Co-benefits of addressing climate change can motivate action around the world

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Personal and political action on climate change is traditionally thought to be motivated by people accepting its reality and importance. However, convincing the public that climate change is real faces powerful ideological obstacles[1-4], and climate change is slipping in public importance in many countries[5,6]. Here we investigate a different approach, identifying whether potential co-benefits of addressing climate change[7] could motivate pro-environmental behavior around the world for both those convinced and unconvinced that climate change is real. We describe an integrated framework for assessing beliefs about co-benefits[8], distinguishing social conditions (e.g., pollution, disease, economic development), and community character (e.g., benevolence, competence). Data from all inhabited continents (24 countries; 6196 participants) showed that two co-benefit types, Development (economic and scientific advancement) and Benevolence (a more moral and caring community), motivated public, private, and financial actions to address climate change to a similar degree as believing climate change is important. Critically, relationships were similar for both convinced and unconvinced participants, showing that co-benefits can motivate action across ideological divides. These relationships were also independent of perceived climate change importance, and could not be explained by political ideology, age, or gender. Communicating co-benefits could motivate action on climate change where traditional approaches have stalled.

Those trying to motivate widespread action on climate change face two hurdles. The first is to convince enough people that climate change is real and important. The second is to move people from accepting its reality and importance to acting, both in pressuring their governments and in their personal lives. A single strategy has typically been used to

overcome both hurdles: present the science and consequences of climate change in more compelling ways[9].

This intuitive strategy was initially successful, but in many places progress has stalled or even reversed. Communicating climate science is now failing to persuade those who remain unconvinced climate change is real ("unconvinced", or climate skeptics)[10], and the public priority of climate change is declining in many countries[5,6]. These issues are strongly linked to political ideology[1-4], giving cause for pessimism – if people need to shift their basic political ideologies to act on climate change, the prospect for further progress is bleak.

New approaches are emerging that could sidestep these hurdles. One promising approach has been to highlight the co-benefits for society from acting on climate change[7], referring to community benefits resulting from mitigation behaviors. As examples, mitigation efforts can reduce pollution[11,12], support economic development through green industries[13,14], or benefit population health by reducing disease or promoting healthier lifestyles (e.g., cycling/walking instead of driving)[12,15,16]. A less obvious co-benefit involves community functioning, where climate change action can contribute to a more benevolent (caring and moral) community[8,17].

One advantage of co-benefits is that they can appeal to people unconvinced or unconcerned about climate change, as they do not depend on believing climate change is real or important. However, two challenges remain for establishing their effectiveness in motivating public action. First, researchers have focused on some co-benefits, such as reduced pollution or economic development, without an integrated approach to understand how co-benefits are related and comparing their importance for motivating public action. Second, climate change requires a global solution, but most co-benefits research has been conducted in Western countries (e.g., USA[16]). It is therefore unclear whether some co-benefits are more influential in different countries, similar to the variation observed in climate

change risk perceptions across countries[18].

Our research addresses these challenges by providing an integrated framework for examining co-benefits, and by collecting data from around the world. By showing how perceptions of co-benefits are related to people's motivations to act on climate change around the world, the findings could help researchers, policy-makers, and communicators develop effective local and global strategies for using co-benefits to motivate action.

Data were obtained from 24 countries spanning all inhabited continents and with diverse carbon emission levels (see Supplementary Information, Table S1). University student samples were selected to facilitate comparisons, as students typically occupy similar socio-economic positions across countries. We also obtained community samples in 10 countries to establish the generalizability and robustness of findings.

Research participants first indicated their beliefs about the reality and importance of climate change. Those who believed climate change is real ("convinced") considered what their nation would be like in the future if action had *successfully mitigated* climate change. Those unconvinced that climate change is real, for whom successful mitigation is not applicable, considered what their nation would be like in the future if people had taken action *aimed at mitigating* climate change.

Participants then considered the potential co-benefits for their society in these scenarios. To develop an integrated framework, we noted that many co-benefits, such as economic development, new technologies, and improvements in disease or poverty, are captured in a model of people's beliefs about the future of society that has been validated across a wide range of social issues, including climate change[8,17]. We used this "collective futures" model and added two mitigation co-benefits for this research: pollution, and green space (extent of parks and reserves).

The collective futures model has four dimensions of co-benefits. Two dimensions

address the social "conditions" in which people live: *Development* (e.g., economic development, scientific progress) and *Dysfunction* (e.g., pollution, disease). Two further dimensions address the "character" of people in society: *Benevolence* (whether people are caring and moral), and *Competence* (whether people are skilled and capable), reflecting the fundamental dimensions used to understand groups[19,20]. Participants indicated whether these co-benefits would improve or worsen in their society (e.g., there would be greater/lesser economic development, people would become more/less moral). The four dimensions formed reliable scales, as in previous research[8,17], indicating that people see close relationships between some co-benefits (e.g., pollution and disease were components of a broader Dysfunction dimension), with lower reliabilities for unconvinced samples in a few countries (see Supplementary Information, Section S1).

We examined how these co-benefit dimensions were related to three measures of motivations to act on climate change[21]. The first assessed public and political actions (*citizenship*), such as voting for pro-environmental politicians and contributing time/money to pro-environmental groups. The second involved *personal* domestic actions, such as conserving energy and green consumerism. The third measured financial behavior (*donation*), where participants were entered into a prize draw (150 US dollars in local currency), and committed an amount for the researchers to donate to a pro-environmental organization if they won.

Correlations between these variables were computed in each country, and meta-analysis[22] was used to identify how each co-benefit dimension was related to motivations to act. Meta-analysis computes the average correlation across all samples (effect size) weighted by sample size, with a 95% confidence interval indicating the likely range of this correlation. Meta-analysis also identifies whether the magnitude of the correlations varies substantially across the samples (Q-statistic).

We first established the strength of relationships between co-benefits and motivations to act, including climate change importance as a benchmark. To provide the toughest test of the additional value of co-benefits, we focused first on "convinced" participants, who were expected to show strong effects for climate change importance. Figure 1 shows that believing climate change is important had the strongest effect size across all action measures for student samples (n=4049). However, this effect varied significantly across countries. Critically, two co-benefits had effects of a comparable size to climate change importance. Development showed the strongest effect sizes for citizenship and personal actions and a weaker effect for donations, with effect sizes also varying across countries. Effect sizes for Benevolence were also relatively strong but were less variable across countries.

We also conducted additional analyses to examine the robustness of these findings (details in Supplementary Information, Section S3). Effect sizes for co-benefits were slightly stronger in community samples (10 countries; n=1239), suggesting that results for student samples may be underestimates. Effects sizes in both student and community samples were not influenced by demographic variables often linked to climate change action: political ideology, age, and gender[3,23]. Effect sizes for climate change importance and co-benefits were also independent of each other, showing that they provide separate motivations for climate change action.

These findings indicate that co-benefits have impressive effect sizes for convinced participants, but their usefulness would be greatly enhanced if they also motivate action for the unconvinced. Most samples included a small unconvinced minority, and to increase power we analyzed countries with at least 20 unconvinced participants combined across student and community samples (14 countries; n=908). Figure 2 shows effect sizes comparing the unconvinced and convinced (student and community combined) from the same countries. Development and Benevolence again had the strongest effects. Compared to

convinced participants, unconvinced participants showed similar or stronger effects for co-benefits related to societal conditions, and similar or weaker effects for character co-benefits. Unconvinced participants seemed particularly motivated by Development co-benefits.

For climate change importance, Development and Dysfunction, correlations varied significantly across countries (see Q-statistics in Figures 1 and 2). We examined whether this variability was related to two theoretically grounded explanations: differences in climate change contributions (greenhouse gas emissions and renewable energy)[24], and country wealth (GDP per capita)[25,26]. We performed meta-regression[22], a meta-analytic technique analogous to regression, to explain this variability across samples, using student samples to maximize the number of countries. Country wealth explained significant variation for climate change importance, indicating that its relationship with motivations to act was weaker in poorer countries. However, these predictors did not account for the variation in Development and Dysfunction effect sizes, nor did other predictors testing alternative explanations (details in Supplementary Information, Section S4), meaning that explanations of the variation in correlations for these dimensions remain to be established.

The results tell a consistent story. Motivations to act on climate change were clearly related to beliefs about co-benefits, especially for economic and scientific development (Development) and for building a more caring and moral community (Benevolence). Commonly cited co-benefits addressing Dysfunction (e.g., pollution, disease[11,12,15,16]) were actually the weakest motivators of action overall. For those convinced climate change is real, co-benefit effects were independent of believing climate change is important, yet were of comparable strength in motivating action. Unconvinced participants showed similar effects to those convinced, and were especially motivated by Development co-benefits.

It is worth noting that the number of unconvinced participants was relatively small, and while community samples increased the generalizability, our samples were not fully
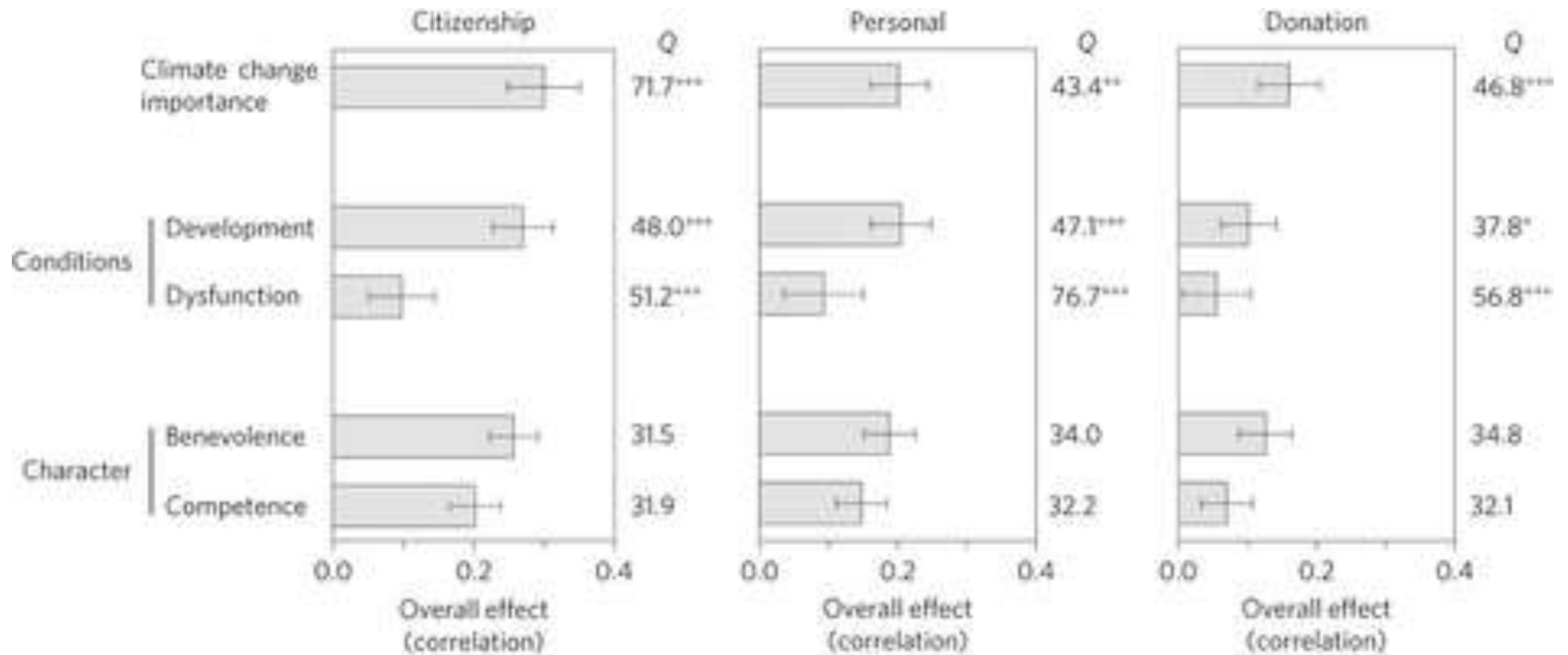
Fig. 1. Meta-analyses showing average effect sizes (with 95% confidence intervals) and tests for cross-country variability (Q) for climate change importance and co-benefit dimensions with motivations to act on climate change for "convinced" participants (n=4049) across 24 countries.

Citizenship refers to public/political behaviors, Personal to domestic behaviors, and Donation to financial behavior. The bars show the average correlation effect across countries, with the 95% confidence interval for this average effect. The Q-statistic evaluates cross-country variability in effect sizes. Development and Benevolence co-benefits showed comparable effect sizes to climate change importance across the behavioral measures. Q-statistics show that climate change importance and Development/Dysfunction co-benefits varied in their effects across countries, while Character co-benefits showed more consistent effects across countries
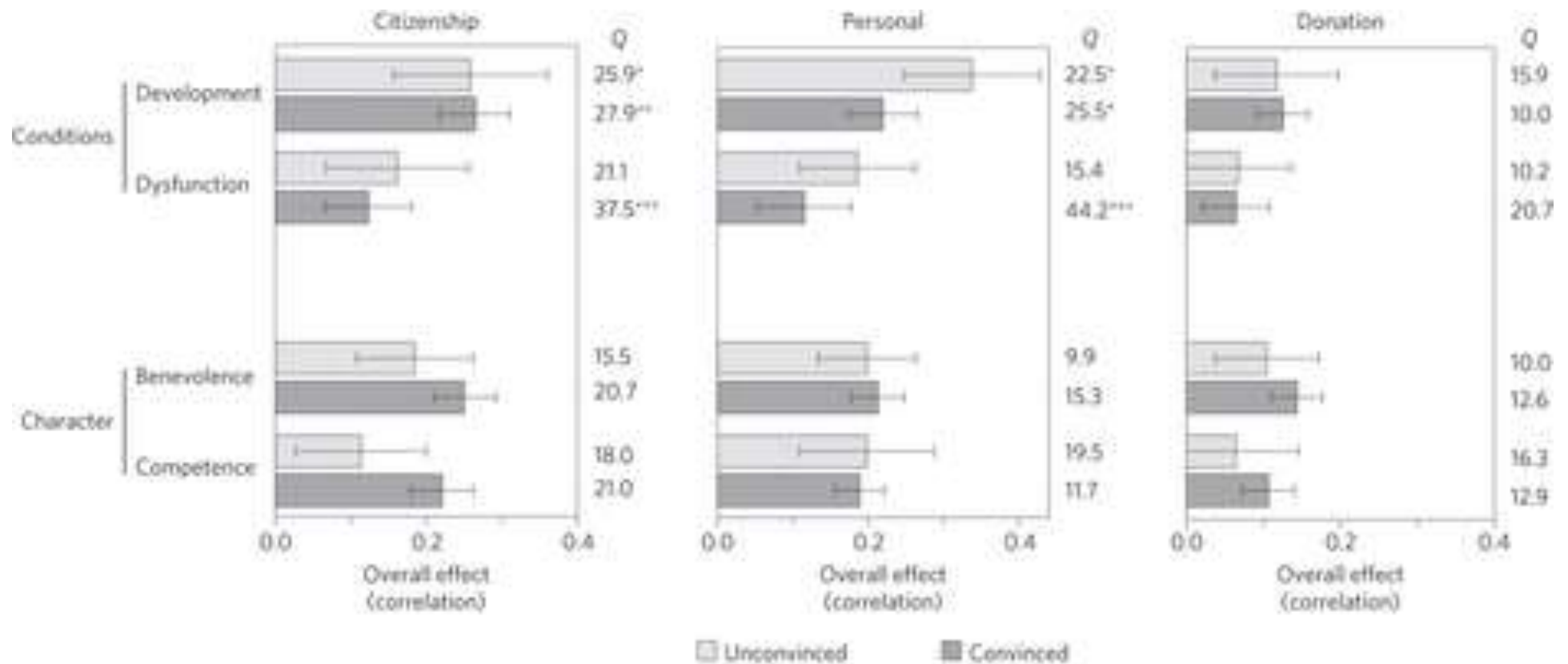
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Fig. 2. Meta-analyses showing average effect sizes (with 95% confidence intervals) and tests for cross-country variability (Q) for climate change importance and co-benefit dimensions with motivations to act on climate change for "unconvinced" participants from 14 countries (n=908; student and community combined), and for "convinced" participants (student and community combined) from the same countries.

Unconvinced and convinced participants showed the strongest effects for Development and Benevolence co-benefits. Compared to those convinced, those unconvinced showed similar or stronger effects for Conditions co-benefits (but with variation across countries) and similar or weaker effects for Character co-benefits.

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representative of the populations of each country. The correlational data also means further research is needed to verify causal relationships. However, the strong and consistent findings across student and community samples, and across those convinced and unconvinced, gives a firm basis for further research on these co-benefits, which are currently not measured in consortium-funded representative surveys.

The findings give cause for hope at a critical time, contrasting with the pessimistic implications of research suggesting action is prevented by ideology[1-3], or relies on personal experience of climate change[27,28]. Communicating the co-benefits of addressing climate change could provide a way to foster public , and thereby influence government action, even among those unconvinced or unconcerned about climate change. Communicating climate change importance may continue to be effective in promoting action in those convinced climate change is real, but less so in poorer countries. Communicating Benevolence co-benefits is likely to have the most consistent effects for a worldwide audience, but in some countries emphasizing Development may have greater impact.

Communicating climate science and co-benefits should be complementary, not competing, strategies. How to combine these approaches most effectively requires further consideration, with research suggesting that importance and co-benefit messages may counteract each other when used together, at least for conservatives in the United States[29]. Crucially, addressing co-benefits requires moving beyond communication to include co-benefits in policy design and decision-making, so that addressing climate change delivers the broader benefits that the public value.

The prospect of mitigating climate change is greater when more people act. We identified which co-benefits can motivate action independently of views about climate change importance, even for those unconvinced climate change is real. Rather than insisting that the public develop stronger concerns about climate change, the present findings show the

potential for connecting climate change mitigation to the broader social concerns of the

public[30].

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Author contributions

P.G.B., T.L.M., and Y.K. designed and coordinated the research project and collected data, with input into design and measures from all authors. P.G.B. analyzed the data and wrote the paper, in conjunction with T.L.M. and Y.K. and with input from all authors. M.B., G.D., R.B.G., V.V.G., Y.G., L.O.J., C.P., V.C.V., J.I.A., A.U., C.D., S.O., J.P., M.S., L.S., R.G., N.L., O.J.M., C.W., G.E., and N.M.S. also translated materials, collected data, and contributed to the manuscript. C.S.A., T.K., J.L.S., and P.W.S. also collected data and contributed to the manuscript.

Competing Financial Interests

The authors declare no financial conflict of interest with the reported research.

Methods

The sections below describe the samples, data collection procedures, measures, and basic analytical approach. Additional information is provided in Supplementary Information.

Samples and data collection

Data were collected from 24 countries (24 student samples and 10 community samples) in the period of June 2013 to July 2014. Countries were targeted to span geographic regions and a wide range of climate change contributions based on the Environmental Performance Index[24], which reflects national CO_2 emissions (both industrial and residential) and traditional/renewable energy production. Countries included 11 high carbon emitters (USA, Netherlands, Russia, Poland, Germany, Australia, China, Japan, South Korea, Israel, South Africa), 9 medium emitters (United Kingdom, France, Spain, Sweden, Norway, Venezuela, Mexico, Chile, New Zealand), and 4 low emitters (Brazil, Switzerland, Iceland, Ghana). Contributors from additional countries were involved in the research (especially in low-emitter countries), but were not able to provide a viable sample within the data collection timeframe. Sample details are shown in Supplementary Information, Table S1.

Contributors in each country were instructed to obtain a student sample of citizens from their country (target N=200), aiming for an even gender-split and a diversity of study disciplines. Contributors who agreed to provide community samples were instructed to obtain a non-student citizen sample (target N=200). Community samples were typically sourced through commercial market research companies who specialize in recruiting across a country population, but some were convenience samples based on local recruitment strategies (e.g., Poland).

Participants completed a survey developed with feedback from country contributors for applicability and relevance. Surveys were completed either online (17 countries) or on paper where local contributors viewed online administration as less practical (7 countries:

Ghana, Japan, Mexico, Poland, South Korea, Spain, and Venezuela). The paper version of the survey adhered strictly to a template developed by the project coordinators to ensure consistency and to match the online surveys.

Surveys were completed in the major local language, except in Switzerland, Ghana, and South Africa where multiple native languages are spoken. Swiss participants could complete the survey in German or French. The common language of student instruction was used in Ghana (English) and South Africa (English or Afrikaans). Translations were obtained using translation-back-translation by competent bilingual speakers, or using parallel translation where multiple bilingual speakers independently translated the survey. In both approaches, discussion of discrepancies between the translators and the project coordinators continued until an acceptable translation was agreed upon.

Measures

The research project was designed to address several research questions in addition to those reported in the article. Below we describe the measures used in the article, and describe additional measures in Supplementary Information, Section S1. Reliability indices (Cronbach's alphas) for multi-item scales and descriptive statistics for all measures are shown in Supplementary Information, Tables S2 and S3, respectively.

Climate change importance.

Participants first rated the item measuring perceived climate change importance which was embedded among other items: *Addressing climate change is one of the most important issues facing society today* (1=*Strongly disagree*, 5=*Strongly agree*).

Climate change beliefs.

Participants then completed a screening item asking them to choose from the following three options used in previous research[17]: (1) *I believe climate change is occurring, and human activities <u>are</u> having significant effects on climate change*; (2) *I believe climate*

change is occurring, but human activities <u>are not</u> having significant effects on climate change;

or (3) *I do not believe climate change is occurring*. Participants who selected (1) were

categorized as believing in anthropogenic climate change ("convinced"), and those who

chose (2) or (3) were categorized as unconvinced or skeptical about the reality of

anthropogenic climate change ("unconvinced").

Co-benefits scenarios.

To give participants a context for thinking about co-benefits of climate change action,

we asked them to think about what their society would be like in the future. Specifically,

convinced participants were instructed to think about their country in 2050 where people

have taken action that *has prevented* significant climate change. Unconvinced participants

were instructed to think about their country in 2050 where people have taken action *aimed at*

preventing significant climate change. The reason for using separate scenarios for convinced

and unconvinced participants arose from pilot testing: The scenario where climate change

was prevented (used for convinced participants) was deemed unsuitable for those

unconvinced, and responses from a substantial number of convinced participants indicated

they interpreted the more general scenario (used for unconvinced participants here) as

indicating that action was *not* successful. Participants were then instructed to imagine what

their country would be like in this scenario, and then proceeded to answer the co-benefit

measures.

Co-benefits measures.

For the scenario participants were instructed to imagine, they then rated their country

in 2050 on scales from the validated collective futures model[17], in which *conditions*,

character, and *societal values* are distinguished.

Conditions. Participants rated the extent to which the following aspects of their

country would become worse or improve compared to today (-5=*Much worse*, 0=*Same as*

today, +5=*Much improved*). The aspects of society reflected two dimensions. *Development* items were "economic development", "education levels", "volunteering", "scientific progress", and "extent of community groups". *Dysfunction* items were "violent crime", "poverty", "disease", "pollution", "theft", and "unemployment levels".

Character. Participants rated how typical a list of personal characteristics would be of people in their country compared to today (-5=*Much less typical than today*, 0=*Same as today*, +5=*Much more typical than today*). These characteristics reflected two dimensions. *Benevolence* items were "caring", "warm", "considerate", "honest", "sincere", "trustworthy", "unfriendly" (reversed), "immoral" (reversed), "insensitive" (reversed), and "unethical" (reversed). *Competence* items were "competent", "capable", "assertive", "lazy" (reversed), and "unskilled" (reversed).

Societal Values. Ratings of how values would change in society were also made, using 12 values selected from the Schwartz Value Survey[31] to reflect four quadrants (3 values per quadrant). However, scales created to reflect each quadrant showed low reliabilities across many countries and were excluded from analyses. *Motivations to act on climate change.*

The three pro-environmental measures were presented in the context of addressing climate change.

Citizenship. Environmental citizenship intentions items were taken from an existing measure[32], and adapted and extended based on feedback from contributors in the different countries. The final 12-item scale focuses on behaviors aimed at bring about public and political action. Items added included exerting influence within a person's social network (friendship networks and social media). As some behaviors were less applicable to some people and in some countries, scale scores were created where participants provided answers (excluding "not applicable") for at least 6 items. The "not applicable" choice was selected

less than a third of the time for every item in every country, indicating that overall participants believed these behaviors were possible in their country. To create scores for each individual, missing and "not applicable" items were excluded, and the scale score was computed by averaging over the remaining items. The scale header and items were:

Many individuals and groups interested in protecting the environment believe addressing climate change is a key concern. With this in mind, how likely are you to engage in the following activities in the next 12 months? (If it is not possible for you to perform an activity, please choose "not applicable")

(1=*Not at all likely*, 5=*Very likely*, na=*not applicable*)

1. Sign a petition in support of protecting the environment
2. Join or renew membership of an environmental group
3. Join public demonstrations or protests supporting environmental protection
4. Write a letter or call your member of Parliament or another government official to support environmental protection
5. Give money to an environmental group
6. Read a newsletter, magazine or other publication written by an environmental group
7. If a local, state or Federal election was called, vote for a candidate at least in part because he or she was in favor of strong environmental protection
8. Write to a newspaper in support of protecting the environment
9. Boycott companies that are not environmentally friendly
10. Volunteer to help an environmental group or event
11. Post pro-environmental messages or links on social media (e.g., Facebook, Twitter)
12. Speak in favor of pro-environmental policies in conversations with your friends or family

Personal. Personal sphere behavioral intentions differ from citizenship in focusing on household domestic behaviors. This scale was drawn from several sources[32-34], and the final version was developed with feedback from contributors about local pro-environmental behaviors. Scale scores were created where participants provided responses (excluding "not applicable") for at least 6 items. In Norway and Sweden, the item "Use car sharing or car-

pooling schemes" was rated as "not applicable" by more than one third of participants, but the vast majority of people viewed the behaviors as possible across the remaining items and countries. Missing and "not applicable" items were excluded, and the scale score was computed by averaging over the remaining items. The scale header and items were:

Some people support action on climate change through activities in their personal lives. With this in mind, how likely are you to engage in the following activities in the next 12 months? (If it is not possible for you to perform an activity, please choose "not applicable")

(1=*Not at all likely*, 5=*Very likely*, na=*not applicable*)

1. Install products to save energy (e.g., low-energy light bulbs)
2. Buy environmentally-friendly products
3. Conserve water at home (e.g., when cooking or showering)
4. Minimize use of air-conditioning or heating
5. Reduce car travel (e.g., walk, cycle, use public transport)
6. Turn off lights and appliances when not in use
7. Avoid or reduce eating meat
8. Recycle
9. Turn off electrical equipment rather than use "standby" mode
10. Eat food which is locally-grown or in season
11. Use car-sharing or car-pooling schemes
12. Buy products with less packaging

Donation behavior. In this measure participants were told they would be entered into a prize draw for a gift card to the value of 150 US dollars (in local currency equivalent, rounded to the nearest large number in the local currency). They were asked whether they would allow the researchers to donate an amount of this prize (if they won) to an environment organization on their behalf. They nominated the amount (which could be zero), and were given the option to nominate an environmental organization. They were told that if they did not nominate an organization, the researchers would donate the amount to an international not-for-profit environmental organization. When this prize draw was conducted, the winner

actually received the full amount (no money was withheld for donation). Analyses were conducted on the proportion of the prize participants donated.

Political ideology.

Political ideology was measured using a single item from previous research[35]: "In political matters, people sometimes talk about "liberals" and "conservatives." How would you place your views on this scale, generally speaking?" A seven-point scale was used, labeled 1= *Very liberal*, 2=*Liberal*, 3=*Slightly liberal*, 4=*Moderate/middle of the road*, 5=*Slightly conservative*, 6=*Conservative*, 7=*Very conservative*.

Analyses

Analyses were conducted on participants who identified themselves as citizens of the country of data collection, and who identified as students (student samples) or non-students (community samples). All data meeting these criteria were included in analyses, except for a single extreme outlier in the Swedish "unconvinced" sample.

Meta-analysis was used to examine the average correlations between co-benefits and motivations to act across countries, as well as the extent to which these relationships varied in strength across countries (Q-statistic). A related analytical method, meta-regression, was used to examine explanations for significant cross-country variation where this occurred. More detailed descriptions of meta-analysis, including comparisons with other analytical approaches, and meta-regression are presented in Supplementary Information, Sections S2 and S4, respectively.

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Section S1. Additional Methods Information

Project overview

The project coordinators (first three authors) conceived of the project and recruited an international team to form the *Collective Futures and Climate Change* research project. Most research team members are academic psychologists, and most correspondence occurred via English-language email. Final data were obtained from 24 countries using 16 different languages (see Table S1).

Samples

Basic sample and country characteristics are shown in Table S1.

Table S1. Sample descriptions

Country	N	Language	Age Mean (SD)	Female %	EPI Climate change index [a]	GDP [b] (per capita)
CONVINCED						
Student						
Australia	177	English	20.5 (3.6)	57	13.4	67556
Brazil	160	Portuguese	25.4 (6.7)	68	71.6	11340
Chile	180	Spanish	19.9 (3.0)	61	46.3	15452
China	221	Chinese (simplified)	24.2 (4.4)	55	31.0	6091
France	115	French	27.7 (9.8)	81	44.6	39772
Germany	197	German	23.3 (4.1)	77	30.0	41863
Ghana	154	English	21.7 (2.0)	52	73.9	1605
Iceland	248	Icelandic	28.6 (10.1)	76	64.5	42416
Israel	142	Hebrew	27.2 (5.4)	55	27.2	33250
Japan	127	Japanese	19.3 (1.1)	62	30.6	46720
Mexico	200	Spanish	20.5 (1.7)	84	40.5	9749
Netherlands	134	Nederlands	19.5 (2.6)	70	27.6	45955
New Zealand	169	English	19.0 (1.7)	72	44.6	37749
Norway	184	Norwegian	25.2 (5.2)	78	56.3	99558
Poland	111	Polish	22.8 (3.3)	96	25.9	12708
Russia	77	Russian	21.4 (3.1)	83	17.9	14037
South Africa	189	English (77%) Afrikaans (23%)	21.5 (4.2)	83	21.0	7508
South Korea	129	Korean	21.9 (2.1)	53	22.7	22590
Spain	255	Spanish	22.1 (5.5)	68	39.5	28624
Sweden	267	Swedish	27.2 (8.7)	64	57.8	55041
Switzerland	154	German (98%) French (2%)	24.5 (6.4)	69	58.2	78925
UK	152	English	20.4 (3.5)	58	34.0	39093
USA	123	English	23.2 (4.8)	78	17.7	51749
Venezuela	184	Spanish	19.9 (2.2)	51	27.3	12729
Community						
Australia	129	English	45.1 (14.5)	62	13.4	67556

Country	N	Language	Age Mean (SD)	Female %	EPI Climate change index [a]	GDP [b] (per capita)
Brazil	179	Portuguese	35.0 (11.7)	73	71.6	11340
China	122	Chinese (simplified)	33.1 (7.8)	49	31.0	6091
Iceland	38	Icelandic	44.1 (14.0)	53	64.5	42416
Israel	119	Hebrew	43.2 (12.9)	53	27.2	33250
New Zealand	82	English	50.1 (15.9)	48	44.6	37749
Poland	144	Polish	26.4 (9.0)	96	25.9	12708
Sweden	95	Swedish	34.0 (12.9)	71	57.8	55041
USA	151	English	37.3 (12.2)	58	17.7	51749
Venezuela	180	Spanish	41.9 (12.9)	64	27.3	12729
UNCONVINCED (student and community combined; n=20+)						
Australia	23	English	41.4 (20.2)	42	13.4	67556
Brazil	39	Portuguese	32.3 (10.4)	49	71.6	11340
China	96	Chinese (simplified)	28.3 (5.3)	50	31.0	6091
Germany	20	German	23.4 (4.8)	45	30.0	41863
Iceland	45	Icelandic	25.9 (7.2)	60	64.5	42416
Israel	97	Hebrew	31.9 (11.1)	41	27.2	33250
Japan	35	Japanese	19.5 (1.1)	46	30.6	46720
Netherlands	31	Nederlands	20.0 (1.7)	52	27.6	45955
New Zealand	290	English	54.8 (17.0)	19	44.6	37749
Poland	95	Polish	25.6 (7.8)	79	25.9	12708
Russia	27	Russian	21.3 (3.7)	67	17.9	14037
Spain	20	Spanish	29.4 (14.0)	55	39.5	28624
Sweden	29	Swedish	31.9 (10.0)	17	57.8	55041
USA	61	English	38.9 (15.9)	51	17.7	51749

a. Sourced from [1]. Lower scores indicate greater climate change contributions.

b.   Sourced from the World Bank:

http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries

Inspection of the means and gender distributions should make it clear that most samples are not representative of the country populations. This is especially the case for student samples, but also for community samples which were more representative than student samples but not fully representative. Our finding that community samples showed reliably stronger relationships than equivalent student samples (summarized in the main text and reported in Section S3, Fig. S1 below), suggest that the reported results for students may actually be conservative estimates of effect sizes in the general population. Existing large-scale surveys such as the World Values Survey or the International Social Survey Programme have a clear advantage in representativeness, but are restricted in the questions they can ask and do not examine these co-benefits from climate change mitigation. We hope that our findings show the potential benefits of incorporating the key measures from this research into larger-scale studies to further establish the strength and representativeness of the findings.

Scale reliabilities and descriptive statistics

Table S2 shows the internal reliabilities (Cronbach's alphas) for the pro-environmental and co-benefits scales for all samples. For reference, values above .7 are considered good, and values above .8 are considered very good. Table S3 shows the descriptive statistics for all measures.

Table S2. Scale reliabilities for pro-environmental and co-benefit measures in each sample (Cronbach's alphas).

| | Pro-environmental measures | | Co-benefits | | | |
| | | | Conditions | | Character | |
Country	Citizenship	Personal	Development	Dysfunction	Benevolence	Competence
CONVINCED						
Student						
Australia	.91	.84	.67	.79	.89	.78
Brazil	.89	.88	.81	.88	.89	.68
Chile	.88	.93	.84	.88	.91	.79
China	.92	.92	.92	.93	.91	.72
France	.92	.84	.70	.81	.90	.73
Germany	.87	.84	.74	.75	.88	.75
Ghana	.85	.84	.79	.84	.80	.66
Iceland	.93	.87	.81	.80	.92	.77
Israel	.92	.90	.81	.81	.88	.71
Japan	.90	.90	.73	.71	.88	.67
Mexico	.89	.90	.90	.87	.88	.68
Netherlands	.91	.90	.57	.74	.90	.65
New Zealand	.91	.89	.78	.70	.89	.74
Norway	.90	.76	.67	.77	.90	.61
Poland	.89	.83	.71	.76	.87	.66
Russia	.86	.89	.86	.82	.93	.79
South Africa	.90	.85	.78	.82	.88	.65
South Korea	.89	.84	.74	.76	.91	.70
Spain	.90	.88	.80	.82	.85	.67
Sweden	.90	.88	.73	.79	.92	.77
Switzerland	.84	.81	.66	.75	.91	.82
UK	.91	.84	.80	.78	.88	.80
USA	.90	.88	.86	.83	.84	.66
Venezuela	.87	.77	.83	.87	.85	.74
Community						
Australia	.93	.85	.92	.90	.89	.75
Brazil	.91	.88	.84	.88	.86	.75
China	.85	.84	.91	.94	.87	.75
Iceland	.91	.83	.81	.89	.95	.89
Israel	.90	.84	.81	.89	.87	.60
New Zealand	.92	.82	.92	.85	.91	.81
Poland	.89	.87	.83	.78	.90	.69
Sweden	.92	.85	.87	.84	.91	.74
USA	.91	.86	.89	.89	.92	.80
Venezuela	.90	.89	.92	.95	.87	.81
UNCONVINCED (student and community combined, n=20+)						
Australia	.95	.89	.66	.51	.89	.64
Brazil	.94	.89	.82	.86	.86	.67

China	.92	.96	.93	.89	.75	.45
Germany	.87	.93	.88	.86	.86	.82
Iceland	.94	.87	.83	.77	.90	.70
Israel	.92	.89	.91	.93	.84	.51
Japan	.78	.85	.59	.83	.83	.55
Netherlands	.92	.91	.64	.57	.86	.54
New Zealand	.92	.91	.90	.92	.90	.68
Poland	.92	.90	.78	.59	.84	.57
Russia	.85	.80	.87	.65	.87	.63
Spain	.91	.89	.55	.62	.86	.60
Sweden	.92	.91	.62	.83	.92	.66
USA	.93	.87	.89	.90	.93	.77

Table S3. Means and standard deviations for pro-environmental and co-benefit measures in each sample.

| Country | Pro-environmental actions | | | Co-benefits | | | |
| | | | | Conditions | | Character | |
	Citizenship	Personal	Donation (proportion)	Development	Dysfunction	Benevolence	Competence
CONVINCED Student	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Australia	2.9 (0.9)	3.8 (0.7)	0.4 (0.3)	2.1 (1.1)	0.6 (1.5)	1.4 (1.2)	1.7 (1.3)
Brazil	3.6 (0.8)	4.1 (0.7)	0.4 (0.3)	3.0 (1.4)	0.4 (2.4)	2.2 (1.6)	2.0 (1.5)
Chile	3.3 (0.9)	3.9 (1.0)	0.2 (0.3)	2.8 (1.4)	0.9 (2.0)	1.9 (1.5)	2.0 (1.5)
China	3.7 (0.9)	4.2 (0.7)	0.2 (0.2)	2.7 (1.6)	0.7 (2.4)	1.8 (1.6)	1.5 (1.5)
France	3.2 (1.0)	4.3 (0.6)	0.5 (0.4)	2.0 (1.2)	0.7 (1.8)	1.9 (1.5)	1.4 (1.3)
Germany	2.8 (0.8)	4.2 (0.6)	0.4 (0.3)	1.9 (1.2)	0.1 (1.4)	1.5 (1.3)	1.5 (1.2)
Ghana	3.5 (0.8)	3.7 (0.7)	0.3 (0.2)	2.4 (1.7)	0.9 (2.2)	1.4 (1.5)	1.8 (1.6)
Iceland	3.0 (1.0)	3.9 (0.7)	0.3 (0.4)	1.6 (1.3)	0.5 (1.4)	1.1 (1.3)	1.0 (1.2)
Israel	2.9 (1.0)	3.9 (0.8)	0.2 (0.3)	1.9 (1.6)	0.4 (1.8)	1.0 (1.6)	0.9 (1.4)
Japan	2.3 (0.8)	3.6 (0.7)	0.3 (0.3)	1.3 (1.3)	0.2 (1.2)	0.6 (1.2)	1.0 (1.2)
Mexico	3.6 (0.8)	4.1 (0.7)	0.3 (0.3)	2.5 (2.1)	0.8 (2.4)	1.9 (1.9)	2.2 (1.7)
Netherlands	2.0 (0.8)	3.0 (0.8)	0.2 (0.3)	1.0 (0.8)	-0.1 (1.1)	0.9 (1.1)	1.0 (1.0)
New Zealand	2.5 (0.9)	3.5 (0.8)	0.3 (0.3)	1.6 (1.3)	0.3 (1.3)	1.2 (1.2)	1.2 (1.3)
Norway	3.3 (0.8)	4.0 (0.6)	0.6 (0.4)	1.5 (1.0)	0.5 (1.4)	1.4 (1.2)	1.1 (1.0)
Poland	2.4 (0.8)	3.8 (0.7)	0.2 (0.3)	2.0 (1.1)	0.6 (1.4)	1.4 (1.3)	1.3 (1.3)
Russia	2.8 (0.8)	3.5 (0.9)	0.4 (0.3)	1.8 (1.6)	0.4 (1.7)	1.2 (1.7)	1.2 (1.5)
South Africa	3.0 (0.9)	3.7 (0.7)	0.3 (0.3)	2.5 (1.5)	1.0 (1.9)	1.5 (1.7)	1.6 (1.6)
South Korea	2.6 (0.7)	3.5 (0.6)	0.3 (0.2)	2.1 (1.5)	0.7 (1.7)	0.8 (1.7)	1.5 (1.6)
Spain	3.1 (0.9)	4.0 (0.7)	0.4 (0.4)	2.3 (1.3)	0.5 (1.8)	1.5 (1.2)	1.5 (1.3)
Sweden	3.2 (0.9)	4.1 (0.7)	0.4 (0.4)	1.7 (1.2)	1.0 (1.4)	1.2 (1.4)	1.2 (1.3)
Switzerland	2.8 (0.8)	4.1 (0.6)	0.5 (0.4)	1.6 (1.0)	0.2 (1.3)	1.3 (1.2)	1.2 (1.2)
UK	2.6 (0.9)	3.8 (0.7)	0.2 (0.3)	1.8 (1.2)	0.6 (1.4)	1.2 (1.2)	1.3 (1.2)
USA	2.8 (0.9)	3.7 (0.7)	0.4 (0.4)	2.2 (1.5)	0.7 (1.8)	1.4 (1.3)	1.6 (1.3)
Venezuela	3.3 (0.8)	4.0 (0.6)	0.4 (0.3)	3.4 (1.2)	1.4 (2.2)	2.3 (1.4)	2.7 (1.4)

	Pro-environmental actions			Co-benefits			
				Conditions		Character	
	Citizenship	Personal	Donation (proportion)	Development	Dysfunction	Benevolence	Competence
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Community							
Australia	3.2 (1.0)	4.2 (0.6)	0.3 (0.3)	1.6 (1.9)	0.4 (2.1)	1.2 (1.6)	1.3 (1.6)
Brazil	3.4 (1.0)	4.1 (0.8)	0.5 (0.4)	2.6 (1.9)	0.4 (2.5)	1.8 (1.7)	1.8 (1.8)
China	4.0 (0.7)	4.3 (0.5)	0.2 (0.3)	2.0 (1.4)	1.0 (1.9)	1.2 (1.4)	1.2 (1.4)
Iceland	3.6 (1.0)	4.0 (0.7)	0.5 (0.5)	1.7 (1.5)	0.6 (1.9)	1.2 (1.8)	1.0 (1.7)
Israel	3.2 (1.0)	4.2 (0.6)	0.2 (0.3)	1.8 (1.8)	0.3 (2.1)	1.2 (1.7)	1.4 (1.4)
New Zealand	3.6 (1.0)	4.3 (0.6)	0.7 (0.4)	1.5 (1.9)	0.6 (1.7)	1.2 (1.5)	1.3 (1.4)
Poland	2.6 (0.9)	3.9 (0.7)	0.2 (0.3)	2.2 (1.6)	0.5 (1.8)	1.6 (1.7)	1.4 (1.6)
Sweden	3.3 (1.0)	4.2 (0.7)	0.4 (0.4)	1.8 (1.6)	1.3 (1.6)	1.4 (1.5)	1.3 (1.3)
USA	3.1 (1.0)	4.1 (0.7)	0.2 (0.2)	2.2 (1.6)	0.8 (1.9)	1.9 (1.5)	1.8 (1.5)
Venezuela	3.7 (0.8)	4.2 (0.6)	0.5 (0.4)	3.1 (2.0)	0.5 (3.2)	2.4 (1.7)	2.8 (1.7)
UNCONVINCED (Student and Community combined, n=20+)							
Australia	2.2 (1.1)	3.3 (0.8)	0.3 (0.3)	1.1 (1.3)	0.1 (1.0)	0.7 (1.1)	0.8 (1.1)
Brazil	2.9 (1.2)	3.7 (1.0)	0.5 (0.5)	2.4 (1.7)	-0.4 (2.2)	1.5 (1.6)	1.6 (1.6)
China	3.6 (0.9)	3.9 (0.9)	0.1 (0.2)	1.3 (1.5)	0.8 (1.5)	0.4 (1.0)	0.4 (0.9)
Germany	2.0 (0.7)	3.6 (1.0)	0.3 (0.4)	0.3 (2.1)	-0.6 (2.1)	0.4 (1.4)	0.7 (1.4)
Iceland	2.3 (1.0)	3.4 (0.9)	0.2 (0.3)	0.8 (1.1)	0.1 (1.3)	0.4 (1.1)	0.6 (0.9)
Israel	2.7 (1.0)	3.7 (0.8)	0.2 (0.2)	1.1 (2.1)	0.2 (2.1)	0.5 (1.5)	0.7 (1.3)
Japan	1.7 (0.5)	3.3 (0.8)	0.3 (0.3)	0.9 (1.2)	-0.2 (1.5)	0.1 (1.0)	0.4 (1.1)
Netherlands	1.9 (0.8)	2.9 (0.9)	0.1 (0.1)	0.9 (0.9)	-0.2 (1.0)	0.8 (0.9)	0.7 (0.8)
New Zealand	1.8 (0.9)	2.9 (1.0)	0.2 (0.3)	-1.3 (2.1)	-2.1 (2.1)	-0.8 (1.7)	-0.5 (1.6)
Poland	2.1 (0.9)	3.3 (0.9)	0.1 (0.2)	1.2 (1.3)	0.3 (1.1)	0.6 (1.3)	0.6 (1.2)
Russia	2.4 (0.8)	3.0 (0.8)	0.3 (0.4)	1.8 (1.6)	0.1 (1.1)	1.1 (1.6)	1.2 (1.4)
Spain	2.4 (0.9)	3.7 (0.8)	0.3 (0.4)	1.2 (1.0)	0.1 (0.8)	0.8 (1.1)	1.0 (1.1)
Sweden	2.0 (1.0)	2.9 (1.0)	0.1 (0.1)	-0.1 (1.3)	-0.8 (1.6)	-0.3 (1.4)	0.3 (1.2)
USA	2.0 (1.0)	3.2 (0.8)	0.2 (0.3)	0.4 (2.0)	-0.2 (2.3)	0.2 (1.8)	0.6 (1.7)

Additional Measures

The measures used in the study were included as part of the larger *Collective Futures and Climate Change* research project on the social psychology of climate change across cultures. In addition to the measures described in the Methods section of the paper, the survey contained the following additional scales and measures:

SCALES

Environmental Identity[2]

Social Dominance Orientation[3]

System Justification[4]

Consideration of Future Consequences[5]

National Identity[6]

Environmental Striving[7]

Human-Nature Relationships[7]

DEMOGRAPHICS

Employment

Religion/Religiosity

Cultural Background

Relative income

Rural/urban location

Duration living in the country

Section S2. Additional information for main analyses.

In this section we present the effect sizes (correlations) for each country sample for climate change importance (for convinced participants only) and for the co-benefit dimensions (for convinced and unconvinced participants). Weighted means (overall effects) are shown in red, which represent the effects reported in the main text. At the end of this section we provide further details on the meta-analytic technique used.
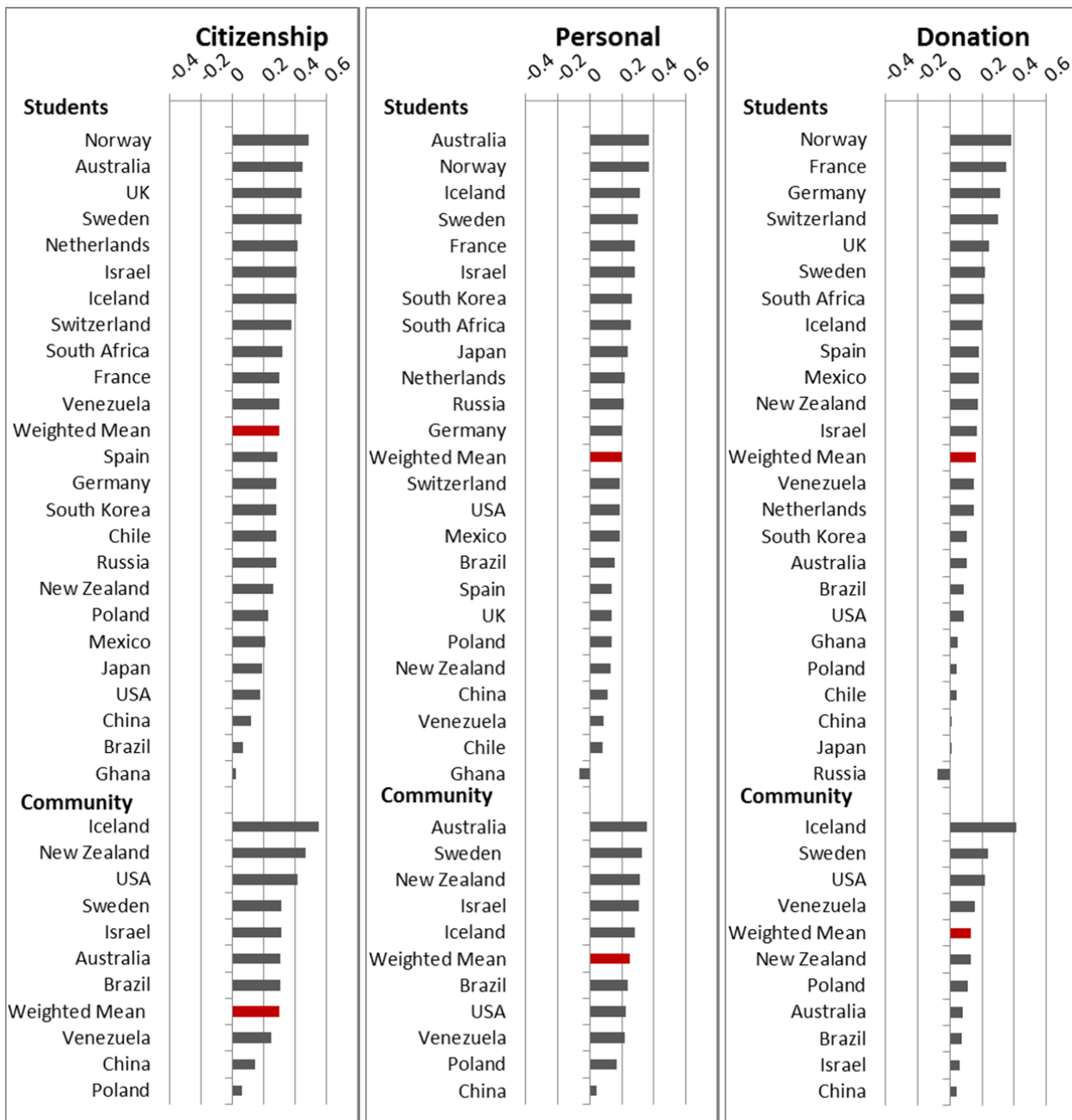
Fig. S1. Effect sizes for each convinced sample relating **climate change importance** to environmental citizenship, personal behaviors, and donations.
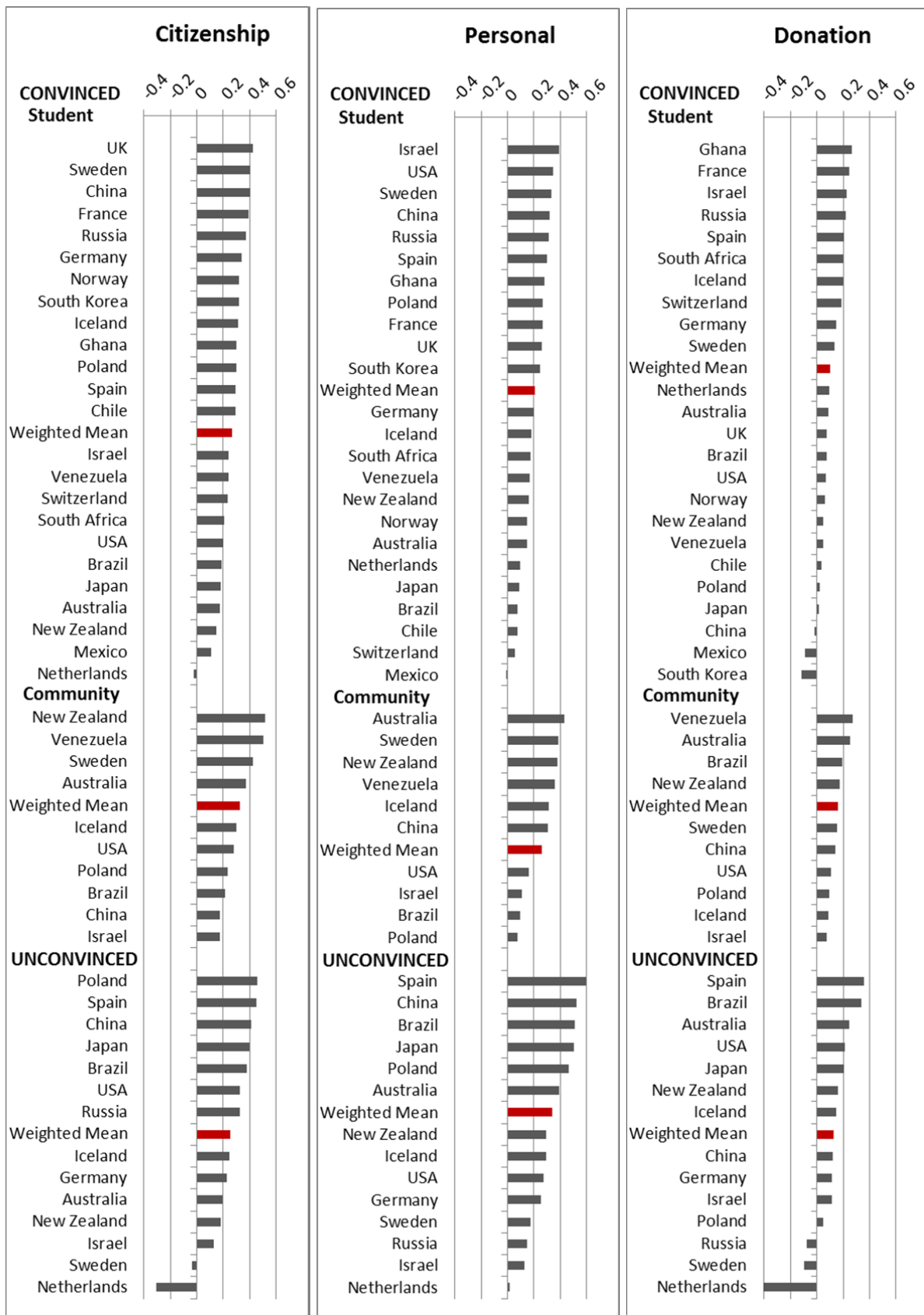
Fig. S2. Effect sizes for each sample relating **Development** to environmental citizenship, personal behaviors, and donations.
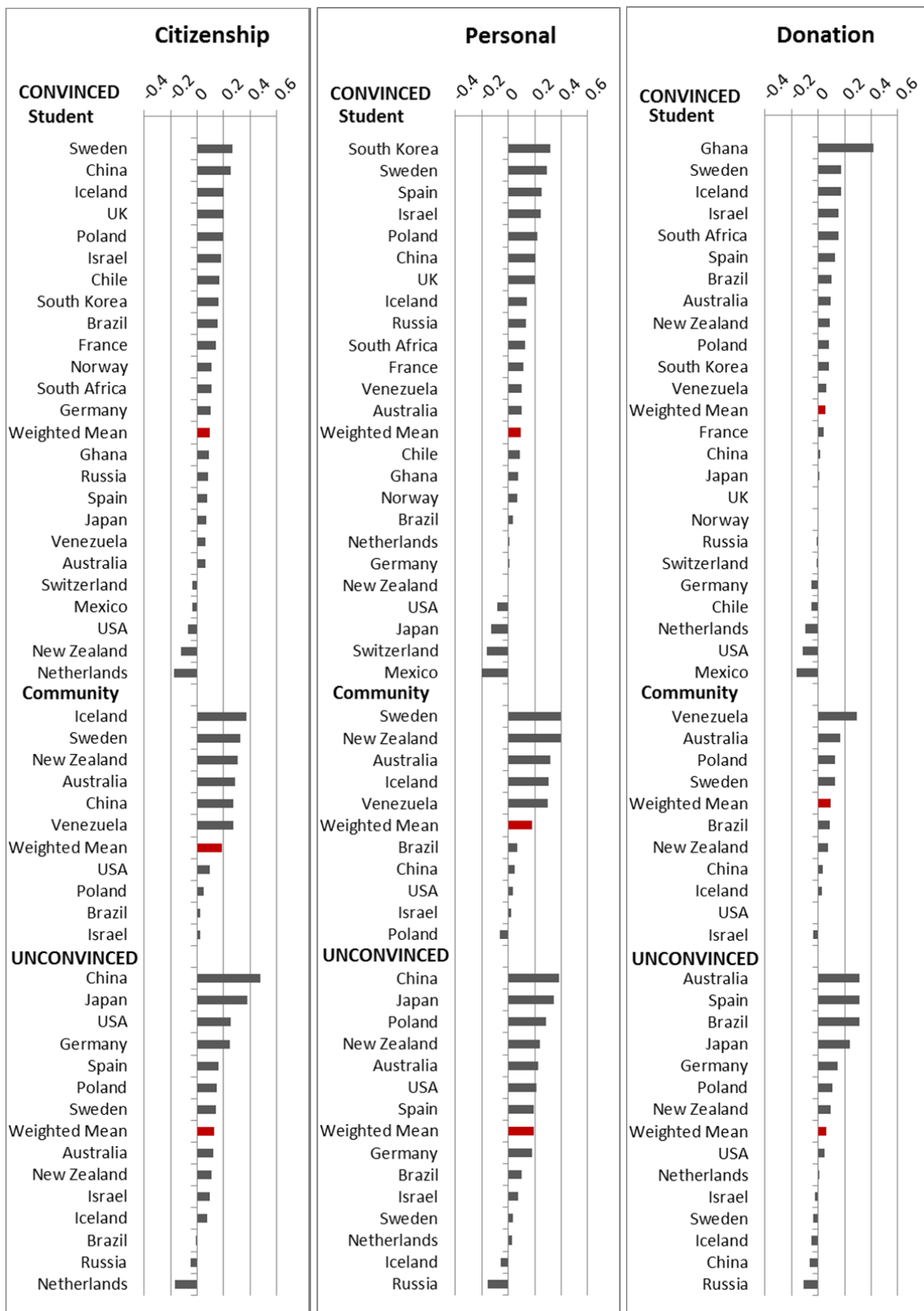
Fig. S3. Effect sizes for each sample relating **Dysfunction** to environmental citizenship, personal behaviors, and donations.
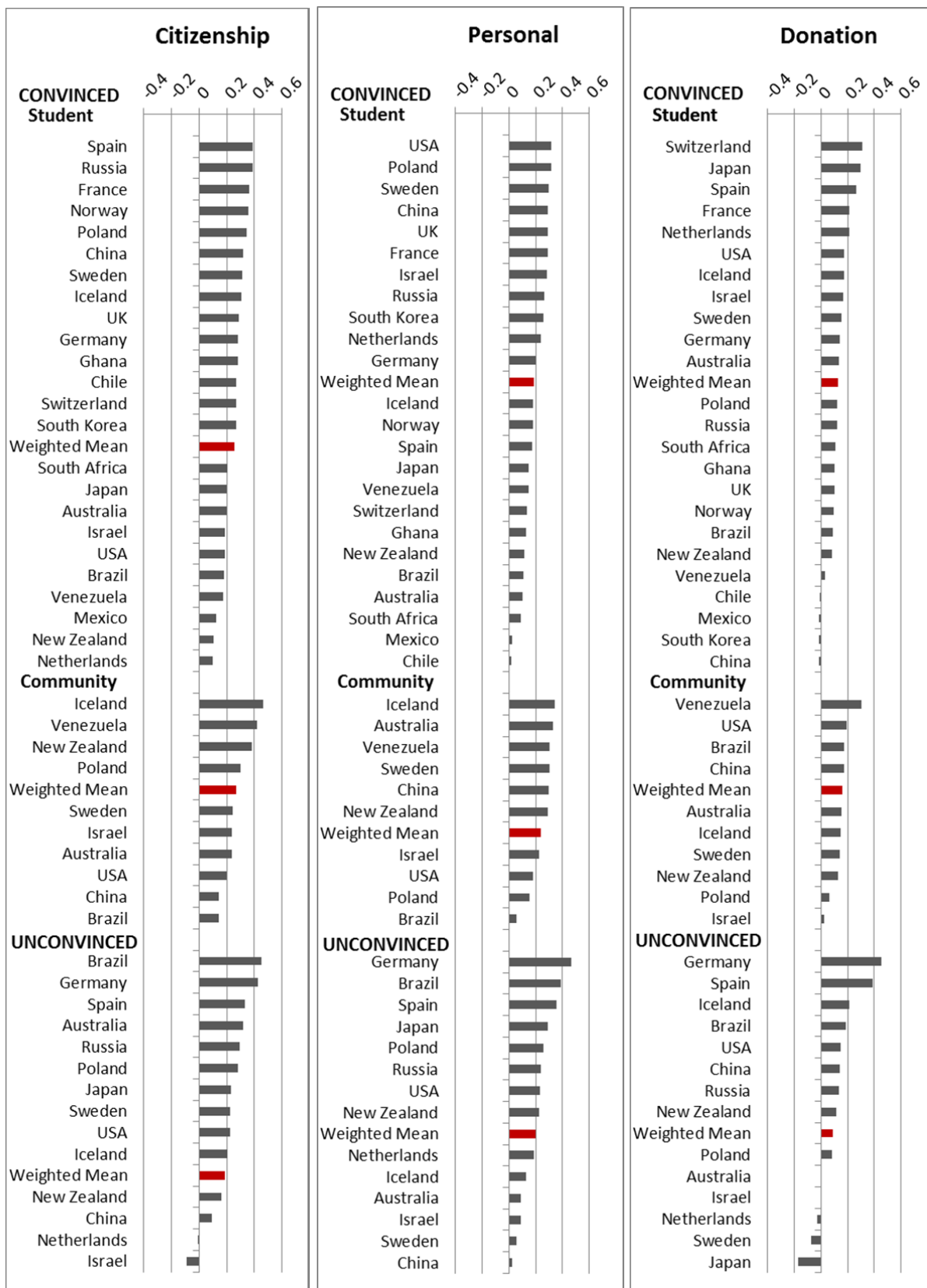
Fig. S4. Effect sizes for each sample relating **Benevolence** to environmental citizenship, personal behaviors, and donations.
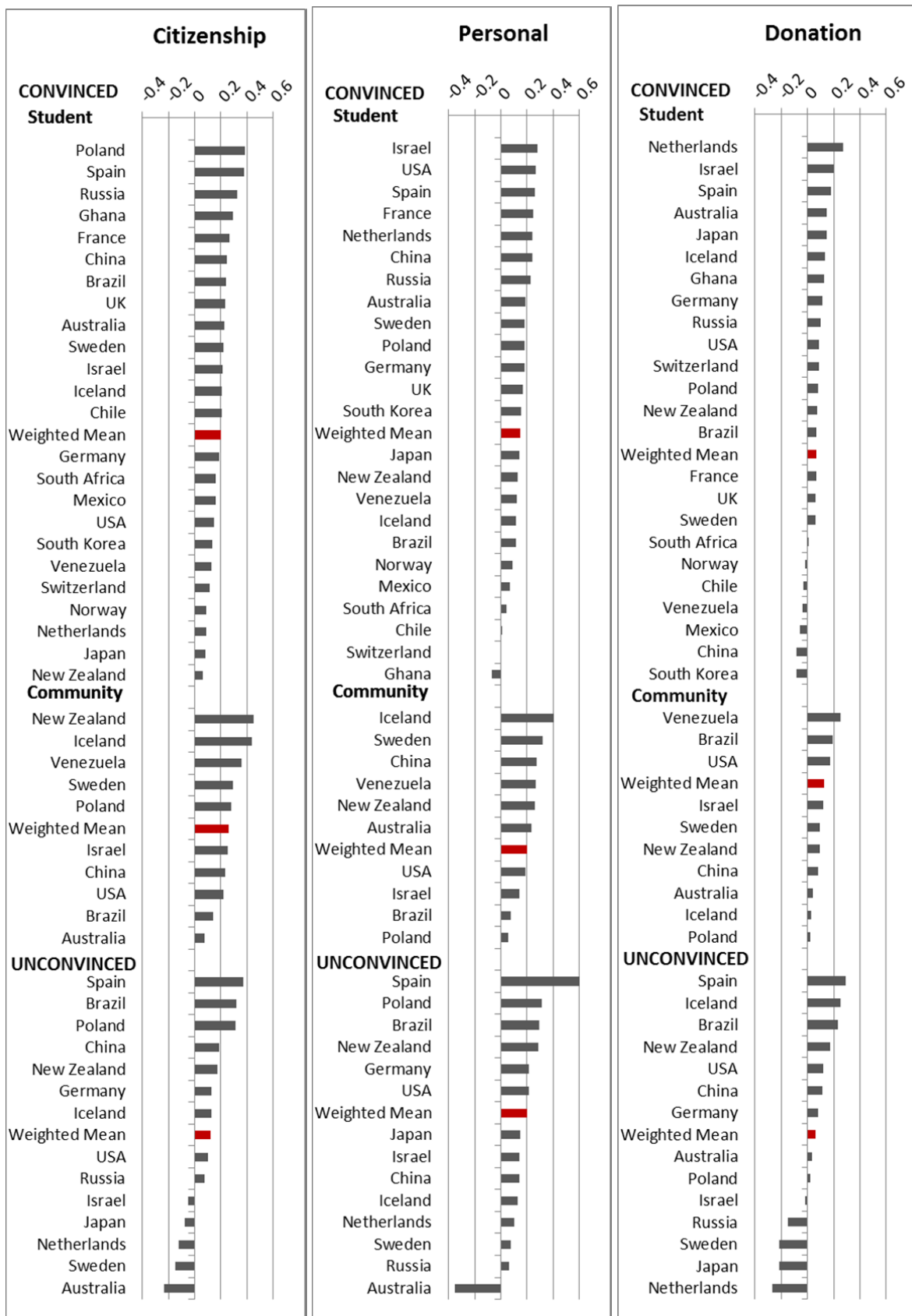
Fig. S5. Effect sizes for each sample relating **Competence** to environmental citizenship, personal behaviors, and donations.

Section S3. Meta-analysis

All meta-analyses were performed using the METANALYSIS macro[8] developed for the statistical program SPSS, using a random effects model and "method of moments" estimation.

Meta-analysis and multilevel modeling are two alternative approaches for examining data from multiple studies across cultures. We chose meta-analysis for a number of reasons. First, we used meta-analysis for its simplicity in communicating the findings. Although multilevel modeling is a common approach used for nested data and for complex models where the aim is to investigate relationships among a large number of factors simultaneously, it is more complex and difficult for a general audience to understand and interpret. For analyzing relatively simple relationships, as is the case in our study, meta-analysis offers a viable alternative, as it can be more easily understood by a general audience without a high level of statistical knowledge beyond correlation (e.g., effect sizes represent the overall correlation across countries between variables).

Second, the meta-analytical approach we used allows for equivalent empirical tests when compared to multilevel modeling. We used "random effects" meta-analysis which does not assume that there is a single "true" effect size being estimated, but rather that effect sizes may differ across samples, distributed as a random variable. For those versed in multilevel modeling, this is functionally equivalent to having a multilevel model with a random slope at level-1. Moreover, we used meta-regression to test whether country-level variables helped explain why effect sizes differed across samples, often described as cross-level interaction or in our case country-level moderation (we detail meta-regression below). We used "method of moments" meta-regression which in multilevel modeling terminology represents a random-effects variable at level-2, which is functionally equivalent to using country-level variables to predict a random variable intercept. Meta-analysis and multilevel modeling can both control for other predictors – in the meta-analyses this was achieved by computing partial correlations between co-benefits and the action variables, controlling for the other variables (e.g., climate change importance, age, gender, political ideology). One clear advantage of multilevel modeling is the ability to easily compare the amount of variance explained at individual and group levels, but this was not a goal of the study.

Section S3. Additional analyses

On the following pages we report details of additional meta-analyses summarized in the main text. The first meta-analysis involved:

(a) comparing effect sizes for student and community convinced samples from the same countries.

Subsequent meta-analyses were performed separately for both student and community convinced samples, examining:

(b) effect sizes for co-benefits after controlling for demographics (gender, age, political ideology);

(c) effect sizes for co-benefits after controlling for climate change importance; and

(d) effect sizes for climate change importance after controlling for co-benefits.

(a) Comparison of student and community convinced samples
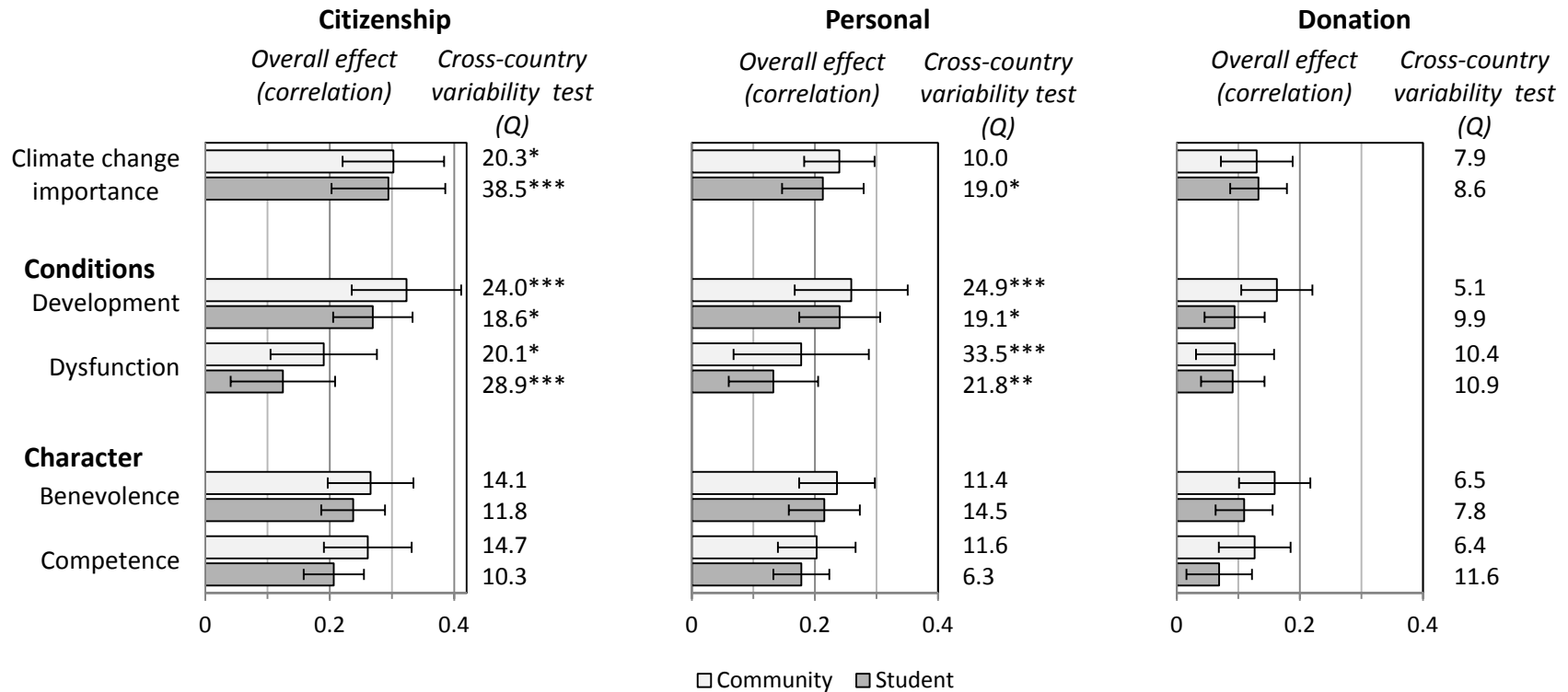
*p<.05, **p <.01, ***p<.005

Fig. S6. Overall effect sizes and tests of cross-country variability (Q) comparing convinced community and student samples from the same countries (k=10).
These figures show that effect sizes were similar in the community and student samples, and for co-benefits the effects on motivations to act were always slightly stronger in the community samples. This suggests that the analyses for student samples may be a slight underestimate of relationships in the wider community. The extent of cross-country variation was also similar in community and student samples.

(b) Effect sizes after controlling for demographics (gender, age, political ideology).
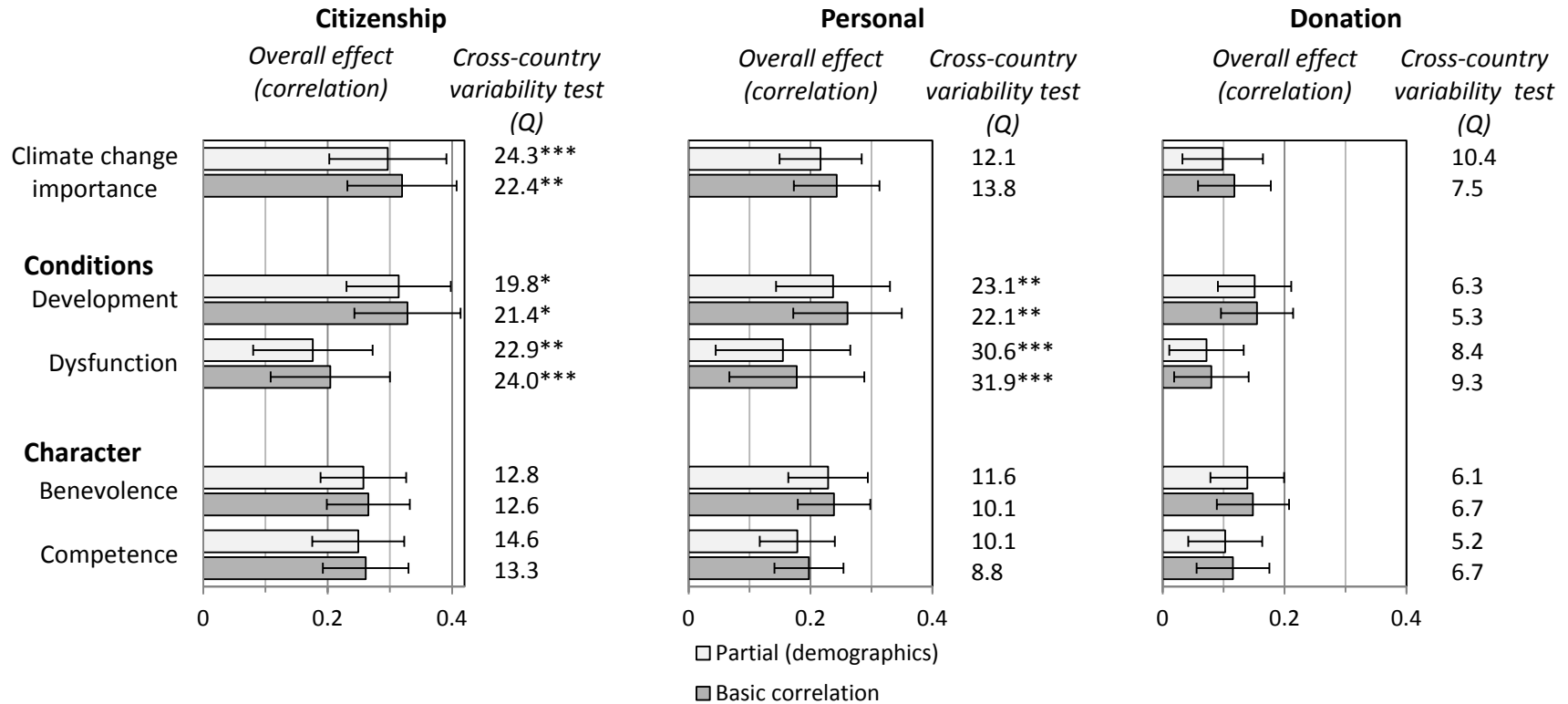
Student samples
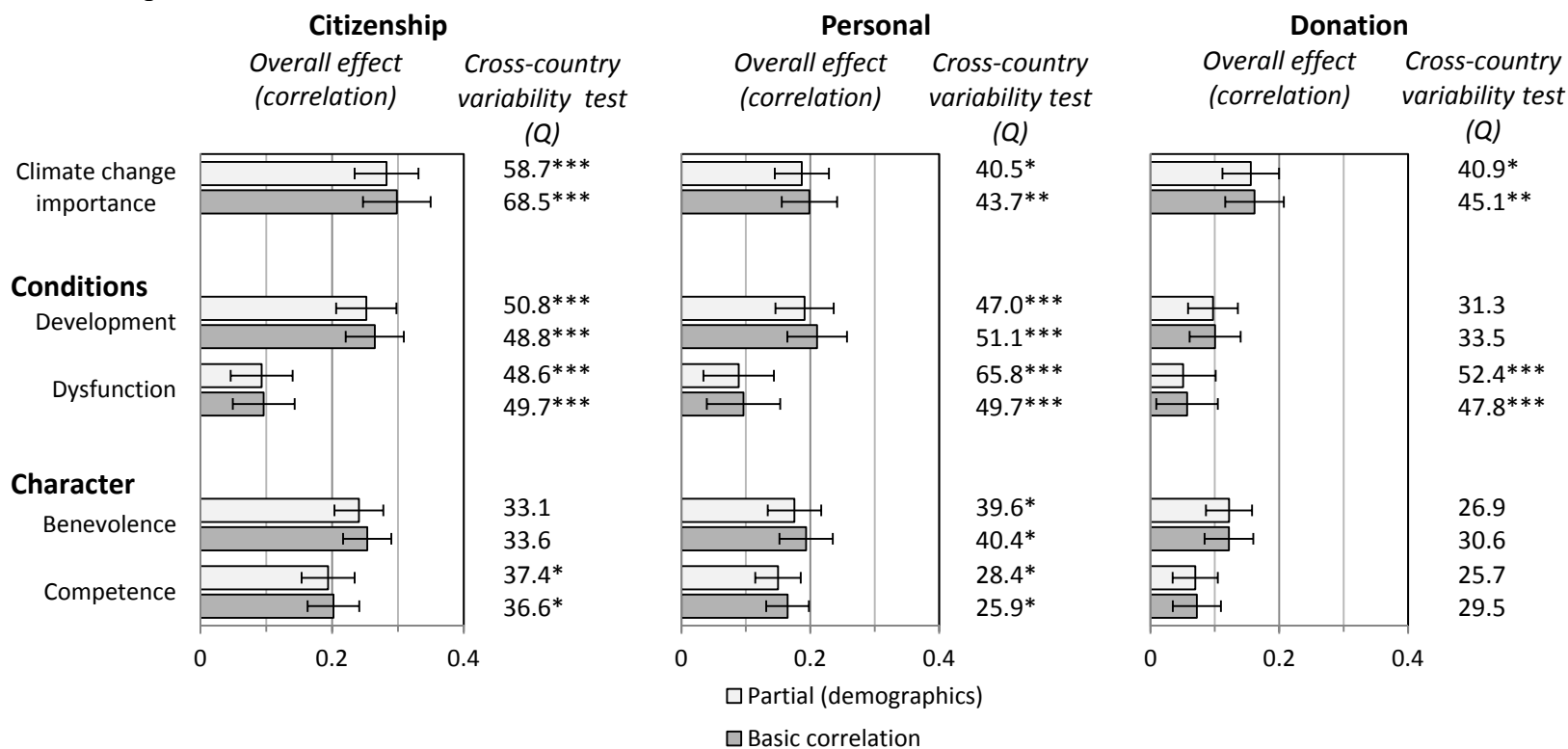
*p<.05, **p <.01, ***p<.005

Fig. S7. Overall effect sizes and tests of cross-country variability (Q) comparing correlations when controlling for gender, age, and political ideology with basic ("zero-order") correlations from the same participants for the student samples (k=24).
After controlling for demographic variables linked to climate change action (partial correlations within countries), effect sizes for co-benefit dimensions and climate change importance showed only small changes from effect sizes without controlling for these variables (basic correlation). This shows that both climate change importance and the co-benefits are largely independent of these demographic variables in their relationships with motivations to act on climate change.
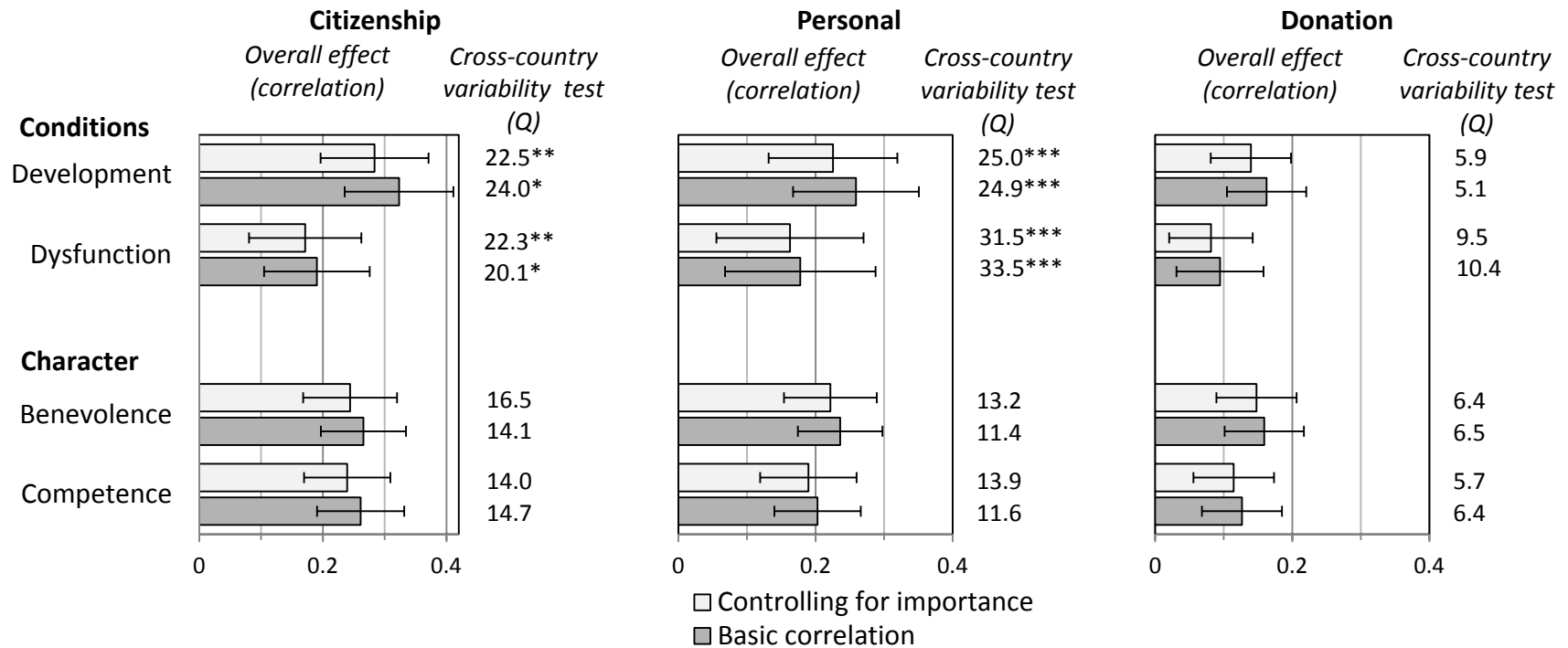
Community samples

Fig. S8. Overall effect sizes and tests of cross-country variability (Q) comparing correlations when controlling for age, gender, and political orientation with basic ("zero-order") correlations from the same participants for the community samples (k=10).
As with the student samples, controlling for these demographic variables showed little influence on effect sizes.
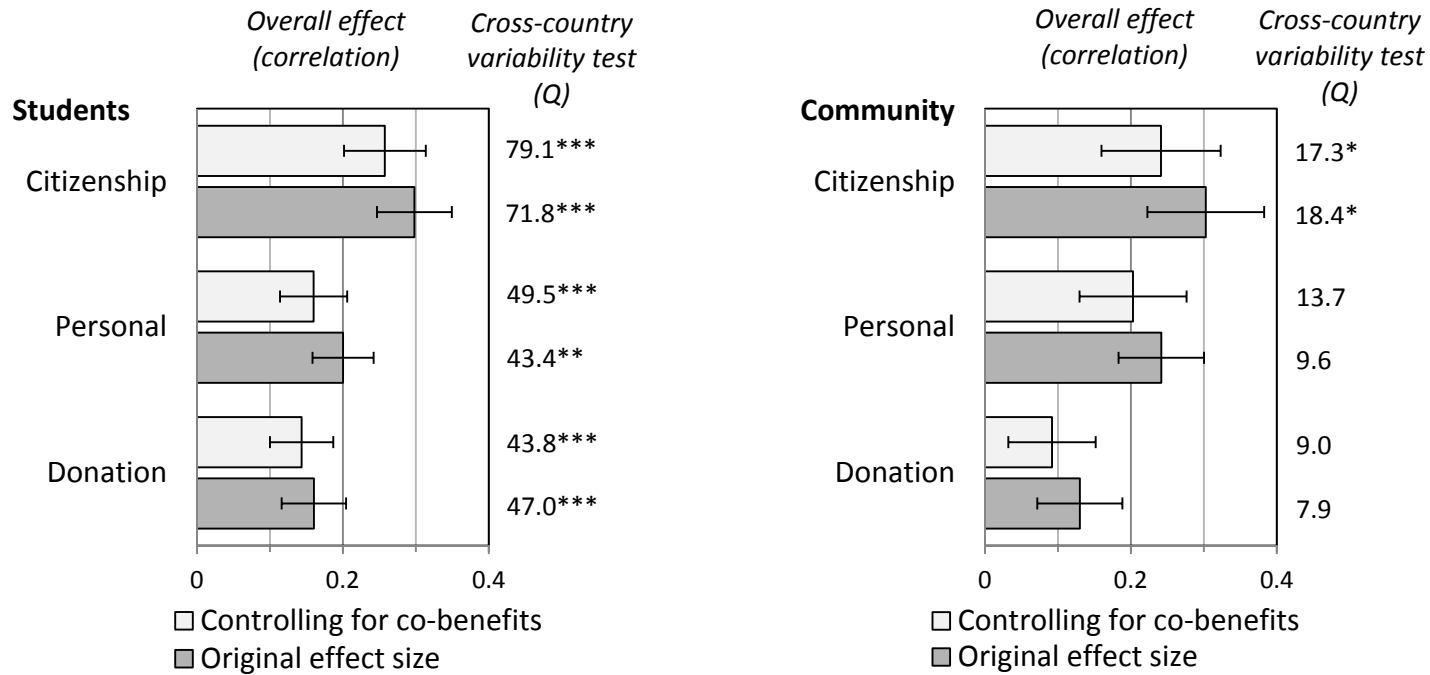
(c) Effect sizes for co-benefits after controlling for climate change importance.

Student samples

*p<.05, **p <.01, ***p<.005

Fig. S9. Overall effect sizes and tests of cross-country variability (Q) comparing correlations for co-benefits after controlling for climate change importance with basic (zero-order) correlations for the student samples (k=24).
Controlling for climate change importance resulted in only minor changes to effect sizes across all co-benefit dimensions and action measures. This shows that societal beliefs are largely independent of climate change importance in their relationships with motivations to act on climate change.

Community samples

Fig. S10. Overall effect sizes and tests of cross-country variability (Q) comparing correlations for co-benefits after controlling for climate change importance with basic (zero-order) correlations for the community samples (k=10).
As with the student samples, controlling for climate change importance resulted in only minor changes to effect sizes across all co-benefit dimensions and action measures.

*p<.05, **p <.01, ***p<.005

(d) Effect sizes for climate change importance after controlling for co-benefits.

*p<.05, **p <.01, ***p<.005

Fig. S11. Effect sizes and tests of cross-country variability (Q) relating co-benefit dimensions to action variables after controlling for climate change importance for student samples (k=24) and community samples (k=10).
Effect size for climate change importance showed only minor differences when controlling for co-benefit dimensions. Considered together with Figures S9 and S10, this indicates that co-benefits and climate change importance are independently associated with motivations to act on climate change.

Section S4. Meta-regressions

Significant cross-country variation was identified for three variables: Climate Change Importance, and the co-benefit dimensions of Development and Dysfunction. Meta-regression was thus used to examine whether some theoretically important factors explained this variation across countries: climate change contributions (climate change index from the Yale Environmental Performance Index), and wealth (GDP per capita). These analyses were performed using the METAREGRESSION macro for SPSS[8], with a random effects model and "method of moments" estimation. Analyses are shown in Table S3, with the findings summarized in the main article.

As the hypothesized model shown in Table S3 did not explain significant variation across countries in effect sizes for Development and Dysfunction, we conducted an exploratory investigation of a range of country-level factors that might predict this variation. These included method factors (mean age of sample, online vs. paper administration, proportion of females in sample), additional environmental factors (general environmental performance [EPI total score], latitude of cities where data was collected, disease prevalence), additional economic factors (income inequality [Gini coefficient], GDP growth, Human Development Index), Hofstede's six cultural dimensions (collectivism, long-term orientation, masculinity, indulgence, power distance, uncertainty avoidance)[9], and features of language (use of time markers[10]). None of these dimensions showed strong or consistent effects with Development or Dysfunction. The cross-country variation in effect sizes for Development and Dysfunction remains unexplained.

Table S4. Meta-regressions predicting variability in effect sizes across countries.
This table shows that a country's level of wealth (GDP per capita) is clearly associated with a stronger relationship between climate change importance and the action variables. This suggests that the belief that climate change is an important issue is a stronger motivator for action in richer countries relative to poorer countries. In contrast, the extent to which a country contributes to climate change emissions (climate performance) did not explain why some countries showed stronger relationships between climate change importance and action. For Development and Dysfunction, neither climate performance nor wealth explained why some countries showed stronger relationships between these co-benefit dimensions and action.

	Climate Change Importance			Societal Development			Societal Dysfunction		
	Citizenship	Personal	Donation	Citizenship	Personal	Donation	Citizenship	Personal	Donation
Proportion of heterogeneity explained	.53***	.50**	.41*	.03 ns	.05 ns	.10 ns	.08 ns	.05 ns	.24 ns
					Betas				
Climate performance									
EPI-Climate Change	-.19	-.20	.20	.17	-.19	.28	.20	-.09	.45*
Economic									
Wealth (GDP per capita)	.72***	.70***	.59***	-.03	-.09	.11	-.21	-.19	-.24

* p < .05, *** p < .005, "ns" not significant.

Note: EPI-Climate Change is the Yale Environment Performance Index – Climate Change score.

Section S5. Further acknowledgements

References (Supplementary Information)

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