avoid any ambiguity. The length of each myth and fact was matched to reduce the risk of individuals attending more to one text than the other.

Procedure

Participants were informed at the outset that the experiment consisted of two parts, both seeking to gather their opinions about vaccines. After providing some demographic details (i.e., gender, age, educational level), they completed the preliminary survey. Next, they were randomly assigned to conditions. Participants then completed the post-manipulation survey (*Time 1*), evaluating their beliefs in the link between vaccines and autism, in vaccines side effects, and vaccination intention. After a 7-day delay, they participated in the second wave of the study during which the same post-manipulation questions were asked (*Time 2*). Finally, participants were carefully debriefed. We opted for a 7-day delay between the two tests as suggested by Nyhan et al.'s (2014) study and to allow a straight comparison with our own previous study (Pluviano et al. 2017). The delay between the two tests was because in previous studies individuals drew on the declarative information contained in a leaflet when it was recent and therefore highly accessible. However, even after a short delay, as this information faded from memory, they increasingly misremembered myths as facts (Schwarz et al. 2007; Skurnik et al. 2005).

Three key outcomes were evaluated: individual beliefs in vaccines causing autism (*Vaccines Cause Autism*) and side effects (*Vaccines Side Effects*), and intention to vaccinate (*Vaccines Hesitancy*). As these outcomes were collected twice for all the participants, our study design consisted of one between-subject variable (*Conditions*) with two levels (*Myths vs. Facts Correction* and *No Myths vs. Facts Correction*), and three within-subject variables (*Vaccines Cause Autism*, *Vaccines Side Effects*, and *Vaccines Hesitancy*), each with two levels (*Time 1* and *Time 2*).

Results

Data were stored and analysed using SPSS (version 20). For ease of interpretation, the item evaluating vaccination intent was reverse-coded so that higher values indicated higher vaccine hesitancy. Therefore, all 3 key outcomes were in the same direction as higher means indicated stronger vaccine misconceptions.

To determine whether correction interventions had a time-varying effect or resulted in null effect on vaccination attitudes, different mixed-design ANOVAs were performed on the whole sample, with independent measure on conditions (treated as a between-subjects variable) and repeated dependent measures on the three items/outcomes of the post-manipulation survey, i.e., *Vaccines Cause Autism*, *Vaccines Side Effects*, and *Vaccines Hesitancy* (treated as within-subjects variables). When significant interactions between conditions and time were found, separate estimates of simple main effects were carried out.

Finally, to test whether the difference between outcomes measurements at Time 1 and Time 2 was statistically significant, we created "change scores" for each of the 3 key outcomes (*Vaccines Cause Autism*, *Vaccines Side Effects*, and *Vaccines Hesitancy*), which were computed as the difference between mean outcomes scores at Time 2 vs Time 1. Significance was accepted at $p < .05$ for all statistical analyses. Table 1 indicates means and

standard deviations for the outcomes at Time 1 and Time 2 in the two subgroups. Following Table 1, the three sub-sections address our three key outcome measures.

Table 1. **Descriptive statistics (means and standard deviations) for the outcomes at Time 1 and Time 2 in the two subgroups.**

	No Myths vs. Facts Correction				Myths vs. Facts Correction			
	Time 1		Time 2		Time 1		Time 2	
Outcomes	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Vaccines Cause Autism	2.37	.89	2.17	.83	2.27	.74	2.63	.76
Vaccines Side Effects	2.5	.82	2.13	.73	2.53	.73	3	.87
Vaccines Hesitancy	2	1.2	2	1.29	1.9	1.02	1.83	.87

Beliefs in vaccines/autism link

Concerning beliefs in the vaccines/autism link, there was a statistically significant interaction between correction interventions and time [$F(1, 58) = 14.133$, $p < .001$, partial $\eta^2 = .196$]. The data in the conditions by time interaction are detailed in Figure 1A. Simple main effect for condition revealed that there was a statistically significant difference in these beliefs between interventions at Time 2 [$F(1, 58) = 5.102$, $p = .028$, partial $\eta^2 = .081$]. Indeed, beliefs in the vaccines/autism link were significantly greater in the Myths vs. Facts condition (M = 2.63, SD = .76) compared to the No Myths vs. Facts (M = 2.17, SD = .84) condition. Simple main effect for time confirmed that there was a statistically significant effect of time on beliefs in the vaccines/autism link for both the Myths vs. Facts [$F(1, 29) = 9.021$, $p = .005$, partial $\eta^2 = .237$] and No Myths vs. Facts condition [$F(1, 29) = 5.118$, $p = .031$, partial $\eta^2 = .150$]. Pairwise comparisons indicated that these beliefs were statistically significantly higher at Time 2 compared to Time 1 for the Myths vs. Facts condition (M = .367, SE = .122, p =

.005) and, conversely, lower at Time 2 compared to Time 1 for the No Myths vs. Facts condition (M = -.200, SE = .088, p = .031). Furthermore, there was a significant difference between the two conditions in *Vaccines Cause Autism Change Score* [F(1, 58) = 14.133, p < .001], with the Myths vs. Facts condition leading to larger changes in scores and therefore strongest beliefs in vaccines causing autism (M = .37, SD = .67), compared to the No Myths vs. Facts condition (M = -.2, SD = .5).

Beliefs in vaccines side effects

Concerning beliefs in vaccines side effects, there was a statistically significant interaction between conditions and time [F(1, 58) = 19.852, p < .001, partial η^2 = .255]. The data in the conditions by time interaction are detailed in Figure 1B. Simple main effect for condition revealed that there was a statistically significant difference in these beliefs between interventions at Time 2 [F(1, 58) = 17.441, p < .001, partial η^2 = .231]. Indeed, beliefs in vaccines side effects were significantly greater in the Myths vs. Facts condition (M = 3, SD = .87) compared to the No Myths vs. Facts condition (M = 2.13, SD = .73). Simple main effect for time revealed that there was a statistically significant effect of time on beliefs in the vaccines side effects for both the Myths vs. Facts [F(1, 29) = 9.733, p = .004, partial η^2 = .251] and No Myths vs. Facts [F(1, 29) = 10.666, p = .003, partial η^2 = .269] condition. Pairwise comparisons indicated that these beliefs were statistically significantly higher at Time 2 compared to Time 1 for the Myths vs. Facts condition (M = .467, SE = .15, p = .004) and, conversely, lower at Time 2 compared to Time 1 for the No Myths vs. Facts condition (M = -.367, SE = .112, p = .003). Furthermore, there was a significant difference between the two conditions in *Vaccines Side Effects Change Score* [F(1, 58) = 19.852, p < .001], with the Myths vs. Facts condition leading to larger changes in scores and therefore strongest beliefs

in vaccines side effects (M = .47, SD = .82), compared to the No Myths vs. Facts condition (M = -.37, SD = .61).

Vaccines hesitancy

Concerning vaccine hesitancy, there was no statistically significant interaction between interventions and time [F(1, 58) = .326, p = .570, partial η^2 = .006]. Simple main effects for condition revealed that there was no statistically significant difference in vaccination intentions between the two groups [F(1, 58) = .226, p = .636, partial η^2 = .004]. Also, simple main effects for time showed that there was no statistically significant effect of time on vaccination intentions regardless of group [F(1, 58) = .326, p = .570, partial η^2 = .006].

Figure 1. Mean scores of the 3 key outcomes evaluated: *Vaccines Cause Autism* (A), *Vaccines Side Effects* (B), and *Vaccines Hesitancy* (C) by condition and time.

----------Insert Figure 1 approximately here----------

Discussion

Numerous strategies have been attempted in an effort to increase vaccination rates (Jarrett et al. 2015). However, debate continues about the best ways to convince hesitant parents to vaccinate their children, mainly because extant studies often have a limited scope, differ in approach, and contradict one other (Kupferschmidt 2017). This is very much the case for one of the most commonly employed strategies to counter vaccine misinformation: the myths vs. facts format. While a number of studies warn about correcting misinformation in this way because it is often ineffective and even counterproductive (Nyhan et al. 2014; Peter and Koch 2016; Pluviano et al. 2017; Skurnik et al. 2005), other studies revealed a

stronger belief updating with explicit repetitions of misinformation while correcting (Ecker et al. 2017; Pashler et al. 2013; Stadler et al. 2013; Putnam et al. 2014; Kendeou and O'Brien 2014; Kendeou et al. 2014).

The present study aimed to assess the potential effectiveness of the myths vs. facts strategy to address vaccine hesitancy, focusing on its impact on belief changes and vaccination intention in parents. Results provided support for the existence of backfire effects associated with the use of this information strategy, with participants in the Myths vs. Facts condition having stronger vaccine misconceptions over time, both in terms of beliefs in the vaccines/autism link and in vaccines side effects, compared with participants in the No Myths vs. Facts condition. As for vaccination intention, the analyses did not reveal any significant differences between the Myths vs. Facts and No Myths vs. Facts conditions. However, this is not particularly surprising considering Italy's recent introduction of compulsory vaccination which coincided with the period when we were gathering data and which means that Italian parents no longer have a choice over whether or not to vaccinate against MMR. Overall, this study lends support to the psychological research showing that the myths vs. facts technique, which is one of the most common strategies adopted to counteract vaccine misinformation, is ineffective on its own. Indeed, using this technique may cause a familiarity backfire effect, unintentionally cementing the ideas one intends to correct, as people tend to mistake repetition for truth and judge something that sounds familiar as correct, regardless of whether it is factually true or false (Peter & Koch 2016). Therefore, instead of repeating vaccination myths, a more effective strategy is to clearly state that vaccinations are safe and to emphasize the scientific consensus around their need and effectiveness (Schwarz et al. 2016).

Clearly, countering vaccines misinformation with education, providing people with more or better information, is necessary but not sufficient to address the issue (Kata, 2012). Vaccination misinformation is, in fact, intertwined with a range of subtle cognitive

mechanisms and biases such as motivated reasoning (clinging to pre-existing beliefs despite contrary evidence to avoid cognitive dissonance; Festinger 1957).

Furthermore, measures countering misinformation should also be informed by the larger political, technological, and societal context. For instance, factors likely to influence parents' decision-making may include the salience of social norms, vaccination uptake in the population, and the presence of structural barriers in terms of access to vaccination and potential financial costs (Betsch et al. 2015). Also, to counteract the loss of societal fear, it is critical to communicate the risks associated with the diseases in an accessible way (Myers and Pineda 2009). Relying solely on the myths vs. facts strategy, or on any other single strategy, is at best ineffective if not counterproductive. Rather, different pro-vaccination messages should be prepared for different portions of the population according to their characteristics (WHO 2017). Ultimately, seeking immunizations is fundamentally a matter of trust. The parents' trust in their doctor and, more generally, in science and institutions also plays a part in shaping individual vaccination decisions (Kupferschmidt 2017). Misinformation research suggests that expertise may not be a very relevant factor here; rather, when people encounter a piece of information, they ask themselves whether and to what extent it fits in with what other people – and particularly trusted others – already believe, which obviously may introduce biases if what other people believe is based on misinformation (Festinger 1957; Guillory and Geraci 2013).

Our results have limitations that are worth nothing. First, the sample used was relatively small, though it generalizes well to the population of parents who are exposed to information, and misinformation, regarding the risks of vaccinating their children. Second, to minimize the complexity of the research design, we did not take into account potential variables that could have influenced our results, pertaining, for instance, to the larger political and societal context (e.g., the impact of newly introduced immunization policies or

participation in cultural events dedicated to vaccines and their use on one's beliefs about vaccination). However, as beliefs can change and evolve dynamically over time, prospective longitudinal research should be carried out to assess the robustness of changes in individual beliefs. Finally, for practical reasons our study relied only on participants' stated intention to vaccinate, which could have been inflated by a social desirability bias.

Conclusions

Taken together, the evidence from this study shows how people exposed to corrections based on the myths vs. facts format might systematically misremember the presented evidence exchanging truth for misinformation, modifying their attitudes accordingly, even after a short delay (Nyhan et al. 2014; Pluviano et al. 2017; Skurnik et al. 2005).

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. Intervention materials