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The effects of social-media based social comparison information and similarity mindsets on COVID-19 vaccination uptake cognitions

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Abstract Vaccine hesitancy—delays in vaccine uptake when one is readily available—is an important public health issue. During the COVID-19 pandemic, the role of psychosocial factors in influencing cognitions and behaviors related to vaccine uptake have been examined. Using an online sample of unvaccinated U.S. adults ($N = 300$), we examined the influence of COVID-19-related social media-based comparison information (e.g., others' attitudes about taking the vaccine)—as well as the moderating impact of (dis)similarity mindsets and indirect influence of affective associations, norm perceptions, and self-evaluations of efficacy—on vaccination uptake intentions. Participants reported higher intentions for vaccine uptake following exposure to cautious comparison models (e.g., those that engaged in health prevention behaviors, intended to get vaccinated) versus risky comparison models (e.g., those who did not engage in health prevention behaviors, did not intend to get vaccinated) and neutral comparison models and this effect was indirect through positive affective associations about taking the vaccine. There were no main or interactive effects of (dis)similarity mindsets. Understanding the psychosocial factors that influence health cognitions and behaviors in the context of an infectious disease pandemic will advance theoretical development and aid in creating interventions targeting vaccine uptake.

Keyword COVID-19 · Social comparison · Assimilation and contrast · Affective associations · Vaccine uptake · Social media

Introductions

"You've got to be able to get…the entire world vaccinated. As we allow this infection to exist to any degree in any part of the world, it will always be a threat."—Interview with Anthony Fauci, M.D., National Institute of Allergy and Infectious Disease Director, on National Public Radio (Gross, 2021).

From late 2019 to present (March 2022), an emerging infectious respiratory disease—novel coronavirus 2019 (COVID-19)—has rapidly spread throughout the world (Centers for Disease Control and Prevention [CDC], 2020a; World Health Organization [WHO], 2021), infecting over 442 million people and causing over 5.9 million deaths to date (Dong et al., 2020). While the COVID-19 pandemic continues to impact employment, education, mental health, and the economy (Béland et al., 2020; Mann, 2020; Tull et al., 2020), the widespread distribution of vaccines in the U.S. presented an opportunity to change the trajectory of the disease (CDC, 2021a). Indeed, evidence strongly supports that COVID-19 vaccines are a safe and effective way to prevent infection and reduce the severity of symptoms for those infected (Baden et al., 2021; Polack et al., 2020). However, despite accumulating and supportive evidence, there has been pronounced hesitation among segments of the U.S. population about vaccination uptake. Indeed, at present (March 2022) only about 65% of the eligible U.S. population has been fully vaccinated (i.e., received two doses of the two-dose mRNA series or received one dose of a single-dose vaccine)—far below target numbers required to reach herd

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immunity. In addition, only 43.9% of eligible citizens have received a booster dose to date (CDC, 2020b).

Causes for vaccine hesitancy or delays in vaccine uptake despite their availability (Butler, 2016; Butler & MacDonald, 2015)—both generally and specifically for COVID-19—are numerous and include sociodemographic characteristics (e.g., political ideology, religiosity, education), fear of needles, risk perceptions, and beliefs and knowledge about the illness and vaccine (e.g., Hamilton, 1995; Rivas et al., 2021; Ruiz & Bell, 2021). Importantly for the current research, emerging infectious diseases are unique relative to standard/known infectious diseases (e.g., the common flu) in that their sudden appearance and unfamiliar attributes are associated with pronounced uncertainty and fear (Harper et al., 2020). Moreover, during times of uncertainty and when under threat, people become particularly attuned to, interested in, and affected by *socially*-relevant information (Kulik & Mahler, 2000; Rofé, 1984). For example, people going through an emotionally- or physically- stressful experience (e.g., occupational burnout, anticipation of electric shocks) report strong desires to learn how others in a similar situation are feeling (Buunk et al., 1994; Schachter, 1959). Similarly, upon experiencing uncertainty, stress, and fear during the COVID-19 pandemic, people have increasingly turned to social media platforms (e.g., Facebook, Instagram) for information and news, social support, and normative clarity regarding the thoughts, feelings, and behaviors of peers (Li et al., 2020; see also Bruns et al., 2015; Winter et al., 2016). The goals of the current research were to examine how exposure to social media-based social comparison information related to COVID-19 behaviors and beliefs (including about vaccine uptake) influenced vaccine intentions, as well as to explore what factors may act as intervening (mediating) variables (i.e., affective associations, norm perceptions, self-evaluations) and moderator variables (i.e., similarity vs. dissimilarity mindsets) in these relationships.

Social comparison

Social comparison is the process of thinking about one or more other people in relation to the self (Festinger, 1954), and decades of research has revealed that people's affect, cognition, and behavior is influenced through the comparisons they make (Gerber et al., 2018; Wood, 1996). For instance, numerous studies have revealed that exposure to social comparison information suggesting one is better or worse than others in a domain (e.g., math performance, appearance) can impact their self-evaluations in the domain, their self-esteem, and their moods (for review see Gerber et al., 2018). Likewise, people are also often exposed to *health*-related social comparison information in a few potential ways. First, people can be exposed to others' engagement in preventative behaviors (e.g., exercise, healthy eating habits). Second, people can be exposed to others' attitudes and behaviors in a particular domain (e.g., drug use, vaccination uptake) that indicate their level of safety or risk. Relevant to the present context, people are frequently exposed to information illustrating others' *attitudes* related to COVID-19 risk and safety (e.g., vaccine beliefs), as well as COVID-19-related *behaviors* that could be viewed as risky or cautious (e.g., whether or not people follow guidelines for wearing masks or social distancing). Importantly, the influence of social comparative information (and more broadly social normative influence) has been directly examined in the context of health prevention behaviors and cognition related to infectious diseases. For instance, social comparative beliefs about one's own COVID-19 prevention efforts (e.g., social distancing, wearing masks) relative to others were uniquely predictive of future prevention intentions (Rose & Edmonds, 2021).

Additionally, in the age of social media, socially-relevant information is ubiquitous. Despite the potential for misinformation and conspiracy theories (Cinelli et al., 2020), people are increasingly turning to social media for news, information, and to learn about the perspectives and behaviors of others, including in a COVID-19 context (e.g., Bruns et al., 2015; Li et al., 2020; Winter et al., 2016). Indeed, as prior research has shown that prevention behaviors (including vaccine hesitancy) can be affected by information learned on social media (Hussain, 2020; Puri et al., 2020; Srivastava et al., 2020), it is important to understand how exposure to social comparison information on social media can affect COVID-19 prevention behaviors. Although pockets of research exist, few studies have systematically examined how exposure to social comparison models who either adopt cautious (e.g., engage in prevention behaviors, express concern about COVID-19, plan to vaccinate) or risky (e.g., do not engage in prevention behaviors, express concern about COVID-19, or plan to vaccinate) approaches to COVID-19-related prevention behaviors might impact vaccine uptake intentions, and no studies to our knowledge have examined potential moderators or mechanisms involved in such relationships.

Impact of similarity on the effects of social comparison on health cognition

As noted above, prior research involving social comparison information in the context of vaccination norms suggests that exposure to a comparison model who displays cautious (risky) health cognitions and behaviors related to illness prevention (including about vaccination uptake) has been associated with increases in a participant's own adoption of cautious (risky) cognitions and behaviors in these same contexts (e.g., Allen et al., 2009; Oraby et al., 2014; Palm et al., 2021). That is, people *assimilate* their own health-related

cognitions and behaviors towards that of the comparison standard. However, in the broader comparative literature, it is notable that *contrast* effects are also possible, such that exposure to a social comparison model displaying cautious (risky) health cognitions and behaviors would be associated with *decreases* in the adoption of cautious (risky) cognitions and behaviors (Gerber et al., 2018). Whether assimilation or contrast is evident depends upon various moderators, including target similarity or similarity mindsets. Indeed, evidence suggests that when the comparison target is similar to (dissimilar from) the self or when similarity (dissimilarity) mindsets are primed, this is more often followed by assimilation (contrast) effects for self-evaluations, affect, and other cognitions (Mussweiler, 2001; Mussweiler et al., 2004; Vogel et al., 2020). As such, the current research examined the moderating influence of (dis)similarity mindsets in shaping how participants are influenced by exposure to cautious and risky social comparison models.

Mechanisms for the influence of social comparison on health cognition

Aside from research demonstrating the role of similarity in influencing responses to social comparison more broadly (Mussweiler, 2001; Mussweiler et al., 2004), limited research exists to explain the other intervening (mediating) mechanisms through which exposure to social comparison information in the context of infectious diseases (and other contexts) might influence people's cognitions and behaviors. In an effort to build upon the assimilation- versus contrast-like effects that emerge after exposure to comparison information (often due to similarity), it is important to investigate these mechanisms as their own, independent influencing factors. Using the Theory of Planned Behavior (TPB), Social Comparison Theory, and the Behavioral Affective Associations Model (BAAM) as theoretical backdrops (Ajzen, 1991; Festinger, 1954; Kiviniemi et al., 2007), we examined select psychological mechanisms through which exposure to cautious and risky social comparison models might impact health cognitions related to vaccination uptake.

First, *affective associations/ attitudes*—how positively or negatively a person feels about a behavior—are among the most robust determinants of intentions and behavior (Kiviniemi et al., 2007; Sheeran et al., 2016; Williams et al., 2018) across a wide array of health behaviors, ranging from flossing and physical activity to illegal drug use and binge drinking (Clemens et al., 2021; Lawton et al., 2009; Murray et al., 2020). For instance, and consistent with BAAM, young adults may not purchase condoms due to feelings of embarrassment (Leary et al., 1994; Williams et al., 2018) and adults may not undergo colonoscopy screenings due to feelings of disgust over the procedure (Kiviniemi et al., 2014). Regarding vaccine uptake, prior research on influenza and the human papillomavirus (HPV) indicates that people are more likely to vaccinate if they experience positive affective associations about the vaccine (Klasko-Foster et al., 2020). Moreover, even considering the emotional benefits of vaccination (e.g., worrying less about getting the illness if vaccinated) was a strong predictor of vaccine compliance (Thompson et al., 2012). Importantly for the current research, affective associations/attitudes can also be shaped via social comparison/normative information (Bohner et al., 1992; Geers et al., 2017). For example, the negative affect from being exposed to social comparisons of physical fitness accounts on social media was related to intentions to engage in extreme weight-loss behaviors (Lewallen & Behm-Morawitz, 2016; see also Appel et al., 2016). In regard to vaccine compliance, anti-vaccine (HPV) beliefs espoused by others on social media were found to elicit negative affect toward the vaccine which, in turn, resulted in weaker vaccine compliance intentions (Chen et al., 2021). Thus, overall, we surmised that exposure to risky or cautious social comparison information may influence outcomes (e.g., vaccine intentions) by changing affect/attitudes related to the outcome (e.g., positive attitudes/affect would increase vaccine intentions).

Second, *norm perceptions* are beliefs about the extent to which others support one's engagement in a behavior (injunctive norms) and whether engagement in that behavior is common (descriptive norms; Cialdini et al., 1991; Tankard & Paluck, 2016). Past research on the TPB demonstrates that norm perceptions are a reliable predictor of health intentions and behaviors (Godin & Kok, 1996; Sheeran et al., 2001), including for behaviors like condom use (Sheeran & Taylor, 1999), exercise (Downs & Hausenblas, 2005; Hausenblas et al., 1997), and smoking (Topa & Moriano, 2010). Importantly, norm perceptions can be influenced by exposure to social comparison models (Abrahamse & Steg, 2013). For instance, several studies (e.g., Allen et al., 2009; Chen et al., 2020; Oraby et al., 2014) have found that beliefs in high social norms for vaccination in others were predictive of greater vaccine intentions for several illnesses (e.g., HPV, pertussis). Critically, research in the context of COVID-19 vaccine compliance (and other prevention behaviors) has found that participants exposed to social comparison information demonstrating a hesitancy norm were less likely to indicate they would take the vaccine (Palm et al., 2021). Thus, exposure to risky or cautious social comparison information may influence outcomes (e.g., vaccine intentions) by changing norm perceptions related to the outcome (e.g., higher norm perceptions would increase vaccine intentions).

Third, *self-evaluations* can be defined as a person's self-appraisals of their effectiveness or capability in a given domain (Judge et al., 2003). Here we focus on self-evaluations of *efficacy* for the relevant behavior, which is among the strongest predictors of behavior across a range

of domains (Holden, 1992; Sheeran et al., 2016). In regard to vaccination intentions, shifts toward high self-evaluations may lead participants to have greater intentions aimed at future prevention behaviors (including vaccine uptake; Rose & Edmonds, 2021), and self-efficacy has been found to be a significant predictor of vaccination intention (Brewer & Fazekas, 2007; Eberhardt & Ling, 2021; Gargano et al., 2011). Importantly, social comparison contexts can directly affect people's self-evaluations (Mussweiler, 2001; Schunk, 1984; Vogel et al., 2020) and efficacy beliefs (Klassen, 2004; Pan & Peña, 2021; Vrugt, 1994), and self-evaluations can subsequently predict motivations and intentions to engage in a behavior (Ajzen, 1991; Guay et al., 2010). For instance, in a health context, participants who were high in prevention focus regarding diabetes management also showed strong motivation and self-efficacy when presented with a comparison other (Schokker et al., 2010). Thus, exposure to risky or cautious social comparison information may influence outcomes (e.g., vaccine intentions) by changing self-efficacy related to the outcome (e.g., higher self-efficacy would increase vaccine intentions).

Current research

Vaccine hesitancy for COVID-19 has been pronounced in the U.S. and has prolonged the pandemic. The current research examined how exposure to cautious or risky (or neutral) social comparison models—in terms of their COVID-19 prevention behaviors, beliefs, and plans to vaccinate—influences people's vaccine intentions. Additionally, we examined whether this effect was moderated by (dis) similarity mindsets and whether the effects of comparative models on vaccination intentions can be explained via changes in select, theoretically-driven mechanisms (i.e., affective associations/attitudes, norm perceptions, and self-evaluations of efficacy). Heretofore, no research to our knowledge has experimentally examined the influence of similarity mindsets and social comparison information on health cognition in the context of COVID-19 prevention behaviors (particularly vaccine uptake), nor examined the intervening variables that might account for the influence of such variables. Thus, our research represents a novel and important step toward understanding the factors that influence health cognitions and behavioral tendencies during an infectious disease pandemic.

Using an online adult sample of unvaccinated U.S. residents, we employed a 3 (Comparison Model: Cautious, Risky, or Neutral) X 2 (Mindset: Similarity or Dissimilarity) between-participants experimental design. Participants completed a mindset manipulation to prime thoughts of similarity or dissimilarity (Mussweiler, 2001) before viewing hypothetical social media accounts of cautious comparison models (e.g., individuals who have engaged in prevention behaviors, expressed concern about COVID-19, and plan to vaccinate) or risky comparison models (e.g., individuals who have not engaged in prevention behaviors, been unconcerned about COVID-19, and do not plan to vaccinate). Additionally, we included a neutral (control) comparison model condition (e.g., individuals who do not have strong cautious/risky beliefs or behaviors related to COVID-19) for sake of completeness and to better interpret our results (Bruchmann, 2017). Next, participants completed our core dependent variables involving vaccination intentions, as well as questions related to their affective associations/attitudes about the vaccine, norm perceptions related to taking the vaccine, and self-evaluations of efficacy for getting the vaccine (among other constructs). Several core hypotheses were tendered.

Hypotheses

Hypothesis 1 (H_1) There will be a main effect of comparison model, such that participants exposed to a cautious comparison model will demonstrate greater vaccination uptake intentions than those exposed to a risky comparison model (with the neutral comparison model falling in-between).[1]

Hypothesis 2 (H_2) There will be an interaction effect, such that the pattern described above in H_1 will be stronger for participants in the similarity (vs. dissimilarity) mindset condition. Note that it is also possible that we could see a full cross-over interaction. However, given that we expected participants to lean (at a default) towards assimilation effects (see H_1), we thought the possibility of achieving a full cross-over interaction would be unlikely.

Hypothesis 3 (H_3) Greater vaccine uptake intentions in the cautious comparison model condition will be indirectly explained (i.e., mediated) via changes in positive affective associations/attitudes about the vaccine, higher norm perceptions for approval from and likelihood of others getting the vaccine, and greater self-evaluations of efficacy for getting the vaccine (Hypothesis 3a). Moreover, we also predicted that the mediation results would be stronger for participants in the similarity rather than the dissimilarity condition (Hypothesis 3b). That is, we predicted a moderated-mediation account.

[1] Of note, from a Selective Accessibility Model perspective, one might expect no main effect of comparison model. However, we based H_1 off extant research related to exposure to social normative/comparison information in a vaccine context (Allen et al., 2009; Oraby et al., 2014; Palm et al., 2021). Findings support that exposure to a vaccine hesitancy (vs. uptake) norm was associated with lower (vs. higher) vaccine intentions and behaviors—evidence of assimilation effects (i.e., main effects of comparison model).

Methods

Participants

Participants ($N = 320$) were recruited from Amazon Mechanical Turk's (MTurk) CloudResearch platform (Litman et al., 2017). Data collection occurred between June 18, 2021 and July 18, 2021, approximately three months after COVID-19 vaccines were available to the general public. Twenty participants were omitted from analyses due to failed bot/attention checks and/or computer programming errors. The remaining data ($N = 300$) were used for analyses. Participants identified primarily as female (56.2%), were mostly between the ages of 31–40 years (34%), were mostly white (77.7%), lived in mostly suburban residential areas (50.7%), had at least a 4-year college degree (40.8%), reported Democrat as the preferred political party (34.8%), and were generally religious (65.7%). The collected sample size provided greater than 97% power ($\alpha = 0.05$) to detect medium effect sizes.

Exclusion criteria consisted of the following: Participants must (a) be at least 18 years of age, (b) currently reside in the U.S., (c) not have received the COVID-19 vaccine at any stage, (d) not have any medically-related reasons that would prevent them from receiving the COVID-19 vaccine (e.g., medical condition or severe allergy; CDC, 2021b), and (e) not be completely for or against taking the vaccine upon baseline entry into the study. For the last point, participants indicated on a 9-point Likert scale their likelihood of getting the vaccine (1 = *Not at all likely*; 9 = *Very likely*). Participants responding with a 1, 2, 8, or 9 on this scale were ineligible. We used this exclusion criteria to avoid extreme polarization in vaccination intentions and COVID-19 beliefs, and to select participants whose responses to our core stimuli would be more malleable. At the time of data collection, vaccines had been open to the general public for approximately three months; thus, it was assumed that people who were strongly for or strongly against vaccine compliance would have had ample time to consider this decision and would likely not change their position.

Measures and materials

Experimental manipulations

Similarity/dissimilarity manipulation We manipulated similarity (vs. dissimilarity) mindsets in two ways. First, participants were presented with two scenes of nineteenth century town squares (Mussweiler & Ockenfels, 2013). Depending on experimental condition, participants wrote up to eight entries about either the similarities or differences between these two pictures. Second, after exposure to the comparison models (see below), participants were additionally asked to list (dis)similarities between themselves and the comparison targets ("Please list three similarities (dissimilarities) you can think of between yourself and the target people").

Comparison model manipulation Participants were exposed to two, gender-neutral and hypothetical social media profiles (Zeoob, 2021). The profile information and content were designed to give the impression that the target individual was cautious, risky, or neutral in their beliefs and behaviors related to COVID-19. Specifically, two basic elements of the social media profile content were modified to create this impression.

First, social media profiles often contain general information about the user, such as their demographics, self-descriptions, interests, and favorite quotes. Prior research has shown that specific personal characteristics (e.g., political orientation, religiosity) are associated with engagement in prevention behaviors (including vaccine uptake intentions and behaviors) for COVID-19 (Rivas et al., 2021; Ruiz & Bell, 2021). Thus, one aspect of our manipulation was to provide general profile information (e.g., quotes, self-descriptions) that highlighted relevant personal characteristics that have been associated with caution versus risk for prevention behaviors related to COVID-19. For example, our cautious comparison models were pro-science and socially conscious (e.g., "I have an unquenchable thirst for knowledge that cannot be filled no matter how hard I try"; "If everyone would care about one another, it would be a much kinder place"), whereas our risky comparison models were pro-personal freedom and religious (e.g., "The world no longer consists of dirt to walk on, you walk on egg shells", "God is protecting us"). Neutral comparison model content was designed to be more generic and not directly tied to personal characteristics associated with COVID-19 vaccination beliefs and behaviors (e.g., "Just your average photography lover", "I love traveling, my family and friends").

Second, and more critically, we created posts for each target person that explicitly conveyed their beliefs, behaviors, and intentions related to COVID-19. That is, the content of posts presented either cautious comparison models who expressed concern about COVID-19, engaged in prevention behaviors related to COVID-19, and plan to vaccinate (e.g., "I'm signing up for the vaccine as soon as I'm able to. I want to start living my life again!"), risky comparison models who expressed a lack of concern about COVID-19, not engaged in prevention behaviors, and do not plan to vaccinate (e.g., "There is no way I am ever signing up for the vaccine. Who knows what's inside this supposedly effective vaccine?"), or neutral comparison models who have not expressed strong cautious/risky beliefs or behaviors related to COVID-19 (e.g., "Whether you agree with mask mandates or not, I think we can all agree that they aren't great for fashion. Lol").

Measures

Vaccination intention Participants were asked about their COVID-19 vaccination intentions using different formats (Rose & Aspiras, 2020; Windschitl et al., 2010): a dichotomous forced-choice question ("Do you intend on getting the COVID-19 vaccination?" *No* = 1*; Yes* = 2), a verbal Likert-style scale ("How likely are you to get the COVID-19 vaccine?" 1 = *Impossible;* 11 = *Certain*), and a matched 11-point scale with numerical percentage anchors ("How likely are you to get the COVID-19 vaccine?" 1 = *0% chance;* 11 = *100% chance*). Responses were standardized and an overall vaccine intentions composite was created ($\alpha = 0.94$).

Affective associations and attitudes First, to assess affective associations, participants were asked how they felt about COVID-19 vaccinations (e.g., "When you think about the possibility of receiving the COVID-19 vaccine, how do you feel"), followed by a series of positive and negative affect-related terms (e.g., excited, afraid) and a 5-point Likert scale (1 = *Not at all;* 5 = *Extremely*). Second, to assess affective attitudes, we used a semantic differential scale approach (adapted from Ajzen, 2013) where participants were provided with a number of bipolar adjectives (e.g., "Bad: Good"; "Harmful: Beneficial") and asked to rate how they viewed the COVID-19 vaccine using a 7-point scale (e.g., 1 = *Bad*; 7 = *Good*). After computing separate indices (after necessary reverse scoring) for affective associations and attitudes, we standardized and created an overall affective associations/attitudes index ($r = 0.58$), such that higher scores reflect more positive feelings.

Norm perceptions First, for injunctive norms, participants answered six items (e.g., "My friends would approve of me receiving the COVID-19 vaccine") on a 5-point scale (1 = *Strongly disagree;* 5 = *Strongly agree*). Second, for descriptive norms, participants completed five items indicating the percentage of individuals (e.g., friends, people in your community) that will eventually receive the COVID-19 vaccine on an 11-point scale (1 = *0% / no one in this group;* 11 = *100% / all of the people in this group*; adapted from Ajzen, 2013). After computing separate indices for injunctive and descriptive norms, we standardized and created an overall norm perceptions index ($r = 0.60$).

Self-evaluations of efficacy To assess self-evaluations, participants rated the extent to which they felt efficacious for getting the COVID-19 vaccine with nine items (e.g., "You can arrange transportation to get the COVID-19 vaccine") using a 5-point Likert scale (1 = *Not at all likely*; 5 = *Extremely;* derived from Scherr et al., 2017). An overall composite was created for self-evaluations of efficacy ($\alpha = 0.93$).

Manipulation checks Several manipulation check items were included for each manipulation. First, to assess the similarity manipulation, participants made two assessments of similarity for the social comparison models (e.g., "How similar are these people to you?"; "How similar are these people's coronavirus vaccine viewpoints to your own coronavirus vaccine viewpoint?") on 5-point Likert scales (1 = *Not at all similar*; 5 = *Completely similar*). An overall composite was created for similarity ($r = 0.67$). Second, to assess the comparison model manipulation, participants provided a variety of evaluative ratings about the comparison models ("Please rate these people on the following dimensions") using a 5-point Likert scale (1 = *Not at all*; 5 = *Extremely*). Among the dimensions, we included two items that were relevant to the manipulation (i.e., "safe", "risky;"). An overall composite (after reverse scoring) was created for the comparison models, such that higher scores reflect that they viewed the source as safe/not risky ($r = 0.57$).

Procedure

All procedures were approved by the university's Institutional Review Board. MTurk participants had at least a 95% approval rating and completed at least 5000 tasks (i.e., Human Intelligence Tasks). All portions of the study were completed using Qualtrics. Ineligible participants were redirected to the end of the study after answering screening questions (described above). Eligible participants provided consent and were told they were in a study about evaluating social media content related to COVID-19. Participants were assigned to one cell of the 3 (Comparison Model: Cautious, Risky, or Neutral) X 2 (Mindset: Similarity or Dissimilarity) between-participants design described above. First, participants completed the (dis)similarity mindset picture task. Second, participants were provided with information about two social comparison models (and completed the second similarity/dissimilarity task) and were asked to imagine how they would actually think, feel, and respond if they were exposed to the information on social media. Participants then completed the measures described above, as well as demographic measures and other measures not directly relevant to the aims of this manuscript.[2] Participants

[2] Note that participants also answered questions about future intentions to engage in COVID-19 related prevention behaviors (e.g., wearing masks, social distancing) and general beliefs, attitudes, and experiences related to COVID-19 (e.g., instrumental attitudes, risk perceptions; Ajzen, 2013; Rose & Edmonds, 2021; Tull et al., 2020). However, as these measures were not central to the thrust of this special issue, they are not described in detail here.

Table 1 Descriptive statistics and correlations for main variables

	Variable	VI Dich	VI Verb	VI Num	1	Affective associations	Affective attitudes	2	Injunctive norms	Descriptive norms	3	Self-evaluations	4
1	VI Index affective				–			.73***			.49***		.18**
2	Associations index							–			.54***		.24***
3	Norm perceptions index										–		.34***
4	Self-evaluations index												–
	Mean	1.48	5.61	5.44	.00	2.96	4.49	.00	3.91	7.21	.00	4.25	.00
	Standard deviation	.50	2.46	2.83	2.84	.87	1.35	.73	.77	1.64	.71	.73	.81

This table provides descriptive statistics for unstandardized individual-level components of each composite index. For instance, the VI (vaccine intentions) Index was composed of a dichotomous VI rating ('VI Dich.'), a verbal rating ('VI Verb.'), and a numerical rating ('VI Num.'). The Affective Associations Index was composed of an affective associations and an affective attitudes measure. The Norm Perceptions Index was composed of injunctive norms and descriptive norms measures. And the Self-Evaluations Index was simply the measure of self-evaluations of efficacy for vaccination. Finally, the correlations reported in the table were computed based on the relationships between the (standardized) indices

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

were debriefed and compensated $2.00 (USD). Data and other materials can be accessed in the data repository Open Science Framework at (https://osf.io/zjdbx).

Results

Descriptive statistics, bivariate correlations, and manipulation checks

Table 1 displays the bivariate correlations between core measures, as well as the descriptive statistics.

Manipulation checks

To examine the similarity manipulation, we submitted the perceived similarity composite to a 3 (Comparison Model: Cautious, Risky, or Neutral) X 2 (Mindset: Similarity or Dissimilarity) between-subjects ANOVA. Confirming the success of the manipulation, there was a main effect of mindset, $F(1, 294) = 12.23$, $p < 0.001$, where participants in the similarity condition had higher perceived similarity ratings ($M = 2.76$, $SD = 1.06$) than did participants in the dissimilarity condition ($M = 2.34$, $SD = 1.00$; Cohen's $d = 0.41$). There was no main effect of comparison model or interaction ($Fs < 1.46$, $ps > 0.23$).

To examine the comparison model manipulation, target evaluations of safety/risk were submitted to the same 3 X 2 ANOVA described above. Confirming the success of the manipulation, there was a main effect of comparison model, $F(2, 294) = 69.22$, $p < 0.001$. Post-hoc analyses revealed that participants in the cautious comparison model condition provided the highest ratings of safety/low risk for the models ($M = 4.15$, $SD = 0.78$), followed by participants in the neutral comparison model condition ($M = 3.74$, $SD = 0.82$; $p < 0.01$, Cohen's $d = 0.51$ comparing the cautious and neutral conditions), and finally participants in the risky comparison model condition ($M = 2.71$, $SD = 1.07$; $p < 0.001$, Cohen's $d = 1.08$ comparing the risky and neutral conditions). There was no main effect of mindset or interaction ($Fs < 3.29$, $ps > 0.05$).

Analyses for H_1 and H_2

For hypotheses 1 and 2 involving main effects and interactions of our core independent variables, the vaccine intentions (VI) composite was submitted to the same 3 X 2 between-subjects ANOVA described above. First, and consistent with H_1, there was a main effect of comparison direction, $F(2, 294) = 4.03$, $p = 0.02$, $\eta_p^2 = 0.03$. Post-hoc analyses revealed that participants in the cautious comparison model condition had higher VI ($M = 0.65$, $SD = 2.65$) than did participants in the risky comparison model condition ($M = -0.37$, $SD = 2.92$; $p = 0.03$, Cohen's $d = 0.37$), and neutral comparison model condition ($M = -0.29$, $SD = 2.85$; $p = 0.05$, Cohen's $d = 0.34$). VI for the risky and neutral comparison models did not differ from one another ($p = 0.97$, Cohen's $d = 0.03$). The main effect of mindset was not significant, $F(1, 294) = 0.07$, $p = 0.79$, $\eta_p^2 < 0.001$. Additionally, and inconsistent with H_2, the comparison model X mindset interaction was not significant, $F(2, 294) = 0.19$, $p = 0.83$, $\eta_p^2 < 0.001$.

Analyses for H_3

Recall that H_{3a} involved an examination of whether the changes in affective associations/attitudes, norm perceptions, and self-evaluations of efficacy indirectly account for the relationship between the comparison model condition and VI. To assess this, a multiple mediation and bootstrap analyses were conducted using PROCESS v. 3.5 model 4 (Hayes, 2017, 2018). For the bootstrap analysis, all indirect relations were evaluated using bias-corrected 95% confidence intervals based on 5000 bootstrap samples (Preacher & Hayes, 2008). For analyses, the multi-categorical predictor variables (cautious, neutral, risky) were indicator coded with a one-unit difference (*1 = cautious*; *2 = neutral*, *3 = risky*) and treated as dichotomous (specifically, we used two dummy-coded variables based on theory and the results described above for VI: 1 vs. 2 and 1 vs. 3; Hayes & Preacher, 2014), the criterion variable was the VI composite, and the mediator variables were the affective associations/attitudes, norm perceptions, and self-evaluations of efficacy composites. All predictors were standardized. The overall model including all variables described above was significant, $F(4, 296) = 4.14$, $p = 0.02$, $R^2 = 0.03$. Importantly, and supporting H_{3a}, the direct paths from comparison direction to VI were reduced in significance when including the indirect effects ($ps > 0.07$). First, for affective associations/attitudes, a bootstrap analysis revealed a significant indirect relation of the cautious ($M = 3.93$, $SD = 0.97$) versus risky ($M = 3.57$, $SD = 1.02$) comparison direction grouping, but not for the cautious versus neutral ($M = 3.68$, $SD = 0.96$) comparison direction grouping. Second, for norm perceptions, findings showed non-significant indirect relations of the cautious ($M = 5.58$, $SD = 1.17$) versus neutral ($M = 5.70$, $SD = 0.94$) comparison direction grouping and the cautious versus risky ($M = 5.39$, $SD = 1.15$) comparison direction grouping. Third, for self-evaluations of efficacy, findings showed non-significant indirect relations of the cautious ($M = 4.17$, $SD = 0.78$) versus neutral ($M = 4.25$, $SD = 0.72$) comparison direction grouping and the cautious versus risky ($M = 4.34$ $SD = 0.67$) comparison direction grouping.[3] See Table 2.

Next, in relation to H_{3b}, we also tested the moderated-mediation model using PROCESS v.3.5 model 8 (Hayes, 2018) involving the following variables: the multi-categorical social comparison model condition (predictor variable) which was dummy-coded as described above, vaccine intentions (criterion variable), affective associations, norm perceptions, and self-evaluations of efficacy (mediators), and (dis)similarity condition (moderator). As with the lack of an interaction effect on vaccine intentions in the main analysis, there was also no evidence of moderated-mediation of these results ($ps > 0.32$).

Discussion

Using a U.S. online adult sample, the current research examined the influence of social media-based comparison on COVID-19 vaccination intentions, as well as the moderators and mechanisms for this relationship. Several notable findings emerged. First, and supporting H_1, we found that participants reported greater VI after exposure to comparison models who were cautious (vs. risky or neutral) with regard to COVID-19 prevention behaviors, beliefs, and vaccination intentions. This result is consistent with prior research demonstrating that people sometimes assimilate their health- and safety-related beliefs and behaviors to social comparison models and norms (e.g., Oraby et al., 2014; Stanton et al., 1999). Interestingly, VI did not differ between risky and neutral comparison models. However, manipulation check data confirmed that target ratings of safety/risk differed across conditions in a linear fashion, suggesting that the strength of the risky comparison model condition was not problematic. One possibility for the lack of assimilation to the risky comparison model (relative to the neutral condition) could be that the research context primed healthy or cautious behaviors, promoting relatively more assimilation towards

[3] Given the role of political affiliation in COVID-19 vaccine uptake and other health prevention behaviors (Fridman et al., 2021; Grossman et al., 2020; Latkin et al., 2021), we additionally examined the moderating impact of political affiliation on our core results involving vaccine intentions, as well as how political affiliation might influence how similarly participants viewed the comparison target (based on condition). First, we submitted the perceived similarity to the comparison model to a 3 (*Comparison Model:* Cautious, Risky, or Neutral) X 2 (*Mindset Priming:* Similarity or Dissimilarity) X 3 (*Political Affiliation:* Republican, Independent, Democrat) between-subjects ANOVA. The main effect of political party affiliation was not significant ($F = .42$; $p = .66$). However, the comparison model X political affiliation interaction was significant, $F(4, 281) = 12.67$, $p < .001$, $\eta_p^2 = .15$. Specifically, the most apparent pattern of findings related to this interaction was that participants who identified as Democrat rated themselves as more similar to the cautious comparison model, whereas participants who identified as Republican rated themselves as more similar to the risky comparison model. This result is not overly surprising, given that we used political affiliation as an additional cue to the social media target's attitudes and behaviors related to COVID-19. No other interactions of political affiliation with our core independent variables were significant (all $Fs < .27$, $ps > .76$). Second, we submitted VI to the same ANOVA. We found that participants who identified as Democrat had higher vaccination intentions than did participants who identified as Republican or Independent. However, and more importantly for our purposes, the *interactions* of political affiliation with our core independent variables were not significant. Taken together, these results suggest that political affiliation influenced how similar participants viewed the target person to themselves, but that this degree of similarity cannot account for our pattern of results for the vaccine intentions variable (due to the lack of comparable interaction effects involving political affiliation).

Table 2 Indirect relation of social comparison model on COVID-19 vaccination intentions through affective associations, norm perceptions, and self-evaluations

Independent variable	Intervening variable	Effect of IV on M		Effect of M on DV		Direct effect		Indirect effect			Total effect	
		(*a*)	*SE*	(*b*)	*SE*	(*c'*)	*SE*	(*a x b*)	*SE*	95% CI	(*c*)	*SE*
Cautious versus neutral comparison condition	Affective associations/attitudes	−.25	.14	1.87***	.13	−.50	.27	−.47	.26	−.98, .03	−.94*	.40
	Norm perceptions	.11	.14	.43**	.13	−.50	.27	.05	.06	−.07, .18	−.94*	.40
	Self-evaluations of efficacy	.11	.14	−.09	.12	−.50	.27	−.01	.03	−.07, .04	−.94*	.40
Cautious versus risky comparison condition	Affective associations/attitudes	−.37**	.14	1.87***	.13	−.26	.28	−.68	.27	−1.22, −.17	−1.04**	.40
	Norm perceptions	−.17	.14	.43**	.13	−.26	.28	−.07	.07	−.25, .05	−1.04**	.40
	Self-evaluations of efficacy	.23	.14	−.09	.12	−.26	.28	−.02	.04	−.10, .05	−1.04**	.40

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

comparison models that were health-promotive. Also, in addition to target ratings of safety/risk (see manipulation checks), we also asked about self-ratings. Interestingly, there was evidence in our data that participants viewed themselves as more safe and less risky than comparison models overall when comparing self and target ratings. Although there were no differences in similarity perceptions across comparison models (see manipulation check results), this data suggests that participants viewed themselves as closer (at a default) to the cautious comparison model than the risky model on relevant dimensions ($|ts| > -27.04$, $ps < 0.001$), resulting in asymmetries in the influence of risky versus cautious comparison models. Regardless of the explanation, these results further highlight the importance of including both experimental and control conditions in social comparison research (Bruchmann, 2017).

Second, and inconsistent with H_2, there was no evidence that the assimilation-type effects of the comparison model on VI were amplified among participants induced to focus on similarities. This result is surprising, given that we used two separate tasks to bolster the manipulation and the fact that ample evidence supports that participants induced with (dis)similarity mindsets demonstrate assimilative (contrastive) tendencies that affect downstream processing and outcomes (Mussweiler, 2001; Mussweiler et al., 2004; Vogel et al., 2020). It could be that the effects of the comparison model manipulation were stronger and overwhelmed the effects of the similarity, despite the fact that we utilized a novel, two-pronged approach to manipulating similarity. A related possibility is that the delay between the main mindset manipulation and the dependent measures was too long, weakening its influence. Moreover, although the manipulation of similarity was successful overall (see manipulation check data), it was also the case that perceptions of target similarity were below the midpoint. This suggests that, even in the similarity condition, participants did not view the comparison model as very similar to the self, potentially undercutting the manipulation. Moreover, it is possible that the impact of the similarity manipulation was mitigated by influential factors related to health prevention behavior in the context of COVID-19 (e.g., political ideology, religiosity). For instance, due to having roughly half of participants in the risky and cautious conditions read about a comparison target who diverged politically from the self and, given that political affiliation is a salient and polarizing personal characteristic (including within the context of COVID-19), this likely made it more difficult to shift similarity perceptions. It is also important to acknowledge that our use of two distinct similarity manipulations has not heretofore been used and may have affected our results. Future research should examine such issues more closely.

Third, and partially supporting H_{3a}, analyses showed that the effect of the cautious versus risky social comparison model on VI was indirect through (i.e., mediated by) positive affective associations and attitudes; on the other hand, there was no evidence of indirect effects through norm perceptions or self-evaluations of efficacy. Further, it is notable that analyses involving the cautious vs. neutral comparison model did not reveal any indirect (i.e., mediational) effects. These results are consistent with research and theory on BAAM and other models (Kiviniemi et al., 2007; Magnan, 2017; Sheeran et al., 2016) that highlight the unique role for affect-related assessments (e.g., worry, affective associations) in influencing health-relevant cognition and behavior, sometimes above and beyond more cognitively-laden constructs (e.g., self-efficacy, likelihood judgments). Although norm perceptions and self-evaluations (particularly self-efficacy) are often robust predictors of health cognitions (e.g., behavioral intentions; Ajzen, 1985; Casper, 2007; Topa & Moriano, 2010), our results demonstrate that norm perceptions and self-evaluations were weaker mechanisms through which social comparison processes operate. Although this could be due to the prominent role of affect-laden constructs in health cognition and behavior (as noted above), it could also be that such constructs were less influenced by social comparison processes than were affective associations or

that cognitively-laden variables play different roles in such processes, at least in this context and for this operationalization of the constructs. Finally, and inconsistent with H_{3b}, there was no evidence of moderated-mediation of the above findings based on whether participants were in similarity or dissimilarity conditions. The reasons for not getting the expected moderated-mediation pattern are likely the same as described above for H_2 involving the moderating impact of the similarity condition on vaccine intentions.

Limitations and future directions

There are several notable limitations in the present research. First, we assessed future intentions for vaccination rather than actual behavior. Although intentions often determine behavior (Godin & Kok, 1996; Sheeran et al., 2001), this is not always the case as future-oriented cognitions are abstract and less amenable to tangible efforts that lead to behavior (e.g., action planning; D'Argembeau et al., 2011). Thus, it is unclear in our research whether the increases in VI after exposure to cautious comparison models would translate to increases in vaccine uptake. As such, it is an important task for future research to examine the influence of social comparison models on vaccination uptake behaviors. Second, the similarity manipulation was not effective in influencing health cognition in this context. Although our manipulation check was successful and past research supports that similarity (dissimilarity) can engage assimilation (contrast) processes, future research could benefit from further exploring the role of similarity in influencing responses to comparison models in this and similar contexts. Third, our results are limited to the COVID-19 context. Future research should examine the relationship between these variables in contexts beyond COVID-19 vaccination uptake, such as engagement in prevention and detection behaviors for other illnesses (e.g., mammograms to detect cancer, flu vaccinations) or general health behaviors (e.g., exercise, diet). Fourth, our study only included participants who were not completely for or against taking the COVID-19 vaccine. While this is an important and large group worth targeting, the issue of vaccine hesitancy becomes more concentrated on the strongly opposed over time as individuals who are "on the fence" eventually become vaccinated (Wake, 2021). Thus, it is vital to understand what factors (including social comparison) influence health prevention cognitions and behaviors in those who are strongly against vaccination. Fifth, more research is needed to understand the mechanisms through which social comparison information influences outcomes in this context. As noted previously, prior research has examined similarity (mindsets and perceptions) as a mechanism through which comparisons achieve assimilative or contrastive processes and outcomes (Mussweiler, 2001; Mussweiler et al., 2004). Our research explored novel mechanisms (e.g., affective associations, efficacy) that may be separable or potentially influenced by similarity (although see results for H_2). However, the exact nature through which these mechanisms operate and relate to one another is unclear at present.

Implications and conclusions

Our research has both theoretical and applied implications. First, our findings contribute to models of health intentions and behaviors (e.g., Theory of Planned Behavior; Ajzen, 1991) by demonstrating that specific psychological factors (e.g., affective attitudes, social comparisons) predict health cognitions. Second, our research is relevant to theoretical perspectives on social comparative processes and social norms (e.g., Social Comparison Theory, Focus Theory of Normative Conduct; Cialdini et al., 1991; Festinger, 1954) in that it highlights the role of social comparison models in informing health cognition and behavior. Third, our findings fit with theory and research on BAAM (Kiviniemi et al., 2007) by illustrating that affective associations were stronger predictors of VI than were cognitive predictors, and that such associations were influenced by social comparative information. Fourth, this research contributes to our understanding of how exposure to information on social media can affect prevention-related behaviors, including vaccine hesitancy for COVID-19 (Puri et al., 2020; Srivastava et al., 2020). Gaining a richer understanding of how social media-based comparison processes affect health-relevant cognition and behavior has become increasingly important as much of the population has turned to social media for news and social information, particularly during the COVID-19 pandemic (Naeem & Bhatti, 2020). Fifth, our finding that exposure to cautious comparison models increased VI (via more positive affective associations with vaccines) may be useful in the creation of interventions, health-relevant advertisements, and communications related to health prevention behavioral compliance. Understanding the factors that impact vaccine hesitancy is a critical task for social and health behavioral scientists, and our research represents an important step toward gaining a deeper understanding of when and why social comparison information might impact health cognitions and behavioral tendencies (e.g., vaccination uptake) during an infectious disease pandemic.

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Declarations

Conflict of interest Noelle K. Herzog, Harika Vasireddy, Dylan A. Drenner, Jason P. Rose have no conflicts of interest to declare that are relevant to the content of this article.

Human and animal rights and informed consent All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

Ethical approval The authors confirm that the study was granted exemption by the University of Toledo's Institutional Review Board and certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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