

The scientific impotence excuse as a bounded defence against unwelcome evidence

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Abstract

Confrontation with scientific evidence that contradicts personal beliefs may lead to various forms of science devaluation. One such response is the ‘scientific impotence excuse’ (SIE), which allows individuals to resolve belief–evidence conflicts by denying the epistemic value (potency) and topical relevance (pertinence) of science. While initial evidence supports the SIE framework, its generalisability and boundary conditions have yet to be thoroughly examined. In eight preregistered experiments ($N_{\text{total}} = 4,215$) involving university students and general population samples in Germany and the USA, we tested the core predictions of the SIE framework. Participants first indicated their agreement with a controversial socio-scientific claim and were then randomly presented with relevant scientific evidence. As predicted, participants more strongly devalued the potency and pertinence of science when the evidence conflicted with their prior belief; however, this effect did not generalise to other outcome measures. Despite this devaluation tendency, participants adjusted their beliefs in response to the evidence, replicating prior findings on the SIE. The occurrence of the SIE was unaffected by potential moderators, including the communication of scientific uncertainty or methodological details. These results corroborate the SIE as a generalizable mechanism of science devaluation, while also delineating its limits. Notably, the present studies demonstrate for the first time that both potency and pertinence of science are subject to devaluation under belief–evidence conflict.

Introduction

Public understanding of science is a critical resource in knowledge societies. However, achieving such understanding is often challenging, requiring not only cognitive abilities (Sinatra et al., 2014; Shtulman et al., 2014, Lau & Roeser, 2002; Metzger et al., 2010) but also motivational orientations (Dawson et al., 2024; Litman, 2008; Svedholm-Häkkinen & Lindeman, 2018; Kahan et al., 2017) to support the unbiased processing of scientific information. Nevertheless, even if these prerequisites are met, individuals’ responses to belief-threatening scientific evidence are susceptible to cognitive and motivational biases (Drummond & Fischhoff, 2017, Britt et al., 2019), which can facilitate science devaluation and, over time, lead to entrenched patterns of science denial (Sinatra & Hofer, 2021; McIntyre, 2018). Such tendencies threaten citizens’ ability to engage with and make informed decisions on *socio-scientific issues*—complex societal topics that intertwine scientific evidence with political stances, social and personal values, and everyday practices (Kienhues et al., 2020; Barzilai & Chinn, 2020; Chinn et al., 2021; Bromme & Gierth, 2021; Hornsey & Fielding, 2017). Understanding the mechanisms and boundary conditions of science devaluation is therefore a pressing issue for research on public understanding of science and science communication.

A core source of motivated science devaluation lies in conflicts between scientific evidence and individual characteristics, such as self-identity, values, or deeply held beliefs. When belief-evidence conflicts arise, individuals often engage in motivated reasoning to defend prior beliefs and arrive at preferred conclusions (cf. Kunda, 1990; Nauroth et al., 2017; Taber & Lodge, 2006; Lord et al., 1979; Druckman & McGrath, 2019; Washburn & Skitka, 2018; Hutmacher et al., 2022; Proulx et al., 2012;

Hornsey & Fielding, 2017; Nisbet et al., 2015; Hansson et al., 2017; Lewandowsky & Oberauer, 2016). Prior research has identified a range of defensive responses to belief-threatening scientific information (Chinn & Brewer, 1993; Chinn & Brewer, 1998; Proulx et al., 2012; Proulx & Inzlicht, 2012; Britt et al., 2019). However, less is known about the generalisability of specific responses and the factors that moderate their occurrence. The present study addresses this research gap by focusing on the *Scientific Impotence Excuse* (SIE; Munro, 2010; Thomm et al., 2021; Futterleib et al., 2022), a specific defensive response that can arise in public engagement with socio-scientific issues.

The Scientific Impotence Excuse Framework

According to the SIE framework, individuals counter belief-threatening scientific evidence by questioning whether the respective topic can be studied using scientific methods. Hence, the SIE challenges the epistemic value of science (i.e., its *potency*; Munro, 2010) to deliver conclusive results on the issue. Rather than directly critiquing the evidence – for instance by disputing methodological flaws – potency devaluation operates at a meta level by asserting that science, in general, cannot yield reliable and valid knowledge about the topic. This approach serves to resolve cognitive dissonance (cf. Festinger, 1957; Gawronski, 2012; Proulx et al., 2012) caused by conflicting evidence with relatively minimal cognitive effort or scientific background knowledge. Fallacious SIE-based arguments are indeed prevalent in public debates about socio-scientific issues – for instance about health (e.g., vaccinations; Evrony & Caplan, 2017), human contributions to climate change (Lörcher & Taddicken, 2017), but also regarding social science topics, such as education (e.g., measuring student learning; Pastor, 2019; educational myths; de Bruyckere et al., 2015). While conceptually related to confirmation bias, which involves selective processing of belief-consistent information (Nickerson, 1998; Abendroth et al., 2022; van Strien et al., 2016), the SIE involves a devaluation of science to protect a prior belief, making it a distinct form of motivated science rejection (Britt et al., 2019; Lord et al., 1979; Oeberst & Imhoff, 2023; Chinn & Brewer, 1998; Kunda, 1990).

Although less frequently examined, *pertinence* devaluation has been identified as another and potentially more critical form of the SIE (Futterleib et al., 2022). Pertinence is grounded in the normative attribution of responsibility and expertise (Thomm et al., 2026; Bromme & Gierth, 2021; Bromme & Thomm, 2016; Kitcher, 2011; Keren, 2018; Blancke & Boudry, 2022). Whereas potency devaluation questions the epistemic value of scientific methods, pertinence devaluation challenges the legitimacy of science in addressing the issue at all, claiming it lacks the proper authority (Harambam & Aupers, 2015; Zapp, 2022). Pertinence devaluation has, for instance, been prevalent in public debates surrounding school reforms, mask-wearing during the COVID-19 pandemic, or green energy transitions – topics in which value-laden judgements are tightly interwoven with scientific claims. Because it undermines the societal role of science more fundamentally, pertinence devaluation may represent a deeper form of discrediting than potency devaluation (Futterleib et al., 2022; Chinn et al., 2020; Thomm et al., 2026). While prior research has primarily examined potency devaluation (Munro, 2010; Thomm et al., 2021), a fuller understanding of the SIE requires investigating both forms.

The SIE framework proposes a set of hypotheses that conceptualise science devaluation as a motivated response to belief-incongruent evidence (Munro, 2010). At its core lies the assumption that individuals tend to downgrade the perceived potency of science – and, in an extended version, its pertinence (Futterleib et al., 2022) – to address a given topic after encountering a belief–evidence conflict (*direct topic-specific devaluation*; H1). As an indirect proxy of devaluation, it may manifest as a decreased preference for scientific over non-scientific sources when seeking further information on the topic (*indirect topic-specific devaluation*; H2). Additional hypotheses address whether devaluation generalises to other topics within the same scientific domain (*domain-related generalisation*) or even to unrelated domains (*domain-unrelated generalisation*; H3). Finally, the framework predicts that individuals will tend to retain their initial beliefs despite conflicting evidence (H4).

Given its role in defending prior beliefs, the SIE represents a crucial phenomenon. However, several gaps in our understanding of its generalisability and boundary conditions persist in the literature. Specifically, it remains unclear whether (a) prior findings replicate and generalise across different samples, (b) both potency and pertinence devaluation occur, and (c) features of science communication – such as expressions of scientific uncertainty and the provision of methodological details – influence the occurrence of the SIE. The last point is particularly relevant given the inherent uncertainty of scientific knowledge (Popper, 2005) and calls for its transparent communication (e.g., Blastland et al., 2020; Fischhoff & Davis, 2014).

Research on the Scientific Impotency Excuse and Its Boundary Conditions

Empirical tests of the SIE framework have employed an experimental paradigm that manipulates the alignment between participants' prior beliefs and presented evidence (Munro, 2010; Thomm et al., 2021; Futterleib et al., 2022; Rosman et al., 2021). Participants first rate their agreement with a claim on a socio-scientific topic. They are then randomly assigned to one of two evidence conditions – supporting or contradicting the claim – and read several brief summaries of scientific studies. Subsequently, participants rate the perceived potency (and, in some studies, pertinence) of science to investigate the topic. Additional outcome measures assess source preferences and potential generalisation of devaluation, and claim agreement is reassessed post-exposure to assess belief change. This design captures both immediate responses to conflicting evidence and downstream effects, making it well suited to testing the framework's core assumptions.

This body of research has consistently demonstrated topic-specific potency devaluation after facing belief-inconsistent evidence, supported by significant disordinal interactions between prior belief and type of evidence – indicating that devaluation is greater when individuals are presented with evidence that contradicts their prior beliefs (Munro, 2010; Thomm et al., 2021, Futterleib et al., 2022; Rosman et al., 2021). Initial but unreplicated findings also suggest that pertinence devaluation may occur (Futterleib et al., 2022), reflecting a deeper rejection of science's relevance to investigating the topic. In contrast, evidence regarding source preferences and generalised devaluation remains mixed, with most findings

failing to support these broader effects (Thomm et al., 2021; Futterleib et al., 2022). Overall, SIE-based devaluation appears largely topic-specific and conflict-driven, rather than indicating a generalised rejection of science. Intriguingly, prior work also finds that belief change often occurs in line with the presented evidence, despite concurrent devaluation tendencies. This has been interpreted as *peripheral belief change under epistemic vigilance* (Thomm et al., 2021; Futterleib et al., 2022; Chinn & Brewer, 1993; Sperber et al., 2010) – a cautious integration of new information under continued scepticism about the evidence itself (Corner, Harris & Hahn, 2010).

Experimental research on the SIE has relied predominantly on convenience samples of university students, whereas evidence from general population samples remains scarce (Munro, 2010; Thomm et al., 2021; Futterleib et al., 2022; Rosman et al., 2021). The selectivity and homogeneity of student samples or instance in terms of age, education, political views, and proximity to scientific environments, may bias results and limit the generalisability of findings to broader populations (e.g. Hanel & Vione, 2016; Peterson & Merunka, 2014, but see: Jager et al., 2017). The present study addresses this limitation by replicating and extending prior research using quota-representative samples drawn from both university students and general adult populations in Germany and the U.S..

Beyond sampling, there is limited evidence on the boundary conditions under which individuals invoke the SIE. It has been suggested that the SIE may be more likely when conflicting evidence is strong – that is, when it provides consistent results, conveys a high degree of certainty, and cannot be easily dismissed by methodological critique (Munro, 2010). In such cases, directly rejecting the evidence may be cognitively demanding or socially untenable, making the SIE a more viable dissonance resolution strategy. Conversely, when evidence is communicated with uncertainty cues or detailed methodological information – key elements of transparent science communication (Gustafson & Rice, 2020; van der Bles et al., 2020; Blastland et al., 2020) – these features may offer "weak spots" for motivated rejection of the evidence, rendering the SIE unnecessary. Thus, while transparency about uncertainty and methodology may foster epistemic trust, it may also interact with individuals' motivational orientations in complex ways that lead to biased responses to belief-incongruent evidence (Dieckmann et al., 2017). Yet, these assumptions have not been systematically tested. Given the importance of communicating scientific uncertainty and methodological transparency in science communication (Gustafson & Rice, 2020; Gustafson & Rice, 2019; van der Bles et al., 2019; van der Bles et al., 2020; Kerr et al., 2022; Ratcliff & Wicke, 2022; König et al., 2024; Jensen, 2008) and public understanding of science (Drummond & Fischhoff, 2017; National Academies of Sciences, Engineering, and Medicine, 2017; Thomm & Bromme, 2012; Covitt & Anderson, 2022; Sinatra & Hofer, 2016), the present study also aimed to investigate their potential role as moderators of the SIE.

The present study

This paper addresses key gaps in the literature on the SIE framework through a series of eight preregistered experiments with three primary objectives: (a) to test the SIE framework across diverse samples, including quota-representative samples of German university students, German adults, and U.S.

adults (Exp. 1–8), and to synthesise results via internal meta-analysis; (b) to extend the empirical evidence on pertinence-related science devaluation within the SIE framework (Exp. 2); (c) and to examine whether features of science communication, specifically uncertainty communication and methodological details, moderate SIE-related potency devaluation (Exp. 3–8).

Exp. 1–2 closely replicated the original paradigm using a previously studied educational topic (effectiveness of grade retention; Thomm et al., 2021; Futterleib et al., 2022). To broaden topical scope and reduce context-specific bias, Exp. 3–8 applied the SIE framework using two health-related topics: cognitive enhancement effects of energy drinks and calming effects of THC products (for further details see Online Supplement).

Overall, this study contributes to evaluating the validity and generalisability of the SIE framework across diverse populations and topics, and extends prior work by examining how science communication features may shape motivated responses to scientific evidence.

Results

The results presented here focus on the preregistered tests of the SIE framework, testing the interaction between participants' prior belief and evidence direction (confirming vs. disconfirming) on all dependent variables. For Exp. 3–8, we additionally examined the roles of uncertainty communication (present vs. absent) and methodological detail (basic vs. detailed) as potential moderators.

Results for the targeted effects are reported in the order of the hypotheses: direct (H1) and indirect (H2) topic-specific devaluation, generalisation of devaluation (H3), and belief change (H4), followed by exploratory moderation analyses (for full results, see the Online Supplement).

Direct topic-specific science devaluation (H1)

Potency and pertinence

We first tested the prediction that belief-evidence conflicts would elicit topic-specific devaluation of science, reflected in increased doubt over the potency and pertinence of science for the focal issue (H1). Across the eight experiments, as predicted, regression analyses revealed significant interaction effects in six experiments. Specifically, participants exposed to belief-inconsistent evidence expressed significantly greater doubt over the *potency* of science to investigate the respective topic in Exp. 1 and 5–8, and about its *pertinence* in Exp. 2. An internal random-effects meta-analysis pooling the interaction terms across all experiments yielded a robust overall interaction effect, consistent with the assumption of direct topic-specific devaluation of science (Fig. 1).

To illustrate these effects, Fig. 2 presents simple slopes analyses for participants with weak (-1 SD), average (grand mean) and strong ($+1$ SD) prior belief. In all studies with significant interactions (Exp. 1–

2 and 5–8), the expected disordinal pattern emerged: as prior belief in the respective claim increased, belief-inconsistent evidence led to more pronounced doubts over the potency or pertinence of science, whereas belief-consistent evidence was associated with comparatively lower doubts. A similar descriptive pattern was observed in Exp. 3, although not statistically significant.

Taken together, these findings provide clear evidence that belief-evidence conflicts elicit direct topic-specific devaluation of science, both in terms of perceived potency and pertinence, consistent with H1.

Indirect topic-specific science devaluation (H2)

We examined whether encountering belief-evidence conflicts would reduce preferences for scientific sources regarding the focal topic, as an indirect manifestation of science devaluation (H2). Following prior work, we assessed these using measures of preferences (Exp. 1–2) or trust (Exp. 3–8) in scientific sources (i.e. scientific experts and institutions) and non-scientific sources (i.e. friends or news outlets). As Fig. 3 shows, the findings revealed a nuanced pattern: In two studies (Exp. 5 and 7), participants reported reduced trust in scientific sources after encountering belief-inconsistent evidence. However, this effect did not emerge in the remaining experiments: neither source preferences (Exp. 1–2) nor in trust ratings (Exp. 3–4, 6, and 8) showed consistent devaluation tendencies. An internal meta-analysis confirmed that, overall, exposure to belief-inconsistent evidence did not systematically reduce participants' preference for, or trust in scientific sources (Fig. 3A).

Complementary analyses of non-scientific sources also failed to support a systematic shift away from science. None of the eight experiments delivered significant results that belief-evidence conflicts increased preferences for (Exp. 1–2) or trust in (Exp. 3–8) non-scientific sources, which was also reflected in the pooled non-significant meta-analytic effect (see Fig. 3B).

Overall, while the results suggest a topic-specific devaluation of science concerning its potency and pertinence (H1), the data do not support the hypothesis of spill-over effects on preferences for scientific sources (H2).

Generalisation to related and unrelated topics (H3)

To test whether science devaluation generalised beyond the focal topic (H3), we examined doubts towards science for topics in related and unrelated domains (Exp. 1–2). In Exp. 1, participants rated the potency of science to investigate issues from the same domain as the focal topic (educational domain), as well as topics from other domains, including medicine and pseudoscientific topics (unrelated domain). Exp. 2 assessed the pertinence of science for related educational topics. Across these analyses, we found no evidence for generalising effects of science devaluation. In the internal meta-analysis (Fig. 4), all relevant interaction effects were statistically non-significant, indicating no evidence of spill-over effects to either related or unrelated issues. Pertinence devaluation for unrelated topics was

not assessed, as research domains are by definition not pertinent to unrelated issues, and testing this hypothesis would therefore not have yielded meaningful insights.

Maintenance of prior beliefs (H4)

Figure 5 | Internal random-effects meta-analysis of belief change following the presentation of scientific evidence. Plotted values are pre vs. post treatment mean differences expressed as Cohen's d. All shown mean differences are based on significant interaction effects between time and evidence condition.

Finally, we examined whether belief-evidence conflicts would primarily foster belief maintenance rather than belief change (H4). Contrary to the assumption of belief maintenance within the SIE framework, all experiments consistently showed that participants adjusted their prior belief in the direction of the evidence presented. Repeated-measures ANOVAs with evidence condition (confirming vs. disconfirming) and time (pre- vs. post-exposure) yielded significant interaction effects in every experiment, indicating that exposure to scientific evidence changed participants' topic-specific belief. Post hoc tests shown in Fig. 5 confirmed that participants updated their belief in line with the evidence, both when it was consistent and when it was inconsistent with their initial position. An internal random-effects meta-analysis summarising pre-post differences further corroborated robust belief change across studies and comparable in size for both directions, confirming and disconfirming evidence (Fig. 5). In sum, these findings robustly contradict the assumption of belief maintenance in the face of belief-evidence conflict (H4). This change occurred despite the observed devaluation tendencies (H1).

Effects of uncertainty communication and methodological detail

In additional analyses, we explored whether communicating uncertainty (present vs. absent) and varying degrees of methodological detail (basic vs. detailed) would exacerbate science devaluation (H1 – H2) or influence belief change (H4). As features of science communication can influence employment of the SIE via different mechanisms that may enhance as well as decrease its likelihood, we did not specify directed hypotheses for these effects. In Exp. 3–8, these features of science communication were experimentally manipulated in addition to evidence direction. Overall, both features of science communication did not systematically alter the core SIE patterns (see results in the Supplement). The key interaction between prior belief and evidence direction on doubting sciences' potency and pertinence remained robust, and we observed no consistent three- or four-way interactions involving communicating uncertainty or methodological detail (H1). Likewise, for trust in scientific versus non-scientific sources, adding these features as moderators did not change the overall conclusion that belief–evidence conflicts did not reliably reduce scientific source preference or increase preference for non-scientific sources (H2). Moreover, we could not identify any systematic effects of these factors on belief change (H4).

A small number of isolated higher-order interactions emerged in individual studies (see results in the Supplementary Materials). In Exp. 3 (university students, DE), the three-way interaction between prior belief, evidence condition, and methodological detail suggested that direct topic-specific devaluation (H1) facing belief–evidence conflicts was more pronounced when only basic methodological information was provided than when detailed methodological information was available. In Exp. 8, a similar pattern emerged for trust in scientific sources, and in Exp. 5 for trust for non-scientific sources: SIE-type responses were mainly observed when methodological information was basic but were attenuated or absent when more detailed methodological descriptions were provided. Finally, in Exp. 5, belief change was somewhat stronger when uncertainty was explicitly communicated than when uncertainty cues were omitted.

Overall, these isolated interactions tentatively suggest that, on the rare occasions when uncertainty communication or methodological detail do matter, they tend to buffer SIE-related devaluation and support belief change rather than undermining them. Across the broader pattern of results, however, these higher-order interactions did not replicate across studies or outcomes.

Discussion

The present study provides robust evidence that the SIE is a consistent and replicable form of motivated science devaluation. Across eight preregistered experiments with multiple samples and topic-domains, we repeatedly observed the core process proposed by the SIE framework: devaluation of the potency and pertinence of science to investigate the topic when scientific evidence conflicts with people's prior beliefs (H1; Munro, 2010; Thomm et al., 2021; Futterleib et al., 2022; Rosman et al., 2021). The internal meta-analysis confirms that the SIE is not a sporadic artefact of individual studies but a generalisable defensive strategy. By establishing this robustness, our work extends prior taxonomies of defensive responses to unwelcome scientific information (Chinn & Brewer, 1993, 1998; Kadel et al., 2024; Panitz et al., 2021). Crucially, the dual devaluation of potency or pertinence observed here signals a deeper undermining of the role of science as the societal institution tasked with producing warranted knowledge – a cornerstone of the relation between science and the public (Bromme & Goldman, 2014). Given the complexity of socio-scientific challenges, public discussions and effective policy making need to rely on science's legitimate expertise (Thomm et al., 2026; Kienhues et al., 2020; Bromme & Hendriks, 2024; Feinstein, 2011; Keren, 2018). Motivated rejection of either the validity or the relevance of that expertise, even in issues where it is directly pertinent, may therefore contribute to broader patterns of science denialism (Lewandowsky et al., 2017; Hornsey, 2020; Hornsey & Fielding, 2017; Kavanagh & Rich, 2018; Hansson, 2017; Huber et al., 2022).

At the same time, the present study offers little support for the conjecture that SIE-based devaluation generalises beyond the topic at hand (Munro, 2010; Thomm et al., 2021). Instead, the SIE appeared as a predominantly topic-specific and situational belief defence in response to cognitive dissonance response, rather than a generalised anti-scientific orientation. Nevertheless, this boundedness should not lead to an underestimation of the SIE's potential individual or societal impact. In highly consequential

and politicised domains such as climate change, vaccination, or public health, localised devaluation on a single issue can have wide-ranging societal consequences if the issue itself has far-reaching implications for policy, behaviour and institutional trust (Han & Kim, 2020; Huber et al., 2022; Mede et al., 2022; Cologna et al., 2025; Kavanagh & Rich, 2018; Hansson, 2017). Thus, while the lack of generalised spill-over may appear reassuring, its importance must be interpreted in light of the societal relevance of the topic in question. Moreover, the complex ways in which situational science devaluation, such as the SIE, interacts with more stable attitudes toward science and political orientations warrant further investigation.

Beyond these issues, the present study also extended prior work by examining whether typical features of science communication – scientific uncertainty and methodological details – moderate the occurrence of the SIE. Aside from isolated higher-order interactions, these factors did not systematically alter the core SIE effect of topic-specific science devaluation. This suggests that transparency, at least in the context of SIE, does not exacerbate science devaluation or foster instrumental discrediting of scientific sources, aligning with evidence that communicating uncertainty does not necessarily undermine trust in science and can even strengthen it (van der Bles et al., 2020; Dries et al., 2024; Kerr et al., 2022; Janssen et al., 2021; Fischhoff, 2013; Guo et al., 2025; but see: Osman et al., 2018). While our findings support calls for transparent science communication (Blastland et al., 2020; van der Linden & Löfstedt, 2019; Petersen et al., 2021; Intemann & de Melo-Martin, 2023; König et al., 2024), the isolated interactions observed underscore the need to further investigate under what circumstances specific science communication may trigger motivated reasoning (e.g. Dieckmann et al., 2017; Dries et al., 2025).

Finally, our results clearly disconfirmed the assumption of belief maintenance (H4) through conflict resolution via the SIE (Munro, 2010). Across all eight experiments and in line with prior research (Thomm et al., 2021; Futterleib et al., 2022; Anglin, 2019; Kube, 2024; Vlasceanu et al., 2023; Kerr & Wilson, 2018; van Stekelenburg et al., 2020; Sharot et al., 2023), participants changed their belief in the direction of the presented evidence, even when it contradicted their prior stance. This finding is intriguing, given that the SIE is conceptualized as a defensive mechanism that leads to the devaluation of science.

Several explanations may account for this apparent contradiction. First, as argued by Thomm et al. (2021) and Futterleib et al. (2022), such shifts may reflect peripheral belief change (Chinn & Brewer, 1993), accompanied by heightened epistemic vigilance (Sperber et al., 2010). Participants may have provisionally accepted the information as representing the current scientific position, while withholding full integration into their belief system due to continued scepticism about science as the source of the evidence (Corner, Harris & Hahn, 2010). In this sense, the evidence may have been kept in abeyance – acknowledged but not fully internalised (Chinn & Brewer, 1993, 1998). Such change would therefore be superficial, reflecting espoused rather than entrenched beliefs, and thus unlikely to be stable. Second, belief revision is rarely an immediate and full replacement of old conceptions with new ones (Chi, 2008; Vosniadou, 2013). People often hold contradictory beliefs, and conceptual change typically requires gradual integration of conflicting information, where the cognitive activation of accurate conceptions strengthens while misconceptions weaken (Kendeou, 2024). From this perspective, the observed shifts

may mark the beginning of a longer process of belief change rather than its completion. Future research should therefore test the stability of such belief adjustment in longitudinal designs (Nyhan et al., 2022; Nagler et al., 2022).

Two main limitations of the present studies warrant consideration. First, although we investigated multiple topics to enhance generalizability, it remains unclear how specific features of topics – and their interactions with participant characteristics – shape the occurrence of the SIE. Certain topics, and the associated scientific disciplines, might be more susceptible to devaluation. For instance, natural sciences are often perceived as more reliable than social sciences, which could affect devaluation tendencies (Lewis et al., 2023; Lilienfeld, 2012). Likewise, topics may differentially engage self-concepts (Hornsey, 2020; Hornsey & Fielding, 2017; Lord et al., 1979) or group identities (cf. Kahan, 2013; Nauroth & Bender, 2015; Taber & Lodge, 2006), thereby influencing both the strength and the form of defensive responses (Hornsey, 2020). We selected salient but not overly politicised socio-scientific topics (e.g. COVID-19, climate change) from both the social and health sciences to account for disciplinary differences in perceived credibility. Future research should extend this approach to additional domains and systematically examine the role of domain or topic characteristics.

Second, the consistent use of a single experimental paradigm across studies, while ensuring comparability, may raise concerns of common method bias. For example, each condition presented participants with multiple scientific texts with consistent conclusions – a necessary design feature, as presenting single studies or divergent findings would likely elicit alternative defensive responses such as cherry picking (Kaanders et al., 2022; Hansson, 2017). However, this may also limit external validity: strong scientific consensus is realistic for some real-world issues but not for others, where evidence may be more mixed or otherwise limited. While the present study design prioritised internal validity to rigorously test the SIE framework, future research should extend this approach to more ecologically valid contexts, such as the presenting participants with scientific findings in form of typical media formats.

Conclusion

Taken together, our findings portray the SIE as a robust but bounded way in which people defend their prior views when confronted with unwelcome scientific evidence. Rather than revealing a diffuse rejection of science, SIE-type responses seem to be tied to specific issues, co-occurring with both doubts about the potency and pertinence of science and with measurable shifts in beliefs towards the evidence. At the same time, we found no indication that core features of transparent science communication, such as acknowledging statistical uncertainty and providing methodological detail, systematically amplify these defensive tendencies; if anything, the few isolated moderation effects pointed in a more favourable direction. By clarifying when and how belief-evidence conflicts translate into localised science devaluation, and by showing that transparent communication need not come at the cost of fuelling motivated rejection, this work helps to refine accounts of public understanding of science and offers a cautiously optimistic message: even in the presence of motivated doubt, people

can adjust their beliefs in line with scientific evidence, and communicators need not sacrifice epistemic honesty to make such adjustment possible.

Methods

All preregistrations, experimental materials, questionnaires, analysis scripts and anonymised data are available on the Open Science Framework (OSF; data & materials: https://osf.io/aywfk/overview?view_only=cb8a291a3c9242df83eb278783df0ecf; preregistrations:

Exp.1: https://osf.io/extd2/overview?view_only=971ed9e34190459da9066a7a28d66db3,

Exp. 2: https://osf.io/wpqk6/overview?view_only=ef5935f6aa814fc1bcf4fb05852e7998,

Exp. 3-4: https://osf.io/by8qz/overview?view_only=0c1fc325a2de4065a69cba8c8c102d7f,

Exp. 5-6: https://osf.io/3h2a5/overview?view_only=5c6d09f44b8545f5917ec96e11481b60,

Exp. 7-8: https://osf.io/zt39k/overview?view_only=da490284eee74bd794fd741c2b8ba343).

Ethical Approval and Sample Recruitment

All eight experiments complied with the ethical principles outlined by the German Research Foundation (DFG) and were reviewed and approved in advance by the Ethics Committee of the University of Erfurt (20211123, 2023-17).

Data were collected online using the survey software Questback Enterprise Systems. Participants were recruited by an external provider (Bilendi), who invited panel member to the studies based on pre-specified quotas to ensure representativeness with respect to age, gender, and educational level for general population samples in Germany and the United States. Participants were compensated by the provider upon completion of the experiment in accordance with panel rules. Before taking part, all participants received detailed information about the study procedures and data protection policies and provided informed consent.

Across all eight experiments, data from a total of $N = 4,215$ participants were included in the analyses (Exp. 1: $n = 317$, Exp. 2: $n = 309$, Exp. 3: $n = 255$, Exp. 4: $n = 264$, Exp. 5: $n = 769$, Exp. 6: $n = 771$, Exp. 7: $n = 767$, Exp. 8: $n = 763$). All experiments and statistical procedures were preregistered. Target sample sizes were determined a priori via power analyses based on the expected key regression coefficients, and data collection continued until the planned sample size was reached. Participants who met pre-specified exclusion criteria (as defined in the preregistrations) were removed from the analyses.

Design and procedure

All experiments followed a common structure, using a between-participants design with variations in the experimental manipulations across studies. After providing demographic information and reporting their

prior beliefs on the focal topic, participants received a short introduction to the issue and were informed that they would read scientific summaries of relevant research findings.

Participants were randomly assigned to the different experimental conditions with equal probability via the survey software's randomizer. In Exp. 1–2, we manipulated only the direction of the evidence: participants received either claim-confirming or claim-disconfirming evidence regarding the effectiveness of grade retention. In Exp. 3–8, we additionally manipulated the presence of methodological information (detailed vs. basic) and uncertainty communication (present vs. absent). In these experiments, the focal topics concerned the use of substances for cognitive enhancement (energy drinks for increasing activation; THC for relaxation).

In all eight experiments, the scientific evidence was presented as a series of short summaries of empirical studies that were based on original research, adapted to provide accessible language, and manipulated according to the assigned conditions (materials on the OSF). Participants in Exp. 1–2 read five summaries per condition; participants in Exp. 3–8 read four summaries due to highly variable word counts resulting from the additionally included conditions.

After reading the summaries, participants completed questionnaires measuring the dependent variables, including doubts over scientific potency to investigate the focal topic (Exp. 1, 3–8); about the pertinence of science to address it (Exp. 2); preferences for (Exp. 1–2) or trust in (Exp. 3–8) scientific and non-scientific sources regarding the topic; evaluations of the potency to investigate issues from related and unrelated domains (Exp. 1); evaluations of the pertinence of science within the same domain (Exp. 2); and a reassessment of participants' topic-specific belief after exposure to the evidence (Exp. 1–8). All measures can be found in Supplementary Table 1.

At the end of each experiment, participants were debriefed, informed about the aims of the experiment, and provided with a concise summary of the current state of scientific evidence on the respective topic.

Analyses

Analytical procedures followed the preregistered plan and were equivalent across all experiments. Data preparation included screening for errors (e.g. incorrect coding) and psychometric analyses (factor analysis, reliability) for multi-item scales (see Supplementary Material, Table 1). For all dependent variables, we examined distributions per experimental condition to assess normality using graphical (e.g. Q-Q plots) and inferential (e.g. z-tests) methods and, in case of significant skewness, applied transformations to ensure reliable standard errors (Tabachnick & Fidell, 2013).

H1 to H3 were tested via multiple regression with experimental conditions (dummy coded) and prior belief (grand-mean centred) as predictors. Due to the more complex designs of Exp. 3–8, analyses employed a two-step modelling approach. First, to ensure comparability with Exp. 1–2, the first model included prior belief, evidence direction, and their interaction as predictors. Second, we estimated a fully specified model, which further included methodological information and uncertainty communication as

predictors, including all interactions. These models were trimmed subsequently using stepwise backward deletion approach to eliminate the non-significant highest-order interaction effects to yield more parsimonious models and aid interpretation (Tabachnick & Fidell, 2013). Note that for the present study, only the three-way interaction interactions of prior belief and evidence direction with methodological information or uncertainty communication, respectively, were of substantive interest. Complete results are available in the Supplementary Materials. To visualize interaction effects, we used the PROCESS tool (Hayes, 2018) in R to conduct simple slope analyses at -1 SD, grand mean, and +1 SD of prior belief, reported as marginal effects. Due to the complexity of the design, it was not feasible to compute simple slope analyses for more comprehensive models.

For H4, we assessed belief change between t1 and t2 using repeated-measures ANOVAs and respective follow-up *t*-tests. Due to violations of ANOVA assumptions, we additionally calculated linear mixed models, which led to the same conclusions as the ANOVA results. For clarity, we report the ANOVA results, as preregistered.

To synthesise findings across experiments, we conducted internal random-effects meta-analyses. We report effect sizes as unstandardised regression coefficients of the relevant interaction effects (see Fig. 1, 2, 3) or as Cohen's *d* (Fig. 4).

Declarations

Use of artificial intelligence tools. The authors used ChatGPT (OpenAI, San Francisco, CA) and Claude (Anthropic, San Francisco, CA) to assist with language editing and phrasing, and to support the development of the analysis scripts. All ideas, study designs and interpretations were conceived and generated by the authors. All analysis code produced with the assistance of these tools was reviewed, tested and critically checked by the authors, who take full responsibility for the content of this article.

Declaration of interest. The authors report no potential conflict of interest.

CRedit statement. **H.F.:** Conceptualization, Methodology, Investigation (lead), Formal analysis, Data curation, Resources, Visualization, Writing – Original Draft, Writing – Review & Editing. **E.T.:** Conceptualization, Investigation, Resources, Writing – Review & Editing. **G.M.:** Methodology, Writing – Review & Editing, Funding acquisition. **J.B.:** Conceptualization, Formal Analysis, Resources, Writing – Review & Editing, Funding acquisition.

Competing Interests.

The authors declare no competing interests.

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Data Availability. The datasets generated and/or analysed during the current study are available in the Open Science Framework (OSF) repository. During the review process, the data can be accessed via the following view-only link: [https://osf.io/aywfk/overview?](https://osf.io/aywfk/overview?view_only=cb8a291a3c9242df83eb278783df0ecf)

[view_only=cb8a291a3c9242df83eb278783df0ecf](https://osf.io/aywfk/overview?view_only=cb8a291a3c9242df83eb278783df0ecf). Upon publication, the data will be made publicly available and assigned a persistent identifier (DOI).

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Figures

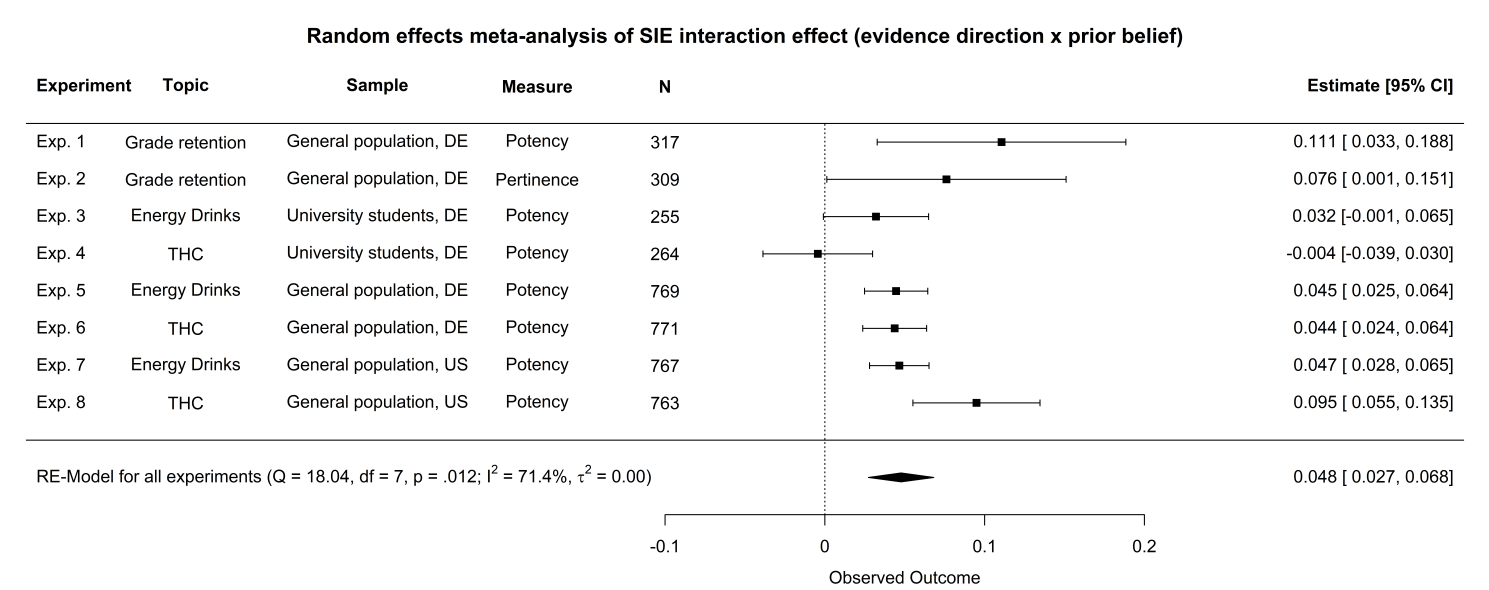


Figure 1

Internal random-effects meta-analysis of topic-specific devaluation of the potency and pertinence of science (H1). Plotted values represent unstandardized regression coefficients for the interaction between prior belief and evidence direction on doubts over the potency and pertinence of science. The diamond reflects the pooled interaction effect.

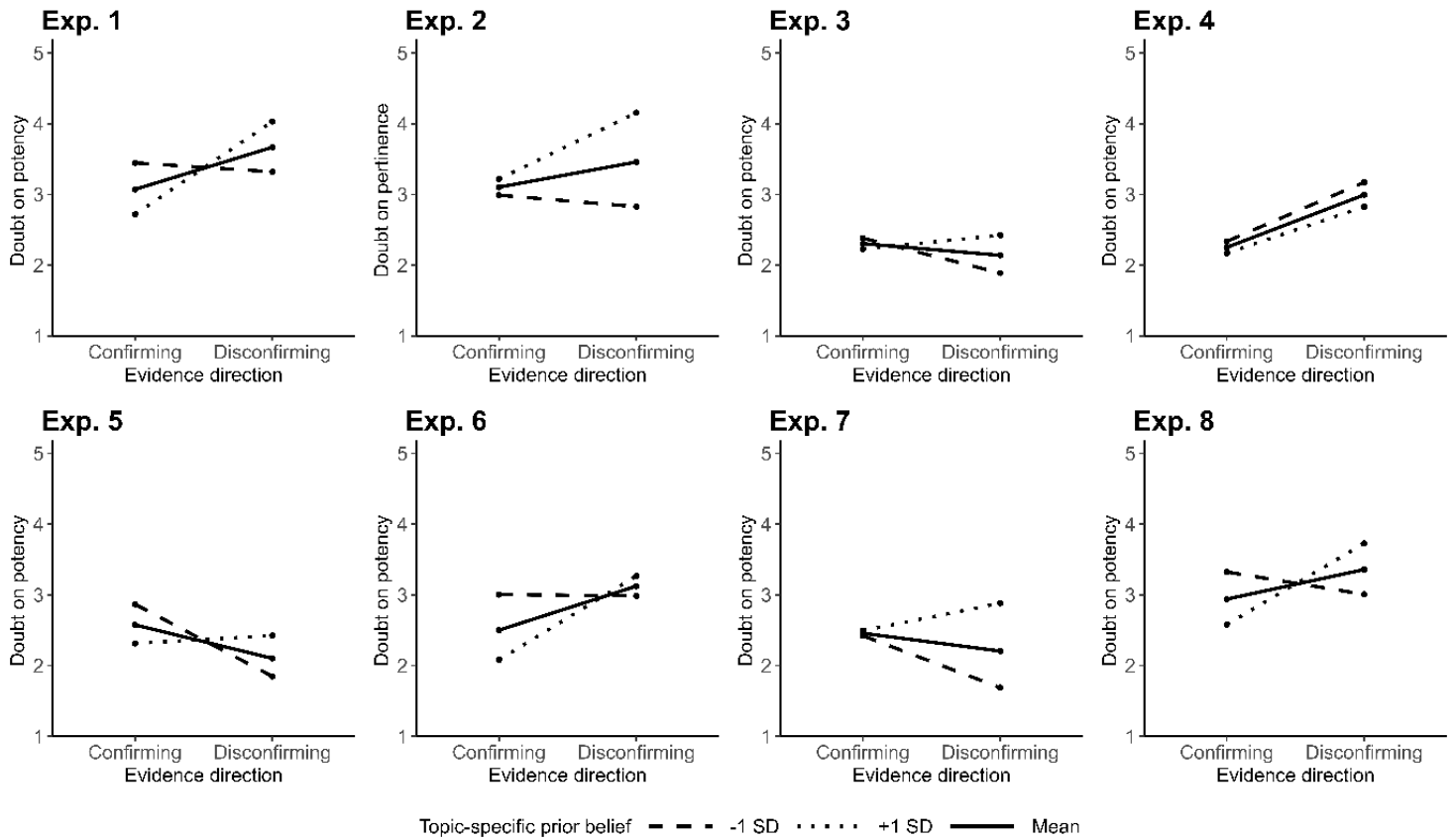


Figure 2

Simple slopes of topic-specific devaluation effects (H1). Plots show estimated marginal means for participants with topic-specific prior belief at -1SD (dashed lines), at the grand mean (solid lines), and at + 1SD (dotted lines). Y-values represent back-transformed data (see Methods section), restricted to observed Y-range (1–5) with higher values indicating stronger doubts over the potency of science (Panels 1, 3-8) and its pertinence (Panel 2).

Effects on preference for scientific and non-scientific sources

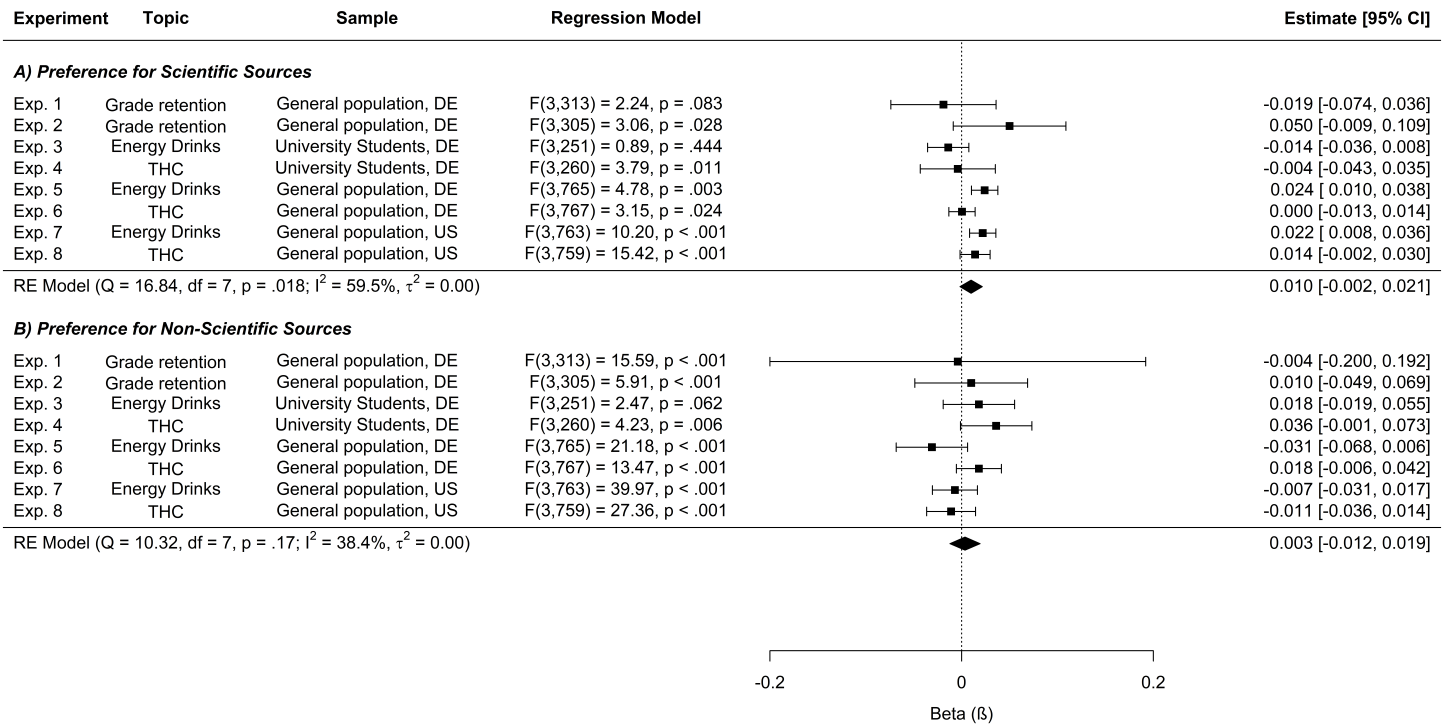


Figure 3

Internal random-effects meta-analysis of effects on preferences for scientific versus non-scientific sources (H2). Plotted values represent unstandardized regression coefficients for the interaction between prior belief and evidence direction. Diamonds reflect the pooled interaction effects.

Effects on science evaluation for other topics

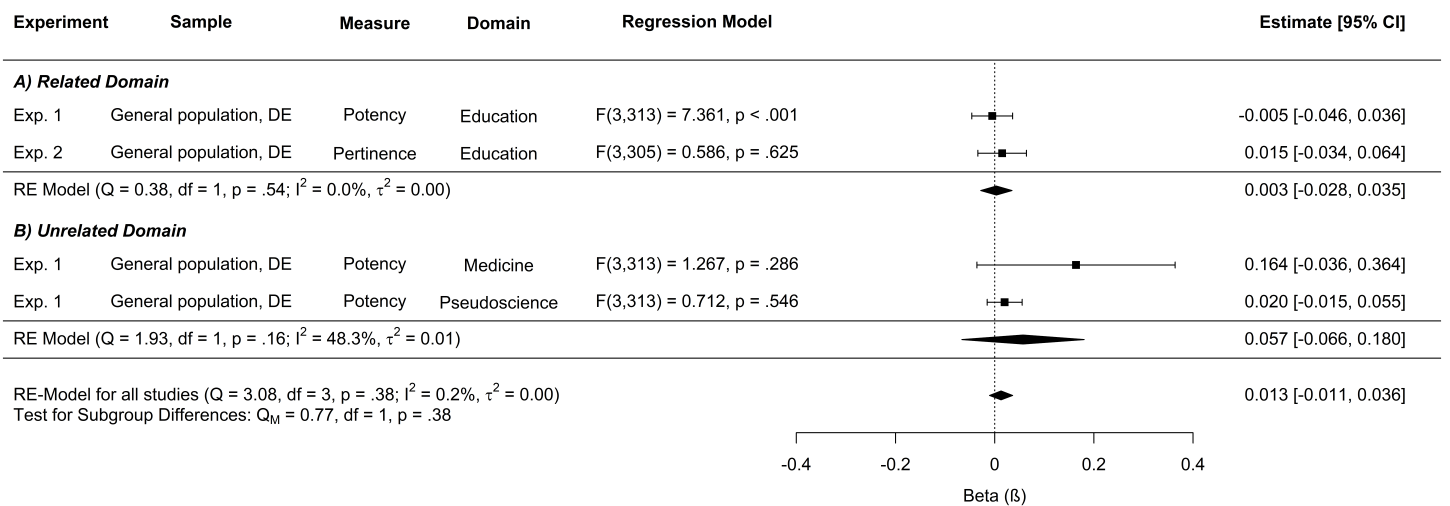


Figure 4

Internal random-effects meta-analysis of generalisation to related and unrelated topics (H3). Plotted values represent unstandardized regression coefficients for the interaction between prior belief and evidence direction. Diamonds reflect the pooled interaction effects.

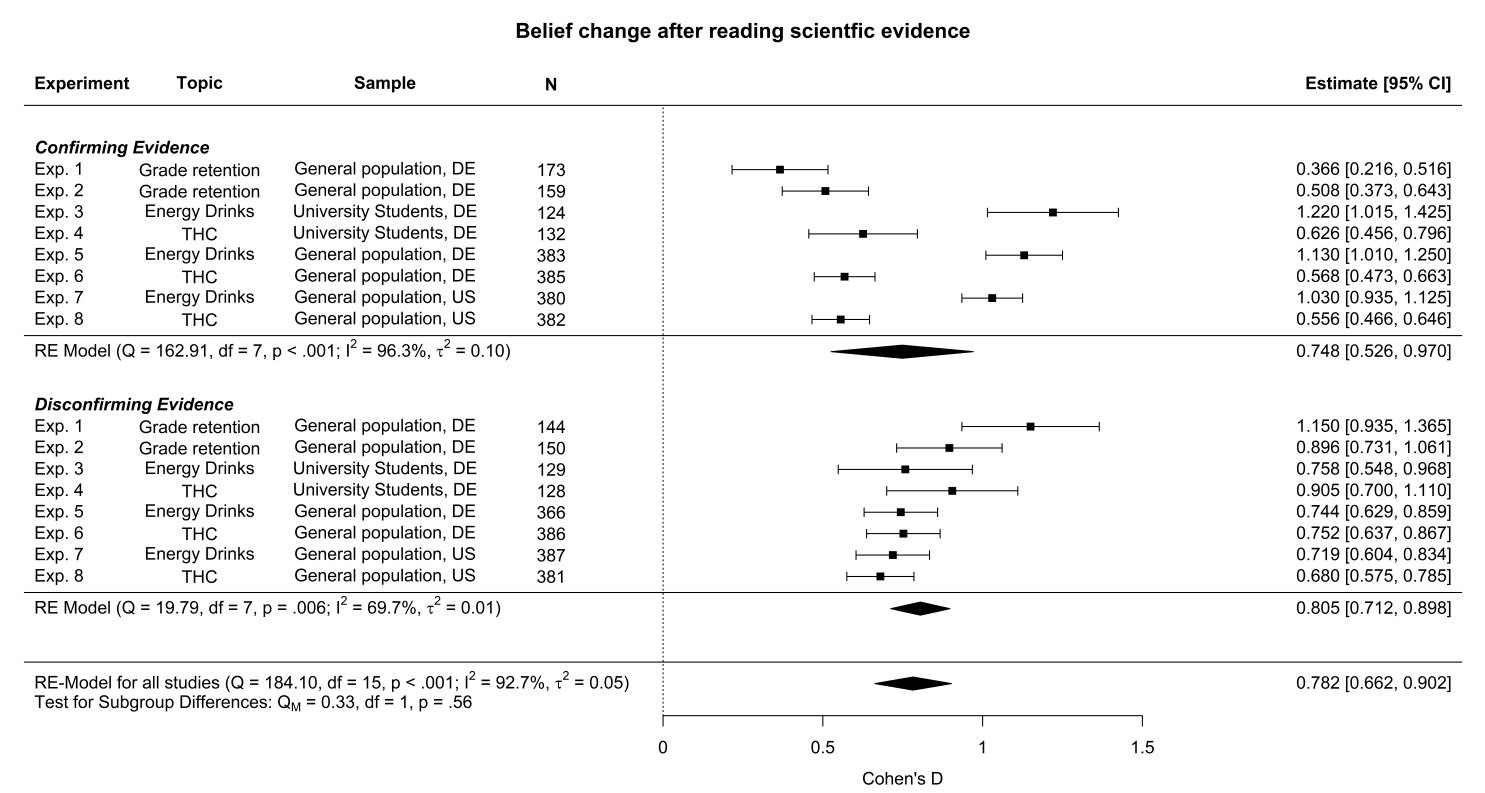


Figure 5

Internal random-effects meta-analysis of belief change following the presentation of scientific evidence. Plotted values are pre vs. post treatment mean differences expressed as Cohen's d. All shown mean differences are based on significant interaction effects between time and evidence condition.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [FutThoMehBau25Supplement.docx](#)