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Scientists as Public Communicators: Individual- and Institutional-Level Motivations and Barriers for Public Communication in Singapore

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Abstract

This study identifies the outreach activities that scientists engage in, as well as their perceived motivations and barriers towards such activities. It examines the forms of communication training that Singapore-based scientists have undergone and the types of communication training they would like to receive. Five focus groups were conducted with scientists across scientific disciplines from public universities and research institutes who engaged in direct and mediated outreach activities. Overall, the lack of time and institutional constraints were the main barriers to outreach activities. Their desire to impact public welfare and secure research funds were primary motivators to conduct outreach activities. The participants also expressed interest in communication training in terms of speech and drama classes, writing newspaper articles, and publicizing their research on blogs and social media. The participants also wished to understand how Singapore's media functions and learn how to liaise with media practitioners. Participants provided different responses based on their seniority, institutional affiliations, and prior experience in outreach activities. Theoretical and practical implications, as well as directions for future research are discussed.

Keywords: Outreach activities; science and technology; motivations; barriers; training

Scientists as Public Communicators: Individual- and Institutional-Level Motivations and Barriers for Public Communication in Singapore

Singapore – a resource-scarce city-state – has leveraged on science and technology (S&T) to drive its economic and national development (Ho, 2015; Ng, 2018). The city-state prides itself as a dynamic science research hub (Ho, 2015; Ng, 2018) and economic powerhouse (Lauria, 2014). In 2016, the government invested S\$19-billion to strengthen S&T research (National Research Foundation [NRF], 2016). The strong support for S&T development has made Singapore a choice destination for multinational technology firms to set up their Asia-Pacific headquarters (Ng, 2018; NRF, 2016). Considering Singapore's substantial achievements through S&T, it is worthwhile to examine the science communication landscape in this context.

In order to continually reap the benefits of S&T, it is important to nurture public appreciation of S&T (Ho, Yang, Thanwarani, & Chan, 2016). A growing body of literature highlights the importance of informal public education on S&T developments (Anderson, Lucas, Ginns, & Dierking, 2000; Falk & Dierking, 2002) in complementing formal education to raise science literacy. As stewards of science, scientists play crucial roles in raising public appreciation of S&T (Besley & Nisbet, 2011; Besley, Dudo, & Yuan, 2018a; Ilani, 2009; Willems, 2003) and reducing the knowledge disparities between experts and laypeople (Dudo, Kahlor, AbiGhannam, Lazard, & Liang, 2014; George, Kaptan, Lee, & Frewer, 2014; Ho et al., 2015). Scientists and science institutes acknowledge the importance of outreach activities: privately funded organizations utilized outreach activities to secure research funds (Dunwoody & Ryan, 1985), while publicly funded institutes emphasized it as part of scientists' duties to the public. Scientists recognized the virtues of enhancing the public's science literacy (Kimura & Kinchy, 2016). Evidently, outreach activities need to grow in tandem with the progress in science to impart knowledge, strengthen recognition, and nurture

appreciation of S&T. To help scientists fulfill these social responsibilities, communication trainings need to focus on equipping them with the necessary skillsets. An increase in scientists' competency in communication, coupled with strong organizational support and heightened public interest in science, can potentially boost the scene for public outreach.

Despite the prominence of S&T in Singapore and the importance of outreach activities, there is limited research about Singapore's outreach activities landscape. Multiple studies in Western contexts have identified key factors that motivate outreach activities (e.g. Besley et al., 2018a; Besley, Dudo, Yuan, & Lawrence, 2018b; Besley, Oh, & Nisbet, 2012; Dudo, 2012; Entradas & Bauer, 2017; Neresini & Bucchi, 2011; Pearson, 2001; Poliakoff & Webb, 2007; Trench & Miller, 2012). Some studies have also explored the science communication landscapes in Asia. For instance, a cross-national study across 13 countries (including China and Malaysia) found that although producing work in media publications is not a popular activity among scientists, those with media publications have higher levels of academic publishing than those without (Bentley & Kyvik, 2011). In addition, Rajput (2017) provided an overview of the prevailing trends of science communication in India while advocating the importance of establishing training initiatives for science communication in India. The author noted that formal education initiatives for training science communication at India's tertiary education institutes were largely unsuccessful. Considering this, the author highlighted the importance for scientists based in India to utilize informal communication training opportunities, such as short-term skills-building and hands-on communication training sessions, as well as massive open online courses for long-term communication training. Despite the growing body of research on non-western contexts, limited research has examined the underlying considerations (i.e. motivations and barriers, communication training) that inform scientists' willingness to partake in outreach activities from an Asian perspective. The coverage of Singapore is lacking even among the published work on

outreach activities in Asia.

To address the aforementioned research gap, this study identifies the considerations that inform Singapore-based scientists' willingness to partake in outreach activities. Most studies based in Western contexts drew upon the theory of planned behavior to empirically fulfill this research objective. The theory of planned behavior predominantly accounts for how individuals' attitudes toward the behavior, subjective norms, and their perceived behavioral control affect individuals' behavioral intentions, and subsequently their behavioral performance. In order not to be limited by the considerations stipulated by the theory of planned behavior, this study intends to uncover all major considerations that are unique to the Singapore context. To this end, neo-institutionalism theory provides a comprehensive overview of triggers on various levels (macro-, meso-, and micro-levels). The neo-institutional theory classifies an institute's interactions with its stakeholders at the institutional and individual levels (DiMaggio & Powell, 1983; Schultz & Wehmeier, 2010). Because of its comprehensiveness, the neo-institutionalism theory is therefore suitable to accomplish this study's aims. Specifically, this study aims to (a) identify the outreach activities that Singapore-based scientists have conducted, (b) understand their motivations and barriers for conducting outreach activities, and (c) identify the types of communication training that they have received and would like to attend.

This exploratory study provides potential conceptual and practical contributions. First, the findings will identify the considerations that inform scientists' involvement in outreach activities in Singapore – an underexplored context in spite of its noteworthy contributions to science and technological advancements on the global stage. In particular, the findings will reveal the considerations identified from past studies conducted in the Western context that are also applicable to Singapore. More importantly, the findings will uncover additional considerations that are unique to the Singapore context. Second, this study value-adds to

research on outreach activities by concurrently examining the perceptions of scientists working in research institutes and universities. Most studies have predominantly examined scientists based on their research fields or affiliations to scientific societies, while limited research (e.g. Scheufele et al., 2007) has clearly delineated scientists based on their institutional affiliation (research institutes vs. academic institutes). Since scientists from academic institutes have additional teaching commitments and are exposed to different corporate cultures from scientists employed in research institutes, this presents a promising premise for research. Third, this study intends to refine the conceptual definition of scientific outreach activities by integrating its findings with those from extant literature. Since existing research has conceptualized and defined such outreach activities differently, this study provides a synthesis on these discrepancies. Finally, this study provides practical implications by informing policymakers, scientific institutions, and communication practitioners on how to facilitate Singapore-based scientists to conduct outreach activities.

Study context: Singapore

Singapore possesses several unique socio-cultural dynamics that may impose different motivations and barriers on Singapore-based scientists as compared with their colleagues based in other countries. First, Singapore-based scientists may possess differing proficiencies in English from scientists based in other Asian countries. Some scientists based in Asia may face linguistic challenges when engaging lay audiences (Chan, 2015; Peters et al., 2008). However, this challenge may not apply to Singapore as English is the *lingua franca* (Goh, 2017) and a language of policy-planning and administration in Singapore (Goh, 2017). Singapore-based scientists would also possess a considerably high level of English proficiency for correspondence and outreach activities. However, communicating science to a lay audience does not wholly depend on scientists' linguistic proficiencies (Chan, 2015). Therefore, some scientists with high linguistic abilities may still feel challenged when

conducting outreach activities if they receive insufficient training (Bankston & McDowell, 2018).

Second, Singapore's strict media system may inhibit Singapore-based scientists from conducting outreach activities. While the government does not directly intervene with editorial policies, local news outlets practice self-censorship, unlike countries where the media serves as a free-ruling agent and watchdog of the government (George, 2007). Also, the Singapore government bars foreign interference in domestic issues (Koh, 2017). This may discourage Singapore-based scientists with foreign nationalities from publicly commenting on topics that run against the grain of the government's political agenda. Scientists may also face personal or institutional constraints in publishing controversial findings that are perceived to be incongruent with authorities' stance (Gomez & Ooi, 2006).

Third, Singapore's cultural values of pragmatism and meritocracy may dissuade Singapore-based scientist from conducting outreach activities. These cultural values are deeply entrenched in Singapore's national policies and corporate environments (Vinayak, Thompson, & Tonby, 2014). Singapore-based scientists may therefore choose to focus on research work that directly enhances their performance reviews and sideline outreach activities.

Finally, the structural workplace culture in Singapore may discourage Singapore-based scientists from partaking in outreach activities. Singapore's workplace culture is recognized to be highly bureaucratic and hierarchical (Sweetman, 2012). This implies that Singapore-based scientists may need to overcome layers of organizational red-tapes to get approval for conducting outreach activities. These cumbersome administrative processes may introduce unnecessary protocols and tighter scrutiny that eventually discourages Singapore-based scientists from participating in outreach activities.

Outreach activities in S&T

From extant literature, some common forms of outreach activities solely involving the scientists include public lectures and demonstrations (Bauer & Jensen, 2011; Besley et al., 2018b; Dudo & Besley, 2016; Entradas & Bauer, 2017), talks with community groups (Besley et al., 2018a) and policymakers (Dudo & Besley, 2016), town hall meetings (Einsiedel, 2008), as well as open days and science festivals (Dudo & Besley, 2016; von Roten, 2011). In addition, some common forms of outreach activities that involve scientists' collaboration with journalists and media practitioners include writing articles, books (Ecklund, James, & Lincoln, 2012), or blog posts, granting media quotes or interviews, participating in online forums, as well as managing science-related websites and social media accounts (Besley et al., 2018b; Dudo & Besley, 2016; Dudo et al., 2014; Kreimer, Levin, & Jensen, 2011; Kyvik, 2005; Liang et al., 2014; Peters, 2013; Poliakoff & Webb, 2007; Torres-Albero, Fernandez-Esquinas, Rey-Rocha, & Martin-Sempere, 2011; von Roten, 2011). While extant literature has uncovered a myriad of outreach activities, this study intends to identify the outreach activities conducted by Singapore-based scientists. Hence, we ask the following:

RQ1: What are the common types of outreach activities that the Singapore-based scientists say they have engaged in?

Outreach activities has been commonly defined in terms of the act of communication, the type of audience, and the communication channels used. However, extant literature has conceptualized and operationalized these aspects in varying degrees of specificity (Bauer & Jensen, 2011). Some studies have described the above-mentioned aspects of outreach activities generically (e.g. Bauer & Jensen, 2011; Ecklund et al., 2012; Gascoigne & Metcalfe, 1997; Pearson, 2001; Peters et al., 2008; Sharman & Howarth, 2016; Torres-Albero et al., 2011; von Roten, 2011). However, other studies have conceptualized and operationalized the act of communication, type of audience, and communication channels of

outreach activities more specifically (Kreimer et al., 2011).

Act of communication

Conventionally, scholars adhered to the deficit model of communication (Simis, Madden, Cacciatore, & Yeo, 2016). This one-way communication process focuses on educating an audience (Besley et al., 2018a; Dudo & Besley, 2016), who is perceived to possess low levels of science knowledge and display skepticism toward the potential benefits of S&T (Besley & Tanner, 2011). However, the deficit model of communication has been criticized for unfairly assuming that laypeople (including journalists and the general public) lack scientific knowledge and are generally cynical of the benefits that S&T developments could engender (Nisbet & Scheufele, 2009).

A growing body of outreach activities research has adopted the dialogical model of communication. This two-way communication between scientists and their intended audience enables scientists to gauge public perceptions and understanding of S&T (Nisbet, 2009). Scholars have defined outreach activities as a strategic, meaningful, and interactive means of scientific engagement (Besley, 2015; Besley et al., 2012, 2015; Kreimer et al., 2011; Peters, 2013), where scientists deliberate about S&T issues with their intended audience (Besley et al., 2018b; Dudo & Besley, 2016; Kyvik, 2005). Congruent with recent research, this study adopts the dialogic approach, with an emphasis on scientists' outreach efforts (Bubela et al., 2009; Cook, Pieri, & Robbins, 2004).

Type of audience

Most studies identified the general or non-specialized public as the intended audience (Bauer & Jensen, 2011; Besley, Dudo, & Storksdieck, 2015; Dudo et al., 2014; Peters, 2013; von Roten, 2011). That is, outreach activities are typically perceived to target any individual outside academia (Kreimer et al., 2011; von Roten, 2011) that interacts with the scientists directly or through any media platform (Dudo & Besley, 2016). Some studies focused on

specific non-scientists (Bentley & Kyvik, 2011; Besley, 2015; Poliakoff & Webb, 2007), such as students (Ecklund et al., 2012), science journalists, museum educators, public information officers, or individuals that are not the scientist's friends or family members (Dudo et al., 2018). However, others included scientists from other fields (Besley et al., 2012, 2018b; Dudo, 2012; Kyvik, 2005). Since outreach activities can be tailored to different audiences (Kreimer et al., 2011), this study focuses on outreach activities directed to non-experts outside of the scientists' research area.

Communication channels

Most studies did not specify whether outreach activities could be conducted in a direct (in-person) or mediated manner (through media practitioners, corporate communications divisions and/or communication channels), and simply regarded them as instances of scientific outreach activities (Besley et al., 2015; Dudo et al., 2014; Poliakoff & Webb, 2007). While Besley (2015) and Dudo et al. (2018) excluded direct communication in classrooms, others included school presentations and conferences (Ecklund et al., 2012; Kreimer et al., 2011; von Roten, 2011). Moreover, most research examined direct and mediated outreach activities across various communication channels (e.g. Besley et al., 2018a, 2018b; Dudo et al., 2018; Dudo & Besley, 2016; Kyvik, 2005; Sharman & Howarth, 2016; Torres-Albero et al., 2011; von Roten, 2011). However, there are nuanced differences in direct and mediated modes of outreach activities. For instance, scientists engaging in direct outreach activities may not encounter the added complexities of working with other individuals to convey their intended messages. Moreover, individuals engaging in mediated outreach may require additional expertise in managing certain communication platforms. Therefore, this study focuses on both direct and mediated forms of outreach activities and assesses if scientists' responses differ based on the communication channels.

Theoretical background: neo-institutional theory

The neo-institutional theory focuses on an institution's relationships with its stakeholders and its legitimacy within a society (Schultz & Wehmeier, 2010). It explains why an institution's formal structures (e.g. policies) is better reflected by its values, norms, and institutional rules than the actual work activities (Powell & DiMaggio, 2012). It also explains how individuals' choices and actions are influenced by macro-, meso-, and micro-level triggers.

Macro-level triggers

Triggers at the macro-level refer to scientists' relations with major societal stakeholders that may shape their willingness to partake in outreach activities, such as policymakers, communication and media practitioners, and the public. In Marcinkowski, Kohring, Fürst, and Friedrichsmeier's (2014) research, the macro-level triggers affecting the likelihood of conducting outreach activities included the nature of the university (e.g., research vs. applied-studies universities, private vs. public universities), university size, and the availability of third-party funding. Among these macro-level triggers, scientists from private and research universities maintained more media contact, while the scientists from smaller universities were less active. Scientists who received less funding from external bodies maintained fewer media ties (Entradas & Bauer, 2017). In Dudo et al.'s (2014) study, scientists' perceptions of the media were strongly associated with their willingness to partake in outreach activities.

Meso-level triggers

Meso-level influences are reflected in terms of organizational-level considerations. In this study, meso-level triggers refer to the institutional assistance, recognition, and restrictions toward outreach activities (Marcinkowski et al., 2014). Additionally, meso-level triggers include the norms perpetuated in the scientist's academic discipline or research field.

In terms of assistance, the support that scientists receive from their corporate communications departments encouraged outreach activities (Marcinkowski et al., 2014; Peters, 2013). On the other hand, a lack of institutional recognition discouraged outreach activities; some institutes prioritized research productivity over outreach activities (Ecklund et al., 2012; Gascoigne & Metcalfe, 1997; Sharman & Howarth, 2016; Torres-Albero et al., 2011). Moreover, scientists' contact with the media was contingent on having strong support from the public relations department (Marcinkowski et al., 2014). Similarly, Peters' multi-country study (2013) found that the public information divisions in research institutions generally encouraged and supported scientists' outreach efforts. However, it is not clear if managerial attitudes might shape scientists' willingness to conduct outreach activities. In some studies, managerial support positively influenced scientists' willingness to participate in outreach activities (Besley et al., 2012; von Roten, 2011); others observed a limited influence of these institutional considerations on scientists' intentions to conduct outreach activities (Besley et al., 2018b; Dudo et al., 2018).

Scientists' perceived autonomy also shaped their considerations for outreach activities. Dudo (2012) found that scientists who experience more freedom in communicating with non-scientific publics conducted more outreach activities. Jensen (2011) observed that senior scientists often served as institutional representatives for outreach activities. Contrastingly, junior scientists could only express their viewpoints on S&T issues in a personal capacity or be required to seek approval from their supervisors before partaking in outreach activities (Peters, 2013). Dudo et al. (2014) also argued that efforts to establish structures and policies for outreach activities would be ineffective if scientists felt restrained by their institutes.

Beyond scientists' immediate workplaces, meso-level triggers also include the scientific community's attitudes toward outreach activities. Outreach activities are regarded

positively among scientists from Western countries (The Royal Society, 2006; The Wellcome Trust, 2000). However, scientists' awareness of the 'Carl Sagan Effect' (i.e. a belief that scientists actively involved in outreach activities are incompetent and therefore dismissed by their colleagues) dissuaded them from outreach activities (e.g. Besley et al., 2018a, 2018b; Dudo et al., 2018; Ecklund et al., 2012). Considering the above-mentioned meso-level triggers, we pose the following:

RQ2: What are the institutional motivations and barriers mentioned by Singapore-based scientists that shape their willingness to conduct outreach activities?

Micro-level triggers

Micro-level triggers are individuals' personal considerations toward the particular practice (Schultz & Wehmeier, 2010). In this study, micro-level triggers refer to individuals' perceptions toward outreach activities (Schultz & Wehmeier, 2010), their personal motivations and barriers, and their perceived competence of conducting outreach activities (Marcinkowski et al., 2014). Scientists' attitude toward outreach activities was positively related to their behavioral intentions and performance of outreach activities (Besley et al., 2012; Dudo, 2012; Dudo et al., 2014; Poliakoff & Webb, 2007). Specifically, attitude toward outreach activities is defined as the degree of positivity or negativity that scientists display toward outreach activities (Besley et al., 2018b; Poliakoff & Webb, 2007). Scientists' concern over their university's visibility was associated with the frequency of media contact. Yet, scientists' desire to increase the academic discipline's visibility was negatively associated with media contact, as they may not recognize the value of doing so.

Scientists' personal motivations and barriers also served as micro-level triggers that informed their willingness to conduct outreach activities. In particular, scientists' motivations could be categorized based on their intrinsic and extrinsic motivators. Intrinsic motivations referred to scientists' desire to enhance public well-being, a sense of duty to the general

public (Dudo, 2012; Kreimer et al., 2011; Peters, 2013; Torres-Albero et al., 2011; von Roten, 2011), passion for research (Sharman & Howarth, 2016), and passion for motivating new scientists (Gascoigne & Metcalfe, 1997). Meanwhile, extrinsic motivations included career progression, increased visibility in the academic field, fostering future research collaborations, and attracting research funds (Dudo et al., 2014). Apart from these motivations, scientists commonly cited their lack of time as a key barrier in conducting outreach activities (Besley, 2015; Dudo et al., 2014; Poliakoff & Webb, 2007).

Scientists' perceived competence is strongly related with their involvement in outreach activities (Maslach, Schaufeli, & Leiter, 2001). In doing outreach activities, scientists' competence refers to their self-efficacy and response efficacy (Besley et al., 2018a, 2018b; Dudo et al., 2018; Dudo & Besley, 2016). Self-efficacy is defined as the scientists' perceived proficiency in interpersonal communication, knowledge, and resources. Response efficacy refers to the scientists' perceived ability to make an impact through outreach activities. These types of efficacy can influence scientists' intentions and actual involvement in outreach activities (Dudo, 2012; Dudo et al., 2014; Ecklund et al., 2012). Specifically, scientists that perceived themselves to possess more communication skills took part in outreach activities more frequently, while scientists experiencing difficulties as public communicators were less willing to partake in outreach activities (Dudo et al., 2018). We pose the following research question:

RQ3: What are the personal motivations and barriers of Singapore-based scientists that shape their willingness to conduct outreach activities?

While scientists' willingness to conduct outreach activities may depend on their self-efficacy and response-efficacy, and by the amount of support that their organizations provide, communication training may help to boost their willingness to do so (Dudo, 2012; Dudo et al., 2014, 2018; Ecklund et al., 2012). With communication training, scientists may begin to

perceive themselves to be able to conduct outreach activities more skillfully (Dudo et al., 2018). They may also become more aware of the social benefits of outreach activities on a wide range of science topics (Besley et al., 2018a, 2018b). Scholars have recognized the importance of providing communication training (Besley & Tanner, 2011; Trench & Miller, 2012). The additional insights about outreach activities that scientists can gain from communication training may contribute to raising their willingness to conduct outreach activities.

Communication training from the perspectives of meso- and micro-level triggers There is growing demand from policymakers for scientists to involve the public more extensively (Trench & Miller, 2012). In particular, there is shifting emphasis to equip scientists with the skills to engage in open discussions (Besley et al., 2015). The mediatization of science (Lundby, 2009) also implies that scientists need to manage their outreach over a range of media platforms. It is imperative for scientists to develop the skills and confidence to become both speakers and listeners in public dialogues. To strengthen scientists' abilities to meet evolving trends, training programs need to develop scientists into competent science communicators.

Scientists typically perceived themselves and their colleagues as unskillful communicators (Ecklund et al., 2012). Despite this lack of self-efficacy, communication training has effectively strengthened scientists' self-perceptions of their interpersonal communication skills (Besley et al., 2015). Scientists' self-efficacy regarding outreach activities also predicts their participation in outreach activities (Besley, 2015; Besley et al., 2012; Chapman et al., 2014; Poliakoff & Webb, 2007).

Similarly, at the meso-level, there might be organizational opportunities or challenges for scientists to attend the communication trainings. Organizations can assist in boosting scientists' outreach by providing training that range from speaking to journalists and the

strategies to speak through the media (i.e. media training) to generic lessons that impart skills on communicating with the public (i.e. communication training; Baram-Tsabari & Lewenstein, 2017). However, the absence of a formal training structure for science communication that organizations across the world can adopt (Bankston & McDowell, 2018) implies that it may be challenging for scientists to acquire a holistic set of skills for carrying out their outreach activities more effectively. Although the practice of training science communication is relatively new, corporate communications departments recognize the importance of such trainings and encourage enrollment (Ecklund et al., 2012; Marcinkowski et al., 2014; Sharman & Howarth, 2016; Torres-Albero et al., 2011). Given the support, it would be worthwhile to understand the meso-level opportunities or lack thereof in terms of scientists' communication training:

RQ4(a): What are the personal and institutional motivations and barriers of Singapore-based scientists that shape their willingness to attend communication training?

RQ4(b): What types of communication training would the Singapore-based scientists like to receive for enhancing their competence in conducting outreach activities?

Method

This study utilized focus group discussions (FGDs) to elicit elaborative responses from Singapore-based scientists. Although the data from FGDs lack generalizability (Berdahl, Bourassa, Bell, & Fried, 2016), FGDs can tease out the similarities and differences among participants. The interactions in participant-led discussions also facilitate information exchange, issue deliberation, and collective ideation. Therefore, FGDs are suitable for addressing the research questions in this study.

Sampling and recruitment

This study recruited 38 Singapore-based scientists through a combination of non-probability sampling: convenience sampling and snowball sampling. First, we collated a list

of scientists from the websites of the six public universities and one public research institute in Singapore¹. Second, we sent out emails to all the participants on this list. Considering the difficulty involved in recruiting highly qualified professionals with busy schedules, we also asked research participants to recommend other research participants.

Five FGDs were conducted, with group sizes ranging from six to 10. The sample, which constituted 71.1% male and 28.9% female respondents were aged between 31 and 61 ($M = 41.1$, $SD = 8.00$). To accurately reflect the diverse nationalities in Singapore's science institutes, this study recruited foreigners and Singaporeans. The respondents consisted of 52.6% Singaporeans, 26.3% permanent residents, and 21.1% foreigners. Most participants have conducted research in Singapore for three to 28 years ($M = 9.30$, $SD = 6.20$). This ensured their awareness of their institutes' policies on outreach activities, communication training opportunities, and Singapore's media environment.

The sample included scientists from different research fields such as bioscience, engineering sciences, physics, and environmental sciences. An equal distribution of junior (e.g. post-doctoral fellows, junior scientists, junior principal investigators, and assistant professors) and senior scientists (e.g. senior principal investigators, senior scientists, associate professors, and professors) was recruited to capture the opinions of scientists from all levels of seniority. The junior and senior scientists were then grouped in separate FGDs so that they could voice their opinions without being inhibited by power distance. Informed consent was obtained from all the participants. Each FGD lasted for approximately 90 min. Upon completion, each respondent received S\$80 as a token of appreciation.

Moderation and guide

The FGDs were conducted in English and moderated by the principal investigator of

¹ The six public universities are Nanyang Technological University, National University of Singapore, Singapore Institute of Technology, Singapore Management University, Singapore University of Social Sciences, and Singapore University of Technology and Design. The public research institution refers to the Agency for Science, Technology and Research (A*STAR).

the research team, who has a doctoral degree in Communication and extensive focus group moderation experience. Every participant was given the chance to voice his/her opinions freely. The moderator followed a semi-structured moderator's guide, which was formulated based on existing research and guided by the neo-institutional theory. It contained a list of pre-determined questions and prompts to elicit elaborative responses from the participants (refer to Appendix for key questions in the moderator's guide).

Analysis

The FGD data were recorded digitally and transcribed verbatim. To safeguard the participants' confidentiality, all identifiable information from the quotes and FGD transcripts were removed and replaced with an alphanumeric code. Thereafter, the data were analyzed using *NVivo*. To analyze the transcripts, we adopted a hybridized approach of data coding: deductive coding and inductive coding. We utilized deductive coding to identify primary themes that were informed by the findings from extant literature. Additionally, we also utilized inductive coding to capture any novel observations that emerged from the FGDs and those that did not belong to any of the primary themes. Based on Berdahl et al.'s (2016) study protocols, we developed the themes by first examining the transcripts meticulously to identify if any subject matter was repeated within or across participants. After which, we finalized the key themes in this study by considering its relevance in answering the research questions and the frequency of mentions in the FGDs. The major nodes or themes identified during the coding process comprised 'types of outreach activities,' 'institutional motivations and barriers,' 'attitudes toward outreach activities,' 'personal motivations and barriers.' Upon establishing the key themes, the coders then developed sub-themes based on the FGD transcripts.

To ensure inter-coder reliability, a coding scheme was established between two coders prior to data analysis. Subsequently, the coders coded the transcripts independently and

compared their coding using *NVivo*. A good average inter-coder reliability (Cohen's kappa = .77) was obtained for the codes in all the transcripts.

Both primary and emergent themes were identified by the repeated presentation of a particular subject matter within and across the participants' responses (Berdahl et al., 2016). These repeated patterns were based on the relevance of addressing the research questions and the frequency of mentions. The transcripts were first coded according to the major themes, followed by sub-themes. The major nodes for coding comprised 'types of outreach activities,' 'institutional motivations and barriers,' attitudes toward outreach activities,' 'personal motivations and barriers'.

Results

Ten key themes emerged from the FGDs. In relation to RQ1, one major theme referred to the types of outreach activities that the participants reported to have engaged in. With regard to RQ2, three major themes related to the institutional recognition, assistance, and restrictions that the participants indicated to have shaped their willingness to conduct outreach activities. To address RQ3, two themes pertained to participants' positive and negative attitudes toward outreach activities. Additionally, four themes related to the personal motivations and barriers that participants mentioned to have shaped their willingness to conduct outreach activities. Among them, two themes that answered RQ4 related to the considerations about communication training mentioned by Singapore-based scientists and the types of communication training they say they would like to receive. Tables 1 and 2 summarize scientists' reported motivations and barriers to outreach activities at the institutional and personal levels, respectively.

[Insert Tables 1 and 2 about here.]

RQ1: common types of outreach activities that Singapore-based scientists mentioned that they have engaged in

The participants mentioned that they engaged in a range of outreach activities. The direct forms of outreach activities included university open-house and science festivals (e.g. One-North Festival²), public lectures (e.g. TED³ talks), and science-related magic performances. Mediated outreach activities included providing quotes to journalists and granting media interviews on television. Several participants stated that they utilized social media such as Twitter and LinkedIn to share their publications and repost content from prominent scientists. One participant also shared that he created and circulated on social media videos that pertained to his research.

RQ2: institutional motivations and barriers mentioned by Singapore-based scientists

Institutional recognition

The scientists unanimously commented that ‘there’s no recognition’ from their institutes for outreach activities. The common point raised was that their institutes regarded outreach as a ‘waste of time,’ and that it only constituted a minor portion of scientists’ annual performance reviews. Most participants stated that their institutes and superiors want them to prioritize ‘research work’ and ‘publishing papers.’ The participants also reported that their institutes regarded outreach as a ‘higher-order thing’ that scientists could pursue after fulfilling their research requirements. Despite this, a few participants mentioned that the institutes enjoyed the publicity from outreach activities ‘because it looks good for the institute.’ The findings reveal contradictions in terms of the institutional recognition for outreach activities.

² The One-North Festival is a science outreach program initiated by the Agency for Science, Technology, and Research (A*STAR) to engage students and their families with science activities and experiments. A*STAR is a public research institute in Singapore that advances innovations and breakthroughs in S&T through research and development. A*STAR’s research has spurred economic growth, generated jobs, and improved Singapore’s standards of living (Agency for Science, Technology, and Research, [n.d.](#)).

³ First introduced in 1984, TED began as a conference, which focused on Technology, Entertainment, and Design. Today, TED is a non-profit entity that shares ideas on a diverse range of topics (e.g., science, business, and social issues) in over 100 languages across the world.

Institutional assistance

The participants indicated that they generally appreciated the assistance provided by the corporate communications department in providing outreach activities opportunities and functioning as a liaison between the scientists and the mass media. Many scientists also noted that corporate communications departments controlled outreach activities in a top-down manner by assigning scientists to specific topics and looked out for media mentions of the institutes' names. Although this instructive approach limited the participants' autonomy, several participants expressed confidence in the supervision given by their corporate communications departments in safeguarding the reputations of the scientists and organizations.

Institutional restrictions

Most participants shared that they felt restricted by 'red tape and bureaucracy,' as they had to seek clearance from their supervisors, the corporate communications departments, and the research directors. One participant expressed that it was 'not worth [his] efforts to go through so many rounds [of approval].' Several respondents, especially the junior scientists without outreach activities experience, mentioned that they were also unclear about the institutional regulations for outreach activities. Additionally, participants shared that they felt restricted by 'a tight regulation' when sharing their research. At times, scientists even had to 'put a disclaimer that the views are not representative of the institute'. One participant recounted an instance when the corporate communications department denied publication of his team's results on the mainstream media out of the concern that the findings would tarnish Singapore's reputation. Several scientists also commented that they felt restricted in publicizing certain research findings when they disagreed with their superiors and the corporate communications department.

RQ3: personal motivations and barriers mentioned by Singapore-based scientists

Attitudes toward outreach activities

Attitudinal differences emerged between scientists with and without outreach activities experiences. Generally, experienced scientists indicated that they regarded outreach activities as ‘enjoyable,’ ‘pleasant,’ and ‘gratifying.’ Scientists who used social media for outreach activities remarked about how social media could efficiently reach ‘a critical mass’ within a short time span. They also mentioned that they derived instant gratification when others liked and shared their posts. Overall, the participants mentioned that their positive attitudes toward outreach activities were shaped by their successful experiences. Conversely, scientists without outreach activities experience expressed negative sentiments towards it. Some participants indicated that they did not recognize its value, while others stated that they prioritized their research over outreach activities. These participants commented that they were fearful that the media would ‘write and misinterpret 95% of [their] work’, ‘[blow] the [findings] out of proportion,’ and potentially evoke public backlash. Notably, some participants also remarked that they viewed outreach activities unfavorably even if they had to directly conduct outreach activities. In fact, these participants explained that their negative sentiments would intensify under these circumstances as they felt that the ubiquity of fake news would undermine the credibility of any efforts in conducting outreach.

Autonomy

Many junior scientists commented that they had limited autonomy, as they require their supervisors’ approvals to conduct outreach activities. Both junior and senior scientists concurred that senior scientists are usually appointed for outreach activities duties as the younger ones are ‘too busy doing a thousand other things.’ Thus, the participants concurred that outreach is something that scientists would do ‘when you get more senior.’

Competence

Most scientists said that they lacked the skills and experience for effective outreach activities. They also expressed different degrees of competency in using different communication channels for outreach activities. Generally, the participants perceived scientific writing on conventional media and media interviews as challenging. However, they expressed mixed sentiments toward social media. One participant commented that it was difficult to break through the online clutter for their content to go viral. Another scientist mentioned that it would be difficult to go digital, as he may even ‘forget [his] own [website] link.’ Despite this, some scientists remarked that it is easier to share their research on social media as they could control over their personal posts with ‘no editing’ from the corporate communications department and journalists. Overall, the junior scientists expressed lower levels of competency in outreach activities than the senior scientists. Scientists without training and experience also perceived outreach activities to be more difficult than scientists with training and experience. Thus, scientists’ perceived competence in outreach activities is related to their communication skills, seniority, training, and prior experience.

Intrinsic motivations

The scientists reflected that they were motivated by altruism to conduct outreach activities. One participant noted the importance of raising public awareness of medical advancements to inform patients about the available treatment options. Another participant stressed the need for ‘accountability’ in informing taxpayers about how their money has been spent, and how their research can benefit the taxpayers’ daily lives.

Extrinsic motivations

Scientists mentioned attracting research funding, increased recognition, and collaboration with external organizations as extrinsic rewards. Many scientists mentioned that publicizing the ‘fruits of [their] research’ through outreach activities may convince potential funding agencies and enhance their academic reputations. One participant felt motivated to

conduct outreach activities in school because it would make him feel ‘distinguished.’ Another participant mentioned that outreach activities using social media would help junior scientists transcend their current work status by gaining ‘big followings’ online.

Personal barriers

Scientists’ cited shortage of time and their personality as personal barriers to outreach activities. Most participants concurred that planning and implementing outreach activities require ‘a lot of time and effort,’ which could detract them from their research and teaching responsibilities. Some junior scientists also noted that they eschewed from outreach activities as they were shy, did not want to come across as promoting themselves, and wished to maintain their privacy.

RQ4: considerations about communication training mentioned by Singapore-based scientists and the types of communication training they would like to receive

Several scientists mentioned that they did not see the value of doing so and felt that ‘we can’t expect scientists to do too much’ for outreach activities as they have research and teaching commitments. Others expressed their receptiveness to attend future communication training sessions. Despite this, many participants commented that opportunities for communication training were not readily available in Singapore. They lamented the lack of communication training provided by their organizations and indicated their hopes for such opportunities.

If given the opportunity by their respective institutions, they said that they wanted to learn about the ‘do’s and don’ts’ for outreach activities, the exemplars, and how to resolve potential pitfalls. One participant suggested conducting half-day workshops involving ‘case studies,’ ‘short assessment or assignment,’ and ‘group discussions.’ The participants also expressed interest in training for ‘title-led generation’ and ‘[newspaper] article writing’. The scientists also stressed the importance of receiving constructive feedback for improvements.

Moreover, the participants expressed interest in ‘speech and drama’ classes to communicate in an interesting manner. The participants suggested training for utilizing blogs and social media to make their research more interesting and accessible to the public. The scientists also mentioned that they would like to understand how the Singapore’s media environment functions, and the ways to liaise with the media and ‘handle journalist questions.’

Interestingly, some scientists noted that journalists and communication practitioners should also undergo training in scientific-writing because ‘they [tend] to misrepresent’ the scientists’ words and ask irrelevant questions. Several participants also commented that the journalists had no basic knowledge and required ‘a lot of clarification’ for technical terms, so they had to ‘start from the very beginning’. Therefore, the participants emphasized that media practitioners should undergo training so that they can accurately convey the research findings to the non-specialized public.

Discussion

With the neo-institutional theory as the framework, this study identified the institutional- and individual-level considerations that inform scientists’ willingness to conduct outreach activities. With regard to RQ1, this study identified a variety of direct and mediated outreach activities that were congruent with extant literature (Bauer & Jensen, 2011; Besley et al., 2018b; Dudo & Besley, 2016; von Roten, 2011). This study also revealed additional direct activities (e.g. magic performances) and mediated activities (e.g. creating YouTube videos based on research findings, reposting information from prominent scientists on social media, etc.) that were not covered in previous studies. Considering the constant development of media technologies, future research could conduct focus group studies to continuously identify the different types of outreach activities.

Regarding RQ2, the participants generally perceived that the institutional barriers far exceeded the institutional assistance. Specifically, the participants commented that the lack of

institutional recognition, cumbersome bureaucratic processes, and multiple administrative restrictions prevented them from conducting outreach activities. These observations are congruent with past studies (Dudo et al., 2014; Ecklund et al., 2012; Gascoigne & Metcalfe, 1997; Jensen, 2011; Sharman & Howarth, 2016; Torres-Albero et al., 2011). Similar to the observations in Besley et al. (2012) and von Roten (2011), the participants mentioned that their involvement relied on their supervisors' approval and support. Yet this observation challenged the findings that institutional considerations have a limited influence on scientists' intentions to partake in outreach activities (Besley et al., 2018b; Dudo et al., 2018).

Evidently, the FGD observations about institutional considerations comply with the meso-level triggers suggested in the neo-institutionalism theory. The findings also indicate that these meso-level triggers could be explicated into positive and negative triggers. That being said, the difference in findings could not solely be accounted for by cultural differences between Asian and Western countries, as mixed findings were observed even among studies conducted within the United States (see Besley et al., 2018b; Dudo et al., 2014; Ecklund et al., 2012). Considering these mixed findings, future studies could conduct a systematic analysis to conclusively determine the influence of institutional considerations on scientists' willingness to conduct outreach activities.

In addressing RQ3, some participants said that they did not feel competent enough to conduct outreach activities because of the lack of proper training. The participants also expressed different competencies for utilizing various communication channels. This finding concurred with past research that examined self-efficacy as a predictor of scientists' willingness to participate in outreach activities (Besley, 2015; Besley et al., 2012; Chapman et al., 2014; Dudo, 2012; Dudo et al., 2014, 2018; Ecklund et al., 2012; Poliakoff & Webb, 2007). Moreover, junior scientists remarked that their institutions did not grant them enough autonomy to conduct outreach activities. Congruent with past research (Jensen 2011; Peters,

2013), junior scientists perceived themselves to possess less autonomy than the senior scientists. Similarly, opportunities for outreach activities were typically provided to accomplished or senior scientists. If junior scientists were given any opportunities, they would need to adhere by the organization's hierarchical policies in seeking approval. This observation therefore pointed to the interplay between individual-level and institutional-level considerations for outreach activities among Singapore-based scientists. In other words, this observation found that micro-level and meso-level triggers in the neo-institutionalism theory do not occur independently.

Some scientists cited their desire to contribute to public welfare as a motivation for conducting outreach activities. However, most scientists shared that they were motivated by extrinsic rewards such as attracting research grants, recognition, and scientific collaborations. This finding contrasted with findings from Western countries, in which attracting research funding was not the key reason for scientists to participate in outreach activities (Poliakoff & Webb, 2007). The prioritization of extrinsic rewards among Singapore-based scientists could be attributed to Singapore's cultural value of pragmatism. This implies that some scientists were more motivated by the practical rewards that public visibility can grant them. Being consulted for their expertise or sought after for research collaborations can help propel their careers. Judging by the rewards that the participants quoted, it should be noted that some scientists view outreach activities as a means to an end. This mindset could be rooted in the quantification of employees' achievements during work performance reviews. In putting forth an economic argument for science communication, Osborne (2000) stated that the achievements that a technologically advanced country makes in science bolsters its economic output. Singapore is one such country that is continuously boosting its S&T innovation as a strategy to achieve economic success (Koh, 2019). To keep up with the expectations of a result-oriented and technocratic workforce, it would not come as a surprise that some

scientists think inwardly in terms of how their commitments to outreach activities as professionals can benefit their careers. Such values would also be pervasive in the local corporate cultures and manifest in terms of its corporate policies (e.g. lack of institutional recognition for conducting outreach activities). Based on these meso-level triggers (corporate culture and policies), such pragmatic mindsets may also inform the participants' prioritization of micro-level triggers (motivations). Therefore, the prioritization of extrinsic rewards among Singapore-based scientists may reflect the trickle-down effect of meso-level conditions, in which institutional considerations interplay with micro-level conditions to shape individuals' behavioral outcomes.

The scientists also cited the lack of time as the most crucial barrier in conducting outreach activities. While this finding concurred with Dudo et al.'s (2014) research, the lack of time failed to significantly predict scientists' willingness to conduct outreach activities in other studies (Besley, 2015; Poliakoff & Webb, 2007). Although this study did not provide statistical testing, the mixed findings in extant literature could be attributed to the scientist's seniority. Junior scientists may be 'too busy doing a thousand other things' due to their research and teaching commitments, while senior scientists may face less pressure to publish papers and have more time for outreach activities.

Overall, the micro-level triggers identified with regard to RQ3 comply with the micro-level triggers in the neo-institutionalism theory. The findings also suggest that micro-level triggers could be similarly explicated into positive and negative dimensions like meso-level triggers. However, it is also vital to consider individuals' self-efficacy as a micro-level trigger as this demonstrates the interplay between meso-level triggers and micro-level triggers in the neo-institutionalism theory.

With regard to RQ4a, the Singapore-based scientists lamented the lack of opportunities by their organizations for communication training. They wanted their

institutions to make communication training opportunities available for them. This finding suggests that it is timely for research organizations to consider providing the general ecosystem, and in particular, the necessary communication training that scientists desire so as to enhance their competency for outreach activities. Regarding RQ4b, this study identified the types of training that Singapore-based scientists would like to attend to enhance their communication competency. The participants were interested in improving their writing and public speaking skills, learning how to utilize social media, and handling media interviews. The scientists wanted to attend training sessions that highlight case studies of exemplary and lackluster outreach activities, assignments, and group discussions. Scientists who recognized the specific trainings needed have arguably adjusted to a mindset that in order to be public intellectuals in the digital age and at a time when audience-segmentation matters, they needed to keep up with the trends set by their peers who are conducting outreach activities over a range of media platforms to reach their target audiences. While most research focuses on examining scientists' responsibility in attending communication training and their preferences, the participants highlighted the need for journalists and communication practitioners to be trained in science communication, so that they would minimize misrepresentation of their scientific findings. Even though this study focused on the scientists' perspective, the findings indicate that scientists' perception and relationship with external stakeholders (e.g. journalists and communication practitioners, the general public) may serve as macro-level triggers. Hence, future studies could consider comprehensively examining macro-triggers of outreach activities by including the perspectives of other stakeholders apart from scientists.

Study implications

Conceptual implications

This study integrates the FGD findings and the literature review to address the

inconsistencies and refine the definition of outreach activities for S&T: scientists across different academic disciplines engaging in planned interactions with non-expert publics associated with the specific communication goals of the outreach activities activity, through mediated and non-mediated communication platforms.

Research implications

Based on the FGDs, Singapore-based scientists are motivated by institutional- and personal-level triggers to conduct outreach activities. Therefore, the application of the neo-institutional theory unveiled broader considerations (i.e. meso-level triggers) that individuals have about workplace expectations, corporate culture, and national policies that go beyond the micro-level triggers identified by TPB. Apart from individuals' motivations and barriers, institutional recognition, assistance, and restraints are also key considerations that shape scientists' willingness to conduct outreach activities.

Practical implications

This study contributes theoretically to outreach activities research by examining the science communication environment in Singapore – an under-explored context that possesses a unique political system, press freedom, and cultural landscape. The findings from this study can inform outreach activities policies in Singapore in the following areas: training, work appraisal, and the institutional policies for outreach activities. First, policymakers, research institutes and universities should consider incorporating the following elements into science communication training: good practices and pitfalls, public speaking, media writing, and managing communication platforms. The increased variety of training programs can cater to the needs of scientists with varying outreach activities experience and media competencies. Second, journalists should verify information with the researchers and the corporate communications departments or undergo training on interpreting science data to reduce the likelihood of misrepresenting research findings. Third, research institutes and universities can

enhance institutional recognition for outreach activities by incorporating them into scientists' annual performance reviews. Finally, research institutes and universities can reduce the institutional barriers for Singapore-based scientists to engage in outreach activities by reviewing, streamlining, and clarifying outreach activities procedures as many junior scientists are still unclear about their institutes' outreach activities policies.

Limitations and directions for future research

In addition to the study's limited generalizability to all Singapore-based scientists because of the method used, this study only yielded qualitative self-report data (i.e. what the participants said they felt). To mitigate this shortcoming, future research could utilize a combination of self-report measures and observational measures (e.g. physiological measures) to accurately gauge the participants' affective responses (i.e. what the participants felt). While this study exclusively examined the meso- and micro-level considerations that inform Singapore-based scientists' willingness to conduct outreach activities, this study did not incorporate macro-level triggers such as the target audience's perspective. As a growing body of science communication research has highlighted the interactive communication process between scientists and their target audience during such scientific outreach activities, future research should examine these similar considerations from the general public's perspective.

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Tables

Table 1. Overview of participants' responses for RQ2.

Motivations	Barriers
Institutional recognitions: <ul style="list-style-type: none"> Featuring research through the media provided publicity for science institutes 	Institutional recognitions: <ul style="list-style-type: none"> Public engagement constitutes a minor part scientists' annual performance review
Institutional assistance: <ul style="list-style-type: none"> Support provided by corporate communications departments for public engagements 	Institutional assistance: <ul style="list-style-type: none"> Top-down manner of determining topics
Attitude toward public engagement: <ul style="list-style-type: none"> Enjoyment of public engagement Perceived efficiency of public engagement through the use of social media to share content 	Institutional restrictions: <ul style="list-style-type: none"> Bureaucracy involved in seeking clearance from the organization Tight regulation on the content permitted for sharing
	Attitude toward public engagement: <ul style="list-style-type: none"> Negative attitude arising from inexperience Prioritization of research over public engagement Fear of being media misrepresented Fear of facing public backlash for content communicated
	Autonomy: <ul style="list-style-type: none"> Limited autonomy in making decisions

Table 2. Overview of participants' responses for RQ3.

Motivations	Barriers
Intrinsic motivation: <ul style="list-style-type: none"> Altruism and a sense of fulfillment of scientists' social duty 	Competence: <ul style="list-style-type: none"> Lacked the relevant skills and experience
Extrinsic motivation: <ul style="list-style-type: none"> Research funding Increased recognition Collaboration with external organizations 	Time: <ul style="list-style-type: none"> Lack of time
	Public Appearance: <ul style="list-style-type: none"> Personal preference to stay away from the media

Appendix

FOCUS GROUP MODERATOR'S GUIDE

Attitude towards public engagement

1. What do you feel about public engagement?

Channels/platforms scientists use for public engagement

1. Which communication channels/platforms do you normally use to engage with the public?
2. What do you like/ dislike about [*this platform*] for public engagement?

Motivators for scientists' public engagement behavior

1. Think back to instances in which you disseminated information of your research to the public. Were your experiences generally good or bad?
2. What are some factors that motivate you/ your colleagues to engage in public engagement activities?
3. On the whole, what do you think are the benefits of scientists like you sharing your research findings with the public?
4. Do you think the current incentives to encourage public engagement activities are attractive and sufficient to motivate you to engage in public engagement on a more frequent basis? (If not, what are some of the incentives you would like to see?)

Barriers to scientists' public engagement behavior

1. What do you think are the challenges you face that deter you from engaging more in public engagement activities?

Institutional motivations/ barriers

1. Does your institution encourage you to participate in public engagement activities?
2. Do your supervisors/reporting officers, colleagues and institution expect you to engage in public engagement?
3. Can you tell us more about the instances when you felt discouraged to communicate to the public regarding your research?
4. What do you think will be an effective policy/program to encourage scientists to engage in public engagement activities more regularly?
5. What kind of support from (a) the media, (b) your research institute, and (c) the public would you like to receive to motivate you to engage in public engagement?

Communication training

1. Have you ever taken/attended a workshop, course, seminar, or learned how to communicate research to a lay audience/non-scientists?

[If scientists say yes: Do you think having communication training motivated you to take part more in public engagement activities? If scientist says no: Would having communication training motivate you to take part in more public engagement activities?]

2. If your institution is offering communication training for you, what forms of training would you like to have?

Scientists' perceptions of journalists

1. Do you think that media reports represent/reflect science research accurately?
2. Do you think that the media reports represent/reflect research by both male and female social scientists fairly?