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Explicating Factual and Subjective Science Knowledge: Knowledge as a Mediator of News Attention and Attitudes

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Abstract

Communication scholars have conflicting views on the relationship between exposure to science news and knowledge, and its subsequent influence on attitudes. Such mixed sentiments could arise from the vague definition of knowledge. Therefore, this paper explicates science knowledge into factual knowledge and subjective knowledge. It also compares the mediating roles of both types of knowledge between news attention and public support for science and technology (S&T). A survey of 967 Singaporeans showed that news attention was positively related to both factual and subjective knowledge. The findings revealed a stronger relationship between subjective knowledge and news attention than factual knowledge and news attention. Additionally, factual knowledge was positively related to public support for S&T, but subjective knowledge was negatively related to public support for S&T. The contrasting directions of these associations demonstrate that factual and subjective knowledge are two distinct dimensions of knowledge. Practically, the findings can inform policymakers and communication practitioners about effective public education and engagement initiatives. This study also provided guidelines for newsmakers in news reporting about S&T.

Keywords: Factual knowledge; subjective knowledge; support for science and technology; news attention

Explicating Factual and Subjective Science Knowledge: Knowledge as a Mediator of News Attention and Attitudes

Science and technology (S&T) have significantly contributed to individuals' improved standards of living and nations' economic progress (Archibugi & Pianta, 1992; Ho, Yang, Thanwarani, & Chan, 2017). To reap the benefits of S&T, it is important to nurture public interest and knowledge in S&T. Apart from incorporating science into the school curriculum, stakeholders frequently leverage on the extensive reach of media platforms to disseminate information regarding S&T to the public. As such, S&T issues often receive extensive coverage across various media platforms including television, print newspapers, the Internet, and social media (Ho et al., 2017).

In today's media environment, individuals can acquire and receive information about S&T issues through various media channels (Jenkins, 2004). Hence, this study seeks to examine how news attention is related to support for S&T. By explicating knowledge into factual knowledge and subjective knowledge, this study also aims to analyze how these knowledge dimensions mediate the relationship between media attention and support for S&T. Specifically, this study utilizes the heuristic-systematic model (HSM) of information processing (Chen & Chaiken, 1999) to understand how news attention is associated with factual knowledge and subjective knowledge. This study also draws upon past literature to demonstrate how these knowledge dimensions are related to attitudes toward S&T.

Theoretically, the findings from this study reveal the mechanisms through which news attention influences public support for S&T. By understanding whether news attention has different effects on factual and subjective knowledge, this study also contributes to media effects theories. Practically, the insights gleaned from this study may provide guidelines for newsmakers to achieve effective news reporting about S&T issues. It can also assist policymakers in formulating and implementing effective public education initiatives.

Fast-paced growth of S&T

Many countries have increasingly focused on developing technologies to resolve national issues (United Nations, 2016). These efforts have spurred rapid S&T advancements, enabling adopters to reap substantial economic benefits. For instance, countries like Singapore have utilized technological innovations to transcend its lack of natural resources to achieve economic affluence. Despite the benefits brought about by S&T, the scientific community has been at the forefront of many controversies. Individuals are often skeptical about S&T advancements, as witnessed in the cases of genetically modified (GM) food (Klerck & Sweeney, 2007) and nuclear energy (Stoutenborough, Sturgess, & Vedlitz, 2013).

Individuals lacking sufficient science knowledge may struggle to comprehend the purposes and intricacies of emerging technologies. Considering the benefits of S&T, it is important for the public to gain an in-depth understanding, form informed judgments, and support developments in S&T (Ho et al., 2017). To achieve these goals, scientists and governments utilize media channels to disseminate information regarding S&T (Nisbet et al., 2002).

Changing news consumption patterns

Before the advent of new media, traditional media was a key source of information for the public. Information was traditionally disseminated in a top-down fashion from media establishments to passive audiences (Valtysson, 2010). However, new media has radically altered the media landscape by enabling users to actively create, collaborate, and distribute content (Valtysson, 2010). This development in communication technologies has made information acquisition more accessible and provided users with more autonomy in the information acquisition process.

Media, knowledge, and attitudes

Science knowledge and attitudes

Scholars argue that more information allows for informed decision-making (Ajzen, Joyce, Sheikh, & Cote, 2011). Hence, extensive efforts have been channeled to understand the relationship between knowledge and attitudes (Rimer, Briss, Zeller, Chan, & Woolf, 2004). For instance, Miller (1998) postulated a direct relationship between knowledge and attitudes. That is, individuals with more science knowledge will regard S&T issues more positively than individuals who lack science knowledge (Miller, 1998). Indeed, individuals who process scientific information systematically tend to form favorable attitudes toward S&T (Kim & Paek, 2009). Therefore, communication scholars (e.g. Brossard, Scheufele, Kim, & Lewenstein, 2009; Nisbet & Lewenstein, 2002), scientists, and governments have acknowledged the influence of knowledge on attitudes toward S&T.

Despite this, some scholars argue that the direct relationship between science knowledge and attitudes toward S&T is overly simplistic. Some studies found that science knowledge had limited or non-significant influence on attitudes toward S&T (Ho, Brossard, & Scheufele, 2008; Ho, Scheufele, & Corley, 2010). Such findings have compelled scholars to postulate that individuals employ judgement heuristics to evaluate unfamiliar issues (Ho et al., 2018). Under these circumstances, individuals form attitudes toward S&T heuristically by tapping on their value predispositions, such as trust in scientists and deference to scientific authority (Ho et al., 2008, 2010).

According to the HSM, individuals process information either heuristically or systematically depending on their motivation and ability (Chen & Chaiken, 1999). Individuals with low motivation and/or low ability process information heuristically by tapping on their judgement heuristics or salient mental schemas. Through the heuristic information processing route, individuals expend minimal cognitive effort, which increases the likelihood of misunderstanding information and impedes their ability to spot inaccurate information (Chen & Chaiken, 1999). Conversely, systematic processing requires individuals

to expend greater effort to analyze information critically, which contributes to the formulation of more informed and accurate judgments (Chen & Chaiken, 1999). Thus, individuals' attitudes may be affected differently based on how they process information.

Disseminating science knowledge via the media

Although the relationship between knowledge and attitudes has been contested in recent years, public outreach initiatives to increase support for national issues are still highly prevalent. Governments and communication practitioners believe in the importance of cultivating a knowledgeable citizenry, particularly regarding significant national issues. Therefore, scientists and governments utilize a combination of communication platforms to inform, educate, and engage the public about S&T developments (Nisbet et al., 2002). Typically, individuals acquire knowledge and gain interest in S&T through school-based science education (Jarman & McClune, 2009). However, its impact is limited after individuals complete their formal education (Jarman & McClune, 2009). As such, the media supplements school-based science education to increase the public's science knowledge (Anderson, Lucas, Ginns, & Dierking, 2000; Falk & Dierking, 2002). For instance, The Straits Times – Singapore's English newspaper with the highest readership – has published numerous news articles on the latest developments in scientific research (The Straits Times, n.d.). The Straits Times has also established a 'Beautiful Science' segment to convey S&T findings by researchers (The Straits Times, 2018). Considering the media's crucial role in educating the public about important S&T issues in the long-term (Falk, Storksdieck, & Dierking, 2007), it is important to examine the relationship between attitudes and knowledge.

Media effects on attitudes towards science

Media effects literature demonstrates that news attention to a topic influences individuals' attitude towards it (McCombs, 2002; Scheufele & Tewksbury, 2007). News stories influence individuals' attitudes by shaping the frame of reference through which they

evaluate issues (McCombs, 2013). For instance, prolonged exposure to antagonistic media messages influence audiences' affective responses to issues (Ball-Rokeach & DeFleur, 1976). Additionally, individuals' degree of news attention on television and newspapers influenced their attitude towards the occurrence of global warming (Krosnick, Holbrook, Lowe & Visser, 2006). Therefore, past studies have attested to the relationship between attention to news with attitudes.

Yet, other studies have challenged the relationship between news attention and attitudes toward S&T issues. In Mares, Cantor, and Steinbach's (1999) study, exposure to S&T issues via television did not influence children's attitudes toward S&T. Penn, Chamberlin, and Mueser (2003) also found that documentaries on schizophrenia did not change general attitudes about the illness. Meanwhile, other studies yielded conflicting relationships between news attention and attitudes toward S&T issues. For example, attention to science news was not associated with the attitudes of individuals with liberal political affiliations (Hart, Nisbet, & Meyers, 2015). On the contrary, attention to science news was related to attitudes among individuals with conservative political outlooks (Hart et al., 2015). Given the conflicting empirical evidence, this study sought to test the relationship between news attention and attitudes toward S&T. Thus, we pose the following research question:

RQ1: How does news attention relate to support for S&T?

Knowledge explication

In light of the mixed findings on news attention, knowledge, and attitudes, it is worthwhile to explicate the different facets of knowledge. Knowledge pertains to an individual's degree of understanding information about S&T. Brucks (1985) distinguished knowledge into two forms: factual knowledge and subjective knowledge. *Factual knowledge* refers to individuals' understanding of factually accurate information (i.e. the amount of relevant facts individuals can recall), while *subjective knowledge* refers to individuals'

perception of what they know (i.e. the amount of factual information individuals think they can recall). Past literature typically defined science knowledge as individuals' factual knowledge (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008). Since significantly fewer studies have examined the impact of subjective knowledge, this paper aims to supplement existing research by filling this research gap.

Prior research highlighted the inconsistencies between factual and subjective knowledge. These two constructs were often far from being perfectly correlated (Klerck & Sweeney, 2007; Ladwig, Darlymple, Brossard, Scheufele, & Corley, 2012). Southwell, Murphy, DeWaters, and LeBaron (2012) found discrepancies between respondents' perceived understanding and their actual knowledge, particularly among the less educated. They suggested that formal education could predict individuals' factual knowledge, but not subjective knowledge. Other studies also brought into question the direction of the relationship between factual knowledge and subjective knowledge. While some scholars obtained a positive association (Carlson, Vincent, Hardesty, & Bearden, 2009; Flynn & Goldsmith, 1999; Raju, Lonial, & Mangold, 1995), others found a negative association (Simonson, Huber, & Payne, 1988).

Comparing factual and subjective science knowledge

There exists explicit conceptual and operational differences between these two constructs (Ladwig et al., 2012). Factual knowledge may increase with education, exposure to factual information, and the retention of facts. However, the relationship between education and subjective knowledge is not as straightforward. An inverse relationship between education and subjective knowledge may occur under certain circumstances (Mattila & Wirtz, 2002). For example, science experts possess high levels of factual knowledge from extensive education and training. However, they may become aware of the complexities that they do not fully comprehend as they delve deeper, resulting in low levels of subjective

knowledge (Mattila & Wirtz, 2002). Alternatively, individuals may have high levels of subjective knowledge despite possessing low levels of factual knowledge due to self-deception or false expertise (Mattila & Wirtz, 2002).

Factual and subjective knowledge are also operationalized differently. Factual knowledge is assessed by an individual's ability to distinguish true statements from false statements, based on the individual's mastery of factual information (Brucks, 1985). In contrast, subjective knowledge is measured through self-reports of an individual's perceived level of knowledge (Brucks, 1985).

Media influence on factual and subjective knowledge

The media serves as one of the key information sources for knowledge acquisition after formal education. However, the types of knowledge acquired from the media differ among individuals. The plethora of information available through the media can facilitate either heuristic or systematic processing, depending on individuals' cognitive ability and motivation to process information.

Scholars are often curious about how the media can influence individuals' knowledge. Even in the pre-Internet era, scholars recognized the role of traditional media in public education (Mares et al., 1999). With the proliferation of the Internet, individuals do not need to rely solely on traditional media, which is subjected to editorial control (Soroka, 2012). The openness of new media enhances civic engagement and participation (Brossard & Scheufele, 2013). Therefore, individuals can obtain information from a variety of perspectives before making decisions that are personally relevant and important (Southwell, Hwang, & Torres, 2006).

Additionally, the accessibility to a large amount of information (Boulianne, 2015) allows media users to consult multiple sources before making decisions (Metzger, Flanagin, Eyal, Lemus, & Mccann, 2003). That is, individuals can gain a greater breadth of exposure by

acquiring information that presents different viewpoints of a topic. This allows individuals who are motivated to systematically process and evaluate information to cross-verify information and achieve content mastery of S&T issues. This heightened accessibility to copious information provides individuals with greater opportunities to acquire factual knowledge. Thus, we posit:

H1(a): News attention is positively related to factual knowledge.

Apart from shaping factual knowledge, news attention may influence subjective knowledge. According to the HSM, individuals process information heuristically when they lack the motivation for in-depth cognitive processing (Chen & Chaiken, 1999). Using information cues and mental shortcuts, users passively accept information provided instead of actively scrutinizing the content presented. For instance, perceived self-efficacy acts as a heuristic that increases individuals' perceptions of how much they think they know about S&T issues (i.e., subjective knowledge; Southwell & Torres, 2006). Individuals' news attention increases their perceived ability to comprehend science topics (Elliott & Rosenberg, 1987). Thus, individuals who process scientific information from the media heuristically may perceive themselves as possessing higher levels of knowledge. As such, we postulate:

H1(b): News attention is positively related to subjective knowledge.

Apart from understanding how factual and subjective knowledge are associated with news attention, we also seek to compare the extent to which these knowledge dimensions are related to news attention. According to the HSM, systematic information processing involves scrutinizing the new information, evaluating its validity, and relating new information with one's previous knowledge of the issue (Todorov, Chaiken, & Henderson, 2002). However, individuals often face external and cognitive constraints that limit their ability to frequently engage in systematic processing (Fiske & Taylor, 1991). The effort required, coupled with the constraints to perform systematic processing, often induce individuals to process information

via the heuristic route instead. Further, studies have revealed that individuals tend to use the media to satisfy their needs for entertainment and socializing, rather than to satisfy their need for cognition (Dunne, Lawlor, & Rowley, 2010; Shao, 2008). Given such circumstances, it is likely that individuals would rely on the heuristic route to process news on S&T issues. As a result of individuals' constant news attention to S&T information, individuals may then perceive themselves to acquire more knowledge of S&T rather than what they actually know. Thus, we hypothesize:

H2: News attention has a stronger association with subjective knowledge as compared to factual knowledge.

The association between news attention and support for S&T may occur indirectly through knowledge. Policymakers and scientists often seek to increase public support for S&T by disseminating information through the media to nurture an informed public. Scholars have argued that heightened levels of factual knowledge would increase support for S&T, primarily due to individuals' improved accuracy in assessing risks and gaining awareness of the benefits from S&T (Nisbet et al., 2002). Thus, we posit:

H3: Factual knowledge positively mediates the relationship between news attention and support for S&T.

Similarly, studies have established the association between news attention and subjective knowledge in the context of S&T (Weberling, Lovejoy, & Riffe, 2011). However, literature typically examined the relationship between knowledge and support for S&T broadly, instead of explicating knowledge into factual and subjective knowledge. As such, this study seeks to fill this research gap by investigating the mediating effect of subjective knowledge on news attention and support for S&T (Figure 1). Thus, we posit:

RQ2: To what extent does subjective knowledge mediate the relationship between news attention and support for S&T?

[Insert Figure 1 about here.]

Method

We obtained ethics approval from the university's Institutional Review Board and collected data from an online survey panel using web-based questionnaires in 2015. The online survey was administered via Qualtrics, a global research organization with substantial academic and applied research experience. A pilot study was conducted before data collection to ensure the measurements possessed face validity and content validity.

Sample and data

A sample of 967 respondents were randomly selected from an available pool of panelists on Qualtrics. To minimize the lack of generalizability in utilizing online surveys to represent the population of interest, quotas for gender, age, and monthly household income were imposed on the sample. This ensured that the sample population accurately reflected Singapore's population demographics. The respondents comprised 46.2% male and 53.8% female, aged from 21 to 76 (M= 38.7, SD = 10.6). Singapore citizens and permanent residents were recruited, consisting of 85.2% Chinese, 5.1% Malay, 7.4% Indian, 0.1% Eurasian, and 2.2% from other ethnicities. Participants' level of education[1] ranged from 1 (no formal education) to 7 (postgraduate degree). Meanwhile, monthly household income[2] ranged from 1 (SGD 1000 or less) to 11 (SGD 10,000 and above). Upon completing the study, respondents received cash-equivalent points that could be accumulated to redeem incentives. Using AAPOR response rate 3, this study yielded a response rate of 30%, an acceptable response rate for web-based surveys (Bosnjak, Das, & Lynn, 2016; Iyengar & Hahn, 2009).

[1] Of the 967 participants, 0.1% had no formal education, 0.2% received primary level education or lower, 1.9% had some secondary education, 3.4% had GCE 'N' levels, 8.8% had GCE 'O' levels, 5.3% had GCE 'A' levels, 24.7% received a diploma, 46% had a Bachelor's degree, while 9.6% had a postgraduate degree.

[2] Among the participants, 2.3% earned S$1000 or below, 5.0% earned S$1001 to S$2000, 8.2% earned S$2001 to S$3000, 7.7% earned S$3001 to S$4000, 8.4% earned S$4001 to S$5000, 7.2% earned S$5001 to S$6000, 9.2% earned S$6001 to S$7000, 9.5% earned S$7001 to S$8000, 9.7% earned S$8001 to S$9000, 10.1% earned S$9001 to S$10,000, and 20.8% earned above S$10,000.

Measures

Factual knowledge

Participants' factual knowledge on S&T issues was assessed using eight dichotomous questions adapted from established sources (Australian Academy of Science, 2013; Miller, 1998; National Science Foundation, 2006). Participants answered if each of the following statements were 'true,' 'false,' or 'don't know.' The items include: 'All radioactivity is man-made (F),' 'Nanotechnology deal with things that are extremely small (T),' 'Lasers work by focusing sound waves (F),' 'Antibiotics will kill viruses as well as bacteria (F),' 'Radioactive milk can be made safe by boiling it (F),' 'The Earth takes a day to go around the sun (F),' 'Sunscreen protects the skin from infrared solar radiation (F),' and 'Stem cells are different from other cells because they are found only in plants (F).' 'T' and 'F' indicated the correct answers to each statement. Participants received a point for each correct answer, and did not receive a point for each incorrect answer provided. The option 'Don't know' was coded as an incorrect response. The eight-item measure yielded a *KR-20* = .73, indicating its high reliability (*M* = .57, *SD* = .28).

Subjective knowledge

Respondents' current perceived level of knowledge about S&T issues was measured using a single-item ratio scale (0 = *knowing nothing* and 100 = *knowing everything you could possibly know about the topic).* The single-item measure was adapted from past studies (Griffin, Neuwirth, Dunwoody, & Giese, 2004; House et al., 2005), and was proportionally scaled down to a 7-point scale in this study to facilitate inter-item comparison during data analysis (*M* = 3.61, *SD* = 1.40).

News attention

Participants' news attention to S&T issues were measured using four items on a 7-point Likert scale (1 = *no attention at all,* 7 = *a lot of attention*). This measure assessed

participants' attention across different news mediums including television, print newspapers, the Internet, and social media. The four-item measure was adapted from established measures in past studies (Eveland, 2001, 2002), and yielded a Cronbach's $\alpha = .78$, indicating a high reliability of measures ($M = 4.79$, $SD = 1.04$).

Support for S&T

Two items measured on a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*) were used to assess the respondents' support for S&T issues ($M = 5.49$, $SD = 1.02$, Spearman's $r = .84$). The items include, 'Overall, I support government funding for research and development in science and technology' and 'I support government funding for science scholarships.'

Analytical approach

Model fit

The hypothesized model was tested using structural equation modeling in *Amos 18*. Before testing the structural equation model, correlation tests were conducted to determine the linear relationships between variables. This assessment of observed relationships between variables satisfied the prerequisites for structural equation modeling. Demographic variables including sex, education level, monthly household income, and participants' degree of religiosity were included as control variables. The model fit was evaluated based on the following criteria: For a good model fit, the maximum likelihood chi-square (χ^2) value obtained should be non-significant ($p > .05$), the relative chi-square ratio (χ^2/df) should lie between 1 and 5 (Wheaton, Muthen, Alwin, & Summers, 1977), the root mean square error of approximation (RMSEA) value yielded should fall below .05 (Hu & Bentler, 1999), while the values obtained for both the comparative fit index (CFI) and Tucker-Lewis Index (TLI) should exceed .95 (Hu & Bentler, 1999).

Results

The descriptive statistics for the measurements and factor loading for each variable in this study are presented in Table 1. All the standardized factor loadings of the latent variables exceeded .40, indicating the reliability of the factors utilized (Stevens, 1992). In addition, the factor loading for all latent variables were significant ($p < .001$). Based on the abovementioned model fit indices, the findings reflect an acceptable fit for the structural model ($\chi^2 = 285.49$, df = 130, $p < .001$; $\chi^2/df = 2.20$; CFI = .96, TLI = .95, RMSEA = .035).

[Insert Table 1 about here.]

With regard to the direct relationship between news attention and support for S&T, the results showed that news attention was positively related with support for S&T (*ß* = .44, $p < .001$), answering RQ1.

Regarding the relationships between news attention and dimensions of knowledge, the findings revealed that news attention was positively associated with factual knowledge (*ß* = .09, $p < .05$), providing support for H1(a). In addition, news attention was positively correlated with subjective knowledge (*ß* = .36, $p < .001$), supporting H1(b). Results also revealed that the relationship between subjective knowledge with news attention was stronger than the relationship between factual knowledge with news attention, thus providing support for H2.

As hypothesized in H3, factual knowledge mediated the relationship between news attention and support for S&T (*ß* = .11, $p < .05$). With regard to RQ2, subjective knowledge negatively mediated the relationship between news attention and support for S&T (*ß* = −.09, $p < .05$). Overall, the model explained 22% of the variance in public support for S&T (see Figure 2).

[Insert Figure 2 about here.]

Discussion

This study contributes to extant literature by examining the mechanisms behind the associations between news attention and attitudes. The hypotheses and research questions about the direct relationship between news attention and public support for S&T, the explication of knowledge into factual and subjective knowledge, as well as their mediating effects on the association between news attention and public support for S&T were all answered or supported. Notably, the direction of the relationship between subjective knowledge and support for S&T was found to be in the opposite direction from the relationship between factual knowledge and support for S&T. The key findings of this study are discussed below.

News attention and knowledge types

The findings support the explication of knowledge into factual and subjective knowledge. News attention was positively associated with factual and subjective knowledge, but to a greater extent with the latter. This finding suggests that news attention is useful in improving factual knowledge on S&T issues. However, individuals have a disproportionate increase in the amount of knowledge they perceive themselves to possess as compared to the actual amount of knowledge they gained. The findings could be explained by the algorithms on new media that track users' media consumption patterns and pushes content to users based on their existing attitudes (Anderle, 2015; Pariser, 2011). Through consistent validation from congruent information and limited exposure to diverging viewpoints, users may feel more confident in their judgments and knowledge, therefore bolstering subjective knowledge.

The findings also supported the postulated mediation effect of factual and subjective knowledge, and news attention on public support for S&T. Overall, the proposed structural equation model managed to account for 22% of the variance. Therefore, scholars should explore other factors that might influence the strength of this relationship.

Knowledge and support for S&T

The findings demonstrated that both factual and subjective knowledge are related to public support for S&T. However, the relationships differ in direction, which could explain why some studies did not find a direct relationship between knowledge and attitude. An increase in individuals' factual knowledge is associated with increased support for S&T. Despite this, the concurrent increment in individuals' subjective knowledge could undermine support for S&T. The contrasting effects of objective and subjective knowledge on support for S&T suggest that it is important for scholars to consider a dual-processing model like the HSM when examining media effects. Future research can also compare the magnitudes of these effects to understand how the media influences individuals' decision-making. These studies can potentially increase our understanding of media effects and the dominant route that individuals use to process information about S&T.

Additionally, distinguishing the effects of factual knowledge and subjective knowledge can inform newsmakers, policymakers, advocacy groups, and scientists about the effective tactics to disseminate information about S&T. In order to nurture a well-informed citizenry that is capable of making calculated decisions, stakeholders should work on increasing factual knowledge. The results of this study suggest that individuals might presume that they have sufficient knowledge on an issue after viewing a few news articles on S&T issues. To avoid this issue, newsmakers can find ways to incorporate multiple perspectives of an issue into one succinct news story. Further, noting that individuals tend to report higher subjective knowledge when they pay more attention to news on S&T issues, newsmakers should avoid assuming that media audiences are able to discern scientific fact from opinion. Hence, newsmakers should refrain from engaging in false balance in news reporting (Grimes, 2016). In other words, when the scientific evidence shows overwhelming support for one side of the argument, journalists should not simply allocate equal coverage to

opposing views of an issue to appear balanced (Grimes, 2016). Instead, they should report solely the facts in order to allow readers to attain an accurate picture of the science issue.

The findings also revealed that factual knowledge had a weak positive relationship with support for S&T. Policymakers, advocacy groups, and scientists can leverage on this relationship to promote support for their cause by trying to elevate the level of factual knowledge of stakeholders. For instance, policymakers and advocacy groups can include facts about S&T issues when crafting reports and communication collaterals. To increase the effectiveness of their communication initiatives, they can also harness the extensive reach of mass media and social media channels.

Factual knowledge and support for S&T

As hypothesized, factual knowledge was positively related to support for S&T, suggesting that the media is a viable channel to inform the public about S&T issues after one's completion of formal education.

Subjective knowledge and support for S&T

Subjective knowledge was negatively associated with support for S&T. Although this study successfully predicted the mediating effects of subjective knowledge on news attention and support for S&T, it did not specify the direction of the relationship. The negative relationship between subjective knowledge and support for S&T presents an interesting premise for future research.

First, future research can explore the mechanism behind this relationship and the boundary conditions in which this relationship holds. For instance, the negative relationship between subjective knowledge and support for S&T could be attributed to the influx and availability of information in the information age. Individuals may perceive an increase in subjective knowledge when they are exposed to a plethora of information regarding S&T issues. However, in today's media landscape, non-expert users with limited knowledge or

biased perceptions can easily publish information that presents reasons to oppose developments in S&T. The presence of competing information might diminish public support for S&T. Hence, future studies can test this possible mechanism through experiments and determine the generalizability of this finding to different media and political landscapes.

Second, future studies can explore whether this direction of relationship holds true for specific S&T issues. This paper examined the public's overall support towards S&T, which includes a broad domain of technological innovations and developments. However, the public may possess varying attitudes toward particular S&T issues. For instance, Singaporeans possess largely unfavorable attitudes toward GM food (Subrahmanyan & Cheng, 2000), but hold positive attitudes toward nanotechnology (Liang et al., 2015). Such discrepancies in prior attitudes toward different S&T issues may influence how news attention influences knowledge and the resulting public support. Testing the relationship between subjective knowledge and attitudes toward S&T issues with differing levels of public support might uncover other factors (e.g., content of news coverage, and psychological reasons). Furthermore, future studies may uncover predictors of subjective knowledge (e.g., self-esteem, credibility perceptions of the media) that affect public support for S&T.

Direct relationship between news attention and support for S&T

News attention was positively related with public support for S&T. This significant direct association is congruent with media effects theories and earlier studies (e.g., Hart et al., 2015). Even though media effects theories were based on traditional communication channels, the results indicate its continued relevance in the prevailing media landscape.

The insights gleaned from this study also provide practical implications for policymakers, scientists, and communication practitioners. News attention was more strongly associated with subjective knowledge than factual knowledge. The direction of this relationship indicates the limited effectiveness of the news in informing and educating the

public about S&T issues. To enhance the mass media's effectiveness in informing and educating the public about S&T, newsmakers should place less emphasis on conflict and sensationalization in their news coverage. Journalists should practice balanced reporting by providing both the positive and negative facets of S&T issues (Kahlor & Stout, 2009). However, journalists should refrain from presenting opinions challenging scientific findings as equally important as the data and evidence that have emerged from rigorous research. Extra effort should also be taken to ensure that media messages regarding S&T issues are framed in a manner where content can be easily grasped by the public. To increase factual knowledge of S&T issues, stakeholders can also disseminate bite-sized facts to avoid information saturation, while increasing the ease of information acquisition for individuals.

This study has several limitations in the study design, which should be addressed in future research. First, this study collected data from an online survey panel using web-based questionnaires. Although this research design potentially limits the generalizability of the findings by under-representing non-Internet users in the population of interest, quotas were imposed to ensure that the sample population were representative of Singapore's population demographics. This limitation is also mitigated in the context of Singapore, as the highly urbanized city-state has a high Internet penetration rate of 82% (We Are Social, 2016). In addition, this study examined the media system as a whole, which includes new media use. Hence, a web-based questionnaire would ensure that respondents have access and experience in utilizing such platforms.

Second, utilizing cross-sectional data does not allow causal inferences to be made. As such, the findings in this study cannot determine whether news attention precedes knowledge and support for S&T, or vice versa. Future research can adopt research designs such as randomized controlled experiments to ascertain causal relationships among the variables due to its high internal validity.

Third, a single-item measure was utilized in this study for subjective knowledge while factual knowledge was assessed with multiple items that focus on a variety of S&T issues. As such, the findings obtained for the effects of subjective knowledge may not be comparable to that of objective knowledge. There are also constraints associated with the use of single-item measures. According to Hoeppner, Kelly, Urbanoski, and Slaymaker (2011), single-item measures are more susceptible to random measurement errors and the internal reliability statistic cannot be computed.

However, literature has attested to the advantages of single-item measures. For instance, single-item measures possess a lower common method variance than multiple-item measures (Hoeppner et al., 2011). In other words, there is a lower chance of observing spurious relationships between variables that are due to the measurement item. Moreover, single-item measures provide pragmatic benefits to increase survey effectiveness. Specifically, single-item measures are less time-consuming, pose lower levels of participant burden, and are more adaptable to several population samples (Hoeppner et al., 2011). This study therefore signals a promising relationship between news attention, subjective knowledge, and support for S&T. Future studies can replicate this study with multi-item measures of subjective knowledge. This approach will enable researchers to compare the predictive validity of single- and multi-item measures, and further verify the findings obtained in this study.

The findings obtained from this study also presents several recommendations for future research. First, it will be useful to conduct a content analysis to understand the prevailing tone of news coverage about S&T issues. By gaining a better understanding of the current media landscape, scholars can predict how news attention influences attitudes with greater accuracy. Second, scholars can conduct experiments to test how simultaneous exposure to different news media frames might influence people’s factual and subjective

knowledge. For instance, conflicting tones and perspectives across different media platforms may induce systematic information processing among individuals, which could increase factual knowledge. However, it may also result in information overload, which can hinder understanding and information processing (Malhotra, 1984). Third, scholars can examine how news attention influences factual and subjective knowledge, and public support of specific S&T issues. This study took a broad approach to understand general support towards S&T. However, the public may react differently to controversial (e.g. nuclear energy) and well-accepted (e.g. nanotechnology) S&T.

This study is premised upon the relationships of news attention with the dimensions of knowledge, and support for S&T. However, news stories are not the only source of information for individuals. Therefore, future studies can look at alternative information sources, such as user-generated content and infotainment programs. Past research found that infotainment programs often expose individuals who do not typically consume news to public affairs (Baum, 2005). Therefore, the inclusion of infotainment programs will allow scholars to understand the influence of the media system in an even more holistic manner that is able to more accurately reflect audiences' media consumption patterns.

Overall, this study is in line with the scarce literature that simultaneously examined factual and subjective knowledge within a single study. This study contributes to extant literature by demonstrating how news attention is associated with the two facets of knowledge differently. In addition, these distinct dimensions of knowledge are associated with public support for S&T differently. The contrasting findings suggest that future studies should not examine factual knowledge in isolation when studying the relationship between knowledge and attitudes. Instead, they should take into account the distinct roles of factual and subjective knowledge. Finally, the proposed model and the findings adds to the growing body of literature which accounts for the underlying mechanisms behind how news attention

influences support for S&T.

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Table(s)

Table 1.

Weighted correlations: support for science and technology as outcome variable.

Variable	*Factor loading*	*M*	*SD*
Factual knowledge			
All radioactivity is man-made.	.55	0.59	0.49
Lasers work by focusing sound waves.	.52	0.53	0.50
Antibiotics will kill viruses as well as bacteria.	.45	0.46	0.50
Radioactive milk can be made safe by boiling it.	.52	0.64	0.48
The Earth takes a day to go around the sun.	.49	0.56	0.50
Nanotechnology deal with things that are extremely small.	.42	0.81	0.39
Sunscreen protects the skin from infrared solar radiation.	.43	0.36	0.48
Stem cells are different from other cells because they are found only in plants.	.58	0.61	0.49
News attention			
Television	.49	4.59	1.45
Print newspaper	.59	4.83	1.30
Internet	.85	5.15	1.20
Social media	.70	4.60	1.40
Support for science and technology			
Government funding for research and development	.86	5.48	1.07
Government funding for science scholarships	.83	5.50	1.13

Figure(s)

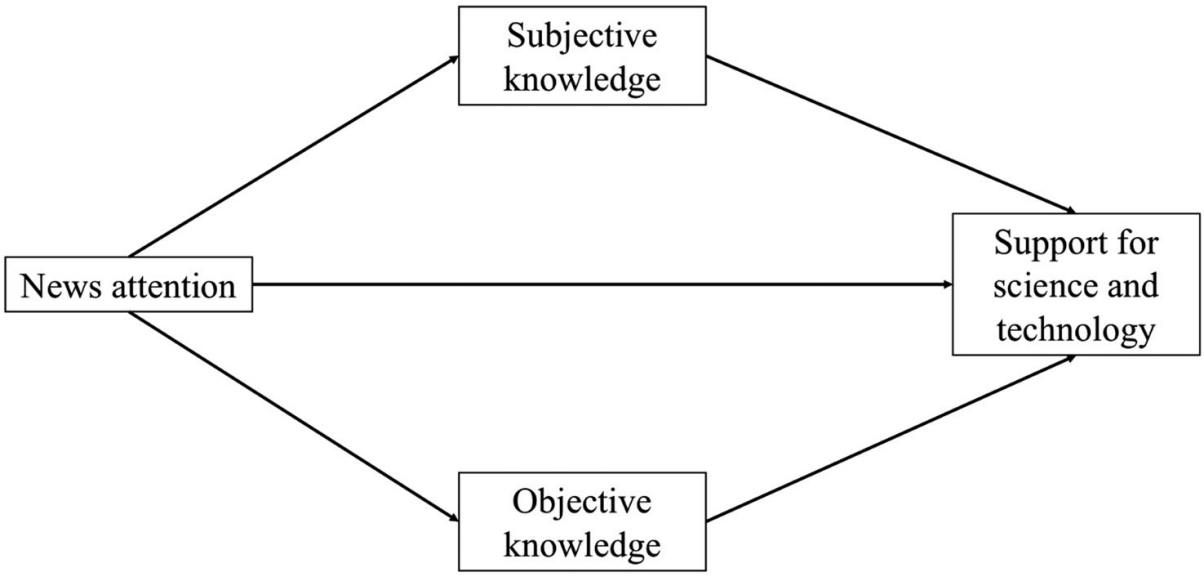

Figure 1. Hypothesized mediation model.

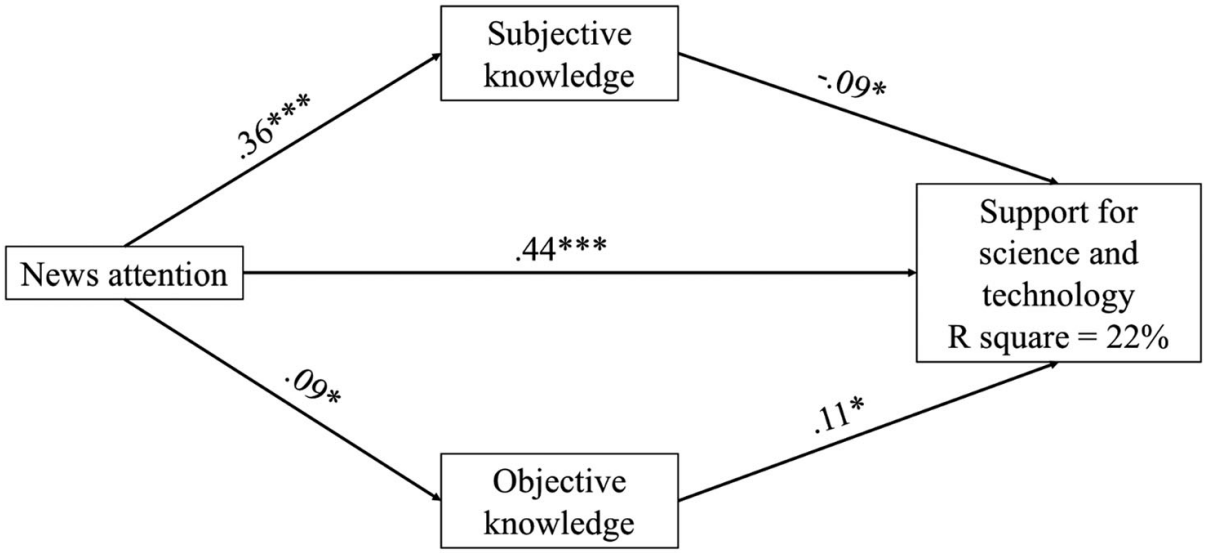

Figure 2. Structural equation model with standardized coefficients (N = 967).