

How the co-benefits of addressing climate change can motivate action across the world.

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It is traditionally thought that the public must be convinced of the reality and importance of anthropogenic climate change in order to take personal and political action. However, convincing the broad public involves overcoming powerful ideological obstacles¹⁻⁴, and in many places climate change is slipping in public importance^{5,6}. Here we examined whether beliefs about the “co-benefits” of mitigating climate change⁷ can avoid these obstacles by motivating behavior in both those who accept climate change and those who are unconvinced or unconcerned. We describe an integrative framework for assessing co-benefits⁸, distinguishing sociological dimensions (e.g., pollution, disease, economic development), and community character (e.g., benevolence, competence). Data from all inhabited continents (24 countries; N=6059), showed that two types of co-benefits, Development (economic and scientific advancement) and Benevolence (a more moral and caring community), rivalled climate change importance in the strength of their relationships with motivations to act. These co-benefits showed effects independent of climate change importance beliefs, and showed similar effects for both climate change believers and skeptics. Communicating these co-benefits of addressing climate change can help motivate action on climate change where traditional approaches have stalled.

Those trying to motivate widespread public 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 taking action, both in their own lives and in convincing their governments to act. A single strategy has typically been used to overcome both hurdles – present climate science and its consequences in convincing ways so that

people become concerned enough to act⁹.

This intuitive approach was initially very successful, but in many places progress has stalled or even reversed. Communicating climate change more clearly is failing to convert skeptics into believers¹⁰, and climate change is slipping down the list of public priorities in many countries^{5,6}. This is strongly related to political ideology¹⁻⁴, giving cause for pessimism – if addressing climate change requires a substantial number of people to shift their basic political ideologies, the prospect for success is bleak.

In response, new approaches have attempted to sidestep these hurdles. One promising approach has been to highlight the “co-benefits” of acting on climate change⁷, referring to the wider benefits to the community that do not necessarily depend on halting temperature rise. For example, mitigation actions can reduce pollution^{11,12}, which could be seen as desirable regardless of its climatic effects. Climate change action can support economic development through “green” industries^{13,14}, which could garner support on the basis of economic considerations independent of climate change. Population health could benefit^{11,15}, for instance infrastructure providing alternatives to cars (e.g., walking/cycling paths) could help reduce obesity-related diseases¹⁶. A further co-benefit involves community functioning, where acting to address climate change can contribute to a more benevolent (caring and moral) community^{8,17}.

A clear advantage of co-benefits is that they can be important both to people concerned about climate change and to those who are unconcerned or even skeptical – they do not require accepting climate science. However, two challenges remain for establishing their usefulness and effectiveness in motivating action. One challenge is that researchers have focused on single types of co-benefits, such as pollution or economic development, without an overarching framework to understand whether some co-benefits are related and which are most important to people. The

second challenge is that while climate change requires a global solution, research on public reactions to co-benefits has predominantly been in Western countries (e.g., the USA¹⁶), and it is not clear whether cultures differ in the co-benefits that are most influential.

Our research aims to address these challenges by providing an integrated framework for examining beliefs about a wide range of co-benefits, and by collecting data across all inhabited continents. By showing how people's beliefs about co-benefits are related to their motivations to act across the world, the findings help researchers, policy-makers, and communicators understand how to promote the co-benefits of addressing climate change using the most effective global and local strategies.

In our research, participants first indicated their beliefs about the reality and importance of climate change. Then, using a framework for understanding beliefs about the future of society⁸, those who believed climate change was real ("believers") considered what their nation would be like in the future if action had *successfully mitigated* climate change. Those unconvinced that climate change was real ("skeptics"), for whom successful mitigation is not relevant, considered a subtly different scenario – what their nation would be like in the future if people had taken action *aimed at mitigating* climate change.

After considering these scenarios, participants rated a wide range of possible co-benefits (see Supplementary Material) corresponding to four dimensions. Two related to society-wide issues: *Development* (e.g., economic development, scientific progress) and *Dysfunction* (e.g., pollution, disease)^{8,17}. Two further co-benefits relate to the "character" of the community: *Benevolence* (whether people are caring and moral), and *Competence* (whether people are skilled and capable), which represent the fundamental dimensions people use to understand groups¹⁸⁻²⁰. Participants could also indicate that these dimensions could worsen (e.g., lower economic

development, greater immorality). These dimensions formed reliable scales (see Supplementary Materials), indicating the people see close relationships between some co-benefits (e.g., pollution and disease), although for skeptics a few scales were less reliable in some countries.

These co-benefit dimensions were related to three scales assessing motivations to act on climate change²¹. The first focused on political action intentions (“*citizenship*”), such as voting for pro-climate 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 volunteered an amount they authorized the researchers to donate to a pro-environmental organization if they won.

Data were obtained from 24 countries spanning all inhabited continents and diverse carbon emission levels (see Supplementary Materials, Table S1). University student samples were selected to facilitate comparisons, as students occupy similar socio-economic positions across countries. In ten countries we also obtained community samples to establish generalizability. Using meta-analysis²², we calculated the average effect size (correlation) across samples, and the extent to which effect sizes varied across countries (Q-statistic).

We first established the strength of relationships between co-benefits and people’s motivations to act, using climate change importance as a benchmark. We first focus on believers, as they were expected to show the strongest effects for climate change importance, providing the toughest test of the value of co-benefits. For student samples (n=3950), Figure 1 shows, unsurprisingly, that believing climate change is important had the strongest effect size across all action measures, although this effect varied significantly across countries. Critically, however, two co-benefits had effects of a comparable size to climate change importance. Development

showed the strongest effects for citizenship and personal actions (although effects varied across countries), and a weaker effect for donations. Benevolence showed similar effects, which were more consistent across countries.

These findings were replicated in the community samples (n=1213; Figure 2), which are compared with student samples from the same countries. In every comparison effect sizes in the broader community were stronger than for students, and for Development the average effect in the community was even stronger than for climate change importance. Together, student and community analyses demonstrate that beliefs about co-benefits relating to Development and Benevolence can be important for motivating people who believe in climate change to act.

It is important to show that co-benefits have distinct motivational implications independent of believing climate change is important. Figure 3 shows effect sizes for co-benefits before and after controlling for climate change importance in both student and community samples. In all cases, controlling for climate change importance led to only minor changes in effect sizes, showing that co-benefit effects are independent of climate change importance, and thus can function as additional reasons for motivating action.

These findings were also replicated for climate skeptics. Most samples included a small (and sometimes very small) skeptic minority, and to increase power we combined student and community samples, using correlations only from countries with at least 20 skeptics (14 countries; n=896). Figure 4 shows effects for skeptics compared to believers (student and community combined) from the same countries. Effects were consistent overall, with Development and Benevolence again showing the strongest overall effects. For society co-benefits, skeptics showed similar or stronger effects than believers, whereas for character co-benefits skeptics showed similar or weaker effects than believers. Skeptics seemed particularly

attuned to Development co-benefits, suggesting this should be focus of communication to this audience.

Development, Dysfunction, and Climate Change Importance typically showed significant variation in their effects (Q-statistics) across countries. Meta-regression²² tested explanations for this variation. We included three country-level predictors on theoretical grounds: (a) climate change contributions (greenhouse gas emissions and renewable energy)²³, indexing responsibility/culpability for climate change; (b) country wealth (GDP per capita), which has been associated with pro-environmental behavior^{24,25}; and (c) the proportion of females in each sample, as women are typically more pro-environmental^{3,26,27}. The basic correlations for student samples were used to maximize the number of countries analyzed.

Summarizing findings (details in Supplementary Materials), wealth (GDP) explained significant variation in effects for climate change importance across the three behavior indicators, with effects weaker in poorer countries. However, these predictors could not account for the variation in effects for societal dimensions, with one significant relationship in 18 statistics, and exploratory analyses with additional variables showed no systematic effects. The reasons why Development and Dysfunction co-benefit effects vary across cultures remains to be established.

A consistent story cuts across these analyses. Across the world, motivations to act on climate change were clearly related to beliefs about co-benefits, especially for economic and scientific development (Development), and in creating a more caring and moral community (Benevolence). For believers, co-benefit effects were independent of believing climate change is important, and rivalled climate change importance beliefs in strength. Skeptics showed effects similar to believers, and for skeptics Development was sometimes even more strongly related to action.

These findings give cause for hope at a critical time, contrasting with the pessimistic implications of research suggesting people's motivation to act on climate change are limited by ideology¹⁻³, or relies on widespread personal experience of climate change^{28,29} (when it may be too late to mitigate). Communicating about co-benefits of addressing climate change can provide another way to engage and motivate the public to act, and to support government action, that do not depend on being convinced or concerned about climate change. For a worldwide audience, communicating about Benevolence co-benefits is likely to have the most consistent effects, but in some countries emphasizing Development may have greater impact (these countries are identifiable in Supplementary Materials). Communicating the importance of climate change may be effective to promote action in believers, but more so in richer countries.

Communication about climate science and co-benefits should be complementary, not alternative, strategies. Moreover, co-benefits should be more than just a communication strategy – they should play incorporated into policy design and decision-making so that addressing climate change can deliver the broader benefits that the public values.

Clearly, further research on co-benefits is needed. The number of climate skeptics was relatively small, and while community samples increased the generalizability of findings they were not as representative as large consortium- or government-funded surveys. However, the present research provides new perspectives not captured by such surveys. The consistency in findings across student and community samples, and for both believers and skeptics, gives a strong basis for inclusion in such large-scale surveys. Another important step is to identify how to communicate these co-benefits to the public most effectively.

The prospect of mitigating climate change is greater when more people take action. Co-benefits can motivate action independently of views on the importance of climate change, and

even in climate change skeptics. Hence, focusing on co-benefits can be a viable strategy that avoids problems inherent in traditional approaches. Rather than scientists and activists insisting the public share their concern about climate change, the findings show the potential for connecting climate change to the social concerns of the public³⁰.

Methods

Data were collected from 24 countries (24 student samples, 10 community samples) in the period of June 2013 to July 2014. Countries were selected to span geographic regions and a wide range of climate change contributions, based on the climate change score from the Yale Environmental Performance Index²³.

The survey was developed with feedback from country contributors for applicability and relevance prior to data collection. Participants completed surveys in the major language(s) in their country, with translations performed using translation-back-translation or parallel translation. Surveys were completed either online (18 countries) or on paper (6 countries).

Participants first rated perceived climate change importance “*Addressing climate change is one of the most important issues facing society today*” (1 “Strongly disagree”, 5 “Strongly agree”), embedded among distractor items. Participants then completed a screening item asking whether participants (1) believed humans were contributing substantially to climate change, (2) believed climate change was occurring, but that humans were not contributing substantially to it, or (3) did not believe the climate was changing¹⁷. Those who chose (1) were directed to a scenario instructing them to think about their country in 2050 where people have taken action that has prevented significant climate change. Those who chose (2) or (3) were directed to a scenario instructing them to think about their country in 2050 where people have taken action aimed at preventing significant climate change. They then rated how different their country would be from today on society and character co-benefits, based on established scales⁸.

After rating the future scenarios, participants rated environmental citizenship and personal (“private sphere”) behavior using established scales²¹, and the donation behavioral measure.

Further details about samples and measures (including scale reliabilities) are contained in Supplementary Information.

Analyses were conducted on participants who identified themselves as citizens of the country, 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 skeptic sample.

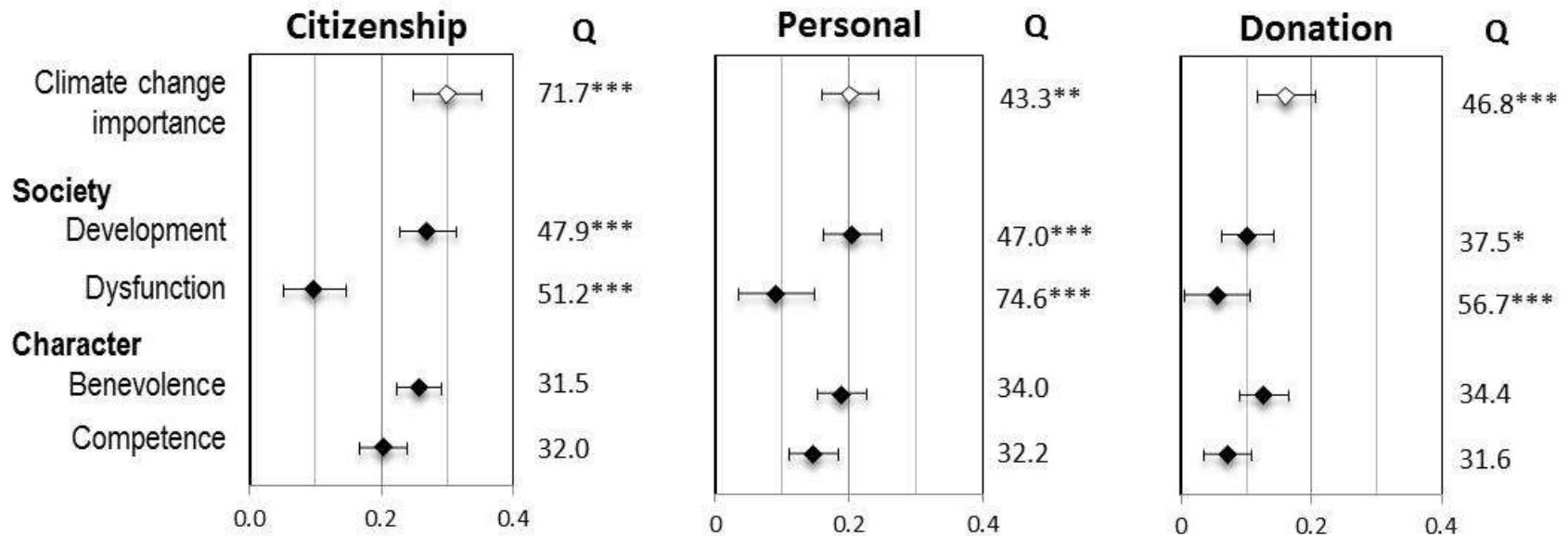
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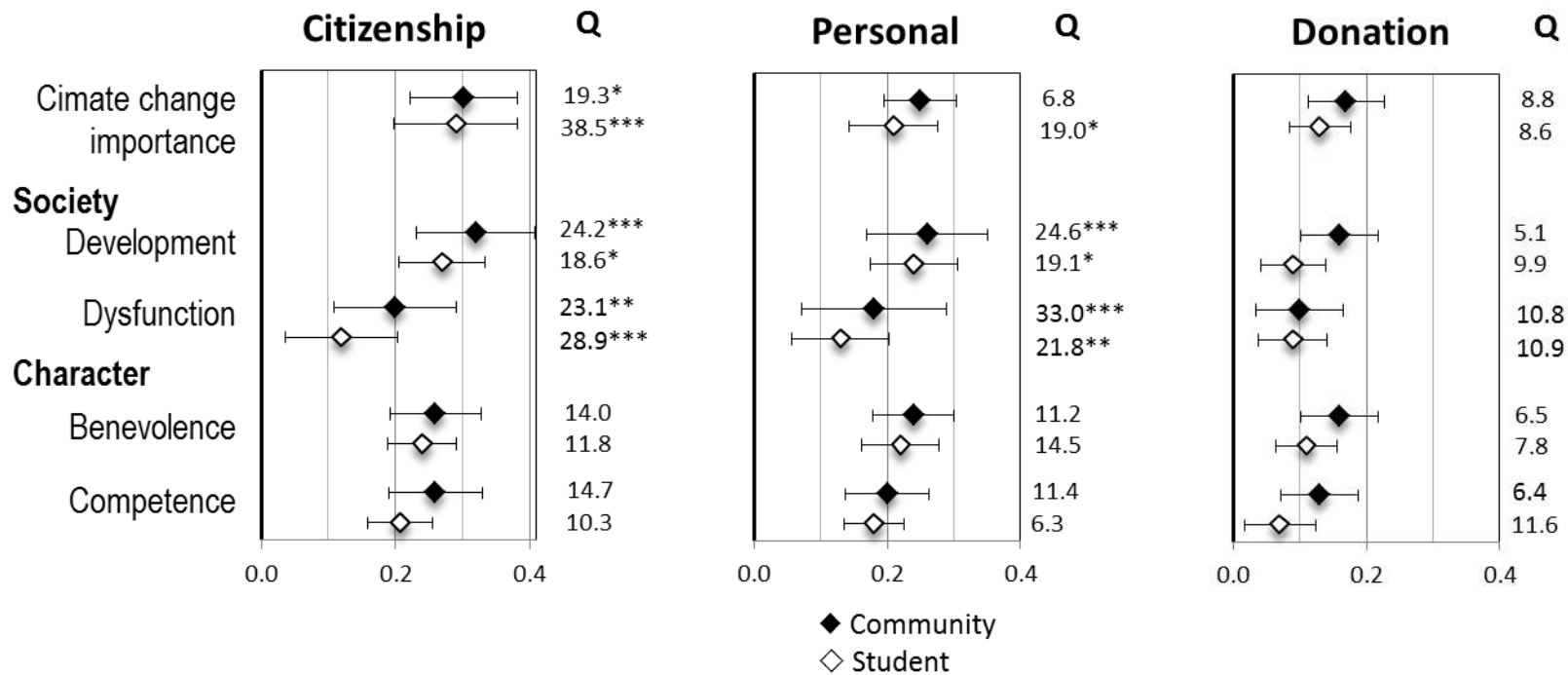
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* $p < .05$, ** $p < .01$, *** $p < .005$

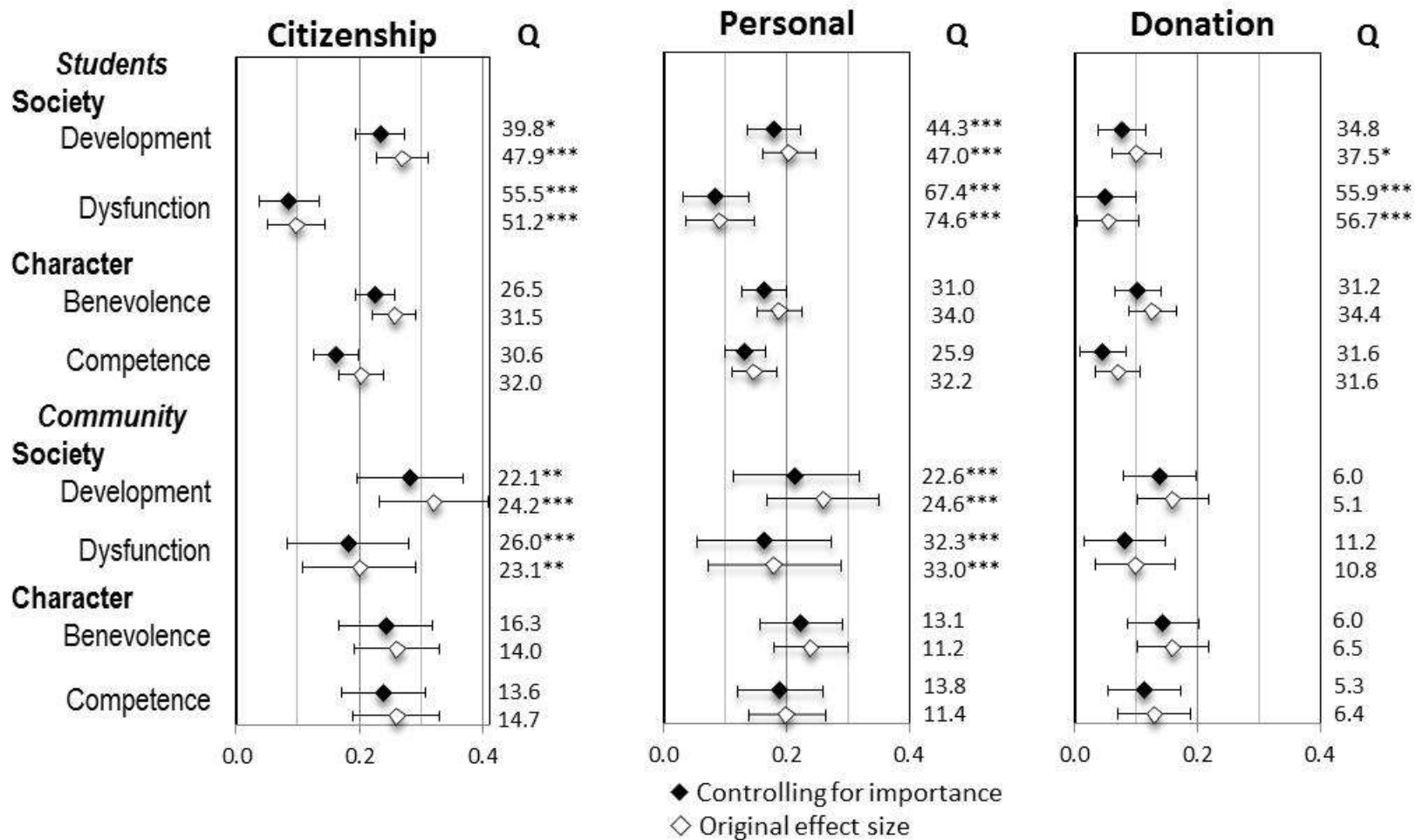
Fig. 1. Meta-analyses showing average effect sizes and cross-country variability (Q) for climate change importance and societal future beliefs with motivations to act on climate change across 24 countries.

“Citizenship” refers to public/political behaviors, “Personal” to domestic behaviors, and “Donation” is a financial behavior. Diamonds are average effect sizes, with bars showing 95% confidence intervals for the average effect. Climate Change Importance (white diamonds) serves as a benchmark for evaluating societal beliefs. The Q-statistic evaluates the extent of cross-country variability in effect sizes. Two beliefs about society’s future, Society Development and Character Benevolence, showed comparable effect sizes to Climate Change Importance across the behavioral measures. Q-statistics show that Climate Change Importance and Societal Development/Dysfunction varied in their effects across countries. In contrast, Character beliefs showed consistent effects across countries.



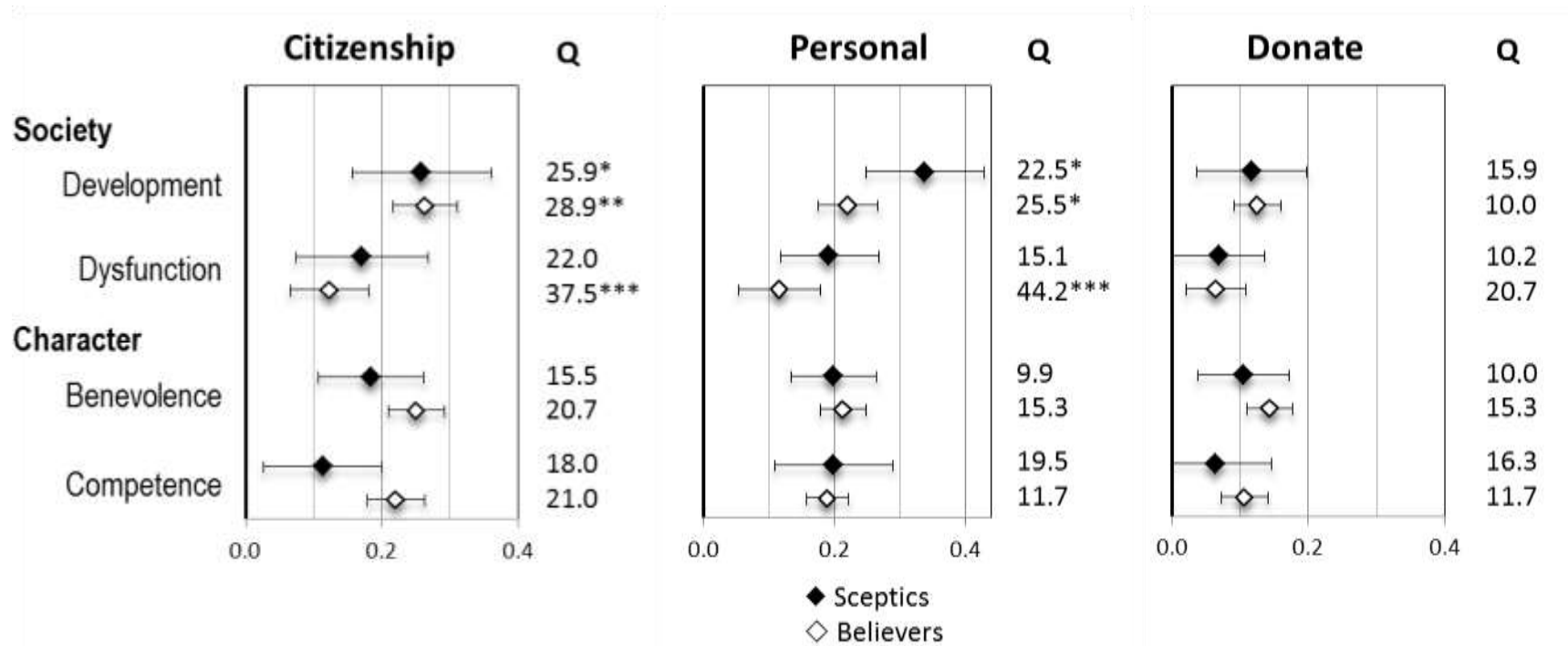
* $p < .05$, ** $p < .01$, *** $p < .005$

Fig. 3. Effect sizes and cross-country variability (Q) for community samples (N=10; black diamonds) and student samples from the same countries (white diamonds). *Community samples (black diamonds) and corresponding student samples (white diamonds) showed similar effect sizes. Although differences between community and student samples were small, community samples showed larger effect sizes in every case. This is highly unlikely to be due to chance (Binomial test, $p < .001$), suggesting that effects in the community are as strong, or stronger, than for students in these countries.*



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

Fig. 3. Effect sizes and cross-country variability (Q) for societal future beliefs after controlling for climate change importance. After controlling for climate change importance ratings (partial correlations), effect sizes for each societal belief (black diamonds) showed only small changes from the original effects reported in Figure 1 (white diamonds). This shows that societal beliefs are largely independent of climate change importance in their relationships with motivations to act on climate change.



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

Fig. 4. Effect sizes and cross-country variability (Q) for skeptics (14 countries; black diamonds) and believers from the same countries (white diamonds). *Skeptics showed the strongest effects for Development and Benevolence, consistent with believers. Skeptics showed similar or stronger effects than believers for Society dimensions (but with variation across countries), and similar or weaker effects for Character dimensions.*