Original Articles and Reviews

Science Denial

A Narrative Review and Recommendations for Future Research and Practice

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Abstract: Science denial has adverse consequences at individual and societal levels and even for the future of our planet. The present article aimed to answer the question: What leads people to deny even the strongest evidence and distrust the scientific method? The article provides a narrative review of research on the underpinnings of science denial, with the main focus on climate change denial. Perspectives that are commonly studied separately are integrated. We review key findings on the roles of disinformation and basic cognitive processes, motivated reasoning (focusing on ideology and populism), and emotion regulation in potentially shaping (or not shaping) views on science and scientific topics. We also include research on youth, a group in an important transition phase in life that is the future decision-makers but less commonly focused on in the research field. In sum, we describe how the manifestations of denial can stem from cognitive biases, motivating efforts to find seemingly rational support for desirable conclusions, or attempts to regulate emotions when feeling threatened or powerless. To foster future research agendas and mindful applications of the results, we identify some research gaps (most importantly related to cross-cultural considerations) and examine the unique features or science denial as an object of psychological research. Based on the review, we make recommendations on measurement, science communication, and education.

Keywords: science denial, climate change denial, motivated reasoning, misinformation, ideological attitudes

Never in history has humanity had more access to education and evidence-based information than today. Concurrently, false information and misleading claims are widespread. Most people accept science (Hendriks et al., 2016), but the abundance of both accurate and false information spreads confusion, provides a fruitful ground for developing distrust and conspiracy theories, and undermines the legitimacy of science-based messages and interventions (Oreskes & Conway, 2010; Zarocostas, 2020). Consequently, even topics that are widely considered unquestionable among scientists – such as the occurrence of climate change, benefits of vaccination programs, that HIV exists and causes AIDS, and that the Earth is not flat – are still questioned and debated (e.g., Hansson, 2017). From a democratic perspective, it is important to acknowledge that individuals have a right to form opinions and draw conclusions independently, even if it entails a refusal to accept scientific evidence. However, science denial must be taken seriously because it can have adverse consequences at individual and societal levels and even for the future of our planet. It is, therefore, critical to identify and understand the processes that can contribute to the rejection of science.

In this paper, we provide an overview of research on science denial to address the question: What leads people to deny even the strongest evidence and distrust the scientific method? To do this, we integrate perspectives often studied separately by describing research on science denial in relation to basic cognitive processes and ideological and emotional reactance in both adult and young populations. Perceptions of different research fields and topics vary among the public and across cultures (Hendriks et al., 2016; Hornsey et al., 2016; Rutjens et al., 2017). Thus, we narrowed our focus mainly on climate change, a controversial topic that polarizes the public in various countries despite ubiquitous scientific support. We discuss the limitations in the research field, the unique features of science denial as an object of psychological research, and how these could be considered in future research and practice.

Science Denial

We define science denial as the dismissal of well-established scientific evidence or the scientific method as a means to gather reliable evidence. That is, people can reject *certain*

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information that has been researched scientifically and/or consider *scientific practices* to provide insufficient methodology altogether. Denial of scientific evidence tends to build on pseudoscientific claims, which are claims that relate to scientific research topics, are founded on unreliable evidence, and aim at creating deviant doctrine by being presented as the most reliable knowledge (Hansson, 2017). As such, and in line with previous conceptualizations that resemble ours (see, e.g., Hansson, 2017; Jylhä, 2016; Normand, 2008; Lewandowsky et al., 2016; Schmid & Betsch, 2019), we explicitly differentiate science denial from skepticism, which is (in its true form) an attitude or a practice characterized by careful scrutiny of evidence before accepting a claim and when updating conclusions. To highlight this, we included the word "established" in our definition to acknowledge that individuals can practice healthy scientific skepticism by not accepting novel or understudied evidence without this constituting denial.

Importantly, we consider science denial to be expressed along a continuum (see also Clarke, 2017; Jylhä, 2016). This means that people can express different forms of denial at various levels along continuums from no denial (or high belief/acknowledgment) to high denial and that the threshold for being classified as "denialist" can be difficult to determine. We avoid such a classification further because, at an individual level – where the term denialist would be applied – denial may be based on true skepticism (Clarke, 2017; Jylhä, 2016): as discussed later in this paper, laypeople may sincerely believe that science is not settled. Nonetheless, science denial can also have anti-scientific grounds, motivated either by the dismissal of the scientific method (e.g., due to subjective beliefs, such as religion) or by some instrumental goals (e.g., to show political support) that make the objective reality irrelevant (e.g., Beniermann et al., 2021; Van Bavel & Pereira, 2018).

Bases of Science Denial

Accuracy Goals and Cognitive Biases

Humans can be described as "naïve scientists" due to our common goal to accurately understand reality, detect causal processes, and predict future events (Heider, 1958). Also, most people accept science (Hendriks et al., 2016), and believe their views are based on a rational thought process and their own thinking about a given issue rather than, for example, emotionality or peer influence (Kenworthy & Miller, 2002). Thus, many likely strive to make accurate judgments, even when denying scientific evidence on some specific topic (see also Jylhä, 2016). In fact, even conspiracy theories – that tend to have very little objective evidence to support them – are, in part, motivated by the desire to find some seemingly rational explanations for some events that individuals aim to understand (Douglas et al., 2019).

However, the public tends to have a limited understanding of the complexities of various research topics or scientific principles and methodologies (Hendriks et al., 2016). Thus, to understand and accept science-based information, they need to access the knowledge of scientific experts and trust scientists and their messages. These aspects are purposefully targeted in disinformation campaigns, for example, by spreading conspiracy theories on scientists' goals and the peer review system and by using fake experts who spread statements that question the messages scientists aim to convey (Cook, 2020; Diethelm & McKee, 2009). Indeed, the public understanding of scientific evidence has for decades been confused by fabricated counterevidence and misleading arguments that tend to be pseudoscientific, meaning they give the impression of being reliable and scientifically sound (Oreskes & Conway, 2010). As a famous example, the key strategy of the tobacco industry was to create a story about the scientific debate, to "fight the science with science" (Oreskes & Conway, 2010, p. 13), when aiming to refute the research findings regarding the link between smoking and cancer. The media has amplified many of these misleading claims by presenting them alongside findings supported by scientific consensus in an effort to appear objective (for discussion on the "false balance effect"; see e.g., Schmid et al, 2020).

However, exposure to disinformation is not a full explanation for why scientific knowledge can be disputed. Importantly, several psychological factors can interfere with the general goal of inferring correct conclusions. Due to our limited cognitive capacity, humans use simple heuristics (mental shortcuts) rather than complex algorithms when interpreting events and information (Tversky & Kahneman, 1974). Some information is also processed more carefully than others, and some are dismissed due to a motivation to discard threatening or undesirable messages. Individuals are also more inclined to believe (or at least express support for) such messages that are conveyed by someone they identify with and consider reliable (Van Bavel & Pereira, 2018) or that enable them to express certain personal identities, such as being a free-thinker or a nonconformist (see Hornsey, 2021). Indeed, one explanation for science denial is motivated reasoning: noticing, interpreting, and recalling information in ways that confirm strongly held worldviews, identities, and other preconceptions (Kunda, 1990). This process tends to be implicit and can entail various strategies, such as approaching or avoiding certain information, selectively searching specific types of memories, or creatively combining knowledge to construct new beliefs that provide seemingly logical bases for the desired conclusion (Kunda, 1990; Westen et al., 2006).

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Worldviews and Ideological Attitudes

Science denial, particularly climate change denial, has commonly been studied concerning ideological variables and sociopolitical identities. Higher scores on climate change denial are typically found among conservatives and right-wing adherents, reflecting motivated reasoning (Hornsey, 2021; Kahan et al., 2012). When an issue is polarized, individuals may take cues from political leaders on which opinions are most appropriate and aim to express and protect their sociopolitical identity by agreeing with the views of their political ingroup (Druckman et al., 2013). Climate change may have become polarized because the solutions to the crisis typically involve threats to the existing socioeconomic status quo (Campbell & Kay, 2014). These climate mitigation solutions increase government regulation or tax emissions, thus challenging the free-market philosophy of less government interference in the economy. Research into this explanation commonly draws on System Justification Theory (e.g., Clarke et al., 2019), which proposes that some people (especially right-wing adherents) are motivated to defend existing social and economic systems that are perceived to be under threat (Jost et al., 2008).

Two additional aspects of conservative ideology are social dominance orientation (SDO) and right-wing authoritarianism (RWA) (Jost et al., 2003) – variables often studied in tandem because they predict similar outcomes, including climate change denial (Stanley & Wilson, 2019), due to different reasons (Duckitt, 2001). SDO captures a relative preference for (vs. objection to) social group-based hierarchy and inequality (Sidanius et al., 1991). Such an anti-egalitarian mindset may enable rejection of climate science due to higher tolerance for the uneven distribution of benefits and risks of climate change (Jylhä, 2016; Jylhä & Hellmer, 2020) and because it may allow the environment and its resources to be used to maintain or enhance inequality and social hierarchy (Jackson et al., 2013; Milfont & Sibley, 2014). RWA captures a preference for tradition, submission to authority, and punishing those deviating from norms and tradition (Altemeyer, 1981), including activists and environmentalists (Hoffarth & Hodson, 2016). A tendency to preserve social norms and traditions may also drive an ideological rejection of social and economic change needed to mitigate climate change (Clarke et al., 2019).

Recently, it has been proposed that conservatism, compared to liberalism, is more generally related to science denial because it is less compatible with the central norms of modern science (Kerr & Wilson, 2021; Lewandowsky & Oberauer, 2021). Merton (1973) summarized these as communism (scientific findings are a product of social collaboration and a property of the community), universalism (validity of claims is independent of individual and sociopolitical attributes of their source), disinterestedness (scientific institutions aim to benefit a scientific community rather than the individuals of it), and organized skepticism (claims are scrutinized based on logical and empirical criteria before being accepted). Moreover, Kerr and Wilson (2021) have argued that SDO is related to negative views on universities, which can be seen as hierarchy-attenuating social institutions (Sidanius et al., 1991), and that individuals high in RWA dislike science because it challenges the established authorities and moral norms.

There is also evidence for partially unique underpinnings for the more specific forms of science denial (e.g., Rutjens et al., 2017; Kerr & Wilson, 2021) and that both liberals and conservatives tend to deny science that is inconsistent with their attitude (Washburn & Skitka, 2018). Therefore, more research is needed on the ideology-denial link, mindful that there is currently an overreliance on quantitative/correlational studies, which precludes a deeper understanding of why individuals across the ideological spectrum hold certain views (for notable exceptions, see Stanley et al., 2021; Whitmarsh & Corner, 2017). The relationship between ideology and climate change denial also seems to be context-dependent. In one German study, the submission facet of RWA positively related to environmentalism, which may be due to (relative) cross-party promotion of environmentalism driving those high in RWA submission to support it (Reese & Schiller, 2012). Likewise, Jylhä and Akrami (2015) suggested that system justification may be better aligned with acknowledgment of climate change in countries with relatively environmental-friendly social norms.

Populism, Far Right, and Conspiracy Mentality

Most of the research on ideology-based science denial has focused on mainstream political landscapes. However, populist and far-right (i.e., radical and extreme) sentiments have been re-emerging across the Western world and often entail particularly dismissive views on experts, researchers, and certain scientific issues (Lockwood, 2018; Mede et al., 2020). While there seem to be at least some direct connections between populism and science denial (Mede et al., 2020), the evidence is still growing and is, in part, contradictory. Populist rhetoric is divisive as it targets the political "elites" and depicts them as immoral and malevolent, in contrast to the virtuous and sensible "people" (Mudde, 2004). Populism thus overlaps with a conspiracy mentality that too includes a worldview where powerful groups (e.g., researchers and governments) victimize the people due to their corrupt personal goals (Castanho Silva et al., 2017). Accordingly, populist views seem compatible with science denial. Indeed, such views correlate with opposition to

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experts, belief in conspiracies, denial of climate change, and the view that people should determine what scientists research and what societies consider "true" knowledge (Castanho Silva et al., 2017; Huber, 2020; Mede et al., 2020).

However, climate change denial is linked to right- but not left-wing populism (Yan et al., 2022). In addition, populism correlates with COVID-19-related views and conspiracy beliefs (Eberl et al., 2021), but when considering the large variance in populist parties' reactions and success in handling the pandemic (Stavrakakis & Katsambekis, 2020), at least some of these correlations (e.g., regarding views on vaccination campaigns) may be context-dependent. Finally, Ylä-Anttila (2018) analyzed right-wing populist rhetoric in Finland and identified the dismissal of climate change and soft sciences, but these views were motivated by counter-knowledge (i.e., an alternative framing of known facts provided by alternative epistemic authorities who were considered as more reliable knowledge sources than the established ones) rather than "folk-wisdom" or anti-expert rhetoric. The analyses also showed approval of the empiricist–positivist sciences that were regarded as "real sciences" (Ylä-Anttila, 2018). It thus seems that populist views may clash with certain aspects of science but not necessarily with science per se.

Importantly, anti-establishment views are expressed both on the right and left sides of the political spectrum. Thus, when there is a correlation between these views and a certain outcome (such as science denial), it should be studied if the correlation is confounded – and better explained – by views on the core issues and ideologies that the populist parties promote (Jylhä et al., 2020; Rydgren, 2017). Particularly in Europe, the contemporary populist far-right tends to promote conservative, authoritarian, and anti-egalitarian agendas – most notably in relation to immigration and other sociocultural issues – while being less invested in socioeconomic issues which are traditionally promoted by the mainstream parties (Jylhä et al., 2020; Rydgren, 2017). Some research has found that anti-egalitarian attitudes, institutional distrust, anti-establishment attitudes, and climate change denial are strongly intercorrelated (Jylhä et al., 2020; Ojala, 2015a). Hence, it should be studied if science denial – and which forms of denial – reflects deeply rooted cynicism of politicians (and the "elite," including media and researchers) and their character, or if people rather, more specifically, reject the research fields and institutions that communicate undesirable (e.g., liberal and egalitarian) messages (Jylhä & Hellmer, 2020).

Emotions and Emotion Regulation

Science denial can also reflect an attempt to cope with difficult emotions in relation to risks (see Hornsey, 2021). If risks threaten something important for a person, like a worldview, people sometimes use different self-protection strategies to cope with the threat/risk (Wullenkord & Reese, 2021). Some emotional aspects, like unconstructive emotion regulation, are closely related to motivated reasoning (Westen et al., 2006). Indeed, one of the goals of motivated reasoning is to restore and maintain a positive emotional state that may be threatened if one's cherished worldviews and identities are challenged (Westen et al., 2006). For example, Feinberg and Willer (2013) found that when people who embraced just-world beliefs were confronted with dire messages about climate-related injustices, they tended to de-emphasize the seriousness of climate change rather than face the aroused anxiety. In another study, a message on dire climate-change consequences for animals induced empathy and guilt in children, but when the responsibility for causing climate change was attributed to industry rather than individuals, the children were more inclined to cope by avoiding and de-emphasizing the climate message (Pearce et al., 2021). Furthermore, Jylhä (2016) found that a predisposition to avoid experiencing anxiety predicted climate change denial, both directly and indirectly, through embracing a conservative ideology, which supports the suggestion that denial is sometimes related to general ways of coping with emotions.

Denial of the science around a threat could also be related to trying to find hope, that is, a less constructive way to cope with difficult feelings. Indeed, Ojala (2012) discovered that climate hope could sometimes be based on de-emphasizing the threat in various ways, such as by arguing that scientists exaggerate the problem. This denial-based hope is negatively associated with different kinds of climate engagement in different countries (Marlon et al., 2019; Ojala, 2015b). Importantly, hope based on more constructive sources, like trust in one's own and other actors' ability to fight the climate problem, is positively related to engagement. Since hope, in a sense, is an existential must but is based on different sources or pathways, some scholars have argued that different powerful actors could be tempted to try to manipulate people into feeling hope based on pathways that align with their interests (see Thompson & Zizek, 2013).

Emotions also influence the uptake of scientific facts through misinformation (Featherstone & Zhang, 2020). For example, misinformation campaigns seem to be particularly effective in inducing antivaccination attitudes if they make people feel angry (Featherstone & Zhang, 2020). In addition, anger is related to accepting misinformation regarding COVID-19 (Han et al., 2020) and misinformation in general (Greenstein & Franklin, 2020). When people are angry, they use heuristics and are more certain in their judgments (Greenstein & Franklin, 2020; Tiedens & Linton, 2001), which could explain these results. Also, positive emotional states like feeling happy are sometimes related to shallow information processing and certainty in judgments

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(Forgas & East, 2008; Tiedens & Linton, 2001), which may make people more gullible regarding false scientific claims (Ecker et al., 2022). One theoretical explanation is that emotions are parts of a basic human defense system working at a preconscious level (see Marcus et al., 2000). Anger and positive emotions, as opposed to, for example, anxiety, signal that everything is safe, leading to a feeling of certainty. When the situation is experienced as such, people do not bother to use systematic information processing but rely on heuristics to save resources for more uncertain situations. This shallow information processing makes people less inclined to question false information. However, more empirical studies about the relation between emotional aspects and science denial are needed – not least regarding positive emotions, where few studies exist.

Views on Climate Change Science Among Young People

Young people have emerged as one group that is particularly concerned about climate change. However, young people are not a homogeneous group. In groups of adolescents, young adults, and even children, a minority denies or de-emphasizes the seriousness of climate change (Leiserowitz et al., 2011; Ojala, 2012, 2013; Stevenson et al., 2014; Tejada et al., 2020). Although similarities have been observed compared with adults, such as higher levels of climate change denial among those with male gender, individualistic, hierarchical, and hedonistic values, and anti-immigration views (Ojala, 2015a, 2015b; Stevenson et al., 2014; Zummo et al., 2021), some other mechanisms may also be relevant in younger populations (Stanley & Wilson, 2019). Climate change denial among adolescents and young adults is particularly vital to understand because this is a transitional phase, which according to developmental psychologists, is important for taking in new information and challenging norms created in the childhood home or peer groups (Bornstein, 2018). Values and identity are not set in stone yet, and therefore it could be beneficial to work with this age group if wanting to prevent science denialism later in life (see Ojala, 2015a). Also, many young people can easily be reached through school.

The few studies that have explored climate change denial among young people identify low environmental efficacy as consistently associated with climate denial (Ojala, 2013, 2015a, 2015b). In addition, one study showed that denial-based hope among adolescents was related to a feeling of low self-efficacy regarding societal problems in general (Ojala, 2015b). Speculating about why this relationship exists, young people who feel powerless when it comes to influencing environmental and social issues perhaps feel that they can only cope with climate change by denying the severity of the threat.

Another key factor seems to be the influence of friends, parents, and teachers. A two-wave longitudinal study showed that perceiving parents to be skeptical regarding the seriousness of climate change predicted an increase in adolescents' own skepticism over time (Ojala, 2015a). In addition, if parents and friends were perceived to talk in foremost a doom-and-gloom way about societal problems, this was related to coping with climate change by de-emphasizing the threat, which was also the case if parents and peers were perceived to not take the young people's emotions regarding societal issues seriously (Ojala & Bengtsson, 2019). Equivalent results were found regarding communication patterns with senior-high-school teachers (Ojala, 2015b).

To summarize, societal powerlessness and social influence are crucial factors in explaining climate change denial among young people. To a certain extent, these results contrast with studies among adults showing that people with a great deal of power defend their societal position by denying climate change (see McCright & Dunlap, 2011). More research is, however, needed in diverse cultural contexts.

Looking Forward

Cross-Cultural and Conceptual Issues

Throughout this review, we have noted that research into science denial is growing, but there are still important gaps in the literature. This section discusses some aspects that we consider meriting deeper examinations. Like many other researchers, we recognized the need for cross-cultural studies, particularly in non-WEIRD samples (e.g., Hornsey et al., 2018). Cross-cultural studies may provide interesting avenues to examine the interactions between psychological and social factors influencing science denial. To exemplify, a large share of research is conducted in Anglophone nations, where the link between conservatism and climate change denial is particularly strong (Hornsey et al., 2018). One reason for this could be that disinformation on climate change has strong connections to the conservative think tanks and political movements in the US, where denialism has become widespread even in mainstream politics and conservative media (McCright & Dunlap, 2011).

How to most accurately operationalize science denial also warrants further consideration. Many psychological constructs (e.g., personality traits) capture latent internal predispositions, defined and measured based on theoretical and statistical observations. Science denial – at least the more specific forms – is unique in its focus on views that are formed and transformed in interaction with science communication and societal discourses and take diverse forms across time and cultures. Consequently, it is challenging to measure these views in ways that capture the very essence of denial. This

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could explain why there are currently no established scales in wide use. We speculate that operationalizations may also influence research results and cross-cultural comparisons. We thus call for extensive cross-cultural collaborations, where the most relevant arguments and psychosocial processes are identified and operationalized to examine the different forms of science denial as well as their more specific manifestations and correlates. This would help with interpreting results and making reliable comparisons of the correlation coefficients across cultural contexts.

While developing a measurement of science denial is a challenging task that will require empirical examinations, we have outlined some recommendations based on our review. Firstly, regarding the problems with deciding the threshold and specific set of beliefs when deciding who is classified as a denialist, as discussed above, we recommend measuring denial as a continuous variable rather than as a dichotomous one. Secondly, several items should be included to capture different manifestations of science denial, particularly when studying highly complex research topics, such as climate change, that entail various uncertainties but also some established and widely recognized conclusions. Multi-item scales would also enable examining if different manifestations of denial are more widespread or have different psychological underpinnings (Clarke et al., 2019), which would be valuable when designing interventions. Thirdly, we recommend not including items that could more accurately be conceptualized as behaviors, policy support, or efficacy beliefs (for related conceptual discussions, see Almiron & Moreno, 2022). Although these tendencies can, in some cases, reflect denial (e.g., interpretative or implicatory denial; Cohen, 2001),[1] they can also be based on reasons not related to scientific reasoning. For example, people may be unvaccinated due to fear of needles or possible side effects (Brewer et al., 2017), oppose climate policies that they consider ineffective or unfair, or because they do not trust the government that formulates and implements them (Drews & van der Bergh, 2015), or not act on climate because they consider their personal behavior to make no difference or due to the structural obstacles in our high-carbon society (Lorenzoni et al., 2007).

Science Communication and Education

Some of the findings described in this paper have been used to identify and study ways to promote acceptance of science (for discussions regarding correlations and processes not covered here, such as religiosity, fears/phobias, see e.g., Hornsey, 2021; Rutjens et al., 2017). As an important starting point, it could be useful to aim to reach audiences that are sincerely attempting to engage in true scientific skepticism and help them navigate the abundance of information. When considering the common human inclination to seek rational and correct explanations for events, it could be beneficial to educate the public on the processes and practices of science to help them recognize the signs of pseudoscience (Weisberg et al., 2021) and the misleading techniques and arguments commonly used when spreading science denial (Cook et al., 2017; Schmid & Betsch, 2019; van der Linden et al., 2017). Moreover, education on reasoning and argumentation competency could be advanced, and the different types of justifications behind different forms of denial could be addressed (Beniermann et al., 2021). It has also been found that knowledge-based approaches can counteract tendencies to deny climate change and buffer the influence of individualistic values among young people (Stevenson et al, 2014).

As to motivated reasoning, exposure to new information may not be helpful. However, as reviewed by Roozenbeek et al. (in press), several strategies to counter misinformation have been proposed and showed some promise. For example, corrections of political misinformation (e.g., with retractions) can be effective – and even equally effective across the political spectrum – although it should be noted that they can also cause a backfire effect and increase polarization (see, e.g., Ecker et al., 2021, 2022). Also, framing studies have shown some promise. For example, when linking an environmental appeal to ideological preferences (e.g., preserving the current lifestyle) or moral foundations (e.g., obeying authority) more important to conservatives, conservative acceptance of climate science and engagement with environmental problems can increase (e.g., Feinberg & Willer, 2013; Whitmarsh & Corner, 2017). However, these studies are relatively scarce and rarely replicated or conducted across cultural contexts. It is also unclear if any promising effects of framed messages last, especially in the current media environment saturated with politicized content. (e.g., Schmid-Petri & Bürger, 2022).

Emotions should also be considered to counteract denial-based hope and other forms of unconstructive coping mechanisms, particularly in the climate context. There are some prospects for promoting emotional awareness, where one empathically and critically discusses emotions and less constructive coping strategies. Such discussions can be designed as, for example, communication campaigns that take the form of climate cafés or science pubs (Ojala, 2015b; Ojala & Bengtsson, 2019). However, thus far, these suggestions are just theoretical speculations. Moreover, since climate change denial among young people often relates to a low sense of efficacy and helplessness,

[1] According to Cohen (2001), people may accept evidence (i.e., do not express literal denial), but reject some interpretations of it (interpretative denial: e.g., state that there is nothing we can do to address climate change) or the responses necessitated by accepting the evidence (implicatory denial: e.g., question the benefits of personally getting vaccinated).

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these feelings could be alleviated, for example, by using participatory processes, where young people are invited to work together with adults to fight climate change (e.g., Haynes & Tanner, 2015). Complex thinking, where one learns to deal with difficulties, uncertainties, and conflicts, could also help to cope with existential threats like climate change. The best way to promote this in education seems to be a combination of practice-based learning and critical discussions (Li et al., 2021; Wynn et al., 2019).

Importantly, while we advocate for further research on, for example, the conservatism-denial association, we also recommend clear and balanced communication of research findings about who denies climate change, avoiding exaggerating current polarization or overestimating community prevalence of denial. Commonly, there are notable within-group variations, and the mean levels of denial are below scale midpoints across the studied populations (Jylhä et al., 2020; Stanley et al., 2021). Thus, associations should not be interpreted as evidence that liberals (or, e.g., women, mainstream voters) *believe* and conservatives (or men, populists) *deny*. A more precise interpretation, which is also in line with our avoidance of "denialist" terminology, is that conservatives tend to accept climate change to a slightly lesser extent than liberals. People tend to overestimate the number of climate deniers in the community (Leviston et al., 2013), which hampers an accurate understanding of the high social consensus. Those who are aware their peers mostly accept climate change are more accepting themselves, with perceived social consensus reducing the ideological divide on climate change (Goldberg et al., 2020).

Researchers and climate communicators may also consider whether changing beliefs is necessary and, if so, why. For example, science denial can pose a risk for the individual who denies (e.g., vaccination refusal) or society and/or the global community (e.g., climate change denial). In some cases, there may not be risks related to the topic in question, but controversies nevertheless risk interfering with individuals' goals to draw correct conclusions and causing polarization and antagonism in society, thereby causing serious challenges for democracy, societal institutions, and people's best interests (see also, review by Kozyreva et al., in press). However, it is difficult to persuade the small cohort heavily invested in denying a scientific issue. Therefore, while research continues to investigate the roots of science denial, we also suggest a greater focus on mobilizing and enabling the accepting majority to act.

Concluding Remarks

This paper examined the factors that may contribute to the dismissal of well-established scientific evidence or methods. It is important to note that we mainly focused on climate change, and some other explanations could be more central when explaining the other forms of science denial. We described the roles of motivated reasoning (with the focus on ideology and populism) and emotional reactance (with the focus on feelings of threat and hope), which are closely linked but often studied separately. We focused on adults and youth and found similarities and differences between these groups. We call for more research on science denial among people in adolescence and young adulthood because this is a transitional phase and important for taking in new information and challenging norms. We identified some crucial limitations both in the research field and in the prospects of applying the results – perhaps most importantly, the need for cross-cultural research and careful efforts to define and operationalize science denial in its various forms. Based on the review, some recommendations were made on measurement, science communication, and education. While much is understood about how humans navigate the vast reality and scientific evidence, the science on the topic is not fully settled.

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