

Environmental Volunteers Endorse Diverse Motivations: Using a Mixed-Methods Study to Assess Initial and Sustained Motivation to Engage in Public Participation in Science Research



CITIZEN SCIENCE:
THEORY AND PRACTICE

RESEARCH PAPER

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ABSTRACT

Understanding why individuals choose to get, and stay, involved in public participation in science research is essential to building and maintaining the strong base of participants required for many research and conservation efforts. This paper explores the differences between initial and sustained motivations of volunteers working in more- and less-intensive environmental citizen science projects in the Mid Atlantic United States. Results from our mixed-methods study show that volunteers endorse different motivation types depending on how the question is asked (survey versus semi-structured interview), and that volunteer motivation varies by program type. Although survey results did not show differences in motivation over time, interview responses indicated a potential shift from more egoistic to more collectivistic motivations. These findings connote implications for volunteer recruitment and retention including the importance of developing appeals that explicitly connect volunteer opportunities to both personal pleasure and to the support of a universal good.

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INTRODUCTION

Public participation in science research (PPSR; also referred to as citizen science) has become a staple in large-scale environmental research. Volunteer participation in these projects can create positive impacts at the scientific, individual, and ecosystem levels (Shirk et al. 2012; Stepenuk and Green 2015). Achieving the scientific and conservation goals of PPSR projects is dependent not only on recruiting volunteers, but also on retaining them (Maund et al. 2020).

This mixed-methods study explores citizen scientists' motivations for engaging with and sustaining their participation in environmental science projects with an organization focused on waterway protection and restoration in the Chesapeake Bay region of the eastern United States. We designed a survey and interview protocol with our nonprofit partner to understand what brought volunteers into the organization, and what motivated them to remain engaged, with an eye toward applying these findings to volunteer recruitment, education, and retention. This project was designed to respond to four identified gaps in existing research: the need for a better understanding of initial versus sustained motivation, particularly in water quality research (Johnson et al. 2018; Wehn and Almomani 2019); the limited research that compares differences in motivation by PPSR program type; the importance of identifying how motivational changes over time affect the management of PPSR programs (West and Pateman 2016; Wright et al. 2015); and the way a theoretical framework supports understanding underlying themes of motivation, as well as framework applicability to volunteer management (Batson, Ahmad, and Tsang 2002; Wehn and Almomani 2019).

LITERATURE REVIEW

THE ROLES OF PUBLIC PARTICIPATION IN SCIENCE RESEARCH

PPSR associated with environmental science (e.g., conservation biology, environmental health, climate change) has proved useful in collecting data at scales beyond the capabilities of individuals or teams of scientists and has contributed to scientific advancement, often with tangible environmental and/or social impacts (Bonney et al. 2014; Ballard et al. 2017). Citizen science also has indirect conservation-related outcomes through engaging and educating participants, which can result in behavioral change (Crall et al. 2013; Krasny et al. 2014; Ballard et al. 2017).

Although the role of PPSR in addressing environmental crises is clear (Ballard et al. 2017), we are still learning

what motivates citizens to do this work (West and Pateman 2016; Wehn and Almomani 2019; Woosnam et al. 2019). Indeed, West and Pateman (2016) reviewed volunteer motivations and found relatively little specifically addressing citizen scientists' motivations. However, Wehn and Almomani (2019) identified a recent increase in publications assessing motivation in citizen-based monitoring programs. Even so, the authors identify an important gap in this emerging literature; few publications are explicit about the conceptual/theoretical grounding of the work. To understand what motivates individuals more comprehensively, there is a need for studies that utilize an underlying theory of motivation.

THEORY OF MOTIVATION

This project uses Batson, Ahmad, and Tsang's (2002) four motives for community involvement as its conceptual framework. Batson et al. (2002) define motives as "goal-directed forces induced by threats or opportunities related to one's values" (p. 430). In this model, behavior alone does not sufficiently describe motivation; though multiple individuals may behave similarly, the underlying reasons for that behavior may differ greatly from individual to individual, and within an individual across different circumstances or conditions. Described in this way, motives are best considered states, rather than dispositions. This characterization of motivation transitioned the conversation about volunteer motives away from frameworks in scholarship that attempted to identify a short list of discreet motivations ("primary motives," p. 433) towards an understanding of volunteer motivation "as rich and varied as one's preferences or values" (pp. 432–433).

Batson et al. (2002) ultimately identify four key types of motivations that underlie human desires to volunteer: egoistic, altruistic, collectivistic, and principistic. Egoistic motivation, or the desire to increase one's own welfare, takes on many forms and is easy to invoke in volunteers (Batson et al. 2002). Egoistic motivations serve the common good while also benefiting the volunteer, who gains an individual material, social, or personal benefit, or avoids a punishment, such as financial losses, bad feelings, or negative social status (p. 435). For example, a homeowner on the Chesapeake Bay may grow water-filtering oysters off his dock to improve water clarity, which, in turn, secures or improves the future value of his property. A volunteer may set out in a kayak to collect data, while motivated by a desire to be outside in the beautiful weather with her spouse.

Altruism is the desire to increase the welfare of one or more individuals other than the self. Batson et al. note that altruistic motivation is not the same thing as helping behavior; the act of helping another may reflect altruism,

but it may also reflect egoism (e.g., helping an elderly person cross the street because you want to feel better about yourself). Empathy, the central emotion at play in altruistic motivation, is a feeling that Batson et al. describe as “other-oriented feelings congruent with the perceived welfare of another person” (p. 436). An altruistic motivation to participate in water quality monitoring might be concern for the ability of a fisherman that you know to maintain a source of income in polluted waterways.

Collectivist motivations aim to increase the welfare of a group or collective and can be characterized as “serving the community to benefit a group” (Batson et al. 2002, p. 437). Typically, individuals are most invested in the welfare of groups in which they are members. For environmental citizen science volunteers, collectivist motivations might include the desire to contribute to important scientific research and to affect environmental policy, or to restore water quality for the good of area residents.

The final motivation that Batson et al. ascribe to community volunteers is principlism, defined as motivation to uphold a moral principle or advance a common good aimed at ensuring the interests of all people regardless of their position in society. Batson et al. describe many common requests for volunteering, philanthropy, and community service as appeals to principlism: you should recycle your cans; it is your civic duty to vote. In environmental volunteering, these appeals may call on a shared obligation to care for non-human species, or the acknowledgement that people are a part of a complex ecosystem in which it is their moral duty to participate responsibly.

The value of this model for the purposes of this project is twofold. First, it illustrates that one behavior (here, volunteering) can be motivated by a variety of values that shift and change in relationship to a wide range of individual and contextual variables. Second, it acknowledges that each motivation type has strengths and weaknesses. This provides a clear framework for applying research findings on volunteer motivation to the goal of developing volunteer experiences that sustain motivation to participate, and as such improve PPSR outcomes.

RESEARCH ON CITIZEN SCIENCE AND ENVIRONMENTAL VOLUNTEER MOTIVATION

Research on citizen science and environmental volunteer motivation has demonstrated the prevalence of egoistic motivations. These include the experience of positive feelings such as personal satisfaction, pride, and meaningful engagement (Lawrence and Turnhout 2010; Vecina et al. 2011; Wright et al. 2015) opportunities for personal education, including skill and content knowledge

development (Bruyere and Rappe 2007; Hobbs and White 2012; Wright et al. 2015; Ganzevoort et al. 2017; Johnson et al. 2018; Ganzevoort and van den Born 2020; Maund et al. 2020); personal wellness-related outcomes like stress reduction (Hobbs and White 2012); opportunities to make friends and connect with others (Bruyere and Rappe 2007; Wright et al. 2015; Ganzevoort and van den Born 2020); and opportunities to connect with nature and place (Bruyere and Rappe 2007; Lawrence and Turnhout 2010; Wright et al. 2015; Ganzevoort and van den Born 2020).

Some volunteer motivations extend beyond individual benefits to include the impact of volunteering on other individuals or on communities. Research on citizen science volunteers documents collectivistic motivations such as the desire to participate in something bigger than oneself (Hobbs and White 2012; Ganzevoort and van den Born 2020), to make positive contributions to scientific research and conservation efforts (Johnson et al. 2018; Ganzevoort and van den Born 2020; Maund et al. 2020), and a general concern for, and desire to help, the environment (Maund et al. 2020; Bruyere and Rappe 2007).

DIFFERENCES BY VOLUNTEER/PARTICIPATION TYPE

Researchers have explored motivational differences between PPSR volunteers with different demographic profiles, levels or types of training, amounts of volunteer experience, and types of participation. West, Dyke and Pateman’s (2021) survey research showed that white, older, participants are more likely to say they’re motivated by values such as contributing to science and helping wildlife (collectivism), while a younger, more ethnically diverse, and less affluent sample were more motivated by opportunities for personal development such as learning something new or helping their career (egoism).

Ganzevoort and van den Born’s (2020) comparison of volunteers in nature-oriented initiatives found overall high levels of motivation; volunteers most often cited contributing to nature conservation (collectivistic) and their personal connection with nature (egoistic) as their primary motivations. However, researchers found some variability in motivation by volunteer type. Restoration volunteers were more motivated by being outside and working with their hands, while educators and administrators were more motivated by improving other people’s connectedness to nature. Biodiversity recording volunteers were more motivated by making a meaningful contribution to science. Similarly, McAteer, Flannery, and Murtag (2021) found that environmental volunteers’ motivation clustered into four main motivation types. “Activists” held altruistic motivations about impacting the broader society, alongside some

egoistic motivations about advancing personal learning. “Professionals” were egoistically invested in developing or using their skills related to their careers and making social connections. “Hobbyists” and “conservationists” endorsed egoistic motivations, such as personal satisfaction and the development of environmental interests.

INITIAL VERSUS SUSTAINED VOLUNTEER MOTIVATION

Increasingly, research on volunteers has considered how motivations differ between newer and more experienced participants, and at different points in time for individual volunteers. It is important to understand what maintains volunteers in addition to understanding what motivates their initial volunteerism (West and Pateman 2016). Research on experienced volunteers shows that satisfaction in volunteer work is a strong predictor of longevity (Omoto and Snyder 1995), and that high levels of personal engagement predict ongoing commitment (Vecina et al. 2011). Ganzevoort et al. (2017) studied the motivations of citizen scientists in relationship to the amount of experience they had volunteering, and found that more experienced volunteers were more likely to value collectivist motivations like contributing to science or nature conservation, whereas younger and less experienced volunteers were more likely to be strongly motivated by personal educational gains. This illustrates a key finding in motivation in relationship to time—a shift between initial egoistic motivations to more collectivistic motivations over time.

Research asking individual participants to reflect on their initial versus sustained motivations for volunteering finds a similar pattern. Rotman et al. (2014) found that multiple egoistic factors affect volunteers’ initial engagement, including personal interest (e.g., spending time with friends, building knowledge), self-promotion (furthering one’s personal opportunities), and self-efficacy (being able to conduct one’s own data analysis). As opposed to initial motivations, sustained motivations were found to be more complex and comprised of egoistic motivations that were more social and relational, such as developing partnerships with scientists, sharing common goals, receiving acknowledgement, developing mentoring relationships, and contributing to scientific research. Rotman et al. (2014) summarize their findings by noting that while most volunteers did not initiate volunteering to create change, for some people this became a key motivation to sustain engagement.

Research on initial versus sustained motivation that uses Batson et al. (2002) as an organizing framework finds small, but consistent, differences in volunteer motivation over time. In general, individuals are more likely to site egoistic motivations for beginning, and collectivistic

motivations for sustaining, their volunteerism. Larson et al. (2020) applied Batson, Ahmad, and Tsang’s (2002) four motivational categories to categorize initial versus sustained motivation of volunteers engaged in the Audubon Christmas Bird Counts. Most participants reported multiple motivations, across category types for initial and sustained motivation; however, 40% of respondents indicated that science and conservation efforts were their primary motivations for beginning to volunteer. Larson et al. coded these responses as altruistic. This percentage grew over time, with approximately 55% of individuals citing these altruistic motivations as the most important reason for their continued participation. Similarly, commitment to tradition, including obligation to contribute to the project, feeling good about being part of a group effort, and continuing an important tradition, increased in relationship to longevity in the program. Larson et al. coded these responses as collectivistic. Other egoistic, principlistic, and collectivistic motivations decreased significantly over time.

Domroese and Johnson’s (2017) research on pollinator conservation volunteers found a small, though not statistically significant, difference between original and sustained motivations. While volunteers joined the pollinator counting and tracking effort to learn more about bees (an egoistic motivation) they attributed their return to making contributions to science (a collectivistic motivation). He et al. (2019) found a similar pattern, where newly recruited seabird surveying participants cited being outside on the beach and learning about birds, while seasoned participants were more likely to cite the importance of the program’s contribution to science over personal learning outcomes. Finally, Asingizwe et al. (2020) found that while both egoistic and collectivistic factors were present in the initial and sustained motivations of citizen scientists participating in a mosquito control program in Rwanda, they shifted priority over time. Semi-structured interviews with volunteers showed that initial motivations tended to be more egoistic, including personal curiosity and a desire to learn, while sustained motivations included more collectivistic considerations, such as helping researchers and contributing to malaria control.

RESEARCH QUESTIONS

This study uses a volunteer survey and semi-structured interviews to answer the following questions: Are environmental volunteers motivated by egoistic, altruistic, collectivistic, or principlistic motivations? Are there differences in motivation by volunteer type (e.g., those who participate in more-or less- intensive PPSR programs)? Are there differences in initial versus sustained motivations for volunteering?

CONTEXT

This research was undertaken in collaboration with an American east coast environmental nonprofit focused on waterway protection and restoration in the Chesapeake Bay watershed, the largest estuary in the continental United States. Like many similar regional organizations, their work in advocacy, education, and research is supported by a large group of unpaid volunteers who serve in a range of capacities, including in three PPSR projects: Oyster Recovery (OR), Subaquatic Vegetation Monitoring (SVM), and Water Testing (WT).

Oyster Recovery volunteers are waterfront property owners who hang cages of oyster spat-on-shell from their docks, which they maintain bi-weekly throughout the nine-month growing season. The juvenile oysters are then planted by non-profit employees and/or volunteers in sanctuaries around the Bay where they contribute to the restoration of water quality and ecosystems. We consider OR less intensive PPSR.

Water Testing volunteers assist the organization's professional riverkeepers in collecting water quality samples. The nonprofit provides volunteers with equipment to assess water parameters such as clarity, salinity, dissolved oxygen, and nutrients. Samples are collected bi-monthly from April through October. All collected data is sent to a lab for processing and is made available to the public through annual report card publications.

Subaquatic Vegetation Monitoring volunteers measure the geographical extent of submerged aquatic vegetation (SAV) beds from April-October. SVM participants collect data on species, density, substrate, shoreline type, depth, clarity, and latitude and longitude of beds. SVM data is used by a regional research institute to ground-truth their annual aerial surveys and to measure progress towards the goal of increased SAV acreage. In partnership with the state Department of Natural Resources, the nonprofit uses the data to select sites to plant SAV seeds. We consider both WT and SVM to be more intensive PPSR.

METHODOLOGY

This mixed-methods study used a researcher-designed, web-based survey and semi-structured interview protocol approved through the institutional review board for human subjects research at the authors' institution. Informed consent was obtained by all participants in both survey and interview protocols. The survey included demographic questions, the Measuring Environmental Motives scale (Schultz 2001), and 25 Likert-scale questions corresponding to Batson, Ahmad and Tsang's (2002) four categories of

volunteer motivation (Supplemental File 1: Environmental Non-Profit Volunteer Survey Sample Questions). These questions were adapted from items used in other studies of citizen science volunteer motivation (Larson et al. 2020; Domroese and Johnson 2017) and extended to include language relevant to specific volunteer tasks and regional ecology. Participants responded to the same set of motivation questions two times, first with the prompt to answer while thinking about their initial motivation, and next to answer while thinking about what sustains their motivation. The interview was designed to supplement the survey findings by providing depth and context to participant responses. The protocol included 14 open-ended questions asking participants to describe the history of their participation as a volunteer in the organization, and to reflect on their initial and sustained motivations for participating (Supplemental File 2: Semi-Structured Interview Questions). Additionally, participants responded to four questions reflecting specifically on personal motivations for participation in each of Batson et al.'s (2002) four categories: egoism, altruism, collectivism, and principlism.

SURVEY

Participants were recruited via email using a bulk message sent to all organizational volunteers in the OR, SVM, and WT programs. In total, 98 volunteers completed the online survey, representing each type of citizen science program. This represents an approximately 16% response rate. The survey was answered by forty volunteers from the OR program, forty-five from the two more intensive PPSR programs (SVM and WT), and thirteen respondents participated in both the OR and SVM or WT.

The sample demographic profile aligns with similar environmental volunteering research (Ganzevoort et al. 2017; Larson et al. 2020). The survey sample was overwhelmingly white (97%), non-Hispanic (95%), and male (70%). Eighty-nine percent of the sample was over the age of 55. This sample was also highly educated, with 30% having completed a 4-year college degree, and 63% having completed a graduate degree. This sub-sample accurately reflects the population of volunteers in the organization.

Volunteers in this sample represent a range of experience with the organization, with a large number of respondents having volunteered for 2–5 years (48%). Forty percent of survey participants spend less than 1 hour a month volunteering for the organization, and 44% volunteer between 2 and 5 hours a month.

To assess whether volunteers are motivated by egoistic, altruistic, collectivistic, or principlistic motivations, and

whether the importance of these motivation types differed depending on the types of PPSR programs in which participants were involved, we performed the Scheirer-Ray-Hare extension of the Kruskal-Wallis test on our Likert-scale survey data. Post-hoc tests were made using Dunn tests with a Bonferroni adjustment. To determine whether there are differences between initial and sustained motivations for volunteering, we performed Wilcoxon Signed-Rank tests with a Bonferroni adjustment on the paired data. To assess whether there were differences among people participating in different types of PPSR programs and their response to the Measuring Environmental Motives scale (Schultz 2001), we used the Scheirer-Ray-Hare extension of the Kruskal-Wallis test with post-hoc analyses using Dunn tests with a Bonferroni adjustment. Analyses and graphics were produced using R (R Core Team 2023, version 4.2.3) and rcompanion, rstatix, dplyr, reshape2, and ggplot2 packages (Supplemental File 3: Full Citations for R Programs).

INTERVIEW

Survey respondents were given the opportunity to volunteer for an additional interview. Thirty-six participants indicated interest, and 21 completed follow-up interviews that were conducted between December 2020 and February 2021. Nineteen of the interview participants were male; 56% of participant participated in SVM or WT volunteering, 24% participated in OR volunteering, and 20% participated in both. Volunteers had been working with the organization from less than 1 to more than 10 years, with an average of about 5.5 years. Interviews were conducted by phone or on Zoom and averaged 23 minutes in length.

Participant interviews were coded using a three-round coding strategy. Preliminary inductive process coding (Saldaña 2013) identified individual motivations for participation using an in vivo coding structure aimed at identifying the specific descriptive language used by volunteers. Second-round pattern coding condensed these initial codes into 22 separate motivations for participation. Third-round deductive coding reorganized the motivations into Batson's four motivational categories.

RESULTS

INTERVIEW RESULTS

Initial versus sustained motivation

Interview participants described a greater number of initial motivations compared with sustained motivations, and the initial motivations were more diverse. Some motivations that were only initial motivations were things that happen only once, or that initiate a volunteer process, such as direct

participation recruitment; retirement and the resultant additional time; and possession of background skill, knowledge, or experience in a related area. Motivations cited as both initial and sustained but more frequently associated with initial motivation included environmental interest or concern, property ownership and value, ease of participation, a general commitment to volunteerism, and a desire to positively impact future generations.

Motivations unique to sustained participation included the desire to make a difference, the establishment of new social connections or relationships, and the ability to contribute to scientific research. Motivations cited as both initial and sustained, but more frequently associated with sustained motivation, included the benefit of learning science, enjoyment and positive feelings, positive experiences with the volunteer organization, and a commitment to oysters.

Participants were most likely to name egoistic examples for both initial and sustained motivations, but they gave more egoistic examples as initial motivators and more collectivistic examples as sustained motivators. Participants rarely offered principled motivations in the opening questions about initial versus sustained motivations for participation.

Batson motivation types

When provided with category definitions for Batson et al.'s four motivation types and asked directly to provide examples of each as they apply to their PPSR work, interviewees offered the most examples of egoistic motivation (84 total, averaging 4 examples per interview). For example, one volunteer described his initial interest as related to the value of his riverside farm, both for himself and for future generations:

The reason I started [volunteering] is I live on a farm that we've had in our family for a hundred years. It has a mile of waterfront [on the river]. So to me, growing up on that river left this need in my brain to pass that down with my grandchildren and their children. When I grew up here, we used to go down to the cove and in an hour, we could get a bushel of crabs with a dinghy and a net. Now, there aren't even any, um, underwater grasses in the cove at all. It's looking at it and saying, "how can we take and turn this over to our children and grandchildren?"

When specifically asked whether volunteering upholds a moral principle, volunteers also offered many examples of principled motivation (63 total, averaging 3 examples per interview). These were accurate examples (i.e., they fit

the Batson definitions), and often connected their efforts to advocacy, a sense of the interconnectedness of all living beings, and a responsibility to our environment. One volunteer noted:

I think it is important that we pay attention, morally, to the environment. I'm not some real liberal-type green person here, but, you know, I really do believe that we have a moral obligation to be responsible for what we do and remind others again, through [this organization that], this is important, that's their job, their advocacy... So the higher principle here is around supporting an organization with my volunteer work that will carry the message further than [my county] further than [our state].

Interviewees were least likely to offer clear collectivistic examples of volunteer motivation. These categories are the least well defined in the minds of volunteers, as evidenced by frequent overlap between category concepts (i.e., egoistic motivation, such as “making friends” listed

as an altruistic or collectivistic motivation, or collectivistic motivation “positive environmental impacts for everyone in the watershed” listed as an altruistic motivation). For example, interview responses see Supplemental File 4.

SURVEY RESULTS

Survey participants assigned different levels of importance to different types of motivation (egoistic, altruistic, collectivistic, and principistic) ($H(3) = 941.20, p < 0.0001$). In general, principistic motivations were most important while egoistic motivations were least important (Figures 1 and 2). The type of PPSR program people were involved in had a significant effect on their scores ($H(2) = 19.40, p < 0.0001$). Additionally, there was a significant interaction between motivation category and PPSR program type ($H(6) = 15.26, p = 0.0184$) (Figure 1).

Posthoc Dunn tests revealed that for individuals in the less intensive OR program, principistic motivations were more important than all other motivation categories ($p < 0.0001$), egoistic motivations were less important than all others ($p \leq 0.0001$), and there was no difference

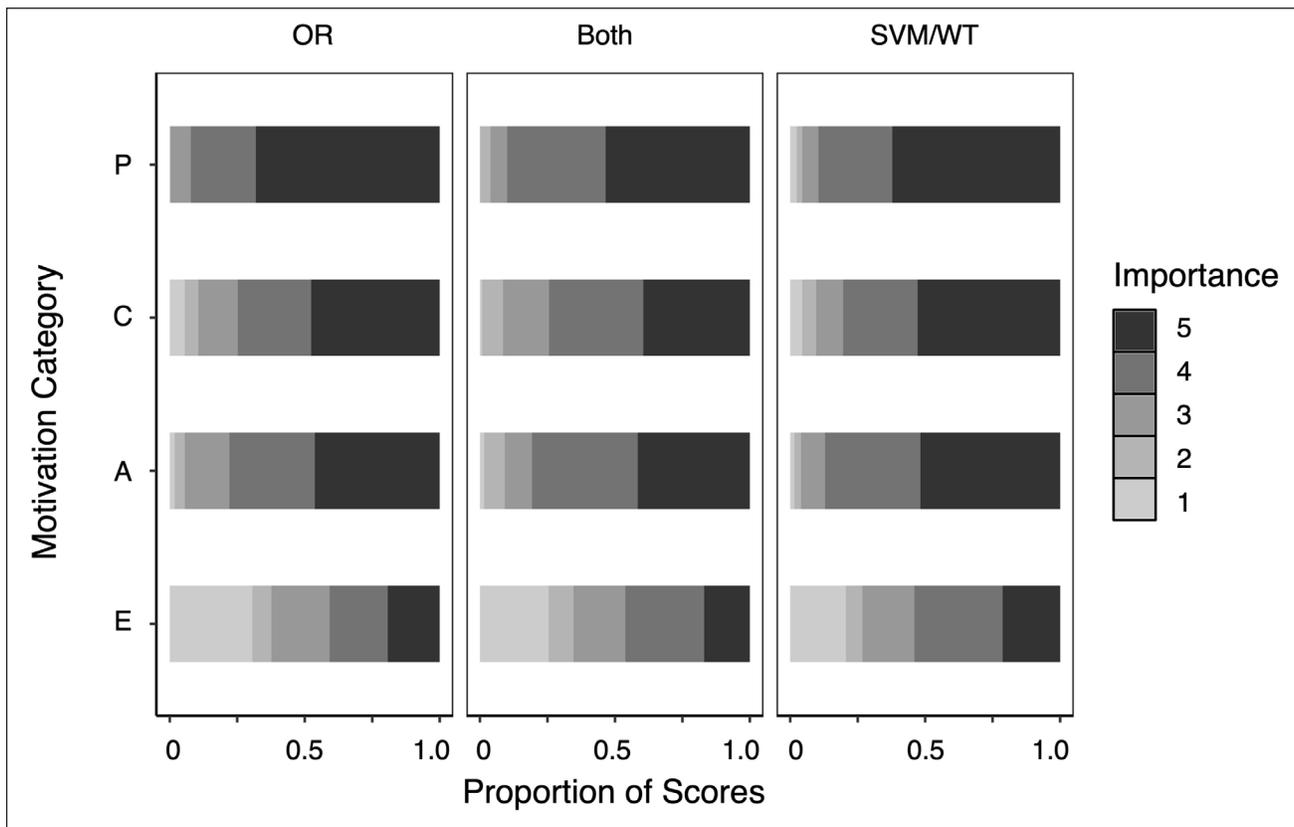


Figure 1 Results from Likert-scale survey. Importance to participants ($N = 98$) of four different types of motivation (E: Egoistic, A: Altruistic, C: Collectivistic, P: Principistic) according to which program type(s) they volunteer in (OR: Oyster Recovery, Both: Oyster Recovery and one of the more intensive PPSR programs, SVM/WT: one of the more intensive PPSR programs only). Higher importance values indicate motivations that are more important for their volunteer work. People in all programs ranked egoistic motivations lower than all other types ($p < 0.0001$). People involved in the more intensive programs (SVM/WT) scored egoistic ($p < 0.0001$) and altruistic motivations ($p < 0.05$) higher than people involved in the OR program.

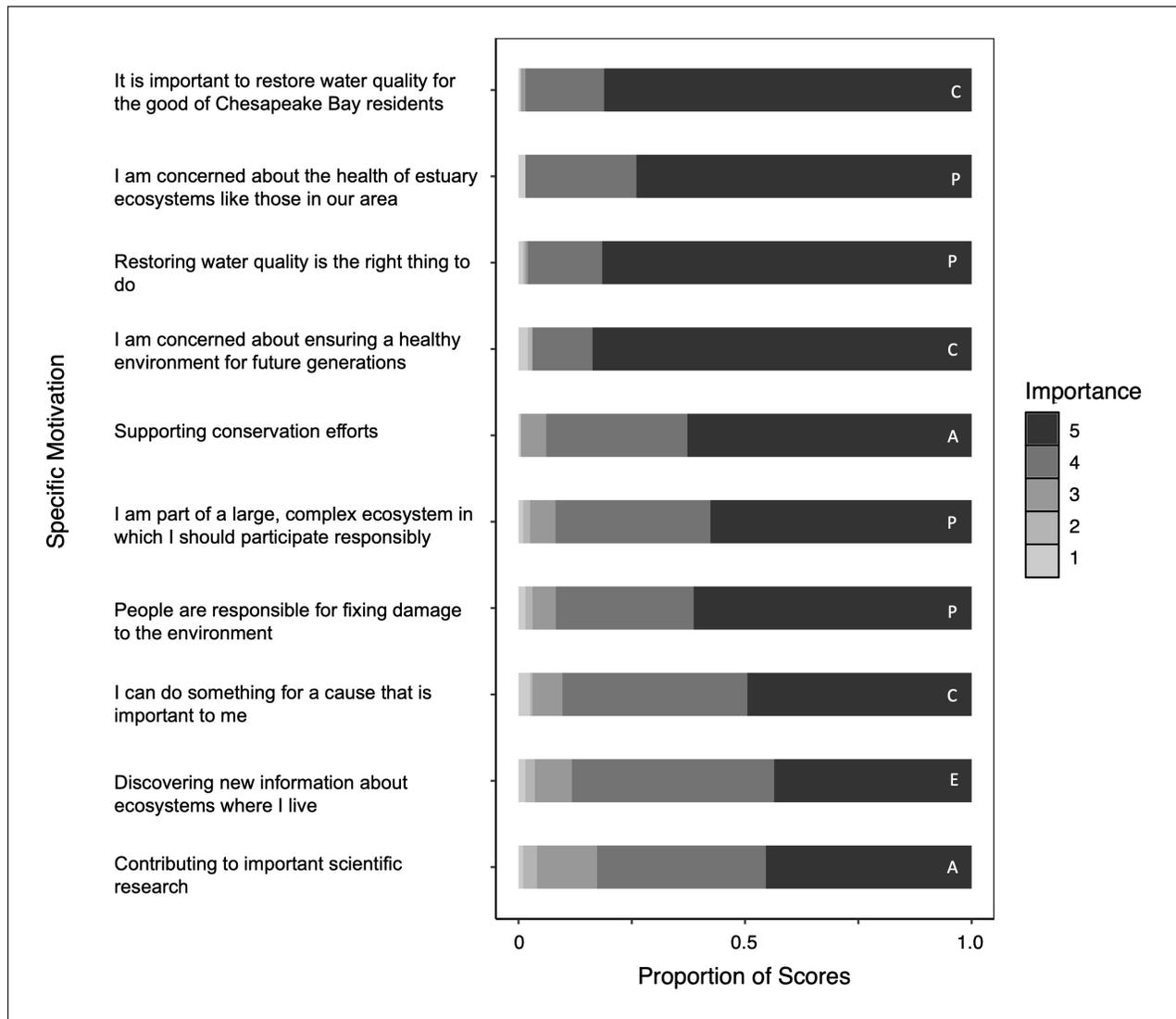


Figure 2 Top ten motivations (ranked by highest number of 4 and 5 scores) among all participants (N = 98) from the Likert-scale survey. Higher importance values indicate motivations that are more important. Motivation categories are indicated with letters on the right of each bar (P: Principlistic, C: Collectivistic, A: Altruistic, and E: Egoistic).

in importance between altruistic and collectivistic motivations. For individuals who do both OR and one or more of the more intensive PPSR programs (SVM and/or WT), egoistic motivations were less important than all others ($p < 0.0001$), and altruistic, collectivistic, and principlistic motivations were not scored differently. For individuals only in more intensive programs (SVM and/or WT), egoistic motivations were scored lower than all other types ($p < 0.0001$) and there was no difference between altruistic and collectivistic or altruistic and principlistic motivation importance, but principlistic motivations did score higher than collectivistic motivations ($p < 0.0055$) (Figure 1).

People in different PPSR programs assigned different levels of importance to the same motivation category. People involved in the less intensive OR program scored

principlistic motivations higher than those involved in both types of programs (OR and SVM and/or WT) ($p = 0.0121$). People involved in more intensive PPSR programs (SVM and/or WT) scored egoistic motivations higher than those involved in the less intensive PPSR program (OR only) ($p < 0.0001$) and higher than those individuals involved in both types of programs ($p = 0.0486$). People involved in more intensive PPSR programs scored altruistic motivations higher than those involved in less intensive PPSR (OR only) ($p = 0.0378$). There was no difference in collectivistic motivation scores (Figure 1).

When corrected for multiple tests using the Bonferroni adjustment, there was not a significant difference between sustained versus initial motivations. However, there was a trend for egoistic motivations to increase in importance over time ($Z = 2.41$, $p = 0.0159$).

Analysis of the Measuring Environmental Motives scale revealed that participants have high levels of concern for the environment, including egoistic concerns about their lifestyle, future, and health; social concerns about all people, people in their country, their children, and future generations; and biosphere concerns, which were particularly high, relating to marine life, animals, birds, and plants (Figure 3). Participants gave different scores depending on the type of concern ($H(2) = 69.041$, $p < 0.0001$) and which PPSR program participants were

involved with ($H(2) = 35.252$, $p < 0.0001$). Post-hoc tests revealed that biospheric concerns ranked significantly higher than social and egoistic concerns ($p = 0.0164$, $p < 0.0001$ respectively). Social concerns were more important than egoistic concerns ($p < 0.0001$). People in the less intensive PPSR indicated higher levels of overall concern (across all concern types) than people participating in the more intensive PPSR programs (SVM and/or WT) ($p < 0.0001$) or in both program types ($p = 0.0002$) (Figure 3).

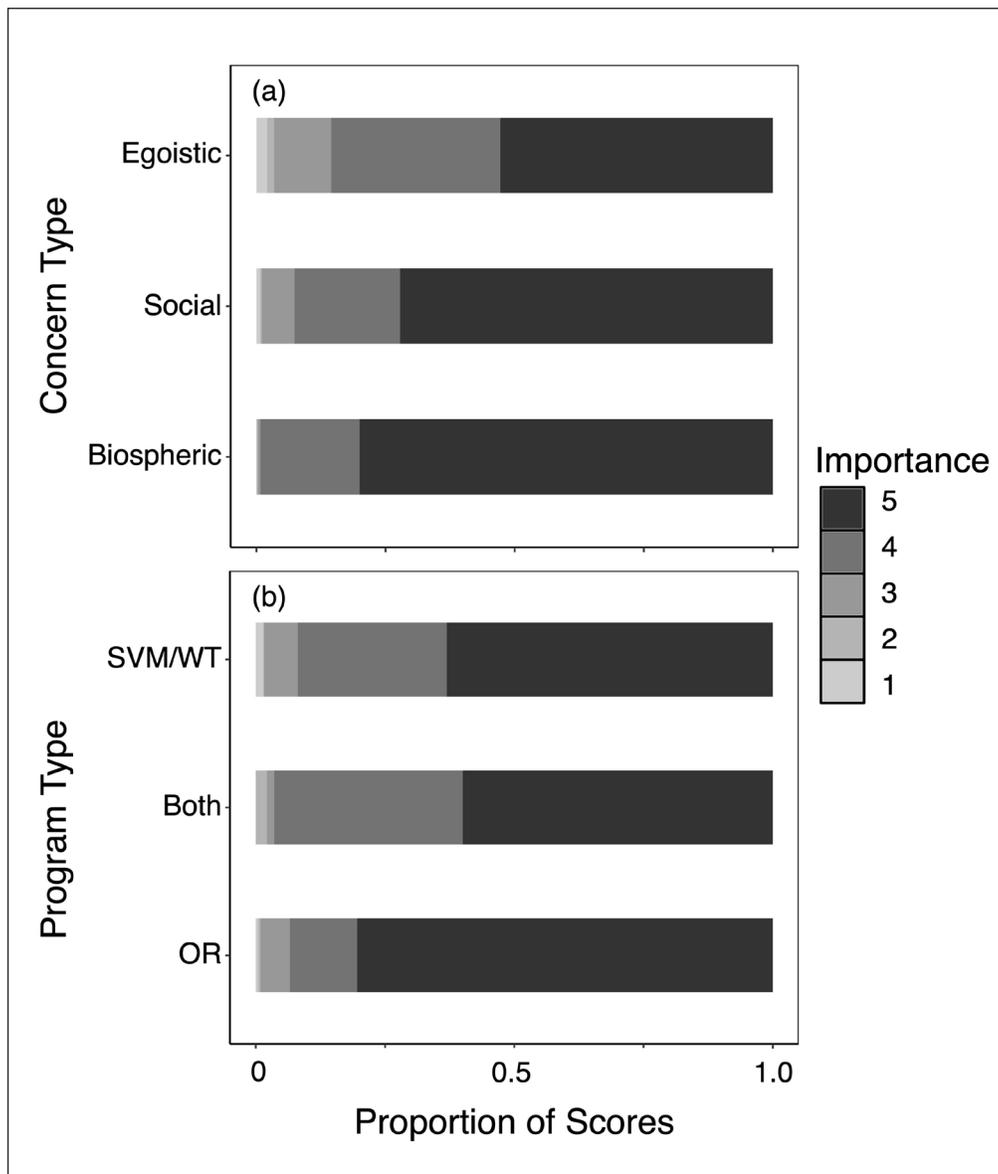


Figure 3 Results from Measuring Environmental Motives, a tool to assess the reasons for participants' ($N = 98$) general concerns about the environment. Participants ranked their concern for the environment based on egoistic, social, and biospheric reasons with higher scores indicating a greater level of concern. **(a)** Concern scores varied by concern type with biospheric concerns ranking higher than social concerns ($p = 0.016$) and higher than egoistic concerns ($p < 0.0001$) and egoistic concerns ranking lowest ($p < 0.0001$). **(b)** Concern scores also varied based on PPSR program type (OR: Oyster Recovery, Both: Oyster Recovery and one of the more intensive PPSR programs, SVM/WT: one of the more intensive PPSR programs only) with people in the Oyster Recovery program articulating higher levels of overall concern (across all concern types) than people participating in SVM/WT ($p < 0.0001$) or in both types of programs ($p = 0.0002$).

DISCUSSION

MOTIVATION OF ENVIRONMENTAL VOLUNTEERS

In this study, environmental volunteers endorse egoistic, altruistic, collectivistic, and principlistic motivations for their participation in citizen science projects. In their survey responses, volunteers ranked principlistic motivations as most important and egoistic motivations as least important. However, during interviews with a subset of volunteers, egoistic motivations were most often discussed. Principlistic motivations were discussed second most often, but only when volunteers were directly asked about this type of motivation. When asked broadly in interviews what initially motivated them to participate in PPSR programs and what sustains their motivation, volunteers most often cited egoistic motivations.

These contrasting results from written surveys and oral interviews may have multiple explanations. One potential explanation is that open-ended questions may inspire answers that focus not only on what is important to volunteers, but also what they are most comfortable or most practiced talking about. For example, many people may be more comfortable saying that they volunteer because they like being outside than that they volunteer because they have a deeply held belief that humans are responsible for fixing environmental degradation. But, when explicitly asked about their principlistic motivations, participants may be able to acknowledge those motivations. Whatever the reason for the difference in responses, our results highlight that different methods can elucidate different components of volunteers' motivations. Therefore, a mixed methods approach may capture more types of information from participants.

While principlist motivations are often cited in our interview and survey data, variables from this category are largely absent from other volunteer motivation research that uses Batson et al.'s conceptual framework. Much of the research collapses these moral obligation motivations into broader categories, such as "values" (see for example Domroese and Johnson 2017), a decision likely related to the idea that what are often presented as discrete motivational categories have considerable conceptual overlap (Asingizwe et al. 2020). This study suggests that, regardless of overlap, environmental volunteers strongly endorse principlist motivations for their own work.

Our research highlights the prominence of egoistic and principlistic motivations for PPSR. However, participants also acknowledged altruistic and collectivistic motivations as important (Figures 1 and 2). In their survey responses, participants did not score altruistic and collectivistic motivations differently, and in our interviews, responses

about altruistic and collectivistic motivations were not clearly distinguished. Perhaps there is a conceptual conflation between altruism and collectivism, especially when discussing volunteerism that is not oriented directly towards helping people. Although the distinction between helping one or more individuals other than the self (altruism) and helping a group (collectivism) might be clear when volunteering at a hospital or food pantry for example, exactly who is benefiting from environmental volunteerism may be more difficult to recognize. To alleviate confusion between altruistic and collectivistic motivations, combining concern for others into one category (e.g., Helm et al. 2018) or discussing definitions in depth with participants before surveys or interviews may be necessary.

INITIAL VERSUS SUSTAINED MOTIVATIONS

Although some previous studies found differences between volunteers' initial and sustained motivations (Domroese and Johnson 2017, He et al. 2019, Larson et al. 2020), this question has remained understudied (West and Pateman 2016, Johnson et al. 2018). On the one hand, although our survey results showed no significant differences between what initially motivates volunteers and what sustains their motivation, there was a trend for egoistic motivations to increase over time. Analysis of our interview data, on the other hand, revealed initial motivations were more egoistic and more diverse, whereas sustained motivations were more likely to be centered around making a difference through contributions to science and through interacting with other volunteers and with the organization.

Our interview findings regarding motivations over time mimic the findings of previous research. For example, surveys of volunteers in the Great Pollinator Project in New York City identified initial motivations that were centered around a desire to learn and sustained motivations that were about contributing to science and interacting with other researchers (Domroese and Johnson 2017). Similarly, in an assessment of participants in Audubon's Christmas Bird Counts, science and conservation-related motivations were more important in sustaining volunteers than in their initial motives (Larson et al. 2020). In general, our interview results may indicate a shift from more egoistic initial motivations to more collectivistic sustained motivations. Whether this pattern holds true in multiple contexts needs further study.

MOTIVATION DIFFERENCES AMONG VOLUNTEER TYPES

Our survey data showed that volunteers involved in different types of PPSR programs articulated different motivations for their work. Interestingly, people who participated in SVM or

WT (the more intensive programs) more heavily endorsed egoistic motivations than those who participated in OR (the less intensive program). There was a trend for those who participated in OR to score principled motivations higher than participants in other programs. The differences in motivations among participants in different program types may reflect differences in those individuals or differences in the program types themselves. Volunteers who participate in OR grow oysters on their docks to contribute to restoration. This action does not involve many of the egoistic benefits that are part of other programs (e.g., work with others or time outside). Instead, it involves less time and effort, but the knowledge of contributing to an important cause (principled). Volunteers who participate in SVM or WT are outside collecting data and working with others on a regular basis, which may contribute to their higher scoring of egoistic and altruistic motivations for this work.

When asked about general concerns about the environment (on the Measuring Environmental Motives scale), participants in the OR program had significantly higher levels of overall concern (across all concern types). Biospheric concerns were ranked highest and egoistic concerns were ranked lowest for participants across all PPSR programs (Figure 3). These data reinforce our finding that participants endorse a multitude of motivations and that those motivations may differ depending on program type and whether we are asking generally, or about specific actions.

STUDY LIMITATIONS

There are limitations to the methods employed in this study. First, our participants were not evaluated during two distinct time periods. Instead, during a single point in time, they were asked to reflect on both their initial and sustained motivations. Although we expect this method to capture some of the differences in initial versus sustained motivation, this method will likely miss some information because it relies, in part, on memory. We also did not capture information from volunteers who did not have sustained involvement, and therefore, we cannot discuss why some people's motivations were not sustained. Other methodologies including pre-post surveys or true longitudinal data collection may aid in answering questions about initial versus sustained motivations (He et al. 2019) as well as about participant attrition.

Additionally, as discussed above, the demographics of our participants were quite limited (predominantly white, male, highly educated, and over 55 years old). Although this is representative of the population that tends to participate in PPSR projects in the geographical area we

studied, it doesn't capture motivations of a more diverse population nor the reasons why people do not participate. Lastly, our survey and interviews were conducted during the first year of the COVID-19 pandemic, but the influence of the pandemic on PPSR remains unmeasured in this study.

CONCLUSION

The use of a theoretical framework is critical to truly understanding what underlies volunteer motivations (Wehn and Almomani 2019). Without a backdrop of theory, it is difficult to find patterns within the various motives that volunteers articulate, or to translate findings from research into practical application. Stimulating volunteer efforts, and sustaining volunteer motivation, requires an appeal to different motives and will likely be most effective when appeal strategies are applied so that the strengths of one motivation type account for the weaknesses of another (Batson et al. 2002, p. 429). In this study, participants most strongly endorsed principled motivations and least strongly endorsed egoistic motives. As a motive, principled is susceptible to rationalization, and can be easy for an individual to dismiss in a situation with competing demands. Egoism, on the other hand, is a strong motivator that is easy to invoke (He et al. 2019). Appeals for volunteers that combine an individual's desire to support universal good, for example to repair a damaged ecosystem "because it is the right thing to do," with an acknowledgment of the personal pleasure that may come from spending time on the Bay, might be particularly effective for volunteer recruitment.

Explicitly communicating with volunteers about how their volunteering efforts benefit the organization, themselves, and the environment may in turn encourage sustained motivation as individuals may be more likely to continue volunteering when they see that their motivations match their work (Clary and Snyder 1999; Millette 2008). To shape this communication, organizations must have information about the volunteers' motivations. For example, it is clear that the volunteers we surveyed have high biospheric concern and are often initially motivated by egoistic motivations, while also assigning strong importance to principled motivations. Knowing this provides an opportunity for the nonprofit organization to specifically articulate how volunteerism in their programs fits these motivations and concerns (Ganzevoort et al 2017). New research exploring the anticipatory motivations of potential citizen scientists affirms this reasoning. In a

survey of the general public, Ngo et al. (2023) found that an individual's perception of their potential contributions to science, and the perceived degree of fun and interest in the project were among the strongest factors influencing future participation in PPSR.

Two additional themes from our data that impact volunteer management for sustained motivation are the importance of connecting with other volunteers and the ease of engagement with the volunteer organization. Prior research has demonstrated the importance of social opportunities to volunteer maintenance (Ryan et al. 2001). One volunteer in our study summed up the impact of a strong social component by saying “[sustained volunteering] is easy when you're around nice people with like minds.” The importance of social ties between participants may be particularly important for older or retired volunteers, like those in our sample, who use volunteering stay socially connected.

Second, while ease of volunteering is an important condition for initial engagement, ease of continued participation remains important for sustaining volunteers (Asingizwe et al. 2020). Another citizen science volunteer shared that our partnering organization was “easy to work with... they communicate readily, easily, frequently. They let their needs be known. So it's easy to know what they're looking for at any given time... And they're encouraging, so when you do work, there's always positive feedback.” This became a common refrain; a strong reason to continue volunteering was that the organization communicated their expectations clearly, and reinforced participation with affirmations and feedback.

In sum, understanding what motivates volunteers to take part in PPSR work is central to sustaining those volunteers, increasing their satisfaction, and enabling the kind of research that PPSR is uniquely poised to contribute to science. A clearer view will come with more studies using a theoretical lens to analyze underlying motivations in PPSR volunteers and communicating with organizations and their volunteers about how motivations are connected to their volunteer efforts and outcomes.

SUPPLEMENTARY FILES

The Supplementary Files for this article can be found as follows:

- **Supplemental File 1.** Environmental Non-Profit Volunteer Survey Sample Questions. DOI: <https://doi.org/10.5334/cstp.506.s1>
- **Supplemental File 2.** Semi-Structured Interview Questions. DOI: <https://doi.org/10.5334/cstp.506.s2>

- **Supplemental File 3.** Full citations for R packages. DOI: <https://doi.org/10.5334/cstp.506.s3>
- **Supplemental File 4.** Sample Interview Responses by Batson Volunteer Motivation Category. DOI: <https://doi.org/10.5334/cstp.506.s4>

ETHICS AND CONSENT

This project was approved in the fall of 2020 by the Washington College Review Board for Research with Human Subjects (IRB experimental number is SP20-090).

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COMPETING INTERESTS

JB is an unpaid member of the advisory board for the non-profit partner organization. SCD has no competing interests.

AUTHOR CONTRIBUTIONS

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