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A Model for Understanding Decision-Making Related to Agriculture and Natural Resource Science and Technology

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Abstract

Agricultural educators, leaders, communicators, and extension professionals are faced with the increasingly difficult task of sharing science-based information to a public that is exposed to an array of media options, which are not always factual. Additionally, issues related to agriculture and natural resources (ANR) have become increasingly complex, and people can elect to only read information or communication that supports their pre-existing views on a topic. The complexity of disseminating information in today's society has led to the proposal of a new theoretical model: The Decision-Making Model for ANR Science and Technology. This is a multi-facetted model utilizing the theoretical foundations from the Theory of Diffusion of Innovations, Theory of the Spiral of Silence, and the Elaboration Likelihood Model. In a world of echo chambers, this theory has the potential to break the cycle of decisions made with incomplete information and equip practitioners with the foundation needed to efficiently and effectively disseminate information through educational practice and informed communication efforts. An informed and aware public could make decisions about ANR science and technology with a more complete understanding of the issue, which would solve some of the wicked problems facing society today.

Keywords: decision-making, agriculture and natural resources, spiral of silence, diffusion of innovations, elaboration likelihood model

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Introduction

Technological advances and a growing population have brought many benefits to society; however, challenges also have arisen. Many of these challenges are complex in nature and have an

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impact on the agriculture and natural resource (ANR) industry. Andenoro, Baker, Stedman, and Weeks (2016) discussed complex challenges as those that are "rich with complexity, embody the diversity and scope of human knowledge, and require multiple perspectives and systems thinking to develop and implement sustainable solutions" (p. 58). Others define complex challenges as wicked issues (Lie & Servaes, 2015). Trowler (2012) defined wicked issues as those that are "ill-understood or understood in multiple, perhaps conflicting, ways and are fundamentally complex in character" (p. 273). Some of the complex issues facing ANR include climate change, land-use, food production, and natural resource management (Andenoro et al., 2016; Lie & Servaes, 2015). Addressing complex issues expands beyond bench and field science research and requires social scientists to investigate public perceptions and adoption decisions related to ANR issues to create sustainable solutions (Andenoro et al., 2016).

Conflict often arises when the public tries to understand and make decisions about complex issues (Trowler, 2012). Conflict forms when the public is introduced to science and fact, but emotions, ethics, morals, and politics guide personal decision-making (Cook, Pieri, & Robbins, 2004). Scientists may be able to identify a solution to address part of a complex issue, but because of the multifaceted nature of the issue, public perception may prevent the science from being implemented (Andenoro et al., 2016; Bardes & Oldendick, 2012).

Andenoro et al. (2016) identified public perception as an overarching problem facing scientists as they wrestle with complex ANR issues. Individuals have a tendency "to seek out information that reinforces and confirms their existing convictions," also known as confirmation bias or the echo chamber (Knutson, 2016, para. 3). Thus, individuals tend to make decisions about or take a stance on a complex issue without understanding all sides. The advent of new media and social media has complicated the adoption of ANR science and technology as solutions to complex issues. Information (Ferguson, 2000) and misinformation (Andenoro et al., 2016) can now spread at an accelerated rate, and individuals have the ability to only consume information that confirms their current beliefs (Slater, 2007).

Public perception "drives the market" and will impact the outcome of complex ANR issues (Andenoro et al., 2016, p. 59). As colleges of agriculture conduct groundbreaking research, it is imperative for agricultural educators, communicators, leaders, and extension professionals to fulfill the Land-Grant mission and disseminate information (Association of Public and Land-grant Universities, 2012) to the public so they are able to make informed decisions on complex ANR issues. However, the complexity of the issues and information-rich landscape make it difficult to reach the public with science-based information. Social science researchers rely on theory to provide discourse and explanation (Trowler, 2012). When examining foundational theories, it is impossible to find one theory suitable to guide the dissemination of information about complex ANR issues. Rather, it takes a variety of theories to guide the dissemination of information about complex ANR issues. As identified by Trowler (2012), "the repertoires of each theory help us organize apparent chaos and to produce texts which communicate these understandings to our audiences in particular ways" (p. 282). In an effort to understand how scientific information about complex ANR issues is used by the public in decision-making, a new theoretical model was developed. The model is titled "The Decision-Making Model for ANR Science and Technology" (see Figure 1).

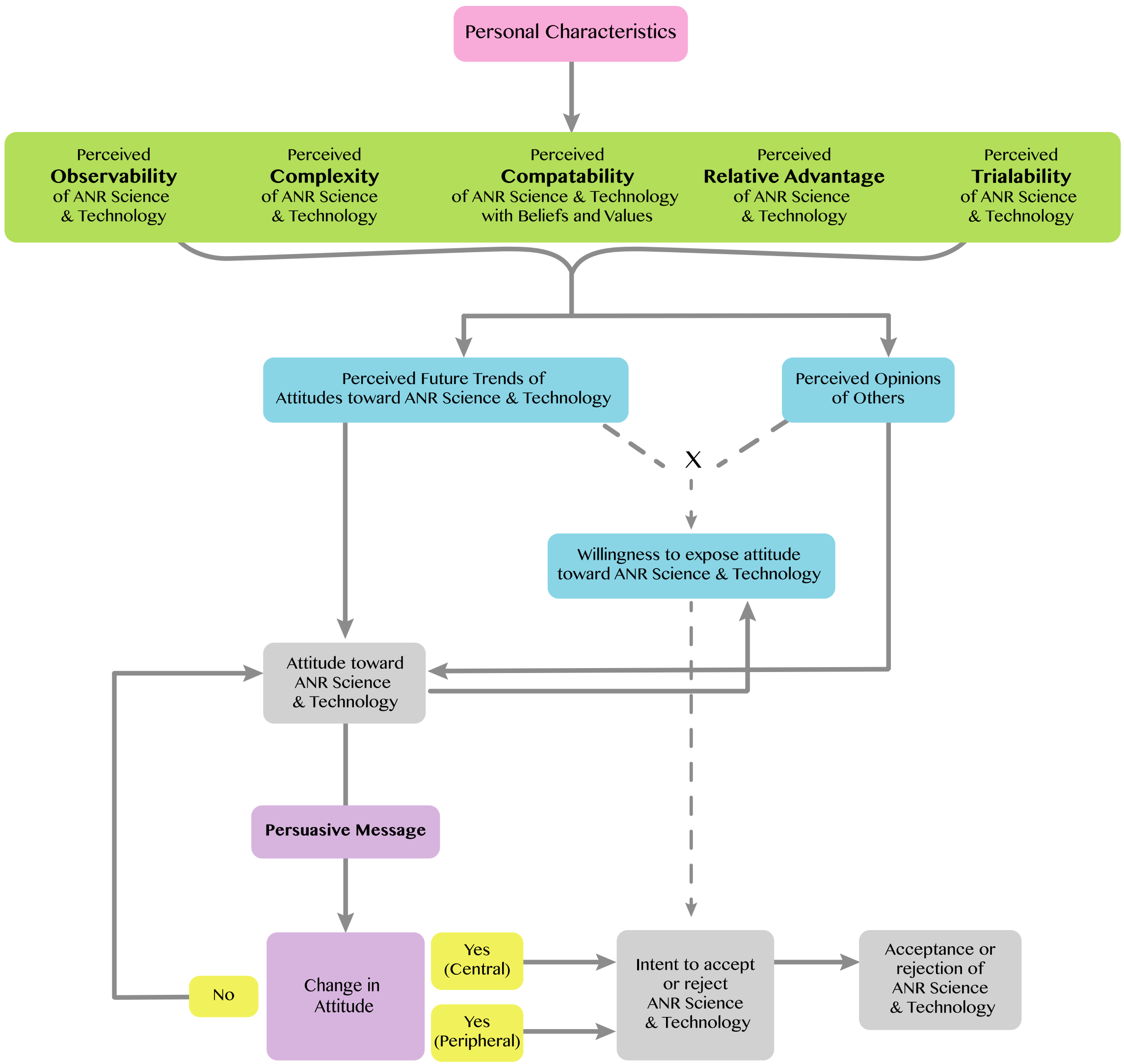

Figure 1. Decision-Making Model for ANR Science and Technology.

The proposed model is based on the theories of Diffusion of Innovations, Spiral of Silence, and the Elaboration Likelihood Model (ELM). These theories were selected after an in-depth review of literature and account for the way people process information. The Diffusion of Innovations theory was selected because it described how individuals make internal judgements toward an idea or product (Rogers, 2003). Because people do not simply form opinions on their own and pressures from peers and society influence attitudes and expressions of attitudes, the Spiral of Silence was included in the model (Noelle-Neumann, 1974). How practitioners could influence attitudes and behaviors was important to consider as well. Therefore, the ELM was added to the model to provide guidance for how communication intervention can lead to attitude changes and eventual behavioral change (Petty, Brinol, & Priester, 2009). The proposed model could inform agricultural communication, education, and extension programming. The following literature review provides a detailed description of each of these theories and their application to the Decision-Making Model for ANR science and Technology and contributes to priority 7 of the American Association of Agricultural Education's National Research Agenda (Andenoro et al., 2016).

Literature Review and Discussion

The first part of the model is derived from Rogers' (2003) diffusion of innovations theory. An innovation is an idea, practice, or item that is perceived as new by an individual or group (Rogers, 2003). The proposed model begins with the *personal characteristics* of an individual. Rogers (2003) generalized that people who adopted an innovation early typically have a higher level of education, income, and literacy compared to late adopters. Additionally, early adopters of an innovation had larger farms or companies and possessed a greater ability to move up socially compared to late adopters (Rogers, 2003). However, Rogers (2003) reported literature was inconsistent on the effect of age on people's likeliness to adopt an innovation.

Prior research regarding ANR communication determined demographic characteristics, such as gender, age, and race/ethnicity, influence people's perceptions of agricultural and life science topics (Antonopoulou, Papadas, & Targoutzidis, 2009; Clark, Stewart, Panzone, Kyriazakis, & Frewer, 2016; Conko & Prakash, 2005; Gaskell, 2003; Hall & Moran, 2006; Irani, Sinclair, & Malley, 2001; Makki, Stewart, Panuwatwanich, & Beal, 2013; McKendree, Croney, & Widmar, 2014; Moon & Balasubramanian, 2001; Ruth, Gay, Rumble, & Rodriguez, 2016). Gender has been associated with influencing perceptions of ANR issues, and Clark et al. (2016) found that women were more likely than men to be concerned with animal welfare issues. Similarly, researchers concluded that women's attitude toward GM foods were negative compared to men (Hall & Moran, 2006; Lockie, Lawrence, Lyons, & Grice, 2005; Pounds, 2014; Ruth & Rumble, 2017). In addition, women in groups of people who considered water conservation to be important were more likely to be engaged in water conservation behaviors compared to men (Lamm, Lundy, Warner, & Lamm, 2016).

Age and socioeconomic characteristics, like education, income, and occupation (American Psychological Association, 2017), also influence perceptions of ANR science, but in varying ways. Young consumers and those with higher levels of education were likely to be aware of modern farming practices and concerned with animal welfare (Clark et al., 2016). However, research also has supported Rogers' (2003) conclusion that the effect of age on innovation adoption was inconclusive as studies regarding GM science perceptions have found conflicting results regarding age and attitude (Antonopoulou et al., 2009; Ruth et al., 2016). Makki et al. (2013) explored differences in socioeconomic status and water conservation while showering. The researchers concluded that consumers with higher education and higher income were less likely to conserve water compared to their counterparts (Makki et al., 2013).

There also is a connection between race/ethnicity and consumer perceptions and acceptance of agricultural science. White and Hispanic consumers would purchase GM-labeled food, but most African American respondents would not purchase the labeled food (Irani, et al., 2001). Additionally, Hispanics were less likely to engage in water conservation when compared to other ethnicities (Makki et al., 2013).

In addition to demographic characteristics influencing perceptions of innovations, perceived attributes of the innovation itself also impact the rate of adoption (Rogers, 2003). Rogers (2003) proposed the perceived attributes of an innovation largely influence the rate of adoption. These attributes include the *relative advantage*, *compatibility*, *complexity*, *trialability*, and *observability* of the innovation. The *relative advantage* of an innovation is the perceived advantage of using the new item/practice/idea over what was used previously (Rogers, 2003). Advantages can be concrete, like economic advantages, or abstract, like satisfaction and social prestige. *Compatibility* of an innovation is how well an innovation aligns with the values and norms of the adopter. If an innovation does not fit within existing social norms, adopters must accept a new social system before adopting the innovation. The third attribute, *complexity*, is used to describe how difficult an innovation is to understand. An idea that is easily comprehensible will be adopted quickly amongst a group. *Trialability* refers to how easily an innovation can be tested initially by the adopters. When people are unable to sample or test a new product, they are less likely to adopt it in the future. The final attribute is *observability*, which is how easily the adopter can see the results of using an innovation by others. Greater visibility of results will lead to discussion amongst groups of potential adopters and eventually adoption of the innovation. High levels of relative advantage, compatibility, trialability, and observability, combined with low levels of complexity of an innovation, have been shown to lead to the quickest rates of adoption (Rogers, 2003).

Researchers have used diffusion of innovations to develop a greater understanding of the adoption of agricultural science practices and technologies amongst stakeholders (Diker, Walters, Cunningham, & Baker, 2011; Moore, Murphrey, Degenhart, Vestal, & Loux, 2012; Rumble et al., 2016; Weick & Walchi, 2002). Weick and Walchi (2002) specifically explored the influence of diffusion attributes on consumers' adoption of GM food. Consumers had neutral to negative attitudes toward each of the attributes, potentially detering the American public from adopting the technology of GM science (Weick & Walchi, 2002). Rumble et al. (2016) explored undergraduate students' perceptions of GM diffusion attributes and found that compatibility was the only significant predictor of likelihood to consume GM citrus even though relative advantage was the most favorable diffusion characteristic described by the respondents.

Diffusion attributes have been studied in contexts beyond GM food and science and have been used to analyze other ANR topics. Diker et al. (2011) examined how diffusion attributes predicted the implementation of a children's nutrition education program and curriculum. Perceptions of program complexity was the only significant predictor of adoption; curriculum use increased as complexity decreased (Diker et al., 2011). The theory also has been the basis for studies of how veterinarians used an Extension-developed animal health network (Moore et al., 2012). Participants in the study expressed that the complexity, compatibility, and relative advantage of the program were easy to assess, but the trialability and observability were difficult to judge (Moore et al., 2012).

While diffusion attributes have been found to influence rate of adoption for ANR science and technology, interpersonal communication can influence the ultimate decision to adopt (Rogers, 2003). People prefer discussion with those of similar opinions (Rogers, 2003), which is reflective of the spiral of silence (Noelle-Neumann, 1974) and the next section of the proposed Decision-Making Model for ANR Science and Technology. Noelle-Neumann (1974) developed the spiral of silence theory to understand how public opinion is formed. Because attitudes are learned and not formed within a vacuum (Perloff, 2014), the spiral of silence theory suggests public opinion forms through the process of individuals' observations within their own social environment (Noelle-Neumann, 1974). However, the issue must have strong moral or ethical components for people to feel pressure from the spiral of silence (Noelle-Neumann, 1993).

The spiral of silence consists of three components: *perceived perceptions of others' opinions*, *perceived future trends of others' opinions*, and *willingness to expose own attitude* (Noelle-Neumann, 1974). Fear of isolation from a group drives a need to evaluate the current and future public opinions about an issue to avoid exposing attitudes that do not align with the majority (Noelle-Neumann, 1993). These assessments influence willingness to expose one's own attitudes and eventually behavior regarding an issue (Noelle-Neumann, 1993). People will happily expose attitudes when they sense they are in the majority but will remain silent if they believe they are in the minority (Noelle-Neumann, 1993). However, perceived public opinions do not always align with the actual opinion of the public, and some opinions can be over or underestimated, depending on how much they are showcased to the public (Noelle-Neumann, 1974). There is an additional positive relationship between perceptions of current and future opinions. Weaker relationships are expected between the two variables, indicating the public is shifting its opinion (Noelle-Neumann, 1974).

The spiral of silence can be present in conversations about ANR science and technology (Gearhart & Zhang, 2015; Kim, Kim, & Oh, 2014; Porten-Chee & Eilders, 2015; Priest & Eyck, 2004). Kim et al. (2014) examined the role of the internet with the spiral of silence and the issue of GM food; hypothesizing the internet could allow users to share their thoughts without fear of isolation. Findings from the study supported that the internet shaped individual perceptions of public opinion toward the topic. Additionally, the extent to which a person's opinion aligned with opinions expressed in an online forum was significantly associated with their likelihood to express their own opinion (Kim et al., 2014). Even though the researchers believed the internet could diminish the effects of spiral of silence in discussions of GM food, they found social pressure still existed to only share like opinions (Kim et al., 2014). While research has found the spiral of silence present in online settings (Gearhart & Zhang, 2015; Kim et al., 2014), Porten-Chee and Eilders (2015) concluded people with minority views were more likely to voice their opinions online regarding climate change compared to those with the majority opinion. However, climate change was not a contentious topic in Germany (where the study was conducted) and the fear of isolation was likely not a factor in conversations about climate change because different opinions were reflective of differing perspectives rather than divergent morals or values (Porten-Chee & Eilders, 2015).

Priest and Eyck (2004) explored the role of mass media's portrayal of biotechnology in the spiral of silence and proposed that the biotechnology industry had control over the stories the news would report and opposition to the technology was rarely covered. However, at the time of the writing, voices from those concerned about biotechnology had broken the spiral of silence and entered mainstream media. Exposure to oppositional messages in the media allowed consumers without a scientific background to question the conclusions made by scientists in mainstream news (Priest & Eyck, 2004).

The main spiral of silence components were included in the proposed model due to the changing media landscape and how consumers are able to receive information from a variety of different platforms (Chan-Olmsted, Rim, & Zebra, 2012). Slater (2007) explored the idea of *reinforcing spirals* based on the spiral of silence and proposed that individuals seek media that supports their personal attitudes, creating a positive feedback loop. This feedback loop has been referred to as an echo chamber (Scheufele, Hardy, Brossard, Waismel-Manor, & Nisbet, 2006). An echo chamber is a homogenous network that eventually constricts members' exposure to oppositional viewpoints across a variety of topics (Scheufele et al., 2006).

In the Decision-Making Model for ANR Science and Technology, perceived opinions of others and perceptions of future trends are expected to have an interaction effect on willingness to expose attitude toward ANR science and technology, which will have an indirect effect on the intent to accept or reject the ANR science or technology. Additionally, each of these variables will serve as a mediator between the innovation characteristics and an individual's attitude toward the topic. Subsequently, depending on the strength of the attitude, a person is expected to be more or less willing to expose their attitude about ANR science and technology. The next and final path of the model addresses how attitudes can be changed.

The final path of the model was derived from the Elaboration Likelihood Model (ELM), which is a comprehensive model used to understand changes in attitude due to persuasive communication (Petty et al., 2009). Attitudes toward agricultural issues will not remain stagnant as people are constantly exposed to new information and messages (Perloff, 2014). Elaboration refers to the amount and depth of thought a person will apply to a communication method or message (Perloff, 2014). The ELM is a dual-process model and accounts for both passive and active processors of information because people will not thoughtfully consider every piece of communication to which they are exposed (Petty et al., 2009).

The two routes in the ELM are the central processing route and the peripheral processing route. An individual will move through the central processing route when motivation and ability are high. Motivation refers either to individuals' involvement with the communication topic or their likelihood to engage in complex thought. If communication can be presented as personally relevant, the receiver of the communication will use greater elaboration to process the information (Fazio & Towles-Schwein, 1999). The ability to process information can be helped or hindered by a number of factors. If a person has high knowledge about a topic, they will have greater ability to process the information. However, if there are too many distractions surrounding communication, ability to process information will be lowered. When motivation and ability are high, an individual can either experience more or less favorable thoughts, depending on the nature of the processing. Meaning, the quality of the argument and the individual's initial attitude can promote or impede changes in thought (Petty et al., 2009). A central attitude change occurs when the change in thought becomes rehearsed and the receiver has time to reflect on the new attitude, thus creating a change in his/her cognitive structure. The central processing route leads to changes in attitude that are resistant to new information, will hold over time, and are predictive of behavior (Petty, Haugtvedt, & Smith, 1995).

Not every piece of communication will be interesting or relevant to an individual. When the motivation or ability to process information is lacking, people will assess information through the peripheral processing route (Petty et al., 2009). Rather than carefully considering the information presented, a person relies on peripheral cues to elicit changes in attitude. These can include the expertise of the source or number of arguments (Petty et al., 2009). People also will use peripheral cues to form attitudes when motivation and ability are high but there is no actual change in their cognitive structure (Petty et al., 2009). Peripheral attitude shifts can easily be influenced by counter information, will not last over time, and are not predictive of behavior (Petty et al., 1995). Changes in attitude are not guaranteed in either route though. If the peripheral cue is not correctly operating or the nature of processing does not produce more or less favorable thoughts, then the initial attitude will be retained (Petty & Wegener, 1998).

The ELM is used often in communication research and has been applied to a variety of contexts. In agricultural fields, researchers have found consumers use the peripheral processing route when exposed to persuasive communication (Goodwin, 2013; Meyers, 2008; Morgan & Gramann, 1989; Verbeke & Vackier, 2004; Verbeke & Ward, 2006). Researchers also have used the model to examine consumers' perceptions toward food-related risks. Frewer, Howard, Hedderley, and Shepherd (1997) explored the role of food hazard type, information source, and persuasive information on consumers' elaboration regarding risk messages about food. Perceptions of risk were found to be lowered when the message came from a government source, but the amount of elaboration used was much more the result of the type of hazard communicated about rather than the information source used. Additionally, as persuasive content increased, so did the amount of elaboration. Thus, ELM was an essential model in assessing risk communication about hazardous food products (Frewer et al., 1997).

Krause, Meyers, Irlbeck, and Chambers (2015) conducted a content analysis of YouTube videos for and against Proposition 37 in California. The bill did not receive enough votes to pass, but if it had, it would have required mandatory labeling of GM food. The majority of sources in the videos opposing the bill were scientists. The researchers concluded consumers likely viewed this positively, which led to effective influence from the peripheral processing route. A study by Ruth and Rumble (2017) used ELM to identify various influences on consumers' attitudes toward GM food after exposure to persuasive communication. Higher perceptions of source credibility and lower perceptions of risk both led to more positive final attitudes after exposure to a message. However, knowledge of GM food science and technology was not found to be predictive of consumers' attitudes toward GM food. Knowledge and facts might not be as important as consumers' values and beliefs when trying to influence attitudes (Ruth & Rumble, 2017).

Walters and Long (2012) used ELM to look at how experts versus novices made judgments about food products after reading nutrition labels. The novice consumers paid close attention to peripheral cues and did not use a lot of consideration when drawing conclusions about the food labels. Conversely, experts used the central processing route when evaluating the food labels and scrutinized the information more than novice consumers. In a study on how supporters and opponents use potable recycled water in Australia, people selectively would pay attention to messages that aligned with their current attitude toward the topic (Price, Fielding, & Leviston, 2012). Additionally, the supporters and opponents did not take the time to critically assess the information that aligned with their personal values (Price et al., 2012).

The final part of the proposed model draws upon ELM to account for *attitude changes* that are the result of *persuasive communication*. If an individual possesses the motivation and ability to process information, he or she will experience a *central* change in attitude (Petty et al., 2009). When motivation and/or ability are lacking, and an attitude change occurs, the change in attitude is *peripheral* (Petty et al., 2009). The change in attitude is predicted to influence *intent to accept or reject ANR science or technology* depending on the strength and direction of the attitude. However, only central changes in attitude are predictive of behavior (Petty et al., 1995), which will be predictive of behavioral *acceptance or rejection of ANR science and technology* rather than only intent. The possibility also exists that the person will experience *no change in attitude* if the communication does not produce more or less favorable thoughts, which loops the model back to the individual's original attitude toward ANR science and technology.

Conclusions, Implications, and Recommendations

The Decision-Making Model for ANR science and Technology was developed to help agricultural educators, communicators, leaders, and extension professionals deliver research-based information to their stakeholders. The variables in the model adapted from the theory of Diffusion of Innovations (Rogers, 2003) and Spiral of Silence (Noelle-Neumann, 1974) will have direct and indirect effects on attitude toward ANR science issues. This attitude will determine the effectiveness of persuasive communication on the individual (Petty et al., 2009). A person's ability and motivation to process the communication, introduced in the ELM, will lead to a potential change in attitude through either the central or peripheral processing route. These changes in attitude could result in a greater intent to accept or reject the ANR science or technology, but only changes in attitude produced via central processing will translate to actual acceptance or rejection (Petty et al., 1995). The third, and final, result of exposure to persuasive communication is no actual change in attitude (Petty & Wegener, 1998).

Research Implications and Recommendations

This model has theoretical value but cannot make a practical impact until it has been further investigated and tested. The multiple components and aspects of the model lead to an array of research opportunities and multiple studies will be needed to validate the model. Quantitative research should investigate how personal characteristics of individuals impact perceptions related to innovation characteristics. Research has already identified the connection between characteristics and general attitudes toward ANR topics (Antonopoulou et al., 2009; Clark et al., 2016; Conko & Prakash, 2005; Hall & Moran, 2006; Gaskell, 2003; Irani et al., 2001; Makki et al., 2013; McKendree et al., 2014; Moon & Balasubramanian, 2001; Ruth et al., 2016), but there is a need to see how demographic and psychographic characteristics influence perceptions of individual innovation characteristics. This type of information will be beneficial when creating communication or education for a target audience. Additionally, understanding how personal characteristics vary in influence across ANR topics will provide agricultural communication practitioners guidance on how to best frame messages for their intended audience.

Future research also should address the connection between innovation attributes, perceptions of others, future trends, and attitudes toward ANR science and technology. While the perceptions of innovation attributes influence attitude (Rogers, 2003), variables derived from the spiral of silence also should influence attitude (Noelle-Neumann, 1974). This interaction can be measured quantitatively, and structural equation modeling should be used to determine the direct and indirect effects these variables have on attitude. Additional research could investigate the role of echo chambers (Knutson, 2016) in attitude development toward ANR science and technology. Current ANR research has been inconclusive regarding the presence of the spiral of silence in online settings (Gearhart & Zhang, 2015; Kim et al., 2014; Porten-Chee & Eilders, 2015), so a deeper understanding of the phenomenon is needed for practitioners to develop strategic communication for online settings. Research also could expand past traditional, self-reported measurements of attitude and use biometrics to explore unconscious perceptions that influence attitudes and acceptance of ANR science and technology.

Understanding the public’s current perceptions and attitudes about ANR science and technology is the first stage in determining how best to disseminate information to stakeholders. Practitioners will need a firm understanding of how persuasive communication impacts attitude, whether it be positive or negative. Research on elaboration is difficult to establish with quantitative methods, but qualitative strategies, like interviews or focus groups, would allow research to assess the amount of elaboration people use when presented with ANR information and messages. Focus groups with purposively selected participants that represent various target audiences would allow researchers to make recommendations about the best type of messages to use depending on the audience characteristics. For people to experience a change in attitude that leads to actual behavior changes, they will need to elaborate upon past experiences and experience a change in cognition using the central processing route (Petty et al., 2009). However, ANR researchers have concluded most people use the peripheral route to assess information related to ANR (Goodwin, 2013; Meyers, 2008; Morgan & Gramann, 1989; Verbeke & Vackier, 2004; Verbeke & Ward, 2006). Researchers should test messages in focus groups and/or in-depth interviews to determine what messages, sources, or communication platforms elicit the greatest amount of elaboration from participants. Purposively selecting participants based on their views toward ANR topics can provide insight into how social pressure influences attitude change or lack thereof. The effects of the spiral of silence could even serve as a distraction for people’s ability to process information, leading to a potential peripheral shift or no shift in attitude (Petty et al., 2009). These research avenues will be instrumental in developing and disseminating information to the public about ANR science and technology, allowing them to make educated decisions on the topic.

Implications and Recommendations for Practitioners

While this model has yet to be tested, it still serves as a theoretical guide for agricultural communicators, educators, leaders, and extension professionals. First and foremost, practitioners should not expect a one-size-fits-all model of education and communication to be effective. Rather, communication and educational campaigns in the ANR industry should be crafted to meet the specific needs of the audience and with an understanding of how that audience currently perceives the topic. Additionally, practitioners should evaluate the current perceptions of their target audience related to each section of the model.

The model segments are interconnected, but areas of weakness should be addressed first to facilitate changes in attitude that will lead to decisions regarding ANR science and technology. For example, if practitioners have identified that the majority of their target audience has negative attitudes toward the ANR science or technology they are introducing or discussing, then their stakeholders will likely demonstrate attitudes reflective of those negative perceptions (Noelle-Neumann, 1974). The issue of how the science or technology is portrayed in the public's eye must be addressed prior to creating communication that simply outlines the science behind the ANR topic. Similarly, if practitioners know that the science they are communicating about is associated with low levels of trialability or observability, that part of the model will need to be addressed first in order to impact attitudes (Rogers, 2003).

The proposed model is not necessarily the definitive solution to public discourse related to ANR science and technology issues, but it can provide practitioners an alternative, holistic approach to their communication and education efforts. After research has been conducted on the model, specific recommendations can be made for practitioners. However, the theoretical foundations for the Decision-Making Model for ANR Science and Technology should provide practitioners with guidance on how to disseminate science-based information to target audiences that will lead to desired changes in attitudes and informed decision-making related to ANR science and technology.

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