An integrated model of communication influence on beliefs

William P. Eveland, Jr.[1] and Kathryn E. Cooper

School of Communication, The Ohio State University, Columbus, OH 43210

Edited by Dietram A. Scheufele, University of Wisconsin, Madison, WI, and accepted by the Editorial Board April 22, 2013 (received for review August 16, 2012)

How do people develop and maintain their beliefs about science? Decades of social science research exist to help us answer this question. The Integrated Model of Communication Influence on Beliefs presented here combines multiple theories that have considered aspects of this process into a comprehensive model to explain how individuals arrive at their scientific beliefs. In this article, we (*i*) summarize what is known about how science is presented in various news and entertainment media forms; (*ii*) describe how individuals differ in their choices to be exposed to various forms and sources of communication; (*iii*) discuss the implications of how individuals mentally process information on the effects of communication; (*iv*) consider how communication effects can be altered depending on background characteristics and motivations of individuals; and (*v*) emphasize that the process of belief formation is not unidirectional but rather, feeds back on itself over time. We conclude by applying the Integrated Model of Communication Influence on Beliefs to the complex issue of beliefs about climate change.

knowledge | learning

Decades of scholarship in communication and related fields have examined the role of mass and interpersonal communication as means by which members of the public acquire information or beliefs about a variety of important topics (1, 2). However, there are several properties of this literature that make it less than ideal for succinctly answering the larger question of how scientific beliefs are formed. First, there is a tendency to focus research on a particular form of communication in isolation from others (e.g., news rather than entertainment or media rather than interpersonal discussion), with an emphasis on media effects. Second, most empirical models offer snapshots of associations among variables (3, 4) rather than consideration of how feedback processes connect communication and beliefs in both causal directions. Third, the models tested often seem to have been developed on the basis of the data available in a particular study rather than on a broader consideration of the theoretical processes involved. In those cases in which the models do seem more comprehensive, they usually eschew formal prediction in favor of offering more abstract frameworks and encouraging data exploration (5). Overall, although there is a wealth of insight and evidence relating communication and beliefs, it tends to be scattered because of emphasis on particular subprocesses rather than emphasis on the whole.

Sociologist Robert Merton [ref. 6, pp. 52–53 (emphasis in original)] argued that "theories of the middle range hold the largest promise, *provided that* the search for them is coupled with a pervasive concern with consolidating special theories into more general sets of concepts and mutually consistent propositions" (6). The current body of research on media selection and impact on beliefs, which has, to date, been relatively circumscribed by focusing attention on subprocesses, would seem to be ripe for a comprehensive effort at theoretical integration. In the spirit of Merton's advice to constantly strive for consolidation and recognizing the steady advancement and contributions of these submodels of communication influence on beliefs, we offer here a synthesis of theory and empirical research across forms of communication—mass and interpersonal, news and entertainment. The result is an Integrated Model of Communication Influence on Beliefs (IMCIB) that we hope will advance our understanding of how people develop beliefs about science.

Preliminary Considerations

A model, as we define it here, "simply represents a portion of reality, either an object or a process, in such a way as to highlight what are considered to be key elements or parts of the object or process and the connections among them" (ref. 7, p. 110). Before presenting the research evidence that we use to build our model, we must first discuss two important decisions that we have made that set boundaries for our efforts. The first decision pertains to the distinction between belief and knowledge; the second decision relates to the deficit approach to science communication.

Philosophers have long debated the boundaries between the concepts of knowledge and belief (8). Rather than engaging in philosophical debates, we briefly address here the similarities and distinctions between beliefs and knowledge from the pragmatic perspective of how we intend to treat them in our model. In the scientific context, Hindman (ref. 9, p. 6) recently argued that "statements of both beliefs and knowledge are intrinsically cognitive processes in that each involves an individual's claim regarding reality. In the case of beliefs, however, the statement is a subjective proposition about the attributes of some aspect of reality."

Given the conceptual overlap between beliefs more generally and knowledge (defined as factually verified or objectively accurate beliefs) and the uncertainty of some forms of knowledge in the domains of science and politics, we do not distinguish between them in our model. This does not mean that knowledge and beliefs should never be distinguished. However, we choose not to do so here, because knowledge and beliefs are likely generated by the same process of exposure to information, be it accurate or otherwise. Imagine, for instance, the beliefs of an astronomer in 1500 about the relative movements of the Earth and sun vs. a comparable astronomer in 2013. A belief that the sun revolved around the Earth in 1500 would be considered knowledge; today, it would be a considered an errant belief instead. However, the belief that the sun revolved around the Earth (in 1500) or that the Earth revolved around the sun (in 2013) may both have been derived, in their respective times, by the identical process of reading a textbook. Of course, we do not mean to deny that some beliefs are clearly accurate, and others are clearly inaccurate by current scientific standards. Rather, we clarify that some beliefs may never be able to be classified as

This paper results from the Arthur M. Sackler Colloquium of the National Academy of Sciences, "The Science of Science Communication," held May 21–22, 2012, at the National Academy of Sciences in Washington, DC. The complete program and audio files of most presentations are available on the NAS Web site at www.nasonline.org/science-communication.

Author contributions: W.P.E. and K.E.C. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission. D.A.S. is a guest editor invited by the Editorial Board.

[1]To whom correspondence should be addressed. E-mail: eveland.6@osu.edu.

accurate or inaccurate, what counts as knowledge can change over time as science progresses, and in any case, beliefs may be derived from the same processes regardless of their accuracy.

As journalist, war propagandist, and presidential adviser Walter Lippmann (ref. 10, p. 2) noted nearly a century ago, "whatever we believe to be a true picture, we treat as if it were the environment itself" (10). Put another way by sociologist W. I. Thomas (ref. 11, p. 572), "If men define situations as real, they are real in their consequences" (11). In short, people act on the basis of their beliefs, regardless of whether these beliefs are considered factually accurate by some external judge. Nonetheless, much of the literature from which our model is built makes the distinction between knowledge and belief, and thus, we cannot entirely avoid the use of the term knowledge as defined as a factually accurate belief.

By defining the end point of our model as beliefs, we avoid critiques regarding the deficit approach that have characterized recent discussion of science communication. The deficit approach (12–14) implies that there is a lack of accurate public knowledge about science and that improvements in public knowledge of science should increase attitudes, such as public support for science and positive evaluations of scientists. By emphasizing beliefs and thereby, leaving accuracy assessments and attitudes to others, our model is agnostic regarding the validity of the deficit model. Rather, our model may be built on from either a deficit approach (by making assessments of the accuracy of beliefs and then extending the model from knowledge to attitudes) or its many alternatives (by integrating our model of belief formation with models of attitude formation, such as the Theory of Reasoned Action or the Theory of Planned Behavior) (15). Nonetheless, we do take the position that accurate beliefs about science are normatively preferable to inaccurate beliefs, regardless of their implications for attitudes.

With these preliminary considerations addressed, we now begin our review of the extant literature on the role of communication in the development of beliefs.

Patterns of Scientific Information in Media Content

Measuring the content and quality of interpersonal discussions about science in the real world is a difficult task. In fact, generalizable studies of the content of everyday scientific discussions do not exist. At best, scholars might describe interaction in a science museum (5) or a particular classroom (16), the results of a researcher-organized focus group discussion (17), or even the content of an online discussion forum (18). Although useful for specific research purposes, unfortunately, these examples are not necessarily representative of the wide variety of contexts in which discussions about science occur, which include but of course are not limited to discussions of DNA testing while watching *CSI*, discussions of science policy reported in a newspaper while having coffee at the office, and health discussions while ordering fried food at a restaurant. We must, therefore, leave aside any meaningful summary of the nature of interpersonal interactions regarding science.

By contrast, there have been hundreds of studies of mass media content in recent decades, many of which offer valuable evidence about how—and how much—scientific information is presented to the public. Most current media learning models (19–21) implicitly assume that news coverage is roughly uniform and accurate, and therefore, they predict that any information exposure will increase the factual accuracy of public beliefs. Of course, this assumption is not always true, especially for socioscientific issues (i.e., issues such as stem cell research that may involve an ethical component). Therefore, those individuals concerned with the accuracy of scientific beliefs must assess the amount and quality of news coverage of scientific topics as well as the extent to and accuracy with which scientific information is portrayed in entertainment media.

The news media act as scientific gatekeepers between research findings published within the academic community and the wider public. Less than 0.5% of science journal articles receive attention from the news media, and articles about health and medicine garner the bulk of this coverage (22). News coverage of scientific topics varies by medium of delivery—newspapers, magazines, and television news—as well as by specific news source. For example, local newspaper attention to cancer research varies substantially across geographic communities in terms of both the amount of coverage and its emphasis (23). Other aspects of reporting about cancer causes and prevention differ between local television news and newspaper coverage (24). Possibly most importantly, Slater et al. (ref. 25, p. 534) find "numerous disparities between cancer news coverage and the realities of the disease in the United States" (25).

The available evidence suggests that these findings regarding cancer news are likely to be consistent across scientific topics. For example, climate change scientists consider print news reports to be more informative than cable news about this topic (26). Coverage of a scientific issue will often vary over time as well, which has been indicated in research on news coverage of nanotechology (27, 28) and stem cell research (29). Thus, we cannot assume that different news media forms convey wholly accurate or even similar science-related information. Indeed, how media present a given scientific issue is an empirical question that must be carefully answered for any topic of interest.

Scientific information is also available in novels, on television, and through various other forms of entertainment media, although there is considerably less research on the quantity and nature of this information. Nonetheless, these portrayals warrant consideration, because the artistic license often taken by entertainment media can make inaccurate science seem realistic. For example, television crime dramas such as *CSI* portray the use of DNA evidence as more reliable, routine, and crucial within the criminal justice system than it actually is (30). However, environmental topics are rarely presented during prime time television programs, thus reducing awareness of these issues (31). Much of the research on entertainment portrayals of science emphasizes the characteristics of scientists and the sort of work that they do (32), often stressing how women and minorities are underrepresented (33) and the extent to which the depicted scientists are fundamentally good or bad (34).

Patterns of Selectivity in Media Exposure

Understanding how science is portrayed differently across media forms is important, in large part, because we know that individuals often actively choose media to meet their particular needs and interests. These choices are frequently linked to important background characteristics, such as education or employment, either directly or indirectly through the impact of the background characteristics on interest in or involvement with a particular topic (35, 36). We also know that both individual and societal patterns of media use change over time, such as in the decline of traditional print newspapers (37) and network television news (38) and the growth of online news and partisan cable news outlets (39). Therefore, we must first understand how people selectively use certain media (particularly, news media) before we can understand the nature of media influence on beliefs.

We know from decades of research (as well as recent survey data) (39) that sociodemographic variables are associated with the media that people choose to consume. For example, individuals with higher incomes and more education are more likely to read newspapers, whereas individuals who are less well off and have lower levels of education are equally or even more likely to use television news sources (37). There are also clear trends to partisan selectivity in news and opinion sources, such that liberals are more likely to view left-leaning programs and conservatives are more likely to view right-leaning programs (40). Younger

adults are more likely to get their news from programs like *The Daily Show*, whereas older adults are more likely to use network television news or newspapers (41). Education, income, male sex, and age are also positively related to the general tendency to prefer news over entertainment (42), although these differences are most dramatic for age (with younger adults showing a greater preference for entertainment over news).

Evidence of Media Impact

The past 50 years of communication and social science research have revealed that the mass media can impact our thinking in a variety of ways. Over time, many theories, models, and hypotheses have sought to explain how communication influences beliefs. Below, we briefly summarize both recent promising advances as well as longstanding approaches that have stood the test of time. In our discussion of these theories and models, we retain the authors' original terminology and logic with regard to the distinction between knowledge and beliefs. In the subsequent section, we will synthesize these ideas into an IMCIB, and in so doing, we make modifications to emphasize belief outcomes.

Cognitive Mediation Model. The cognitive mediation model (19, 43) draws our attention to the importance of motivations in driving the level of information processing in which individuals engage when they are exposed to media and the importance of information processing in the process of learning from media. The model points out that motivations alone cannot produce knowledge; they only produce knowledge by encouraging attention to and elaboration on relevant media content, which increases the likelihood of storage in memory and the later ability to retrieve the information. Evidence indicates that knowledge gained from media use ultimately facilitates future processing of new mediated information (44). This model has been successfully applied to the health context (45).

Knowledge Gap. The knowledge gap hypothesis (21) predicts that the impact of media messages on knowledge and beliefs will not be uniform across all segments of society. Rather, mediated information tends to be more rapidly and effectively learned by those individuals who are higher in socioeconomic status (SES), with formal education typically viewed as the central component of SES. The knowledge gap, thus, predicts that education both drives communication (media use and discussion) and moderates the effects of communication, with greater communication effects for those individuals with higher education. As a result, the differences in knowledge between those individuals of higher and lower SES may be magnified over time. Subsequent research has shown that motivation may function in a role similar to SES, suggesting that, rather than deficits in knowledge produced by SES, the reality is simply differences in usefulness of information based on needs and desires that are a product of SES (46). Research continues to test and advance the knowledge gap hypothesis, and there is meaningful evidence that, although some forms of communication may exacerbate gaps, other forms may close them (47).

Cultural Cognition/Belief Gap. Theories of cultural cognition consider the role of values in moderating media influence (48). Cultural cognition assumes that individuals are cognitive misers, meaning that they attempt to use the least possible mental effort to achieve a given aim (48, 49). Thus, individuals rely heavily on cultural schemata to process new information. They are the mechanisms by which values shape and bias thoughts. As a result, those individuals with opposite values (e.g., Democrats vs. Republicans) may react divergently to the same media messages, because they will adjust new information to their already held values (50). A similar approach is the belief gap hypothesis (9, 51), which is a variation of the knowledge gap hypothesis that shifts the source of differential effects from SES to political ideology. The belief gap hypothesis argues that, as scientific issues become politicized, greater media attention to those issues will lead to increasingly different beliefs about them depending on one's political ideology.

Differential Gains/Intramedia Interaction. The differential gains hypothesis (52) predicts that the influence of media use is partly determined by the presence or absence of related interpersonal discussion. That is, discussing topics encountered in the media should lead to better understanding and recall of the media information than exposure to media content-absent discussion. The intramedia interaction hypothesis (53) suggests that the impact of media use across different sources and channels should not be viewed as a simple process of additive effects, with each additional source of news being used adding an additional increment of influence. Rather, the impact of using any given source (e.g., ABC vs. NBC vs. CNN vs. Fox News) or form (e.g., CNN vs. CNN.com) of media may depend on which other forms of media (if any) are also being used. Use of redundant sources should lead to diminishing returns rather than additive effects, whereas the use of diverse or complementary sources should lead to additive or possibly even synergistic effects.

Intramedia/Intracommunication Mediation. The notion of intramedia mediation (20) draws our attention to the fact that communication forms should not be treated as being in competition with one other as independent contributors to media effects, but rather, they should be viewed as working together to produce them. In particular, use of one form of communication may often drive the use of other forms of communication, and thus, the impact of one form of communication may be simultaneously direct on a given belief and mediated by—that is, occurring through—engaging in other forms of communication. For example, an individual may notice a story about a scientific discovery in the evening news that piques her interest. The next morning, she searches the science section of the local newspaper to find more detail—or maybe, an alternative way of thinking—about the implications of the discovery. Here, not only did the exposure to television news potentially have some direct impact on her beliefs, but it also prompted additional exposure through another media form that itself may have had some impact on her beliefs. Therefore, rather than media forms being in competition with one another (such that the question becomes "which is more effective at influencing beliefs: television news or newspapers?"), the use of different media forms should be seen as having both direct and indirect (through encouraging additional information-seeking behavior) effects on beliefs.

The notion of intramedia mediation has been expanded to the relationship between mass media use and interpersonal discussion under the label intracommunication mediation. That is, the effects of mass media may occur by prompting discussion that ultimately alters beliefs; alternatively, anticipated discussion of a given topic may encourage preparatory media use, which itself alters beliefs (54). Revisiting our example from above, the woman who saw the story about the scientific discovery on television news one evening may also approach a colleague over coffee and attempt to share information from the story, solicit an opinion about the story, or debate its implications, all of which can facilitate the formation and strengthening (or possibly weakening) of beliefs. Also, she may choose to pick up and read the morning paper in anticipation of having lunch with a colleague who she expects to bring up recent developments in science. In support of intracommunication mediation, research has shown that exposure to science news can promote later conversations about science (55).

Reinforcing Spirals. The reinforcing spirals model (56) draws our attention to the reciprocity between media selection and effects. In the present context, it would suggest that, although media use can influence scientific beliefs, particular beliefs can also influence amounts of media use as well as prompt selective exposure to certain types of media messages. The reinforcing spirals approach has recently been applied to media use and beliefs about climate change (57).

Extended Elaboration Likelihood Model and Entertainment Overcoming Resistance Model. The extended elaboration likelihood model (58) highlights the wide range of motivations that individuals may have for selecting different media forms and the implications of these motivations for how the media messages are processed. Importantly, it draws our attention to how different media message types may be approached differently by their audiences and the implications of these differences for persuasive effects. The entertainment overcoming resistance model (59) builds on the extended elaboration likelihood model to explain how the features of narrative media content (such as fictional television and movies) can overcome resistance to embedded persuasive messages. When individuals are aware of persuasive intent, they are more likely to resist the message through reactance (resisting perceived pressure to change) and counterarguing (the production of thoughts that contradict a persuasive message) (59). Entertainment media that contain persuasive messages can reduce these forms of resistance through greater involvement with the narrative (58). This involvement facilitates the development of message-consistent beliefs, especially in audiences otherwise predisposed to disagree with the message.

Cultivation. The cultivation hypothesis (60) predicts that the more time that individuals spend in the television (or more generally, media) world, the more that their beliefs about the nature of the real world will be similar to the content of the media world. Thus, the hypothesis predicts that heavy use of media will be positively related to holding media-consistent beliefs, regardless of whether these media representations of reality are objectively correct. Scholars have found value in the cultivation approach for understanding media influence in many contexts, including science (30).

Integrated Model of Communication Influence on Beliefs

Each of the theories, models, and hypotheses discussed above addresses important aspects of how the process of communication affects our beliefs, and each has received at least a moderate degree of support in the existing literature. Although there are some redundancies across these models and theories, each also makes a unique contribution to our understanding of communication processes and effects. What is limiting, however, is that there is insufficient integration of these models into a more comprehensive—but still parsimonious—model of communication effects on beliefs. In the remainder of this article, we show how the extant models can be integrated into a whole to increase our understanding of the larger processes and cognitive effects of communication about science.

We begin by noting that all of the key variables in these models can be classified into one of four major categories. The key outcome (right side of model) is the generic concept of beliefs, which may be objectively accurate, objectively inaccurate, or unable to be classified as either. On the far left of the model are the most distant and potentially stable root causes of beliefs (and communication exposure and processing), which we loosely label priors. The middle of the model is dominated by communication. We divide communication into two components: exposure to communication messages in the form of mass media use and interpersonal discussion and processing of those messages by counterarguing against and elaborating on communication content. A detailed visual model is presented in Fig. 1.

Priors. In our integrated model, we begin by considering some longstanding and often stable factors that are likely to have at least indirect influence (through communication exposure and processing) on beliefs. First, sociodemographic factors, such as sex, income, race, and especially, level of formal education, are fundamental and require consideration. Less longstanding but still relatively stable factors include basic values, such as political ideology. Finally, we include motivations, such as interest in a

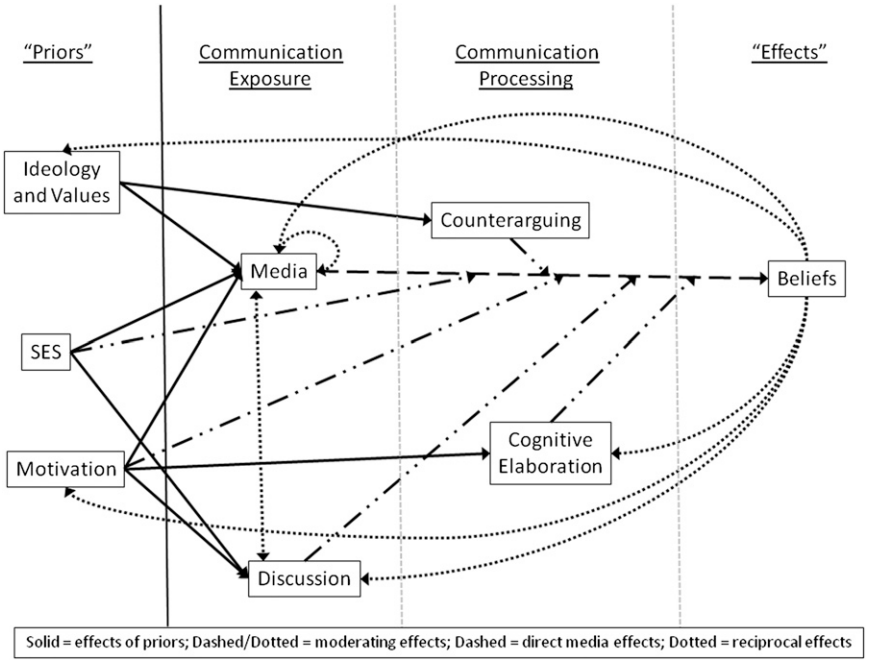

Fig. 1. The IMCIB.

particular topic, as well as structural factors, such as topic relevance for employment, and even short-term goals, such as a desire to make an accurate decision (e.g., for an election or purchase).

Although some of these variables could directly impact beliefs, their dominant influence is likely to be as causes of communication exposure and processing or variables that could alter—by amplifying or inhibiting—the impact of communication exposure and processing on beliefs. We would expect that exposure and processing will be driven by the motivations, demographic characteristics, and values of individuals in accordance with the findings presented earlier. For example, people interested in science with higher levels of education are more likely to read about and discuss science topics than are those individuals lacking science interest. They should also be more likely to invest mental effort in elaborating on those messages and would be more capable of counterarguing messages inconsistent with their beliefs. Similarly, such individuals are more likely to be exposed to information that is consistent with their values, and they are more likely to counterargue information that is inconsistent with their values.

Direct Communication Effects. Our primary theoretical emphasis is the communication exposure and processing that most proximally influence beliefs. We would anticipate some simple and direct effects of exposure to mass media sources, such as news and entertainment (as well as interpersonal communication) on beliefs as long as the media sources addressed content relevant to the beliefs being studied. That is, direct effects must be clearly tied to the nature of communication content as described above, and any study of media effects on science beliefs must begin with a clear, empirical picture of (or at bare minimum, very explicitly stated assumptions about) the nature of media content. For instance, there would be no reason to expect exposure and processing of news to affect beliefs about global climate change if there was no evidence for at least some minimal news coverage of the topic. By the same token, there would be no reason to expect direct effects of exposure to entertainment programming depictions of scientists to produce accurate beliefs about scientists if the entertainment content portrayed scientists in an inaccurate manner.

Mediation Processes. Despite the likelihood of some direct effects, we would expect many of the effects of communication exposure to be mediated. First, most exposure effects are likely mediated through processing of the communication messages, although we acknowledge that some learning is automatic or unintentional. Second, use of one form of communication has implications for engaging in other forms of communication. Often, exposure to communication in one mediated form (e.g., television news) can stimulate exposure to additional media sources (e.g., online news) to obtain additional information or confirmation. Third, mediated information is commonly viewed as a stimulant for interpersonal communication just as the anticipation of future conversation can motivate mediated information-seeking behavior to gather information for use in those discussions. These complex mediation processes are more critical to understanding communication effects than simply seeking to identify (in a competitive manner) the unique impact of any given form of communication pitted against all others.

Moderation Processes. We would expect that exposure to some forms of communication would be more effective in producing learning among particular subgroups, such as individuals with higher SES or higher levels of motivation. We also would expect that media would be more effective in communicating information that is consistent with preexisting values, partly because of selective exposure but also because of the fact that people are more likely to counterargue messages that disagree with their prior values. However, counterarguing should also vary depending on the format of the message (entertainment vs. news vs. explicitly persuasive messages, such as advertisements or opinion programs). Additionally, counterarguing should moderate the impact of exposure on beliefs, such that the impact of a given unit of exposure will be weaker in the presence than absence of counterarguing.

The use of different communication forms should also alter one another's impacts. Media exposure effects should be amplified when accompanied by related interpersonal discussion. Exposure to primarily redundant media sources should lead to diminishing returns of exposure to each new source, whereas exposure to complimentary media sources (such as one providing useful verbal contextual information in conjunction with one providing dramatic visuals) could produce synergistic effects, in which the influence of media as a whole is greater than the sum of the influence of its constituent parts.

Reciprocal Causality. Many of the processes described above as unidirectionally causal are, in fact, systems at least partly influenced by feedback loops. Building a store of relevant beliefs facilitates understanding and processing of similar future messages and thus, learning. The development of communication-derived beliefs also may alter (however slowly) one's underlying values or ideology or at least, one's future communication exposure. Thus, in a reciprocal causal model such as this model, there is no need to directly refer to concepts such as prior knowledge or prior beliefs, because they are incorporated by the reverse causal pathways between beliefs and media use, discussion, elaboration, motivation, and ideology. In summary, although our primary emphasis is to understand communication effects on beliefs, it would be unwise to ignore the implications of prior beliefs as well as communication processes and effects for subsequent values, motivation, and communication.

IMCIB in Context: Global Climate Change

To show the broad scope of the IMCIB, in this section, we emphasize a single scientific topic—climate change—and we show where the IMCIB would focus our attention and elaborate on the predictions that it would make. We hope that this example will clarify the implications of the IMCIB for scientific topics.

Several sociodemographic factors may influence beliefs about climate change. Higher income, being female, being African American, and being younger each predict the belief that climate change is occurring (61–63). Public forums and discussion of climate change science can also be used to increase people's belief in their own vulnerability to its effects (64).

Research indicates that the belief gap about climate change between Democrats and Republicans has increased over time, with greater climate change skepticism among Republicans than Democrats (65). Prior attitudes, such as partisanship or ideology, can strongly bias how individuals process climate change information through selective exposure (66). As a result, equally intelligent citizens may use the information that they have received through communication to support their own value predispositions, thus expanding ideological belief gaps (51, 67, 68). When individuals are motivated to discount messages that contradict their prior beliefs, they will invest effort into mentally denigrating and counterarguing this incongruent information, thereby reaffirming their current position, regardless of the message (69). In addition, values can bias assessments of the degree of scientific support for human causes of climate change; people overestimate the degree of certainty about and support for positions that are congruent with their value predispositions (50).

Differences in climate change beliefs between Democrats and Republicans are greatest among the most highly educated (70). This increased polarization occurs because more highly educated individuals are more likely to possess the contextual information and mental schemas necessary to acquire, judge, counterargue,

and integrate new information (71). The belief that there is scientific consensus about human causes of climate change can also motivate increased information-seeking behavior about the polar regions (57). For instance, the global warming movie *The Day After Tomorrow* (and likely, the corresponding marketing for the movie) seems to have increased the use of websites related to global warming (72).

Education and individual values may not only drive these variations in beliefs but also interact with systematic differences in media content (62, 73). For example, conservative outlets, such as Fox News Channel, tend to emphasize climate change skepticism more than other news outlets, such as CNN and MSNBC (61). Therefore, as Americans increasingly self-select into political news outlets that conform to their ideological predispositions, polarization in climate change beliefs also increases (57, 74). This effect is an example of the reciprocal causality suggested by the reinforcing spirals model—skeptical climate change messages on Fox News may cause viewers to adopt these beliefs, and viewers who are already skeptical about climate change may choose to watch Fox News, because it expresses views that agree with their own values (75).

Cultivation research indicates that environmental content in primetime entertainment television has declined in recent years and argues that this deficiency causes symbolic annihilation (31, 76). By not showing environmental problems, the mass media are promoting the perception of a reality in which problems, such as climate change, are minimal or do not exist. Thus, heavy entertainment television viewers may have less accurate beliefs about environmental issues, regardless of ideology (77). However, environmental messages embedded within entertainment programs may be more effective than overtly persuasive messages for audiences predisposed to disagree with them, because entertainment media tend to reduce both reactance and counterarguing (59).

Comment on Empirical Applications of the IMCIB

Our primary goal in the IMCIB is to address matters of theory and theoretical integration. However, we believe that it is necessary to also briefly discuss matters of method, because this model must ultimately be tested as a whole using empirical data. The data requirements to test the IMCIB are substantial. Clearly, traditional experimentation could only address a few subcomponents of the model at a time and thus, is more appropriate to provide evidence for the models from which our integrated model is derived. Survey evidence would seem to be most effective at testing our model as a whole. However, considerable hurdles in testing the model exist, even with survey data.

First, measurement is an important consideration. There are meaningful questions to be raised about the validity of survey self-reports of the cognitive processing of communication (78). Even the measurement of simple communication exposure using typical survey methods has been (fairly) critiqued on grounds of reliability and validity (79, 80). These measurement issues and others need to be addressed for us to have good faith in the results of any test of the IMCIB.

Second, given its many reciprocal pathways of causal influence, the ideal test of the IMCIB requires some sort of panel design, in which survey data are gathered from the same individuals at least two or more times so that a time order between cause and effect may be established. One important question begged by panel designs is what is the appropriate time lag (or delay) between waves of measurement? This question should be answered based on theorizing regarding how long each effect in the model may take to manifest and how long any effects that do appear might take to dissipate (81). When the timing of these theoretical processes varies depending on the specific causal path considered in the model (like they are likely to do in any complex model such as the IMCIB), difficult tradeoffs must be made in the design and implementation of the panel study.

Third, we must be cautious in assessing any simultaneous statistical model that attempts to test all of the subhypotheses of this model. We would argue for a model comparison approach that would clearly specify a set of competing theoretical models in advance (the IMCIB being one model) that could be tested against one another rather than simply empirically deriving a good-fitting model from a single data source. In doing so, scholars must also be attentive to the fact that some sorts of effects—specifically, interaction tests—are much more difficult to observe in survey data than experimental data (82). We must not throw the proverbial baby out with the bath water, especially in a model such as the IMCIB, which gains most of its sophistication by reference to moderated effects. Therefore, we must ensure that, before rejecting any model, it is given a fair test. Overall fit statistics are likely to be less relevant than comparative fit indices for competing models.

Despite its complexity, for simplicity's sake, we have limited the IMCIB primarily to individual-level variables. We leave for future theorizing the role of factors such as network structures and community-level influences on media content and individual influence processes. We know, for instance, that aspects of community structure and community conflict have implications for knowledge gap processes through their impact on individual motivation as well as the availability of information in the mediated environment (83). We also know that the structure of one's community (84) and one's communication network (85) can affect the impact of interpersonal communication on information flow. One might think of these contextual effects as the background environment within which the IMCIB operates. However, the reality is much more complex because often social contexts, such as the political system (e.g., democratic vs. autocratic) or the media system (e.g., commercial vs. public) may serve to alter the nature of relationships between any of the variables in the model. Moreover, context exists at not only the level of social or media systems but also lower levels, such as reference groups, local communities or regions, and even social networks and family groupings. Therefore, the absence of clearly specified macrostructural and other contextual variables in the IMCIB is a limitation that should be addressed in future theorizing and empirical efforts.

The IMCIB is also limited by its (implicit) emphasis on adult learning in a particular cultural context. The process of belief formation may vary considerably among nonadults based on variations in cognitive development. Moreover, we acknowledge that most of the data on which the subprocess models have been built have been tested using individuals from Western, educated, industrialized, rich, and democratic cultures (86). Future scholarship should endeavor to extend the IMCIB to accommodate a more diverse human population in terms of both age and culture.

Summary and Conclusion

The influence of communication on belief formation is complex. Any model that attempts to capture these complexities needs to address matters of the differential exposure to diverse content as driven by diverse motivations, the implications of accelerants and inhibitors of the learning process, the implications of intermediate steps that are necessary for learning, and the implications of feedback loops. To date, most communication effects models have emphasized only a small part of this complex process, and empirical work to test these isolated models has, thus, ignored other important variables that play a role in the process. Therefore, considerable research must be done to confirm that any of the individual submodels described in the IMCIB actually operate as predicted when situated within the larger communication process.

The IMCIB pulls together these diverse strands of research and makes explicit predictions regarding the implications of communication for the development of beliefs—be they accurate or otherwise—that correspond to the content of the communication. In doing so, it makes clear some of the challenges facing not only researchers who study communication effects but also those communicators who hope to increase the accuracy of the public's scientific beliefs.

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