CHAPTER 7

Scientific Climate Consensus, Human Causation, and the Divergent Public: The Continued Influence Effect of Misinformation

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Abstract

Climate misinformation has a persistent effect on public perceptions even after corrections. This is the continued influence effect (CIE) of misinformation as explored in the cognitive sciences. The present study regards some noteworthy findings on the CIE as a niche in the search for strategies to address the contrast between a robust consensus among climate scientists (97%) and divergent public perceptions of climate change. The central question concerns the implications of an alternative causal correction approach for minimising the effect of climate misinformation. The main objective is to advance scholarship on the CIE by connecting it to public perceptions of climate change and the communication of the scientific climate consensus. Methods that produce cognitive results, like experimental research, raise some concerns, bringing up the concept of causation as part of the suggested innovations. Some outstanding areas for future study involve improvements with inter- and transdisciplinary approaches, briefly summarised in the conclusions and general discussion.

Keywords: misinformation, continued influence effect, causal correction, causation, climate change, scientific climate consensus

7.1 Introduction

The most troubling aspect of misperceptions is that they persist and continue to influence the public domain long after they have been corrected on a factual basis (Nyhan & Reifler, 2010; Nyhan, 2021). While corrections may have a certain effect, they fail to eliminate the reliance on misinformation in subsequent reasoning. Despite being incorrect, the misinformation continues to influence perceptions and is still utilised in reasoning. This phenomenon, known as the continued influence effect (CIE), exposes the cognitive processes that make misinformation resistant to correction (Lewandowsky et al., 2012: 112).

Misconceptions of human-caused climate change as both an ideology and a myth are prevalent despite a near-unanimous scientific climate consensus and accumulating evidence. This scientific consensus contrasts with heterogeneous and varied public perceptions, including views that reject the consensus among climate scientists (Markowitz & Guckian, 2018: 35–36). The misperceptions have various consequences: they cause public confusion, disrupt communication on the scientific consensus, and erode the effectiveness of policies designed to address climate change. Misperceptions are defined as "factual beliefs that are false or contradict the best available evidence in the public domain" (Flynn et al., 2017: 128). Diverse responses and strategies have emerged to settle the divergence and contrast, dispel misinformation, and encourage increased public engagement.

This study will regard research on the continued influence effect as a *niche*, signifying a space of innovation with potential implications for addressing the discrepancy between the scientific consensus and the divergent public perceptions of climate change. The enduring effect of misinformation is contingent upon perceptions, which in this context are defined as reasoning, beliefs, and attitudes. This effect has been the subject of extensive research in the cognitive and behavioural sciences over the last forty years. For now, however, the resonance of findings on the CIE in climate science and policy is notably limited. To my knowledge, John Cook is an exception (Cook, 2019, 2016), along with a few other scholars who mention it but do not systematically address it (Markowitz & Guckian, 2018: 46; Stubenvoll & Marquart, 2019: 33–35, 41; Drummond et al., 2020: 2; Maertens et al., 2020: 2; Treen et al., 2020: 10, 14).

From prior research on CIE, one type of corrective information effectively dispels misperceptions: this type of rectification centres on the *causal structure* of misinformation. The corresponding correction approach posits that by offering an *alternative* cause and explanation, the correction can diminish the dependence on and confidence in the initial erroneous cause (Johnson & Seifert, 1994). It provides a causal alternative for addressing misinformation and is different from fact-finding, which involves straightforwardly opposing and rejecting unfounded public claims.

The central question concerns the implications of an alternative causal correction approach for minimising the effect of climate misinformation. The main objective is to advance scholarship on the CIE by connecting it to public perceptions of climate change and the communication of the scientific climate consensus. The chapter comprises two main sections. The first examines climate change in terms of misinformation, the CIE, and the causal correction approach. The second section explores what causal correction means for communicating the scientific consensus. It also addresses some issues on theory and methods, such as experimental research and the nexus correlation-causation, resulting in suggested innovations in the concept of causation and the need for inter- and transdisciplinary approaches.

The conclusions and general discussion briefly review the findings and set out some avenues for future research.

7.2 Persistence of Misperceptions and Climate Change

This section explores why misinformation and misperceptions persist and how the continued influence effect of misinformation is understood in the cognitive sciences. What does it mean for climate change, why does it matter, and how is it addressed in causal corrections?

7.2.1 Misinformation and perceptions

Misinformation can be defined as inaccurate or faulty information presented as true. It consists of myths, rumours and errors accidentally or deliberately circulated by the media, governments, or interest groups (e.g. Walter & Tukachinsky, 2020). Misinformation can adopt many forms, like incomplete information, misleading content, circulation of scientifically invalid information, fake news, conspiracy theories, or hate speech. A key element of misinformation is its *dissemination* in the public domain, both inadvertently and purposely (Lewandowsky et al., 2012: 108). Misinformation has to be distinguished from disinformation: fabricated false information deliberately meant to mislead and cause harm. Disinformation is usually seen as a subset of misinformation (Treen et al., 2020). Though misinformation (inaccurate or faulty information) differs from misperception (defined as contradicting the available factual evidence in the public domain), both concern the effects of information exposure.

Both are pervasive, worrisome, and prominent since they create or keep up controversies on issues concerning health and vaccinations, science, intelligence, politics and elections, and climate change. Misinformation holds claims unsupported by scientific evidence, for example, that genetically modified mosquitoes caused the Zika virus outbreak in Brazil, that there is a causal link between autism and childhood vaccinations (Chan et al., 2017: 1531), or that the coronavirus vaccine contained microchips to track citizens (Chan & Albarracin, 2023: 1514). Despite explicit and repeated corrective information, such unfounded claims persist in society. The most illustrious example is the long-continuing disinformed claim that Iraq had weapons of mass destruction, one of the reasons for the US invasion in 2003. Though US intelligence agencies and the government widely and resentfully corrected it after the invasion, more than ten years later, in 2015, a poll showed that 42% of Americans, at least up until 2014, still believed US troops had found weapons of mass destruction or Iraq had hidden them (Nyhan, 2021: 2). Like this, misinformation sticks in perceptions

and can involve reluctance to believe in new facts. Those who deliberately rely on deep-rooted misinformation firmly hold misbeliefs, which brings poor judgements and decision-making (Markowitz & Guckian, 2018: 45; Ecker et al., 2022). The most problematic aspect of misinformation is that, despite their occasional effectiveness, corrections typically fall short of countering its persistence.

Climate misinformation has become an issue of global concern because of its similar prevalence and persistence, pressed forward by systematic dissemination efforts. Climate misinformation is about inaccurate facts and incorrect beliefs about the existence, human causation, and the consequences of climate change. This type of misinformation has specific impacts because it creates denial of the evidence of climate change, mistrust in climate science, and unbelief in the severity of climate forecasts. First, misinformation confuses public debates on climate change and biases public beliefs to downplay climate security risks. Second, it discredits climate science and sustains the public divergences about the scientific climate consensus (Treen et al., 2020). Third, it increases societal polarisation and restrains support for climate change policies (Cook, 2019; Cook et al., 2017). However, perceptions "are often malleable rather than fully formed and fixed" (Weber, 2016: 125, 127) and can be corrected.

Public perceptions of climate change refer to how the existence, the causes, and the consequences of climate change are perceived. These perceptions are of interest for assessing to what extent there is support for climate policies. While there is widespread agreement that climate change exists, public beliefs differ on the extent to which humans cause climate change and its consequences (van Valkengoed et al., 2021). Some remain sceptical, persist in contrarianism, and strongly resist climate policies (Treen et al., 2020). In analyses of scepticism-denial, it is widely observed that the arguments have *shifted* from a categorical denial of climate change – which is no longer defendable in the face of scientific evidence – to a denial that humans are the cause of the change and downplaying the consequences (van Valkengoed et al., 2021). It raises the question of what the strategic effects would be: if the existence of climate change is regarded as more commonly acceptable than the fact that it is caused by human behaviour and has adverse consequences, it should have implications for strategies to address it.

Multiple corrective strategies, such as fact-checking, have been developed for decades to counter or reduce misinformation. However, contradicting the facts and declaring misinformation untrue is not enough to set it aside, as explained below. New facts are less likely to be accepted when the counterinformation opposes it and flags the misinformation as false rather than providing new *causal* details. For example, in countering misinformation, the Associated Press (AP) brings out a weekly article called 'Not Real News: A look at what didn't happen this week.' The misinformation claims are derived from widely shared popular messages on

social media. The AP-article repeats the false claims and contradicts each claim with the facts, which raises the question of how effective this is (see Kan et al., 2021: 1). Countering misinformed statements by labelling them as untrue makes the removal of the initial misbeliefs more difficult. Contradicting the wrongs by repeating the same details of the misinformed claims reinstates them and ultimately reinforces an enduring imprint in memory. Additional exposure to corrective facts that contradict the explanations provided by the misinformation only more negatively influences how the retracted information is processed in perceptions. It implies, more concretely, that reporting about misinformation (e.g. on the climate consensus in science documents or policy briefs) should be done in ways that avoid echoing and retelling the exact details present in the misinformation (Chan et al., 2017: 1544). Another approach, named causal correction, will be explored in the next section. It brings up a collection of cognitive and behavioural concepts and theories on the continued influence effect of misinformation in which this approach is embedded.

7.2.2 Continued influence effect

Misinformation is hard to correct. It influences perceptions and may continue to shape reasoning and later judgments long after corrected information has been provided (Johnson & Seifert, 1994: 1420–1421; Seifert, 2014: 53). Explanations of the *initial* cause of an event or a story continue to affect cognitive reasoning and judgments, even if it turns out that the original information was inaccurate or wrong. Misinformation resists correction and persists in the logic of thinking and inferential reasoning: it is the continued influence effect.

In 1994, Hollyn Johnson and Colleen Seifert coined the concept of the continued influence effect of misinformation (Johnson & Seifert, 1994: 1420). They focused on the properties and features of misinformation and questioned *how* precisely it influences reasoning and what its sources would be, which they found in memory. Elaborating on earlier canonical studies in cognition, which had noted the centrality of misinformation and already found that it could continue to influence reasoning despite corrections (Wilkes & Leatherbarrow, 1988), they now moved on by further examining the links between perception and misinformation. Based on experimental psychological tests, Johnson and Seifert identified and explained the *causal structure* of misinformation (Johnson & Seifert, 1994: 1421–1433). They found that misinformation provides a comprehensible causal explanation: when a correction merely negates the earlier information, it causes a gap in cognition because it offers no alternative. They also discovered that providing a plausible *causal alternative* explanation mitigates the effect of misinformation instead of refuting and disproving it (Johnson & Seifert, 1994: 1421, 1431–1433).

With their findings on CIE, Johnson and Seifert revealed that misinformation after correction maintains its effect on inferential reasoning *unless* a reasonable causal alternative is provided (Johnson & Seifert, 1994). Based on several experiments, they asserted that rather than simply opposing misinformation, providing an alternative that *replaces* the information's causal explanatory component would reduce the effects of misinformation because the revision restores the coherence of the narrative. The new alternative information *fills the gap* in explaining and is applicable to a new context and the cause of a possible new event. They build on prior work by Amos Tversky and Daniel Kahneman on the influence of information on inferences and judgments and how it becomes part of memory and is retrieved from it (Tversky & Kahneman, 1973; Johnson & Seifert, 1994: 1421).

Briefly, cognitive science illuminated the causal structure that misinformation provides. The continued effect of misinformation on memory diminishes when corrective information presents an alternative for the explanation gap that a correction leaves. The alternative information must replace the initial causal explanation enclosed in misinformation and adequately fill this causal component (Johnson & Seifert, 1994: 1421, 1429, 1431). In effect, Johnson and Seifert offered a strong *explanatory* theory that encompasses issues of method when analysing the links between experiments and theory, which will be taken up in the section on methods below.

After their original contribution, Johnson and Seifert explained their findings in subsequent studies (Johnson & Seifert, 1998; Seifert, 2002, 2014). When observing the field, they achieved a quickly expanding research area on the effects of misinformation with a still-growing follow-up by numerous researchers. They have realised a breakthrough by linking their experiments to persuasive theoretical interpretations and created a focal point of investigations for various subdisciplines of psychology, in all its diversity and far beyond. Scholars followed up to explore the multiple cognitive features of perceptions and how they impact the continued reliance on misinformation after correction. The most relevant features are *worldviews*, prior beliefs and attitudes, and their influence on accepting a correction (Gordon et al., 2019). Cognitive research found that corrections or retractions are less effective when misinformation aligns with pre-existing beliefs and attitudes. If misinformation is consistent with other things assumed to be true and "feels right" (Lewandowsky et al., 2012: 112), the new information provided by corrections is inconsistent with the earlier beliefs, which is a reason why it tends to be rejected (Markowitz & Guckian, 2018: 45). Another cognitive feature of perceptions concerns the *source's credibility*. Source perceptions involve the perceived authority of the misinforming source as more or less expert or trustworthy (Pluviano et al., 2020) or the reliability of the later retracting or correcting sources (Connor Desai et al., 2020; Westbrook et al., 2023). The culmination point of the continued influence effect is

framed as the *backfire effect*. This effect is hypothesised in experiments when corrected information about a controversial issue inversely results in a more strongly endorsed misperception. Reinforced misperceptions, due to the backfire effect of corrective information, it was assumed, could specifically be linked to worldview and the credibility of the source when the correction challenges or contests prior beliefs or predispositions (e.g. Swire-Thompson et al., 2020; Nyhan, 2021).

7.2.3 Causal correction and implications

One issue of importance is whether and to what extent misinformation plays a *causal role* in perceptions. As Irene Kan and co-authors argue, by definition, "causal information is central because it has important downstream consequences for the remainder of the story" and "is likely to have more connections with the rest of the story than non-causal information" (e.g. the cause of the fire and the spread of the fire) (Kan et al., 2021: 14, 22).

Multiple experimental cognitive tests of the continued influence effect consistently found that providing alternative causal information is vital since it contributes to the various facets of perception updating. If a correction rejects a core part of the event or a story, it affects the coherence of the perception. The continued influence of misinformation then occurs if this integrative coherence fails or is selective (Ecker et al., 2020: 2). By contrast, renovating and re-establishing the coherence is facilitated if an alternative causal explanation is given: it functions to replace the gap left by the corrected misinformation in the perception. Giving out a correction that offers an alternative explanation is more effective than just the correction, which threatens the coherence in the perception (Seifert, 2014: 46–47; Johnson & Seifert, 1994). In sum, the continued influence of misinformation is the effect of causal explanations in perceptions, particularly in memory.

A central aspect regards the acceptability or rejection of new alternative information. Providing alternative information is mutually exclusive with the original causal misinformation. This is why cognitive reluctance is found in experiments where a central part of misinformation is displaced by the correction but not further explained. Such reluctance emerges because of the substantive change such displacement brings to the overall narrative structure. It has been called a 'state of indecision': the combined effect of reluctance to reject the discredited information and readiness to consider new information (Kan et al., 2021: 22–23). It has been suggested that *both causes*, provided by misinformation and the alternative, can be perceived as equally possible and may co-exist, resulting in partially updated cognitive perceptions. Experiments showed that when the alternative is inserted *within* the correction statement, the new information tends to be maintained *alongside* the misinformation. But when the alternative is *not* part of the correction, the

indecision and uncertainty may remain unless additional reasonable replacement information is given for the rest of the narrative (Kan et al., 2021: 23). At this point, as mentioned by Kan and co-authors, future work to investigate the plausibility and acceptability of *both* the misinformation and the corrected content is necessary to understand the rebuilding of perceptive coherence after correction with alternative information.

Some meta-analyses (Walter & Tukachinsky, 2020; Walter & Murphy, 2018; Chan et al., 2017) further document that including an alternative in the correction effectively reduces the continued influence effect of misinformation. Though correction does not completely eradicate the effect of misinformation, it is found more effective when the source of the misinformation delivers the correction itself, and it is coherent with the worldview, but less effective when the misinformation is ascribed to a credible source, is transmitted repeatedly, or when there is a significant interval between the delivery of the misinformation and the subsequent correction (Walter & Tukachinsky, 2020: 172–173). Also, other follow-up research showed that a causal explanation for assimilating new pieces of information is significantly more effective than rejection or denial (Nyhan & Reifler, 2015: 81). However, full elimination of the CIE appears to remain exceptional in almost all studies (e.g. Kan et al., 2021; Lewandowsky et al., 2012; Chan et al., 2017; Ecker et al., 2010; Johnson & Seifert, 1994).

The most challenging argument from the preceding section is that the continued influence of misinformation is rooted in its causal structure. Consequently, the corrective information focuses on the capacity of misinformation to influence perceptions causally. The significance of the causal explanatory element for the outcomes of corrections may shed fresh insight into the role of misinformation in public perceptions of the scientific consensus.

7.3 Scientific Consensus and Human-Caused Climate Change

The scientific consensus on the human causation of climate change is significant in shaping public support for the climate agenda. Much discussion surrounds the disparities between the estimated 97% scientific consensus on anthropogenic global warming (AGW) and the mixture of public perceptions. Despite the agreement by climate scientists that humans are the primary cause of accelerated global warming, significant parts of the public continue to doubt human causation. Particular concerns regard the scenario in the US, where it is extensively studied (e.g. Bayes et al., 2023). Since implementing policies to mitigate and adapt to climate change relies on this consensus and necessitates public acknowledgement and involvement, this debate includes conveying and communicating the consensus. So far, to

my knowledge, no research has explored the topic of the CIE and the alternative correction approach for communicating the consensus; this will be addressed further below.

7.3.1 Anthropogenic causation and its communication

The scientific consensus regarding the anthropogenic causation of global warming (AGW) is consistent and shared by a vast majority (97%) of climate scientists (Cook et al., 2013, 2016; Tol, 2014, 2016). Depending on the measures and methodologies used for quantifying this consensus on human causation, there is a discussed margin between 90%–100% and 97% consistency across many investigations (Myers et al., 2021). The consensus was initially proclaimed based on a study of 11,944 abstracts in peer-reviewed science journals from 1991 to 2011, mapping them according to statements in the abstracts. It was considered that papers might disagree with AGW despite the absence of a rejection statement in the abstract (Cook et al., 2013). Studies of journal abstracts in subsequent years found an above 99% consensus on AGW among publishing scientists (Powell, 2015; Powell, 2016; Lynas et al., 2021), though disputed (e.g. Skuce et al., 2016; Dentelski et al., 2023). The primary body of support for the consensus is the Intergovernmental Panel on Climate Change (IPCC), which consists of thousands of climate scientists (Bray, 2010). Within and outside this group, human-caused climate change is not undisputed: the consensus is not unanimous. For example, scholarship on the pre-industrial history of climate change draws attention to natural climatic changes long before the onset of anthropogenic global warming, which has sparked some larger debates (Degroot et al., 2021).

The difficulties of informing the public about the consensus have most often been related to spreading misinformation and the politicisation of climate science (Bayes et al., 2023: 17). Climate misinformation concerns inadequate or false information, raising doubts about the scientific evidence for the anthropogenic causes and consequences of climate change. The 'manufacture of doubt' on the consensus by some political actors, vested corporations with fossil fuel interests and certain media is part of this (Lewandowsky et al., 2013). There has been much research done on the effectiveness of strategic disinformation on climate issues, how it spreads into the public domain, and how climate change has become contentious and politicised (e.g. Lewandowsky, 2021: 5–8; Dunlap & Brulle, 2020). When misinformation and organised disinformation target the scientific climate consensus and exploit scientific dissent, it tends to confuse the wider public and may result in declining support of the climate agenda and adaptive policies (Cook, 2019; Cook et al., 2017). Most importantly, the global climate countermovement not only institutionalises climate denial but also undermines public perceptions of human-caused

climate change through targeted efforts, reinforcing public uncertainty regarding the scientific consensus. Such strategies heavily doubt scientific numbers, methods, and figures to mislead the public into believing that the consensus among climate scientists regarding human-induced climate change is significantly lower. 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 (e.g. Chan & Albarracin, 2023).

Communicating the scientific consensus comprehensibly to diverse publics and contexts amid such complexities is exceedingly challenging. Effective strategies to respond to misinformation on the scientific consensus are slowly developing, but there is no agreement on how to do so effectively. Justin Farrell and co-authors suggest that scientists may have underestimated the public impact of misinformation and overlooked its institutional embedding, organisational power and financial roots (Farrell et al., 2019: 191). Nevertheless, the issue is studied with lively debates on how to process consensus messaging and when it works, or what strategies of multi-way (engaging scientists in discussions) or one-way communication may contribute.

The scientific climate consensus is groundbreaking because of its occurrence at the intersection of multiple disciplines while incorporating dispersed expertise in climate science and addressing substantial complexities of climate change. Corresponding to the consensus is the need to address the most severe effects of climate change, which requires, among others, a rapid reduction in global emissions. However, misinformation, disinformation, and persistent active denialist opposition to the consensus among some segments of the public are prolific sources of maintaining a 'consensus gap' (Cook et al., 2013: 6; Skuce et al., 2016: 153): the difference between the public perception of the consensus and the majority of scientists' support for it. This gap has raised uncertainties and worries about the international community's ability to act in concert on climate change (Markowitz & Guckian, 2018: 35).

As a result, the public perception of the human causation of climate change has become an important issue in communicating the scientific consensus, which is increasingly studied based on large-scale surveys (e.g., a Gallup poll from April 2021 found a deepening divide in US politics on this issue). Public perception of the consensus is considered an important 'gateway' to science acceptance (van der Linden, 2021). It is suggested that emphasising the consensus in climate change messages will increase the acceptance of AGW, which associates the perception of the consensus with attitude change (Lewandowsky et al., 2013).

The effectiveness of a specific focus on human-caused climate change for communicating the scientific consensus to the general public has, for such reasons, become the subject of wider debate (Bayes et al., 2023). However, the continued influence effect of misinformation on communicating the consensus is

not addressed as yet in the literature, though it may offer promising pathways. As previously mentioned, in sceptical-denialist arguments, the focus has shifted from denying the existence of climate change (not tenable anymore) to rejecting its causes and consequences. In this perspective, Teresa Myers and co-authors have offered a most helpful contribution to consensus messaging by distinguishing between consensus message (emphasising the agreement), causes message (explaining the human causation and mechanisms), impacts message (focusing on the disparate effects of climate change), and solutions message (highlighting the actions taken) (Myers et al., 2023: 2). This draws attention to the role of human-caused messages in conveying the scientific consensus (in the setting of focusing on agreement, cause, impact, solutions).

7.3.2 Theory and method matter

Collecting the theoretical and strategic inputs from cognitive work on misinformation and climate change is challenging, even more so to connect and integrate it with extant theory. Its recommendations cannot easily be assembled. There is consistency in the focus on misinformation but some contradiction in the conclusions. For example, research focusing on the causal explanatory capacity of misinformation concludes that corrections do *not* eliminate the beliefs in and influences of misinformation (e.g. Lewandowsky et al., 2012). Other research, however, centres on the perception of the original source of misinformation and finds that corrections *do* reduce belief in misinformation and impact its continued influence (e.g. Westbrook et al., 2023). No joint theoretical framework keeps the multiple cognitive findings together or positions the differences, which may hinder their integration into a coherent body of literature on misinformation within the same discipline. This section takes up some debates on theory and methods to explore a few perspectives towards a more comprehensive set of approaches to misinformation. Though methods are an integral part of evolving and sustaining the scientific consensus, they have, to my knowledge, not explicitly been discussed as part of consensus communication and public support.

First, some comments on theory development could be useful. Most literature on climate misinformation comes from the cognitive and behavioural sciences (e.g. Samoilenko & Cook, 2023; Maertens et al., 2020; Cook, 2019; Cook et al., 2018). These sciences represent a wide variety of experts in cognition and memory, behaviour, the brain, language, and society, coming from the subdisciplines of psychology, sociology, communication sciences and more. In the area of misinformation, the principal contribution of this expertise is the application of largely the same type of quantitative experimental testing, data, methods, templates, and models, with almost similar ways of presenting the findings (Connor Desai & Reimers, 2023;

Sanderson et al., 2022; Swire-Thompson et al., 2021; Ecker et al., 2020; O'Rear & Radvansky, 2020). The tests have undergone additional refinement as tools, instruments or techniques of the correction approach itself (e.g. Ecker et al., 2010; Ecker et al., 2015). Of course, there always remain, as Mathew Vowels argues, problematic issues that relate to modelling, replication, extrapolation from data, measurement issues, or the risks of invalid inferences (Vowels, 2023: 507–508). However, as the experimental methods for studying misinformation further improve, the link between the multiple empirical findings and ongoing theory development may sometimes become lost.

The explanatory theory Johnson and Seifert derived from experiments in their seminal work (Johnson & Seifert, 1994) still stands out as a challenge for current research. Since then, various theoretical propositions have developed to understand the complexities of the continued influence effect of misinformation. However, there is also some fragmentation since testing such propositions is usually bound to the conditions of each specific study design that do not allow for comparisons or generalisations. In addition, there are specific requirements regarding which designs or evidence are suitable for generalisation (O'Keefe, 2015). More substantial reflection might be needed on how empirical findings from new experiments support or contest extant theories in the same field or how they challenge, for example, broader theories on climate change. After Johnson and Seifert, subsequent research mainly extended the experiments and consistently revisited, reassessed or replicated them (e.g. Laurent et al., 2023), while its contribution to the explanatory theoretical framework on CIE often remains unexplored. The limitations stand out vividly: cognitive science offers much empirical data on misinformation but finds no thorough systematic theoretical framework to further account for and interpret the contradictions and contributions the new data analyses and theoretical propositions bring. Is the acquisition of new knowledge and the further development of theory sufficiently related? What Paul Meehl noted in 1978 for some areas of psychology seems to be still relevant 45 years later: specification and testing of ever more elaborate and precise quantitative models, only occasionally addressing more substantive theory (Meehl, 1978).

Second, a few notes on experimental methods might be included. Can data and findings experimentally obtained from labs under controlled and regulated conditions inform theories and practical approaches for real-world contexts? What about experiments aimed at correcting false beliefs? How might this translate towards effective strategies in real-world contexts where the public domain is part of a complex information environment full of confusing events and political controversies? Experiments and simulations are long-standing scientific tools and widely accepted methods for research in psychology and much broader in social, natural, and data sciences involved in climate change. Such experimental research

brings up results with robust *internal* validity. The use of standardised procedures for conducting experiments improves the reliability of methods and tests, thereby strengthening comparative advantages. However, the findings' *external* validity and generalisability are the subject of much broader debate and one of the complications. Victoria Westbrook and co-authors may be among the few exceptions who directly address the latter difficulties in the context of CIE research (Westbrook et al., 2023: 1327).

The experiments on misinformation measure the impacts of corrections on beliefs, reasoning and attitudes (i.e., Ecker & Ang, 2019; Swire-Thompson et al., 2021; O'Rear & Radvansky, 2020; Ecker & Antonio, 2021) or test broader effects of interventions designed to reduce the influence of misinformation and advance communication of the scientific consensus (e.g. Cook et al., 2017; van der Linden, 2021). The empirical data originates from lab exposure of individuals and groups to misinformation: CIE research encompasses, on average, 120 to 160 total participants (e.g. Westbrook et al., 2023: 1320; Walter & Tukachinsky, 2020; Ecker et al., 2015). Though some experiments extend the CIE to political challenges, focus on political misinformation (e.g. Ecker & Ang, 2019; Thorson, 2016), the effects of politically incorrect statements (Swire et al., 2017), or the correction of political misperceptions (Nyhan & Reifler, 2010, 2015; Flynn et al., 2017), in experimental settings, real-life contexts are commonly absent and irrelevant (Lebow, 2022: 17, 75–85). To reiterate, the cognitive preference for experiments, associated with certain fundamental assumptions, could restrict the variety, diversity and flexibility of the methods and methodologies used. It probably necessitates integrating complementary methods in inter- and transdisciplinary collaboration on misinformation.

Third, some observations on correlation-causation could be beneficial. Climate change is part of major power shifts in the international order, with changing security concerns, potentially internationalising wars, and political polarisation in Western democracies. Climate insecurity and political instability have uncertain effects on (inter)national policies and strategies of institutions and organisations, involving the complexity of climate change causes and consequences. In international relations, where causation is fundamental, ferocious debates surround causal analysis due to some underlying problematic assumptions (positivist, deterministic, mechanistic and empiricist) (Kurki, 2008). However, though Kurki ingeniously proposes to reclaim causal analysis in the social sciences and open it up for multi-causal and methodologically pluralist avenues, it may still run the risk that the same assumptions re-enter, but now under the label of pluralism. Alternatively stated, a pluralistic framework comprising several causal assumptions could permit their coexistence without requiring interactions.

Cognitive misinformation research presents potential hazards when its contribution to broader climate change debates is questioned. The correlational analyses

based on experimental research are not entirely convincing. Such analyses clarify whether and how positive or negative correlations can be found and reveal important empirical regularities and patterns. They may clarify that X and Y covary, that X precedes Y, and find analytic descriptions for these associations (Bleske-Rechek et al., 2015: 49). However, these analyses often cannot explain and interpret the causal relations: correlational data do not allow for it. For example, a meta-analysis of the psychological efficacy of debunking found that a detailed message correlated positively with the debunking effect *and* the misinformation-persistence effect (Chan et al., 2017) but could not move further to *explain* causality in the regularities found. Whereas the analysis is most relevant to the field, the correlational approach limits further interpretation. Questions thus remain as to whether such correlations have causal properties.

Correlational analyses also prevail in climate science research, particularly concerning the relationships between the consequences of climate change, public perceptions, and support for climate policy. This research examines the environmental effects of climate change (such as global warming, sea level rise, and weather extremes) and questions to what extent it links with public perceptions of the consequences in terms of risks, threats, and security (such as increased flooding, conflict, and migration), and public endorsement of the climate agenda (e.g. Xia et al., 2022; Lacroix & Gifford, 2018; Hagen & Pijawka, 2015). The assumption underpinning such correlational approaches is that lower or higher-risk beliefs of the severe consequences would be associated with less or more active public support for the climate agenda. However, though such correlational analyses may reveal whether and to what extent positive or negative correlations exist, they cannot link the causal connections to convincing explanations or sometimes conflate correlation with causation.

Finally, the scientific climate consensus reaches over multiple disciplines with usually limited understanding of each other's research traditions. An inter- or transdisciplinary debate on consensus communication has not started. Open discussion about the underlying assumptions and methodologies is still absent, including those in experimental psychological studies on climate misinformation. If the study of climate misinformation and the scientific consensus compels inter- and transdisciplinary approaches to face the complex and multifaceted issues, it would require innovation and inventiveness. Rather than addressing the ever-continuing knowledge gaps and data pitfalls, greater transparency regarding research paradigms and methodologies necessitates innovation. It transcends applying the same methods to accommodate larger datasets or additional empirical realities. Innovation encompasses improvements across the different parts of the research process, including but not limited to data generation and data analysis. Furthermore, it exposes the various empirical and conceptual choices and clarifies

the methodological assumptions that underpin the research design. Similarly, innovation would be demanded in creating partnerships with policymakers and practitioners to overcome methodological divides and link methodologies towards more thorough theoretical explanations and public communication.

7.3.3 Causal correction and a different concept of cause

When communicating the scientific consensus, the causal correction approach may become a feasible part of a more comprehensive set of strategies to counter misinformation. The strategic potential of this approach can be identified in *three central components* outlined below. They may support broader objectives and outcomes to counter misinformation when communicating the scientific climate consensus.

First, the alternative correction approach's foundation is the internal causal structure of misinformation. The persistent effect of misinformation, framed as the continued influence effect, is due to the 'causal gap' in perceptions after corrective information. Perceptions rely on an *initial cause* provided in the misinformation that explains and facilitates the integration of new events or stories. Corrections of misinformation are likely to be successful if the initial source of the misinformation is questioned (Johnson & Seifert, 1994: 1421–1433). Also, the internal coherence of the explanation provided in the misinformation determines the degree of influence it has. When the cause of the fire in a misinformed message offers a reasonable and logical explanation (e.g. how the fire was lit), the impact capacity of the misinformation is more long-lasting (Johnson & Seifert, 1994: 1431). Because the causal structure of misinformation allows it to be internalised, it is notoriously difficult to remove it from perceptions. The conclusion at this point is that changing the perception of the original source explanation, as the key internal to misinformation, reduces its continued influence effect.

Second, providing an *alternative* causal explanation has to be integral to correcting misinformation since it reduces the dependence on and confidence in the initial cause. Such an alternate causal explanation needs to add complementary information (e.g. an electrician noticed a short circuit, and the fire was not lit), which may transform the persistent impact of the original explanation in the misinformation (Nyhan & Reifler, 2015: 84). Third, the approach is *substitutive*: it replaces the initial causal explanation in the misinformation. The alternative corrective explanation substitutes the original cause provided by misinformation. In addition, by ousting and displacing the initial cause with a causal alternative *and* a new explanation, the strategy ultimately fills the gap left by the retracted misinformation (Johnson & Seifert, 1994: 1421, 1429, 1431), to the effect that it becomes less enduring.

As mentioned before, this approach has implications for how to regard the effectiveness of fact-checking in support of the scientific consensus. Corrections

are less likely to be accepted when fact-checking opposes the misinformation and brands it as false. Upfront negation of misinformation does not address misinformation's perceived original value as true and accurate, neither does it explain where the rejection comes from (Seifert, 2002: 284). Misinformation even invalidates the acceptance of new facts. By contrast, the causal approach does not confront and oppose but substitutes the initial and original value perceived in misinformation. However, the concept of cause in this approach needs more attention since it mainly focuses on the initial and original explanation that misinformation provides.

There are compelling reasons for climate misinformation scholars from various disciplines to develop a concept of causality free from linear X-leads-to-Y conceptions. Such a concept should be able to connect different methods and methodologies against deterministic and other limiting understandings of cause (as 'necessary' or 'sufficient' to generate an outcome) and towards comprehensive strategies in support of scientific consensus. Jonathan Culler's deconstructive approach (Culler, 1982), inspired by Nietzsche's concept of causality (*The Will to Power*), could be beneficial since it opens ways for not just falling back on the option for a plurality of causal assumptions and arguments. Moreover, it draws attention to a distinction between a principled philosophical understanding of cause and how cause may be commonly perceived. Culler posits that it is taken for granted that a cause produces an effect: the cause is given the primary position in the conceptual pair cause-effect. Commonly, cause comes first and gets priority over the second, which accords to 'cause' the position of origin. However, the effect (e.g. of pain in the foot and not the pin) comes first in the experience and "the cause gets imagined after the effect has occurred" (Culler, 1982: 86). It is the effect (the pain) that makes a cause (the pin) receive the status of a cause. In the words of Culler: "If the effect is what causes the cause to become a cause, then the effect, not the cause, should be treated as the origin" (Culler, 1982: 88).

Culler's approach of cause has implications: first, if the perceived effect is the origin for a cause to get the position of a cause, it upsets the hierarchy and changes the properties attributed to cause and effect (Culler, 1982: 88). Second, when this notion of cause is applied to causation itself (Culler, 1982: 87), and the cause is not the origin of its effect, it has implications for causal statements and origins approaches, since what is secondary may well be primary. Though Culler reiterates that he does not reject causal thinking as such since the occurrence of the effect still sets the need for identification of its cause, two observations might be needed. First, Culler's strength is revealing the perceptual sequence of events regarding causes and causality. Once the pin cutting the foot is discovered, the perceptual order is reversed to produce the causal order (pin-pain). However, the problem with Culler is that he seems to state that the effect *produces* the cause instead of arguing that the pain causes the *discovery* of the cause (the pin), more closely following

the example from Nietzsche. Second, for Culler, the "principle of causality asserts the logical and temporary priority of cause to effect" (Culler, 1982: 86). The point here is that he refers to the *principle* that a cause precedes effects, whereas it later seems as if Culler creates a new principle: that the effect precedes a cause, and only through the effects can a cause be known. What he actually means is Nietzsche's causal 'structure' of the temporal relationship, where causes precede effects in the temporal sequence of events.

Based on Culler's implicit distinction between a principled and a perceived understanding of cause, the concepts of cause and causation in misinformation studies might need a reassessment, which has potential implications for the causal correction approach and ways of communicating the scientific consensus. When talking about the CIE and the 'causal structure' (Johnson & Seifert, 1994: 1421, 1425, 1426–1427, 1429, 1431; Seifert, 2002: 285) of misinformation, Johnson and Seifert focus on how the initial causal explanation of an event influences later inferential reasoning and the continued influence. For them, the structural aspect of causality is its temporal priority in an event, story or message. Causal correction then primarily focuses on the original coherence of the causal explanation provided by misinformation. However, when the effect of misinformation at the level of perception occurs first, as in Culler's example (pain-pin), the effect is *perceived* as the origin: it may reverse prevailing approaches of causation, with potential practical implications for conveying public messages on the scientific consensus. Adopting Culler's view on cause might call for reorientating the primary emphasis on human causation of climate change towards highlighting its *perceived effects*: the consequences of anthropogenic global warming.

Advancing on these matters could be accomplished through interdisciplinary and transdisciplinary research. Because knowledge classifications into specialised domains and disciplinary systems tend to be inadequate when facing the complexity of global issues, inter- and transdisciplinary research has more generally been strengthened. The indispensability of transdisciplinary research in addressing contemporary climate-related challenges is acknowledged mainly for its integrative capacity (e.g. Vienni-Baptista et al., 2023; Butt & Dimitrijević, 2023). Transdisciplinary research traverses across and beyond scientific disciplines: it encompasses interdisciplinary research but goes beyond it by stakeholder involvement towards integrated knowledge for science and society. This research engages stakeholders such as policymakers and practitioners in the full research process of problem-setting, design, data, methods, and output (Mitchell et al., 2017). This inter- and transdisciplinary work constitutes a form of boundary crossing with academic researchers and stakeholders that may have different purposes, contexts, institutional structures, and degrees of integration and interaction. Emerging assessments in climate science illustrate the benefits of initiating such initiatives

(Mitchell et al., 2017). Others also argue that knowledge creation in collaborative efforts has intricate dynamics and is fraught with difficulties (e.g. Meehan et al., 2018). Although transdisciplinarity is gaining traction, it is yet to get its position in academia: the concepts, processes, relevance, and impacts keep developing.

7.4 Conclusions and General Discussion

Scholars from many academic disciplines investigate approaches to counter climate misinformation and increase public support for the climate agenda. The assumptions correspond to the extent and scope of misinformation and its capacity to have a persistent influence on reasoning, beliefs, and attitudes. In the search for effective strategies, improved public communication of the scientific climate consensus has garnered much attention recently. In this context, the present study contributed to climate misinformation research by arguing that the continued influence effect and the corresponding causal correction approach might become significant parts of a more comprehensive set of strategies to counter misinformation when publicly communicating the scientific climate consensus.

Regarding the main objective of this study, the continued influence of misinformation was studied both regarding the correction efforts and the theoretical explanations provided. It was shown that the cognitive sciences bring substantial novelty to the debate on climate change and the scientific consensus. A few key findings were identified as a niche. First, what drives the continued influence effect is the powerful causal explanation embedded in misinformation, which continues influencing reasoning even when it is known to be inaccurate. When a new event necessitates an explanation, the fallback on the initial cause provided by misinformation illustrates its power. Second, by revealing the causal structure of misinformation and the perception gap left by corrected information, research on the CIE has revealed the unique characteristics of misinformation and why it has such enduring effects on inferential reasoning. The explanatory coherence of misinformation also impacts its degree of influence, which is why a causal alternative explanation is required to correct it.

In communicating the scientific climate consensus on anthropogenic global warming, the public *acceptance* of human causation has emerged as a focal point of the recent debates on the most effective ways of publicly conveying the consensus. However, climate disinformation affects perceptions of climate change and precisely consists of the *denial* that humans are the cause of climate change while downplaying its severe consequences. Concerning this conundrum, the question became how much emphasis is placed on causal messages of climate change and what the position of cause is (in the setting of emphasising the agreement, cause, impact, or solutions).

In response, this study proposed reassessing the concepts of cause and causation. In cause-effect concepts in climate science and cognitive science, the cause is given the principled status of the origin that produces the effect. By contrast, when the effect at the level of the perception is occurring first, as in Culler's example (pain-pin), then the effect is *perceived* as the origin, the secondary gets the primary position, the properties attributed to cause and effect change, and the cause is not the origin of its effect. To put it succinctly, how a cause is *perceived* may have an impact distinct from that of cause as a philosophical principle, thereby subverting prevailing approaches to causation. It might have potential practical implications for publicly conveying the scientific consensus. Taking the proposed concept of cause would presumably shift the priority emphasis in consensus communication from the human causation of climate change, which is the core of the scientific climate consensus, to highlighting its *effects* in consensus messaging: the consequences of anthropogenic global warming. Evidently, questioning the notion of cause and causality by considering the possibility of another concept of cause-effect is novel to the debates on the continued influence of misinformation and scientific consensus communication and requires much further exploration.

The present study also responded to the central question posed at the outset. Strategies for communicating the consensus may take the causal correction approach as a feasible way to counter climate change misinformation. As explained before, this approach has much potential for integration into a more comprehensive set of strategies. However, it also brings up one of the limitations of this study. Such a broader set of strategies would involve political mechanisms, legal instruments, channels for financial transparency, educational approaches, and much more, which have remained outside the scope of this study. Subsequent research might concretely position the alternative causal correction approach in this broader setting.

Several other potential avenues have emerged that hold significance for follow-up research. It was shown that studies on the continuous influence effect have a vigorous empirical basis in experimental tests that produce consistent evidence. Based on such evidence, the cognitive sciences have generated original theoretical clarifications that may support more comprehensive strategies to respond to misinformation. However, some critical challenges surfaced regarding the empirical evidence and the theoretical contributions due to limitations inherent to the experimental methods and research designs.

The proposal was to take up such issues of method and theory, comparability and generalisability, in a wider setting of inter- and transdisciplinary approaches. Whereas interdisciplinary research fosters collaboration among scholars of different disciplines, transdisciplinary research expands the scope by opening scientific inquiry to involve policymakers, practitioners, and other stakeholders in

knowledge creation. Such integration of knowledge facilitates the feedback effects of policies and practices on joint problem identification, research co-design, method re-invention, scope definition, strategic impact mapping, and joint implementation of knowledge beyond academia.

Finally, climate issues are discussed within complex global contexts with diverse publics. When information is uncertain, whether through the unreliability of sources, information manipulation, missing evidence, or complexity of the issues, it is difficult to collect information, opt between alternatives, judge and decide on the correct information. Public information processing, distinguishing and judging the possible alternatives, demands public partnerships and integrative approaches to the relationship between science and the public.

The climate change agenda necessitates such advanced public partnerships, requiring stakeholders to collaborate in knowledge discovery and shared decision-making. Accordingly, public communication on the scientific climate consensus is uniquely positioned to advance the climate agenda in meaningful and effective ways, with numerous opportunities, challenges, and complexities.

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