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Spokespersons for science: examining social media influencers' popularization of controversial technologies on YouTube

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Abstract

An online experiment involving 251 Singaporeans assessed how social media influencers' (SMIs) prototypicality (i.e., embodiment of group attitudes) and social attraction affected their popularization of nuclear energy development. Participants exposed to a SMI with high prototypicality perceived the YouTube video more favorably, displayed greater intention to share the YouTube video, and possessed greater attitude intensity toward nuclear energy development. Participants displayed greater intention to share the YouTube video when the SMI had high social attraction and possessed moderate to high prototypicality. Conversely, participants displayed less intention to share the YouTube video when the SMI had low social attraction and prototypicality.

Keywords

Popularization of science and technology; Public engagement with science and technology; Science and media

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Context

The ease of content creation and distribution on social media has facilitated the proliferation of social media influencers [SMIs; Djafarova & Rushworth, 2017; Neubaum & Krämer, 2017]. SMIs are internet celebrities that possess a substantial number of followers [De Veirman, Cauberghe & Hudders, 2017; Lou & Yuan, 2019]. Although SMIs typically endorse consumer brands and products [Lou & Yuan, 2019], government agencies have increasingly featured SMIs in prosocial campaigns. For instance, the Ministry of Sustainability and Environment in Singapore engaged SMIs to advocate the adoption of pro-environmental behaviors [Tan, 2018]. Public health authorities in the United States also collaborated with SMIs to encourage the adoption of COVID-19 prevention behaviors [Diamante, 2020].

Despite the popularity of SMIs, several research gaps persist: specifically, Galetti and Costa-Pereira [2017] highlighted the importance of leveraging SMIs'

story-telling ability and clout on social media to popularize scientific issues and technological developments. However, few studies have investigated the role of SMIs in science communication. Additionally, advertising research predominantly utilized Ohanian's [1990] source credibility framework to analyze how SMI endorsements shape consumers' attitudes and behavioral intentions. Similarly, science communication scholars [e.g., Ho, Looi, Chuah, Leong & Pang, 2018; Ho et al., 2019; Hoti, Perko, Thijssen & Renn, 2021; Ryu & Kim, 2015] have drawn upon Ohanian's [1990] source credibility framework, Chaiken's [1980] heuristic-systematic model of information processing, and the psychometric paradigm [Fischhoff, Slovic, Lichtenstein, Read & Combs, 1978] to assess the public's opinion-formation regarding contentious technologies. Yet, these interpersonal and mass communication theories overlook the group dynamics among SMIs and their community of followers. Furthermore, previous studies examined the text and visuals in SMI endorsements on Instagram [Kay, Mulcahy & Parkinson, 2020], Twitter [C. S. Park & Kaye, 2017; Xu, Sang, Blasiola & Park, 2014], and Weibo [L. Zhang, Zhao & Xu, 2016]. However, these social media platforms lack generalizability to how SMIs have increasing utilized YouTube and Tiktok to produce video endorsements. Finally, prior science communication research extensively examined the valence of attitude changes as a persuasion outcome, with far fewer studies examining individuals' attitude intensity [Howe & Krosnick, 2017; Luttrell & Sawicki, 2020; van Strien, Kammerer, Brand-Gruwel & Boshuizen, 2016].

Objectives

To address these research gaps, this study draws upon the social identity theory of leadership to examine SMIs' opinion leadership on social media. In doing so, this study analyzes how SMIs' prototypicality (i.e., embodiment of group attitudes toward nuclear energy development) and social attraction independently and jointly shape individuals' attitudes and behavioral intentions. Specifically, this study determined how the aforementioned characteristics influenced individuals' attitudes toward the YouTube video, intention to share the YouTube video, and their attitude intensity toward nuclear energy development. Altogether, this study evaluates the role of SMIs in heightening the salience of nuclear energy development in public discourse on social media, particularly in a country that is contemplating its technological adoption.

The findings provide potential research and managerial implications: first, this study contributes to science communication and influencer marketing literature by evaluating SMIs' effectiveness in popularizing scientific issues that lie beyond their expertise in consumer brands and products. Second, this study adopts a novel theoretical perspective in science communication, which has primarily utilized interpersonal and mass communication theories. Considering the ubiquity of online communities, this study provides theoretical contributions by assessing individuals' interaction with SMI endorsements in terms of intragroup and intergroup communication. Third, this study extends the social identity theory of leadership from offline, organizational settings to a prominent social media platform with varied visual content. Fourth, this study examines attitude intensity, which is an understudied component in attitudinal outcomes [Howe & Krosnick, 2017; van Strien et al., 2016]. This study also addresses Luttrell and Sawicki [2020]'s call for further research to assess the determinants and moderators of attitude strength. Altogether, the findings contribute to extant literature on the

popularization of controversial technologies. Practically, the findings will inform advertisers, corporations, and government agencies regarding the selection of SMIs as campaign spokespersons based on their characteristics.

Literature review

Social Media Influencers (SMIs)

SMIs are laypeople that have attained prominence by amassing a substantial following on social media [De Veirman et al., 2017; Lou & Yuan, 2019; L. Zhang et al., 2016]. As content creators, SMIs provide reviews and recommendations for brands and products within their expertise in beauty, fashion, food, or travel [De Veirman et al., 2017]. Hence, SMIs are capable of influencing information flows by directing consumers' attention toward specific issues [C. S. Park & Kaye, 2017]. SMIs also drive societal trends by shaping consumers' attitudes and behaviors [C. S. Park & Kaye, 2017].

SMIs are analogous to opinion leaders on social media that establish, reinforce, and alter social group norms [Dalrymple, Shaw & Brossard, 2013; Weeks, Ardèvol-Abreu & Gil de Zúñiga, 2017]. Despite their persuasiveness, SMIs are not restricted to a privileged minority of individuals from elite socioeconomic segments. Instead, SMIs span across social, economic, or political standing in society [Katz, 1957; Nisbet & Kotcher, 2009; C. S. Park & Kaye, 2017]. Rather than obtaining opinion leadership from occupying formal positions of authority, SMIs derive influence by exhibiting their prototypicality and social attraction [Hogg, 2001; Hogg, Hains & Mason, 1998].

Prototypicality refers to audience perceptions about an individual's embodiment of the social group identity [Hains, Hogg & Duck, 1997; Hogg et al., 1998]. Individuals exhibiting traits that are central to the social group identity are conferred opinion leadership [Hains et al., 1997; Hogg et al., 1998; Neubaum & Krämer, 2017]. These prototypical traits are context-specific and can be established or modified by the social group [Hogg, 2001]. Apart from demographic traits (e.g., gender, ethnicity, nationality), prototypical traits may include ideological inclinations (e.g., political affiliation, religion) and pre-existing attitudes toward specific issues (e.g., sports team, societal issues). Contextualizing this to the present study, participants' social group identity will be delineated by their pre-existing attitudes toward nuclear energy development. As such, the SMI's prototypicality will be manipulated by matching the participants' pre-existing attitudes with the valence of attitudes (i.e., pro-nuclear vs. anti-nuclear) conveyed in the SMI's YouTube video and user comments.

Social attraction refers to an individual's popularity with social group members [Katz, 1957]. Specifically, individuals perceived as likable and possess extensive social connections are conferred opinion leadership [Hogg, 2001; Katz, 1957]. Since SMIs establish and sustain relationships with their followers through blogs and social media [Nisbet & Kotcher, 2009; C. S. Park & Kaye, 2017; Xu et al., 2014], their social attraction is measured with the number of followers or channel subscribers [Djafarova & Rushworth, 2017; De Veirman et al., 2017; Jin & Phua, 2014; C. S. Park & Kaye, 2017]. Additionally, SMIs' social attraction has been operationalized in terms of the number of likes, comments, and shares that the SMI's posts receive [Chiregi & Navimipour, 2016; L. Zhang et al., 2016]. As such, YouTube videos from

SMIs with *high* social attraction will obtain more likes, comments, and shares than SMIs with *low* social attraction. Moreover, SMIs with *high* social attraction are rewarded with the status of a "trending" YouTube video, which is promoted alongside other trending YouTube videos to all users in a specific country [Google, 2017]. SMIs that are deemed public figures and industry leaders also receive algorithmic validation in terms of a verification badge [Kowtun, 2020; L. Zhang et al., 2016]. Therefore, this study adheres to extant literature by operationalizing the SMI's social attraction in terms of the number of subscribers, video views, YouTube verification, and the YouTube video's trending status.

Social Identity Theory (SIT) of leadership

Guided by the social identity theory of leadership, this study evaluates SMIs' role in heightening the salience of complex and controversial technologies in public discourse on social media. Since individuals lack the specialized knowledge regarding the technicalities of nuclear energy development [Ho et al., 2019; Ho et al., 2018], they would turn to both opinion leaders and other social group members to inform their perceived benefits, risks, and support for national policies about nuclear energy development. While scholars typically utilize Ohanian's [1990] source credibility framework to assess how SMIs' shape their followers' attitudinal and behavioral responses [Djafarova & Rushworth, 2017; Lou & Yuan, 2019], this theory does not account for the intragroup and intergroup interactions among SMIs and other users within niche online communities. Given that opinion leadership reflects social group members' collective validation for a SMI's embodiment of the social group identity (i.e., prototypicality) and social attractiveness, the social identity theory of leadership is better suited to fulfill this study's objectives.

The social identity theory of leadership is derived from Tajfel and Turner's [1979] social identity theory [Hogg, 2001], which posits that an individual's self-concept encompasses personal and social identities. In certain social settings, individuals evaluate interpersonal interactions independently based on their personal preferences [Tajfel, 1974]. However, in many social situations, individuals perceive themselves based on their identification with social group prototypes [Tajfel, 1974; Tajfel & Turner, 1979]. These social group prototypes are delineated by context-specific group attitudes and behaviors [Hogg, 2001] or group-specific cues such as nationality and ethnicity [Tajfel & Turner, 1979]. The social group's prototypical attitudes and behaviors can also be established and emphasized on SNS using video content and user comments [S. Zhang, Jiang & Carroll, 2010]. Hence, this study adheres to prior research by operationalizing participants' social group affiliation in terms of their pre-existing attitudes toward nuclear energy development.

The social identity theory of leadership also draws upon self-categorization theory's (SCT) cognitive and interactive social processes, whereby individuals categorize themselves and others into ingroups or outgroups based on prototypical traits [Fielding & Hogg, 1997]. Contextualizing these theoretical arguments to this study, participants will categorize the SMI and other users on the YouTube page as ingroup members if they share similar pre-existing attitudes toward nuclear energy development. As such, participants will perceive the SMI to possess *high*

prototypicality. Conversely, participants will categorize the SMI and other users on the YouTube page as outgroup members if they possess dissimilar pre-existing attitudes regarding nuclear energy development. In these conditions, participants will perceive the SMI to possess *low* prototypicality. This categorization process emphasizes individuals' similarities with ingroup members while enhancing their differences with outgroup members [Fielding & Hogg, 1997; Hogg, Terry & White, 1995].

When the social group's identity is salient, individuals turn to opinion leaders and ingroup members to understand the prevailing social group norms [Hogg et al., 1995; Tajfel & Turner, 1979], which informs their attitudes, attitude intensity, and behavioral intentions [Hogg, 1996; Sechrist & Young, 2011; Turner, Hogg, Oakes, Reicher & Wetherell, 1987]. Based on these theoretical arguments, participants exposed to a SMI with *high* prototypicality will regard the YouTube video more favorably than those exposed to a SMI with *low* to *moderate* prototypicality. Participants' attitudes toward nuclear energy development would also intensify as they cognitively assimilate to the prevailing social group norms. Additionally, participants will assert their social group affiliation by sharing the YouTube video, thereby reinforcing the prototypical social group attitudes and reiterating their differences with outgroup members. Thus, this study hypothesizes:

H1: Participants exposed to a SMI with *high* prototypicality will (a) perceive the YouTube video more favorably, (b) possess greater attitude intensity toward nuclear energy development, and (c) be more willing to share the YouTube video, than participants exposed to a SMI with *low* prototypicality.

H2: Participants exposed to a SMI with *high* prototypicality will (a) perceive the YouTube video more favorably, (b) possess greater attitude intensity toward nuclear energy development, and (c) be more willing to share the YouTube video, than participants exposed to a SMI with *moderate* prototypicality.

H3: Participants exposed to a SMI with *moderate* prototypicality will (a) perceive the YouTube video more favorably, (b) possess greater attitude intensity toward nuclear energy development, and (c) be more willing to share the YouTube video, than participants exposed to a SMI with *low* prototypicality.

The social identity theory of leadership also states that opinion leaders are regarded as attractive, trustworthy, and legitimate when group norms are salient [Hogg, 2001]. Since these perceptions imbue opinion leaders with charisma, prestige, and a superior status, individuals will cognitively and behaviorally conform to the opinion leader's ideas and suggestions [Hogg, 1996, 2001]. Contextualizing these tenets to the present study, participants exposed to a SMI with *high* social attraction will undergo greater cognitive assimilation than those exposed to a SMI with *low* social attraction, thus regarding the YouTube video more favorably and intensifying their attitudes toward nuclear energy development. Participants exposed to a SMI with *high* social attraction will also experience greater behavioral compliance than those exposed to a SMI with *low* social attraction, therefore expressing greater willingness to share the YouTube video. Thus, this study posits:

H4: Participants exposed to a SMI with *high* social attraction will (a) perceive the video more positively, (b) possess greater attitude intensity toward nuclear

energy development, and (c) be more willing to share the YouTube video, than participants exposed to a SMI with *low* social attraction.

H5: The SMI's prototypicality and social attraction will interact, such that participants exposed to conditions with *high* prototypicality and social attraction will experience increased effects on participants' (a) attitudes toward the YouTube video, (b) attitude intensity toward nuclear energy development, and (c) their willingness to share the YouTube video relative to *lower* levels of prototypicality and social attraction.

Attitudes

Attitudes are an individual's favorable or unfavorable evaluations of an idea, object, or person [Eagly & Chaiken, 1998]. Beyond the positive and negative valence, Breckler [1984] explicated attitudes into the affective, behavioral, and cognitive dimensions. Since individuals' attitude may be represented by one or all these components [Breckler, 1984], this study assesses the affective, behavioral, and cognitive dimensions of attitude to holistically evaluate the SMI's persuasiveness.

Affective attitudes refer to an individual's sentiment and intuition toward an attitude object, such as feelings or moods [Breckler, 1984]. Prior research measured affective attitudes using self-reports of positive affect (e.g., happy, pleasant), negative affect (e.g., angry, unpleasant) [Hagger & Chatzisarantis, 2005], and physiological responses (e.g., heart rate) [Breckler, 1984]. Thus, this study adheres to prior research by measuring affective attitudes toward the YouTube video and nuclear energy development using self-reports of positive and negative affect.

Behavioral attitudes pertain to an individual's behaviors toward an attitude object. In Breckler's [1984] research, behavioral attitudes were operationalized using self-reports of behavioral intention, performance, and preferred physical distance. Since this study examines SMIs' role in enhancing issue salience and public discourse about nuclear energy development on YouTube, it measures behavioral attitudes using participants' willingness to share the SMI's YouTube video.

Cognitive attitudes relate to individuals' thoughts and beliefs toward an attitude object [Breckler, 1984]. Specifically, advertising researchers focused on consumers' perception of the advertising value (i.e., informativeness, usefulness) in SMI endorsements [Lou & Yuan, 2019]. Hence, similar to past studies [Hagger & Chatzisarantis, 2005; Kang, Cappella & Fishbein, 2006], this study measures participants' instrumental attitudes toward the YouTube video and nuclear energy development as indicators of the SMIs' opinion leadership.

Attitude intensity

Since nuclear energy development is a contentious issue whereby individuals possess polarized and entrenched attitudes [Ho et al., 2019], this study examines participants' attitude intensity as an indicator of the SMI's opinion leadership instead of the valence of attitudinal change. Attitude intensity refers to the degree, strength, or extremity of an individual's emotional response toward an attitude object [Haddock, Rothman, Reber & Schwarz, 1999; Howe & Krosnick, 2017;

Krosnick & Schuman, 1988; Luttrell & Sawicki, 2020; Petty & Krosnick, 1995; van Strien et al., 2016]. An individual's attitude intensity is influenced by their knowledge and perceived relevance of the attitude object [Krosnick & Schuman, 1988; Luttrell & Sawicki, 2020; Petty & Krosnick, 1995]. Individuals who know more about the attitude object or regard it to be interesting, valuable, and relatable would possess stronger attitudes [Krosnick & Schuman, 1988; Luttrell & Sawicki, 2020; Petty & Krosnick, 1995]. Attitude intensity can also be strengthened by matching the content of media messages to individuals' pre-existing attitudes [Luttrell & Sawicki, 2020]. While prior research asked participants to indicate how intense their feelings are [Haddock et al., 1999; Krosnick & Schuman, 1988], this study adheres to recent literature which utilized participants' attitudes in the post-test to assess its intensity [Carr & Hayes, 2014; Mansell, Mock, Rhea, Tecza & Piereder, 2021].

Study context: nuclear energy development

In extending influencer marketing to science communication, this study examines SMI endorsements in popularizing nuclear energy development. Nuclear energy development has consistently drawn extensive media coverage due to its controversial nature [Ho et al., 2019]. Since individuals typically lack nuclear-specific knowledge [Ho et al., 2019; Ho et al., 2018], they will look toward nuclear experts, influential figures, or prevailing social group norms to inform their attitudes and behaviors. Hence, this context is appropriate in determining SMIs persuasiveness in shaping individuals' attitudes and behavioral intentions toward prominent and contentious technologies.

The polarized opinions toward nuclear energy development are reflected in energy policies across countries [Ho et al., 2019]. Some countries (e.g., Austria, Germany, Switzerland) intend to discontinue nuclear energy or developmental plans [Ho et al., 2018]. However, other countries (e.g., United States, United Kingdom, France) plan to construct more nuclear power plants [Ho et al., 2018] or adopt nuclear energy (e.g., Indonesia, Thailand) [Ho et al., 2018; World Nuclear News, 2016].

Such polarized attitudes are also observed within countries [Ho et al., 2019]. Detractors have criticized the potential weaponization of nuclear energy, improper disposal of radioactive waste, and potential occurrence of nuclear accidents [Ho et al., 2018; International Atomic Energy Agency, 2014]. Yet, advocates have touted nuclear energy as an environmentally sustainable, reliable, and efficient energy source [Ho et al., 2018; International Atomic Energy Agency, 2014].

Most studies about nuclear energy development are premised in countries currently equipped with industry-scale nuclear facilities [Ho et al., 2019], including Japan [Arikawa, Cao & Matsumoto, 2014], South Korea [E. Park & Ohm, 2014], United Kingdom [Venables, Pidgeon, Parkhill, Henwood & Simmons, 2012], and United States [Besley & McComas, 2015]. Yet, limited research has examined countries contemplating the adoption of nuclear energy [Ho et al., 2019; Ho et al., 2018], such as Singapore. Singapore is a city-state with an estimated population of 5.7 million [Singapore Department of Statistics, 2019]. Due to its limited natural resources, Singapore relies on regional imports of petroleum, crude oil, and natural

gas for energy production [Energy Market Authority, 2022]. Notably, the Singapore government has considered adopting nuclear energy to meet rising energy demands [Ang, 2022; Ministry of Trade and Industry, 2012]. Although Singapore possesses the financial and technological capabilities for nuclear energy development, these plans were deemed unfeasible due to Singapore's small land area and high population density [Ministry of Trade and Industry, 2012]. Moreover, Singaporeans unanimously perceived nuclear energy development as a risky technology susceptible to radioactive meltdowns [Ho & Chuah, 2021; Ho et al., 2019; Tan, 2015]. Despite this, local authorities intend to nurture expertise in upholding nuclear safety and for educating the public about the plans for nuclear energy development in Southeast Asia [Ang, 2022].

Method

This study utilized a 3 (Prototypicality: *high* vs. *moderate* vs. *low*) $\times$2 (Social attraction: *high* vs. *low*) between-subjects factorial experiment. An online experiment was conducted for participants to respond under naturalistic settings of web browsing, thereby ensuring this study's ecological validity in examining SMI endorsements.

Experimental procedure

Prior to data collection, ethics approval was sought from the institutional review board (IRB-2018-04-021) and informed consent was obtained from all participants. Thereafter, participants indicated their pre-existing attitudes toward nuclear energy development in the pre-test questionnaire. Participants were then randomly assigned to one of the six experimental conditions where they interacted with a YouTube mock-up page: specifically, participants viewed a fictitious SMI's YouTube video about nuclear energy development. Then, they read a comment thread restating the SMI's opinion about nuclear energy development, followed by the comments from other YouTube users' agreeing with the SMI. Finally, participants answered the post-test questionnaire containing the dependent measures, manipulation checks, and demographics. Upon completion, participants received research incentives from the online survey panel provider.

Experimental stimuli

Six YouTube mock-up pages were created to reflect each experimental condition (see Appendix A). The YouTube page featured a fictitious SMI's YouTube channel to prevent confounds from using actual SMIs. The SMI's *prototypicality* was manipulated by matching the valence of participants' pre-existing attitudes toward nuclear energy development in the pre-test questionnaire with the valence of the YouTube video and comments.

The SMI's *YouTube video* was created by editing third-party material from existing videos that do not require formal permission [Google, 2022]. The videos were edited to resemble video listicles (e.g., three reasons why I support/oppose nuclear energy), which reflect the content of videos commonly created by SMIs. Three equivalent YouTube videos were created, and participants were exposed to a YouTube video conveying pro-nuclear, anti-nuclear, or both pro-nuclear and

anti-nuclear arguments. The YouTube video's duration was also kept constant to prevent confounds. To enhance the experimental manipulation, the valence of the SMI's YouTube video was reiterated in the video description and the SMI's comment that was pinned on top of the comment thread.

Participants were exposed to *user comments* that were mostly pro-nuclear comments, mostly anti-nuclear comments, or had an equal amount of pro-nuclear and anti-nuclear comments. These comments were adapted from publicly available comments on social media. The word count was kept constant to prevent confounds. An example of the pro-nuclear comments includes "I am all for nuclear energy… it produces way more energy and takes up way less space…" One instance of the anti-nuclear comments includes "NEVER should we say YES… we cannot take a risk to put ourselves in danger…"

The thumbnails for related videos, commenters' usernames, and commenters' profile pictures were kept constant to prevent confounds. To ensure ecological validity, the thumbnails of related videos were obtained from actual thumbnails of existing YouTube videos that do not require formal permission [Google, 2022]. Additionally, the commenters' usernames were sourced from actual and publicly accessible YouTube accounts. To reflect the contemporary YouTube environment, the commenters' profile pictures were obtained from publicly available images including alphabetical icons, landscape photos, memes, and informal photographs.

The SMI's *social attraction* was manipulated in terms of the number of subscribers, video views, verification badge, and the video's trending status. Conditions featuring a SMI's YouTube channel with *high* social attraction had many subscribers, many views, a verification badge, and the video's trending status. Comparatively, conditions featuring a SMI's YouTube channel with *low* social attraction included less subscribers, less views, no verification badge, and no trending status.

Measurements

The measures in the pre-test and post-test questionnaires are provided below. A full list of the measurement items are detailed in Appendix B.

Participants' *general attitudes toward nuclear energy development* before and after exposure to the experimental stimuli were measured using two items on a 6-point Likert scale (1 = *strongly oppose*, 6 = *strongly support*) adapted from Ho and McLeod [2008]. The neutral point was omitted to exclude respondents who are fence-sitters. Participants indicated their support or opposition for nuclear energy development in general and the context of Singapore ($M = 3.04$, SD $= 1.40$, Pearson's $r = .86$, $p < .001$).

Participants' *attitudes toward the YouTube video* constituted instrumental and affective dimensions. Instrumental attitudes were measured using a four-item measure with a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*) adapted from past studies [Hagger & Chatzisarantis, 2005; Kang et al., 2006]. An example includes, "Overall, I find the arguments raised in the YouTube video to be 'Uninformative–Informative'". Affective attitudes were measured using a

four-item measure with a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*) adapted from Hagger and Chatzisarantis [2005]. An example includes, "Overall, I find the YouTube video to be 'Unenjoyable–Enjoyable'". Due to the high correlation (Pearson's $r = .86$, $p < .001$), both dimensions were collapsed into one variable ($M = 5.40$, SD $= .90$, $\alpha = .96$).

Participants' *attitude intensity toward nuclear energy development* comprised of instrumental and affective dimensions. Participants' instrumental attitudes were assessed using a four-item measure with a 7-point semantic differential scale adapted from Neuwirth and Frederick [2004]. An example includes, "I feel that nuclear energy development is 'bad–good'". Participants' affective attitudes were assessed using a three-item measure with a 7-point semantic differential scale adapted from past research [Hagger & Chatzisarantis, 2005; Kang et al., 2006]. An example includes, "I feel that nuclear energy development is 'useless–useful'". Due to its high correlation (Pearson's $r = .82$, $p < .001$), both dimensions of affective and instrumental attitudes were combined into one variable ($M = 1.54$, SD $= .88$, $\alpha = .89$). The valence of participants' attitude toward nuclear energy was collapsed and recoded into a 3-point scale to focus on attitude intensity (0 = *low attitude intensity*, 3 = *extremely high attitude intensity*), which is congruent with prior research [e.g., Mansell et al., 2021; Haddock et al., 1999; Krosnick & Schuman, 1988]. The "neither agree nor disagree" option was recoded into 0 (*low attitude intensity*), the "somewhat agree" and "somewhat disagree" options were collapsed into 1 (*moderate attitude intensity*), the "agree" and "disagree" options were recoded into 2 (*high attitude intensity*), while the "extremely agree" and "extremely disagree" options were recoded into 3 (*extremely high attitude intensity*).

Participants' *willingness to share the YouTube video* were measured with two items on a 7-point Likert scale (1 = *highly unlikely*, 7 = *highly likely*) adapted from Pang et al. [2016]. Participants indicated their likelihood of sharing the YouTube video or speaking about the YouTube video in offline conversations ($M = 4.52$, SD $= 1.58$, Pearson's $r = .75$, $p < .001$).

Manipulation checks. Participants indicated whether the YouTube video and comments contained arguments that were mostly supportive, mostly unsupportive, or both supportive and unsupportive of nuclear energy development. Additionally, participants' social identification with all the users on the YouTube page was measured using a four-item measure with a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*) from Cameron [2004]. An example of the items included, "I feel strong ties with the users featured on this YouTube page". To evaluate if social attraction was successfully manipulated, participants indicated whether the YouTube user's channel was influential using a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*).

Results

Participant recruitment and sample

In total, 251 Singaporeans were recruited from an online survey panel using quota sampling. To mitigate gender biases, quotas were implemented to ensure a balanced distribution of male and female participants. Racial quotas were also utilized to enhance the study's representativeness for Singapore's population demographics. Participants were required to have prior YouTube use to ensure

their familiarity with YouTube's interface. The sample constituted 90.8% Chinese, 6.4% Malay, 2.4% Indian, and 0.4% Eurasian. The respondents were aged 21 to 63 ($M = 38.4$, SD $= 11.3$), and comprised of 47.4% males and 52.6% females.

Manipulation checks

Prototypicality. A one-way Welch's ANOVA (as Levene's test for homogeneity of variances, $p < .05$) revealed that prototypicality significantly influenced participants' social identification with all users on the YouTube page, Welch's $F(2, 158.95) = 7.12$, $p < .01$, $\omega^2 = .01$. The Games-Howell test showed that participants displayed significantly greater social identification when exposed to conditions with *high* prototypicality ($M = 4.43$, SD $= 1.11$) than those exposed to *moderate* prototypicality ($M = 3.98$, SD $= 0.87$) and *low* prototypicality ($M = 3.84$, SD $= 1.01$). However, participants exposed to conditions with *moderate* prototypicality ($M = 3.98$, SD $= 0.87$) did not differ significantly from those exposed to *low* prototypicality ($M = 3.84$, SD $= 1.01$). Thus, participants' social group identity was successfully established based on their pre-existing attitudes toward nuclear energy development.

Social attraction. An independent samples *t*-test revealed that participants regarded the SMI's YouTube channel with *high* social attraction ($M = 5.01$, SD $= .92$) as significantly more influential than the SMI's YouTube channel with *low* social attraction ($M = 4.73$, SD $= 1.19$), $t(241.04) = 2.08$, $p < .05$, 95% CI $[.02, .54]$. Therefore, social attraction was successfully manipulated.

Hypothesis tests

Multiple two-way ANOVAs were conducted to test how SMIs' prototypicality and social attraction influenced participants' attitudes toward the YouTube video, attitude intensity toward nuclear energy development, and willingness to share the YouTube video. Regarding the SMI's prototypicality, participants were divided into three groups (Group 1: high, $n = 96$; Group 2: moderate, $n = 84$; Group 3: low, $n = 71$). For the SMI's social attraction, the participants were divided into two groups (Group 1: high, $n = 121$; Group 2: low, $n = 130$).

Attitudes toward the YouTube video. The SMI's prototypicality significantly affected participants' attitudes toward the YouTube video, $F(2, 245) = 7.00$, $p < .01$, $\eta_p{}^2 = .05$ (see Table 1). Tukey HSD tests indicated that participants exposed to a

Table 1. Two-way ANOVA for attitudes toward the YouTube video.

Effect	*df*	M^2	*F*	*p*	$\eta_p{}^2$
Social attraction	1	.07	.09	.77	.00
Prototypicality	2	5.46	7.00	.00	.05
Social attraction × Prototypicality	2	.23	.30	.75	.00
Error	245	.78			
Total	251				
Corrected total	250				

SMI with *high* prototypicality ($M = 5.67$, SD $= .09$) perceived the SMI's YouTube video more favorably than those exposed to a SMI with *low* ($M = 5.24$, SD $= .11$) to *moderate* prototypicality ($M = 5.24$, SD $= .10$). Thus, H1(a) and H2(a) were supported. However, the differences between participants exposed to a SMI with *moderate* prototypicality ($M = 5.24$, SD $= .10$) and *low* prototypicality ($M = 5.24$, SD $= .11$) were non-significant. Thus, H3(a) was unsupported.

The SMI's social attraction did not significantly affect participants' attitudes toward the YouTube video, $F(1, 245) = .09$, $p > .05$, $\eta_p{}^2 = .00$ (see Table 1). Tukey HSD tests revealed that participants' attitudes toward the SMI's YouTube video did not differ significantly if they were exposed to a SMI with *high* ($M = 5.40$, SD $= .08$) or *low* ($M = 5.36$, SD $= .08$) social attraction. Hence, H4(a) was unsupported.

The interaction effect between the SMI's social attraction and prototypicality on participants' attitudes toward the YouTube video was non-significant, $F(2, 245) = .30$, $p > .05$, $\eta_p{}^2 = .00$ (see Table 1). Thus, H5(a) was unsupported.

Attitude intensity toward nuclear energy development. Participants' attitudes toward nuclear energy development were compared before and after their exposure to the experimental stimuli. On average, participants' attitudes toward nuclear energy development improved after exposure to the experimental stimuli ($M = 3.16$, SD $= 1.45$), relative to their pre-existing attitudes ($M = 3.04$, SD $= 1.35$). However, a paired samples t-test revealed that these changes were non-significant, $t(259) = -1.82$, $p > .05$ (see Figures 1 and 2).

The SMI's prototypicality significantly influenced participants' attitude intensity toward nuclear energy development, $F(2, 245) = 16.08$, $p < .001$, $\eta_p{}^2 = .12$ (see Table 2). This relationship was corroborated with a one-way Welch's ANOVA (as Levene's test for homogeneity of variances, $p < .05$), Welch's $F(2, 155.41) = 15.89$, $p < .001$, $\omega^2 = .108$. Tukey HSD and Games-Howell tests revealed that participants

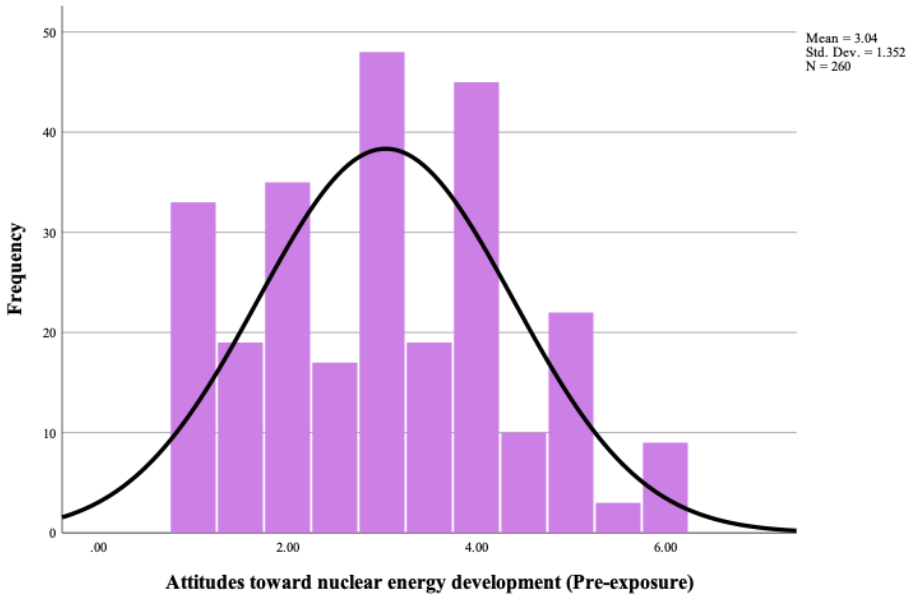

Figure 1. Frequency distribution of participants' pre-existing attitudes toward nuclear energy development.

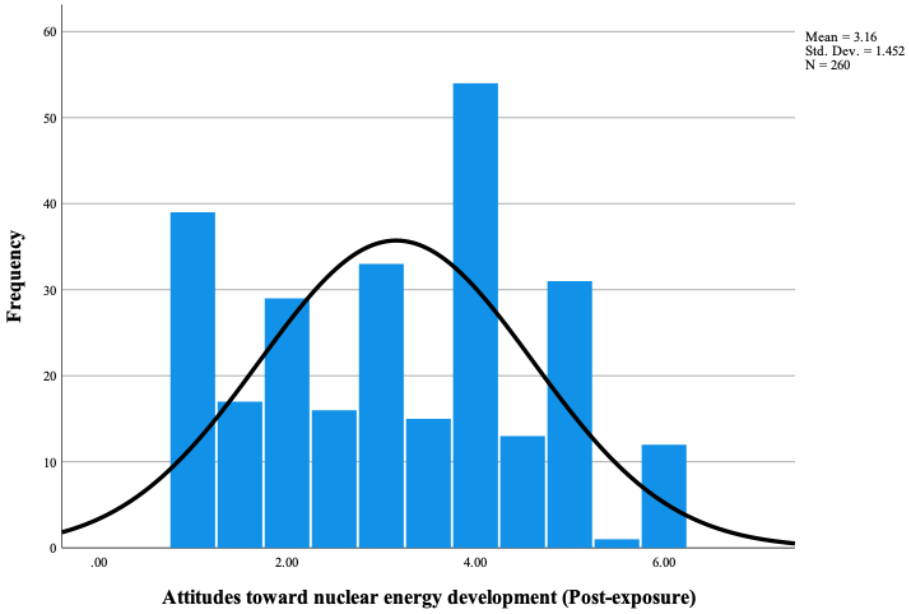

Figure 2. Frequency distribution of participants' attitudes toward nuclear energy development after exposure to the experimental stimuli.

Table 2. Two-way ANOVA for attitude intensity toward nuclear energy development.

Effect	df	M^2	F	p	${\eta_p}^2$
Social attraction	1	.74	1.09	.30	.00
Prototypicality	2	10.97	16.08	.00	.12
Social attraction × Prototypicality	2	.97	1.42	.24	.01
Error	245	.68			
Total	251				
Corrected total	250				

exposed to a SMI with *high* prototypicality ($M = 1.91$, SD $= .09$) displayed significantly more intense attitudes than those exposed to SMIs with low ($M = 1.26$, SD $= .10$) to *moderate* prototypicality ($M = 1.34$, SD $= .09$). Thus, H1(b) and H2(b) were supported. However, participants' attitude intensity toward nuclear energy development did not differ significantly among participants exposed to a SMI with low ($M = 1.26$, SD $= .10$) and *moderate* prototypicality ($M = 1.34$, SD $= .09$). Hence, H3(b) was unsupported.

The SMI's social attraction did not significantly affect participants' attitude intensity toward nuclear energy development, $F(1, 245) = 1.09$, $p > .05$, ${\eta_p}^2 = .00$ (see Table 2). Tukey HSD tests indicated that participants' attitude intensity toward nuclear energy development did not differ significantly if they were exposed to a SMI with *high* ($M = 1.45$, SD $= .08$) or *low* ($M = 1.56$, SD $= .07$) social attraction. Hence, H4(b) was unsupported.

The interaction effect between the SMI's social attraction and prototypicality on participants' attitude intensity toward nuclear energy development was non-significant, $F(2, 245) = 1.42$, $p > .05$, ${\eta_p}^2 = .01$ (see Table 2). Thus, H5(b) was unsupported.

Table 3. Two-way ANOVA for willingness to share the YouTube video.

Effect	*df*	M^2	*F*	*p*	$\eta_p{}^2$
Social attraction	1	.10	.04	.84	.00
Prototypicality	2	8.86	3.67	.03	.03
Social attraction × Prototypicality	2	8.20	3.40	.04	.03
Error	245	2.41			
Total	251				
Corrected total	250				

Willingness to share the YouTube video. The SMI's prototypicality significantly influenced participants' willingness to share the YouTube video, $F(2, 245) = 3.67$, $p < .05$, $\eta_p{}^2 = .03$ (see Table 3). This relationship was corroborated with a one-way Welch's ANOVA (as Levene's test for homogeneity of variances, $p < .05$), Welch's $F(2, 158.26) = 3.57$, $p < .05$, $\omega^2 = .019$. Tukey HSD and Games-Howell tests revealed non-significant differences between participants exposed to a SMI with *high* ($M = 4.83$, SD $= .16$) and *low* prototypicality ($M = 4.44$, SD $= .19$). Therefore, H1(c) was unsupported. As predicted in H2(c), participants exposed to a SMI with *high* prototypicality ($M = 4.83$, SD $= .16$) were significantly more willing to share the YouTube video than those exposed to a SMI with *moderate* prototypicality ($M = 4.21$, SD $= .17$). Contrastingly, participants exposed to a SMI with *moderate* ($M = 4.21$, SD $= .17$) and *low* prototypicality ($M = 4.44$, SD $= .19$) did not differ significantly. Hence, H3(c) was unsupported.

The SMI's social attraction did not significantly affect participants' willingness to share the YouTube video, $F(1, 245) = .04$, $p > .05$, $\eta_p{}^2 = .00$ (see Table 3). The differences between participants' exposed to a SMI with *high* ($M = 4.51$, SD $= .14$) or *low* ($M = 4.47$, SD $= .14$) social attraction were non-significant. Thus H4(c) was unsupported.

The SMI's prototypicality and social attraction significantly interacted to affect participants' willingness to share the YouTube video, $F(2, 245) = 3.40$, $p < .05$, $\eta_p{}^2 = .03$ (see Table 3 and Figure 3). Tukey HSD tests indicated that, when the SMI possessed *high* prototypicality, participants were significantly more willing to share the YouTube video from a SMI with *high* ($M = 4.96$, SD $= .23$) than *low* social attraction ($M = 4.71$, SD $= .22$). Similarly, when the SMI possessed *moderate* prototypicality, participants were significantly more willing to share the YouTube video from a SMI with *high* ($M = 4.50$, SD $= .24$) than *low* social attraction ($M = 3.93$, SD $= .24$). Conversely, when the SMI possessed *low* prototypicality, participants were significantly less willing to share the YouTube video from a SMI with *high* ($M = 4.09$, SD $= .27$) than *low* social attraction ($M = 4.78$, SD $= .26$).

Discussion

This study determined SMIs' role in popularizing nuclear energy development on YouTube. The SMI's prototypicality significantly predicted participants' attitudes toward the YouTube video, attitude intensity toward nuclear energy development, and willingness to share the YouTube video. However, the SMI's social attraction failed to impact participants' attitudinal and behavioral responses. Despite this, the SMI's social attraction and prototypicality significantly interacted to influence participants' willingness to share the YouTube video. Altogether, the SMI's

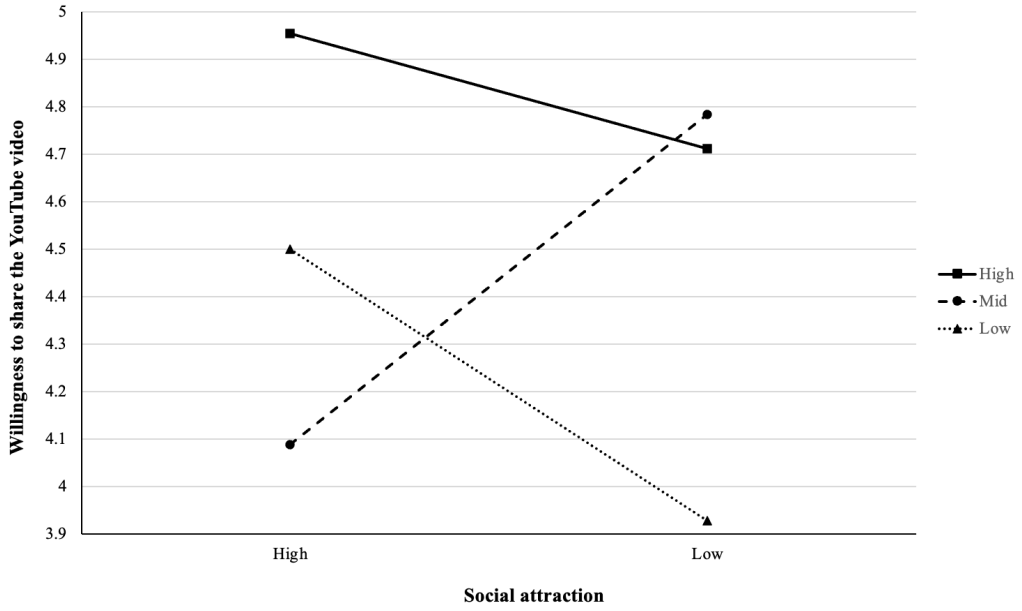

Figure 3. Interaction effects between prototypicality and social attraction on participants' willingness to share the YouTube video.

prototypicality prevailed over social attraction in determining participants' attitudinal and behavioral responses.

Notably, participants' pre-attitudes toward nuclear energy development did not significantly intensify upon exposure to the experimental stimuli. Since individuals may hold entrenched attitudes toward nuclear energy development, the non-significant differences could be attributed to this study's cross-sectional method. Therefore, future research may conduct a longitudinal experiment with a within-subjects design to track the changes in individuals' attitudes toward nuclear energy development upon each exposure to the experimental stimuli. The findings would also illuminate the long-term impacts of influencer marketing in science communication.

Main effects of prototypicality

The SMI's prototypicality consistently predicted participants' attitudinal and behavioral responses. Participants that encountered a SMI with *higher* (vs. *lower*) prototypicality evaluated the YouTube video more favorably, possessed greater attitude intensity toward nuclear energy development, and were more willing to share the YouTube video. These observations supported the social influence mechanisms stipulated in the social identity theory of leadership and its theoretical foundations (i.e., social identity theory and self-categorization theory) [Hogg et al., 1995; Tajfel & Turner, 1979]. The findings also concurred with Lou and Yuan's [2019] study, whereby participants displayed greater trust and purchase intentions when they perceived the SMIs to possess similar demographic traits and ideologies. Moreover, the findings attested to Dyagilev and Yom-Tov's [2014] study where Twitter users engaged in civil discourse more actively upon interacting with other Twitter users with *high* (vs. *low*) prototypicality (i.e., echo-chamber effects).

However, participants' attitudinal and behavioral responses did not differ significantly when exposed to SMIs with *low* to *moderate* prototypicality. These findings may be attributed to the absence of a salient social identity, which is a precondition for social influences to occur. Thus, future research may strengthen the experimental manipulation for these conditions by establishing a multi-faceted social group identity on social media comprising both demographic and ideological traits. The findings also suggest that extraneous variables could mediate the effects of participants' information sharing behaviors on social media. For instance, individuals may share information to endorse or refute opinions [Wang, Zhou, Qian & Liu, 2022]. Individuals may also deliberately incite disagreements among other users with controversial comments and disrupt civil discourse on social media by posting irrelevant comments [Chiregi & Navimipour, 2016]. Hence, future research may identify the motivations and psychological processes underlying individuals' information sharing behaviors on social media.

Main effects of social attraction

Contrary to the social identity theory of leadership, SMIs' social attraction did not significantly influence participants' attitudinal and behavioral responses. These findings also challenged influencer marketing research, whereby individuals regarded SMIs with more followers to possess greater expertise, trustworthiness, and social attraction than SMIs with less followers [De Veirman et al., 2017; Jin & Phua, 2014]. Yet, this study supported Kay et al.'s [2020] findings whereby consumers liked the product endorsements more and displayed greater purchase intentions when exposed to SMIs with less followers and likes (i.e., micro-influencers) than SMIs with more followers and likes (i.e., macro-influencers). Similarly, consumers possessed deeper relational bonds, greater trust, and engaged with micro-influencers more than macro-influencers [Marques, Casais & Camilleri, 2021]. Therefore, future research could resolve these mixed findings by comparing the impact of SMI's social attraction for endorsements within and beyond the SMI's domain of expertise. Future research could also replicate this study on less controversial technologies (e.g., renewable energy).

Interaction effects of prototypicality and social attraction

The significant interaction between prototypicality and social attraction on participants' willingness to share the YouTube video attested to Hogg's [2001] social identity theory of leadership and Hogg et al.'s [1995] self-categorization theory. When the SMI possessed *moderate* to *high* prototypicality, participants were more willing to share a YouTube video endorsed by a SMI *high* (vs. *low*) social attraction. Contrastingly, when the SMI possessed *low* prototypicality, participants exhibited greater reluctance to share a YouTube video endorsed by a SMI *high* (vs. *low*) social attraction. These findings could be attributed to participants' intent to accentuate outgroup differences by hindering the SMI's ability to influence information flows [Dyagilev & Yom-Tov, 2014; Wang et al., 2022]. Alternatively, participants may refrain from sharing the YouTube video to avoid evoking criticisms from the SMI's followers. Hence, future studies may conduct focus groups to understand the considerations underlying individuals' willingness to share information on social media.

Conclusions

The findings provide conceptual, theoretical, and practical contributions: first, the findings addressed research gaps in science communication by examining SMIs' role in popularizing controversial technologies [Galetti & Costa-Pereira, 2017]. The findings also contributed to influencer marketing research by examining how SMI characteristics shaped individuals' attitudinal and behavioral responses. Since prototypicality plays a greater role than social attraction, SMIs should emphasize their shared demographic (e.g., nationality, ethnicity) and ideological traits (e.g., political affiliation, religiosity) with their target audience to encourage deliberation about controversial technologies. While this study examines SMIs' popularization of controversial technologies with low issue salience in daily conversations, future research may replicate the findings in contexts with existing nuclear facilities, which may enhance its issue salience. Future studies may also verify the findings' generalizability to other emerging technologies with high personal relevance and issue salience, including artificial intelligence and lab-grown meat.

Second, this study extended the social identity theory of leadership to science communication and influencer marketing. Science communication scholars have utilized Ohanian's [1990] source credibility framework [Ho et al., 2019; Brossard & Nisbet, 2007; Krause, Brossard, Scheufele, Xenos & Franke, 2019], heuristic-systematic model of information processing [Ryu & Kim, 2015], and the psychometric paradigm [Ho et al., 2018; Hoti et al., 2021] to assess individuals' opinion-formation and decision-making processes regarding emerging and controversial technologies. Since prior research has assessed the effects of strategic science communication from an interpersonal and mass communication perspective, this study's novel theoretical perspective accounts for intragroup and intergroup communication on social media [Fielding & Hogg, 1997; Hogg et al., 1995]. Considering the ubiquity of communities on social media, this theoretical perspective also ensures ecological and external validity to the prevailing media environment.

The findings also identified the social identity theory of leadership's boundary conditions: the SMI's social attraction had limited attitudinal influence when the endorsements were beyond their domains of expertise. While the SMI's social attraction enhanced participants' behavioral intentions in conditions with *high* or *moderate* prototypicality, this effect was not observed in conditions with *low* prototypicality. Thus, future studies should verify if these boundary conditions are observed on other salient, yet under-studied SNS (e.g., Tiktok).

Despite this, the findings attest to the social influence mechanisms on social media [Hogg et al., 1995; Tajfel & Turner, 1979], whereby the salience of social group norms determine individuals' attitudes and attitude intensities [Hogg, 1996; Sechrist & Young, 2011; Turner et al., 1987]. The significant effect of prototypicality is also pertinent to echo chambers on social media, where users exclusively seek and disseminate opinions from like-minded users [Dyagilev & Yom-Tov, 2014; Wang et al., 2022]. Hence, future studies may examine the mediating role of individuals' exposure to ideologically diverse content.

Practically, the findings may inform policymakers, nonprofit, and corporate entities in engaging SMIs to popularize controversial technological developments. Specifically, SMI should assert their prototypicality with their target audience by highlighting their similar demographic traits (e.g., ethnicity, nationality),

ideological inclinations (e.g., political ideology, religion), and shared attitudes regarding specific societal issues (e.g., environmental sustainability). In doing so, SMIs can effectively encourage their followers' engagement and deliberation regarding the viability and consequences of nuclear energy development.

Considering the limited impact of SMI's social attraction, public engagement campaigns are not restricted to working with mega-influencers with at least 1 million followers [Foxwell, 2020; Wiley, 2021]. Instead, campaigns may feature several lower-tier influencers, including nano-influencers (1,000 to 9,999 followers), and micro-influencers (10,000 to 99,999 followers). By collaborating with lower-tiered SMIs with varying demographic traits, ideological inclinations, and advocacy for specific societal issues, prosocial campaigns can target diverse segments of the general public. Meanwhile, campaigns seeking to enhance issue awareness should not only highlight the SMI's prototypicality, but also feature SMIs with *high* social attraction.

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