



The complex relationship between personal sense of connection to animals and self-reported proenvironmental behaviors by zoo visitors

Alejandro Grajal,^{1*} Jerry F. Luebke,² Lisa-Anne DeGregoria Kelly,² Jennifer Matiasek,² Susan Clayton,³ Bryan T. Karazsia,³ Carol D. Saunders,⁴ Susan R. Goldman,⁵ Michael E. Mann,⁶ and Ricardo Stanoss⁷

¹Woodland Park Zoo, 5500 Phinney Avenue N., Seattle, WA 98103, U.S.A.

²Chicago Zoological Society, Center for Conservation Leadership, 3300 Golf Road, Brookfield, IL 60513, U.S.A.

³College of Wooster, Psychology Department, Morgan Hall, 930 College Mall, Wooster, OH 44691, U.S.A.

⁴Antioch University New England, Department of Environmental Studies, 40 Avon Street, Keene, NH 03431, U.S.A.

⁵University of Illinois at Chicago, Learning Sciences Research Institute, 1240 W. Harrison Street, Chicago, IL 60607, U.S.A.

⁶Pennsylvania State University, Earth System Science Center, 523 Walker Building, University Park, PA 16802, U.S.A.

⁷Smithsonian Conservation Biology Institute, Smithsonian-Mason School of Conservation, 1500 Remount Road, Front Royal, VA 22630, U.S.A.

Abstract: *The global biodiversity crisis requires an engaged citizenry that provides collective support for public policies and recognizes the consequences of personal consumption decisions. Understanding the factors that affect personal engagement in proenvironmental behaviors is essential for the development of actionable conservation solutions. Zoos and aquariums may be some of the only places where many people can explore their relations with wild animals and proenvironmental behaviors. Using a moderated-mediation analysis of a survey of U.S. zoo and aquarium visitors (n = 3588), we explored the relationship between the sense of connection to animals and self-reported engagement in proenvironmental behaviors related to climate change and how this relationship is affected by certainty that climate change is happening, level of concern about climate change, and perceptions of effectiveness in personally addressing climate change. We found a significant, directional relationship between sense of connection to animals and self-reported proenvironmental behaviors. Political inclination within the conservative to liberal spectrum did not affect the relationship. We conclude that a personal sense of connection to animals may provide a foundation for educational and communication strategies to enhance involvement in proenvironmental actions.*

Keywords: aquariums, biodiversity targets, CBD, climate change, education, moderated-mediation models, psychology, zoos

La Relación Compleja entre la Sensación Personal de Conexión con los Animales y los Comportamientos Pro-Ambientales Auto-Reportados por los Visitantes de los Zoológicos

Resumen: *La crisis mundial de biodiversidad requiere de una ciudadanía comprometida que proporcione un apoyo colectivo para las políticas públicas y que reconozca las consecuencias de las decisiones de consumo personal. Entender los factores que afectan al compromiso personal con los comportamientos pro-ambientales es esencial para el desarrollo de soluciones de conservación factibles. Los zoológicos y los acuarios pueden ser algunos de los pocos lugares en donde las personas pueden explorar sus relaciones con los animales silvestres y los comportamientos pro-ambientales. Con un análisis de mediación moderada de una encuesta a*

*email alejandro.grajal@zoo.org

Paper submitted October 9, 2015; revised manuscript accepted June 1, 2016.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

visitantes de acuarios y zoológicos de EUA (n = 3,588), exploramos la relación entre la sensación de conexión con los animales y el compromiso auto-reportado con los comportamientos pro-ambientales relacionados con el cambio climático y cómo esta relación es afectada por la certidumbre de que el cambio climático está sucediendo, el nivel de preocupación por el cambio climático y las percepciones sobre la efectividad de tratar personalmente el cambio climático. Encontramos una relación significativa y direccional entre la sensación de conexión con los animales y los comportamientos pro-ambientales auto-reportados. La inclinación política dentro del espectro conservador - liberal no afectó a esta relación. Concluimos que una sensación personal de conexión con los animales puede proporcionar un fundamento para las estrategias educativas y de comunicación para mejorar la participación en las acciones pro-ambientales.

Palabras Clave: acuarios, cambio climático, CBD, modelos de mediación moderada, objetivos de biodiversidad, psicología, zoológicos

Introduction

One of the key strategic goals of the United Nations Decade on Biodiversity (known collectively as the Aichi Biodiversity Targets [CBD 2013]) is to mainstream awareness of biodiversity values into society and governance (Aichi Target 1). Achievement of this goal requires collective public actions as well as personal commitment from citizens. Personal decisions on consumption choices or support of proenvironmental public policies play a critical role in the future of global environmental threats, such as unsustainable wildlife harvest or climate change.

Environmental education and communication strategies are often used to encourage an engaged citizenry capable of making sound personal and policy decisions. Many such education and communication strategies reflect the perception that telling someone to behave in a certain way and providing sound reasoning that supports the behavior directly affects adoption of the behavior. Yet, over the last 2 decades, this knowledge-deficit model of behavior change has been debunked by numerous research studies that show the relationship between knowledge and behavior is weak or nonexistent (e.g., Hungerford & Volk 1990; Schultz 2002; Jaspal et al. 2014; Carmi et al. 2015). Indeed, the pathways that lead to behavior change may be affected by multiple ways of learning; diversity of backgrounds and beliefs; structural, economic, and cultural factors; and social and psychological contexts that ultimately affect behavioral outcomes.

We explored one such pathway, the relationship between sense of connection to animals and self-reported proenvironmental behaviors that address climate change in zoo and aquarium visitors. Other researchers have explored relationships between connections with animals and proenvironmental behaviors (Clayton et al. 2011; Moss et al. 2015), but it is likely that this relationship is complex and not linear (Heimlich & Ardoin 2008) and that predispositions and other factors affect the relationship between connections with animals and self-reported proenvironmental behaviors. Thus, we took a multivariate approach to examine possible mediators and moderators of this relationship, including concern for the effects

of climate change on animals and people, knowledge that climate change is happening, perceptions of effectiveness of personal actions, and political inclination.

We explored the nature of the proposed relationship with moderated-mediation models (Preacher et al. 2007; Hayes 2013). We analyzed how various factors mediated and moderated the strength of the relationship between zoo and aquarium visitors' sense of connection to animals and their self-reported participation in proenvironmental behaviors, particularly in behaviors that address climate change. These factors included: level of personal concern for the effects of climate change on animals and people; perception of effectiveness of personally addressing climate change; degree of certainty that climate change is happening; lack of knowledge about the effectiveness of actions that address climate change; and self-defined political inclination of the respondents within the conservative to liberal spectrum.

Role of Zoos and Aquariums in Science Learning and Proenvironmental Behavior

At a time when the world population is increasingly urbanized, the causes and consequences of the biodiversity crisis are becoming depersonalized and distant. In large urban centers, connections between individual consumer actions and far-flung global biodiversity consequences are often muddled or invisible. For a vast proportion of the world's humans, zoos and aquariums are rapidly becoming the most important, and in many cases, the only places to experience diverse live animals. This may help explain why zoos and aquariums are widely popular.

Zoos and aquariums attract very large audiences, estimated conservatively at 700 million people annually worldwide (Gusset & Dick 2011). This large attendance cannot be solely explained by the zoos' entertainment value or marketing prowess. Zoo visits are motivated by a variety of factors, including the primeval affective bond that humans have with animals (e.g., Wilson 1984; Vining 2003; Myers et al. 2004). This bond is enhanced during the zoo and aquarium visit by encounters with animals,

which induce cognitive, affective, and social experiences (Schwan et al. 2014). In turn, these experiences may motivate care and concern for the protection of the natural environment.

Zoos and aquariums are important venues for science learning (NRC 2009) and biodiversity literacy (Gusset et al. 2014; Moss et al. 2015). It is increasingly evident that the vast majority of lifelong learning about science happens outside formal educational settings (Falk & Dierking 2010). Therefore, life-long and free-choice learning environments like zoos and aquariums have a huge potential to reach and educate the public about global environmental problems and to increase biodiversity literacy (Moss et al. 2015). Zoos can also provide information that is relevant to specific behaviors. Although knowledge by itself seems insufficient to motivate proenvironmental behavior, motivation needs to be combined with knowledge for visitors to recognize that a problem exists and to make the conceptual link between threats to biodiversity and their own behavior. How people engage in proenvironmental behaviors is also partially explained by the presence of barriers that create a gap between knowledge and actions (Kollmuss & Agyeman 2002).

Zoos and aquariums are particularly important venues for exploring the relations between visitors' sense of connection to animals and proenvironmental behaviors. Zoo and aquarium visitors experience affective engagement with animals (Myers et al. 2004; Luebke et al. 2016), which supports learning about environmental issues (Ballantyne & Packer 2005) and interest in engaging in proenvironmental behaviors that support animal conservation (Clayton et al. 2009; Clayton et al. 2011; Moss et al. 2015). The context of a zoo visit also supports construction of a social identity related to concern for animals and the environment (Clayton et al. 2011). Learning events at zoos and aquariums are facilitated by a rich social context in which visitors actively share the experience with family, friends, colleagues, interpreters, or other visitors (e.g., Falk & Dierking 2000; Allen 2002). These social conversations with family and friends are powerful elements of the overall zoo and aquarium learning experience and may greatly influence engagement in proenvironmental behaviors, even when visitors do not actively intend to learn or recognize they are learning (Clayton et al. 2009). The active explanation and interpretation within the context of the social group elicits good retention of scientific facts and appreciation of new knowledge and experiences (Briseño-Garzón et al. 2007).

Study Rationale

Our objective was to explore the relationship between zoo and aquarium visitors' sense of connection to animals and their self-reported participation in proenvironmental behaviors, particularly in behaviors that address climate change. We used a large data set from a national study of

zoo and aquarium visitors in the United States (Luebke et al. 2012). The purpose of the original study (Luebke et al. 2012) was to investigate visitors' cognitive, attitudinal, and self-reported behavioral predispositions toward climate change; their attitudes and viewpoints regarding wildlife and nature; and their self-reported engagement in proenvironmental behaviors. Overall results of the study indicate zoo and aquarium visitors exhibit higher levels of acceptance, awareness, and concern about climate change than the general U.S. public (see also, Leiserowitz et al. 2012). Luebke et al. (2012) also found that even highly receptive zoo and aquarium audiences reported barriers to their engagement in proenvironmental behaviors. For example, of the visitors who indicated they would like to do more to address climate change, 92% mentioned at least one barrier to doing so. The most prevalent barrier to action was lack of knowledge of what actions would be effective in addressing climate change. Sense of connection with animals was significantly correlated with certainty that climate change is happening, level of concern about climate change, perception of effectiveness in personally addressing climate change, and self-reported participation in proenvironmental behaviors that address climate change. These findings are consistent with those of other researchers who investigated how proenvironmental behaviors are related to the psychological connection between a person's self-identity and their perspective of their relationship with the natural world (e.g., Schultz 2001; Clayton 2003) and provide the rationale for conducting our moderated-mediation study.

Hypotheses

We hypothesized that individuals reporting a stronger sense of connection to animals are more likely to be certain that climate change is occurring, report more concern about climate change, and report a stronger perception of effectiveness in their ability to personally address climate change, and in turn, they are more likely to report their participation in proenvironmental behaviors.

Furthermore, we hypothesized that the strength of the relationship between the mediating and outcome variables is affected by 2 moderating variables: perceived lack of knowledge about the effectiveness of actions that address climate change and political inclination. We hypothesized that the mediating processes are stronger among individuals who perceive themselves as having relatively more knowledge on the topic and that the mediating processes are stronger among politically liberal individuals than conservative individuals. In the United States, environmental concern has been strongly associated with the liberal side of the political spectrum (Borick & Rabe 2010). Endorsement of free-market ideology, social norms associated with political views, and system justification (Gifford 2011) combine to encourage people

Table 1. Results of the factor analysis of self-reported proenvironmental behaviors of zoo and aquarium visitors that address climate change.^a

	<i>Response of always do it or do it sometimes (%)^b</i>	<i>Consumer behaviors (rotated factor loadings)^c</i>	<i>Environmental support behaviors (rotated factor loadings)^c</i>
Self-reported consumer behaviors			
Buy food grown locally	76	0.713*	0.265
Make at least one dinner a week meatless	62	0.710*	0.345
Swap out all incandescent (regular) light bulbs for compact fluorescents at home	72	0.674*	0.357
Turn your thermostat to 65° or lower in winter and up to 78° in summer	59	0.617*	0.423
Drive a fuel-efficient car (i.e., hybrid or a car that gets at least 30 miles per gallon)	30	0.583*	0.382
Self-reported environmental support behaviors			
Sign a petition or take political action for a conservation cause	34	0.404	0.877*
Donate money to a conservation or environmental group	39	0.405	0.855*
Talk to others about the importance of addressing climate change	39	0.498	0.803*

^aFactor analysis results based on a principal component analysis with a Promax rotation.

^bResponse scale: 6, always do it; 5, do it sometimes; 4, planning on doing it; 3, thinking about it; 2, never thought about it; 1, not interested.

^cPrimary factor loadings marked with an asterisk.

on the conservative side of the political spectrum to deny or minimize the importance of environmental problems. Because people across the political spectrum tend to rely on different sources of information (Leiserowitz et al. 2012), it can be difficult to communicate information about environmental threats in a way that is not influenced by political inclination.

Methods

Survey Overview and Data Preparation

The data set was generated using a questionnaire distributed at 10 zoos and 5 aquariums geographically distributed across the United States. (Questionnaire is given in Supporting Information.) All procedures and materials were reviewed and approved by the Institutional Review Board of the University of Illinois at Chicago. The data-collection methods were standardized across institutions to ensure a consistent data collection procedure across locations. A designated coordinator at each participating zoo and aquarium received data-collection training and procedure documents. Data-collection staff at each of the participating sites systematically approached every second group that crossed a predetermined line at various

locations and time of day within their facility. A refusal log was kept at each site and the number of visitors who refused to complete a survey was noted on a daily basis.

One questionnaire item asked visitors whether they thought climate change was happening (response range from 1, “No, but I’m not at all sure.” to 9, “Yes, and I’m extremely sure.”). We used 12 items to measure the degree of concern about the effects of climate change on self (you, your health, your lifestyle, and your future), other people (humanity, children, future generations, and people in your country), and the biosphere (animals, birds, marine life, and plants) (Schultz 2001) (response range from 1, “Not at all.” to 7, “Very much so.”). A principal-components factor analysis was used to examine latent constructs or factors underlying the 12 item ratings regarding visitors’ climate-change concerns. Only one factor underlaid the 12 items. A composite score was then calculated by taking a visitor’s total score across the 12 item ratings.

There were 8 items to assess visitors’ self-reported current actions in addressing climate change. These items were rated on a 6-point response scale ranging from 1, “Not interested.” to 6, “Always do it.” An exploratory factor analysis using a Promax rotation method with the 8 items revealed 2 underlying factors: one centered on various self-reported consumer behaviors and another

centered on self-reported environmental support behaviors. These 2 factors accounted for 54% of the variance in the ratings (Table 1). Both factors are consistent with 2 general types of environmentally significant behavior that Stern (2000) classifies as private-sphere environmentalism (consumer behaviors in our study) and public-sphere environmentalism (support behaviors). Thus, we developed a composite score by taking a respondent's total score across the respective item ratings for each factor.

Another questionnaire item asked visitors to rate their sense of connection with the animals they see at a zoo or aquarium (response range from 1, "Not at all." to 5, "I feel a strong connection."). Visitors were also asked to rate their perceived personal control over addressing climate change (response range from 1, "None." to 5, "A great deal."). Respondents also rated their political inclination on a scale ranging from 1, "Very conservative." to 5, "Very liberal." Finally, respondents indicated whether not knowing what actions would be effective was standing in their way of doing more for climate change (yes or no answer). The bivariate correlations of the variables are given in Table 2. As a prelude to the moderated-mediation model analysis, we transformed these variables to standard z scores with a mean of 0 and an SD of 1.

Moderated-Mediation Model Analysis

Moderated-mediation models offer advantages over bidirectional models of relations. Our models included one predictor variable, sense of connection with animals, and one outcome variable, level of self-reported participation in proenvironmental behaviors that address climate change. Once this bivariate relation is established, mediating models offer potential explanations for why the variables may be associated. That is, mediators answer the question of how a process occurs or through what mechanisms the predictor leads to the outcome (Baron & Kenny 1986; Hayes 2013; Karazsia et al. 2014). A moderated-mediation analysis recognizes that the mediation pathway may not be universal. That is, there may be subgroups within the sample for which the model works better or worse. In this context, the moderator variables answer the question of for whom or under what conditions the mediating paths apply (Baron & Kenny 1986; Hayes 2013; Karazsia et al. 2014).

To incorporate these constructs in a unified conceptual model, we developed 2 moderated-mediation models that were identical in all respects except for the proposed outcome variable. One model tested the relationship between sense of connection with animals and self-reported consumer behaviors (model 1) and the other tested the relationship between sense of connection with animals and self-reported environmental support behaviors (model 2). The moderated-mediation models were tested using the PROCESS Model Template 17 macro in SPSS (IBM Corp.) (Hayes 2013). To overcome limitations of the

Baron and Kenny (1986) approach to testing mediation, we used a nonparametric bootstrapping procedure to test mediation directly (MacKinnon et al. 2012). This test was accomplished by taking a large number of samples ($n > 1000$) from the original data and computing the mediating effect in each sample. A confidence interval (CI) was then generated. When the CI did not contain zero, it was considered evidence of mediation. This method yields more accurate results than traditional approaches to testing for mediation (Hayes 2013). The PROCESS macro allowed us to test the mediation paths in the context of proposed moderators simultaneously. So, the presentation of mediating effects should be fully interpreted only in the context of moderation results as well.

Results

Overall, 3588 adult visitors consented to participation, and data were available on variables in the present study from 2985 participants. The overall response rate to the questionnaire was 49%. Some salient characteristics of this sample include: The majority of respondents were females (61%), were with children younger than 13 years old (70%), were not zoo members (71%), lived within 50 miles of the zoo or aquarium (53%), and visited zoos or aquariums occasionally (57%). Respondents' ages ranged from 18 to 89 years old with an average age of 39.6 years old (SD 13.61). In terms of self-reported political inclination, 29% considered themselves very or somewhat conservative, 40% were politically moderate, and 31% were very or somewhat liberal.

These models accounted for 26.67% of the variance in self-reported consumer behaviors and 42.98% of the variance in self-reported environmental-support behaviors. As hypothesized, both overall models were significant. When the directionality was reversed, the models were not supported.

Self-Reported Consumer Behaviors

The predictor, sense of connection with animals, predicted each of the mediators significantly (certainty: $b = 0.28$ [SE 0.017], $p < 0.001$; concern: $b = 0.28$ [SE 0.18], $p < 0.001$; and perceived effectiveness: $b = 0.23$ [SE 0.018], $p < 0.001$). Two of these mediators, certainty and concern, predicted the outcome of consumer behaviors significantly, and there was a statistical trend for effectiveness (certainty: $b = 0.26$ [SE 0.22], $p < 0.001$; concern: $b = 0.21$ [SE 0.25], $p = 0.004$; and perceived effectiveness: $b = 0.07$ [SE 0.02], $p = 0.097$). There were also significant interactions between the proposed moderators and 2 of the mediators. Specifically, political inclination interacted significantly with perceived effectiveness ($b = 0.06$ [SE 0.02], $p < 0.001$) and certainty ($b = 0.06$ [SE 0.02], $p = 0.007$) in the prediction of consumer

Table 2. Bivariate correlations of variables in the moderated-mediation analysis of the relationship between the sense of connection to animals and self-reported engagement in proenvironmental behaviors.*

Questionnaire item	Questionnaire item					Mean (SD)
	2	3	4	5	6	
1. Do you feel a sense of connection with the animals you see at a zoo/aquarium? (5-point scale)	0.23	0.28	0.28	0.27	0.36	3.56 (1.04)
2. Do you think climate change is happening? (9-point scale)	-	0.56	0.38	0.33	0.44	7.53 (1.93)
3. Overall concern about the effects of climate change (composite score of 12 item ratings)		-	0.52	0.42	0.54	60.74 (18.86)
4. How much of an impact do you believe you can have personally on addressing climate change? (5-point scale)			-	0.41	0.48	3.40 (0.94)
5. Self-reported consumer behaviors (composite score of 5-item ratings)				-	0.54	21.36 (5.02)
6. Self-reported conservation support behaviors (composite score of 3 item ratings)					-	10.18 (4.16)

* All correlations significant at $p < 0.001$.

behaviors. However, 95% CIs of these conditional indirect effects overlapped, and none of them contained zero. Therefore, there was evidence of mediation at all examined levels of political inclination.

A significant interaction also emerged between knowledge and perceived effectiveness ($b = 0.10$ [SE 0.05], $p = 0.03$). Reporting the barrier lack of knowledge about what actions would be effective weakened the path between effectiveness and consumer behaviors. Specifically, when lack of knowledge was not endorsed, the magnitude of the mediating effect was 0.07 (95% CI 0.056–0.09), but when it was endorsed, the magnitude of the mediating effect decreased to 0.03 (95% CI 0.001–0.054).

Self-Reported Environmental Support Behaviors

The predictor, sense of connection with animals, predicted each of the mediators significantly (certainty: $b = 0.28$ [SE 0.017], $p < 0.001$; concern: $b = 0.27$ [SE 0.02], $p < 0.001$; and perceived effectiveness: $b = 0.23$ [SE 0.02], $p < 0.001$). Once again, 2 of these mediators, certainty and concern, predicted the outcome of support behaviors significantly, and effectiveness did not predict this outcome (certainty: $b = 0.23$ [SE 0.019], $p < 0.001$; concern: $b = 0.28$ [SE 0.02], $p = 0.002$; and perceived effectiveness: $b = 0.15$ [SE 0.17], $p = 0.36$). There were also significant interactions between one of the proposed moderators, political inclination, and 2 of the mediators. Political inclination interacted significantly with concern ($b = 0.04$ [SE 0.02], $p = 0.02$) and certainty ($b = 0.07$ [SE 0.02], $p < 0.001$) in the prediction of environmental support behaviors. However, 95% CI of these conditional indirect effects overlapped, and none of them contained

zero. Therefore, there was evidence of mediation at all examined levels of political inclination. Finally, there were no significant interactions between lack of knowledge and the 3 mediators (Fig. 1).

Discussion

Our results illuminate a complex pathway between sense of connection to animals and self-reported proenvironmental behaviors to address climate change. Each model represents a low-to-moderate amount of variance explained and is typical of applied research that attempts to explain human behavior. Individuals with a stronger sense of connection to animals were more likely to report participation in proenvironmental behaviors than individuals with less of a connection to animals. The directionality of this relationship has important implications for educational and interpretive practices in zoos and aquariums. This finding provides further evidence that education strategies and communication messaging should not be simple didactic approaches that enumerate or explain scientific facts, such as the mechanics of climate change (Kelly et al. 2014; Luebke et al. 2014; Moss et al. 2016). Rather, animal-based exhibits and programs should be designed to provide opportunities for visitors to develop, reflect upon, and articulate their sense of connection to animals. In fact, social norms and the favorable conditions of social discourse at zoos and aquariums can play vital roles in motivating proenvironmental behavior (Bamberg & Moser 2007; Osbaldiston & Schott 2012). Zoos and aquariums already provide a supportive social context in which families and social groups report enjoying the opportunity to discuss their relationship with

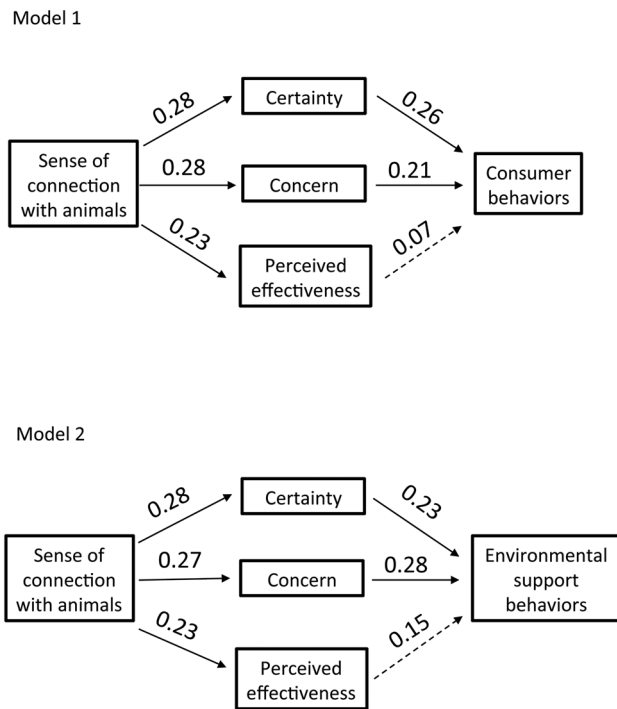


Figure 1. The relationship between zoo and aquarium visitors' sense of connection to animals and their self-reported participation in consumer proenvironmental behaviors (model 1) and environmental support behaviors (model 2) related to climate change as mediated by certainty that climate change is happening, level of concern about climate change, and perception of effectiveness of personal actions that address climate change. Values provided are unstandardized coefficients indicating the strength of the relationship between variables (dotted lines, nonsignificant coefficients).

animals and nature among themselves or with zoo educators (Luebke & Matiasek 2013). Therefore, zoos and aquariums have a powerful opportunity to effectively leverage visitors' sense of connection to animals and to weave together interpretive displays, educational opportunities, and social interactions to further engage audiences in conversations about their own relationship with animals and nature and engagement in proenvironmental behaviors. These are important lessons for zoos and aquariums and potentially for other venues where people are exposed to animals, such as national parks or wildlife reserves.

Political inclination did not affect the relationships between each of the mediating variables (certainty, concern, and effectiveness) and self-reported participation in proenvironmental behaviors to address climate change. The political polarization that has surrounded climate change in the United States (Borick & Rabe 2010; McCright & Dunlap 2011) has made it a subject that

can be difficult to communicate in a way that is not affected by politics. It is likely that conservatives and liberals exhibit differences in their levels of certainty, concern, effectiveness, and self-reported proenvironmental behaviors. Our results suggest, however, that when considering visitors' sense of connection to animals, political inclination was not a significant factor in defining the relationships between self-reported behaviors and climate-change concern, certainty, and perception of effectiveness in addressing climate change. Thus, zoos and aquariums may be able to provide a politically neutral forum for the topic of climate change.

The reliance on self-reported proenvironmental behaviors constitutes a methodological limitation of our study in that we examined self-reported perceptions of behavior, and not actual behavior. Sometimes, there are differences between self-reported environmental behaviors and observed behaviors (Kormos & Gifford 2014), although studies that empirically measure these differences are particularly difficult (Corral-Verdugo 1997) or impossible. The gap between self-reported behavior and actual behavior is sometimes attributed to a social-desirability bias under which one assumes that responses to questions about environmental issues are affected by social acceptability or social desirability concerns and by corollary one assumes that surveys measuring self-reported behaviors may not be valid. However, Milfont (2009) found a weak effect or no impact of social-desirability bias on self-reported environmental behaviors. Furthermore, Milfont found that there is no moderating effect of social desirability on self-reported environmental attitudes.

There is the potential for a relationship between individual actions and the support for local or national policies. In the case of climate change, it is still debated whether individual actions are enough to stem the tide of greenhouse gas emissions, yet research shows that public perceptions of risk drive policy as much or more than scientific arguments (Tierney et al. 2001). There is also strong evidence that engagement in individual consumer behaviors can pave the way for further public support for more assertive individual engagement in climate-change communications, policy, and activism, what Dietz et al. (2009) call the social-behavioral wedge.

Although we focused on climate change, we suspect that similar pathways may exist between the sense of connection to animals and self-reported proenvironmental behaviors that address other biodiversity threats. Individual activities by themselves may not be sufficient to create social movements or structural changes to global environmental problems. But individual engagement in proenvironmental behaviors can send a strong symbolic message to engage others and foster the emergence of innovation and social learning, which help to define early adoption activities or solutions (Arroyo & Preston 2007). Research has demonstrated that people are more likely to engage in proenvironmental behaviors when they perceive that

others are also doing so, particularly others with whom they have something in common (Goldstein et al. 2008). Zoo and aquarium visits allow people to experience positive emotional connections with animals in a context of socially shared experiences, demonstrating social support for environmental protection. With over 700 million annual visits worldwide (Gusset & Dick 2011), zoos and aquariums may help individuals overcome perceived barriers to their engagement in proenvironmental behaviors while building bottom-up political and economic pressures that encourage various social groups to develop coalitions and leverage strengths (Arroyo & Preston 2007; Moser 2010). This may lead to stronger collective support for larger social changes, including policy and economic incentives that address global biodiversity threats. It is essential that more research be dedicated to increasing comprehension of how people value biodiversity and of the factors that motivate their engagement in proenvironmental consumer choices and actions.

Acknowledgments

This material is based on work supported by the National Science Foundation under grant 1043284. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. The authors acknowledge the participation of 15 collaborating zoos and aquariums: Aquarium of the Bay, Chicago Zoological Society - Brookfield Zoo, Columbus Zoo, Como Park Zoo & Conservatory, Indianapolis Zoo, Louisville Zoo, Monterey Bay Aquarium, National Aquarium (Baltimore), New England Aquarium, Oregon Zoo, Pittsburgh Zoo and PPG Aquarium, Roger Williams Park Zoo, John G. Shedd Aquarium, Toledo Zoological Gardens, and Woodland Park Zoo.

Supporting Information

The survey questionnaire of zoo and aquarium visitors (Appendix S1) is available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature Cited

- Allen S. 2002. Looking for learning in visitor talk: a methodological exploration. Pages 259–303 in Leinhardt G, Crowley K, Knutson K, editors. *Learning conversations in museums*. Lawrence Erlbaum, Mahwah, New Jersey.
- Arroyo V, Preston B. 2007. Change in the marketplace: business leadership and communication. Pages 319–338 in Moser SC, Dilling L, editors. *Creating a climate for change: communicating climate change and facilitating social change*. Cambridge University Press, Cambridge.
- Ballantyne R, Packer J. 2005. Promoting environmentally sustainable attitudes and behaviour through free-choice learning experiences: What is the state of the game? *Environmental Education Research* **11**:281–295.
- Bamberg S, Moser G. 2007. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behavior. *Journal of Environmental Psychology* **27**:14–25.
- Baron RM, Kenny DA. 1986. The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology* **51**:1173–1182.
- Borick C, Rabe B. 2010. A reason to believe: examining the factors that determine individual belief in global warming. *Social Science Quarterly* **91**:777–800.
- Briseno-Garzon AD, Anderson D, Anderson A. 2007. Adult learning experiences from an aquarium visit: the role of social interactions in family groups. *Curator* **50**:299–318.
- Carmi N, Arnon S, Orion N. 2015. Transforming environmental knowledge into behavior: the mediating role of environmental emotions. *Journal of Environmental Education* **46**:183–201.
- Clayton S. 2003. Environmental identity: a conceptual and an operational definition. Pages 45–65 in Clayton S, Opatow S, editors. *Identity and the natural environment*. MIT Press, Cambridge, Massachusetts.
- Clayton S, Fraser J, Burgess C. 2011. The role of zoos in fostering environmental identity. *Ecopsychology* **3**:87–96.
- Clayton S, Fraser J, Saunders C. 2009. Zoo experiences: conversations, connections, and concern for animals. *Zoo Biology* **28**:377–397.
- Convention on Biological Diversity (CBD). 2013. Aichi biodiversity targets. CBD, Montreal. Available from <http://www.cbd.int/sp/targets/default.shtml> (accessed September 2015).
- Corral-Verdugo V. 1997. Dual 'realities' of conservation behavior: self-reports vs observations of re-use and recycling behavior. *Journal of Environmental Psychology* **17**:135–145.
- Dietz T, Gardner GT, Gilligan G, Stern PC, Vandenberg MP. 2009. Household actions can create a behavioral wedge to rapidly reduce U.S. carbon emissions. *Proceedings of the National Academy of Sciences of the United States of America* **106**:18452–18456.
- Falk JH, Dierking LD. 2000. *Learning from museums: visitor experiences and the making of meaning*. Altamira Press, Walnut Creek, California.
- Falk JH, Dierking LD. 2010. The 95 percent solution: school is not where most Americans learn most of their science. *American Scientist* **98**:486–493.
- Gifford R. 2011. The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *American Psychologist* **66**:290–302.
- Goldstein N, Cialdini R, Griskevicius V. 2008. A room with a viewpoint: using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research* **35**:472–482.
- Gusset M, Dick G. 2011. The global reach of zoos and aquariums in visitor numbers and conservation expenditures. *Zoo Biology* **30**:566–569.
- Gusset M, Moss A, Jensen E. 2014. Biodiversity understanding and knowledge of actions to help protect biodiversity in zoo and aquarium visitors. *WAZA Magazine* **15**:14–17.
- Hayes AF. 2013. *Introduction to mediation, moderation, and conditional process analysis*. The Guilford Press, New York.
- Heimlich JE, Ardoin NM. 2008. Understanding behavior to understand behavior change: a literature review. *Environmental Education Research* **14**:215–237.
- Hungerford HR, Volk T. 1990. Changing learner behavior through environmental education. *Journal of Environmental Education* **21**:8–21.

- Jaspal R, Nerlich B, Cinnirella M. 2014. Human responses to climate change: social representation, identity and socio-psychological action. *Environmental Communication* **8**:110–130.
- Karaszia BT, Berlin KS, Armstrong B, Janicke DM, Darling KE. 2014. Integrating mediation and moderation to advance theory development and testing. *Journal of Pediatric Psychology* **39**:163–173.
- Kelly L-AD, Luebke JF, Clayton S, Saunders CD, Matiasek J, Grajal A. 2014. Climate change attitudes of zoo and aquarium visitors: implications for climate literacy education. *Journal of Geoscience Education* **62**:502–510.
- Kollmuss A, Agyeman J. 2002. Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* **8**:239–260.
- Kormos C, Gifford R. 2014. The validity of self-report measures of proenvironmental behavior: a meta-analytic review. *Journal of Environmental Psychology* **40**:359–371.
- Leiserowitz A, Maibach E, Roser-Renouf C, Hmielowski J. 2012. Global warming's six Americas in March 2012 and November 2011. Yale University and George Mason University, Yale Project on Climate Change Communication, New Haven, Connecticut. Available from <http://environment.yale.edu/climate/files/Six-Americas-March-2012.pdf> (accessed September 2015).
- Luebke JF, Clayton S, Saunders CD, Matiasek J, Kelly L-AD, Grajal A. 2012. Global climate change as seen by zoo and aquarium visitors. Chicago Zoological Society, Brookfield, Illinois.
- Luebke JF, Kelly L-AD, Grajal A. 2014. Beyond facts: the role of zoos and aquariums in effectively engaging visitors in environmental solutions. *WAZA Magazine* **15**:27–30.
- Luebke JF, Matiasek J. 2013. An exploratory study of zoo visitors' exhibit experiences and reactions. *Zoo Biology* **32**:407–416.
- Luebke JF, Watters JV, Packer J, Miller LJ, Powell DM. 2016. Zoo visitors' affective responses to observing animal behaviors. *Visitor Studies* **19**:60–76.
- MacKinnon DP, Lockwood CM, Williams J. 2012. Confidence limits for the indirect effect: distribution of the product and resampling methods. *Multivariate Behavioral Research* **39**:99–128.
- McCright AM, Dunlap RE. 2011. The politicization of climate change and polarization in the American public's view of global warming 2001–2010. *Sociological Quarterly* **52**:155–194.
- Milfont TL. 2009. The effects of social desirability on self-reported environmental attitudes and ecological behavior. *Environmentalist* **29**:263–269.
- Moser SC. 2010. Costly knowledge—unaffordable denial: the politics of public understanding and engagement on climate change. Pages 161–187 in Boykoff MT, editor. *The politics of climate change*. Oxford Routledge, London.
- Moss A, Jensen E, Gusset M. 2015. Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1. *Conservation Biology* **29**:537–544.
- Moss A, Jensen E, Gusset M. 2016. Probing the link between biodiversity-related knowledge and self-reported pro-conservation behaviour in a global survey of zoo visitors. *Conservation Letters* DOI: 10.1111/conl.12233.
- Myers OE Jr, Saunders CD, Birjulin AA. 2004. Emotional dimensions of watching zoo animals: an experience sampling study building on insights from psychology. *Curator* **47**:299–321.
- NRC (National Research Council). 2009. Learning science in informal environments: people, places, and pursuits. Pages 11–26 In Bell P, Lewenstein B, Shouse AW, Feder MA, editors. *Committee on learning science in informal environments*. The National Academies Press, Washington, D.C.
- Osbaldiston R, Schott J. 2012. Environmental sustainability and behavioral science: meta-analysis of pro environmental behavior experiments. *Environment and Behavior* **44**:257–299.
- Preacher KJ, Rucker DD, Hayes AF. 2007. Addressing moderated mediation hypotheses: theory, methods, and prescriptions. *Multivariate Behavioral Research* **42**:185–227.
- Schultz PW. 2001. The structure of environmental concern: concern for self, other people, and the biosphere. *Journal of Environmental Psychology* **21**:321–339.
- Schultz PW. 2002. Knowledge, information and household recycling: examining the knowledge-deficit model of behavior change. Pages 67–82 in Dietz T, Stern PC, editors. *New tools for environmental protection: education, information, and voluntary measures*. National Academy Press, Washington, D.C.
- Schwan S, Grajal A, Lewalter D. 2014. Understanding and engagement in places of science experience: science museums, science centers, zoos, and aquariums. *Educational Psychologist* **49**:70–85.
- Stern PC. 2000. Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues* **56**:407–424.
- Tierney KJ, Lindell MK, Perry RW. 2001. Facing the unexpected: disaster preparedness and response in the United States. Joseph Perry Press, Washington, D.C.
- Vining J. 2003. The connection to other animals and caring for nature. *Human Ecology Review* **10**:87–99.
- Wilson EO. 1984. *Biophilia*. Harvard University Press, Cambridge, Massachusetts.

