Personality Traits and Climate Change Denial, Concern, and Proactivity: a Systematic Review and Meta-Analysis

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Abstract

Background

Climate Change is a global issue which touches the lives of all human beings, each with different outlooks and motivations. The high degree of complexity which emerges from the involvement of such a large number of people might be better understood through the lenses of their individual differences.

Methods

We performed a pre-registered systematic review and meta-analysis (PROSPERO ID: CRD42022364726) following PRISMA guidelines. We searched keywords on Web of Science™ and Scopus®, including peer-reviewed articles which quantitatively examined correlations between personality and climate attitudes, published from inception to October 26, 2022.

Findings

109 articles were assessed. 54 were included in our review. Meta-analyses show that Climate Change Denial is positively correlated with Social Dominance Orientation (n = 31505; r = 0.40; p < 0.001) and Right-Wing Authoritarianism (n = 22037; r = 0.45; p < 0.001), and negatively with Openness (n = 10326; r = -0.15; p < 0.001), Neuroticism (n = 7030; r = -0.06; p <0.001), Consideration of Future Consequences (n = 1662; r = -0.32; p < 0.001) and Actively Open-Minded Thinking (n = 2116; r = -0.40; p < 0.05). Concern for Climate Change correlates with Openness (n = 19951; r = 0.15; p < 0.001), Consideration of Future Consequences (n = 1573; r = 0.29; p < 0.001), and negatively with Social Dominance Orientation (n = 4027; r = 0.36; p < 0.001). Finally, Proactivity towards Climate Change correlates positively with Consideration of Future Consequences (n = 1573; r = 0.29; p < 0.01), and negatively with Social Dominance Orientation (n = 2615; r = -0.25; p < 0.001) and Right-Wing Authoritarianism (n = 1345; r = -0.30; p < 0.001). Moderation analysis shows geographical variations in the Social Dominance Orientation and Climate Denial relationship.

Interpretation

Personality's involvement in Climate Change is significantly different from other environmental issues. Future targeted research, policies, and communication campaigns should take these peculiarities into account.

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Introduction

Climate change (CC) and its anthropogenic origin are held in a virtually unanimous consensus in the scientific community (1,2). Despite the overwhelming scientific evidence warning about this phenomenon and its tangible effects on the weather, the reaction (or even the acknowledgment) of the general population has so far been insufficient to achieve a substantial change in net greenhouse gas emissions (3).

This lack of widespread action sits in surprising contrast against other past environmental catastrophes and public health crises – such as lead compound pollution due to additives in fuel (4) – which historically incited a reaction in the general population followed by a resolutive intergovernmental action. While the previous crises could be solved through the implementation of simple policies (e.g. the ban of fuel additives), climate change has no definitive univocal solution; it is the product of multiple interconnected systems, and involves several stakeholders, each with conflicting motivations. These characteristics define climate change as a "*wicked problem*" (5) exceedingly challenging for the human mind to grasp and tackle (6).

Interpersonal and sociocultural dynamics influence societal attitudes and reactivity towards wicked problems. Environmental sensitization campaigns which might gain a positive reaction in a particular group of individuals might also obtain a contrarian reaction from another; this "*boomerang effect*" (7) might thwart many institutional attempts to inform and stimulate collective action towards climate change or other issues (8). On a more optimistic note, research shows encouraging evidence that reframing an issue in a way which better aligns to the characteristics of an individual (e.g. its political values) might elicit support even from sections of the population which frequently tend to be opposed to it (9).

Thus, many of the strategies implemented to approach wicked problems also seek to bridge the gap between different individuals by taking into account their different beliefs, attitudes, and goals (10).

For their generalizability over radically different populations and cultures, personality traits, that is the "[...] relatively enduring patterns of thoughts, feelings, and behaviours that distinguish individuals from each other" (11), are valid psychological constructs on which to base tailored climate campaigns (12–14). Previous research on environmental issues has shown that there is a frequent link between personality

traits, environmental attitudes, and pro-environmental behaviour (15–19). Moreover, there have been attempts to identify a specific "Green personality" inclined towards pro-environmental behaviour (20,21). However, how personality traits influence attitudes and behaviours in the specific issue of climate change still remains unclear.

To fill this gap, herein we report a systematic review and meta-analysis aimed at aggregating extant literature on the involvement of personality traits in constructs and processes related to climate change; including, but not limiting to: climate change denial, concern for climate change, and intention to act towards climate change. When sufficient data are gathered, a quantitative synthesis of the literature is also provided by performing a meta-analysis.

Unlike previous meta-analyses (e.g. Soutter et al., 2020), we will examine this relationship in isolation, detached from other environmental issues or attitudes.

Methods

Search strategy and selection criteria

This systematic review and meta-analysis was conducted in conformity with the PRISMA 2020 guidelines (22) and it has been pre-registered on the PROSPERO platform (ID: CRD42022364726).

In order to highlight relationships between personality traits and measures pertaining climate change, we included only articles which:

1. Provided at least one quantitative measure of a personality trait.
2. Provided at least one quantitative measure which *explicitly* pertains to climate change attitudes and behaviours.
3. Reported empirical research (thus excluding literature reviews, conference proceedings, and other types of papers).
4. Had been published in peer-reviewed journals.

The electronic databases selected for this research were Elsevier's Scopus®, and Clarivate's Web Of Science™. A number of keywords relating to personality traits and climate change were selected *a priori* based on current literature in the field of personality psychology. We included keywords referring to models and frameworks of personality for which a sizable body of research exists, such as the Five Factor Model (FFM) (23), Eysenck's personality questionnaire (EPQ) (24), Cloninger's Temperament and character inventory (TCI) (25), and Grey's reinforcement sensitivity theory (RST) (26). After a limited exploratory research on the topic, three more keywords representing relevant personality traits were added to the initial list (i.e. Social Dominance Orientation (SDO), Right Wing Authoritarianism (RWA), and Consideration for Future Consequences (CFC). Keywords pertaining to climate change were selected *a priori* following other meta-analyses on general environmental attitudes (e.g. the Meta-Analysis by Soutter and colleagues) (18). The keyword "global warming" was added to better include literature published before the phasing out of this terminology in favour of "climate change" (27,28).

Table S1.0 in Supplementary Materials displays the full list of keywords from which search queries were constructed for Scopus® and Web Of Science™ search engines. Both searches were performed on the 26th of October, 2022 and included articles published since database inception. Full search queries are available in Supplementary Material (S2).

Collected articles were screened and selected independently by two of the authors (EC & DM). After electronically removing duplicates, a first screening was conducted by assessing titles and the abstracts. A second screening was then performed by evaluating full-text articles. The inclusion, or the exclusion, of dubious articles was determined on agreement after discussion between two of the authors (EC & DM). In order to include articles originally not available in English, we sent an email to the corresponding author asking to provide us with a full translation of the paper.

Due to the majority of the gathered studies being cross-sectional surveys (number of studies: $k = 67$; 88.2% of the total), we assessed study quality by employing the "Quality Assessment Checklist for Survey Studies in Psychology" (Q-SSP) (29). For non-survey studies, we employed the "Effective Public Health Practice Project Quality Assessment Tool (EPHPP) (30). All the checklists and tools were compiled by EC & SF.

Data analysis

The measurements pertaining to CC attitudes and behaviours were largely heterogeneous, due to the instruments ranging from single questionnaire items (e.g. "I think climate change is a hoax"), to complex multidimensional scales; and measuring constructs which – although overlapping – are not perfectly equivalent. In order to manage this, measurements were coded in three "meta-measures": "Denial" (e.g. CC scepticism); "Concern" (e.g. CC risk perception); and "Proactivity" (e.g. CC policy support) upon which the meta analyses were calculated. A full list of the measures coded in each meta-measure is displayed in Table 1.

[INSERT TABLE 1 "META-MEASURES" HERE]

We provide a flux diagram of the meta-analytic stages in Supplementary Materials (Figure S3.0). Below, to better explain the meta-analytic process we refer to the individual steps in the diagram (steps S3.1 to S3.19).

For each study gathered with our systematic search (S3.1), two of the authors (EC & DM) searched for correlation coefficients pertaining to relationships between quantitative personality measures and quantitative measures of CC attitudes, which were the effect size indices to compute the meta-analysis. In case a study didn't provide this information, we contacted the corresponding author and asked to provide them (S3.3) in order to include his/her study in meta-analysis (S3.5). The extracted effect sizes were then written in a table (S3.4). This process resulted in a raw effect size table for each "personality trait - CC attitude" relationships (S3.6).

Next, the raw table was subjected to operations in order to make it suitable for meta-analysis calculations: if two or more effect sizes in a table were obtained from the same sample (S3.8), only the most recently published one was retained (S3.7). If two or more effect sizes in a table were sub-dimensions of the same measure (S3.9), they were averaged (S3.10). Then, effect sizes which were thematically coded in the same meta-measure but were directionally opposite (such as belief in CC in the "CC Denial" meta-measure) were sign-changed (S3.11). These operations resulted in the final effect size tables (S3.12).

Subsequently, we performed random-effect meta-analysis model calculations (31) using the *metafor* package version 3.4-0 (32) for R Studio 2022.02.3 (33), obtaining Fisher's Z summary statistic (Z_r) and heterogeneity indices ($\boldsymbol{\tau}$, I^2, and Q test of heterogeneity) for each effect size table (S3.13). In the case of meta-analytic combinations of personality measures and CC measures with very few studies ($k < 4$; S3.15), we computed its achieved power using equations reported by Valentine and colleagues (34) (S3.14). If the meta-analytic model did not reach a satisfactory statistical power (), we opted to exclude it (S3.16). Next, we generated forest plots and funnel plots (S3.17). Finally, we assessed possible publication bias by visually inspecting generated funnel plots. This assessment was aided by performing an Egger's regression test (S3.19), calculated using the function "regtest()" in metafor (35). Following the recommendations in the handbook by Higgins and colleagues (36), we performed moderator analyses by meta-regression (S3.19) only for meta-analyses which reached a satisfactory number of studies ($k \geq 10$). We decided *a priori* to test separately the moderating effects of average age, gender, and country of origin of these samples. The rationale behind this choice was the frequent association that age and gender have with CC measures (37,38), and the extant significant difference in CC attitudes across different countries and cultures (39,40). Following a similar meta-analysis by Soutter and colleagues (18), we coded each sample in four larger groups corresponding to their geographic region: "Europe", "North America", "Australia and New Zealand", and "Mixed".

All data and the code script used to perform this meta-analyses can be retrieved in the Open Science Framework by consulting the following link: https://osf.io/erbfg/?view_only=004faac07ec64ca1aeaf81b829113be4.

Results

The electronic database search was performed on 26/10/2022, and yielded a total of 1805 articles, after removing duplicates. After title and abstract screening, the literature search yielded a total of 105 articles eligible for full text examination. Of these, 56 were excluded due to not conforming to the inclusion criteria. Five relevant papers were also retrieved from the reference list of other articles during the full text reading phase, and thus added to the pool, resulting in a final group of 54 included articles. A flowchart of the full screening process is displayed in Figure 1.

A synthetic table of the studies included in our review is displayed in Table 2 including: numerosity of the sample, mean age of the sample, country of origin of the sample, percentage of females in the sample, personality traits studied, CC measures studied, main findings, and risk of bias assessment score. 12 studies scored < 75% on the Q-SSP, indicating questionable quality.

An extended summary of included articles is available in Supplementary Materials (S6).

[INSERT TABLE 2 "STUDY SYNTHESIS" HERE]

[INSERT FIGURE 1 "PRISMA FLOWCHART" HERE]

Figure 1: PRISMA flowchart of all the phases of the study selection process. "CC" = Climate Change.

From the included articles we extracted 76 datasets encompassing a total of $n = 205988$ individual data points, sampled from 19 different countries and locations from all continents. The single country which was most frequently sampled was the U.S.A. ($k = 25$; 33%), while the geographic region which was most represented in our sample of studies was Europe ($k = 28$; 37%).

By applying the criteria we set *a priori*, we performed a meta-analysis of 16 discrete correlations between personality constructs and CC meta-measures. A summary table of our meta-analyses results is displayed in Table 3. Full forest and funnel plots of each meta-analysis are available

in the Supplementary Materials (S4 and S5).

A forest plot showing summary statistics of meta-analyses is displayed in Figure 2.

Our moderation analysis through a meta-regression model of the SDO and CC Denial relationship (k = 23) did not show any significant effect for both age, and percent of females in the sample. Besides, we found a significant effect for the geographical region factor, accounting for 31% of heterogeneity between samples. Samples gathered from Europe (b = 0.36; p = 0.015*) or North America (b = 0.41; p = 0.006**) show a significant effect, meaning that samples obtained from these geographical regions vary considerably from those gathered from other sites. Further, our moderation analysis of the RWA and CC Denial relationship (k = 15) did not yield significant effects for country, and age. However, it did a significant effect for percent of females (b = 0.57; p = 0.015*), accounting for 29% of between-sample heterogeneity.

[INSERT FIGURE 2 "FOREST PLOT OF SUMMARIES" HERE]

Figure 2: Forest plot of meta-analysis statistics. Size of the dots is relative to the number of studies included in the meta-analysis. CC = Climate Change; "FFM" = Five Factor Model; "SDO" = Social Dominance Orientation; "RWA" = Right-Wing Authoritarianism; "CFC" = Consideration of Future Consequences. "AOT" = Actively Open-Minded Thinking.

"" = Value significant at $p \leq 0.05$; "**" = Value significant at $p \leq 0.01$; "***" = Value significant at $p \leq 0.001$.*

A summary table of the heterogeneity measures and achieved power for each meta-analysis is displayed in Table 4.

[INSERT TABLE 3 "META-ANALYSIS RESULTS" HERE]

Examining values of Q, τ^2, and I^2, suggests substantial levels of heterogeneity across the majority of the meta-analyses we performed, with the notable exception of the meta-analyses of the correlations between Conscientiousness, Neuroticism, Extraversion, and climate change denial. Large values of heterogeneity are expected in the field of personality and social psychology (41). In the case of our study, this large variability might be attributable to the wide breadth of different instruments through which climate change is measured. However, the small quantity of studies we gathered for most of our meta-analyses (k < 10) renders unfeasible the computation of moderator analyses which are capable of examining the impact of measure instruments, and thus we cannot ascertain this effect.

Publication bias was assessed with visual inspection of funnel plots, supported by the Egger's test. Egger's test was not feasible for meta-analyses with k = 2 (Openness to experience and CC concern; RWA and CC proactivity, AOT and CC denial). We found little evidence of consistent publication bias, although sporadic patterns of asymmetry were detected. These asymmetries are likely to be imputable to the high levels of heterogeneity of the models. We found the meta-analysis of the correlation between CFC and CC denial, and the correlation between SDO and CC concern to be significant to the Egger's test (see Table 4).

[INSERT TABLE 4 "HETEROGENEITY" HERE]

Discussion

The systematic review and meta-analysis of the literature on the associations between personality traits and climate change (CC) attitudes and behaviours yielded a final selection of 54 papers, including samples from the whole world. Most of these studies indicate that some personality traits show significant correlations with attitudes towards CC.

From the systematic review and the meta-analyses emerged innovative conclusions, not evident from single studies. CC denial was not significantly correlated to personality traits which had been previously found to be correlated with general environmental attitudes (i.e. Agreeableness, Conscientiousness, and Extraversion) (18). In actuality, the higher complexity of CC makes it a *wicked problem,* thus different from any other environmental issue. As an example, the preservation of endangered species can be solved just by reducing a single behaviour (the hunting) carried on by a restricted group of people. On the contrary, a full understanding of the complex causes and consequences of CC does not suggest an immediate solution depending on the mere willingness to solve the problem: this higher complexity and abstraction paves the way for a stronger influence of socio-cultural and political influences on pre-existing individual specificities.

The meta-analysed factors that showed a significant impact on CC attitudes are summarised as follows: Most of the selected studies found a correlation between CC denial and personality traits associated with conservative political identification (42), in particular Social Dominance Orientation (SDO; trait tendency to espouse non-egalitarian social structures based on dominance) (43); and Right Wing Authoritarianism (RWA; trait tendency to follow and maintain authoritarian hierarchies) (44). These correlations were meta-analytically confirmed in a paper by Stanley and Wilson (19). In our meta-analyses (see Table 3), these effects might be interpreted as an indirect measurement of political identification. Indeed, some studies suggest a central role of sociopolitical dynamics in the nexus between SDO, RWA, and CC attitudes: CC denial is stronger in individuals high in SDO who are interested in politics (45), and feeling threatened by climate mitigation measures or environmentalist groups

moderates the relationship between SDO, RWA, and CC denial (46,47). Coherently with these results, our meta-analysis found that the geographic origin of the sample was a significant positive moderator of the correlation between SDO and CC denial, suggesting that the socio-political context of each country plays a dominant role in determining attitudes towards CC.

However, this boosting effect of socio-political context does not imply that SDO could not predict denial towards CC independently from political orientation. Indeed, many personality traits are reported to play a significant role in attitudes towards CC: both SDO and RWA predicted negative CC attitudes even better than political identification (47–49) and system justification (50); Neuroticism achieves a very small, albeit significant, negative correlation with CC denial; trait Perceived Vulnerability to Disease induced conservatives to support CC policies regardless of the endorsing party, contrary to author's prediction that being higher in this trait would make individuals less open-minded to outgroup ideas; individuals high in SDO appear to be less willing to support CC policies endorsed by the opposing political party (51,52).

To this regard, our meta-analysis confirmed the relevance of open-mindedness and cognitive flexibility in polarising the debate on CC: the Openness factor of the Five Factor Model of personality (FFM) (23) and trait tendency to engage in Actively Open-Minded Thinking (AOT) (53) were negatively correlated with CC denial; trait Consideration for Future Consequences (CFC) shows a transversal involvement in all three meta-measures of our meta-analysis and especially with proactivity towards CC, indicating that individuals high in this trait might possess an increased salience of the threat which CC constitutes, and thus act to mitigate it.

Finally, personality traits involved in the affective aspects of intergroup dynamics also appear to be involved: trait tendency to empathy (i.e. Empathic concern) was reported to be negatively correlated – although not significantly, in our meta-analysis – with CC denial (50), while Psychopathy and Machiavellianism – personality traits characterised by callousness and lack of empathy – showed a positive correlation with CC denial (54,55).

Taken together, these findings depict a complex relationship between personality traits and attitudes toward CC, justifying the need to investigate it separately from other environmental issues.

The integration of cultural, political, social, and individual dynamics calls for a greater understanding of how to better tailor CC interventions and communication campaigns to reach each person in the most effective way. Based on the outcomes of the present systematic review and meta-analysis, CC communication campaigns should aim at: 1) defusing or de-escalating polarisation and politicisation of the debate on CC; 2) piercing intergroup barriers (e.g. employing testimonials belonging to groups tendentially opposed to CC action might increase their trust in the communication campaign); 3) considering the difficulty of accepting harsh truths as those revealed with growing alarm by the scientific community.

Our work contains a number of limitations: 1) Personality traits are a broad class of constructs with difficult operational definition. 2) The majority of studies gathered for our review employed a cross-sectional survey design, and thus causal relationships between variables cannot be established. 3) Although explicitly seeking them, our literature search did not yield any articles relating to Eysenck's EPQ, Cloninger's TCI, or Gray's RST. Although articles analysing the relationship of these models with general environmental attitudes exist (e.g. the paper by Wiseman & Bogner (56)), it seems that their specific correlates with the psychology of climate change still remain to be investigated. This might be an interesting future avenue of research to pursue, especially in relation to the relevance of these models for the field of psychophysiology, and thus their focus on the biological architecture of personality.

To conclude, adopting a theoretical framework which takes into account these exceeding levels of social complexity – i.e., treating CC as a *wicked problem* – might be advisable. Future policies and communication campaigns should take into account these dynamics and their possible complex effects, while researching targeted methods to reach out to different segments of the population. Indeed, *wicked problems* might require *wicked solutions*.

Declarations

Contributors

EC and DM ideated the research. AG supervised and advised the research process. EC performed the initial literature search in the online databases. EC and DM screened the articles independently for inclusion. EC and SF scored the articles using bias assessment tools. EC performed the statistical analyses and generated the graphs. EC and SF wrote the first draft of the manuscript with input from DM. DM finalised the manuscript.

Declaration of interests

The authors declare no conflict of interest.

Data sharing

Full dataset, R meta-analysis scripts, outputs, and original plots are available online in Open Science Framework Platform at following link: https://osf.io/erbfg/?view_only=004faac07ec64ca1aeaf81b829113be4

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Tables

Table 1: Climate change meta-measure coding

Denial	Concern	Proactivity
CC denial	CC temporal distance*	CC policy support
CC certainty*	CC risk perception (for self)	CC Mitigation Threat (CCMT)*
CC belief*	CC risk perception (for others)	CC moral attitude
CC skepticism	CC concern	CC subjective norms
CC knowledge*	CC threat perception	CC self-efficacy
Distrust of climate science	CC anxiety	CC intentions
CC anthropogenic origin denial		CC national responsibility
CC Attitude Survey (CCAS)*		CC action
CC plausibility*		CC petition signing

Table 2: Sample-level summary of studies included in the systematic review.

**: Study quality assessment. Q-SSP score is reported for survey studies (<75% indicates questionable quality). For other study designs global EPHPP is used. †: Age reported in paper is a median. NA: Not Applicable. RCT: Randomized Controlled Trial. CFC: Consideration for Future Consequences. FFM: Five Factor Model. SDO: Social Dominance Orientation. RWA: Right Wing Authoritarianism.*

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Anderson & Zebrowitz, 2020(1)	327 (68%)	NA	U.S.A.	Cross-sectional (survey)	Perceived vulnerability to disease (PVD); Need for closure	Beliefs	Low PVD participants have less support for other party's CC policies. High PVD subjects supported CC regardless of endorsing party. Need for closure correlates with CC belief, but only in Republicans.	80%
Aydin et al., 2022 (Study 1)(2)	1121 (61%)	36 (15)	Turkey	Cross-sectional (survey)	SDO	Beliefs; National responsibility	SDO is negatively correlated to CC beliefs and CC national responsibility.	75%
Azevedo & Jost, 2021 (Sample 1) (3)	1500 (51%)	NA	U.S.A.	Cross-sectional (survey)	SDO; RWA	Distrust of climate science	SDO is a significant predictor of distrust of climate science. RWA is a significant negative predictor of distrust in climate science.	85%
Azevedo & Jost., 2021 (Sample 2) (3)	2119 (21%)	NA	U.S.A.	Cross-sectional (survey)	SDO; RWA	Distrust of climate science	SDO is a significant predictor of distrust of climate science.	85%
Beiser-McGrath & Huber, 2018 (Sample 1) (4)	3007 (49%)	NA	China	Cross-sectional (survey)	CFC	Scepticism; Mitigation behaviours	CFC is the greater predictor of individual intention to reduce carbon emissions.	80%
Beiser-McGrath & Huber, 2018 (Sample 2) (4)	3000 (51%)	NA	U.S.A.	Cross-sectional (survey)	CFC	Scepticism; Mitigation behaviours	CFC is the largest predictor of individual intention to reduce carbon emissions.	80%
Beiser-McGrath & Huber, 2018 (Sample 3) (4)	1919 (38%)	53	Switzerland	Cross-sectional (survey)	CFC	Scepticism; Mitigation behaviours	CFC is the largest predictor of individual intention to reduce carbon emissions.	80%
Caddick & Feist, 2021(5)	377 (64%)	37 (13)	U.S.A.	Cross-sectional (survey)	FFM Openness & Neuroticism; Need for cognition (NFC)	Beliefs; Motivated reasoning (vignettes)	FFM measures and NFC are not significant predictors of motivated reasoning. Individuals which endorsed CC had significantly higher Neuroticism.	85%
Carrus et al., 2018(6)	1525 (47%)	54 (16)	U.S.A.	Cross-sectional (survey)	SDO; RWA	Denial	SDO and RWA are moderately correlated to CC denial. Their effect is stronger and more significant for individuals with high interest in politics.	85%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Chan & Tam, 2021 (Study 3)(7)	370 (52%)	48 (17)	U.S.A.	Cross-sectional (survey)	FFM	Beliefs	Only Openness shows a significant bivariate correlation with CC belief, but when controlling for social axioms only Agreeableness emerges as a significant predictor.	90%
Clarke et al., 2019(8)	334 (41%)	35 (6)	U.S.A.	Cross-sectional (survey)	SDO; RWA	Climate mitigation threat; Denial	SDO-D and RWA-A predict denial of CC existence. SDO-E predicts denial of CC human cause and denial of CC impact. RWA-C predicts all forms of denial. CCMT moderates all these relationships.	80%
Corral-Verdugo et al., 2017(9)	245 (58%)	20 (2)	Mexico	Cross-sectional (survey)	CFC	Belief	CFC-F significantly predicts CC acceptance and commitment towards CC action.	65%
Fritsche et al., 2012 (Study 1a) (10)	95 (58%)	22 (3)	Germany	Quasi-experimental	RWA (Aggression and Submission only)	Threat salience (manipulated)	After threat manipulation there was a significant increase in RWA-A but not RWA-S.	Moderate
Fritsche et al., 2012 (Study 1b) (10)	56 (73%)	21 (3)	Germany	Quasi-experimental	RWA (Aggression and Submission only)	Threat salience (manipulated)	After threat manipulation there was a significant increase in RWA-A but not RWA-S.	Moderate
Fritsche et al., 2012 (Study 2) (10)	155 (85%)	19 (4)	United Kingdom	Quasi-experimental	RWA (Aggression and Submission only)	Threat salience (manipulated)	After threat manipulation there was a significant increase in RWA-A but not RWA-S.	Moderate
Geiger et al. 2021 (Study 2)(11)	798 (60%)	47 (17)	U.S.A.	Cross-sectional (survey)	CFC	Action	CFC-F positively, and CFC-I negatively, predict likelyhood of intention of engaging in CC action as individuals age.	85%
Gibbon et al., 2021(12)	400 (64%)	25 (10)	NA	Cross-sectional (survey)	FFM	Denial	Openness/Intellect and Agreeableness are significant negative predictors of CC denial. On an aspect level, only Openness is a significant predictor of CC denial.	75%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Graca, 2021 (Study 1) (13)	1270 (53%)	49 (18)	Portugal	Cross-sectional (survey)	SDO	Concern; Policy support; National responsibility	SDO is a significant predictor of CC concern only.	90%
Häkkinen et al., 2014 (Study 1) (14)	135 (68%)	26 (7)	Sweden	Cross-sectional (survey)	SDO; RWA	Denial	SDO outperforms RWA and political identification in predicting CC denial.	60%
Häkkinen et al., 2014 (Study 2) (14)	101 (60%)	NA	Sweden	RCT	SDO; RWA	Denial	After exposing subjects to a pro-climate newscast, SDO remains a significant predictor of CC denial.	Weak
Hoffarth et al., 2016(15)	384 (46%)	36 (6)	U.S.A.	Cross-sectional (survey)	SDO; RWA	Denial; Denial of human cause	Perceived environmentalist threat fully mediates the relationship between SDO, RWA, and CC denial.	85%
Hopwood et al., 2021 (a) (16)	58784 (53%)	48 (17)	Germany	Cross-sectional (survey); Prospective (survey)	FFM	Concern	Increases in Openness and Neuroticism predicted increases in CC concern.	85%
Hopwood et al., 2021 (b) (17)	61479 (62%)	49 (15)	New Zealand	Cross-sectional (survey)	HEXACO	Belief; Concern	Agreeableness, Openness, and Neuroticism are associated to CC belief and CC concern. Increases in Agreeableness are associated to increases in CC belief and CC concern.	80%
Hu et al., 2017(18)	464 (43%)	38 (12)	U.S.A.	Cross-sectional (survey)	CFC	Risk perception; Knowledge	Individuals identifying as liberal and high in CFC scores reported higher levels of CC risk perception.	95%
Jessani & Harris, 2018(19)	219 (50%)	37 (12)	U.S.A.	Cross-sectional (survey)	Tolerance for ambiguity (TA)	Beliefs	The relationship between TA and CC beliefs is fully moderated by political orientation.	80%
Joireman & Liu, 2014(20)	299 (48%)	35†	U.S.A.	Cross-sectional (survey)	CFC	Beliefs	CFC and CFC X Gender interaction are significant predictors of CC beliefs. Females higher in future orientation score higher on CC beliefs.	70%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Jylha & Akrami, 2015(21)	221 (66%)	28 (11)	Sweden	Cross-sectional (survey)	SDO; Empathic concern	Denial	Relationship between SDO and CC denial is moderated by support for group-based dominance. Empathetic concern is negatively correlated with CC denial.	70%
Jylha et al., 2016 (Brazil sample) (22)	367 (41%)	30 (11)	Brazil	Cross-sectional (survey)	SDO	Denial	SDO fully moderates the relationship between gender, political conservatism, and CC denial.	80%
Jylha et al., 2016 (Sweden sample) (22)	221 (34%)	28 (11)	Sweden	Cross-sectional (survey)	SDO	Denial	SDO fully moderates the relationship between gender, political conservatism, and CC denial.	80%
Jylha & Hellmer, 2020 (Study 1) (23)	1587 (70%)	29 (12)	Sweden	Cross-sectional (survey)	FFM	Denial	In a path model, anti-egalitarian attitudes and support for traditional values mediate the relationship between FFM Openness and CC denial.	90%
Jylha & Hellmer, 2020 (Study 2) (23)	909 (78%)	28 (10)	Sweden	Cross-sectional (survey)	SDO; FFM	Denial	SDO is better at explaining variance in CC denial than populist attitudes, however this relationship is moderated by exclusionist/anti-egalitarian attitudes. Openness remains a significant, albeit distant factor.	90%
Jylha et al., 2021 (New Zealand sample) (24)	286 (78%)	19 (3)	New Zealand	Cross-sectional (survey)	SDO; Empathic concern	Denial	SDO predicts CC denial.	95%
Jylha et al., 2021 (Sweden sample) (24)	223 (68%)	28 (9)	Sweden	Cross-sectional (survey)	SDO; Empathic concern	Denial	SDO predicts CC denial.	95%
Jylha et al., 2021 (Hong Kong sample) (24)	196 (44%)	21 (1)	Hong Kong	Cross-sectional (survey)	SDO; Empathic concern	Denial	SDO doesn't predict CC denial. Beliefs of human dominance over nature and animals are better predictors.	95%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Kahan & Corbin, 2016(25)	1600	NA	U.S.A.	Cross-sectional (survey)	Actively open-minded thinking (AOT)	Belief	Political polarization on CC beliefs is possitively correlated with AOT.	50%
Kerr & Wilson, 2021 (Study 1) (26)	547 (76%)	19 (4)	New Zealand	Cross-sectional (survey)	SDO; RWA	Belief	RWA and SDO are negative predictors of belief that anthropogenic CC is occuring.	70%
Kerr & Wilson, 2021 (Study 2) (26)	663 (49%)	NA	U.S.A.	Cross-sectional (survey)	SDO; RWA	Belief	Conservatism, free market beliefs, and perceptions of scientists' credibility significantly mediate the effects of SDO and RWA towards CC beliefs.	90%
Kerr & Wilson, 2021 (Study 3) (26)	8101 (47%)	NA	New Zealand	Cross-sectional (survey)	SDO; RWA	Belief	RWA and SDO have significant, negative effects on CC beliefs mediated by percieved credibility of scientists.	80%
Meleady et al., 2020 (Study 3) (27)	501 (70%)	37 (13)	United Kingdom	Cross-sectional (survey)	SDO	Denial	SDO is a significant moderator of the relationship between positive/negative intergroup contact and CC denial outcomes.	85%
Meleady et al., 2020 (Study 4; T1)(27)	654 (68%)	32 (13)	United Kingdom	Prospective (survey)	SDO	Denial	SDO is a significant moderator of the relationship between positive/negative intergroup contact and CC denial outcomes. Positive or negative intergroup experiences produce a longitudinal impact on CC denial.	85%
Milfont et al., 2013 (Study 1) (28)	6518 (59%)	48 (16)	New Zealand	Cross-sectional (survey)	SDO	Beliefs	SDO is a significant negative predictor of CC beliefs.	85%
Milfont et al., 2013 (Study 4) (28)	3869 (61%)	51 (15)	New Zealand	Cross-sectional (survey)	SDO; RWA	Beliefs	SDO and RWA are significant negative predictors of CC beliefs.	85%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Milfont et al., 2015(29)	6489 (59%)	48 (16)	New Zealand	Cross-sectional (survey)	HEXACO	Beliefs	CC sceptics tend to have lower Agreeableness and higher Honesty/Humility than CC believers, while the latter tend to have higher Agreeableness and Openness to experience. CC believers have a slightly higher Neuroticism than other profiles.	85%
Monday & Sunday, 2020(30)	203 (43%)	24 (5)	Nigeria	Cross-sectional (survey)	FFM	Attitudes; Beliefs	In a multiple regression model, Openness and Agreeableness emerge as the biggest predictors of CC attitudes and beliefs.	80%
Morosoli et al., 2022(31)	5791 (52%)	44 (15)	NA	Cross-sectional (survey)	Dark Triad	CC Conspiracy engagement	Dark triad traits (Narcissism, Psychopathy, and Machiavellism) predict willingness to engage with CC conspiracy content.	85%
Nicol et al., 2022 (Study 1)(32)	270 (56%)	33 (11)	U.S.A.	Cross-sectional (survey)	SDO; RWA	Denial	SDO and hostile sexism are associated to CC denial after controlling for RWA, age, and gender.	80%
Orr et al., 2020(33)	1100 (66%)	NA	U.S.A.	Cross-sectional (survey)	Need for cognitive closure (NCC)	Worry; Policy support	The relationship between NCC and CC worry is moderated by political conservative attitudes.	75%
Panno et al., 2018 (Study 2) (34)	NA (61%)	41	Italy	Cross-sectional (survey)	SDO	Beliefs	SDO is a significant moderator of the relationship between trait mindfulness and endorsement of CC.	70%
Panno et al., 2021(35)	268 (49%)	41 (17)	Italy	Cross-sectional (survey)	HEXACO	Action	Openness is a significant predictor of CC action. Besides Openness being a direct predictor, Moral anger partially moderates this relationship.	80%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Pitirut et al., 2022(36)	201 (88%)	25 (8)	Romania	Cross-sectional (survey)	Dark Triad	Attitudes	Psychopathy and Machiavellianism have a significant negative correlation with CC attitudes, while Narcissism doesn't.	70%
Preston & Shin, 2022 (Study 1) (37)	409 (66%)	33 (10)	NA	Cross-sectional (survey)	RWA; Trait Compassion	Belief	RWA moderates the effect of religious fundamentalism on CC belief. Trait compassion is postively correlated with CC belief.	75%
Preston & Shin, 2022 (Study 2) (37)	500 (50%)	36 (12)	NA	Cross-sectional (survey)	RWA; Trait Compassion	Belief	RWA moderates the effect of religious fundamentalism on CC belief. Trait compassion is postively correlated with CC belief.	75%
Rothermich et al., 2021(38)	194 (49%)	36 (12)	U.S.A.	Cross-sectional (survey)	FFM; Trait anxiety; Interpersonal reactivity	Beliefs; Risk perception	FFM Openness and the perspective taking scale of IRI are significantly correlated with CC belief and CC risk perception. No significant correlation with Trait anxiety were found.	85%
Searle & Gow, 2010(39)	236	NA	Australia	Cross-sectional (survey)	Intolerance of uncertainty	Distress	Intolerance of uncertainty is positively correlated with CC distress.	80%
Sibley et al., 2011(40)	5576 (59%)	47 (16)	New Zealand	Cross-sectional (survey)	HEXACO	Beliefs	See Milfont et al., 2015.	95%
Sinatra et al., 2012(41)	140 (85%)	25 (8)	U.S.A.	Prospective (survey)	Need for cognitive closure (NCC); Need for cognition (NFC)	Attitudes; Action	NCC is negatively associated to CC action after reading a persuasive pro-climate text. NFC is positively correlated to CC attitudes and CC action both before, and after, reading the persuasive text.	75%
Stanley et al., 2017a (Study 1) (42)	6516 (59%)	48 (16)	New Zealand	Cross-sectional (survey)	SDO	Beliefs	SDO-E is the stronger negative predictor of CC belief compared to SDO-D.	95%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Stanley et al., 2017a (Study 2) (42)	504	NA	New Zealand	Cross-sectional (survey)	SDO	Beliefs	SDO-E is the stronger negative predictor of CC belief compared to SDO-D.	65%
Stanley et al., 2017a (Study 3) (42)	674 (77%)	19	New Zealand	Prospective (survey)	SDO	Denial	Both SDO-E and SDO-D are non-significant predictors of long-term changes in CC denial.	65%
Stanley et al., 2017b (T1)(43)	674 (77%)	19	New Zealand	Prospective (survey)	SDO; RWA	Denial	After 5 months, RWA was a significant predictor of CC denial, while SDO remained non-significant.	70%
Stanley et al., 2021 (Study 1) (44)	535 (48%)	33 (12)	U.S.A.	RCT	SDO; Time orientation	Belief; Distance; Policy support	No significant effects of SDO time-framing manipulation in individuals high in SDO.	Moderate
Stanley et al., 2021 (Study 2) (44)	1102 (54%)	35 (13)	United Kingdom	RCT	SDO; RWA	Belief; Temporal distance; Policy support	No significant effects of SDO time-framing manipulation in individuals high in SDO.	Strong
Thacker & Sinatra, 2022(45)	516 (81%)	20†	U.S.A.	RCT	Actively open-minded thinking (AOT)	Knowledge; Plausibility	AOT is a significant predictor of post-test knowledge and moderated the effects of the intervention.	Strong
Uenal et al., 2021 (Study 1)(46)	378 (48%)	45 (13)	U.S.A.	RCT	SDO	Threat perception	SDO moderates the relationship between CC threat, outgroup threat, and modern racism, when CC threat cues are manipulated.	Strong
Uenal et al., 2021 (Study 2)(46)	653 (44%)	36 (13)	United Kingdom	RCT	SDO	Threat perception; Petition signing	SDO moderates the relationship between CC threat, outgroup threat, and modern racism, when CC threat cues are manipulated.	Strong
Uenal et al., 2022 (Study 1)(47)	398 (44%)	38 (12)	U.S.A.	Cross-sectional (survey)	SDO	Risk perception; Policy support	SDO is a significant predictor of CC concern and CC policy support.	75%
Uenal et al., 2022 (Study 2)(47)	317 (45%)	38 (11)	Germany	Cross-sectional (survey)	SDO	Risk perception; Petition signing	SDO is a significant predictor of CC concern.	75%

Author and Year	Numerosity (% females)	Age M (SD)	Country	Study Type	Personality Constructs	Climate Change Constructs	Main Findings	Quality*
Vainio et al., 2020(48)	1012 (44%)	NA	Finland	Cross-sectional (survey)	CFC	Policy support	CFC-future significantly predicts CC policy support. CFC-immediate negatively predicts CC policy support.	75%
Veckalov et al, 2021 (Pilot)(49)	117 (73%)	34 (16)	Netherlands	Cross-sectional (survey)	CFC	Denial	CFC is moderately correlated with CC denial.	75%
Veckalov et al, 2021 (Study 1) (49)	186 (80%)	29 (13)	Netherlands	Cross-sectional (survey)	CFC	Scepticism; Temporal distance	CFC is moderately correlated with CC scepticism.	85%
Veckalov et al, 2021 (Study 2) (49)	351 (64%)	35 (12)	United Kingdom	Cross-sectional (survey)	CFC	Denial	CFC is moderately correlated with CC denial.	100%
Wang, 2017(50)	572 (50%)	49	U.S.A.	Cross-sectional (survey)	CFC; Empathetic concern	Risk perception; Moral attitude; Subjective norm; Self efficacy; Action intention	CFC and Empathetic concern are significant predictors of CC action intention.	85%
Wullenkord et al., 2021(51)	1011 (51%)	44 (14)	Germany	Cross-sectional (survey)	SDO; RWA	Anxiety; Denial	SDO and RWA do not correlate with CC anxiety but show a positive correlation with CC denial.	90%
Wullenkord et al., 2022(52)	1007 (51%)	44 (14)	Germany	Cross-sectional (survey)	SDO; RWA	Action	SDO and RWA correlate with both implicatory and interpretive CC denial in a sample representative of the general population.	75%
Yu et al., 2017(53)	275 (67%)	21	Taiwan	Cross-sectional (survey)	FFM	Concern; Policy support; Social norms	Conscientiousness and Agreeableness are significant predictors of CC policy support. FFM traits mediate the relationship between CC concern and CC policy support.	70%
Zhu et al., 2020 (Study 3) (54)	770	NA	U.S.A.	Cross-sectional (survey)	CFC	Seriousness; Mitigation; Policy support; Citizenship	CFC is positively correlated with CC seriousness and CC mitigation.	80%

Table 3: Meta-analyses summary

Personality trait	Climate measure	Fisher's Z estimate [CI 95%]	Pearson's *r*	*k* (n. of samples)	*n* (total numerosity)
Five Factor Model – Openness					
	Denial	-0.15*** [-0.23, -0.08]	-0.15	7	10326
	Concern	0.15*** [0.05, 0.26]	0.15	2	19951
Five Factor Model – Conscientiousness					
	Denial	-0.02 [-0.04, 0.01]	-0.02	4	7453
Five Factor Model – Extraversion					
	Denial	-0.00 [-0.02, 0.02]	-0.00	4	7453
Five Factor Model – Agreeableness					
	Denial	-0.09 [-0.19, 0.00]	-0.09	6	9949
Five Factor Model – Neuroticism					
	Denial	-0.06*** [-0.08, -0.04]	-0.06	5	7030
Social Dominance Orientation (SDO)					
	Denial	0.43*** [0.37, 0.50]	0.40	23	31505
	Concern	-0.38*** [-0.54, -0.21]	-0.36	6	4027
	Proactivity	-0.33*** [-0.45, -0.21]	-0.32	6	3983
Right-Wing Authoritarianism (RWA)					
	Denial	0.48*** [0.41, 0.56]	0.45	15	22037
	Proactivity	-0.34*** [-0.47, -0.22]	-0.30	2	1345
Consideration of Future Consequences (CFC)					
	Denial	-0.33*** [-0.51, -0.15]	-0.32	6	1662
	Concern	0.30** [0.11, 0.50]	0.29	4	1573
	Proactivity	0.39*** [0.21, 0.57]	0.37	5	2978
Empathic Concern					
	Denial	-0.13 [-0.29, 0.02]	-0.13	5	1120
Actively Open-Minded Thinking (AOT)					
	Denial	-0.42* [-0.75, -0.08]	-0.40	2	2116

Table 3: summary of meta-analysis effects, number of studies and total numerosity. "k" = number of studies; "n" = total numerosity; "FFM" = Five Factor Model; "SDO" = Social Dominance Orientation; "RWA" = Right-Wing Authoritarianism; "CFC" = Consideration of Future Consequences; "AOT" = Actively Open-Minded Thinking.

"" = Value significant at $p \leq 0.05$; "**" = Value significant at $p \leq 0.01$; "***" = Value significant at $p \leq 0.001$.*

Table 4: Summary of heterogeneity, publication bias, and achieved statistical power

Personality trait	Climate measure	Q	τ^2	I^2	Egger's test (p-value)	1 - β
Five Factor Model – Openness						
	Denial	44.40***	0.008	89.10	0.386	> 0.999
	Concern	2.44	0.004	59.04	N/A	> 0.999
Five Factor Model – Conscientiousness						
	Denial	2.46	0.002	0.23	0.682	0.088
Five Factor Model – Extraversion						
	Denial	1.91	0.000	0	0.203	0.029
Five Factor Model – Agreeableness						
	Denial	32.55***	0.012	92.79	0.780	> 0.999
Five Factor Model – Neuroticism						
	Denial	2.24	0.000	0	0.910	0.987
Social Dominance Orientation (SDO)						
	Denial	617.87***	0.146	96.34	0.456	> 0.999
	Concern	154.43***	0.204	96.31	0.007**	> 0.999
	Proactivity	73.25***	0.021	92.77	0.112	> 0.999
Right-Wing Authoritarianism (RWA)						
	Denial	387.60***	0.143	96.28	0.349	> 0.999
	Proactivity	4.09*	0.006	75.53	N/A	0.992
Consideration of Future Consequences (CFC)						
	Denial	55.29***	0.046	92.39	< 0.001***	0.997
	Concern	55.40***	0.036	93.15	0.988	0.986
	Proactivity	101.12***	0.204	95.88	0.233	> 0.999
Empathic Concern						
	Denial	31.95***	0.029	86.54	0.482	0.335
Actively Open-Minded Thinking						
	Denial	46.31***	0.058	97.84	N/A	> 0.999

Table 4: summary of heterogeneity parameters, publication bias, and achieved statistical power.

"Q" = total variance; "τ^2" between-study variance; "I^2" = proportion of variability due to heterogeneity between studies; "1 – β" = achieved statistical power. "FFM" = Five Factor Model; "SDO" = Social Dominance Orientation; "RWA" = Right-Wing Authoritarianism; "CFC" = Consideration of Future Consequences; "AOT" = Actively Open-Minded Thinking.

"" = Value significant at $p \leq 0.05$; "**" = Value significant at $p \leq 0.01$; "***" = Value significant at $p \leq 0.001$.*

Figures

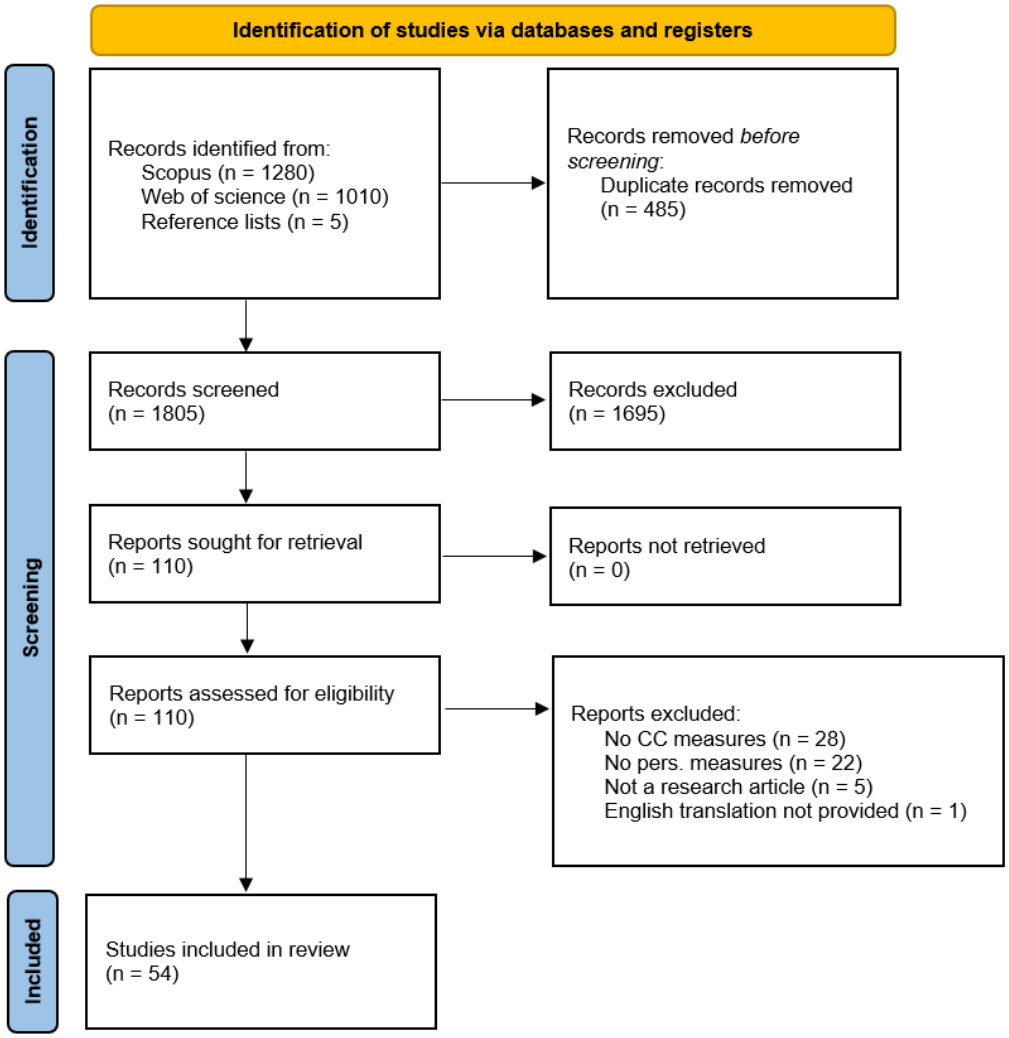

Figure 1

PRISMA flowchart of all the phases of the study selection process. "CC" = Climate Change.

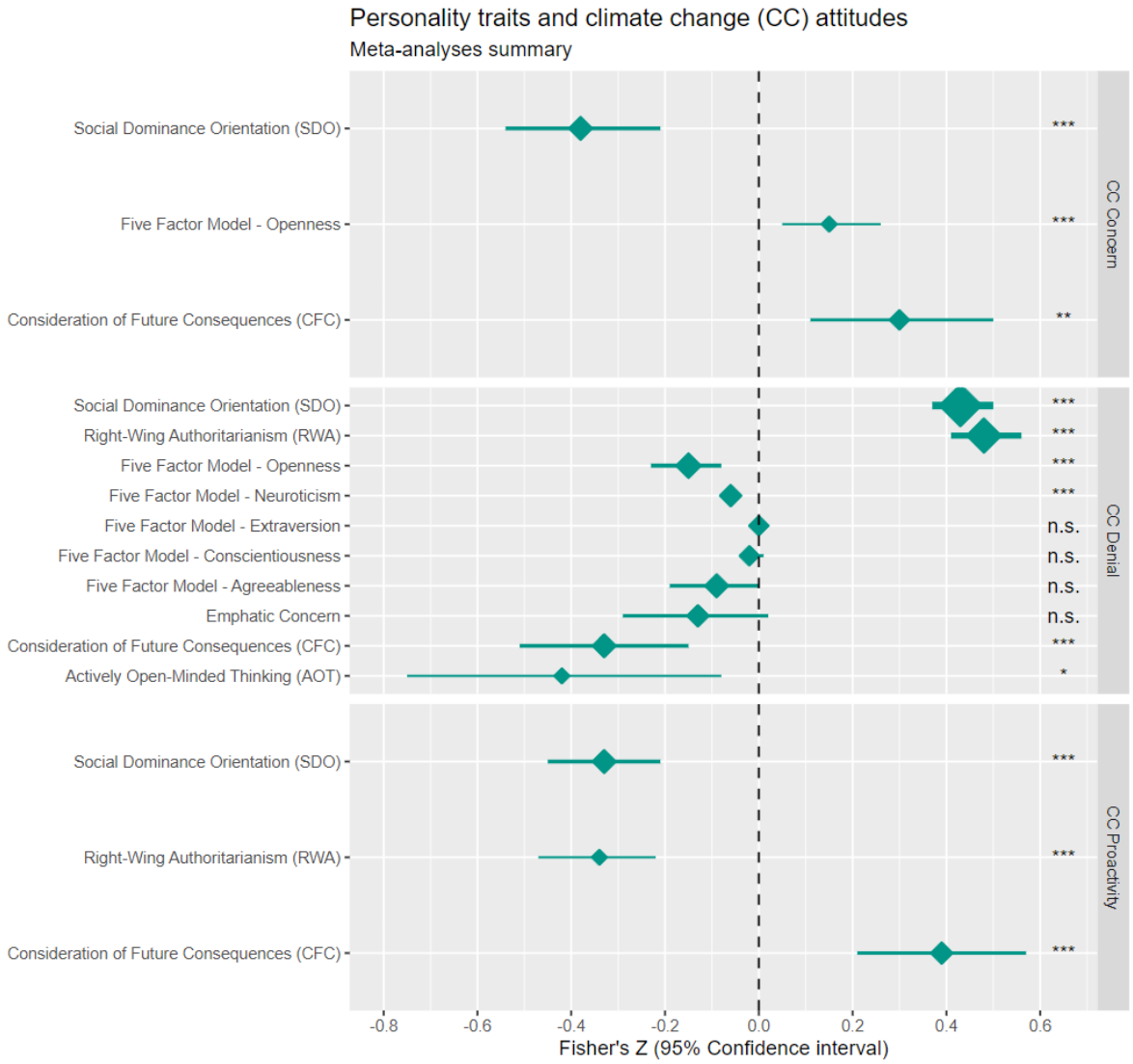

Figure 2

Forest plot of meta-analysis statistics. Size of the dots is relative to the number of studies included in the meta-analysis. CC = Climate Change; "FFM" = Five Factor Model; "SDO" = Social Dominance Orientation; "RWA" = Right-Wing Authoritarianism; "CFC" = Consideration of Future Consequences. "AOT" = Actively Open-Minded Thinking.

"" = Value significant at $p \leq 0.05$; "**" = Value significant at $p \leq 0.01$; "***" = Value significant at $p \leq 0.001$.*

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