JOURNAL OF THE ROYAL SOCIETY OF NEW ZEALAND
2024, VOL. 54, NO. 4, 395–411
https://doi.org/10.1080/03036758.2023.2272842

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RESEARCH ARTICLE

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Climate change profiles of New Zealanders over time: a one-year latent transition analysis of climate change beliefs and concern

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ABSTRACT

Scientific evidence unequivocally shows that human activities cause climate change, but some people still deny it. Using New Zealand Attitudes and Values Study data from 2018 and 2019 (N = 34,733), we examined segmentation profiles regarding beliefs and concern about climate change ('Climate change is real', 'Climate change is caused by humans', 'I am deeply concerned about climate change'), the probabilities of transitioning to and from profiles over time, and the characteristics of individuals in each profile. Five profiles were identified with varying levels of climate change beliefs and concern. The largest profile (60.4% of respondents) had the highest levels of climate change beliefs and concern, while the smallest profile (3.7% of respondents) had the lowest. Over time, more people moved from profiles of lower into profiles of higher levels of climate change beliefs and concern. The profile with the highest levels was the most stable, with members having an 82.7% chance of staying in this profile over time. Compared to this group, members of the profile with the lowest levels of climate change beliefs and concern were more likely to be male, New Zealand European, parents, religious, and to endorse conservative and system-justifying ideologies. We discuss the implications of the findings.

ARTICLE HISTORY
Received 15 May 2023
Accepted 12 October 2023

HANDLING EDITOR
Rebecca Priestley

KEYWORDS
Climate change; beliefs; concern; segmentation; individual differences; New Zealand; NZAVS

Introduction

The most recent synthesis report by the Intergovernmental Panel on Climate Change has again confirmed that human activities, chiefly through greenhouse gas emissions, are unequivocally causing climate change. Despite the weight of scientific evidence and the overwhelming scientific consensus on the current existence and future worsening of climate change, there is still denial regarding anthropogenic climate change. Importantly, climate change denial is not uniformly spread across the population, meaning that some individuals are more prone to climate change denial than others. The extant literature has documented the individual characteristics of those more prone to anti-

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/03036758.2023.2272842.

environmentalism sentiments and climate change denial (for meta-analytical summaries, see Zelezny et al. 2000; Milfont 2012b; Wiernik et al. 2013; Hornsey et al. 2016; Cruz 2017). To illustrate, McCright and Dunlap (2011) documented a 'conservative white male' effect whereby conservative white males in the USA are disproportionately more likely than other adults to deny climate change. This effect has since been observed in other countries too (e.g., Jylhä et al. 2016; Poortinga et al. 2019), confirming that socio-psychological characteristics play a role in shaping people's attitudes and beliefs towards climate change.

Understanding the individual characteristics of those who deny climate change is important for several reasons, including the development of effective communication strategies and the prevention of the spread of misinformation (Wong-Parodi and Feygina 2020; Hornsey and Lewandowsky 2022). Contributing to this challenge, our study investigates the demographic and socio-psychological make-up of New Zealanders regarding their levels of climate change beliefs and climate change concern, which are important factors that motivate people to engage in climate actions. It is reasonable to expect that levels of climate change beliefs and concern are not homogenous within the New Zealand population, so segmenting the population based on levels of climate change beliefs and concern, as well as demographic and socio-psychological characteristics can help with climate change communication by making it more tailored and targeted to specific subgroups of the population (Hine et al. 2014; Detenber and Rosenthal 2020).

A few scholarly publications have conducted climate change segmentation in the New Zealand population. Examining two key climate change beliefs ('Climate change is real', 'Climate change is caused by humans'), Sibley and Kurz (2013) identified four distinct segmentation profiles of climate change belief patterns in the New Zealand population ($N = 6{,}072$; 71.5% New Zealand European, 59.5% female). These subgroups represented those who believe in the reality of climate change and its human cause (53%), those who are undecided (30%), the complete sceptics (10%), and those who believe the climate is changing but is not caused by human activity (7%). Examining these four subgroups in more detail, Milfont et al. (2015) reported that those who are younger, female, educated, politically liberal, and belong to minority groups (compared to the NZ European majority) are more likely to uphold stronger climate change beliefs. When considering key psychological variables, their findings indicated that belief in climate change was also stronger for those who perceive they can influence environmental outcomes, for those who endorse self-transcending and openness-to-change values as guiding principles in their lives (e.g. 'Equality (equal opportunity for all)' and 'A varied life (filled with challenge, novelty and change)', respectively), and for those with personality traits of Agreeableness and Openness to Experience (i.e. willing to achieve social harmony and willing to try new things, respectively).

Other New Zealand studies have also examined belief in anthropogenic climate change. To illustrate, Thaker (2021) observed that most of the surveyed New Zealanders ($N = 1{,}083$; 64% New Zealand European, 51% female) believe in the reality of climate change, that it is human caused, and are also worried about it. In their analysis of data from a representative New Zealand sample ($N = 8199$; 74.7% New Zealand European, 55.1% female), Abrahamse et al. (in press) observed that only a minority of New Zealanders (2.8%) selected the option expressing that 'There is no such thing as climate change'

and only 10% attributed climate change 'entirely' or 'mainly' to natural processes. Abrahamse and colleagues also observed that belief in anthropogenic climate change was stronger for respondents with higher education levels and who identified as female and Māori (compared to those who identified as male and those who indicated any other ethnic group). Examining this dataset further, Milfont et al. (2021a) observed that denial of anthropogenic climate change was greater for those who endorse system-justifying ideologies, including greater levels of both conservative political orientation and Social Dominance Orientation – which indexes 'the degree to which individuals desire and support group-based hierarchy and the domination of 'inferior' groups by 'superior' groups' (Sidanius and Pratto 1999, p. 48).

The current research extends on these prior studies in three main ways. First, we examine the extent to which climate change beliefs are independent to climate change concern. Along with considering beliefs about climate change and anthropogenic climate change ('Climate change is real', 'Climate change is caused by humans'), we included an item examining concern about climate change ('I am deeply concerned about climate change'). The previous research conducted by Sibley and Kurz (2013) considered only climate change beliefs and identified four subgroups in the New Zealand population, with the smaller subgroup (7% of the respondents) indicating belief in climate change but not in its anthropogenic cause. Inclusion of the concern item might modify the number and characteristics of the subgroups observed by Sibley and Kurz (2013). For example, certain individuals might believe that climate change is real and that it is caused by humans but be unconcerned about it. Second, along with including the climate change concern item, we use a larger and more recently collected national sample to examine the extent to which the previously observed four profile model emerges, and the characteristics associated with membership in each of the identified profiles. Finally, we use one-year longitudinal data to calculate the probabilities of transitioning from or remaining in the same belief profile over time.

To these ends, we conducted a Latent Transition Analysis (LTA) using a national probability sample from the New Zealand population. The LTA was used to calculate the number of underlying subgroups in the population who produce unique response patterns to the climate change measures and to simultaneously calculate the probabilities of transitioning from each profile to every other profile over a one-year time period. In addition to the LTA, we conducted a three-step multinomial regression as part of a Latent Profile Analysis (LPA) at the first time point to assess whether membership in each profile is associated with certain demographic and socio-psychological predictors.

Both LTA and LPA are person-centred analyses that focus on understanding individual differences within a population based on the relationships between specific variables – here New Zealanders' responses to measures of climate change beliefs and concern. By identifying similarities among individuals, these analyses create subgroups who quantitatively differ from each other to accurately represent the population (Howard and Hoffman 2017; Osborne and Sibley 2017). As noted by Osborne and Sibley (2017), this is 'an approach that treats the individual as the unit of analysis by identifying subgroups of people who share a set of characteristics that differentiate them from other subgroups of people' (p. 289). This approach is thus distinct from variable-centred analyses (e.g. correlations and descriptive statistics such as mean distribution) that treat variables (rather than individuals) as the unit of analysis. Since we are interested in identifying

climate change segmentation in the New Zealand population, this person-centred approach is the appropriate methodological tool. By investigating over-time change in profile membership, our study also advances previous climate change segmentation studies (Hine et al. 2014).

We investigated two main hypotheses for the LTA analysis, pre-registered on the Open Science Framework (https://osf.io/udpeh). First, we expected to find at least four underlying profiles in the population with different patterns of climate change beliefs and concern based on previous findings reported by Sibley and Kurz (2013). Second, we expected that these profiles would be relatively stable over a one-year period. Despite the lack of longitudinal research on climate segmentation (Hine et al. 2014), we reasoned that individuals who believe in climate change and are concerned about it are unlikely to become ardent climate change deniers or unconcerned the following year. This is because the pattern of change for climate change beliefs and concern is relatively small annually in the New Zealand population (Milfont et al., 2021b).

Finally, we examined the extent to which demographic and socio-psychological factors would help explain profile membership. Climate change denial often has strong political and ideological overtones, with individuals who identify as conservative being more likely to express denial (Milfont et al. 2015, 2021a; Hornsey et al. 2016). Although political polarisation around climate change is stronger in the USA compared to other countries (Hornsey et al. 2018), we still expected that profile membership would be associated with political and ideological variables in New Zealand – as well as associated with other variables – as observed in previous studies.

Method

Participants

Data for this research were collected as part of the New Zealand Attitudes and Values Study (NZAVS), which is a national study that has collected information about the socio-political attitudes of the New Zealand population annually since 2009. The initial NZAVS participants were randomly sampled from the Electoral Roll using a stratified random procedure, with additional opt-ins over the years. The University of Auckland Human Participants Ethics Committee reviews the NZAVS every three years. The NZAVS was most recently approved by the committee on 26 May 2021 (reference Number: UAHPEC22576).

The current study uses data collected in Time 10 (2018, $N = 47{,}948$) and Time 11 (2019, $N = 42{,}681$), which were selected because these waves had the largest sample sizes in the NZAVS to date. The Time 10 wave included 29,958 women (62.5%), 17,783 men (37.1%), and 207 participants identified as gender diverse (0.4%); and 42,543 people identified as New Zealand European (83.7%), 4,696 as Māori (9.2%), 2,541 identified with an Asian ethnic group (5%), and 1,039 were Pacific Nations peoples (2%). Note that participants could identify with multiple ethnic groups (and hence be counted multiple times). Time 10 participants had a mean age of 49.10 years ($SD = 13.86$). The Time 11 wave included 27,176 women (63.7%), 15,238 men (35.7%), and 267 participants identifying as gender diverse (0.6%); and 39,525 people identified as New Zealand European (84.3%), 4,314 as Māori (9.2%), 1,900 identified with an

Asian ethnic group (4.1%), and 1,148 were Pacific Nations peoples (2.4%). Time 11 participants had a mean age of 52.05 years ($SD = 13.87$). Sibley (2023) provides detailed information about the NZAVS and sampling strategies.

The final sample for the LTA was restricted to respondents who provided complete responses to the three climate change items at both Time 10 and Time 11 ($N = 34,733$). The final sample for the LPA (used to assess demographic and socio-psychological predictors) was larger as it was only restricted to respondents who provided complete responses to the three climate change items at Time 10 ($N = 45,430$). A de-identified dataset containing only the variables analysed in this manuscript is available upon request from the corresponding author, or any member of the NZAVS Advisory Board for the purposes of replication or checking of any published study using NZAVS data. The M*plus* syntax used to test the models reported in this manuscript is available on the NZAVS OSF: https://osf.io/75snb/.

Measures

Three items developed by the NZAVS team were used to measure climate change beliefs and concern. These were: 'Climate change is real', 'Climate change is caused by humans', and 'I am deeply concerned about climate change'. All three items were rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

We considered a range of demographic variables in the analysis based on previous studies that showed their relevance in explaining climate profiles membership (Milfont et al. 2015; Athy et al. 2022). These included age, gender (dummy coded as 0 = female, 1 = male), ethnicity (0 = minority group member, 1 = New Zealand European majority), parental status (0 = no children, 1 = parent), education level (0 = no qualifications to 10 = Doctoral Degree), total household income (participant estimate), religious status (0 = not religious, 1 = religious), employment (0 = unemployed, 1 = employed), and political orientation (1 = extremely liberal to 7 = extremely conservative). We also considered three psychological constructs: Social Dominance Orientation (SDO) indexed the degree of support for group-based hierarchy (Pratto et al. 1994); Right-Wing Authoritarianism (RWA) indexed conventionalism as well as submission to in-group authority figures and aggression towards those who violate in-group norms (Altemeyer 1996); and six personality trait dimensions were assessed using the Mini-IPIP6 (Sibley et al. 2011). Items and details for these psychological measures are presented in the Supplementary Material.

Data analysis

As noted above, we used person-centred analyses to identify segmentation profiles based on New Zealanders' responses to measures of climate change beliefs and concern. First, we conducted a LTA to assess the extent to which the previously observed four-profile model emerges after the inclusion of the climate change concern item as well as with the use of more recent data collected with a larger national sample. More importantly, we used the LTA to examine the probabilities of transitioning from each identified profile to every other profile, along with calculating the probability of remaining in the same profile over time.

We considered several statistical criteria to evaluate model fit and select the appropriate number of segmentation profiles for the data. The statistical criteria we used were log likelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size adjusted Bayesian information criterion (aBIC), and entropy. Smaller numerical values for the first four criteria (i.e. log likelihood, AIC, BIC, and aBIC) and greater numerical entropy values indicate better model fit. Beyond the statistical fit of the models, we also considered whether the model was overfitting the data and the interpretability of the resulting profiles (e.g. whether there was a reasonable number of respondents in each profile to avoid segmentation profiles with too few or too many respondents).

We then conducted a three-step method in a multinomial logistic regression in M*plus* (Asparouhov and Muthén 2014), which allows investigating the relationships between the latent profiles and predictor variables. The process involves the following steps. First, the profile model was estimated as part of a LPA using only the latent profile indicator variables (i.e. the three climate change items). Second, the most probable profile variable is generated by leveraging the latent class posterior distribution from the first step. Finally, a regression is performed with the most likely profile as the dependent variable (taking into consideration the misclassification in the second step), and the predictor variables as independent variables. We used Time 10 of the NZAVS, which has the largest sample size, to examine whether membership in each of the climate change belief/concern profiles was predicted by specific demographic and socio-psychological characteristics. Both LTA and LPA analyses were conducted in M*plus* version 8.6 (Muthén and Muthén 1998-2017–1998-2017) with maximum likelihood estimation with robust standard errors.

Before continuing, it is important to note that all statistical analyses rely on certain assumptions. For example, the LPA models apply the assumption of local independence, meaning that all observed variables are assumed to be uncorrelated within each latent profile (Lubke and Muthén 2007; Williams and Kibowski 2016); both LTA and LPA models assume measurement invariance over time, repondents and/or observed variables (Lubke and Muthén 2007; Muthén and Asparouhov 2022); and multinomial logistic regression likewise involves several assumptions, including error-free measurement of predictors (Stefanski and Carroll 1987). We use current best practice in the field (see, e.g. Hine et al. 2014; Osborne and Sibley 2017), and are thoughtful of the assumptions and limitations of these statistical analyses. Moreover, the diverse and large sample in our study and the use of maximum likelihood estimation with robust standard errors means the model parameters are assumed to be robust, even in the presence of non-normality.

Results

Latent transition analysis

We began the LTA by estimating models ranging from 2 to 7 profiles from the respondents who completed the three climate change items at both time points. We constrained the intercepts of all three climate change items within each profile at the first time point (2018) to be equal to the corresponding profile at the second time point (2019), and used model fit statistics and model interpretability to identify the best-fitting and most parsimonious model.

Table 1. Model fit statistics for the models ranging from 2 to 6 profiles of the latent transition analysis.

Profiles	Log likelihood	AIC	BIC	aBIC	Entropy
2 profiles	−318854.760	637739.519	637866.351	637818.681	0.924
3 profiles	−297016.756	594079.513	594273.988	594200.894	0.925
4 profiles	−285583.680	571233.360	571512.389	571407.516	0.914
5 profiles	−258961.025	518012.050	518392.545	518249.536	0.980
6 profiles	−228118.254	456354.508	456853.379	456665.878	0.981

Note: AIC = Akaike Information Criterion. BIC = Bayesian Information Criterion. aBIC = sample-size adjusted Bayesian Information Criterion.

Results for the 7-profile model yielded model nonidentification, and thus this model was discarded from further analysis. Model fit statistics for the other LTA models are presented in Table 1. Inspection of the fit statistics indicate that both the 5-profile and 6-profile models had significantly lower log likelihood, AIC, BIC and aBIC compared to the 1–4 profile models. The entropy began to decrease at the 4-profile model (0.914) but was significantly greater for the 5-profile model (0.980), indicating that 98% of the sample was correctly classified into each of the five profiles. The entropy of the 5-profile model was also only slightly lower than the 6-profile model (0.981), and the 6-profile model had one segmentation profile with a very small number of respondents (i.e. 2.1% in Time 10 and 3.7% in Time 11). Based on these findings, we selected the 5-profile model as the best-fitting and most parsimonious segmentation solution for these data.

In addition to the fit statistics and interpretability, further analysis indicated very high levels of certainty in correct classification for all profiles in the 5-profile model at both time points. Results indicate that, for example, individuals assigned to Profile 1 at Time 10 had a 96% chance of being correctly classified into this profile and a 1% chance of being incorrectly classified into Profile 2 (see Table 2). Similarly, results in Table 3 indicate that the certainty in correct classification was above 99% for each profile in the 5-profile model at Time 11.

The mean agreement levels with the climate change items for the final constrained 5-profile model are visually depicted in Figure 1 and detailed in Table S1 of the Supplementary Material. The largest profile, comprising 60.4% of the respondents at Time 10 and 58.6% at Time 11, showed high agreement with all three climate change items, and we labelled respondents in this profile *Climate Believer Concerned*. Respondents in the second largest profile (19.0% at Time 10 and 18.0% at Time 11) showed slightly less agreement with all three items than respondents in the first profile but still had relatively high agreement with all three items; we thus labelled respondents in this profile *Moderate Climate Believer Concerned*. Additionally, two smaller profiles of similar size emerged. In

Table 2. Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column) for the final 5-profile model at time 10 wave.

Profile number	*N*	1	2	3	4	5
1	6615	**0.96**	0.00	0.01	0.01	0.02
2	1278	0.01	**0.96**	0.01	0.02	0.01
3	3024	0.00	0.00	**1.00**	0.00	0.00
4	2832	0.01	0.01	0.01	**0.96**	0.01
5	20984	0.01	0.00	0.00	0.00	**0.99**

Table 3. Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column) for the final 5-profile model at time 11 wave.

Profile number	*N*	1	2	3	4	5
1	6251	**0.99**	0.00	0.00	0.00	0.01
2	1574	0.00	**0.99**	0.00	0.01	0.00
3	3089	0.01	0.00	**0.99**	0.01	0.00
4	3484	0.00	0.00	0.00	**0.99**	0.00
5	20335	0.00	0.00	0.00	0.00	**1.00**

one of these profiles, respondents showed slightly lower agreement with all three items, and we labelled respondents in this profile *Somewhat Climate Believer Concerned* (8.7% and 8.9% at Times 10 and 11, respectively). In the other profile, respondents had mean scores at the approximate mid-point of the scale for each of the three items, so we labelled respondents in this profile *Undecided/Neutral* (8.2% and 10.0% at Times 10 and 11, respectively). Finally, the smallest profile to emerge (3.7% and 4.5% at Times 10 and 11, respectively) had low agreement with each of the climate change items, and we labelled respondents in this profile *Climate Sceptics*. Figure S1 in the Supplementary Material visually depicts the proportion of respondents in each profile for both time points, and Table S2 provides the descriptive statistics and correlations between the climate items in both waves.

We then examined the stability of profile membership over time more formally, with the latent transition probabilities over one-year reported in Table S2 and visually depicted in Figure 2. In this figure, arrows on the same profile and their associated probabilities represent the likelihood of staying within that profile over one-year and arrows between profiles and their associated probabilities represent the likelihood of transitioning to another profile over one-year.

We highlight three key patterns observed in Figure 2. First, the *Climate Believer Concerned* profile was the most stable, with members having an 82.7% chance of staying in this profile over one year, and all other profiles were significantly less stable than this profile. Respondents in this profile had the highest probability (11.4%) of

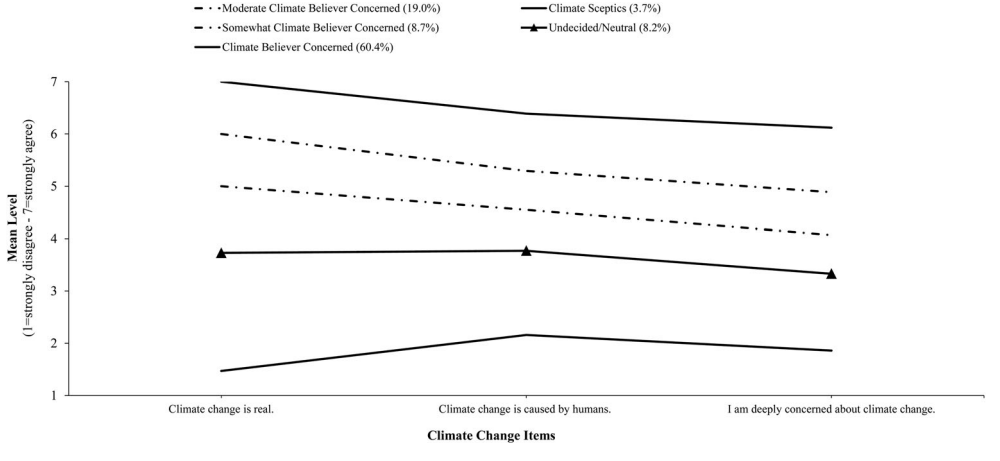

Figure 1. Mean levels of agreement with the climate change items for the identified profiles in the constrained 5-profile LTA model observed in time 10 (2018; $N = 34{,}733$).

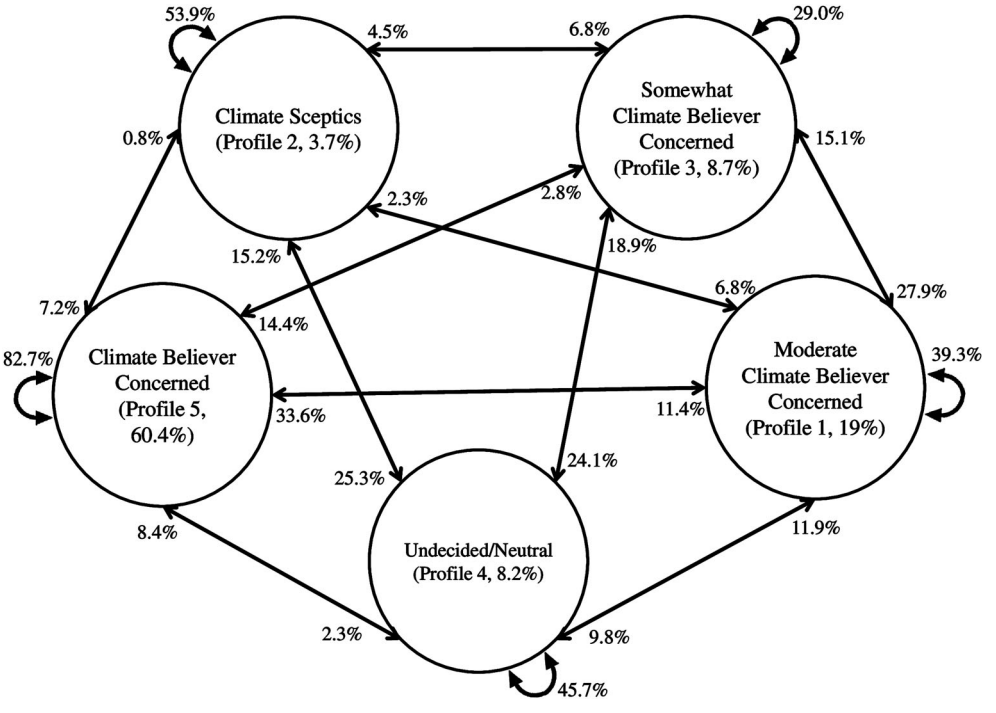

Figure 2. Transition probabilities between each profile for the constrained 5-profile model from 2018 to 2019.

Note: $N = 34{,}733$.

transitioning into the *Moderate Climate Believer Concerned* profile. Second, the least stable profile was the *Somewhat Climate Believer Concerned* profile, in which there was only a 29% probability that members would remain in this profile after one year. Members of this profile had the second largest transition probability (27.9%) of transitioning into the *Moderate Climate Believer Concerned* profile, followed by a 24.1% chance of transitioning into the *Undecided/Neutral* profile and a 14.4% chance of transitioning into the *Climate Believer Concerned* profile, but only a small chance of transitioning into the *Climate Sceptics* profile (4.5%). Finally, members of the *Climate Sceptics* profile had the greatest chance of transitioning into the *Undecided/Neutral* profile (25.3%) after one year but had a low chance of transitioning into any of the other three profiles (i.e. less than 7.2% transition probability).

Overall, the largest probabilities of transitioning to another profile occurred from profiles of lower agreement with the climate change items to profiles of higher agreement with the climate change items. The only exception to this being the *Somewhat Climate Believer Concerned* profile having a 24.1% chance of transitioning to a profile of slightly more neutral climate agreement, the *Undecided/Neutral* profile.

Demographic and socio-psychological predictors of profile membership

Table 4 presents the results of the three-step multinomial regression, and the mean item agreement levels for each profile of the LPA are displayed in Table S6. The reference

Table 4. Multinomial logistic regression predicting the likelihood of belonging to each profile (relative to the *Climate Believer Concerned* profile) as a function of demographic and socio-psychological predictors in time 10 (2018).

	Climate Sceptics (vs. Climate Believer Concerned)			Somewhat Climate Believer Concerned (vs. Climate Believer Concerned)			Moderate Climate Believer Concerned (vs. Climate Believer Concerned)			Undecided/Neutral (vs. Climate Believer Concerned)		
	B	*SE*	Odds Ratio	*B*	*SE*	Odds Ratio	*B*	*SE*	Odds Ratio	*B*	*SE*	Odds Ratio
Gender[a]	0.49***	0.06	1.64	−0.04	0.04	0.96	0.10**	0.03	1.11	0.13**	0.05	1.14
Age	0.02**	0.00	1.02	0.00	0.00	1.00	0.01***	0.00	1.01	0.01***	0.00	1.01
NZ European[b]	0.49***	0.10	1.63	0.46***	0.07	1.59	0.30***	0.05	1.35	0.40***	0.07	1.49
Parent[c]	0.23**	0.08	1.25	0.27***	0.05	1.31	0.13***	0.04	1.14	0.27***	0.05	1.31
Education Level	−0.11***	0.01	0.89	−0.05***	0.01	0.95	−0.04***	0.01	0.96	−0.11***	0.01	0.90
Income	−0.02**	0.01	0.99	−0.01**	0.00	0.99	−0.00**	0.00	1.00	−0.01**	0.00	0.99
Religious[d]	0.23***	0.07	1.26	0.01	0.05	1.01	−0.02	0.03	0.98	0.07	0.05	1.08
Employment[e]	0.11	0.08	1.12	0.28***	0.05	1.32	0.23***	0.04	1.26	0.22***	0.05	1.25
Conservative Political Orientation	0.52***	0.03	1.68	0.27***	0.02	1.31	0.19***	0.01	1.21	0.34***	0.02	1.41
Extraversion	0.07*	0.03	1.07	0.01	0.02	1.01	0.01	0.01	1.01	0.05*	0.02	1.05
Agreeableness	−0.10**	0.04	0.90	−0.06**	0.02	0.94	−0.05**	0.02	0.95	−0.04	0.02	0.96
Conscientiousness	−0.03	0.03	0.97	−0.12***	0.02	0.89	−0.06***	0.01	0.95	−0.03	0.02	0.97
Neuroticism	−0.05	0.03	0.96	−0.05**	0.02	0.95	−0.05***	0.01	0.96	−0.07***	0.02	0.93
Openness	−0.06	0.03	0.94	−0.13***	0.02	0.88	−0.12***	0.01	0.89	−0.09***	0.02	0.91
Honesty-Humility	0.09**	0.03	1.10	−0.03	0.02	0.97	−0.05***	0.01	0.95	0.01	0.02	1.01
SDO	0.83***	0.04	2.30	0.70***	0.02	2.02	0.50***	0.02	1.65	0.72***	0.02	2.04
RWA	0.45***	0.04	1.56	0.39***	0.02	1.47	0.31***	0.02	1.37	0.41***	0.02	1.51

Note: $N = 45{,}430$. LL = −177698.55; AIC = 355441.09; BIC = 355633.02; aBIC = 355563.10. Ent = 0.99. [a]Gender was dummy-coded (0 = female; 1 = male). [b]NZ European (0 = all other ethnicities; 1 = NZ European). [c]Parental status was dummy-coded (0 = no children, 1 = parent). [d]Religious status was dummy-coded (0 = non-religious, 1 = religious). [e]Employment was dummy-coded (0 = unemployed, 1 = employed). SDO = social dominance orientation. RWA = right-wing authoritarianism. *B* = unstandardized regression coefficient. *SE* = standard error. *$p < .05$; **$p < .01$; ***$p < .001$.

profile for the analysis was the profile with the highest agreement with each of the climate change items (i.e. *Climate Believer Concerned*).

Of the demographic predictors, non-New Zealand Europeans, individuals with no children, individuals with a higher education, and individuals with a higher income were all *more* likely to be a member of the *Climate Believer Concerned* profile than every other profile ($Bs \geq 0.30$, $ps < .001$, $Bs \geq 0.13$, $ps < .001$, $Bs \geq -0.04$, $ps < .001$, and $Bs \geq -0.00$, $ps < .01$, respectively). In addition, men and older individuals were *more* likely to be a member of every profile, excluding the *Somewhat Climate Believer Concerned* profile, relative to the *Climate Believer Concerned* profile ($Bs \geq 0.10$, $ps < .01$, and $Bs \geq 0.01$, $ps < .01$, respectively). Employment was also predictive of membership in three profiles. Specifically, employed individuals were *more* likely to be a member of the *Somewhat Climate Believer Concerned* profile, the *Moderate Climate Believer Concerned* profile, and the *Undecided/Neutral* profile relative to the *Climate Believer Concerned* profile ($Bs \geq 0.22$, $ps < .001$).

Regarding the psychological variables, profile membership was most consistently predicted by political orientation, SDO, and RWA. More specifically, in comparison to their peers, individuals with higher levels of conservative political orientation, SDO and RWA were *more* likely to be a member of every other profile compared to the *Climate Believer Concerned* profile ($Bs \geq 0.19$, $ps < .001$, $Bs \geq 0.50$, $ps < .001$, and $Bs \geq 0.31$, $ps < .001$, respectively). Apart from Openness to Experience showing somewhat consistent effects, personality traits inconsistently predicted profile membership.

Contrasting the profiles with higher and lower climate change beliefs and concern, a very clear pattern emerges (see the first profile comparison in Table 1 with odds ratio above 1.20). New Zealanders more likely to be a member of the *Climate Sceptics* profile are male, New Zealand European, parents, religious, conservative in their political orientation, and have higher levels of RWA and SDO ($Bs \geq 0.23$, $ps < .01$). For example, holding the other predictors constant, the odds of belonging to the *Climate Sceptics* profile (as opposed to the *Climate Believer Concerned* profile) were 1.63 times higher for New Zealand Europeans than ethnic minorities. Members of these contrasting profiles are also likely to differ in their education level, income, and certain personality traits (see other statistically significant effects, $ps < .05$, in the first profile comparison in Table 1). That is, there is a trend for members of the *Climate Sceptics* profile to be less educated, have lower income, to have more Extraversion ('the life of the party') and Honesty-Humility ('feel entitled to more of everything') traits, and have lower Agreeableness traits ('sympathize with others' feelings'). Notably, the strongest predictor of profile membership was SDO, indicating that members of the *Climate Sceptics* profile are more prone to support and justify social systems that maintain and reinforce group-based hierarchies.

Discussion

Using large national data of citizens who partake in the New Zealand Attitudes and Values Study (NZAVS; $N = 34{,}733$), we examined segmentation profiles around beliefs in the reality and human causes of climate change as well as concern about this issue, the probabilities of transitioning to and from profiles over the one-year period examined (from 2018 to 2019), and the demographic and socio-psychological characteristics of individuals belonging to the identified profiles using 2018 data ($N = 45{,}430$). Here we

review the key findings and indicate how the results replicate and extend previous research.

First, our results indicated five profiles of New Zealanders with varying levels of climate change beliefs and concern (see Figure 1). Notably, the two largest segmentation profiles comprised New Zealanders with comparatively high levels of belief and concern about anthropogenic climate change, which represented 79.4% of our sample. This indicates that the vast majority of New Zealanders believe in the reality of climate change, its human cause and are concerned about it. These findings align with other national studies (e.g. Thaker 2021; Abrahamse et al. in press), demonstrating a very high level of consensus in the New Zealand population regarding the climate crisis.

It is worth noting that the 5-profile solution we observed departs from those reported by Sibley and Kurz (2013) who identified four profiles when considering the two climate change beliefs. We observed that each profile represents a higher level of each of the three variables than the subsequent profile (see Figure 1), which is distinct from the 4-profile solution reported by Sibley and Kurz (2013); in particular, they observed one profile comprising 6.7% of respondents with high levels of belief in the reality of climate change but low levels of belief in human causation. This high-reality/low-causation profile was not replicated in our analysis. Perhaps this finding and the increase in profile numbers suggest that including the climate concern item adds variability in profile membership. An inspection of Figure 1 clearly indicates that levels of climate concern are lower than climate change belief levels, particularly for the profiles with higher agreement regarding climate reality and human causation. One possible explanation for the comparatively low levels of climate concern might be the inclusion of 'deeply' in the wording of the climate concern item, which might make respondents express their levels of concern more cautiously.

However, additional results reported in the Supplementary Material indicate that a 5-profile solution also emerges when the climate concern item is excluded, and that the high-reality/low-causation profile observed by Sibley and Kurz (2013) does not emerge even when forcing a 4-profile model. In conjunction, our findings indicate that a segmentation profile characterised by a comparatively higher level of belief in the reality of climate change and a comparatively lower level of belief in anthropogenic climate change no longer emerge in the New Zealand population. Perhaps this can be explained by differences in the period the data were collected and sample size. The 4-profile reported by Sibley and Kurz (2013) emerged from 2009 data with 6,072 respondents while our 5-profile emerged from 2018 to 2019 data with 34,733 respondents. It is likely that back in 2009 New Zealanders were still forming their attitudes about climate change, but things have now stabilised into consistent belief or disbelief. As a result, these two climate change beliefs are much more aligned in the New Zealand population, meaning that an individual who believe in the reality of climate change is also likely to believe in human causation, and vice-versa. This is supported by an observed increase in the correlation between these two climate change beliefs – Sibley and Kurz (2013) reported a .54 correlation while we observed correlations above .68 (see Table S2) – and by previous findings indicating an overall increase in the levels of these climate change beliefs across the New Zealand population (Milfont et al., 2021b).

Returning to the importance of including the climate concern item, the present study focused on a person-centred analysis to identify segments of the New Zealand population

who respond similarly to items measuring climate change beliefs and concern while differing from other subgroups of the population. Future studies could employ a variable-centred analysis to investigate the longitudinal relationships between climate change beliefs and concern. Both climate change beliefs and concern have downstream impacts on other variables (e.g. Milfont 2012a), so it is reasonable to expect bi-directional associations between these variables, meaning that higher levels of climate change beliefs and concern at a particular time point would lead to subsequent increases in these variables at another measurement point.

Second, we report novel findings regarding the probability of individuals to transition to and from the observed climate profiles over the one-year period (see Figure 1). The profile with the highest levels of climate change beliefs and concern was the most stable, with members in this *Climate Believer Concerned* profile having an 82.7% chance of staying in this profile over one year. This is positive and indicates that individuals who believe in the reality of anthropogenic climate change and are concerned about it would likely remain convinced and concerned at another point in time, which might motivate them to act. It is worth noting that the second most stable profile comprised members of the *Climate Sceptics* profile, with an 53.9% chance of staying in this profile over one year. Although this finding suggests an entrenched position, it is calibrated by two important observations: (1) climate sceptics represents a very small proportion of the New Zealand population (3.7%; at least when considering NZAVS respondents), and (2) members of this profile transitioned to other profiles in the one-year period, with a particularly high probability of transitioning (25.3%) to the *Undecided/Neutral* profile. This affords some optimism that the existing majority of New Zealanders who accept the reality of anthropogenic climate change and are concern about it will increase further. It remains to be seen whether climate change beliefs and concern upheld by the majority will lead to mitigation and adaptation actions, but previous findings indicating that the national environmental identity prevalent in New Zealand is associated with pro-environmentalism (Milfont et al. 2020) provides some hope.

Our final set of analysis examined the underlying demographic and socio-psychological variables associated with profile membership. We considered several variables that have been useful in characterising climate segmentation profiles in the New Zealand population (Milfont et al. 2015; Thaker 2021; Athy et al. 2022). When examining the consistent predictors of profile membership, our findings indicate that non-New Zealand Europeans, individuals with a higher education, individuals with a higher income, individuals with a more liberal political orientation and those with lower endorsement of system-justifying ideologies (as indexed by SDO and RWA) were all *more* likely to be a member of the profile with the highest levels of climate change beliefs and concern. Compared to this group, members of the *Climate Sceptics* profile are more likely to be male, New Zealand European, parents, religious, and to endorse conservative and system-justifying ideologies that are expected to perpetuate a hierarchical social system. Overall, these findings replicate past studies showing that climate change denial is more prevalent among a certain subgroup of the population in New Zealand and elsewhere (McCright and Dunlap 2011; Milfont et al. 2015; Hornsey et al. 2016; Jylhä et al. 2016; Abrahamse et al. in press).

Notably, our findings support previous observations that denial or scepticism of climate change is motivated by a desire to maintain current societal structures (McCright

and Dunlap 2011; Milfont et al. 2013, 2021a; Milfont and Sibley 2014; Jylhä et al. 2016). This is particularly illustrated by the high predictive power of SDO in explaining membership in the *Climate Sceptics* profile. The results reported in Table 1 indicate that, holding the other predictors constant, the odds of belonging to the *Climate Sceptics* profile (as opposed to the *Climate Believer Concerned* profile) were 2.3 times higher for New Zealanders with high SDO. Following previous work (e.g. Pratto, Sidanius, and Levin 2006), we use 'high SDO' to refer to respondents who are higher than their peers in SDO, irrespective of their absolute scores on the SDO scale. Individuals with high SDO are more likely to endorse group-based hierarchy and the domination of 'inferior' groups by 'superior' groups. Reactance to climate mitigation and adaptation efforts by this subgroup of the population makes sense when understood as a confrontation to changing the status quo and undermining social hierarchies as has been shown experimentally (Milfont and Sibley 2014). The importance of SDO for climate change denial is further enhanced by the observation that this psychological variable helps explain gender differences in attitudes towards environmental protection (Milfont et al. 2013, Study 4; Milfont and Sibley 2016), meaning that male individuals might be more prone to climate change denial because they uphold higher levels of SDO compared to their female counterparts.

In conclusion, our findings indicate that the majority the New Zealand population believe in and are concerned about anthropogenic climate change and that they tend to hold these beliefs and concern stably over time. These New Zealanders are more likely to be non-New Zealand European, politically liberal, have higher levels of education and income, and exhibit lower endorsement of system-justifying ideologies. Noticeably, a desire to dominate and be superior to others is the main predictor of membership in the climate change denial segment of the population, which fortunately represents a minority of the New Zealanders in our sample. However, although representing a minority, the demographic and socio-psychological characteristics of individuals within the climate change denial profile are often overrepresented in powerful socio-economic positions in society, meaning that their denial can be extremely consequential in delaying action (see Lamb et al. 2020). We hope our findings will lead to further discussions on ways to foster individual and collective efforts to embark on the transformational changes needed to mitigate and adapt to climate change.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Templeton Religion Trust [grant number TRT0196].

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