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Which scientist are you? Creating self-outgroup overlap with a scientist through a personality matching game

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Abstract

Based in intergroup contact theory, we investigated how messaging about shared characteristics affects perceived closeness with scientists (i.e., self-outgroup overlap). In an online study, participants ($N = 486$) played a personality matching game that matched them with a real scientist, then they responded to a survey. We replicated the study at a zoo ($N = 63$) to examine implementation as a facilitated game. Self-scientist overlap improved in the online setting; in the in situ setting, trust increased, but not self-scientist overlap. Findings suggest that learning about how one scientist is similar to one's self can increase perceived closeness to scientists overall.

Keywords

Public engagement with science and technology; Public perception of science and technology; Science centres and museums

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Introduction

Science communicators balance the delicate roles of serving as science authorities, while also making science information approachable and engaging [e.g., Jarreau et al., 2019; Fiske & Dupree, 2014]. While many people hold stereotypical perceptions of scientists as cold and unfeeling [Rutjens & Heine, 2016], science communicators are not as susceptible to these stereotypes, placing them in a better position to show the public how science benefits society [Jarreau et al., 2019; Fiske & Dupree, 2014]. Informal science institutions (ISIs), such as zoos, aquariums, nature centers, and museums, are places of science communication with expertise in providing free-choice experiences that broaden participation in science [Godinez & Fernandez, 2019; Stocklmayer, Rennie & Gilbert, 2010; Schwan, Grajal & Lewalter, 2014]. ISIs often draw visitors into science learning opportunities by making connections to their personal experiences and everyday lives [Bevan, Rosin, Mejias, Wong & Choi, 2022; Phiddian, Hoepner & McKinnon, 2020; McCallie et al., 2009]. This approach highlights ISIs and their potential to shift public perceptions of scientists.

Like other places of science communication, ISIs often develop interpretation and activities that put faces to scientists, introducing the public to the people behind discoveries and innovations [Schwan et al., 2014; McCallie et al., 2009; Phiddian et al., 2020]. This strategy bridges the perceived divide between scientists and society. When people have negative perceptions of a social group they are not a part of, including latent negative perceptions, interacting with a group member can increase familiarity with the group and improve attitudes toward the group as a whole [Pettigrew & Tropp, 2006; Pettigrew, Tropp, Wagner & Christ, 2011]. Applying this theory to scientists, opportunities to learn about and form positive impressions of individual scientists will improve trust in scientists as a group [Pettigrew & Tropp, 2006].

This study explores the benefits of showing scientists as individuals, examining whether a personality matching game can improve public perceptions of closeness with scientists. By matching a person to an individual scientist and providing details about the scientist, researchers can assess if the social cognitive mechanisms that make scientists seem dissimilar from a participant can instead be leveraged to create a sense of interconnectedness with scientists as a group. Feelings of connectedness that are related to trust and attitudes toward scientists are also examined.

Changing perceptions through self-outgroup overlap

Biases against groups of people stem from a human tendency to assign others to social groups, distinguishing between "us" (i.e., the "ingroup" or groups we share an identity with) and "them" [i.e., the "outgroup" or groups we do not share an identity with; Tajfel & Turner, 2004; Hornsey, 2008]. This tendency reinforces the idea that the groups are fundamentally different from one another, leads to positive associations with the ingroup and negative associations with the outgroup, and increases the perceived psychological distance among groups [Brown & Hewstone, 2005; Hornsey, 2008; Tajfel & Turner, 2004].

Scientists are subject to negative outgroup perceptions. Most people have little direct contact with scientists and instead rely on impressions formed through current media, which can be oversimplified or stereotypical [Većkalov, Zarzeczna, McPhetres, van Harreveld & Rutjens, 2022; Suleski & Ibaraki, 2010; Jarreau et al., 2019; Hardy, Tallapragada, Besley & Yuan, 2019; Weingart, Muhl & Pansegrau, 2003; Fujiwara, Velasco, Jones & Hite, 2022]. This framing commonly makes an implicit, and sometimes explicit, assumption that scientists and the public have different norms, motivations, and behaviors [Mede & Schäfer, 2020; Rutjens & Heine, 2016; Jaspal, Nerlich & van Vuuren, 2016; Hardy et al., 2019; Weingart et al., 2003], which can diminish trust and willingness to cooperate, as well as increase stereotyping and skepticism of scientists [Kawakami, Amodio & Hugenberg, 2017; Fiske & Dupree, 2014].

According to Intergroup Contact Theory, positive contact with outgroup members can diminish perceived distance and reduce bias [Brown & Hewstone, 2005; Pettigrew & Tropp, 2006; Kawakami et al., 2017; Galinsky & Ku, 2004; Galinsky, Ku & Wang, 2005]. Interactions, such as having cross-group friends or practicing perspective-taking with an outgroup member, can increase perceived closeness to an outgroup and the overlap of mental representations of oneself relative to the outgroup [i.e., self-outgroup overlap; Galinsky et al., 2005; Turner, Hewstone, Voci & Vonofakou, 2008; Wright, Aron, McLaughlin-Volpe & Ropp, 1997]. Self-outgroup overlap is a mediator of the relationship between intergroup contact and positive attitudes toward the outgroup, building understanding of how the outgroup thinks and feels [Boin et al., 2021; Turner et al., 2008]. Taking steps to improve self-scientist overlap will encourage people to see scientists as more like themselves and themselves as more like scientists, generating positive feelings and decreasing prejudice toward scientists [Galinsky et al., 2005; Todd & Burgmer, 2013; Galinsky & Ku, 2004].

Intergroup interactions can take a variety of forms. They can be in person, but do not need to be, and may involve imagining an interaction with an outgroup or learning about an outgroup member from a friend [Dovidio, Eller & Hewstone, 2011; Di Bernardo, Vezzali, Stathi, Cadamuro & Cortesi, 2017]. Additionally, the parasocial contact hypothesis suggests that interactions with characters or people through media can produce effects similar to direct contact, meaning that online engagement may also be effective [Schiappa, Gregg & Hewes, 2005]. Regardless of form, an important component of these interactions is insight into how the outgroup thinks and feels [Boin et al., 2021].

Creating intergroup contact in informal science settings

Many ISIs already use practices that promote indirect intergroup contact, such as embedded narratives, personalized interactions with staff, and reconstructed scenarios involving scientists [Schwan et al., 2014]. While intended to promote curiosity and science learning, an additional effect of including a scientist, whether a real life scientist or fictional scientist character, is the establishment of intergroup contact and changes to visitor's perceptions of scientists as a group [Dovidio et al., 2011; Schiappa et al., 2005].

Intergroup contact through a personality matching quiz game

Similarly, a personality matching quiz game can apply the mechanisms of intergroup contact to positively impact intergroup relations in a free-choice learning environment. Personality matching games or identity quizzes, popularized by websites like Buzzfeed, pose an overarching question like "What type of cheese are you?" or "What is your ideal travel destination?" with users replying to a small number of loosely-related questions to generate a response. At the end of the game, users receive the 'match' considered to best fit their responses and a short explanation describing why they received that match [Wojdynski, 2019]. For example, a match for 'What type of cheese are you?' game could be 'Parmigiano-Reggiano' with a short description including, "because like the cheese you can withstand a lot of heat and you can always be found around a pizza". By leveraging a personality matching game as a tool for engaging the public in science, science communicators may then be able to apply intergroup mechanisms to reduce perceived differences between scientists and the public [Galinsky et al., 2005; Jarreau et al., 2019].

While these types of online personality games likely have little predictive power, their value lies in the experience, not necessarily in the outcome itself. Reflecting on one's self-identity, disclosing personal information, and ultimately, drawing similarities between the self and feedback target, activates numerous cognitive mechanisms which can have downstream consequences on a person's perceptions of themselves and others [Boin et al., 2021; White et al., 2021; Galinsky et al., 2005]. There are several embedded mechanisms that may foster positive intergroup relations through this form of parasocial interaction:

The process of self-discovery. A primary motivator of personality matching games is self-discovery, learning about ourselves through the answer we receive [Urban, 2020; Wojdynski, 2019]. Customized feedback and concrete descriptions in the match feedback prompts respondents to reflect on themselves and explore their personal identities [Wojdynski, 2019; Valentine & Hammond, 2016]. More subtly, the experience prompts the respondent to reflect on similarities with the target — an individual scientist — which may lead to perspective-taking and imagining the world from the viewpoint of that scientist. Considering the needs, thoughts, and actions of the scientist, and relating those experiences back to the self, builds self-other overlap [Galinsky et al., 2005; Boin et al., 2021].

The process of self-disclosure. Intrinsic to the game is self-disclosure of personal information. The game is predicated on the idea that the answer you receive reflects the information you put in [Wojdynski, 2019]. However, the process of self-disclosure also indicates a stronger positive relationship and is a known mediator of intergroup contact on outgroup attitudes [Turner, Hewstone & Voci, 2007; Boin et al., 2021]. By disclosing information during the game, individuals may feel a more intimate relationship to the feedback target simply by engaging in the process of providing personal information [Turner et al., 2007].

The process of learning about others. Other potential impacts include increased knowledge about the outgroup and altered perceptions of norms regarding cross-group interactions, both of which are effects of intergroup contact [Boin et al., 2021; White et al., 2021]. As the game provides feedback about the target, players will be learning more about the outgroup, as well as information about how intergroup interactions occur. For example, individuals may learn about how scientists' work improves the lives of a local community or helps protect society from environmental disasters. This information communicates norms about the presence of science in our everyday lives, generating positive intergroup attitudes [Schwan et al., 2014; McCallie et al., 2009; Boin et al., 2021].

Research question & hypotheses

This study aimed to answer the question, "Can self-driven games prompt feelings of interconnectedness and more positive attitudes toward scientists?" Participants played a personality matching game, received feedback about their scientist match (*Scientist Match* condition), and took a survey to measure their sense of overlap. We also included a condition that matched participants to a science job (*Job Match* condition), rather than an individual scientist. Understanding the affordances of this type of fun, accessible tool can help science communicators more effectively engage the public in conversations about scientists as a community and science as a profession.

The game matched respondents to an individual scientist based on their answer choices, and as such, we expected it to build a level of perceived similarity with the scientist, allowing the participants to see aspects of themselves in the scientist and aspects of the scientist in themselves. This sense of similarity would translate into a greater sense of interconnectedness to scientists as a group [Galinsky et al., 2005; Turner et al., 2008]. For our first hypothesis, we expected *those in the Scientist Match condition to report greater self-scientist overlap compared to those in the control condition (no manipulation) and Job Match condition*. We expected *those in the Job Match condition would not significantly differ from the control condition*.

Changes in self-outgroup overlap have demonstrated positive downstream consequences on attitudes, reduced stereotyping, and increased interest in contact with outgroups [Galinsky et al., 2005; Turner et al., 2008; Wang, Kenneth, Ku & Galinsky, 2014]. Thus, we also examined whether participants' self-scientist overlap was positively related to intergroup beliefs and trust. We expected self-outgroup overlap would be positively related to other intergroup perceptions and the second hypothesis was that *self-scientist overlap would be positively correlated with trust in science, trust in scientists, and general attitudes toward scientists*.

Methods

We designed a personality matching game and tested the same game in two study settings: online and in situ at a zoo. The online study tested whether the game could produce effects on self-scientist overlap and trust using a survey emailed to a large sample of recent visitors to a zoo. The in situ study tested whether the game could produce analogous effects when translated into an in-person, guided activity, similar to live interpretation activities at ISIs [Schwan et al., 2014]. The in situ study was exploratory due to coronavirus restrictions preventing larger-scale, in-person data collection. The Wildlife Conservation Society IRB (FWA #00016913) reviewed and approved all research materials and protocols.

Game design

The game included two conditions: a *Scientist Match* and a *Job Match* condition. The game profiled four scientists who worked in biology or ecology, fields consistent with zoos conservation mission. Their profiles were compiled through personal interviews conducted for a previous project to highlight individual scientists in education programs. The format was designed to mimic a typical personality quiz, with questions presented in consecutive order, followed by a categorical feedback match [Wojdynski, 2019]. The quiz was designed to take under five minutes to align with other live interpretation activities at the zoo and still allow time for survey responses.

In both the *Scientist Match* and *Job Match* conditions, participants could select one of four multiple choice options for each of the five questions (Figure 1). Match feedback was given based on the answer they gave to a single question: "which words best describes you?" The rationale for using a single question was to maintain the perception of customized feedback while minimizing differences in

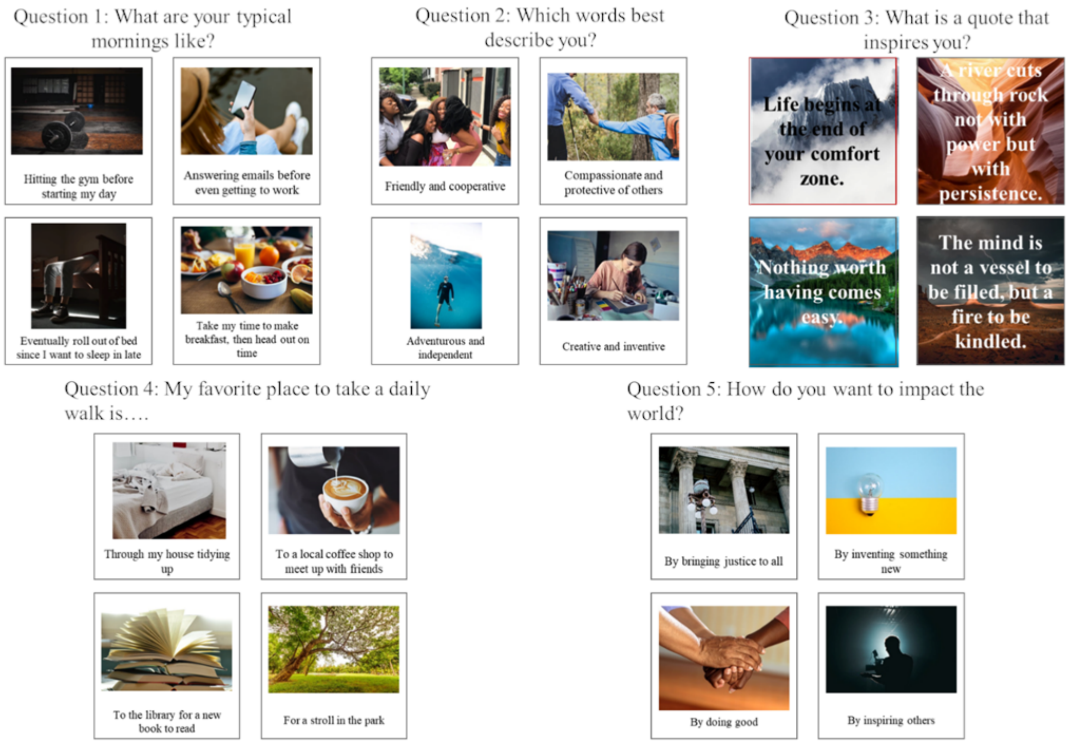

Figure 1. Questions during the personality matching game.

feedback due to noise for the purposes of the experiment. An additional benefit was that it allowed actors in the in situ study to hand-calculate scores to produce feedback quickly.

Questions and descriptions were developed by the authors. The one question used for matching was "Which words best describe you?" and had four response options: friendly and cooperative; compassionate and protective of others; adventurous and independent; and creative and inventive. These choices were deliberately selected to run counter to common stereotypes about scientists as cold [Rutjens & Heine, 2016; Jarreau et al., 2019] and matched with job responsibilities of the four scientists who were potential matches. All options consisted of a pair of words to maximize the potential for participants to feel they were effectively matched. The options for the four questions that were not used to generate a match were general enough to be applicable regardless of which scientist a participant was matched with.

***Scientist Match* content.** Participants in this condition received feedback describing one of four scientists. They did not see feedback for the three non-matches. This condition represented the main test of the hypothesis, as individuals received feedback about a person, creating parasocial contact [Schiappa et al., 2005]. Descriptions included the scientist's name, photo, how they were involved in science, and some biographical information (Figure 2). The descriptions also included information relevant to the matched trait; for example, the friendly and cooperative match feedback included information about how the scientist is a people person who regularly works with the local community. While traits were not exclusive to the matched scientist, this information was specifically

Figure 2. Example of the friendly and cooperative match feedback during the Scientist Match condition.

included to provide a rationale for the match. (See appendix A in the supplemental materials for all feedback possibilities.)

***Job Match* content.** The *Job Match* condition served as a comparison with the control to see if increasing science knowledge without contact with specific group members was sufficient to produce the expected effects. Participants in this condition received feedback about one of four science jobs that matched the jobs of the scientists in the *Scientist Match* condition. Similarly, they only saw feedback for their match and not for the non-matches. Feedback included a nature photo and described daily activities, responsibilities, and the types of skills necessary for success. Descriptions also included an explanation of how the traits identified by the participant were relevant to a scientist in that position and information about how the job was related to science. No information was given about specific scientists. (See appendix A in the supplemental materials for all feedback possibilities.)

In both conditions, feedback was in the form of several short paragraphs, consistent with the traditional game structure [Wojdynski, 2019]. Feedback for all match options was similar in format, length, and level of detail to avoid differences due to the amount of information participants received. The type of feedback varied between the *Scientist Match* and *Job Match* conditions, but all feedback was contextualized, i.e., all scientists and jobs involved science relevant to zoo animals or their wild counterparts. In the online study, learning about the scientist or science job was self-directed and not prompted by the researcher.

Procedure: online study

We recruited participants using two email invitations between May and October 2021. Invitations were sent to people who had visited the Central Park Zoo, Prospect Park Zoo, or Queens Zoo in the preceding year. These zoos are all based in New York City and operated by the Wildlife Conservation Society. Due to the potential for low email click-through ($\sim$ 1%) and completion rates, this broad recruitment approach ensured a sufficient minimum sample size of 158 to detect a medium-sized effect, with a power of .80 and one covariate in an ANCOVA [Faul, Erdfelder, Lang & Buchner, 2007]. The first email was sent to 47,538 individuals (13.53% opened the email) and a second email was sent approximately one month later using the same one-year criteria, consisting of 53,599 individuals (12.59% opened). A total of 684 participated in the study, of which 486 met the inclusion criteria of not identifying as a scientist.

After consenting to participate, participants completed a question about whether they considered themselves to be a scientist and were randomly assigned to one of three conditions: *Scientist Match*, *Job Match*, or control. In the control condition, no manipulation was given. In the *Scientist Match* and *Job Match* conditions, the participants were introduced to the quiz game as described above and were assigned a match based on their response to one of the personality questions. After receiving their match feedback, participants completed the remaining survey items, including questions about their trust and attitudes in scientists, as well as demographics. Participants were provided with the researchers' contact information for any follow-up questions about the survey or game.

Procedure: in situ study

Study participants were visitors to the Central Park Zoo in New York City and were recruited by a researcher who was posted by the entrance to an exhibit. Using an opportunistic sampling technique, the researcher described the study and asked visitors if they were interested in participating. If they agreed, they were brought into a private outdoor area where they completed a quick questionnaire about their science identity. They were then directed to the game station, where professional actors guided them through the game. 86 visitors were recruited to the study, with 63 meeting the non-scientist inclusion criteria.

Data collection took place over six days, spread across one month and participants were assigned to condition based on the day, with each day randomly assigned a condition. Accompanied by physical question and answer cards, the actors asked the same questions and gave the same match feedback as in the online version, but with a higher level of interaction.

The in-person version of the game differed most notably from the online version because it was interactive, with actors facilitating the interaction. The content of the feedback remained the same as the online version, but to avoid participants having to read a large paragraph during a social interaction, actors provided the feedback verbally with an accompanying visual of the same picture as the online study, along with the name or job title. Participants also had the option to converse with the actors about their result, including asking further questions. The actors could also ask the participant questions to prompt further inquiry or reflection, such as, "Why do you think you matched?" Actors had the freedom to interact and ask questions to increase ecological validity, mirroring how this activity would be conducted in a real-world setting. All actors were trained in educational theater, conducting research, and data collection standards. Interactions were time-limited (about 8 minutes for game and survey to be consistent with live interpretation activities at the zoo).

During the game, a trained researcher recorded participants' responses and the duration of the game using a stopwatch. As in the online version, the participant's match was announced using a photo of the scientist or a nature photo consistent with the condition. After the game was over, the researcher provided an abbreviated version of the online study survey to reduce contact time between researchers, actors, and participants. Afterwards, participants were thanked and given an opportunity to ask questions about the game and study overall.

A limited sample size for in-person data was collected due to coronavirus restrictions in Summer 2021, with social distancing limiting the number of participants allowed and the length of interaction during the activity.

Measures

All measures described below were used in the online version of this study. Given time limitations, we included only a subset of measures in the in situ version (see appendix B in the supplemental materials for additional scale information).

Self-scientist overlap. The Inclusion of Other in the Self Scale [Schubert & Otten, 2002; Aron, Aron & Smollan, 1992] is a seven-point pictorial scale which asked participants to select the image that best represented their relationship with scientists from a series of increasingly overlapping pairs of circles.

Attitudes toward scientists. Using the feeling thermometer format [e.g., Inbar, Pizarro & Bloom, 2012; Turner et al., 2008], one question asked how participants felt about scientists on a sliding scale of 0 to 100. This data was collected for the in situ study as well, but due to issues with the scale used, data failed to be collected for 35% of the sample (N missing = 22).

Trust in scientists. A single nine-point item asked, "How trustworthy are scientists?"

Trust in science (online study only). Trust in science was measured on a seven-point scale containing eight items [Bauer, Durant & Evans, 1994]. Items included, “Scientists can be trusted to make the right decisions” and “The benefits of science are greater than any harmful effects” among others.

Scientist bias (online study only). Participants evaluated how much they considered science to be biased toward specific groups or agendas on a 0 to 100 scale (0 = extremely biased; 100 = extremely unbiased).

Scientist identity. Online participants were asked whether they work in a science profession on a 1 to 5 scale (strongly disagree to strongly agree). In situ participants were asked a multiple-choice question about whether they considered themselves, someone in their visiting group, both, or neither, to be a scientist.

Demographics. Online participants were given the option to self-disclose their gender identity, race and ethnicity, education, political affiliation, and religious affiliation.

Demographics were not collected for the in-person study due to the need to limit interaction time. Information was collected on whether the participant was traveling with children, the level of interaction between participant and actor via the number of self-volunteered responses, and the size of the group the participant was traveling with.

Analysis

Contact with a scientist through the game was meant to reduce intergroup distance and bias, so participants who did not identify scientists as an outgroup (i.e., those who identified as scientists) were removed from the analyses. In the online study, participants who agreed or strongly agreed they work in a science profession were excluded. In the in situ study, those who responded ‘themselves’ or ‘themselves and someone in their group’ to be a scientist were excluded from analysis.

We examined the effects of condition on self-scientist overlap using an ANCOVA, controlling for perceived bias of scientists. This covariate was included because beliefs that scientists hold a biased agenda can produce feelings of threat [Mede & Schäfer, 2020; Bos et al., 2020], which may alter the relationship between the conditions and self-outgroup overlap by changing how a person perceives intergroup interactions [Dovidio et al., 2011]. Post-hoc comparisons were conducted for significant effects between conditions using a Bonferroni correction.

In addition, three sequential, multiple linear regressions were conducted for trust in science, trust in scientists, and attitudes toward scientists. Science bias was again used as a control, placed as a predictor in the first model, with the second model adding self-scientist overlap.

For the in situ study, we used non-parametric tests due to the small sample sizes. A Kendall’s Tau-b correlation coefficients were computed to examine the relationships between self-scientist overlap and actor-participant engagement, and between self-scientist overlap and trust in scientists. Kruskal-Wallis tests were used to examine differences in self-scientist overlap and trust in scientists between game conditions.

Results

Online study

Participants

A total of 684 individuals participated in the online study, of which 486 (71%) met the criteria of not identifying as a scientist and thus were included in the study. Individuals who identified as scientists were excluded from analyses as the study is examining intergroup differences and people who considered themselves scientists wouldn't consider scientists an outgroup. The majority of participants were female (72%), White, non-Hispanic (61%), held a bachelor's degree or above (82%), and had an average age of 41 (SD $= 14$). 60% identified as Democrats, and 34% identified as Christian or some denomination of Christianity. Sample sizes were similar between the control ($N = 154$), *Scientist Match* ($N = 159$) and *Job Match* ($N = 173$) conditions (see appendix C in the supplemental materials for full demographics).

Conditions on self-outgroup overlap

The ANCOVA examining the effect of condition on self-scientist overlap indicated a significant effect of condition on self-outgroup overlap, $F(2, 239) = 3.45$, $p = .03$, $\eta_p{}^2 = .03$ (see Figure 3). Those in the *Scientist Match* condition ($M = 4.51$, SE $= 0.19$) reported greater self-scientist overlap compared to the control ($M = 3.87$, SE $= 0.18$), $t(239) = -2.47$, $p = .04$, 95% CI $[-1.24, -0.03]$, although not significantly different from the *Job Match* condition ($M = 4.39$, SE $= 0.17$), $p = 1.00$. The *Job Match* condition was not significantly different from the control, $p = .13$.

Partially consistent with Hypothesis 1, self-scientist overlap was higher in the *Scientist Match* condition than the control. However, contrary to the hypothesis, the

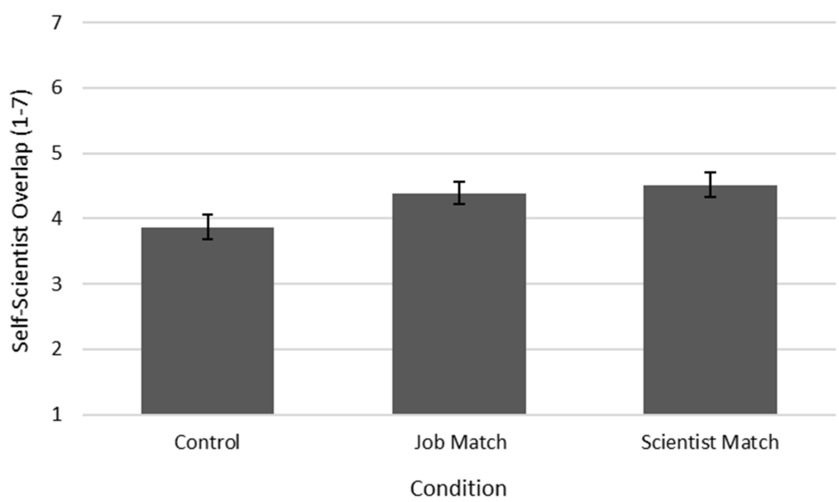

Figure 3. Online study effect of condition on self-scientist overlap.

Scientist Match condition did not differ from the *Job Match* condition, which fell in between the *Scientist Match* and control, and did not improve self-scientist overlap relative to the control.

Trust and attitudes

In all linear regressions examining the relationship between self-scientist overlap and trust (or attitudes), the initial model was significant, indicating a negative relationship between science bias and attitudes, $R^2 = .04$, $F(1, 212) = 8.40$, $p = .004$, trust in scientists, $R^2 = .09$, $F(1, 241) = 22.77$, $p < .001$, and trust in science, $R^2 = .13$, $F(1, 241) = 35.97$, $p < .001$. The introduction of self-scientist overlap showed a significant effect as an overall model for all three variables including attitudes, $R^2 = .15$, $F(2, 211) = 17.90$, $p < .001$, $\Delta R^2 = .11$, trust in scientists, $R^2 = .14$, $F(2, 240) = 19.26$, $p < .001$, $\Delta R^2 = .05$, and trust in science, $R^2 = .17$, $F(2, 240) = 23.93$, $p < .001$, $\Delta R^2 = .04$. For all three models, the addition of self-scientist overlap showed a significant change to the model, $p's \leq .001$. In the model which included both self-scientist overlap and science bias, self-scientist overlap was positively related to attitudes toward scientists, $p < .001$, trust in scientists, $p < .001$, and trust in science, $p = .001$ (see Table 1 for regression statistics).

In summary, consistent with our hypotheses, increased self-scientist overlap was positively related to attitudes toward scientists, trust in scientists, and trust in science.

In situ study

Participants

86 people participated in the in situ study, of which 63 (73%) did not identify as scientists (control $N = 25$; *Job Match* $N = 19$; *Scientist Match* $N = 19$). Those who identified as scientists were excluded as they would not consider scientists and outgroup. About half of the participants (48%) visited the zoo in a group of one to two people and a similar percentage (51%) attended with a child.

Self-scientist overlap and trust

Results from the Kendall's Tau-b analysis showed that higher levels of interaction between actor and participant were positively related to self-scientist overlap ($N = 38$), $T_b = .26$, $p = .05$. Self-scientist overlap was not significantly related to other measured environmental factors, such as group size, $p = .13$, or length of interaction, $p = .66$.

Unlike the online study, a Kruskal-Wallis test examined the effects of the conditions on self-outgroup overlap, but found no significant effect, $p = .51$. However, like the online study, self-scientist overlap was positively related to trust in scientists ($N = 46$), $T_b = .27$, $p = .03$.

Due to the lack of an effect on self-scientist overlap, we conducted an additional analysis to examine if the game may be positively impacting perceptions of

Table 1. Regression table for the relationship between self-scientist overlap and the three outcomes of interest (Attitudes toward Scientists, Trust in Scientists, Trust in Science).

				95% CI					
	β	*B*	*SE*	*LL*	*UL*	*t*	*p*	Fit	Difference
Attitudes toward Scientists									
Model 1									
(Intercept)		81.51	1.93	77.71	85.31	42.24	$<$ .001		
Science Bias	0.20	0.09	0.03	0.03	0.15	2.90	.004		
								$R^2 = 0.04^{**}$	
Model 2									
(Intercept)		69.99	2.89	64.29	75.69	24.21	$<$ .001		
Science Bias	0.22	0.10	0.03	0.04	0.16	3.43	$<$ .001		
Self-Scientist Overlap	0.33	2.51	0.49	1.55	3.48	5.14	$<$ .001		
								$R^2 = 0.15^{***}$	$\Delta R^2 = 0.11$
Trust in Scientists									
Model 1									
(Intercept)		6.27	0.19	5.89	6.64	32.98	$<$ .001		
Science Bias	0.29	0.02	0.003	0.01	0.02	4.77	$<$ .001		
								$R^2 = 0.09^{***}$	
Model 2									
(Intercept)		5.42	0.29	4.85	5.99	18.74	$<$ .001		
Science Bias	0.30	0.02	0.003	0.01	0.02	5.04	$<$ .001		
Self-Scientist Overlap	0.23	0.19	0.05	0.09	0.29	3.81	$<$ .001		
								$R^2 = 0.14^{***}$	$\Delta R^2 = 0.05$
Trust in Science									
Model 1									
(Intercept)		4.85	0.10	4.65	5.06	47.49	$<$ .001		
Science Bias	0.36	0.01	0.002	0.01	0.01	6.00	$<$ .001		
								$R^2 = 0.13^{***}$	
Model 2									
(Intercept)		4.46	0.16	4.16	4.77	28.47	$<$ .001		
Science Bias	0.37	0.01	0.002	0.01	0.01	6.23	$<$ .001		
Self-Scientist Overlap	0.19	0.09	0.03	0.04	0.14	3.24	.001		
								$R^2 = 0.17^{**}$	$\Delta R^2 = 0.04$

Note. ** indicates $p < .01$, *** indicates $p < .001$. *LL* and *UL* indicate the lower and upper limits of the 95% confidence interval (*95% CI*), respectively. Total $N_{\text{Attitudes}} = 213$, total $N_{\text{Science Trust}} = 242$, total $N_{\text{Scientist Trust}} = 242$.

scientists without impacting self-scientist overlap. The additional Kruskal-Wallis test was conducted with condition directly predicting trust in scientists. Results showed a significant effect, $H(2, 43) = 8.65$, $p = .01$, $\eta^2 = .15$ (see Figure 4). Dunn's post-hoc comparisons, using a Bonferroni correction, indicated those in the *Scientist Match* condition ($M = 8.44$, SE $= 0.44$), $z(43) = -2.48$, $p = .04$, reported higher trust in scientists compared to the control ($M = 7.32$, SE $= 0.28$). The *Job Match* condition ($M = 8.42$, SE $= 0.23$) was not significantly different from the control, $p = .08$, or the *Scientist Match* condition, $p = 1.00$.

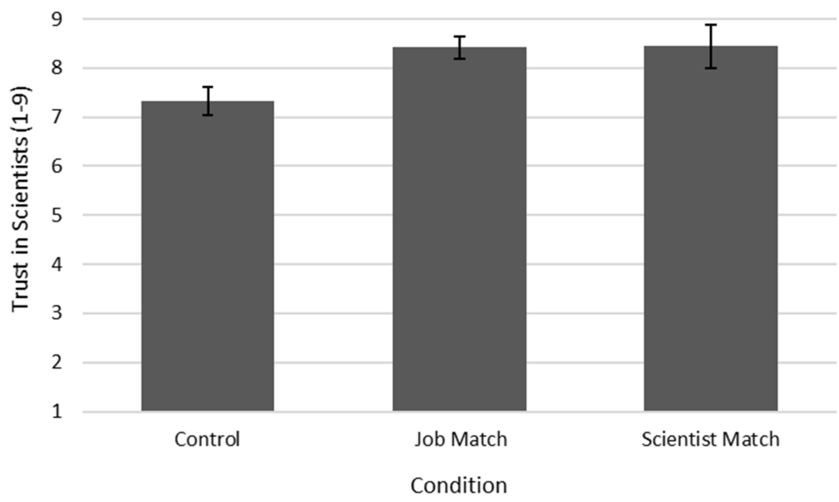

Figure 4. In situ study trust in scientists by condition.

While these results should be interpreted with caution due to the low sample sizes, they provide preliminary evidence that those in the *Scientist Match* condition reported higher trust, although no differences in self-outgroup overlap were found.

Discussion

Informal science institutions design exhibits and activities to encourage visitors to interpret science through their personal experience [Schwan et al., 2014]. This research adds to an expanding body of work examining how these connections, which bridge a person's perceptions of themselves and science, can create positive impacts on public perceptions of science and scientists. Furthermore, the study supports the literature on intergroup differences suggesting that when intergroup differences are reduced, and people can consider themselves and scientists as more alike, attitudes toward scientists can improve [Galinsky et al., 2005; Todd & Burgmer, 2013; Galinsky & Ku, 2004].

The online study explored if providing information about specific scientists through a personality matching game could increase self-scientist overlap, increasing the similarities a person sees between themself and scientists. We expected that the *Scientist Match* condition would improve self-scientist overlap and overlap would be positively related to trust and attitudes toward scientists.

Results from the online study supported the ability of a personality matching game to improve self-scientist overlap when the game provided feedback about an individual scientist. Findings were largely in line with our hypothesis, with the *Scientist Match* condition showing greater overlap compared to the control, and overlap positively related to attitudes and trust. Self-scientist overlap was also positively correlated with trust and attitudes toward scientists and trust in science. This evidence indicates that a person's perceptions of scientists as a group can improve after learning about a scientist who shares some traits with them, and suggests the potential for these forms of parasocial interactions to set the stage for further positive intergroup interactions [Galinsky et al., 2005; Wang et al., 2014].

Notable however, was the lack of significant differences between the *Scientist Match* and *Job Match* conditions, contrary to expectations. This could be due to other mechanisms positively impacting the *Job Match* condition. While there was no intergroup contact, the *Job Match* condition could still have had a positive impact on participants' perceptions of scientists as a community because participants learned about norms of the scientific community, which can also improve attitudes toward the outgroup [Boin et al., 2021].

While the game is designed to be brief and inherently unstructured, lengthening engagement time or using such activities as a starting point for further engagement could have more direct and substantial consequences for participants. This idea led to the in situ study to examine the effectiveness of the game in a real-world setting, a zoo.

Results from the in situ study were more mixed than those from the online version. The in situ study found the game increased trust and that self-outgroup overlap was positively related to engagement during the activity, but the expected effects of study condition were not found. We posit two potential reasons for these findings. First, the small sample size may have prevented detection of an effect. Second, the presence of a person guiding the activity may have altered the social mechanisms which resulted in the effects within the online version, preventing changes to self-outgroup overlap. For example, rather than the interaction serving as a form of intergroup contact with a scientist outgroup and increasing positive perceptions of scientists, the interaction is contact with a science communicator, an intermediary who may not have the same negative stereotypes as scientists and therefore did not impact perceptions of scientists to the same degree [e.g., Fiske & Dupree, 2014].

Despite the mixed results, these findings do not suggest a guided activity would not be valuable, as indicated through the significant difference in trust with the *Scientist Match* condition, but rather that other mechanisms may be at work when the game is facilitated. Additionally, live interpretation activities are common at ISIs and this in-person format capitalizes on this broadly-used approach to create meaningful interactive experiences. This type of guided game could provide science communicators with a flexible tool that they could use to explore more complex scientific topics and nuances within the game, with the facilitator guiding and prompting players in ways that create meaningful connection.

Theoretical implications

Work on the impacts of stereotypes has demonstrated the influential role of social perceptions on people's trust in scientists [Jarreau et al., 2019; Rutjens & Heine, 2016]. Whether face-to-face, online, or even imagined, contact with outgroups can positively impact a person's perceptions of an outgroup [Boin et al., 2021; White et al., 2021]. While this study did not intend to identify an exact mechanism of change, it did indicate the potential for changing outgroup perceptions through a self-explorative game. Furthermore, the game may represent another form of parasocial contact, where individuals can establish a feeling of connection to a character without direct interaction [Schiappa et al., 2005]. As a result, personality match games could serve to create intergroup contact and result in positive outcomes, such as improved trust and the reduction of stereotypes [Schiappa et al., 2005; Galinsky et al., 2005; Turner et al., 2008]. These findings raise the potential for such methods to effectively combat common scientist stereotypes [Rutjens & Heine, 2016; Rutjens, Heine, Sutton & van Harreveld, 2018].

Practical implications

These findings supported the use of a personality matching game as a method for online engagement with public audiences, providing an initial point of entry to science-related topics. Set up as an online or digital asynchronous game, this method can establish shared experiences as participants reflect and elaborate on the feedback they receive [Wojdynski, 2019; Valentine & Hammond, 2016]. The increase in self-scientist overlap could also increase willingness to engage with scientists and science communicators in future activities or exhibits [White et al., 2021; Wang et al., 2014].

In contrast, the in situ study raised questions about the effectiveness of this game as a facilitated activity, because while trust increased, self-scientist overlap did not. Further study is needed to identify whether this is due to the facilitator altering the social mechanisms that increased self-scientist overlap online. That being said, the increase in trust despite the small sample size indicates that this could still be a valuable in-person activity for establishing an openness to, and interest in, science. It is also possible that the effects on self-scientist overlap could emerge with a re-design of the activity, such as allowing participants to independently take the quiz rather than have a facilitator guide them through the reflection.

A notable consideration

Due to the simplified gamification, practitioners should consider some limitations if seeking to apply this game with real people as matches, including the possibility of identity oversimplification. Quiz games are designed to be quick and easily consumable, so the match feedback section is short, and steps should be taken to ensure the feedback does not end up reinforcing stereotypes [Berberick & McAllister, 2016]. Additionally, both for the feedback and question portions of the game, consideration should be given to the multiple identities of both the scientist and the participant. Games should not minimize the value or relevance other identities may hold, particularly given the historical exclusion of non-majority identities in science [Berberick & McAllister, 2016; Dawson, 2019].

Limitations and future directions

Limitations of the current study include the inability to identify the specific type of indirect intergroup contact occurring and the overreliance on single-item self-reported measures. While the experimental design selected for this study created a more realistic setting for intergroup contact to occur, further research should address what aspects or types of intergroup contact are most relevant for producing effects.

An additional limitation to the generalizability of these effects was to the population selected. Both samples were drawn from audiences to zoos in New York City and additional research would need to test this work with other audiences and types of ISIs. The sample size for the in situ study was small, preventing sufficient power for some analyses. This was a situational limitation of the current work, and future studies can replicate this with larger samples.

Despite these limitations, this study provides preliminary evidence for the potential of personality matching games as a mechanism for inducing indirect intergroup contact through self-directed discovery. Participants who took an online game and matched with a scientist reported greater self-scientist overlap and more positive attitudes toward scientists compared to a control condition. While results from the in situ study did not show the relationship between condition and self-scientist overlap, there were still meaningful differences for trust, with those experiencing the *Scientist Match* condition reporting higher trust in the post-game survey compared to a no-game control group. From a theoretical perspective, this study suggests personality matching games with single individuals as matches could serve as another method for parasocial intergroup contact, similar to reading a book or watching a movie. Implementation of personality matching games are another tool for science communicators to reduce the perceived intergroup divide between scientists and the public and thereby aid in overcoming negative stereotypes of scientists. Thus, a personality matching game, while a form of entertainment and a pursuit of self-understanding [Urban, 2020; Wojdynski, 2019], may also provide an avenue to converse about the role of scientists in society and positively impact the public's relationship with science.

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Supplementary material

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Appendix A: Game information
Appendix B: Study measures
Appendix C: Demographics

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