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Are we measuring concern about global climate change correctly? Testing a novel measurement approach with the data from 28 countries

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Abstract The aim of this study is to test the Campbell paradigm (Kaiser et al. 2010) as a novel theoretical framework for the measurement of concern about global climate change and to compare this measurement approach with conventional assessment of GCC concern which is based exclusively on evaluative rating of global climate change concern. Using survey data from 28 European countries (N = 27,919), we find that GCC concern can be inferred not just from evaluative statements related to GCC, as is done in conventional measures, but also from other types of attitude-relevant responses (such as self-reports of mitigation activities and evaluation of mitigation policies). In addition, we also find that even though Campbellian measure is related in a theoretically expected way to conventional evaluative scale of GCC concern, and both measures assess the same latent construct, the former measure can predict difficult mitigation activity whereas the evaluative scale fails in this test of criterion validity. The poor performance of the conventional evaluative measure of GCC concern is due to the relative easiness of evaluative items that makes this measure insensitive to higher levels of GCC concern.

Keywords Global climate change concern · Global climate change attitude · The Campbell paradigm · Attitude measurement · Rasch model

Concern about global climate change (GCC) is an important concept that appears in literature on public perception of GCC (e.g., Krosnick et al. 2006; O'Connor et al. 1999) and which has been traced in opinion polls for several decades (e.g., European Commission 2014; Pidgeon and Fischhoff 2011). Conventional measures of GCC concern are typically based on cognitive and affective evaluations (e.g., Arbuckle et al. 2015; Dienes 2015; Leiserowitz 2006).

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The problem of evaluative attitudinal measures is that evaluations are relatively easy response outcomes when compared to other type of responses such as behavioral self-reports (Byrka and Kaiser 2013; Kaiser et al. 2010). As a consequence, evaluative measures have restricted ability to assess high levels of attitudes, which can result in their deficiency in terms of criterion validity (Kaiser and Byrka 2015).

Returning to the classical notion of attitudes as tendencies that are manifested not just in cognitive and affective responses, but also in conative responses (e.g., Rosenberg and Hovland 1960), and building on the attitude measurement theory of the Campbell paradigm (Kaiser et al. 2010), we propose and empirically test an alternative approach to measurement of GCC concern with the survey data from 28 European countries (N = 27,919). Specifically, we hypothesize that Campbellian measure of GCC concern is related in a theoretically expected way to conventional evaluative measure of GCC concern and measures the same latent construct. In addition, we also expect that a Campbellian measure of GCC concern can differentiate between people who engage in relatively demanding mitigation activity, whereas a conventional evaluative measure of GCC concern will perform substantially worse in this test of criterion validity. This failure of the conventional evaluative scale has to do with the relative easiness of evaluative rating of GCC concern, which cannot be used to discriminate between persons holding relatively high levels of GCC concern. As far as we are aware, this is the first attempt to calibrate a Campbellian measure of GCC concern and compare its validity with a conventional evaluative measure, and also the first study that tests this measurement approach on such a large multi-country dataset.

1 Conventional measures of concern about global climate change

Conventional measures of concern about GCC are based exclusively on evaluative statements reflecting the notion of attitudes restricted to evaluative tendencies (e.g., Albarracín et al. 2005). Some of these measures elicit *affective evaluations* (by letting people evaluate the level of their concern or worry) related either to global climate change in general (e.g., Dienes 2015; Spence et al. 2011), its general impacts (e.g., Leiserowitz 2005), or its specific impacts (such as water shortages or the spread of diseases) on the global or local level (e.g., Haden et al. 2012). Other measures of concern about GCC are based on *cognitive evaluations* of the likelihood of global change impacts (e.g., Leiserowitz 2006; O'Connor et al. 1999), rating of the seriousness of GCC as a whole (e.g., Wicker and Becken 2013) or its impacts (e.g., Leiserowitz 2005). Several measures combine evaluations of the likelihood and seriousness of GCC impacts (e.g., Krosnick et al. 2006). Still other measures of GCC concern combine *cognitive* and *affective evaluations* (e.g., Arbuckle et al. 2015; Leiserowitz 2006; Tobler et al. 2012), which seems warranted by the fact that such items apparently measure the same construct (viz. Leiserowitz 2006; Tobler et al. 2012). The differentiation that many scales make between concern about global, societal and local-level impacts of GCC seems to be relatively less important from the measurement point of view because these different aspects of GCC concern are empirically closely related (Spence et al. 2012).

One potential weakness of GCC concern measures based exclusively on evaluative items stems from the fact that evaluative items, as opposed to behavioral self-reports, have been shown to be rather easy items (Byrka and Kaiser 2013; Kaiser et al. 2010). In addition, elicitation of concern about some phenomenon seems to tap only less intense degrees of the underlying attitudinal construct, even in comparison to alternative evaluative items that elicit

fear or worry (Wright and Masters 1982, pp. 137–147). As a result of the restricted difficulty of evaluative statements, evaluative measures can have lower criterion validity when compared to measures that are based on items with a wider range of outcome difficulties, such as behavioral self-reports (for an empirical demonstration of this phenomenon, see Kaiser and Byrka 2015).

2 The Campbell paradigm

The Campbell paradigm (Kaiser et al. 2010) is a novel attitude theory that proposes a view of attitudes that contrasts with conventional attitude theories (cf. Albarracín et al. 2005) by arguing that attitudes are manifested in a wider range of responses that include not just evaluative statements, but also behavioral self-reports, behavioral intentions, observed locomotor responses, and possibly also other attitude-relevant responses. Each of these manifestations has a specific difficulty that can suppress manifestation of a particular attitude-relevant response. If a person's attitude is strong, he or she will manifest a wide range of attitude-relevant responses. Conversely, if a person's attitude is rather weak, he or she will manifest only relatively easy attitude-relevant responses and not those that are more difficult. Consequently, a person's attitude level can be inferred from the number and difficulty of attitude-relevant responses that he or she manifests. Campbellian assessment of attitudes is somewhat similar to the testing of abilities (e.g., math ability) whereby a person's ability can be inferred from the difficulty of tests (e.g., math exercises) that a particular person can correctly answer. Both a person's attitude and the difficulty of a particular response (test item) are latent unobserved properties that can be estimated from observed attitude-relevant outcomes (i.e., responses in questionnaires as well as overt behavior).

Unobserved difficulties of attitude-relevant responses mirror differential behavioral costs (e.g., personal effort, time, financial expenses, sanctioning by social norms etc.) that are associated with each outcome (Scheuthle et al. 2005) in line with the notion that situational influences make some actions relatively easy and others more difficult (Guagnano et al. 1995; Tanner 1999). Campbellian research has revealed that differential outcome difficulties can be fairly uniform within the cultural context of national states (Kaiser and Biel 2000; Scheuthle et al. 2005), but there is some evidence that they may also vary even within states as a function of environmental conditions (Kaiser and Wilson 2000), or as a function of infrastructure development and social climate (Kaiser and Keller 2001).

In spite of its relative recency, the Campbell paradigm has received considerable empirical support as a theoretical framework for the measurement of environmental attitudes (Kaiser et al. 2014a, b; Kaiser et al. 2014a, b; Kaiser and Byrka 2015; Kaiser et al. 2010; Kaiser et al. 2013; Kaiser et al. 2007) that results in measures with good predictive (Kaiser and Byrka 2015), discriminant and convergent validity (Kaiser et al. 2013). Other studies have successfully employed the Campbell paradigm as a framework for the measurement of attitudes to personal health (Byrka and Kaiser 2013), to nature (Brügger et al. 2011; Roczen et al. 2012), the tendency towards exploitive utilization and preservation of nature (Kibbe et al. 2014), and the need for recovery (Smolders et al. 2012).

Recent findings that evaluative statements are less variable and generally easier in terms of their implicit difficulties than related behavioral self-reports (Kaiser et al. 2010; Byrka and Kaiser 2013; but see also Campbell 1963) imply that evaluative attitudinal measures should be somewhat constrained in terms of their discrimination, especially at the higher levels of the underlying latent variable. Although only few tests have been conducted that would compare

performance of Campbellian attitude measures with that of conventional evaluative measures, the results available up to now point to the superiority of the former measurement approach. For instance, it has been shown that a Campbellian measure of environmental attitude predicted relatively difficult ecological behavior (vegetarianism), whereas the conventional evaluative measure did not (Kaiser and Byrka 2015). In a similar vein, Campbellian measure of environmental attitude has been repeatedly found to predict an individual carbon footprint (Arnold et al. 2015b; Urban 2015), something which has not been found with conventional evaluative measures of environmental attitude (Buchanan 2011; Csutora 2012). No similar tests have been conducted with a Campbellian measure of GCC concern. However, the results of a previous study indicate that Campbellian measure of environmental attitude has been found to correlate strongly with acceptance of GCC and its anthropogenic causes (Arnold et al. 2015 quoted in Ranney and Clark 2016, p. 54), suggesting that a Campbellian measurement approach can be useful for measurement of GCC concern as well.

3 Research goals

Our goal is to test empirically the Campbell paradigm (Kaiser et al. 2010) as a theoretical framework for measurement of GCC concern using data from a large cross-cultural survey conducted in 28 European countries. Following the logic of the Campbell paradigm, we propose an ad-hoc measure of concern about GCC based on pool of evaluative items combined with self-reports of mitigation actions and we test empirically whether such a measure truly measures only one latent construct. In the next step, we demonstrate that such novel measure of GCC concern is related to a conventional measure of concern in a theoretically expected way, but that the former measure has superior criterion validity because it can differentiate between people who engage in difficult mitigation activity (installation of renewables in one's home), whereas the conventional evaluative scale of GCC concern fails this test. Finally, we show that inability of the conventional scale of concern to differentiate correctly between people holding high levels of GCC concern has to do with the relative easiness of evaluative statements in general and evaluative rating of GCC concern in particular.

4 Method

4.1 Participants and procedures

The data for this study come from the Special Eurobarometer 409 survey which was conducted in November and December 2013 by professional opinion poll companies on samples of national populations of 28 European countries (the dataset can be retrieved for free from the GESIS database, www.gesis.org). Stratified random sampling was used to select country-specific samples of respondents (N = 500–1600) from national populations of residents aged 15+ (for details on the sampling procedure, see European Commission 2014).

Samples of respondents from 28 European countries differed considerably in terms of proportion of males (38.8 %–50.6 %), average age (42.9–57.1), and the proportion of people who finished their full-time studies at age of 20 or at a higher age (18.6 %–80.3 %) taken as a proxy for tertiary education (see Appendix 1 of the Supplemental Materials). We did not apply ex-post weights to remedy minor discrepancies between characteristics of national populations

and respective samples because the purpose of the present study was not to estimate population parameters but, rather, to test a general theory that should hold in any sub-sample of the population under the condition that the sub-sample is sufficiently varied.

4.2 Measures

4.2.1 Evaluative scale of GCC concern

Stated concern about GCC is assessed with a one-item cognitive evaluative measure that asks the respondent to evaluate the seriousness of GCC as a problem at the present moment on a 10-point Likert scale with anchored response categories 1 ("Not at all a serious problem"), and 10 ("An extremely serious problem"). Similar measures of environmental concern based on cognitive evaluations of the seriousness of GCC or its impacts have been used in previous studies (e.g., Krosnick et al. 2006; Leiserowitz 2005; Wicker and Becken 2013).

4.2.2 Campbellian measure of GCC concern

Our Campbellian measure of GCC concern comprises a set of 10 self-reports of mitigation activities and 4 evaluative statements related to GCC (for verbatim and coding of items, see Appendix 2 of the Supplemental Materials). Behavioral self-reports tap purchase of a fuel-efficient car, use of environmentally friendly modes of transportation, insulation of home, purchase of a low-energy home, purchase of energy-efficient appliances, choice of an energy-supplier which offers energy from renewable resources, purchase of locally produced and seasonal food, avoidance of short-haul flights, reduction and separation for recycling of waste, and reduction in consumption of disposable items. Behavioral self-reports took the form of a list of multiple-choice items out of which each respondent chose those that were applicable in his or her case.

Two of the evaluative items captured the respondent's perception of the effects of climate change policies and reduction in fossil fuel imports on the EU economy. Agreement with the statements was recorded using 4-point Likert scales (1 = *totally agree*, 2 = *tend to agree*, 3 = *tend to disagree*, 4 = *totally disagree*); responses were recoded prior to data analysis by collapsing the categories *totally agree* and *tend to agree* and the categories *tend to disagree* and *totally disagree*. The two remaining evaluative items captured perceived importance of national policies aimed at increasing the share of renewable energy and improving energy efficiency. Perceived importance of national policies was assessed using a 4-point Likert scale (1 = *very important*, 2 = fairly important, 3 = *not very important*, 4 = *not important at all*); responses were recoded prior to data analysis by collapsing the categories *totally agree* and *tend to agree*, and the categories *tend to disagree* and *totally disagree*. Note that such dichotomization has been shown to reduce measurement error in the Rasch attitude measurement model (viz. Kaiser and Wilson 2000).

4.2.3 Installation of renewable sources of energy in the home

Installation of renewables, an example of a relatively difficult mitigation behavior (e.g., Kaiser and Wilson 2004; Urban and Ščasný 2016), is measured by asking respondents whether they have installed equipment to generate renewable electricity in their homes. Respondents could answer "yes" or "no".

4.3 Statistical analyses

The expected unidimensionality of the Campbellian GCC concern measure is judged by the fit of the statistical model (Rasch model, viz. Bond and Fox 2012), which embodies theoretical assumptions of the Campbell paradigm (viz. Kaiser et al. 2010), to observed responses.

Under the Rasch model, the conditional probability of p-th person giving a positive answer on i-th item is a non-linear function of that individual's attitude level (unobserved GCC concern), θ_p, and the difficulty of that item (basically associated behavioral costs), δ_i, which can be formally expressed as follows,

$$prob\left(x_{i,p} = 1|\theta_p, \delta_i\right) = \frac{\exp\left(\theta_p - \delta_i\right)}{1 + \exp\left(\theta_p - \delta_i\right)} \quad (1)$$

The fit of the model to the data is measured by mean-square fit statistics (MS) which are based on the comparison of observed response values with those that are predicted by the model. MS fit statistics, which ranges between 0 and positive infinity and has a value of 1 for a perfectly fitting model, has an intuitive interpretation: MS value of $1 + x$ means that there is x% more (or less) variability in the data than what would be expected by the Rasch model. We the take threshold values of $0.7 < MS < 1.3$ and standardized case fit values of $|t| < 1.96$ as an indication of acceptable item and person fit as recommended by Bond and Fox (2012).

All data analysis is conducted in *R*, Rasch model estimation is done in *eRm* package in *R*.

5 Results

5.1 Evaluative scale of GCC concern

Average country-specific score of concern about GCC measured on the 10-point evaluative scale (1 = *GCC is not a serious problem*, 10 = *GCC is an extremely serious problem*) is somewhat high in all countries and ranges between 5.6 (Estonia) and 8.2 (Italy). Distribution of responses is left-skewed in all countries: the three lowest levels of environmental concern were chosen on average only by 1.8 %, 1.3 % and 3.0 % of respondents, whereas the three highest values on the scale were chosen by 20.1 %, 10.4 % and 19.0 % of respondents (in respective order of increasing concern (see Appendix 3 of the Supplemental Materials for details). The percentage of participants who could not answer this question was negligible (< 4 %) in all of the 28 countries.

OLS regression reveals that GCC concern assessed through the evaluative measure is statistically significantly higher among women and people with university-level education, even though these patterns are not statistically significant in all countries. The effects of other background variables are either not frequent enough across the pool of 28 countries to rule out the possibility that they are due to inflated type I error in repeated tests (effect of age), are running in both directions (type of living area, wealth, social class, and presence of children in the household), or are not statistically significant in any of the countries (household size; see Appendix 4 of the Supplemental Materials for details).

5.2 Campbellian measure of GCC concern

We now proceed to the calibration of the Campbellian measure of GCC concern composed on the 10 self-reports of mitigation actions and the 4 evaluations of climatic policies. The overall

fit of the evaluative and behavioral items to the Rasch model is very good in each of the 28 countries, M(MS) = 0.83–0.93, SD(MS) = 0.07–0.15, t = −2.72 to −1.16, SD(t) = 1.02–3.45, meaning that the items constitute a unidimensional measure of the latent construct, presumably GCC concern. The resulting measure contains between 7 % and 17 % less random variation than is expected by the Rasch model. Inspection of MS indices for individual items (for details, see Appendix 5 of the Supplemental Materials) reveals that none of the items exhibit excess of random variation, but several items have less random variation than expected by the Rasch model (MS = 0.59–1.23). Lack of random variation in individual items may signal redundancy of some items or their clustering (neither of which would be surprising considering the fact that we are conducting a secondary analysis on a pool of pre-existing items, but this does not invalidate an overall good item fit).

The fit statistics for participants, M(MS) = 0.84–0.96, SD(MS) = 0.35–0.61, t = −0.41 to −0.16, SD(t) = 1.02–1.20, suggest that responses observed on evaluative and behavioral items fit the expectations of the Rasch model well. We find that response patterns of the vast majority of participants (95 %–97 %, depending of the country) are in line with expectations of the Rasch model (t < 1.96). Reliability of the Campbellian measure is rather low as indicated by the low scale reliability (α = .49–.66) and low personal separation reliability (PSI = .50–.66). We return to this finding in the Discussion.

The difficulty of evaluative and behavioral statements varies considerably across the countries (see Appendix 5 of the Supplemental Materials), but the difficulty of evaluative statements (δ = −5.77 to −0.461) is somewhat lower than the difficulty of behavioral items (δ = −2.18 to +4.61). Although there is an overlap in difficulty of evaluative and behavioral items, we observe that in 14 out of the 28 countries the most difficult evaluative statement is still easier than the easiest behavioral item (see Appendix 5 of the Supplemental Materials for details).

OLS regression reveals several relatively consistent effects of background variables on GCC concern assessed through the Campbellian measure, even though these effects are not statistically significant in all countries. Specifically, females and highly educated people manifest higher level of GCC concern, whereas people belonging to lower social classes, those who are less wealthy, and older people (65+), but also very young people (15–29) are less concerned about GCC. Other patterns seem to be less clear across the countries. For instance, size of the household and presence of children in the household tend to have a statistically significant and positive effect in some countries, but such patterns are not frequent enough to rule out that they result from inflated type I error in repeated tests. Type of living area (i.e., rural area, small and middle-sized towns, and large towns) does not have a consistent effect across the 28 countries (see Appendix 6 of the Supplemental Materials for full details).

Correlation between conventional evaluative scale of environmental concern and the Campbellian measure is weak to moderate and statistically significant in all countries, rs(499–1538) = .07–.34, p < .05, except for one —Cyprus, rs(449) = .04, p = .332.

5.3 Criterion validity of the evaluative measure and Campbellian measure of GCC concern

We expect that people who engage in demanding climate change mitigation behavior, such as installation of renewable energy technologies in homes, should have, on average, a higher level of environmental concern than people who do not have renewables installed.

The average proportion of participants who installed renewables in their homes was generally very low in our sample and ranged between 1.2 % (Portugal) and 13 % (Belgium),

suggesting already that installation of renewables is a relatively difficult mitigation activity that only a minority of people undertake (see Table 1 for details). Because of the low proportion of those who installed renewables (and related larger variance of GCC concern in this group), and also due to the fact that the distribution of responses on the evaluative scale of GCC concern is left-skewed (see Appendix 3 of the Supplemental Materials for details), we used a non-parametric Mann-Whitney U test (rather than t-test) to compare levels of GCC concern between those who have and those who have not renewable technologies installed.

As expected, when we assess GCC concern with the Campbellian measure, we find that average concern level is smaller in the group of people who have not installed renewable energy technologies than in the group of people who have renewables installed in all but one country (Croatia; viz. Table 1). In addition, the Mann-Whithey U test suggests that the two groups have statistically different level of GCC concern ($p < .05$) in the theoretically expected direction in 18 out of the 28 countries (viz. Table 1). Note that observing, by chance, 18 significant results out of the total of 28 tests, each at significance level $\alpha = .05$, is extremely unlikely (binomial test, $p = 10^{-7}$).

To check for the possibility that differences in average concern levels inferred through the Campbellian measure are only spurious and due to background variables having an effect on both the concern indicators and the criterion variable (installation of renewables), we ran an ANCOVA model where a number of background variables (gender, age, type of area, household size, presence of children in the household, education, social class, and wealth) were included to account for differences in GCC concern. We found that differences in concern levels between those who installed renewables and those who did not persist, even after we controlled for background covariates, in 11 out of the 28 countries (see Appendix 7 of the Supplemental Materials for details). Such a result is remarkable considering the low variability of the criterion indicator (only a tiny proportion has installed renewables, see Table 1), which necessarily attenuates the relationship of the criterion variable and GCC concern. Statistically, observing 11 significant results ($\alpha = .05$) out of the 28 test is highly unlikely to be a result of chance (binomial test, $p < 10^{-6}$).

In contrast, when we employ evaluative scale, and compare the average level of GCC concern in the group of people which does not have renewables installed with the average level of concern in the group that has renewables installed, we find the theoretically expected pattern (i.e., smaller GCC concern in the group that does not have installed renewables) in only 16 out of the 28 countries, whereas the pattern is reversed (i.e., average GCC concern is smaller in the group of people which has renewables installed) and thus violates the theoretical expectation in the remaining 12 national samples. In addition, the Mann-Whithey U test shows that differences in GCC concern are not statistically significant across the countries, except for two countries (Belgium and Netherlands) where these differences are marginally statistically significant ($.1 > p > .05$) and run in the expected direction (viz. Table 1). Observing two marginally significant results ($\alpha = .1$) out of the total of 28 tests by chance is highly likely (binomial test, $p = .75$) suggesting that the evaluative scale does not differentiate between the two groups better than chance. Note that statistically significant patterns observed in the two countries did not survive the ANCOVA test similar to the one conducted for the Campbellian measure (see Appendix 8 of the Supplemental Materials for details).

5.4 Same latent construct revealed in the two GCC concern measures

Based on the Campbell paradigm, we still expect that conventional measure of GCC concern and the Campbellian measure of GCC concern do, in fact, measure the same latent construct.

Table 1 Comparison of GCC concern scores measured with Campbellian and evaluative measures in the group of people who have renewable installed and those who do not

	Campbellian measure				Evaluative scale				Proportion of participants who installed renewables [%]
	Mean level of concern		Mann-Whithey		Mean level of concern		Mann-Whithey		
	Renewables not installed	Renewables installed	U	P	Renewables not installed	Renewables installed	U	P	
Austria	-0.22	-0.01	37,263	.421	7.85	7.58	43,154	.091	8.4
Belgium	-0.21	0.27	51,125	< .001	7.16	7.46	58,776	.062	13.0
Bulgaria	-1.54	-0.58	3407	.012	7.60	7.82	4886	.690	1.2
Croatia	-0.94	-1.20	14,458	.196	7.41	7.04	13,941	.341	2.6
Cyprus (Rep.)	-1.07	-0.10	3461	.015	7.72	7.52	5274	.650	4.2
Czech Republic	-0.73	-0.48	13,152	.203	7.32	7.58	13,766	.392	3.1
Denmark	0.03	0.21	48,505	.046	6.77	6.79	53,550	.800	12.2
Estonia	-0.70	-0.29	6823	.104	5.63	5.67	8401	.868	1.8
Finland	-0.44	-0.05	25,077	.033	6.48	6.36	30,284	.739	6.8
France	-0.48	0.01	18,549	.016	7.08	7.21	21,725	.491	4.7
Germany	-0.17	0.44	65,383	< .001	7.59	7.63	87,139	.623	7.8
Greece	-0.82	-0.44	9378	.297	8.06	8.05	10,673	.949	2.2
Hungary	-0.85	-0.84	8439	.990	8.00	7.47	9205	.438	1.7
Ireland	-0.67	0.04	24,354	.002	6.59	6.39	32,589	.315	6.8
Italy	-0.66	-0.29	23,356	.050	8.22	8.36	25,013	.251	5.8
Latvia	-1.18	-0.85	7835	.131	6.02	6.60	8184	.265	2.0
Lithuania	-1.37	-0.83	5771	.147	7.10	7.00	7469	.864	1.5
Luxembourg	0.12	0.39	9922	.129	7.29	7.14	11,668	.568	9.9
Malta	-0.40	0.40	7090	.002	7.58	7.88	9006	.460	8.6
Netherlands	-0.17	0.26	32,219	.004	6.50	6.95	34,726	.064	8.2
Poland	-1.17	-0.91	13,927	.837	7.08	6.90	14,506	.489	3.1
Portugal	-1.05	-0.07	3739	.018	7.91	8.42	5011	.284	1.2

Table 1 (continued)

	Campbellian measure				Evaluative scale				Proportion of participants who installed renewables [%]
	Mean level of concern		Mann-Whithey		Mean level of concern		Mann-Whithey		
	Renewables not installed	Renewables installed	U	P	Renewables not installed	Renewables installed	U	P	
Romania	-1.30	-0.64	6347	.043	7.22	7.59	6792	.305	1.8
Slovakia	-0.88	-0.09	5301	.010	7.96	8.47	6894	.233	1.7
Slovenia	-0.24	0.52	23,937	< .001	7.71	7.66	36,610	.897	6.5
Spain	-0.71	0.15	10,293	< .001	7.96	8.18	15,683	.731	3.4
Sweden	0.13	0.64	27,933	< .001	7.24	7.11	38,436	.456	7.8
Unit. Kingdom	-0.36	0.31	29,063	< .001	6.06	6.49	34,888	.187	4.8

The lack of strong correlation between the two measures of GCC concern and the restricted ability of the conventional evaluative measure to differentiate adequately between the high levels of GCC concern that we have seen so far is due to the relative easiness of the evaluative scale of GCC concern. To test this general hypothesis, we fit the 14 items of the original Campbellian GCC concern measure together with the dichotomized score on the evaluative scale (values > 5 coded as 1 and 0 otherwise) and the item that captures installation of renewables as a one-dimensional Rasch-calibrated measurement model.

Our results support this hypothesis quite well. We find that adding the two additional items improved the reliability of the original measure (average reliability improvement across the countries: $\Delta\alpha$ = .015; ΔPSI = .021; α increased in 25 out of 28 countries, PSI increased in 27 out of 28 countries) and that the fit of all items was very good, M(MS) = 0.84–0.93, SD(MS) = 0.07–0.13, M(t) = −2.46 to −1.01, SD(t) = 0.98–3.39 (see also Appendix 9 of the Supplemental Materials for details of item MS fit indices). Importantly, the fit of the evaluative item to the scale was sufficient, M(MS) = 0.842–1.195, suggesting that this item measures the same construct as the remaining items. Person fit statistics are also sufficient, M(MS) = 0.85–0.97, SD(MS) = 0.32–0.60, M(t) = −0.40 to −0.14, SD(t) = 1–1.24, and only a negligible proportion of responses (between 2 % and 5 %) in each of the national samples deviates from the expectations of the measurement model ($t > 1.96$). Consistent with the Campbell paradigm, we also observe that estimated difficulties of the evaluative item are on average very low (−3.46 to −0.77 on the logit scale) compared to the difficulty of the installation of renewables (+2.03 to +3.89 on the logit scale).

6 Discussion

The purpose of the present study was to test the Campbell paradigm (Kaiser et al. 2010) as a theoretical framework for measurement of concern about global climate change. Using survey data from 28 European countries, we have corroborated the Campbellian measurement approach and shown its superiority, in terms of criterion validity, over conventional measurement of GCC concern that is based exclusively on evaluative statements. Consistent with the prediction of the Campbell paradigm (Byrka and Kaiser 2013; Kaiser et al. 2010), we have found that concern about GCC can be inferred not just from evaluative statements related to GCC (e.g., Arbuckle et al. 2015; Leiserowitz 2006), but also from other types of attitude-relevant responses (such as self-reports of mitigation activities and evaluation of mitigation policies) provided differential difficulties of these responses are taken into account in the measurement model. Moreover, we have also demonstrated that although evaluations and behavioral self-reports are indicative of the same attitude (concern about GCC), evaluative statements related to GCC are generally easier than behavioral self-reports of mitigation activities (for similar results in the context of environmental protection and health care, see Byrka and Kaiser 2013; Kaiser et al. 2010). These differential difficulties result in a non-linear relationship between the two types of responses and can produce attenuated correlations between mitigation activities and evaluative measures of GCC concern observed in some previous studies (e.g., Tobler et al. 2012; Wicker and Becken 2013). As we have also shown, the generally low difficulty of evaluative statements makes the conventional evaluative measure of GCC concern less sensitive to higher levels of concern, which leads to it failing the criterion validity test.

Attitude measurement grounded in the Campbell paradigm contrasts with some contemporary attitude theories that restrict the notion of attitudes only to evaluative tendencies (Albarracín et al. 2005; Eagly and Chaiken 1993; Fishbein and Ajzen 2010). One should

recognize though that Campbellian attitude measures that infer attitudes not just from evaluative statements, but also from behavioral self reports (e.g., Byrka and Kaiser 2013; Kaiser et al. 2007; Roczen et al. 2012), are actually returning to the traditional notion in social psychology that attitudes are manifested in cognitive, affective and conative responses (e.g., Rosenberg and Hovland 1960). Also of note is that formally similar attitude measures combining behavioral self-reports and evaluative statements as Rasch scales have become popular in psychometrics and education psychology in recent years (e.g., Howard et al. 2014; Papanastasiou and Schumacker 2014; Rojas Tejada et al. 2011), even though they are not necessarily grounded on the Campbell paradigm. An important advantage of the use of the Campbell paradigm for attitude measurement is that it links the measurement model with explicitly formulated attitude theory (viz. Kaiser et al. 2010). An additional advantage of the Campbell paradigm is that its measurement model (Rasch model) represents a stronger measurement theory than the classical test theory (Embretson and Reise 2000) and provides strong theoretical framework for linking and comparison of measurement scores across populations and across individuals (e.g., Wolfe 2000).

Previous studies that have demonstrated the superiority of a Campbellian attitude measure over conventional evaluative measures in terms of predictive validity (Kaiser and Byrka 2015), the relevance of a Campbellian attitude measure for prediction of individual carbon footprint (Arnold et al. 2015b; Urban 2015), and also the empirical relationship between a Campbellian measure of environmental attitude and the acceptance of the existence of GCC and its anthropogenic causes (Arnold et al. 2015 quoted in Ranney and Clark 2016, p. 54). The present study adds to this literature by showing, for the first time and across the pool of 28 countries, that attitude to GCC can be inferred from evaluative and behavioral statements related to GCC, that such measure is unidimensional and is related to conventional measure of GCC in a theoretically expected way and also that such Campbellian measure outperforms a conventional evaluative scale in that it can correctly assess even higher levels of GCC concern.

Validity of the Campbellian measure of GCC concern used in this study is supported also by the fact that its scores relate to socio-demographic background variables in an expected way. Specifically, we found females, the highly educated and wealthier people to be relatively more concerned, and older people comparatively less concerned about GCC, consistent with the results of previous empirical studies (see meta-analysis by Hornsey et al. 2016). These patterns were not fully recovered with the evaluative measure of GCC concern tested in this study.

It is important to note that the Campbell paradigm is not just an attitude measurement approach, but also an attitude theory that can be used to predict specific behavior as a function of a person's attitude level and the difficulty of particular behavior (Kaiser and Byrka 2011, 2015). For instance, if we know how difficult it is to support the adoption of a certain climatic policy (i.e., by voting for it), we can estimate for each person the probability of he or she supporting such a measure. This should be possible because, as this study shows, policy preferences are expressions of GCC concern.

The relatively low reliability of our Campbellian measure of GCC concern can be considered one of the limitations of the present study. The low reliability of this scale is hardly surprising considering its ad-hoc nature and the fact that it comprises only 14 items, whereas reliable Campbellian attitude measures consist of up to 50 items (e.g., Byrka and Kaiser 2013; Kaiser et al. 2014a, b; Kaiser and Byrka 2015). If anything, the low reliability of Campbellian measure works against our hypothesis by weakening the correlation between inferred concern and mitigation behavior. Low reliability does not invalidate our finding of unidimensional Campbellian attitude measure as evidenced by the very good fit of the Rasch model to the data.

Even though our ad-hoc measure is not suitable for very accurate measurement of GCC concern, it may serve as a starting point for the development of more reliable measure through successive stages of scale recalibration and scale revision (viz. Wilson 2005).

Obviously, the Campbellian measure of GCC concern presented in this study includes behavioral self-reports of mitigation action, rather than overt mitigation actions. In addition, the criterion validity test used in this study is based on self-report of mitigation action. Although recent meta-analysis has found behavioral self-reports to correlate highly with overt behavior (r = .46; for details see Kormos and Gifford 2014), it would be desirable to conduct additional criterion tests that would employ overt behavior as the criterion variable (for similar tests of Campbellian measure of environmental attitude, see Arnold et al. 2015b; Kaiser and Byrka 2015). Worth noting is also the fact that Cambellian measures of GCC concern can theoretically incorporate, besides behavioral self-reports, also indicators of overt behavior and – what is probably more practical for conventional surveys – behavioral traces (cf. Lewandowski and Strohmetz 2009). However, such measures have not been empirically developed yet.

Another limitation of this study lays in the fact that we compare our Campbellian measure with a one-item cognitive evaluative scale. Although similar measures of GCC concern have been used in previous studies (e.g., Leiserowitz 2006; O'Connor et al. 1999), one could argue that more elaborate measures assessing also the affective aspects of GCC concern (e.g., Dienes 2015; Spence et al. 2011) could fare better in terms of criterion validity. Regardless of these limitations, the present research clearly demonstrates that it is not necessary to restrict choice of indicators of GCC concern only to evaluative statements and that including behavioral self-report items in measures of GCC concern can actually increase their ability to differentiate between higher levels of GCC concern.

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