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I Am a Scientist… Ask Me Anything: explicating the role of past behavioral attitudes on scientists' future public engagement intentions

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Abstract   There is growing pressure within the scientific community for scientists to participate in public engagement of science (PES) activities. As such, science communication scholars have worked to identify factors that predict a scientist's intention to participate in PES activities. One factor that has not been explicated is the role of experience performing PES activities in the past on one's future behavioral intentions. Using an augmented theory of planned behavior, we examine how one's experience participating in a question-and-answer forum on the popular website Reddit affected scientists' willingness to participate in a future PES activity.

The call for scientists to engage with the public has grown louder and more urgent over the past decade. Indeed, leaders within the scientific community have united to urge their colleagues to participate in public engagement events [Leshner, 2003, 2015; Peters, 2013], as research suggests that positive interactions between scientists and the public increase understanding and excitement about science [Sardo & Grand, 2016; Rose, 2017]. Federal funding agencies, such as the National Science Foundation, have moved to incentivize public engagement as grant applications are encouraged to include a description of the broader impacts one's research has on the public [National Science Foundation, 2002]. In response to the growing need for scientists to engage with the public, coupled with the pressures from granting agencies, much research within science communication has been dedicated to investigating the factors that motivate a scientist to engage with the public. Understanding these factors helps practitioners develop effective messages and trainings that can aid scientists in their science communication endeavors. Here we build upon this research by examining the role that *experience* performing a behavior in the past has on one's willingness to participate in a future public engagement activity.

The primary focus of previous research has been developing an understanding of the cognitive and affective factors that predict a scientist's intention to participate in a future public engagement event in an effort to build a model of scientists' public engagement intentions. Public engagement with science (PES) activities are defined as any event or interaction where scientists are actively interacting with a non-scientist public outside of the classroom [Besley, 2015]. Previous research examining these interactions largely adopt the Theory of Planned Behavior [TPB; Ajzen, 1991] as the primary framework guiding their model-building endeavors as the TPB effectively predicts a range of desired behaviors such as recycling [Park & Ha, 2014] and blood donation [Masser, White, Hyde, Terry & Robinson, 2009]. Most of the model's concepts — attitude towards public engagement activities and self-efficacy perceptions — consistently predict a scientist's willingness to participate in a future engagement activity [Besley, Dudo, Yuan & Lawrence, 2018; Besley, Newman, Dudo & Tiffany, 2020; Copple et al., 2020; Dudo, 2013; Dudo & Besley, 2016]. These studies have primarily depended on large-scale surveys as they were designed with theory-construction in mind. As such, they have largely been unable to isolate and extrapolate the role that *previous* experience performing a public engagement activity might play on future willingness. Indeed, it is likely that one's experience performing a behavior in the past likely influences not only their willingness to perform the behavior again but also one's attitudes towards the behavior *and* one's evaluation of their ability to perform that behavior.

This is an important gap in the literature as research suggests that scientists *are* engaging with the public [Dudo, Kahlor, AbiGhannam, Lazard & Liang, 2014; Peters, 2013] and these experiences are likely affecting how scientists feel about future public engagement endeavors. For instance, one might think that if a scientist had a poor experience, then this experience would deter them from future outreach or lead them to have a poor outlook on the public's interest in science. Experience performing a behavior in the past, furthermore, is an important predictor of future behavioral intention [Ajzen, 2015]. While most recent studies have included past behavior as a control variable, Besley [2015] took the first step in isolating the role of past behavior by examining how past online engagement *overall* impacts future engagement. Besley [2015] noted, however, that the analysis was unable to "assess the degree to which scientists' actual online behaviors were high quality attempts at policy dialogue or to fully assess whether their future efforts would be dialogue based" [p. 202]. This is an important limitation because, PES activities often involve a dialogue between scientists and the public, rather than one-way communication [e.g., an op-ed in a newspaper; Bauer & Jensen, 2011; Brossard & Lewenstein, 2009]. By looking at past engagement overall, researchers are unable to account for whether the scientists received feedback from the public, which likely impacts their attitudes and cognitions relative to public engagement [Andrews, Weaver, Hanley, Shamatha & Melton, 2005]. As a response to this gap in the literature, we conducted a survey among scientists who have participated in a specific type of PES activity: participation in a Reddit "I am a Scientist... Ask Me Anything. Utilizing components of the TPB we examine how their experience participating on the platform influenced their attitude towards PES events, perceived self-efficacy, social norms about PES, and willingness to participate in a future PES activity.

Our reasoning for focusing on Reddit is two-fold. First, Reddit is a popular website with more than 52 million daily active users and a large audience of over 430

million total active users [Dean, 2021]. The main function of Reddit is for users to engage in conversations about posted content with other users on the platform. The overall platform is made up of individual "subreddits," which are forums dedicated to a specific topic where users post and comment on information relevant to that topic. In the research reported here, we focus on the subreddit dedicated to question-and-answer sessions which have often been carried out by members of the scientific community. This subreddit is called "I am a... Ask Me Anything" (r/IAmA). r/IAmA has over 21 million members and is the eighteenth most popular subreddit [Todorov, 2022]. In r/IAmA a scientist may create a post describing themselves, their research, and their position, and then members of the group may ask the scientist questions and engage in a conversation with the scientist and other members of the site. For example, an individual might post "I am an ecologist, Ask Me Anything" and then they would answer questions posed to them. Typically, the scientist answering questions stays on the site for a pre-specified amount of time that they chose (e.g., two hours) enabling users to ask questions and receive an answer from the scientist in real time. Between the years 2014 and 2018 the subreddit hosted up to five science-related AMA sessions each week [Wikipedia, 2022] resulting in a large number of scientists engaging in conversations about science with members of the platform over these years. The second reason for our focus on an online community is that recent scholarship has been dedicated to investigating scientists' use of social media as a means for engaging with the public, because it is seen as an "important channel for interactions between scientists and the public" [Dudo & Besley, 2016, p. 5]. Indeed, social network sites (SNSs) afford scientists the opportunity to engage members of the public in a dialogue about science. The SNS Reddit exemplifies this affordance as the main purpose of the site is for individuals to engage in a conversation about a given topic.

Given the prevalence of scientific engagement occurring on this site, a growing number of studies have focused their attention on understanding Reddit as an outlet for PES. Edwards and Ziegler [2022], for example, observationally investigated whether U.S. National Oceanic and Atmospheric Administration scientists participated in Reddit AMAs with either "deficit" or "dialogue" communication goals in mind. Hubner and Bond [2022], furthermore, observationally investigated whether there were gendered differences in the way male and female scientists were treated during their AMA sessions. While studies such as these have been important endeavors in understanding PES on the platform, they largely rely on observational methods and are thus limited in the measures they are able to obtain. As such, they are unable to measure how the scientists themselves feel about the activity and whether their experience participating in a Reddit AMA affected their evaluations of PES activities in general. By surveying a sample of scientists who are known to have engaged in this type of PES activity, we are able to better understand these perceptions and how they may relate to future behavioral intentions.

Theoretical background

Public engagement activities range from informal activities (e.g., a science pub night) to formal activities (e.g., a town hall meeting). Critically, these activities allow for scientists and members of the public to engage in an active conversation about scientific topics [Bauer & Jensen, 2011]. While this type of bidirectional activity is considered best practice by science communication scholars, research has

shown that scientists themselves tend to favor participating in unidirectional activities where they do not need to invest time in tailoring their messages for a particular audience [Yuan et al., 2017].

Scientists' preference for unidirectional interactions reflects a traditional top-down approach to public outreach known as the deficit model approach [Brossard & Lewenstein, 2009]. According to the deficit model approach, scientists are responsible for educating the public about their science [Ziman, 1991]. Early analyses of scientists' prioritization of communication objectives found that scientists preferred deficit-type objectives such as educating the public about science and protecting science from misinformation [Besley & Nisbet, 2013; Dudo & Besley, 2016]. This perspective about the public seems to be shifting as recent studies have found that scientists prioritize communication objectives such as helping people use science to make better personal decisions and ensuring that culture values science [Besley, Dudo & Yuan, 2018; Besley et al., 2020]. Regardless of the objectives that scientists have in mind when setting out to participate in a public engagement activity, we know that having scientists engage with members of the public increases understanding about scientific topics [Rose et al., 2020] and builds excitement about science [Sardo & Grand, 2016]. Given the positive outcomes that arise from scientific outreach, much research has been invested into identifying the factors that predict a scientist's willingness to participate in PES activities. These research efforts are largely guided by the Theory of Planned Behavior [TPB; Fishbein & Ajzen, 2010].

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is one of the most widely tested behavioral models in the social sciences [Ajzen, 2011; Armitage & Conner, 2001]. The model focuses on understanding one's *intention* to perform a behavior, positing that intention will lead to performance of the behavior [Ajzen, 1991]. According to the TPB, behavioral intention is largely explained by three constructs: one's *attitude* towards the behavior, one's assessment of their *ability* to perform the behavior (self-efficacy), and *social norms* relevant to the behavior [Ajzen, 1991]. The TPB has informed much of the research investigating scientists' willingness to engage with members of the public [e.g., Besley, 2015; Besley, Dudo & Yuan, 2018; Besley, Dudo, Yuan & Lawrence, 2018; Besley et al., 2020; Dudo & Besley, 2016; Poliakoff & Webb, 2007]. Most of the studies using the TPB have found that attitudes towards public engagement, norms related to public engagement, and efficacy levels have a positive effect on one's willingness to participate in a public engagement activity [e.g., Besley, Dudo & Yuan, 2018; Besley, Dudo, Yuan & Lawrence, 2018; Besley et al., 2020; Besley, O'Hara & Dudo, 2019].

Within the TPB, one's attitude towards a behavior is one of the strongest predictors of whether the individual will perform the behavior [Glasman & Albarracín, 2006]. Essentially, the model predicts that if an individual has a positive attitude towards a behavior, they will have a high intention to perform the behavior. On the other hand, if they possess a negative attitude towards it, they will likely not perform the behavior. Unsurprisingly, most studies examining a scientist's willingness to engage with the public have found that attitude is a strong predictor of willingness [Besley, Dudo & Yuan, 2018; Besley, Dudo, Yuan & Lawrence, 2018; Besley et al.,

2020; Besley et al., 2019; Dudo, 2013; Dudo & Besley, 2016]. Essentially, scientists who have a positive attitude towards public engagement activities are more willing to participate in public engagement activities.

Beyond attitudes, the TPB predicts that a scientist's belief that they possess the ability to engage with members of the public (internal efficacy) compounded with their belief that engaging with the public will have a beneficial impact on members of the public (external efficacy) will have a positive effect on their willingness to engage with members of the public. Internal efficacy, therefore, is largely the scientist's assessment of whether they possess the skills necessary to communicate effectively with members of the public. Previous research has found that internal efficacy is a consistent predictor of willingness to engage with members of the public [Besley et al., 2020; Besley, Dudo & Yuan, 2018; Besley et al., 2019; Copple et al., 2020]. While response efficacy is also a consistent predictor of willingness to participate [e.g., Besley, Dudo, Yuan & Lawrence, 2018] we focus solely on internal efficacy as we are interested in the role that previous experience exerts on one's perceptions of their ability to effectively communicate.

While attitudes and internal efficacy have been consistent predictors, research investigating the role of social norms on scientists' willingness have been mixed. Social norms are typically broken into two components: One's beliefs that others want them to perform a behavior (injunctive norms) and one's beliefs about whether others the individual looks to in order to understand what a desirable behavior is are performing the behavior themselves [descriptive norms; Ajzen, 1991]. In other words, if a scientist believes that others within the scientific community think that they should participate in engagement events *and* they believe that their peers are actively engaging with members of the public themselves, then they should be more willing to engage with the public. While social norms as a complete construct (injunctive and descriptive norms) are typically a consistent predictor within studies testing the TPB for explaining other behaviors such as recycling [Nigbur, Lyons & Uzzell, 2010] or wearing sunscreen [Jackson & Aiken, 2000], social norms as a complete construct and a deconstructed one appear to be inconsistent predictors of behavior in the context of scientist's PES intentions. For example, Poliakoff and Webb [2007] found that descriptive norms positively predicted willingness to engage in a PES activity while injunctive norms did not play a significant role. On the other hand, Besley [2015] found that injunctive norms were a significant predictor of willingness to participate in online public engagement activities while descriptive norms were not a significant predictor. A recent study isolating the role that norms — whether injunctive or descriptive — play on a scientist's intention to participate in a future public engagement activity also found that norms exerted little, if any, influence [Tiffany, Hautea, Besley, Newman & Dudo, 2022].

Taken together, previous research has found that attitudes and perceived efficacy play an important role in predicting a scientist's willingness to participate in a future public engagement activity. Previous research has also found that norms are an inconsistent predictor of willingness to engage. However, until a consensus is made within the literature about whether social norms should be removed from investigations into scientist's public engagement activities, we offer hypotheses in-line with previous work. Therefore, we offer the following four hypotheses based upon previous research investigating scientists' willingness to engage with

the public in the context of the TPB:

Hypothesis 1: Positive attitudes towards PES will be positively associated with willingness to participate in future PES activities.

Hypothesis 2: Higher self-efficacy will be positively associated with willingness to participate in future PES activities.

Hypothesis 3: Higher ratings that PES activities are injunctively normative will be positively associated with willingness to participate in future PES activities.

Hypothesis 4: Higher ratings that PES activities are descriptively normative will be positively associated with willingness to participate in future PES activities.

Past experience performing a behavior as an influence

In addition to testing the efficacy of the TPB at predicting a scientist's willingness to engage in a PES activity, we incorporate one's experience performing a behavior in the past into the model. Indeed, past behavior *is* an important predictor of future behavioral intention [Ajzen, 2002, 2015; O'Connor & Armitage, 2003; Ouellette & Wood, 1998]. As such, adding experience performing a behavior in the past into the model is intuitive as an individual's previous experience — whether positive or negative — performing a behavior is likely to affect three of the TPB constructs: their willingness to perform the behavior again, their evaluation of their ability to perform the behavior, and their attitude towards the behavior.

Within the scholarship on scientists' behavioral intentions, researchers have acknowledged the likely importance of past behavior as some have found support for the relationship between past behavior and future behavioral intentions [Besley, 2015; Besley, Dudo, Yuan & Lawrence, 2018; Dudo et al., 2014]. Yet, previous research has not been able to fully explicate this relationship as prior researchers were relying on self-reported measures of a scientist's behavior over the past year (e.g., how many days over the past year a scientist has participated in any type of public engagement activity) rather than focusing on how a *specific* PES activity might have affected the scientist's perceptions. This is an important limitation in the current scholarship as a meta-analysis explicating the attitude-behavior link in the TPB found that when an individual has direct experience with a behavior, their attitude towards that behavior is a strong predictor of intention to perform that behavior again as compared to when an individual has no previous experience performing the behavior [Glasman & Albarracín, 2006]. It is likely, therefore, that the experience of performing the behavior in the past — and one's attitude towards that experience (e.g., if it was enjoyable or not) — likely influences one's intention to perform that behavior again in the future.

In the research reported here, we have the unique opportunity to focus on how attitudes towards a specific PES activity that participants in the study are known to have engaged in — participating in an Ask Me Anything (AMA) session on Reddit — impacts willingness to participate in a future PES activity. Given that one's attitude towards a specific experience is a steadfast predictor of future intentions, we predict that individuals who have positive attitudes towards their AMA session on Reddit will be more willing to engage in a future PES activity.

Hypothesis 5: Scientists with more positive attitudes towards the Reddit AMA session will be more likely to be willing to participate in future PES activities.

Beyond past behavioral-related attitudes exerting a direct influence on future willingness to perform a behavior, it is likely that it affects two other TPB constructs: general attitudes towards the public engagement activities and one's self-efficacy assessments. Attitude towards public engagement is one's appraisal of whether performing the behavior — in this case, engaging with the public — would be beneficial or harmful to the scientist [Ajzen, 1991]. Individuals with more positive attitudes towards engagement activities are more willing to engage with the public [Ajzen, 1991; Besley, Dudo & Yuan, 2018; Besley, Dudo, Yuan & Lawrence, 2018; Besley et al., 2020; Besley et al., 2019; Dudo, 2013; Dudo & Besley, 2016]. While there are various factors that contribute to one's attitude towards a behavior, one important factor is one's attitudes about a specific past-experience that is related to that behavior [Duerden & Witt, 2010; Fazio & Zanna, 1981]. This means that if a scientist has had a positive experience participating in a specific engagement activity, such as participating in a Reddit AMA session, then they are likely going to have positive attitudes towards public engagement activities overall. This prediction is further supported by a meta-analysis which concluded that attitudes related to a past, direct experience is a strong predictor of general, behavioral-related attitudes [Glasman & Albarracín, 2006].

In addition to affecting general attitudes, it is likely that previous experience interacting with the public likely influences one's assessment of their ability to effectively engage with the public. Indeed, an individual's assessment of whether they can perform a behavior successfully is likely affected by their experience performing the behavior in the past. For instance, if a scientist felt that they were able to successfully answer Reddit users' questions during their AMA session, then this positive experience might increase their assessment of their self-efficacy related to PES activities. Indeed, past successful attempts at performing a behavior increases one's confidence in their ability to perform the behavior again in the future [Armitage, 2005; Artistico, Oliver, Dowd, Rothenberg & Khalil, 2014].

Previous research supports the idea that attitudes towards a specific behavioral experience likely influence one's attitudes towards a behavior in general and measures of self-efficacy. It is unclear, however, whether and how previous experience will influence the relationships predicted by the TPB. Rather than proposing formal hypotheses about these relationships, we propose the following research questions (for a visual representation of all hypotheses and research questions, see Figure 1):

Research Question 1: What is the relationship between attitude towards the Reddit AMA session and the TPB antecedent variables related to public engagement activities?

Research Question 2: Will the effect of Reddit AMA-related attitudes on willingness to participate in future PES activities be mediated by general attitudes towards PES activities?

Research Question 3: Will the effect of Reddit AMA-related attitudes on willingness to participate in future PES activities be mediated by self-efficacy?
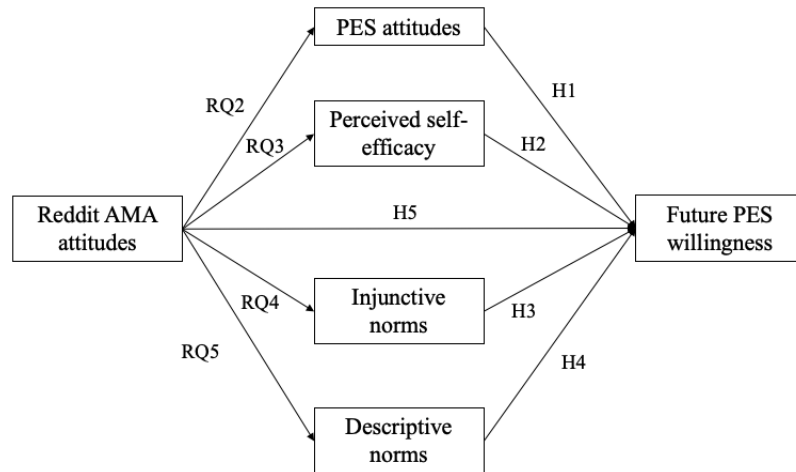
Figure 1. Theoretical model with visual representation of hypotheses 1–5 and research questions 2–5.

Research Question 4: Will the effect of Reddit AMA-related attitudes on willingness to participate in future PES activities be mediated by injunctive norms?

Research Question 5: Will the effect of Reddit AMA-related attitudes on willingness to participate in future PES activities be mediated by descriptive norms?

Method

This study adopted a questionnaire design and was carried out with individuals who participated in an "I Am A Scientist… Ask Me Anything" session on Reddit from January 1, 2016 through December 31, 2018 ($N = 457$ posts). After collecting all the science-related AMA posts from this period, we had a team of seven research assistants identify each scientist that had participated by reading the post. Once the names of the scientists were identified, the research assistants determined whether the scientist had at least some schooling past a bachelor's degree. In other words, the individuals needed to have completed at least some graduate school in order to be included in our study. If the individual did not meet this criterion, then the research assistants excluded them from the study and stopped looking for information about them ($n = 126$ were removed from the study due to this criterion). At this stage, we had a total of 755 scientists that were eligible for the study. The research assistants then searched for an email address for every scientist who had been identified, among the 755 individuals who had participated in an AMA session, we were able to identify working email addresses for 565 individuals who were then invited to participate in the study. Of the individuals contacted ($N = 565$), a total of 154 individuals completed the survey for a response rate of 27.25 percent. This is a higher response rate than other surveys examining scientists' beliefs about public engagement [e.g., Besley, Dudo & Yuan, 2018; Yuan, Besley & Dudo, 2019].

Procedure

The identified scientists were sent a total of up to three emails during the three-week data collection period (February 6, 2019–February 22, 2019). In the first

email, participants were informed about the purpose of the study and asked to participate. Those who did not participate after the first contact were sent a follow-up email one week later inviting them to participate with a link to the survey. Finally, individuals who had not yet participated were contacted one further week later (two weeks after the initial contact email) to notify them that it was the final reminder and once again inviting them to participate. As an incentive for participation, invited scientists were told that for every 50 people that participated we would be raffling off a $50 gift card for Amazon.com *and* be donating $50 to the American Association for the Advancement of the Sciences.

Participants

Of those who completed the survey ($n = 154$), 62% identified as male ($n = 95$), 36% identified as female ($n = 56$), and 2% identified as neither male nor female ($n = 3$). The sample population was 82.5% White ($n = 127$), 7% Asian ($n = 10$), 1% African American ($n = 1$), and 7% identified as Other/Mixed ($n = 10$). Most of our sample works in academia (e.g., professor, student, etc., $n = 110$) while the remainder of the sample works in industry (e.g., government employees, independent scholars, $n = 44$). When examining the participants' subject-areas, most of the sample identified as natural scientists ($n = 79$), followed by the humanities ($n = 32$), physical sciences, ($n = 22$) and social sciences ($n = 21$).

Measures

Attitude towards the Reddit AMA.   Attitude towards the Reddit AMA was measured by asking participants to respond to the following stem, "Participating in the Reddit AMA was..." using three 7-point semantic differential scales: not enjoyable/enjoyable, useless/useful, and worthless/valuable ($M = 5.56$, SD = 1.23, $\alpha = .85$). See Table 1 for descriptive statistics of all measures.

Attitude towards public engagement.   Attitude towards public engagement was measured by using an adapted five-item semantic differential scale [Poliakoff & Webb, 2007]. The stem for the five semantic differential responses asked individuals to respond to the following statement, "Taking part in a public engagement activity would be..." The five semantic differentials were: bad/good, unenjoyable/enjoyable, pointless/worthwhile, foolish/wise, and harmful/beneficial ($M = 6.24$, SD = .87, $\alpha = .87$).

Table 1. Variable Spearman correlation, unstandardized mean and standard deviation.[†]

	1	2	3	4	5	M	SD
1. Attitude towards Reddit	—					5.56	2.34
2. Attitude towards PES overall	.27**	—				6.24	0.87
3. Perceived self-efficacy	.14	.39**	—			6.10	0.78
4. Descriptive norms	.08	.03	−.07	—		3.6	1.23
5. Injunctive norms	.10	.16*	−.02	.31**	—	4.88	1.14
6. Future willingness to participate in PES	.26**	.41**	.44**	.02	−.08	6.11	1.01

[†] All means and standard deviations are based off of a 7-point scale.
* $p < 0.05$, ** $p < .01$.

Descriptive norms. Descriptive norms were measured by adapting Besley's [2015] scale which asked individuals to respond to two 7-point Likert items. The first item asked individuals to what extent they agree or disagree with the statement that "Most scientists do NOT take part in online public engagement." The second item asked individuals to respond to the statement "My colleagues do NOT take part in online public engagement" on a scale of 1 (strongly disagree) to 7 (strongly agree). Both items were reverse coded, so a higher value means that the individual thinks their peers are engaging with the public ($M = 3.60$, SD $= 1.23$, $\alpha = .68$).

Injunctive norms. Subjective norms were measured by adapting two 7-point Likert items [Besley, 2015]. Both items asked the individual to think generally about if a scientist who engages with the public online would be "Well regarded by his/her peers" and "Approved by his/her peers." Both items were measured on a scale of 1 (strongly disagree) to 7 (strongly agree; $M = 4.88$, SD $= 1.14$, $\alpha = .94$).

Perceived self-efficacy. Perceived self-efficacy was measured using three 7-point Likert scale items [Poliakoff & Webb, 2007]. The first item asked individuals the extent to which they agreed or disagreed with the statement, "I feel confident that I could prepare the necessary materials to participate in a public engagement activity." The second item asked individuals whether they agreed or disagreed with the statement, "I feel confident that I could answer questions posed to me by the public." The final item was reverse coded, "I do not have enough communication training to participate in a public engagement activity" ($M = 6.10$, SD $= .98$, $\alpha = .78$).

Willingness to engage with the public. Willingness to engage with the public was measured using three 7-point Likert items. Individuals read the following statement "Looking forward, how willing would you be to take part in the following types of engagement or outreach..." The first item asked them how unwilling (1) to willing (7) they would be to participate in "Online engagement through a website, blog, and/or social networks". The second item asked how willing they would be to participate in "Interviews with a journalist or other media professional (e.g., from a newspaper, television, online news site, documentary film, etc.)". The final item asked individuals how willing they would be to participate in "Face-to-face engagement where you discussed science with ADULTS who are not scientists" ($M = 6.11$, SD $= 1.01$, $\alpha = .76$).

Results

The focus of the current study was to investigate whether experience participating in a specific public engagement activity influences one's willingness to engage in a future public engagement activity via constructs central to the TPB. Given our focus on both direct and indirect influences, we used Hayes [2017] "Model 4" of the PROCESS macro in SPSS to test a parallel multiple mediation analysis. Our model included one control for gender, which has been common practice for analyses of this nature [e.g., Dudo & Besley, 2016; Besley et al., 2019]. Our antecedent independent variable (attitudes towards the Reddit AMA session) was tested for mediation by four variables (perceived self-efficacy, general PES attitudes, injunctive, and descriptive norms). Finally, our outcome variable was willingness to participate in future PES activities. A bootstrap sampling procedure was utilized

Table 2. Model coefficients for willingness to engage, predictors, covariates, and mediators.

|		Attitudes towards PES (M_1)			Perceived self-efficacy (M_2)			Subjective norms (M_3)			Descriptive norms (M_4)			Willingness to engage (Y)	
Antecedent variable		B	SE		B	SE		B	SE		B	SE		B	SE
Constant		5.43	0.34		5.83	0.39		4.55	0.45		3.23	0.50		1.63	0.68
Reddit attitudes (X)	$a1$	0.17**	0.06	$a2$	0.07	0.07	$a3$	0.05	0.08	$a4$	0.09	0.09	$c1$	0.13*	0.06
Attitudes towards PES (M_1)		–	–		–	–		–	–		–	–	$b1$	0.31***	0.09
Perceived self-efficacy (M_2)		–	–		–	–		–	–		–	–	$b2$	0.34**	0.08
Injunctive norms (M_3)		–	–		–	–		–	–		–	–	$b3$	−0.07	0.07
Descriptive norms (M_4)		–	–		–	–		–	–		–	–	$b4$	0.06	0.06
Sex (C_1)		−.029	0.15		0.21	0.18		0.05	0.20		−0.13	0.22		−0.22	0.15
		$R^2 = .07$, $F_{(2, 136)} = 5.32$, $p < .001$			$R^2 = .02$, $F_{(2, 136)} = 1.03$, $p = .34$			$R^2 = .004$, $F_{(2, 136)} = .26$, $p = .77$			$R^2 = .01$, $F_{(2, 136)} = .62$, $p = .54$			$R^2 = .269$, $F_{(2, 136)} = 5.31$, $p < .001$	

* $p < .05$, ** $p < .01$, *** $p < .001$.

with 5,000 samples generated in SPSS with a 95% confidence interval (CI) for all indirect relationships. All p-values reported are the result of a two-tailed test.

To examine the relationship between Reddit AMA-related attitudes and TPB variables (RQ1) we look at the *a* paths in the PROCESS output. Positive Reddit AMA-related attitudes had positive and significant relationships with general PES related attitudes and a direct relationship to willingness to participate in a future PES activity (H5: Supported). Perceived self-efficacy (*a1*), injunctive norms (*a3*), and descriptive norms (*a4*) demonstrated no significant relationship to Reddit AMA-related attitudes. Consistent with past research, the overall regression model with willingness to engage as the main dependent variable was statistically significant as seen in Table 2.

The remaining hypotheses investigated the included mediator variables for self-efficacy, injunctive norms, descriptive norms, and attitudes for their direct relationship (b_1–b_4) to the outcome variable (H1, H2, H3, H4). All direct relationships controlled for gender. Consistent with previous research, general attitudes (H1) and perceived self-efficacy (H2) had a positive and significant, direct relationship with willingness to engage. Neither injunctive (H3) nor descriptive (H4) norms produced significant, direct relationships with willingness to engage. The findings presented here, both the significant and null findings, are consistent with previous studies on the psychological constructs that make a scientist more willing to participate in PES activities.

Research Questions 2 to 5 examined the mediating role of the four TPB variables consistent with predicting scientists' willingness to engage (see Figure 2 for a
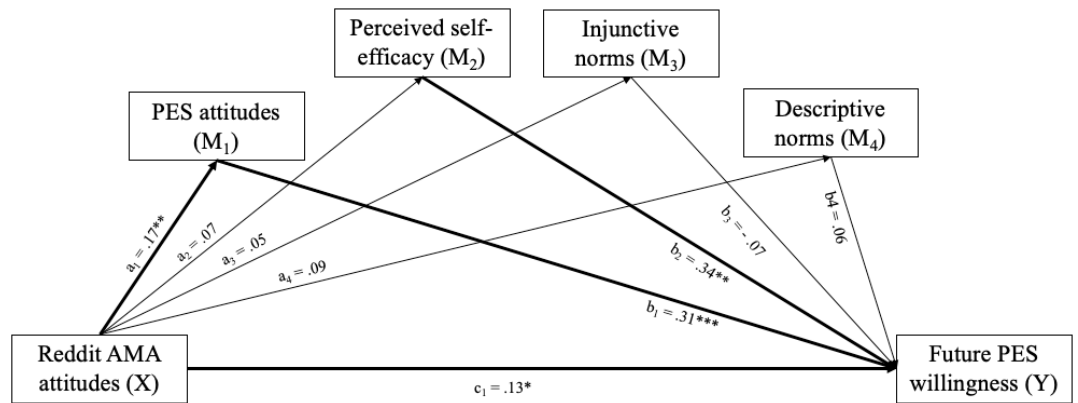
Figure 2. Parallel multiple mediation model depicting antecedent (X), mediator (M1–M4), and outcome (Y) variables.

visual representation of results). A significant indirect relationship between Reddit AMA attitudes and willingness to engage via attitudes was found to be statistically significant via bootstrap samples. This finding can be interpreted to mean that a more positive attitude towards the Reddit AMA increases positive attitudes towards PES in general, which in turn increases future willingness to participate. Perceived self-efficacy, injunctive and descriptive norms did not have a significant indirect effect. Finally, the total effect ($c' + a_1b_1 + a_2b_2 + a_3b_3 + a_4b_4$) of Reddit AMA-related attitudes on willingness to engage independent of the mediators included in this study was statistically significant.

Discussion

Within science communication, much research has been dedicated to investigating the factors that motivate a scientist to engage with the public. Within these model-building efforts, the role of past behavior is often either controlled for or measured using a general measure (e.g., measuring the number of times an individual has performed a PES activity in the past year). In the research reported here, we isolated the role that experience of participating in a *specific* PES activity might play on a scientist's attitudes and beliefs related to participating in a future PES activity. Indeed, it is likely that one's experience of actually performing a behavior affects their attitudes towards the behavior in general, their assessments about their ability to perform the behavior, and their willingness to participate in a future PES activity.

We first examined whether the original TPB concepts predicted the scientists' willingness to participate in a future PES activity (H1–H4). Consistent with past research, we found that one's general attitude towards participation (H1: Supported) and assessment of their own ability to perform the PES activity (H2: Supported) predicted their willingness to participate in a future PES activity. This adds further evidence that the link between attitudes and self-efficacy are robust, important predictors of a scientist's willingness to engage with the public. Some prior work has found that descriptive norms are important for willingness to engage in PES activities [Poliakoff & Webb, 2007], but others have consistently found that social norms may play a more limited role [see Tiffany et al., 2022, for a discussion]. Our work shows that norms did not play a significant role in scientists' future willingness to engage in PES activities. There may be reason to think that

this result could be particular to our sample, however, future research may wish to further investigate what consistent role, if any, norms play in these processes.

Beyond examining the core predictions of the TPB, we also investigated the influence attitudes towards participating in a Reddit AMA session might have on the model. First, we found that attitudes towards the Reddit AMA session directly influenced one's willingness to participate in a future PES activity (H5: Supported). Additionally, we found that the direct influence of Reddit-related attitudes on willingness to participate in a future PES activity was mediated by general attitudes towards PES activities (RQ2). This means that a more positive attitude towards the Reddit AMA increases positive attitudes towards PES activities in general, which in turn increases future willingness to participate in a PES activity. This finding adds further nuance to the attitude-behavior link as it illustrates that one's attitudes towards a *specific* activity influences one's overall attitude towards PES activities. Given that both general and specific attitudes influence one's willingness to participate, it is important that individuals developing communication trainings aimed towards helping scientists develop the skills necessary to engage with the public pay special attention to bolstering positive attitudes towards the activities. Furthermore, it is important that science communication scholars pay close attention to how attitudes towards PES activities might evolve as each experience interacting with the public might influence their general attitudes and future willingness.

Additionally, we found that the influence of AMA-related attitudes on willingness to participate in a future PES activity was not mediated by perceived self-efficacy nor social norms. This lack of a relationship between previous behavior and self-efficacy diverges from previous studies that have consistently found that past behavioral experience is strongly related to perceived self-efficacy [Artistico et al., 2014]. Given that this study relied on self-report measures taken after the scientist had already participated in the Reddit AMA session, it is difficult to disentangle whether there is actually a null relationship between the two constructs. Indeed, a scientist might have already had confidence in their ability to discuss their science with the public and a positive experience participating in the Reddit AMA might have served to validate their evaluation. Therefore, a different methodological design, such as an experiment, might be necessary to explicate the role between past behavior and perceived self-efficacy.

Limitations and future directions

While our study was an important case study meant to explicate the role that a specific behavioral experience might have on future willingness to engage in PES activities, there are several limitations to note. First, our study relied on self-reported, correlational measures to examine how scientists were impacted by an activity they participated in in the past. As such, we cannot fully speak to how participating in the AMA session changed the scientist's perceptions relative to PES activities. While it would be preferable to have measured the scientists' perceptions two times — prior to their participation and after their participation — we established that past PES activity behavior likely plays a role on a scientist's future intentions. Therefore, future research should build upon this finding by examining a cohort of scientists prior to their PES activity and again after they have

participated. This would build a greater understanding of how these activities affect the individuals. Additionally, we only focused on the scientist's past experience participating in a Reddit AMA, rather than measuring past behavior in a more holistic manner. Future research should include a measure of both overall past experience engaging with the public *and* more specific measures targeting a specific experience in order to gain a better understanding of the role that past experience plays on future willingness to participate in a PES activity.

Another possible limitation is our decision to only sample scientists who had participated in a r/IAmA session. While we purposefully chose a sample where we could verify their participation in a PES activity, these scientists are likely different from the scientific community in general. For one, these individuals chose to participate in an online PES activity. As such these individuals are already likely invested in engaging with the public. Because of this bias, these individuals might be more willing than the average scientist to report willingness to participate in future PES activities. This possibility could also explain why the scientist's perceived self-efficacy was not affected by their attitudes towards their r/IAmA session — these scientists might already be more confident in their abilities than the average scientist. While this is a limitation of our study when it comes to generalizability to the general scientific community, our use of purposive sampling is also a strength of the study. Indeed, we know that these individuals have participated in a PES activity in the past and we found evidence that this experience influences their overall attitudes towards PES as well as their future behavioral intentions to engage with the public. It is therefore important for future research to critically assess scientists' past experiences with the public and reflect on how these experiences might affect their overall beliefs about the public and PES.

Additionally, the measures we used have limitations. We measured attitude towards public engagement activities and attitude towards the Reddit AMA using two different scales. This prevented a direct comparison between the two scales. As such, future research might consider measuring attitudes towards PES in general and attitudes towards a specific PES activity with the same scale. Second, we relied on a self-reported measure of past experience completing a PES activity. In the future, researchers may wish to either include self-reported or behavioral measures of past behavior, as the effects of experience and actual behavior may differ.

Finally, our study only examined the scientist's perceptions of how the r/IAmA session went, rather than also examining the actual content of the session. While examination of the actual session would have added additional nuance to our findings, our focus was on understanding how the scientist's felt about their session as that is important for understanding whether the scientists would be willing to do another similar event in the future. Indeed, when our participants were asked whether they would consider participating in another r/IAmA session, the majority ($n = 138$; 89.6%) said yes. Future research could examine the actual content of the posts, and the feedback that the scientists received, in order to paint a more complete picture of scientific outreach within the Reddit community.

Despite the limitations discussed above, our study took an important step towards isolating the effect of past behavioral experience on constructs related to the TPB. We identified that the effect of past behavioral experience on future behavioral

intentions is mediated by general attitudes towards PES activities. Future research should continue to investigate the role of specific behavioral experience and determine whether it should be formally included in a model of scientists' willingness to participate in a future PES activity, rather than a construct that is statistically controlled for.

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