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Reply to: Corrections are effective for science misinformation

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REPLYING TO L. H. Butler et al. *Nature Human Behaviour* https://doi.org/10.1038/s41562-025-02245-y (2025)

In our meta-analysis[1], we investigated how misinformation, correction and recipient factors affect the impact of corrective information. We combined the results from studies of different correction approaches (that is, belief updating, belief perseverance, debunking, correction and continued influence) to draw conclusions about the efficacy of debunking to science-relevant misinformation, finding that attempts to debunk are, on average, not successful, and tend to be less effective than in other fields. In Butler er al.'s response to our study, they[2] state that "the reported null effect was due to the inappropriate pooling of two distinct effect types into a single estimate". Here we explain our reasons for integrating effect sizes and re-evaluate how our results have been reported in the literature.

Literature effect sizes, biases and reasons for integration

We initially calculated a correction effect and a misinformation persistence effect. The correction effect is defined as the comparison between the ratings for post-test 1 (that is, after misinformation exposure) and post-test 2 (that is, after correction) in studies with a within-participants design or the difference between the misinformation-only group and the correction group in studies with a between-participants design. The misinformation persistence effect is obtained from the comparison of the ratings for the pre-test (that is, before misinformation exposure) and post-test 2 (that is, after correction) in studies with a within-participants design or the differences between the correction group and control group in studies with a between-participants design.

We then focused on the extent to which corrections eliminated or debunked misconceptions. We calculated a debunking effect as an overall measure of the success of the correction versus the misinformation and the failure of the correction to remove the misinformation influence. This effect was synthesized by assigning the misinformation persistence effect sizes a negative sign before meta-analysing them along with the correction effect sizes. A zero effect would represent as much correction as misinformation persistence, whereas a positive effect would signal a win for correction and a negative effect would signal a backfiring effect. This definition is consistent with the general use of debunking to denote falsifying a misconception rather than simply reducing belief in it.

Although we calculated the three effects described above and primarily used the debunking effects, our pre-registered analyses concerned moderators. We did not focus on the average effect of corrections, nor did we indicate that correction and the reverse of misinformation persistence are identical effects. Moreover, the correction and misinformation persistence effects were clearly separated in our dataset, Methods and Discussion, and indeed allowed Butler et al.[2] to run our own R code with the two effects.

Combining effects is the essence of meta-analysis, which was created to integrate disparate tests of a phenomenon and different measures[3–11]. Researchers conduct meta-analyses to integrate quantitative evidence from related individual studies or experiments using different measures[6,7,10]. Thus, decisions about what to combine are necessary. Should one average changes in beliefs and changes in behaviour? Should different treatments for depression be combined? These decisions are the bread and butter of meta-analysis.

In addition to our interest in the overall impact of corrections relative to misinformation, we chose to assess the overarching debunking effect for three reasons.

First, the experiments we reviewed typically examined only correction effects or only misinformation persistence effects. Only 28% of the experiments provided both effects, whereas 45 and 27% examined only correction effects or only misinformation persistence effects. Thus, the approach we adopted maximized the number of effect sizes and is ideal for moderator analyses, thus meeting our pre-registered objective.

Second, the primary experiments investigated the phenomenon by estimating the correction effect and/or the misinformation persistence effect. As is typical of meta-analysis, the integration of disparate effect sizes is necessary. The meta-analytic methods available for this integration were network meta-analysis, the selection of a single comparison or the integration of different conditions while accounting for their statistical dependence through adjustments to the error terms. We selected the latter.

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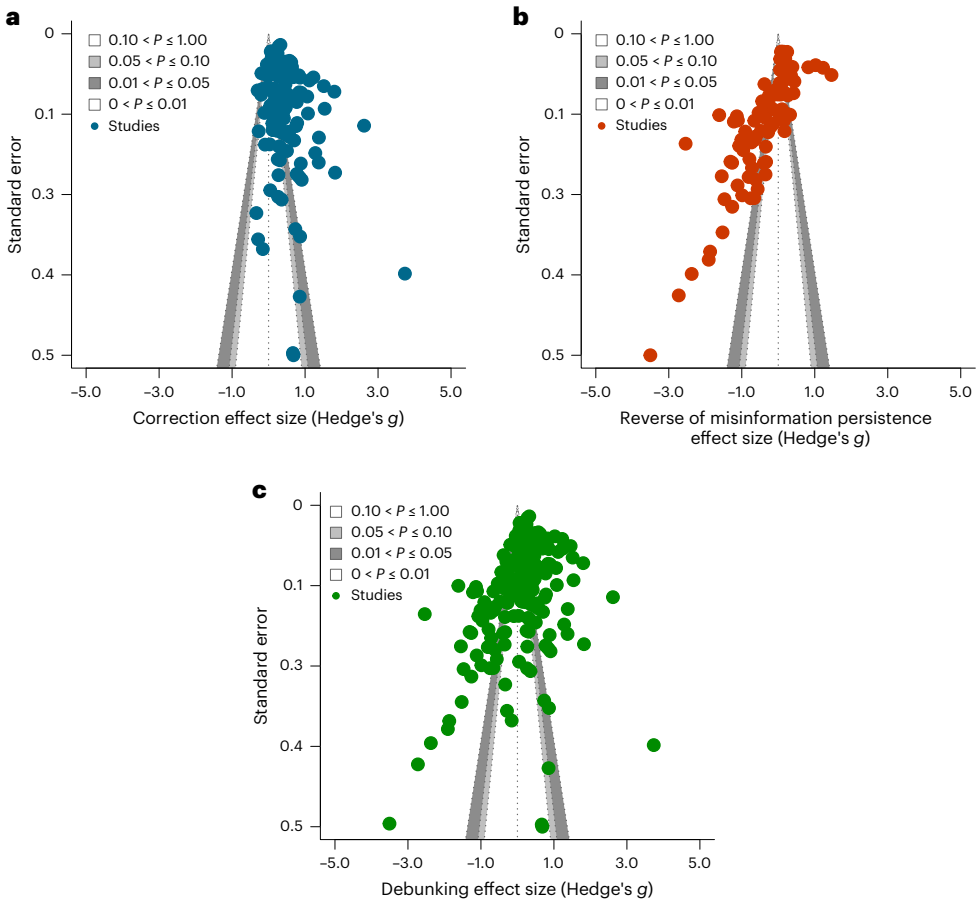

Fig. 1 | Funnel plots of the effect sizes obtained in the meta-analysis. a–c, Plots of correction effect sizes (**a**), reverse of misinformation persistence effect sizes (**b**) and debunking effect sizes (**c**) against standard error.

Other methods could be used to combine these effect sizes, such as including one of the effect sizes as a covariate and computing a ratio of the correction effect to the misinformation persistence effect. However, these methods pose a challenge as they require the reporting of both correction and misinformation persistence effects in the same experiment, which, as mentioned, is not the norm.

Third, the correction effects in this dataset had unusually biased funnel plots. The correction effect (Fig. 1a) was missing effects on the left, whereas the reversed belief persistence effect (Fig. 1b) was missing effects on the right. These differences may imply that researchers who study correction avoid publishing studies with ineffective corrections. In contrast, researchers who study belief persistence may avoid publishing studies with lesser misinformation persistence. Note that we reported these biases in a previous meta-analysis of the topic[12], but we found the optimal solution only in our more recent paper[1].

As a result of integrating the correction and reverse of belief persistence effects, the debunking effect (Fig. 1b) had greater symmetry and did not show consistent evidence of publication bias. This suggested that the debunking effect represents a meaningful set of observations that also improve the validity of the meta-analysis.

Butler et al.[2] expressed concern about the technical decision to combine: (1) correction effect sizes; and (2) reverse of misinformation persistence effect sizes, which Butler et al.[2] describe as "the inappropriate pooling of two distinct effect types" and "unconventional metrics". They state that, due to this "break from convention", the paper is being cited as suggesting that "corrections have little to no effect on science-relevant misinformation", adding that "the unconventional metrics used in the paper have led to inaccurate interpretations of the findings by the field". Clearly, however, our decision to combine the correction and misinformation persistence effects was scientifically justified and not meant to mislead the audience. In fact, on page 1517 of our original meta-analysis[1], we report the correction effect to prevent confusion.

Success of corrections in this and other meta-analyses

The correction effect from our meta-analysis[1] is $d = 0.39$ (95% confidence interval (CI) = 0.28 to 0.50). This is notably smaller than that reported in Chan et al.'s meta-analysis[12] ($d = 1.14–1.33$; 95% CI = 0.62 to 2.04). However, this was not our focus, as our pre-registered objective clearly indicates.

Reassessment of how our results have been reported

We were surprised by Butler et al.'s statement that "numerous papers have cited Chan and Albarracín[1] as evidence that corrections have little to no effect on science-relevant misinformation". By their calculations, 18 out of 52 studies they reviewed (35%) cited our evidence as implying that corrections are ineffective. We re-analysed the findings of these 52 studies, which Butler et al. present in Supplementary Table 1 of their paper[2], and found that only six of them (11.54%) make such statements (Table 1). Overall, most papers reviewed by Butler et al.[2] (88.46%) did not interpret our findings as stating that corrections of science-relevant information have no effect.

Closing note

We believe that correction is important and never suggested that corrections had no effect. However, a significant but small correction

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Table 1 | Re-analysis of which of the 52 papers reviewed by Butler et al. claim that corrections to science-related information are ineffective

Paper citing ref. 1	Relevant quote(s)	Does the paper use ref. 1 to claim that corrections of science-related misinformation are ineffective?	Have we been able to verify that Butler et al.'s assertion is correct?
Albarracín, D. & Granados Samayoa, J. A. (2025)[13]	"Corrections of scientifically relevant false information do not have a significant debunking effect and corrections in the context of politics are less effective than those in the context of health information (Chan & Albarracín, 2023)."	Ambiguous	No
Albarracin, D. et al. (2024)[14]	"...science-relevant corrections do particularly poorly in domains that are politically polarized (Chan & Albarracin, 2023; Table 1, Recommendation 8)."	No	No
Albarracín, D. & Zhou, Y. (2025)[15]	"Whereas, as mentioned, the chances of the initial misinformation succeeding are 272 to 1, the chances of the correction succeeding are about 8 to 1 (M.-P.S. Chan et al., 2017). Indeed, the introduction of novel beliefs is 34 times more effective than the correction of previous ones. Another meta-analysis of the impact of corrections that also makes this point focused on the impact of misinformation and corrections about science, a domain where people often have preexisting beliefs (M.-P.S. Chan & Albarracin, 2023). As in the prior meta-analysis (Chan et al., 2017), the effect of the initial propositional information, whose chances of success were 7 to 1, was stronger than the effect of the correction, which did not achieve statistical significance. Interestingly, there was also an indication that defensive processes intervened to make the effect of corrections negligible."	Yes	No, the authors described the impact of information in the presence and absence of previous beliefs
Alrashdi, J. H. A. et al. (2022)[16]	"Whether debunking has an effect may be heavily reliant on the recipient's prior understanding and convictions, presentation techniques, and the information that is viewed in addition to the debunked material (Chan & Albarracin, 2023)"	No	No
Halliday, E. (2024)[17]	"So why is it that being presented with facts doesn't change our mind or our behaviors? Scientists have researched this question as well (Chan & Albarracin, 2023; Ecker et al., 2022)."	No	No
Bode, L. et al. (2023)[18]	"Second, providing an alternative explanation for the misinformation, often by providing detailed arguments rather than simple denial, produces stronger effects (Chan & Albarracin, 2023; Lewandowsky et al., 2012)." In the annotation section as a paper of special interest: "This study evaluated the effectiveness of debunking efforts for science related misinformation with a meta-analysis of 74 research reports. The results showed that corrective efforts to debunk science-related misinformation were ineffective (d =.19, P=0.131). Three important moderators are identified that influence the effectiveness of corrective efforts to combat science-relevant misinformation..."	Yes	Yes
Charles, C. M. et al. (2024)[19]	"Data suggested that it is challenging to debunk science-relevant misinformation (Chan & Albarracin, 2023)."	Ambiguous	No
Cheung, M. W. L. (2024)[20]	Additional context: "We use a sample dataset from Chan et al. (2017) to demonstrate models with a bivariate meta-analysis. Chan et al. (2017) investigated the misinformation and the debunking effects. The primary studies included in the meta-analysis involved three groups of participants: (1) those exposed to a misinformation message, (2) those exposed to both the misinformation message and a debunking message, and (3) control participants who received neither message. To illustrate, we selected the standardized mean difference (Hedges' g) for two effects: the misinformation effect (the standardized difference between groups 1 and 3) and the debunking effect (the standardized difference between groups 2 and 1). As group 1 was involved in calculating both effect sizes, their sampling errors were correlated (Gleser & Olkin[8]). For convenience, we refer to the effects of misinformation and debunking as y1i and y2i, respectively." "Another example is Chan and Albarracín (2023), a follow-up study of Chan et al. (2017)[12], which aimed to study the debunking effect while controlling for the misinformation effect. Researchers usually test these hypotheses using meta-regression by treating one effect size as a predictor, ignoring the known sampling variance of the predictor. As discussed in the "Regressing a Covariate on a True Effect Size" section, this approach can lead to incorrect parameter estimates and SEs." "In their analysis, Chan and Albarracín (2023) examined the impact of misinformation (y1i) on debunking (y2i) while considering various covariates and control variables in their regression models. However, they did not test any mediation model. For illustrative purposes, let us assume y1i (misinformation effect) as the mediator and y2i (debunking effect) as the outcome variable in this example."	Not focused on misinformation or correction; contrasts with papers in which the debunking effect is defined differently	No
Chomanski, B. (2024)[21]	"Lastly, meta-analyses of empirical work on debunking appear largely to confirm the ineffectiveness of the intervention. Walter and colleagues' (2020) paper is a case in point. Having examined a range of individual studies, the authors find that 'the effects of fact-checking on beliefs are quite weak and gradually become negligible the more the study design resembles a real-world scenario of exposure to fact-checking. For instance, though fact-checking can be used to strengthen preexisting convictions, its credentials as a method to correct misinformation (that is, counterattitudinal fact-checking) are significantly limited.'" "A similar finding has been reported by Chan and Albarracin (2023), whose meta-analysis of over 70 studies of debunking scientific misinformation, also discovered that "attempts to debunk science-relevant misinformation were, on average, not successful". Moreover, to the extent that small positive effects were observed, they concerned corrections of counterattitudinal misinformation."	Yes	No, the authors referenced the debunking effect, not the correction effect

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Table 1 (continued) | Re-analysis of which of the 52 papers reviewed by Butler et al. claim that corrections to science-related information are ineffective

Paper citing ref. 1	Relevant quote(s)	Does the paper use ref. 1 to claim that corrections of science-related misinformation are ineffective?	Have we been able to verify that Butler et al.'s assertion is correct?
Dan, V. & Coleman, R. (2024)[22]	"Yet, false beliefs about polarized topics are known to be particularly difficult to debunk because they drive people to engage in directionally motivated reasoning to protect their political identity (Chan & Albarracín, 2023)." "Misinformation is particularly difficult to debunk when topics are polarized (Chan & Albarracín, 2023; see Dan & Dixon, 2021)." "This has vast relevance as views on more than one issue divide societies and are exceptionally difficult to debunk (Chan & Albarracín, 2023; see Dan & Dixon, 2021)" "Despite this, this study extends knowledge of fact checks beyond U.S. borders, where most of the research is conducted (Chan & Albarracín, 2023; Walter et al., 2020)."	No	No
Douglas, K. M. et al. (2024)[23]	"...science-relevant misinformation appears more difficult to correct than misinformation in general (Chan and Albarracín 2023), and even if corrections are effective, the influence of misinformation on one's beliefs still lingers significantly."	No	No
Ecker, U. K. et al. (2024)[24]	"...the retrospective correction (or "debunking") of false claims is still an important tool for fact-checkers and communicators if the first line of defense is not implemented or successful (Prike & Ecker, 2023). Debunking is also generally more effective at reducing belief in specific claims than pre-emptive skill-based interventions, making it particularly important for countering harmful misinformation (Chan & Albarracín, 2023; Walter et al., 2020). A pervasive challenge for debunking interventions is the robust finding that even after misinformation has been credibly corrected, people often continue to rely on it in their thinking and reasoning—a phenomenon known as the continued influence effect (Chan et al., 2017; Ecker et al., 2022; Johnson & Seifert, 1994; Walter & Tukachinsky, 2020)."	No	No
Erbaugh, J. T. et al. (2024)[25]	"Scientific misinformation may be particularly challenging to correct (Chan & Albarracín, 2023), suggesting a particular difficulty for environmental governance, which often relies on scientific evidence to inform policies and practice"	Ambiguous	No
Globig, L. & Sharot, T. (2024)[26]	"To mitigate the spread, scientists and practitioners have begun developing interventions (Sanderson & Ecker, 2020), such as digital literacy programs (Traberg et al., 2022), fact-checking tools (Pröllochs, 2022), and tighter regulations (Glaeser & Ujhelyi, 2010). The outcomes of these interventions, however, have been mixed (Aghajari et al., 2023; Chan et al., 2017; Chan & Albarracín, 2023; Grady et al., 2021; Lee et al., 2022)."	No	No
Goldewijk, B. K. (2024)[27]	"In brief, the persistent effects of climate disinformation and disbelief in the human drivers of accelerated climate change are integral to the problems of communicating the consensus and most challenging to correct (for example Chan & Albarracin, 2023)."	No	No
Granados Samayoa, J. A. & Albarracín, D. (2025)[28]	"In a sweeping meta-analysis of the correction literature, Chan et al. (2017) found a large "debunking" effect, such that providing a correction led to a significant attenuation of the influence of misinformation on people's beliefs and attitudes (*d*s = 1.14–1.33). Other meta-analyses have found medium-sized average debunking effects (*r* =.35; Walter & Murphy, 2018). A related meta-analysis focusing specifically on science-relevant misinformation found that the average debunking effect was not statistically different from zero (*d*=0.19; Chan & Albarracín, 2023), suggesting that corrections may be differentially effective across domains."	Ambiguous; contrasts with papers in which the debunking effect is defined differently	No, the authors referenced the debunking effect and did not suggest that corrections were ineffective
Hartwig, K. et al. (2024)[29]	"Furthermore, when literature reviews, or meta-analyses deal with concrete interventions, they often focus on the detection step and machine learning interventions instead of user-centered interventions or focus on a specific subgroup like corrections Chan and Albarracin (2023)." "Chan and Albarracin (2023) conducted a meta-analysis on the efficacy of corrections/debunking in the context of scientific misinformation, examining over 200 effect sizes and revealing that corrections are more successful when detailed. Still, in general, the debunking effect was not significant. Given the overall estimated lower impact of corrections/debunking and the strong research focus of the majority of studies on this type of intervention revealed in a related meta-analysis (Blair et al., 2024), which was confirmed in our review, this suggests scholars should not disregard other intervention types that might be less studied but more promising."	Yes	No, the authors referenced the debunking effect, not the correction effect
Heiss, R. et al. (2024)[30]	"Overall, a number of meta-analyses (Walter & Murphy, 2018; Walter, et al., 2020, 2021) show that correction is effective at reducing misperceptions among those that see it, though one exception may be science-related misinformation, where a meta-analysis determined that correction was not successful on average (Chan & Albarracin, 2023)."	Yes	Yes
Helfers, A. (2024)[31]	"In the meanwhile, further recent meta-analyses (Walter et al. (2021) (*k*=24; *N*=6,086; with data up to August 2019), (Janmohamed et al., 2022) (*k*=16; *N*=33,378; with data up to September 2021) Chan and Albarracín (2023) (*k*=205; *N*=60,861); with data up to August 2022) systematically explored the effectiveness of debunking in stimulating belief change in misinformation beliefs." "Similarly, the most recent meta-analysis by Chan and Albarracín (2023) (*k*=205; *N*=60,861); with data up to August 2022) found debunking messages on average ineffective in stimulating belief change regarding "science-relevant misinformation" (for example; on vaccines and climate change) (*d*=0.19, *p*=0.31)." "For a very unfamiliar topic (like the mRNA vaccines and most other scientific issues) debunks, need to be guided by general information and educational attempts as well, as thematically informed recipients were found to profit more of such corrections (for example, Chan & Albarracín, 2023; Janmohamed et al., 2022)."	Yes	No, the authors referenced the debunking effect, not the correction effect

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Hornsey, M. J. et al. (2025)[32]	"Another step is to engage in education campaigns that help people detect falsehoods. This is the principle of 'pre-bunking', training community members in the methods and motives of those who spread disinformation (Lewandowsky and van der Linden 2021;Roozenbeek, van der Linden, and Nygren 2020). Although there is mixed evidence for the success of these strategies (Spampattiet al. 2024), 'inoculating' community members against future disinformation campaigns seems more plausible than playing whack-a-mole' by debunking individual myths as they arise, a strategy that appears to be relatively ineffective (Chan and Albarracín 2023)"	Yes	No, the authors referenced the debunking effect, not the correction effect
Hutmacher, F. et al. (2024)[33]	"...it has also been shown that correction messages can be particularly successful when they are detailed and when the topic under investigation is not highly politicized (cf. Chan & Albarracín, 2023; Chan et al., 2017)."	No	No
Ittefaq, M. (2023)[34]	"Indeed, misinformation correction process is complex in terms of its efficacy and sometime the findings are conflicting too. For instance, Chan and Albarracín (2023) meta-analysis suggests that misinformation correction generally yielded limited success particularly in non-health related matters."	Yes	Yes
Johnson, N. & Sparks, G. (2024)[35]	"A common strategy for countering information or stories that are factually incorrect is to find the factually correct information and present it, such as fact-checking. Fact-checking appears to be a generally robust strategy for combatting misinformation [Walter et al., 2020] and appears to have efficacy to endure over time as well [Porter & Wood, 2021]. However, recent meta-analyses have found no significant overall effects for the correction of science-related misinformation [Walter & Murphy, 2018; Chan & Albarracín, 2023], and additionally, different forms of fact-checking or correction have been differentially effective. Corrections that are partial or do not make a strong claim about the veracity of the original misinformation (such as a scale of truthfulness) tend to be weaker in their effect [Walter et al., 2020], while more detailed corrections have an overall tendency to be more effective [Chan & Albarracín, 2023]."	Yes	Yes
König, L. M. et al. (2025)[36]	"However, people may react differently to topics that are not as politically or morally charged; strategies for communicating about less controversial topics (for example, diet myths, see L. M. König, 2023) might thus be somewhat different from strategies for communicating about controversial topics (cf. Chan & Albarracín, 2023).""For instance, we only identified a small number of papers studying interventions to debunk misinformation, despite the topic being heavily debated in research (Chan & Albarracín, 2023)."	No	No
Lavigne, M. (2023)[37]	"The best-known solution is misinformation correction or debunking. Despite initial claims that misinformation correction could have a backfire effect (Nyhan & Reifler, 2010), there seems to be a growing consensus that correction increases belief accuracy even when the misinformation is consistent with one's political predispositions (Carey et al., 2022; Nyhan, 2021; Wood & Porter, 2019; but see Chan & Albarracín, 2023)"	Ambiguous	No
Ma, Z. & Ma, R. (2025)[38]	"Debunking targets specific misinformation after individuals have been exposed to it. Debunking interventions may vary in their level of detail: Some merely tag the misinformation as false, while others provide an alternative explanation and point out the logical fallacies in the misinformation (Ecker et al., 2022). There are mixed results regarding the corrective impact of debunking strategies. Some meta-analyses suggest that debunking is on average effective (Chan et al., 2017; Walter et al., 2021), but others indicate that the effect is negligible (Chan & Albarracín, 2023)."	Yes	No, the authors cited a non-significant effect without stating which effect it was
Moon, Z. et al. (2025)[39]	"Our findings have implications for the development of strategies to reduce vaccine hesitancy in people from ethnically minoritised groups. These insights may be relevant to other vaccination programmes and other populations. Attempts to engage people and change attitudes need to consider the specific beliefs people have about vaccines and how this might affect their decision making. Previous research has suggested that simply debunking people's opinions is unlikely to be successful (Chan & Albarracín, 2023), and may even backfire and reinforce false beliefs (Peter & Koch, 2016)."	Ambiguous	No
Nai, A. et al. (2024)[40]	"Especially in light of recent research showing that misinformation effects are harder to curb afterwards (Chan & Albarracín, 2023), taking the lead and developing cognitive skills to recognise it and "inoculate" against its possible nefarious effects seems to be the way to go."	No	No
National Academies of Sciences, Engineering, and Medicine (2025)[41]	"Exposure to misinformation leads to misbeliefs just as exposure to accurate science can teach people correct information (van der Linden et al., 2023). This has been demonstrated in meta-analyses of experimental studies in lab settings (Chan et al., 2017; Chan & Albarracín, 2023) as well as in real-world settings (for example, Feldman et al., 2012)...In addition, debunks that provide more detailed information (particularly more than a simple true/false label) tend to be more effective and have a longer lasting effect (Chan & Albarracín, 2023; Ecker et al., 2020)."	No	No

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Paper citing ref. 1	Relevant quote(s)	Does the paper use ref. 1 to claim that corrections of science-related misinformation are ineffective?	Have we been able to verify that Butler et al.'s assertion is correct?
Oktar, K. & Lombrozo, T. (2025)[42]	"Second, the average effect size for consensus messaging is small: around one-tenth to three-tenths of a standard deviation in meta-analyses for scientific consensus (Chan & Albarracín, 2023; van Stekelenburg et al., 2022) with similarly weak effects in studies of anti-democratic attitudes (Druckman 2023; Voelkel et al., 2023)"..."For instance, combining information about the scientific consensus on global warming with an explanation of the mechanisms of global warming (which plausibly illustrate the objective knowability of global warming) results in substantial belief change (Ranney & Clark, 2016), whereas interventions that provide scientific consensus alone do not yield much change (Chan & Albarracín, 2023).""As we reviewed above, interventions that aim to change beliefs through aggregated opinion, such as those that communicate scientific consensus to bolster belief in climate change, tend to have small effects (Chan & Albarracín, 2023)"In the reference section: "This meta-analysis describes the relative weakness of interventions that provide the aggregate opinions of scientists to foster view change about contested issues."	No	No
Orticio, E. et al. (2023)[43]	"Inoculation interventions are completely ineffective after 48 hours if participants don't receive an immediate post-test (Capewell et al., 2023). These interventions have also been criticized for fatal methodological weaknesses in the assessment of their efficacy (Guay et al., 2023; Williams, 2023; Chan & Albarracín, 2023)."	No	No
Petty, R. E. (2024)[44]	"The three research domains just outlined might be the most dominant, but there are also many other more isolated studies aimed at understanding misinformation, and many excellent reviews of this literature are available (for example, Chan & Albarracín, 2023; Ecker et al., 2022; Lewandowsky et al., 2012)."	No	No
Porter, E. & Wood, T. J. (2024)[45]	"One meta-analysis of 205 correction effects shows that corrections targeting political misinformation are more effective than corrections targeting scientific misinformation (Chan & Albarracín, 2023). Another meta-analysis, focused on health issues, finds that false claims about infectious diseases are less correctable than false claims about other issues"	Ambiguous	No
Pretus, C. et al. (2024)[46]	"Similarly, a recent meta-analysis found that most strategies for debunking misinformation were not very effective overall (Cohen's d=0.19), and were even less effective when the issue was politically polarized (Chan & Albarracín, 2023). As such, there is an urgent need to develop effective and scalable correction strategies for misinformation in the political domain that works across the political spectrum."	Yes	No, the authors referenced the debunking effect, not the correction effect
Pretus, C. et al. (2024)[47]	"The effectiveness of most debunking misinformation strategies has been found to decrease when the topic is politically polarized"	No	No
Prike, T. & Ecker, U. K. (2023)[48]	"...corrections have generally been found to be at least somewhat effective at reducing false beliefs and reliance on misinformation (Chan & Albarracín, 2023; Walter et al., 2020""...providing additional details within a correction is nearly always possible (for example, details about why the misinformation is false, or why it may be believed or spread), and this is also a well-established strategy for enhancing the effectiveness of misinformation corrections, as confirmed by a recent meta-analysis (Chan & Albarracín, 2023)."	No	No
Román-Caballero, R. & Vadillo, M. (2025)[49]	"Perhaps because of its simplicity of use or its parsimonious solution to the problem of model divergence, this approach has become common in recent meta-analyses (for example, Chan & Albarracín, 2023; Yang et al., 2023)." "In the same vein, the meta analyses conducted in recent years have applied RoBMA with its default specifications and without contrasting the results when PET-PEESE models were included or not as a sensitivity analysis (for example, Chan & Albarracín, 2023; Yang et al., 2023)."	No	No
Ruggeri, K. et al. (2024)[50]	"The backfire effect is a concerning pattern in which disproving misinformation reinforces it and deepens false beliefs. But this phenomenon is not consistently observed in practice. Effects of debunking might be highly dependent on the recipient's background knowledge and beliefs, methods of presentation, and what other information is viewed (Chan & Albarracín, 2023; Ecker et al., 2023)."	No	No
Sanna, G. A. & Lagnado, D. (2025)[51]	"Similarly, misinformation has been shown to undermine climate change initiatives by promoting doubt about the scientific consensus and downplaying the urgency of climate action, making it more difficult to achieve support for necessary policy measures (Chan & Albarracín, 2023; Van der Linden et al., 2017)."	No	No
Seo, H. (2023)[52]	"In response to the deleterious consequences caused by misinformation, many organizations (Li & Chang, 2023), researchers (Chan & Albarracín, 2023; Whitehead et al., 2023), and social media companies (Broniatowski et al., 2023; Koch et al., 2023) have dedicated their efforts to various studies aimed at combating it."	No	No

Table 1 (continued) | Re-analysis of which of the 52 papers reviewed by Butler et al. claim that corrections to science-related information are ineffective

Paper citing ref. 1	Relevant quote(s)	Does the paper use ref. 1 to claim that corrections of science-related misinformation are ineffective?	Have we been able to verify that Butler et al.'s assertion is correct?
Spampatti, T. et al. (2024)[53]	"This effect size was based on the meta-analytic effect of fact-checking one disinformation statement in general (Walter & Murphy, 2018); it should be noted, however, that a more recent meta-analysis found no significant effect and high heterogeneity of fact-checking misinformation about scientific evidence, especially for polarized scientific topics such as climate change (Chan & Albarracín, 2023)." "Further discussion of the effect size provided within the sampling plan: "We identified the required sample size a priori, with G*Power (version 3.0; Perugini et al., 2014), to have 95% power to detect a difference between any intervention condition and the passive disinformation control condition of $\delta = 0.20$ in a one-tailed t-test with $\alpha = 0.005$, for all main hypotheses separately. We selected the smallest effect size of interest (SESOI) from the lower bound of the confidence interval of the meta-analytically identified effect size (Bryan & Jenkins; 2016) of fact-checking interventions on political topics (Chan & Albarracín, 2023), as we reasoned that a new disinformation intervention would be of interest if and only if it has an effect that is larger than already available interventions such as fact-checks"	Yes	No, the authors cited a non-significant effect without stating which effect it was
Stasielowicz, L. (2024)[54]	"However, a more recent meta-analysis shows that not all types of misinformation can be easily corrected (Chan & Albarracín, 2023). A comparison of that meta-analysis with the present findings indicates that science-relevant misinformation seems to be similarly challenging to reduce ($d = 0.19$, CI 95% [−0.06, 0.43]) as conspiracy beliefs. Notwithstanding the utility of such comparisons, one should not put a lot of emphasis on the mean effect size, as large differences between intervention effects were found in the present meta-analysis."	Ambiguous	No
Tang, R. et al. (2024)[55]	"Broadly speaking, a number of meta-analyses have supported the power of corrections (Chan et al., 2017; Janmohamed et al., 2021; Walter & Murphy, 2018; Walter et al., 2021) and factchecking (Walter et al., 2020; Wood & Porter, 2019) in reducing misperceptions on the specific topic being debunked, although a more recent content analysis cast doubt on the ability of corrections to mitigate science misinformation specifically (Chan & Albarracín, 2023)"	Yes	Yes
Thorson, E. et al. (2025)[56]	"It has been shown in several studies (Coleman et al., 2024; Feldman and Hart, 2018) that pre-existing beliefs interact with news stories. This effect is explained as people engaging in directionally motivated reasoning to protect their ingroup identity, such as political partisanship or ideology (Chan and Albarracin, 2023)."	No	No
Tu, F. (2024)[57]	"Interventions in this tradition usually employ refutation strategies, which include methods like debunking with corrections, delivering fact-checks (for example, Chan & Albarracın, 2023; Walter et al., 2020)...However, they may not scale easily...Rather than relying on refutation strategies to tell people what is true and false through corrections and fact-checks (Bachmann & Valenzuela, 2023; Chan & Albarracın, 2023), the interventions in the current study were developed to actively involve the participants."	No	No
Van Bavel, J. J. et al. (2024)[58]	"A test of multiple interventions designed to increase mask use by leveraging moral and identity-based frames found that such manipulations failed to affect masking intentions or attitudes (Gelfand et al., 2022). This underscores the challenge of correcting beliefs after they have been entrenched and polarized (see Chan & Albarracin, 2023)."	No	No
Van Bavel, J. J. et al. (2024)[59]	"Partisans who heard these false stories may have ignored or forgotten contradictory evidence and rationalized partisan positions. This helps explain why corrections are often ineffective for highly polarized issues where identity needs outweigh accuracy goals (Chan & Albarracin, 2023; Pretus et al., 2023)." In the annotation section as a paper of special interest: "This meta-analysis of 205 effect sizes showed that attempts to debunk science-relevance information were not effective on average ($d = 0.19$, $P = 0.131$, 95% confidence interval −0.06 to 0.43). Corrections were most effective when they were concerning issues that were not politically polarized."	Yes	No, the authors referenced the debunking effect, not the correction effect
Van der Linden, S. (2024)[60]	"...a recent meta-analysis found no significant average effect of corrections in the context of scientific misinformation (Chan & Albarracín, 2023)."	Yes	Yes
Van der Linden, S. & Roozenbeek, J. (2024)[61]	"A 2023 meta-analysis reported that debunking science-related misinformation was, on average, unsuccessful in reducing misperceptions." "However, correcting false information using proven messaging strategies can still improve misperceptions (Chan & Albarracín, 2023)."	Yes	No, the authors referenced the debunking effect, not the correction effect
Vendeville, A. (2023)[62]	"Debunking false information is also rarely effective at best (Chan and Albarracín, 2023), and counter-productive at worst (Betsch and Sachse, 2013; Zollo et al., 2017)." "Debunking false information is not only ineffective on average (Chan & Albarracín, 2023), it can often lead to an increase in the misplaced belief (Betsch & Sachse, 2013)."	Yes	No, the authors referenced the debunking effect, not the correction effect
Ruggeri, K. et al. (2023)[63]	"Because more recent waves of vaccine hesitancy have been driven both by politicization of public health as well as polarization tied to largely unregulated circulation of content online, contemporary methods have begun shifting techniques to fit within social media (Arechar et al., 2023; Chan & Albarracín, 2023)."	No	No

Table 1 (continued) | Re-analysis of which of the 52 papers reviewed by Butler et al. claim that corrections to science-related information are ineffective

Paper citing ref. 1	Relevant quote(s)	Does the paper use ref. 1 to claim that corrections of science-related misinformation are ineffective?	Have we been able to verify that Butler et al.'s assertion is correct?
Zhou, Y. & Shen, L. (2024)[64]	"Meta-analytical evidence documented large effects for the persistence of misinformation despite debunking and observed that a more detailed debunking message was associated with a stronger misinformation-persistence effect (Chan et al., 2017). The challenge is particularly apparent when it comes to real-world misinformation, with research suggesting that the effectiveness of debunking real-world misinformation may diminish by 60% in comparison to constructed misinformation due to Walter and Murphy (2018). Indeed, a recent meta-analysis of correction effects in science relevant misinformation found a non-significant effect, indicating that efforts to debunk misinformation on issues such as COVID-19 and climate change were overall not successful (Chan and Albarracín, 2023). While corrective messages may be more successful in certain instances, it is evident that they do not eliminate the effect of misinformation (Walter and Tukachinsky, 2020)."	Yes	No, the authors referenced the debunking effect, not the correction effect
Number of papers (from a total of 52) with the response 'Yes'		18	6
Percentage of papers with the response 'Yes'		34.62	11.54

against a background of misinformation persistence remains problematic. As Butler et al.[2] point out, "Extensive literature shows that corrections often meaningfully reduce, but rarely eliminate, misinformation effects at the group level", and the study of correction effects alone cannot paint a complete picture of misinformation impact. For example, a minor reduction in misinformation may be insufficient to trigger changes in attitudes and behaviours.

The effects of combating misinformation are heterogeneous in the literature. The social psychology tradition uses belief persistence measures, whereas the cognitive psychology tradition uses correction measures. Some of the authors of Butler et al.'s paper typically measure correction. For example, the papers included in our meta-analysis that were authored by Swire-Thompson and Ecker reported mostly correction effects. In fact, about 81% of all effect sizes obtained from these papers entail correction rather than misinformation persistence effects. Their preferred metric, however, might obscure the enormous difficulty of correcting the persistence of misinformation and has a pronounced publication bias in the literature (Fig. 1a).

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Author contributions

M.S.C. and D.A. wrote the original draft of the manuscript and reviewed and edited the final version.

Competing interests
The authors declare no competing interests.

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