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The UK public's trust in tobacco industry involvement in science – an experimental survey

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Introduction: Despite the tobacco industry's (TI) decades-long history of manipulating science, Philip Morris International (PMI) now frames itself as a benevolent funder of science and, in 2017, launched a new scientific organisation, the Foundation for a Smoke-Free World (FSFW). With concerns mounting that PMI's actions are echoing historical TI influence on science, we aimed to understand the extent to which the public trusts PMI's involvement in science, and whether channelling funds through a third-party organisation affects these levels of trust.

Methods: Through a representative survey of the UK public (n=1580) we investigated trust in direct (PMI), indirect (FSFW), and no (Cancer Research UK) TI involvement in science. Conservative worldview was investigated as a possible predictor of trust. Structural equation modelling was used to explore associations between variables.

Results: Although PMI was significantly less trusted than FSFW and Cancer Research UK, the public did not completely distrust it as a scientific source. Trust in FSFW's involvement in science was higher before participants understood its TI funding. People with conservative worldviews demonstrated greater trust in TI involvement in science.

Discussion: The UK public needs to be better informed that the TI is not a trustworthy scientific source. Since channelling TI research funds through a third party increases the perceived trustworthiness of its science, steps to prevent such relationships are warranted. People with conservative leanings hold concerning views on TI involvement in science, which may be particularly hard to correct.

KEYWORDS

tobacco industry, science, agnogenesis, disinformation, ethics, trust

Introduction

The tobacco industry has used science to create doubt and ignorance (or "agnogenesis") about the harms of smoking and the efficacy of regulation since the 1950s (Brandt, 2012; Lee et al., 2012; Bero, 2013; Fernandez Pinto, 2017). When faced with evidence that smoking causes cancer, tobacco corporations funded their own science to distract attention from industry harms, and worked with public relations experts to paint themselves as "committed participant(s) in the scientific enterprise rather than…self-interested critic(s)" (Brandt, 2012). To further obfuscate the link between cigarettes and health harms, the industry funded purportedly-independent scientific organizations, including the Tobacco Industry Research Committee (later renamed the Council for Tobacco Research) in the 1950s (Tobacco Control Research Group, 2020b) and the Center for Indoor Air Research in the 1980s (Tobacco Control

Research Group, 2020a) to disseminate scientific misinformation. Here, the intention was to create trust in the science emanating from these groups by obscuring the industry's involvement (Legg et al., 2021a).

The industry's manipulation of science, and the key role these third parties played in the deception, was recognized in 1998 through the Master Settlement Agreement (MSA) between several tobacco corporations and the attorneys general of 46 US states, National Association of Attorneys General (1998) as well as in subsequent civil litigation which found the tobacco industry guilty of defrauding the American public (United States District Court For the District of Columbia Vs Philip Morris USA, 2006).

Now, in an echo of history, Philip Morris International (PMI) claims it is conducting "rigorous, robust, and transparent science" on its newer tobacco and nicotine products (Philip Morris International, 2020b). The tobacco corporation frames this as part of its "transformation" into a responsible industry actor (Philip Morris International, 2020a), yet a recent investigation of this industry-wide "transformation" narrative concluded that it is best understood as a "pseudo-transformation" designed to rehabilitate the industry's reputation while obstructing tobacco control policies (Edwards et al., 2022). As part of these efforts, in 2017, PMI launched a new scientific organization, the Foundation for a Smoke-Free World (FSFW) with funding of USD 1 billion originally pledged over 12 years (Yach, 2018; Foundation For a Smoke-Free World, 2018b). FSFW describes itself as an independent organization aiming to fund research to end smoking (Foundation For a Smoke-Free World, 2018a). This was the first major tobacco industry-funded scientific third party launched since three such bodies were forced to disband by the MSA because of their egregious role in spreading misinformation and hiding tobacco harms (Legg et al., 2021b).

Concerns have been raised about the robustness of PMI's new science (Lasseter et al., 2017; Organized Crime and Corruption Reporting Project, 2020), the level of PMI's control over FSFW and its science (Cohen and Eissenberg, 2017; Van der Eijk et al., 2018), and FSFW's potential role as an "arms-length front organization" (Daube et al., 2017) serving to obscure tobacco industry involvement in science. An analysis of FSFW's scientific activities and outputs recently concluded it should be understood as a scientific lobby group furthering the tobacco industry's interests (Legg et al., 2023).

Any benefits (or otherwise) of the tobacco industry's newer products in tackling the tobacco epidemic are yet to be scientifically established. There is thus a real danger that tobacco industry involvement in this science and research will be used to generate controversy (rather than establish a scientific consensus), and unduly influence the public's perceptions of these products, tactics the tobacco industry has used historically when evidence on smoking and passive smoking threatened its profits (Brandt, 2012; Bero, 2013; Legg et al., 2021a). For this reason, an understanding of the extent to which scientific messaging from the tobacco industry is trusted by the public is needed.

Trust in scientific messengers is multi-dimensional and has been operationalized in various ways. Sanz-Menendez and Cruz-Castro found that evidence on climate change was deemed most "credible" (it had the highest degree of believability) when attributed to academic institutions, and deemed least "credible" when attributed to business associations (Sanz-Menendez and Cruz-Castro, 2019). Myers and colleagues' investigation of trust in US federal agencies and their science included dimensions of "perceived competence" (the expertise of an actor) and "perceived character" (the extent to which an actor will work in a benevolent way, with the interests of others at heart) (Myers et al., 2017).

There is also growing evidence on individual factors influencing the public's perceptions of scientific evidence. Studies have begun to demonstrate that individuals' worldviews predict their acceptance (or otherwise) of certain science, with political conservatism—and in particular economic libertarianism—predicting rejection of evidence which could have implications for the regulation of industry activity, such as climate science (Lewandowsky et al., 2013, 2020; Lewandowsky and Oberauer, 2021). Such investigations provide supporting evidence for the theory of motivated reasoning: that people's perceptions (of, for example, scientific evidence and norms) are informed by psychological processes which act to protect and uphold their existing world views (Kunda, 1990; Leviton, 2007).

When the tobacco industry creates and disseminates science, little is known about the extent to which it is seen as credible. When the industry channels research funds through a third-party organization, the extent to which this affects public trust in the scientists and the resulting science is again unknown. In this article, we use the real-world examples of PMI and FSFW to explore both issues, and to investigate whether worldview (specifically, political conservatism) plays a role in the public's trust in tobacco industry involvement in science. We address the following research questions:

- To what extent does the UK public trust a tobacco corporation as a funder and communicator of science?
- What effect, if any, does channeling research funds through a third-party scientific organization have on the UK public's trust in tobacco industry-funded science?
- Do the UK public's worldviews affect their perceptions of direct and indirect tobacco industry involvement in the funding and communication of science?

Materials and methods

Overview

We conducted a between-groups survey of adult UK residents to investigate the public's trust in direct (PMI) and indirect (FSFW) tobacco industry involvement in science. Cancer Research UK (CRUK) was chosen as a control group. CRUK is a major funder of research on tobacco and smoking, is wholly independent from the tobacco industry, and champions protecting science and research from tobacco industry interference (Cancer Research UK, 2014). Further, CRUK is a highly-trusted organization – in a 2016 study of public perceptions of UK charities, CRUK was the most trusted (Populus, 2016). Here, we measure trust in CRUK specifically as a scientific organization. Our measure of trust is based on dimensions developed by Myers et al. (2017). We also measured individuals' levels of conservatism, using questions developed by Thomas Scotto and Jason Reifler for their ESRC project "Public Opinion and the Syrian Crisis in Three Democracies" (ES/L011867/1) recently employed in a study investigating people's rejection of scientific evidence (Lewandowsky, 2021).

Materials

Descriptions of PMI, FSFW and CRUK were taken from their websites (Supplementary material S1). These were used to introduce participants to the organizations and outline the organizations' stated involvement in science on tobacco and smoking. FSFW's description did not include information on its industry funding, but this was provided to participants at a later stage. Survey questions comprised three demographic questions (age, gender and country of residence, the latter used to exclude anyone based outside of the UK), five questions on worldview (WV1-WV5), and four questions on trust in a scientific body (PMI, FSFW, or CRUK) (Supplementary material S2). The trust questions comprised four items which measured: trust in the scientists to conduct the science in a competent way (T1), trust in the scientists to conduct the science in an honest or benevolent way (T2), trust in the scientific outputs themselves (T3), and trust in the organization to use the science in a benevolent way (T4).

Participants were also asked about the level of education they had reached, and their smoking status. Since including these variables in our analysis made the data subsets small (potentially impacting the reliability of any findings), we decided not to consider these variables further.

Survey development

In September 2020 we conducted a "soft launch" ($n = 71$) as part of the sampling procedure, which gave opportunity for inspection of some initial data. We discovered some participants were completing the survey very quickly (median completion time = 109 s) and concluded this was probably due to inattention. To deal with this, we added minimum click times on certain pages (30 s on the consent form, and on the pages giving descriptions of the organizations) in an attempt to ensure that participants read that information properly. Upon relaunch (starting the data collection again, and discarding soft launch data), the median time extended to 183 s, suggesting that this additional step helped.

Ethics statement

The Department for Health ethics committee at the University of Bath gave ethical approval for this study (EP19/20039). Participants were given an information sheet outlining the research, and how data would be used and stored. Participants who gave their informed consent with a mouse click after reading this form were then taken through to the online survey.

Participants and procedure

A sample of 1,580 UK residents 18 years and older was recruited during October 2020 via electronic invitations by Qualtrics, an online market research company that specializes in representative internet surveys. Participants were drawn from a panel of UK residents to ensure representativeness in terms of gender and age. Thus, our findings are specific to the UK cultural context. Participants were compensated using the company's standard reward scheme.

Participants were randomly assigned to one of the three conditions, provided with a description of either PMI, FSFW or CRUK, and asked about (i) their perception of this group's involvement in science and (ii) their own worldviews. In the case of the FSFW condition, the trust questions were asked twice: once before FSFW's tobacco industry funding was revealed, and again afterwards. This enabled us to compare people's trust in FSFW when it was presented as an independent body to when it was made clear it is an industry-funded organization.

Results

After exclusion of 243 respondents (because they held "no opinion" about one or more question) 1,337 observations were retained for analysis. This final sample included 677 females, 654 males and 6 people who answered "other" or declined to reveal their gender. The mean age of participants was 44 (with a range of 18–97).

Gender was not correlated with trust, and only very slightly correlated with worldview (the highest correlation being 0.18 with WV2, meaning females had slightly more support for free markets than males). Age exhibited some minor associations with worldview and trust. Older participants were slightly more likely to have conservative family values (WV3, a correlation of −0.25), were less likely to think we should adjust our views of moral behavior based on a changing world (WV4, 0.25), and were less likely to support socialism (WV5, 0.22). Older participants also reported slightly higher trust in CRUK (an average correlation of 0.25 between age and T2, T3, and T4) but not in the other organizations. Because of the small nature of these associations, we did not consider gender and age further.

We now briefly outline our statistical analysis approach, then discuss findings from the three parts of our analysis: (i) trust in tobacco industry involvement in science, (ii) the effect of channeling research funds through a third-party organization on trust, and (iii) the relationship between worldview and trust.

Analysis technique

The analysis techniques used were a one-way ANOVA (to compare the mean levels of trust across the three organizations), paired-samples t-tests (to compare any change of trust in FSFW before and after its funding is revealed), and structural equation modeling (SEM) (to model the relationship between trust and worldview). The SEM was conducted using the Lavaan package (an open source package for latent variable analysis) in statistical analysis software R (Rosseel, 2012). Our two constructs – trust and worldview – are represented by latent (that is, not directly observable) variables estimated from participants' responses to the corresponding survey items. We chose SEM rather than multiple regression, for example, since the latter is prone to measurement error, while in the former, measurement error is reduced (Sturgis, 2016; Lewandowsky and Oberauer, 2021).

Trust in tobacco industry involvement in science

First, we considered the extent to which the public perceived tobacco industry involvement in science as problematic. In

comparison with PMI, CRUK and FSFW's *scientists* were viewed as more trustworthy (both in terms of competence [T1] and benevolence [T2]), its *scientific outputs* as more trustworthy (T3), and the organization itself viewed as more likely to *use* findings from its research in ways that benefit the public (T4) (see Supplementary material for summary of raw responses).

Composite trust scores were determined by calculating the means of the four trust items. For the FSFW condition, only the initial trust rating was considered in this analysis. CRUK's science and scientists scored highest (5.79, 95% CI 5.68–5.91) followed by FSFW (5.04, 95% CI 4.92–5.16), then PMI (4.66, 95% CI 4.65–4.67) (Table 1). See Figure 1 for frequency distributions of the composite trust scores. A one-way ANOVA revealed a statistically significant difference between the composite trust scores, F (2, 1,335) = [92.39], $p < 0.001$. Pairwise comparisons of the means indicated significant differences between PMI and FSFW, between PMI and CRUK, and between CRUK and FSFW (all $p < 0.001$).

The effect of channeling research funds through a third-party organization

Next, we investigated the impact the tobacco industry channeling its research funds through a third-party organization has on the public's trust in the organization, the scientists, and the science. We approached this question by comparing responses before and after tobacco industry involvement was revealed in the FSFW condition.

Paired-samples t-tests found that although individuals' trust in the *competence* of FSFW's scientists (T1) did not change significantly pre- and post-funding information ($t(430) = -0.97$, $p = 0.33$), trust in the scientists' benevolence (T2) ($t(430) = 4.89$, $p < 0.001$), the scientific outputs (T3) ($t(430) = 5.10$, $p < 0.001$), and the organization's use of science (T4) ($t(430) = 5.88$, $p < 0.001$) decreased significantly once participants understood the organization was funded by the tobacco industry.

How worldview affects trust in tobacco industry involvement in science

Our final analysis considered the extent to which an individuals' worldview (specifically, levels of support for political conservatism) affects their trust in tobacco industry involvement in science. See Supplementary material for summaries of raw responses to the worldview questions, and Figure 2 for a frequency distribution of the composite worldview scores (formed by averaging scores across each of the five items once WV1 was converted to 1–7 rather than 0–10).

For the worldview measurement model used in the SEM, initial fit was poor ($\chi 2 = 296.121$, CFI = 0.665, RMSEA = 0.209, = SRMR 0.099) based on conventional standards of good fit (CFI > 0.90, RMSEA <0.06 and SRMR <0.08) (Hu and Bentler, 1999). Based on modification indices, two pairwise correlations between residuals were introduced (for WV4/WV5 and WV2/WV4) to respecify the model, resulting in a modestly acceptable fit ($\chi^2 = 79.085$, CFI = 0.913, RMSEA = 0.138, SRMR = 0.041).

The trust measurement models across the three organizations (treating the retest data on FSFW as a separate, fourth group) indicated good fit between the model and the observed data (Table 2). No modification indices were needed for these measurement models.

Conservative values within the public correlated significantly with trust in PMI's involvement in science (a correlation of 0.33, $p < 0.001$). Although worldview did not correlate with initial trust in FSFW (−0.04), it did correlate with a decreased change in trust pre- and post- FSFW funding information given (−0.21, $p < 0.001$). That is, the greater leanings toward conservatism an individual had, the smaller amount their trust in FSFW decreased once they knew it was tobacco industry funded. Path diagrams in the Supplementary materials S8, S9 show correlation coefficients. Worldview did not correlate with trust in CRUK (0.03).

Discussion

Overview

First, despite extensive evidence demonstrating the tobacco industry's historical manipulation of science (Glantz et al., 1998; Brandt, 2012; Bero, 2013; United States District Court for the District of Columbia, 2014), our analysis reveals the UK public does not completely distrust the industry's involvement in science, and may therefore be vulnerable to uncritically accepting its scientific messaging. Second, when the tobacco industry channels its funds through a purportedly independent third-party scientific organization, this increases the perceived trustworthiness of the scientists and the science that emerges. This result supports earlier research positing that individuals use the perceived credibility of a messenger as a "heuristic, or information shortcut, for deciding whether to accept…[its]…

TABLE 1 The UK public's trust in PMI, FSFW, and CRUK's involvement in science.

Condition	Trust 1 (scientists' competence, maximum of 7)	Trust 2 (scientists' benevolence, maximum of 7)	Trust 3 (scientific outputs, maximum of 7)	Trust 4 (organization's use of science, maximum of 7)	Average trust
CRUK	5.44	5.80	5.97	5.97	**5.79**
PMI	4.91	4.54	4.57	4.63	**4.66**
FSFW 1 (before funding information provided)	4.86	5.06	5.06	5.18	**5.04**
FSFW 2 (after funding information provided)	4.93	4.71	4.71	4.74	**4.77**

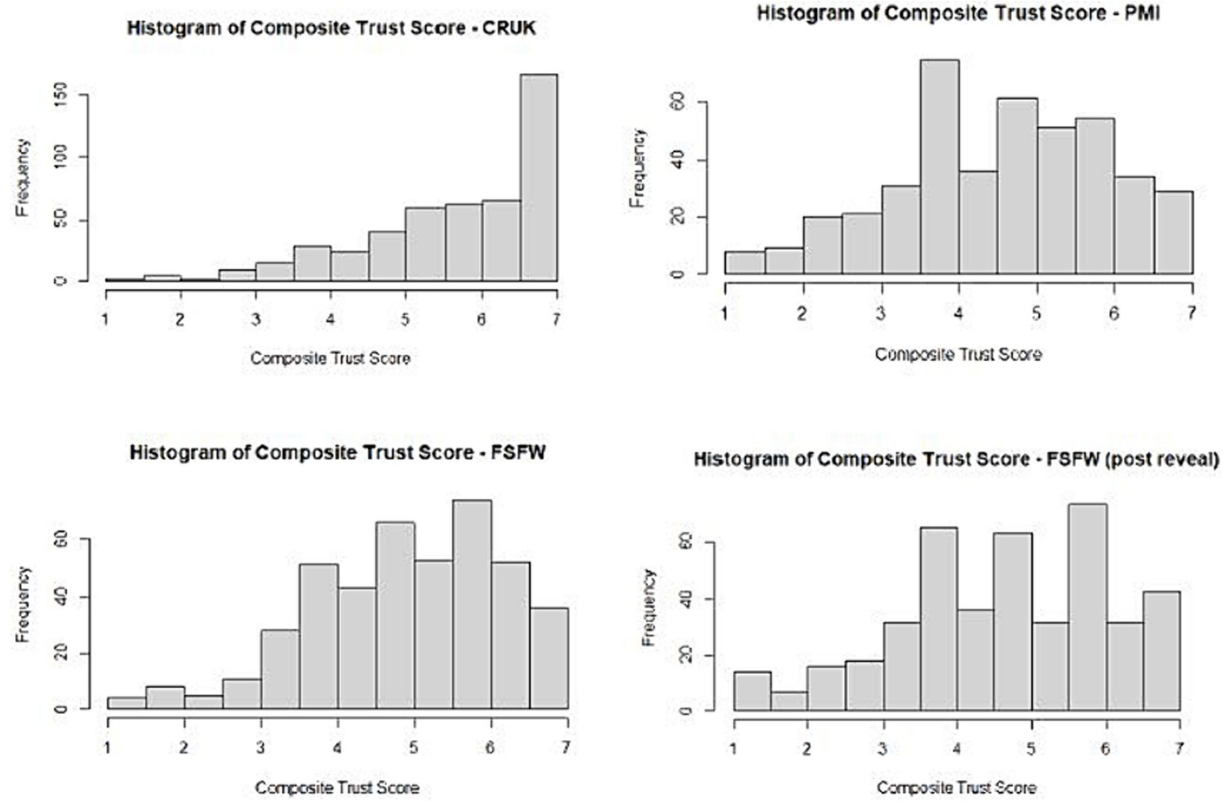

FIGURE 1
Distribution of composite trust scores.

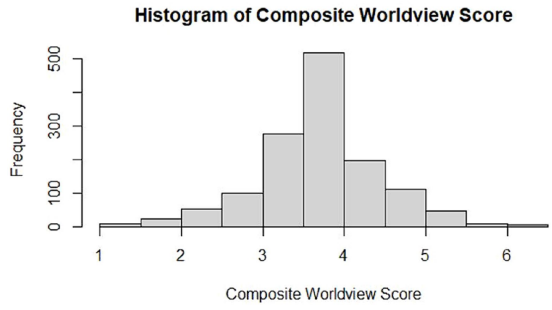

FIGURE 2
Distribution of composite worldview scores.

communicative messages" (Brewer and Ley, 2013). Finally, within the UK public, conservative values were associated both with greater trust in PMI's science and scientists, and with a smaller decrease in trust in FSFW's science and scientists on learning about the organization's connections to the tobacco industry. This adds to the growing body of work linking individuals' worldviews to their perceptions of science.

Strengths and limitations

Much of the evidence base linking worldview and perceptions of science has thus far been focused on the US population, and on science related to climate change (and vaccines and genetically-modified food, to a lesser extent) (Lewandowsky et al., 2013; Hamilton et al., 2015; Lewandowsky and Oberauer, 2016; Myers et al., 2017). Our investigation of the UK public's worldviews and perceptions of science related to smoking extends this body of work to new contexts. Our work accords with a previous survey of the UK public's views on the tobacco industry (not directly related to science) which concluded consumers are not fully informed about the industry's activities (Moodie et al., 2016).

Our findings are not necessarily generalizable to other geographical settings however – in countries which have a high reliance on tobacco, trust in the industry and its involvement in science may be significantly higher, for example.

Although little experimental work has been conducted on the effects of corporate activities, research in this vein is needed, as without it, it is "difficult to draw inference about the magnitude of the distal effects of…corporate actions on the health of populations" (Maani et al., 2020). Here, we quantitatively investigated different routes through which industries have attempted to influence science, namely framing themselves as trustworthy scientific actors, and conversely, concealing their involvement in science.

Our study benefits from using real-world examples, and using these organization's own words when describing them to participants. FSFW announced in late 2023 that it would be rebranding itself, and that this would include changing its name (Legg, 2023; Cohen et al., 2024). Whether or not this rebrand will impact the public's trust in the organization's involvement in science is yet to be seen.

TABLE 2 Model fit indices associated with measurement model for Trust construct for each of the three organizations.

Group	χ^2	*df*	SRMR	CFI	RMSEA
CRUK	9.774	2	0.019	0.994	0.090
PMI	5.692	2	0.014	0.997	0.066
FSFW 1(before funding information provided)	6.138	2	0.015	0.996	0.069
FSFW 2 (after funding information provided)	16.628	2	0.016	0.990	0.130

Nb. SRMR, standardized root mean square residual; CFI, comparative fit index; RMSEA, root mean square error of approximation.
Hu and Bentler (1999) criteria for evidence of good fit are cut offs close to CFI > 0.90, RMSEA < 0.06, SRMR < 0.08.

Future research should also investigate trust in other industries known to influence science. This should include examining the extent to which scientific third parties, such as the sugar industry-funded International Life Sciences Institute (Steele et al., 2019), the alcohol industry-funded International Alliance for Responsible Drinking (IOGT International and Big Alcohol Exposed, 2019), and the agrichemical industry-funded American Council for Science and Health (Malkan et al., 2022) similarly allow industry-funded science and scientists to benefit from greater perceived credibility.

Implications for policy and practice

Common sense would dictate that to "debunk" industry scientific misinformation, experts simply need to disseminate accurate evidence, resulting in an informed public. However, findings from cognitive psychology suggest such an approach may be ineffective: evidence suggests a substantial proportion of people continue to rely on information they know to be false even when corrected (Lewandowsky et al., 2012). Further, industry influence on science often occurs in subtle ways, not only through outright deception. For instance, diverse industries have funded "safe" research which may be methodologically sound, but functions to frame industry products as the "solution" to complex problems (for instance by medicalizing social issues) or to distract attention from industry harms by focusing on other explanations of harm (such as the tobacco industry funding research on the links between nutrition and cancer rather than smoking and cancer, and on "indoor air quality" rather than second-hand smoke) (Tobacco Control Research Group, 2020a; Legg et al., 2021a).

At an individual level, enhancing the critical thinking skills of the public, and those who disseminate information to the public, is one possible protection against undue industry influence on science. For instance, "agnotology-based learning" or "refutation-based learning," through which myths and misconceptions are directly addressed, has been shown to be effective in countering climate change denial (Bedford, 2010; Cook, 2019). Critical appraisal workshops based around a "cycle of bias framework" that illustrates key points at which vested interests can skew the scientific process, have been found to improve participants' critical thinking skills related to health evidence (Odierna et al., 2015). Pedagogical approaches based on "critical ignoring" (Kozyreva et al., 2022), that is, choosing where to invest one's attention, and what information to ignore, may also prove effective. Since worldviews (which become entrenched by adulthood) influence perceptions of science (Lewandowsky et al., 2012), adolescents may be more receptive to these types of learning (Stevenson et al., 2014).

Some – often those with industry connections - argue the tobacco industry should not be excluded from science (Hughes et al., 2018), and that as long as scientists fully disclose their industry links, this is sufficient, since it allows consumers of science the autonomy to reach their own conclusions about the veracity of any scientific claims made (Polosa and Crawley, 2017; English, 2022). However, our finding that trust in PMI's science and scientists was surprisingly high despite participants knowing the origin of its funding demonstrates that transparency is not a panacea (Grundy et al., 2018; Moynihan et al., 2019), since some individuals fail to take into account, or may be unaware of, the risks inherent in trusting tobacco industry involvement in science. This aligns with research findings indicating that transparency can have unintended consequences, including that disclosure of conflicts of interest can lead to an increase (rather than decrease) in trust, because it is interpreted as a sign of honesty (Loewenstein et al., 2011). Further, disclosure does not eliminate bias, and can even cause authors to inflate their bias to counteract any discounting the reader may do on the basis of the disclosure (Loewenstein et al., 2011). Even if transparency (rather than independence from industry influence) were the best way to manage tobacco industry involvement in science, evidence suggests that FSFW and its grantees repeatedly fail to fully disclose their industry links in (and beyond) scientific publications (Legg et al., 2021b). Therefore, future research should not only continue to monitor the tobacco industry's and other industries' (direct and indirect) involvement in science and demonstrate the effects of that involvement, but should also investigate the viability – including any unintended consequences - of different suggested solutions to protect science from undue industry influence.

The tobacco industry uses its involvement in science as supposed evidence that it is a credible, transformed industry, to some degree of success, according to our findings. Careful consideration of how best to communicate the risks inherent in tobacco industry involvement in science to the public is needed, especially to those with conservative views, whose perceptions may be difficult to correct. Use of third-party scientific organizations is an effective way for corporations with damaged reputations to increase the credibility of their scientific messaging in the eyes of the public, and steps are needed to prevent relationships of this kind.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval for the study on human participants was obtained from the Department for Health ethics committee at the University of Bath (EP19/20039), in accordance with the local legislation and institutional requirements. Participants were given an information sheet outlining the research, and how data would be used and stored. Participants who gave their informed consent with a mouse click after reading this form were then taken through to the online survey.

Author contributions

TL: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Writing – original draft, Writing – review & editing. LB: Conceptualization, Methodology, Writing – review & editing. SL: Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2024.1360277/full#supplementary-material

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