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# Sixty Years Later

## A Replication Study of McGuire's First Inoculation Experiment

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**Abstract:** Inoculation theory was introduced 60 years ago, after McGuire and Papageorgis (1961) published their first study on how resistance to persuasion can be induced. They demonstrated that people who are pre-exposed to weakened arguments against an attitude or position they currently hold (i.e., inoculated) are less affected by a subsequent strong counter-attitudinal message than people who are pre-exposed to arguments consistent with their attitude (i.e., supportive defense treatment) or to no arguments. Although these results significantly impacted both science and practice on a general level, rigid tests of the key theoretical propositions are lacking. We conducted a highly powered replication study ($N$ = 679) and found that an inoculation treatment is more effective in increasing resistance toward persuasion compared to a supportive defense treatment and a no-treatment control condition. Our results were mostly consistent with McGuire and Papageorgis's original work.

**Keywords:** replication, inoculation theory, persuasion, resistance

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In this paper we present a replication study of the first inoculation experiment conducted by McGuire and Papageorgis (1961), who introduced inoculation theory. The question that guided McGuire's research was: How can resistance to persuasion be induced? In an era in which there had been a great emphasis on factors increasing persuasive effects, McGuire and his colleagues shifted the focus to how persuasion could be resisted. They aimed to obtain a better understanding of how people's attitudes could be made resistant to persuasive messages. Today this remains a very relevant and urgent question, because people are now more than ever bombarded with persuasive messages, misinformation, and fake news on topics such as the environment (e.g., climate change), politics (e.g., elections), and health (e.g., COVID-19). Knowledge on how to resist persuasive attacks may help people to protect their current beliefs and attitudes in situations where this is desired and contribute to academic knowledge on resistance to persuasion in a rapidly changing media environment.

Inoculation theory uses a biological metaphor to describe how people can resist persuasion. The theory suggests that people's attitudes can be made resistant to (unwanted) persuasive attempts in the same way the body can be inoculated against a virus. By exposing someone to a weaker version of a virus, the body builds resistance in the form of antibodies that make it more robust to future, stronger attacks from the virus. In the case of persuasion, being exposed to a weakened counterargument against an attitude one holds is supposed to motivate a person to come up with arguments in favor of their position, which bolsters a person's original attitude and helps to resist subsequent stronger persuasive attempts (McGuire, 1964/1981). The inoculation thus helps to build up resistance to future persuasive attempts.

The first experiment that tested the main premises in inoculation theory (McGuire & Papageorgis, 1961) focused on beliefs that have seldomly been attacked in the past. These beliefs were referred to as *cultural truisms*. Cultural truisms are defined as beliefs that are widely shared within a social environment and their validity is unquestioned (e.g., it is good to frequently brush your teeth; democracy is good). These types of beliefs have been proven particularly vulnerable to persuasive attacks, because people are unmotivated and unprepared to defend them. The aim of



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inoculation theory, as conceived of by McGuire, is to make attitudes about these cultural truisms resistant to persuasive attacks. Doing so is very relevant, especially in our present society, in which people face a rising amount of potential misinformation and disinformation. This is for instance evident in the growing number of parents who doubt the necessity of early childhood vaccination (Van Lier et al., 2022). For years, early childhood vaccination was the preferred default, and was regarded as one of the benefits of medical advancement. It is therefore likely that many forewarnings (Cialdini et al., 1981), disclosures (Boerman & van Reijmersdal, 2016), persuasion knowledge (Amazeen & Wojdynski, 2019), warning labels (e.g., Argo & Main, 2004), and "prebunking" (Roozenbeek et al., 2020) originates from inoculation theory. Although the research described above is based on inoculation theory, the studies themselves do not provide a strict empirical test of the originally proposed ideas because essential elements of such an empirical test are missing. Therefore, it is important to focus on a replication of the original study.people never really thought about why vaccination is important and, more pressing, never learned to counterargue anti-vaccination information and bolster pro-vaccination attitudes. As a result, pro-vaccination attitudes are susceptible to persuasive attacks. This may be one reason for a rise in vaccine hesitancy (Casiday et al., 2006). Given the continued importance of inoculation today, solidifying evidence regarding the applicability of the classic theory is imperative.

A typical inoculation treatment involves two steps. First, people need to experience a *threat*. The aim of this step is to create awareness that one's beliefs on a certain issue are vulnerable to a persuasive attack. The threat component motivates people to guard themselves against counter-attitudinal information. Threat can be accomplished implicitly by the mere presence of an unexpected challenge, i.e., counterarguments, or more explicitly by means of a forewarning in which the audience is explicitly told their attitude is likely to be attacked (Compton, 2013). Second, people should be exposed to a refutational pre-emption, which usually consists of weak counterarguments against people's current position as well as a refutation of these counterarguments (Compton et al., 2016).

In their seminal study, McGuire and Papageorgis (1961) first induced threat by pre-exposing participants in the inoculation treatment to weakened counter-attitudinal arguments against people's current attitudes about four cultural truisms. Second, these arguments were subsequently refuted in the message (i.e., refutational pre-emption). This process consisting of a threat and subsequent refutational pre-emption is referred to as the *inoculation treatment* and is assumed to motivate and help people to resist future persuasive attacks. This inoculation treatment was compared with a no-treatment control condition and a treatment in which participants were exposed to a one-sided argumentation that offered evidence in support of their current attitude (i.e., supportive treatment). This was done to demonstrate that an inoculation treatment not only creates more stable attitudes, compared with no treatment, but also outperforms a supportive treatment. A few days after the treatment, participants were exposed to a strong counter-attitudinal message. The results of this study demonstrated that the inoculation treatment resulted in less attitude change after a subsequent attack than a supportive and a no-treatment condition. Based on the findings of McGuire and Papageorgis (1961), the following expectations are formulated and tested in the current replication:

*Hypothesis 1 (H1)*: An inoculation treatment results in more resistance (less attitude change) to the attacking information than a supportive treatment.

*Hypothesis 2 (H2)*: An inoculation treatment results in more resistance (less attitude change) to the attacking information than a no-treatment control condition.

There are several reasons that warrant a replication of the original inoculation study. Inoculation theory had and still has a massive impact on theorizing about (resistance toward) persuasion, social influence, attitude, and behavioral change within various fields such as communication and psychology. In their classic persuasion text, Eagly and Chaiken (1993) describe inoculation theory as the "grandparent theory of resistance to attitude change" (p. 561), highlighting both its longevity and importance to the field of persuasion and resistance. Inoculation theory and its empirical tests have also inspired many other lines of academic research related to inducing resistance toward persuasion and attitude change. Research on media and advertising literacy (e.g., Hindmarsh et al., 2015), as well as parental mediation intervention research (e.g., Clark, 2011) designed to decrease the potential negative effects of media exposure, is primarily based on the assumptions and findings of inoculation theory. Similarly, the extensive field of forewarnings (Cialdini et al., 1981), disclosures (Boerman & van Reijmersdal, 2016), persuasion knowledge (Amazeen & Wojdynski, 2019), warning labels (e.g., Argo & Main, 2004), and "prebunking" (Roozenbeek et al., 2020) originates from inoculation theory. Although the research described above is based on inoculation theory, the studies themselves do not provide a strict empirical test of the originally proposed ideas because essential elements of such an empirical test are missing. Therefore, it is important to focus on a replication of the original study.

Inoculation theory is also used as a foundation for many interventions that are adopted in practice. A well-known example is Project DARE (Drug Abuse Resistance Education), which was designed to "give young people the facts about drugs and alcohol and to 'inoculate' them against negative peer pressure by teaching them self-management and resistance skills" (US Department of Justice, 1988, p. i). All these techniques and interventions are based on the idea that resistance to persuasion can be induced by making an audience aware of the persuasive attempt (i.e., experience of threat), which motivates critical thinking and counterarguing.

Another reason for replicating the propositions of inoculation theory is that the original experimental materials were carefully documented and remain available. Well ahead of his time, McGuire deposited the materials used in his studies with the American Documentation Institute, making replication very feasible. Although the materials and procedures were well documented, the reporting of statistical information and sample size of McGuire and Papageorgis's experiment, as well as subsequent experimental studies on inoculation, is far below current standards. As a result, key questions about their findings, such as how large the effects size is that the inoculation treatment produced, remain unanswered. Additionally, while a meta-analysis on inoculation studies (Banas & Rains, 2010) showed an overall positive effect of inoculation treatments, there are various studies reporting negative or null findings, and to date no direct replication of the original study by McGuire and Papageorgis is available. Interestingly, due to a lack of statistical information provided in the original article, the study that we will replicate was not included in the available meta-analysis (Banas & Rains, 2010). In fact, none of McGuire's work was included in the meta-analysis due to insufficient statistical reporting suggesting a pressing need to replicate this work. Replicating their research would allow it to be accounted for in future meta-analyses of inoculation scholarship.

Additionally, in many follow-up studies on inoculation theory, the essential comparison between the inoculation treatment and the supportive treatment is not made. The meta-analysis on inoculation theory demonstrates that only about half of the included studies make this essential comparison (Banas & Rains, 2010). Without this comparison it remains unclear whether inoculation treatments have a stronger effect on resistance than supportive treatments, which is the core assumption of inoculation theory. Moreover, in the original experiment a within-subjects design with attitude measurements directly after the treatment (T0) and after exposure to the stronger counter-attitudinal message (T1) was adopted. This is the only way in which it is possible to measure whether participants show more resistance toward the subsequent stronger counter-attitudinal message, as a result of the treatment they received. In many follow-up inoculation studies, however, a between-subjects design is used with only an attitude measurement after exposure to the strong counter-attitudinal message. This makes it unclear whether people's attitudes are changed because of the manipulation itself or, as proposed by inoculation theory, whether the treatment makes people more resistant toward the subsequent stronger counter-attitudinal message.

Finally, as stated above, McGuire and Papageorgis tested their ideas in the context of cultural truisms. This means that there was little variety on the belief scores regarding the topics when exposed to the strong counter-attitudinal message, because everybody believed in them (scores > 13 on 15-point scales and small standard deviations). By using truisms (and thus avoiding floor effects), McGuire and Papageorgis ensured that the counter-attitudinal messages would have a lot of room to affect attitudes and, in turn, the interventions would have ample opportunity to help resist attitude change. In many studies, however, often more contested topics are examined, which is likely to result in greater variance in initial attitudes making it more difficult to capture a true inoculation effect (especially in a between-subjects design with one measurement). To summarize, replicating this seminal work will thus yield novel insights and reliable effect size estimates that will help move this theory forward, and do justice to the original work.

## Method

The study was pre-registered at OSF as a registered report. The data and materials can also be found at OSF: https://osf.io/6kphr/

We received approval of the Ethics Board of the second author's university (PC-2021-13778); participants' consent was acquired at all universities where data were collected. All participants were paid (7.50 € when both parts were completed or 2.50 € when they were not invited for Part 2 due to a belief score < 10) or received research participation credits for partaking in this study.

### Design, Procedure, and Measure

The original procedure of McGuire and Papageorgis (1961) was followed as closely as possible. The only major deviations from the original study involved three changes made to overcome design flaws or make the project feasible: (1) In the original experiment four messages on truisms were used to test the effects. In this replication study we used only two truisms: one original and one contemporary to make the project feasible. To select the truisms to use in our study, we conducted a pilot test with 56 students.

On the basis of the outcomes, we selected one original truism ("The effects of antibiotics have, almost without exception, been of great importance to mankind") and one contemporary truism ("It is of great importance to invest in education"). In this way the inclusion of truisms that meet the original criteria (i.e., mean score of 13 or higher) is ensured, but also one of the original truisms is included, allowing us to make use of the original materials, as documented by McGuire. See Electronic Supplementary Material, ESM 1, for more information on the pilot test. Moreover, the original design resulted in participants being exposed to different treatment conditions. This can be perceived as a flaw in the design, as it was not possible to separate the effects of a given experimental condition relative to any interactive effects of participating in multiple conditions. In the current study, participants were thus exposed to two truisms in the same treatment condition. (2) In the original study, there were different versions of the treatment conditions related to active and passive treatments (writing vs. reading, passive/outline vs. underline/no outline). Since the results were the same for these different versions (based on the reported means) and the results were collapsed for hypothesis testing, we asked participants to read the threat and refutational pre-emption and provided participants with counterarguments against potential persuasive attacks (inoculation treatment) or with arguments in favor of the position (supportive treatment). This corresponds to the passive-reading condition in the original study. We selected this approach as it is the most feasible approach and it is most consistent with contemporary inoculation theory research (Banas & Rains, 2010; the active refutation designs are no longer used in inoculation research). (3) The study was conducted online (rather than in the laboratory).

A 3 (treatment: inoculation vs. supportive vs. control) × 2 (time: T0 vs. T1) mixed design was adopted. Treatment is a between-subjects factor and time is a within-subjects factor. Participants were exposed to two truisms (the order was counterbalanced). For both truisms, participants were in the same treatment condition. The data were collected in student pools from the first, second, and last author's universities. As in the original study, the experiment consisted of two sessions. In the first session, participants were randomly assigned to one of the three treatment conditions (on two different truisms). In the *inoculation treatment condition* participants read essays (between 700–800 words) on the truisms, in which some arguments against the truisms were presented and subsequently refuted. In the *supportive treatment condition*, participants read essays (between 700–800 words) offering only arguments in favor of the truisms (the materials can be found in ESM 1). Participants in the *control condition* did not receive a treatment.

After the treatment (T0), participants' beliefs regarding the two truisms were measured by answering the same scale as used in the original study and the pilot test. Belief scores were assessed by asking participants to what extent they believed the truisms were true on a 15-point interval scale (1–3 = *definitely false*, 4–6 = *probably false*, 7–9 = *uncertain*, 10–12 = *probably true*, 13–15 = *definitely true*). The assessment of their belief in the truisms, while this may appear counterintuitive, was assessed after the treatment (but before the stronger persuasive attack 2–7 days later). This follows the original procedure and enables us to establish that the effect is not caused by an increased/decreased belief in the truisms caused by the treatment, but by resistance to persuasion following the persuasive attack at T1. As in the original experiment, participants were explicitly asked to indicate their own belief regardless of the position taken in the treatment message. Participants who had a belief score of < 10 were not invited for the second part of the experiment since initial attitudes toward the topic should be high and great variance between participants is undesirable.

At T1, which took place minimally 2 days and maximally 7 days after the treatment, all participants were exposed to the persuasive attack. The attack messages consisted of essays (between 750–800 words) containing strong arguments against the truisms (see ESM 1). After reading the messages, as an attention check participants answered three simple multiple-choice questions on the content of the message. Participants who failed to answer two out of three questions correctly were redirected to the end of the experiment and were not included in the data analyses. Next, participants' beliefs regarding the truisms were measured again at T1 (using the same measure as at T0).

At the end of the T1 session, participants were debriefed, and it was explained that all the treatment messages and the strong counterargument messages were designed for the purpose of this experiment and were not based on the truth.

## Participants

A total of 1,331 students from three different Dutch universities started the first part of the study (T0). After data collection it appeared 207 participated twice or sometimes even three or four times during T0. We decided to remove all the data of these participants because they could have been exposed to different experimental manipulations, which makes the results of the measurement during T1 unreliable. An additional 92 participants did not finish T0 or did not leave an email address, which was necessary for inviting them for part two and connecting the data of T0 and T1. An unexpectedly large number of participants ($n$ = 188), scored lower than 10 on one or both belief

 

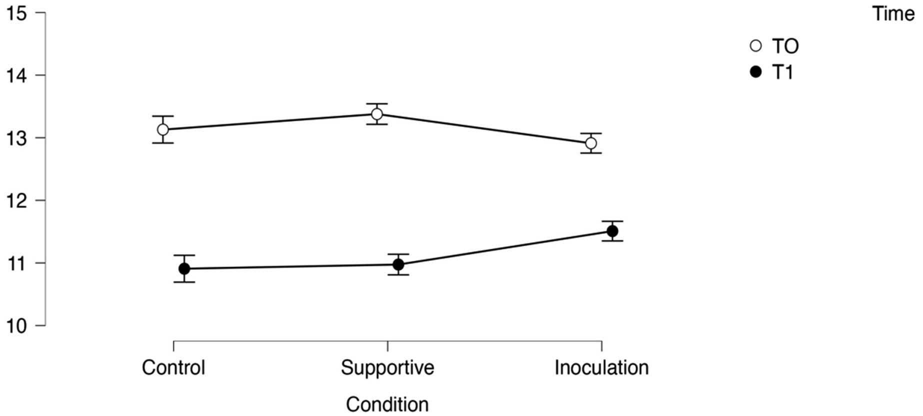


**Figure 1.** Means and confidence intervals of the interaction between condition and time on the average scores on the truisms.

questions and were therefore excluded and not invited for the second part of the study. Overall, 148 participants did not respond to the invitation for T1, and 17 participants did not respond within 2–7 days, as was required. All participants who were not excluded for the reasons described above passed the attention check by correctly answering a minimum of two questions for each message. The unanticipated high dropout means that the total number of included participants was 679 ($n_{\_inoculation}$ = 233, $n_{\_supportive}$ = 234, $n_{\_control}$ = 212). Of these participants, 391 identified as female, 281 as male, five as non-binary, one as other, and one preferred not to say. The mean age was 20.17 years (*SD* = 2.08). The number of participants is lower than indicated by the power analysis that was conducted a priori. This analysis demonstrated that we needed 326 participants per condition to detect the smallest sought-out difference, that is, that between the supportive versus inoculation condition, H1: effect size *f* = .11, CI [.06, .16], as reported in the meta-analysis on inoculation studies of Banas and Rains (2010). See ESM 1 for more information on the power analysis. A sensitivity analysis demonstrated that with the obtained sample size of 679 we can detect an effect size of *f* = .13, which falls within the confidence interval of the effect size reported in the meta-analysis for this effect. The reported effect size in the meta-analysis (Banas & Rains, 2010) of the difference between the inoculation and control condition (H2) is *f* = .21, CI [.19, .24]; our sample size is thus also large enough to detect this effect.

## Results

See ESM 1 for the registered analysis plan. We first conducted a between-subjects ANOVA with treatment (inoculation vs. supportive vs. control) as the independent variable and the average of the two belief scores on the different topics at T0 as the dependent variable to check whether the belief scores on the truisms were similar directly after the treatment. The results demonstrated, contrary to the expectations, a significant difference between the three conditions on the belief scores, $F(2, 676) = 9.74$, $p < .001$, $\eta^2_p = .028$. Bonferroni post hoc tests demonstrated a significant difference between the inoculation (*M* = 12.91, *SD* = 1.20) and the supportive condition (*M* = 13.38, *SD* = 1.13); $p < .001$, CI [.21, .71], effect size *f* = .20. No significant differences were observed between the inoculation and the control condition ($p = .135$) and the supportive and control condition ($p = .07$). The differences between the conditions are quite small and comparable in size to the differences that were observed in the original study. This means that even though participants are requested to answer this question independently from the text they read, the treatment texts did have an effect on their beliefs at T0. This demonstrates the importance of assessing a T0 and a T1 measurement of beliefs.

Because resistance was conceptualized as the change in support for the truisms between T0 and T1, the hypotheses were tested in a repeated measures ANOVA with treatment as the between-subjects factor (inoculation vs. supportive vs. control) and time (T0 vs. T1) as a within-subjects factor. Following McGuire, we tested the hypotheses on the average scores of both truisms (antibiotics and education). The results revealed a main effect of time, $F(1, 676) = 740.06$, $p < .001$, $\eta^2_p = .52$, indicating that participants had higher belief scores directly after the treatment (T0; *M* = 13.14, *SD* = 1.14) compared to after the strong attack message (T1; *M* = 11.13, *SD* = 2.09). Importantly, the analysis also revealed a significant interaction effect between treatment and time, $F(2, 676) = 17.78$, $p < .001$, $\eta^2_p = .05$. Bonferroni post hoc comparisons showed a significant difference between T0 (*M* = 13.13, *SD* = 1.09) and T1 (*M* = 10.91, *SD* = 2.30) in the control condition (mean difference 2.22), $p < .001$, CI [1.83, 2.61], effect size *f* = .66. Also, in the supportive condition a significant difference between T0 (*M* = 13.38, *SD* = 1.13) and T1 was found (*M* = 10.97, *SD* = 1.97, mean difference 2.40), $p < .001$, CI [2.03,



 

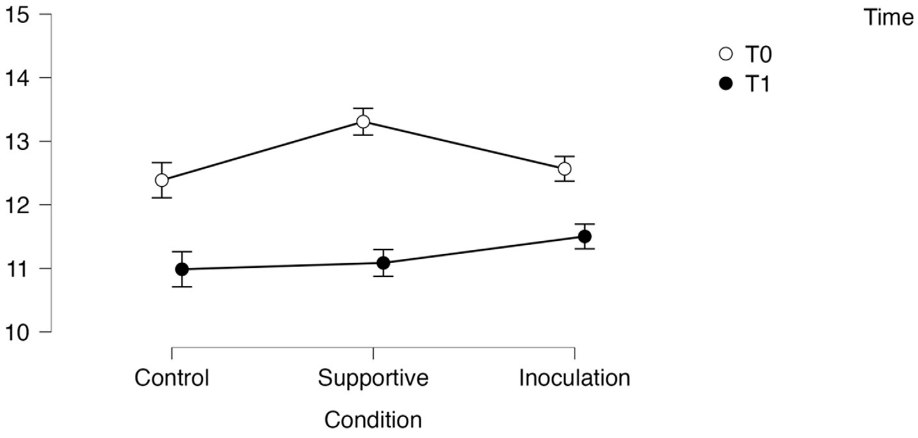


**Figure 2.** Means and confidence intervals of the interaction between condition and time on the antibiotic belief scores.



2.77], effect size $f$ = .715. As expected, the difference appeared smaller, albeit still significant, in the inoculation condition; T0 ($M$ = 12.91, $SD$ = 1.20) and T1 ($M$ = 11.51, $SD$ = 1.99), mean difference 1.40, $p$ < .001, CI [1.03, 1.78], effect size $f$ = .418 (see Figure 1). To test whether the difference scores differ significantly between conditions, a between-subjects ANOVA was conducted with treatment as the independent variable and the difference score (T0–T1) between the average beliefs scores on the truisms as the dependent variable. The analysis showed a significant effect of the treatment, $F(2, 676) = 17.78$, $p$ < .001, $\eta^2_p = .05$. Post hoc tests demonstrated a significant difference between the inoculation treatment ($M$ = 1.40, $SD$ = 1.72) and the supportive treatment ($M$ = 2.40, $SD$ = 1.8), $p$ < .001, mean difference 1.00, CI [0.58, 1.41], effect size $f$ = .26, CI [.15, .37], confirming H1. On the basis of our (conservative) estimation of the size of this effect in the original study, $f$ = .34 (see ESM 1), we can conclude that this effect size falls within the 95% CI of the replicated effect size (Asendorpf et al., 2013). Interestingly the effect size of this replicated effect is substantially larger than the effect size observed in the meta-analysis on inoculation effects (effect size $f$ = .11). There was also a significant difference between the inoculation treatment ($M$ = 1.40, $SD$ = 1.72) and the control condition ($M$ = 2.22, $SD$ = 2.24), $p$ < .001, mean difference 0.82, CI [0.39, 1.25], effect size $f$ = .21, CI [.10, .33]. This confirms H2. Our conservative estimate of this effect size in the original study is $f$ = .43 (see ESM 1). We can conclude that this latter effect size does not fall within the 95% CI of the effect size of the replicated effect (Asendorpf et al., 2013). However, the replicated effect size is very similar to the effect size observed in the meta-analysis on inoculation effects (effect size $f$ = .22).

## Exploratory Analyses

To test whether the effects are different for the two truisms (antibiotics and education), we conducted a three-way repeated measures ANOVA with both time and topic as within-subjects factors and treatment as the between-subjects factor. The results demonstrated a significant three-way interaction between treatment, time, and topic, $F(2, 676) = 10.51$, $p$ < .001, $\eta^2_p = .03$, indicating a difference in treatment effects for the two topics. Therefore, we also conducted repeated measures ANOVAs for the two topics separately.

The repeated measures ANOVA on the antibiotics belief scores revealed a main effect of time, $F(1, 676) = 275.9$, $p$ < .001, $\eta^2_p = .29$, indicating that participants had higher belief scores directly after the treatment (T0; $M$ = 12.75, $SD$ = 1.55) compared to after the strong attack message (T1; $M$ = 11.19, $SD$ = 2.60). Importantly, the analysis also revealed a significant interaction effect between treatment and time, $F(2, 676) = 13.77$, $p$ < .001, $\eta^2_p = .039$. Bonferroni post hoc tests showed a significant difference between T0 ($M$ = 12.39, $SD$ = 1.50) and T1 ($M$ = 10.99, $SD$ = 3.03) in the control condition (mean difference 1.40), CI [.91, 1.90], $p$ < .001, effect size $f$ = .33. Also, in the supportive condition a significant difference between T0 ($M$ = 13.31, $SD$ = 1.49) and T1 was found ($M$ = 11.09, $SD$ = 2.35), mean difference 2.22, $p$ < .001, CI [1.75, 2.69], effect size $f$ = .52. In the inoculation condition the difference was smaller than expected, albeit significant; T0 ($M$ = 12.57, $SD$ = 1.50) and T1 ($M$ = 11.50, $SD$ = 2.42), mean difference 1.06, $p$ < .001, CI [.59, 1.54], effect size $f$ = .25 (see Figure 2).

To test whether the difference scores differ significantly between conditions, a between-subjects ANOVA was conducted with treatment as the independent variable and the difference score (T0–T1) between the antibiotic belief scores. The analysis showed a significant effect of the treatment, $F(2, 676) = 13.77$, $p$ < .001, $\eta^2_p = .04$. Post hoc tests demonstrated a significant difference between the inoculation treatment ($M$ = 1.06, $SD$ = 2.13) and the supportive treatment ($M$ = 2.22, $SD$ = 2.31), $p$ < .001, mean difference 1.16, CI [0.63, 1.69], effect size $f$ = .24 CI [.13, .35] confirming H1 for the antibiotic beliefs. There was no

 

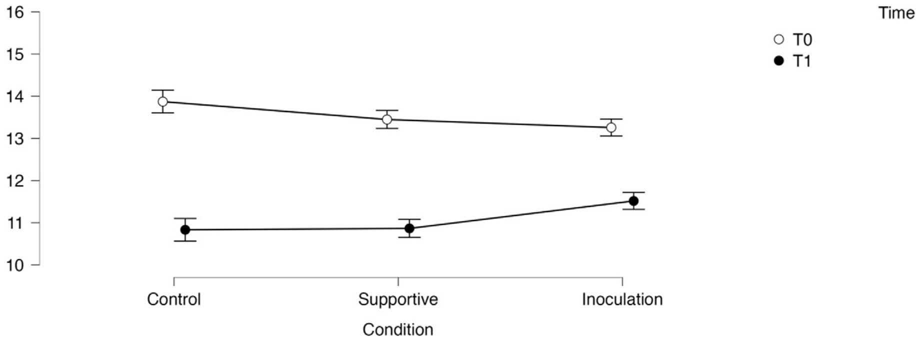


**Figure 3.** Means and confidence intervals of the interaction between condition and time on the education belief scores.

significant difference between the inoculation treatment (*M* = 1.06, *SD* = 2.13) and the control condition (*M* = 1.40, *SD* = 2.89), *p* = .444, mean difference 0.34, CI [−0.21, 0.88], effect size *f* = .07, CI [−.05, .18]. This is not in line with H2.

A second repeated measures ANOVA with education as the topic demonstrated a significant main effect of time, $F(1, 676) = 677.64$, $p < .001$, $\eta^2_p = .501$, indicating that participants have higher belief scores after the treatment but before the strong attack message (T0; *M* = 13.53, *SD* = 1.42) compared to after the strong attack message (T1; *M* = 11.07, *SD* = 2.48). The results also yielded a significant interaction effect between treatment and time, $F(2, 676) = 16.18$, $p < .001$, $\eta^2_p = .05$. Bonferroni post hoc tests demonstrated a significant difference between T0 (*M* = 13.87, *SD* = 1.33) and T1 (*M* = 10.83, *SD* = 2.73) in the control condition (mean difference 3.04), *p* < .001, CI [2.55, 3.54], effect size *f* = .75. In the supportive condition also a significant but somewhat smaller difference between T0 (*M* = 13.45, *SD* = 1.47) and T1 (*M* = 10.86, *SD* = 2.39) was found, mean difference 2.59, *p* < .001, CI [2.11, 3.06], effect size *f* = .64. Although the difference is, as expected, substantially smaller, there is also a significant difference between T0 (*M* = 13.26, *SD* = 1.47) and T1 (*M* = 11.52, *SD* = 2.31) in the inoculation condition; mean difference 1.74, *p* < .001, CI [1.27, 2.22], effect size *f* = .43 (see Figure 3).

To test whether the difference scores differ significantly between conditions, a between-subjects ANOVA was conducted with treatment as the independent variable and the difference score (T0–T1) between the belief scores regarding education. The analysis showed a significant effect of the treatment, $F(2, 676) = 16.176$, $p < .001$, $\eta^2_p = .046$. Bonferroni corrected post hoc tests demonstrated a significant difference between the inoculation treatment (*M* = 1.74, *SD* = 2.21) and the supportive treatment (*M* = 2.59, *SD* = 2.35), *p* < .001, mean difference 0.84, CI [0.31, 1.38], effect size *f* = .17 CI [.06, .28], confirming H1 for the beliefs on education. There was also a significant difference between the inoculation treatment (*M* = 1.74, *SD* = 2.21) and the control condition (*M* = 3.04, *SD* = 2.81), *p* < .001, mean difference 1.30, CI [0.75, 1.85], effect size *f* = .26 CI [.15, .38], which confirms H2.

## Discussion

The results demonstrate a (for the most part) successful replication. When grouping the truisms, we find the same pattern of results as in the original study. The inoculation treatment resulted in more resistance than the supportive treatment and the control condition, confirming H1 and H2. The estimated original effect size of the difference between the inoculation and supportive condition falls within the confidence interval of the observed effect size. This is not the case for the difference between the inoculation and the control condition. The effect size for this effect, however, is nearly identical to the effect size observed in the meta-analysis on inoculation studies (Banas & Rains, 2010). These findings lend convincing support for the assumptions of inoculation theory. With this replication study, effect sizes of the original design with the original materials are identified making it possible to include these results in future meta-analyses. After more than 60 years, the same effects were produced. This shows the robustness of the theory and demonstrates that more recent studies that base their assumptions on inoculation theory are building from a solid foundation.

When analyzing the two truisms separately, the original results (H1 and H2) are fully replicated for the education topic and partly for the original antibiotics topic (H2, i.e., inoculation vs. control, was not confirmed for this topic). As in the original study, all participants were students. Indicating one's beliefs about antibiotics without relevant information (no treatment control condition) at T0 may have been more difficult for students than indicating their beliefs regarding investments in education. Moreover, the texts on the antibiotic messages are more than 60 years old, and since we used the original texts, the argumentation presented is potentially outdated and new information on the topics might be available today making the texts less credible.

Interestingly, in our pilot test we observed that all the truisms that were used in the original study could not be classified as truisms when considering 13 as a minimum belief score. Mean belief scores on the truisms ranged from 6.25 to 11.73, and the more contemporary topics that we tested as truisms scored between 7.07 and 13.64 with relatively high standard deviations. This could indicate that people today are more critical and hold more diverse beliefs about the topics that were previously considered as true by most people. This attests to the idea that cultural truisms are fluid and change over time. We also see this in the data of our replication study; unexpectedly many participants had a belief score lower than 10 on one or both topics at T0. This might be a result of the overwhelming information that is available today and the many different opinions, misinformation, and disinformation people are confronted with daily.

Like the results in the original study, it was found that the attitude scores at T0 already differed between treatments. Participants who received the inoculation treatment showed lower belief scores, especially when compared with participants who received the supportive treatment. This shows that it is difficult for people to indicate their beliefs without taking the information that they just read into account, even when they are specifically asked to do so. The difference in T0 scores attests to the importance of including two measures because this is the only way to distinguish direct effects from the treatment on beliefs from effects of a subsequent strong attack message on beliefs. Using repeated measures excludes the possibility that belief scores measured after the strong attack message are different because the treatment immediately changed people's beliefs rather than that the inoculation treatment increases resistance toward the subsequent strong attack message. This is important because it is the core idea of inoculation theory. Although the current results show that beliefs differed at T0 between conditions, they clearly show an effect of the inoculation treatment on resistance (i.e., less belief change) toward the strong attack message. This replication study therefore empirically supports the fundamental assumptions of inoculation theory. Although in many previous inoculation studies beliefs are only measured after the strong attack message (e.g., Pfau & Burgoon, 1988) or before the treatment and after the strong attack message (e.g., Lim & Ki, 2007), making it unclear which process drives the effects, there are also studies measuring beliefs before the treatment, directly after the treatment, and after exposure to the strong counter-attitudinal message (e.g., Godbold & Pfau, 2000). This way baseline attitudes can be included in the analysis, which is an improvement of McGuire's original design in which baseline attitudes are only measured after the treatment. In those studies, however, baseline attitudes (measured either before or after the treatment) are mostly included as covariates in the analyses rather than treated as repeated measures. For future studies it would be recommendable to include three measures (before treatment, after treatment, and after attack message) and tests difference scores in a repeated measure design to truly test inoculation effects.

It is noteworthy that we observed strong effects of time, independent of condition; all belief scores were lower at T1 compared to T0. This means that a strong persuasive message in which a truism is attacked results in lower belief scores. This provides evidence that the attack messages were effective in changing participants' beliefs and shows that truisms are susceptible to attacks by persuasive messages. The observed differences are quite large, and it may be argued that they might become even larger after repeated exposure (Pillai & Fazio, 2021) to strong attacking messages. This is particularly worrying in the current media landscape in which people are likely to be confronted with misinformation and disinformation. Inoculation treatments could be a potential solution to counter this type of information in order to protect currently held (correct) beliefs. In research and practice we can observe different interventions that are derived from inoculation theory. These treatments, such as media literacy interventions (Jeong et al., 2012) and pre-bunking (Roozenbeek et al., 2020) that generally teach people about manipulation techniques used in the media, help audiences to recognize, for example, fake news. Although these types of interventions are often effective, they lack one crucial component from inoculation treatments as proposed by McGuire and Papageorgis (1961). The major difference is that inoculation treatments are always related to the topic of the information. The inoculation treatment motivates people to think about arguments in favor of their position, which bolsters their beliefs. This makes their beliefs stronger and less vulnerable to future inaccurate information. This clearly is a different process than the process that occurs after warning or teaching people about manipulation and persuasive attempts. In this case, it is argued that people resist a message because they might recognize that the information is manipulative or wrong (e.g., Roozenbeek et al., 2020), while inoculation interventions strengthen people's already held belief on a topic. These strategies thus focus on recognizing misinformation by assessing, for example, the perceived reliability of the information as an outcome variable. However, knowing that information is misleading or inaccurate may not prevent people's beliefs being influenced by the information. Active thinking about message arguments is often not required in the current media landscape, in which people have become passive recipients of large numbers of algorithm-selected messages. This is potentially worrying, because active thinking about message arguments remains the cornerstone of informed decisions.

## Conclusion

Based on the successful replication of inoculation theory, it would be fruitful to further investigate the working of actual inoculation interventions in practice to strengthen people's beliefs. Although inoculation treatments might be more difficult to implement because they are topic specific, it might be worthwhile for topics such as vaccination or climate change (e.g., Bingaman et al., 2022). These topics are relevant for everyone, and people are exposed to much (mis)information on these topics. Challenging people who believe in vaccination and climate change to come up with arguments for their position might be an effective way to establish long-term resistance for preventing potential future influence by misinformation. The advantage of this strategy is that it focuses on strengthening people's own beliefs, making them resistant to all kinds of future attack messages on these beliefs as well as better-informed citizens.

## Electronic Supplementary Materials

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1027/1864-1105/a000396

**ESM 1.** A: Pilot test truism. B: Estimation of original effect size based on incomplete information. C: Analysis plan. D: Materials.

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**Open Data**
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