Chapter 4
Attitude Change and Polarization

Abstract A key reason for conducting public engagements around science and innovation policies is to find out what the public thinks and feels about those policies and the innovations themselves. However, some scholars have suggested deliberation can create attitude polarization, which could be a barrier to effective group decision-making and social progress. Thus, it is important to know when, if, and why processes lead to polarization. In this chapter, we examine individuals' attitudes toward nanotechnology and describe whether and how they are impacted by the design of public engagement. We focus particularly on the degree to which individuals' attitudes change and perhaps become more extreme, as a function of deliberation. We find that for the most part, the average of participants' attitudes toward nanotechnological development shifted toward being slightly more cautious over the course of the semester during each study we conducted, although other significant patterns of attitude change were evident among individuals. The features of deliberation that most consistently influenced attitudes were critical thinking prompts and information formatting, such that encouraging critical thinking and presenting information in a way that presented multiple perspectives often led individuals to take on more cautious views toward nanotechnology. Other features commonly theorized as having important consequences for deliberation showed mostly no effects, and we found little evidence of attitude polarization, a phenomenon feared by many scholars who have remained skeptical of deliberation. However, the degree to which group dynamics during deliberative discussion (specifically, group homogeneity) influenced attitude change and polarization was moderated by the personality variable trait of openness. Those high in openness were the least likely to experience attitude extremitization (attitude change in the direction of becoming more extreme) in attitudinally heterogeneous groups but the most likely to experience attitude extremitization in attitudinally homogeneous groups.

Keywords Attitudes · Attitude change · Homogeneity · Heterogeneity · Benefits versus risks · Common ingroup identity model

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4.1 Introduction

One of the main reasons researchers and public officials may want to conduct public engagements is to discover what the public actually wants when it comes to science and innovation policy. For many, scientific discovery and technological development may not necessarily seem like democratic ventures, but there are few scientific or technological advances that would have been possible without some degree of support from the public.

We need look no further than the case of genetically modified organisms (GMOs) in the USA and Europe to see how vital public support is to an emerging technology. GMOs are organisms whose genetic material has been altered in some way via genetic engineering, and they have been around since the 1970s (although some have argued that selective breeding, which has existed since 12,000 BC, is a form of genetic engineering; see Kingsbury, 2009). The applications of GMOs include medical research, the production of pharmaceutical drugs, development of biofuels, and plant and animal conservation, but the most controversial application of GMOs is in agriculture and food production. The scientific consensus is that GM foods are no more likely to cause harm to humans than other foods (e.g., Alessandro, Manzo, Veronesi, & Rosellini, 2013), and GM foods have provided nutrients for millions of people who otherwise would be severely malnourished (e.g., FAO). However, the public remains far more skeptical about GM foods than scientists in the USA and Europe (Funk & Rainie, 2015; Marris, Wynne, Simmons, & Weldon, 2001). This skepticism is surely driven in part by a lack of knowledge about what GMOs are, but it is also driven largely by individuals' values and moral learnings (Kam & Estes, 2016; Scott, Inbar, & Rozin, 2016). Further, some people's opposition to the use of GMOs in food seems driven not by concern over the health effects of GMOs but instead by ideological concerns such as perceived overreach by the government or the possibility of monopoly by large corporations invested in GMOs (Dewey, 2017). Ultimately, public opposition to GM foods has had substantial policy implications. Twenty-eight countries in the European Union (EU), as well as 36 other countries, require GM foods to be labeled as such, and 19 countries in the EU have "opted out" of growing GM crops. The US Congress recently passed a law mandating that information be made available regarding whether foods use GMOs (Charles, 2016). Laws mandating that GMO foods be labeled are not mere inconveniences for companies developing and using GMOs. These laws may have a significant impact on the consumption of GM foods in developed countries as well as on the distribution of GM foods to underdeveloped countries (The Economist, 2014), and proposals to ban the production of GM foods continue to spring up across the USA (Karlamangla, 2014).

Although the success of new technologies depends upon public acceptance and support (discussed further in Chap. 5), the lack of scientific knowledge and literacy among citizens (discussed in Chap. 3) makes it difficult for opinions to be developed and clearly expressed and for policymakers to decide how seriously to take public opinion in the first place. Even when citizens form opinions about science or

technology, the issues often become politicized, leading to attitude extremity and polarization (McCright & Dunlap, 2011; Kahan et al., 2012; Lewandowsky, Gignac, & Oberauer, 2013). Members of the public often lack the familiarity with new technologies needed to grasp both its benefits and its risks, and views toward regulations are often politicized, hijacked by political rhetoric, and defined in extremist terms. Extreme views, which are far from unrepresented in the contemporary USA (e.g., McCarty, Poole, & Rosenthal, 2006), can yield polarization even over otherwise non-political issues. With polarization comes gridlock, which can stifle scientific and technological development as well as prevent policymakers from implementing effective regulations. For these reasons, scientists, investors, and policymakers are wise to be concerned with finding ways to measure public opinion toward science and technology, guiding development in a way that takes into account public opinion, and perhaps even developing engagement strategies that encourage citizens to adjust their attitudes based on new and accurate information.

As discussed in Chap. 1, scientists and policymakers have increasingly turned to public deliberations as a means of addressing a variety of concerns about democratic engagement, and among these concerns is the potential for polarization over controversial issues related to science and technology. The hope is that by getting citizens together, informing them, and having them hash out their differences, the public as a whole can come to a more enlightened, reasonable consensus and move forward accordingly. However, a substantial body of research in psychology, communications, and political science suggests we should question whether this is really what we should expect when citizens deliberate. It may be the case, for instance, that certain features of deliberation lead people to take sides, to become more extreme in their original views, or conversely even to acquiesce to a less informed, suboptimal opinion in response to conformity pressures.

In this chapter, we explore the effects of various features of deliberation on attitude change and polarization. The ways in which the features and context of a deliberation influence participants' views of the issue at hand should be a central concern of researchers and policymakers interested in scientific and technological development because these issues often have been shown to be easily politicized. Climate change, vaccinations, stem cell research, genetically modified organisms (GMOs), and even evolution are examples of science and technology issues that have been significantly impacted by public discourse, disagreement, and polarization. Properly designed public deliberation might represent an avenue for researchers and policymakers to avoid the pitfalls of a polarized public, but first we need to better understand how different features of deliberation influence people's attitudes.

The results of our analyses call into question some of the assumptions about the roles of various commonly used features of deliberation. The modal outcome of our experimental conditions is no effect on attitudes, although there are some cases in which we see indications of a pattern. The conditions that resulted in significant attitude change most often were those aimed at encouraging critical thinking in some way, but these effects were sporadic and did not occur in the majority of cases. These findings may be interpreted optimistically, because we did not find much evidence of adverse changes such as polarization or extremitization. However, we also did not find any

evidence of conditions leading to "positive" outcomes. Counter to what many deliberative theorists would suggest, discussing nanotechnology in groups did not produce any significant changes in aggregate attitudes compared to simply deliberating about the issue on one's own, suggesting the positive impacts of discussion may be overstated.

4.2 The Effects of Deliberation: Unification or Polarization?

When is it that we should expect scientific and technological development to be welcomed with open arms versus shunned or even actively resisted with fear and skepticism? When should we expect deliberation to lead individuals to consensus versus polarization? What, if anything, should we expect to happen to people's attitudes when they are asked to deliberate about issues of science and technology? Over the last few decades, scholarship in psychology, communication, and political science has made some headway in shedding light on the answers to these questions. However, the conclusions of this scholarship have been somewhat mixed. Many of the large-scale deliberations conducted by scholars have shown substantial attitude changes via deliberation toward more well-informed opinions that resemble those of experts (e.g., Fishkin, Iyengar, & Luskin, 2005; Fishkin & Luskin, 1999; McLean et al. 2000), but it is often difficult to disentangle what exactly changed opinions, and quite different patterns of attitude change have been found in smaller-scale studies on the effects of group discussion. This suggests the relationship between deliberation and attitudes is more nuanced than simple analyses might imply. What we do know is that deliberations do not have a single, universal effect on people's attitudes. Context matters (Delli Carpini, Cook, & Jacobs, 2004), even if we do not yet fully understand why or how (Chap. 1). Below, we outline the existing theories and research that pertain to deliberation's "good" or "bad" effects on people's attitudes.

4.2.1 The Promises of Public Deliberation: Informed, Enlightened Consensus

The point of view that the possible benefits of deliberation outweigh the possible harms emanates predominantly from the theoretical arguments of deliberative theorists. Dewey (1927) argued that without the communication offered through public deliberation, apathy and self-serving biases would leave the public divided as citizens walled themselves off into disparate echo chambers. Although it is never argued that consensus will or should be the universal result of all deliberation, it is believed that exposure to new information and a diverse set of viewpoints through deliberation will or should lead to some degree of open-mindedness and engagement with alternative perspectives (see also, Chambers, 2003; Gutmann & Thompson, 1996;

Habermas, 1996; Fishkin & Luskin, 1999). At the least, according to some deliberative theorists, deliberation should lead people to come to terms with the idea that some level of disagreement is inevitable, and thus people will become more likely to tolerate opposing views (Cohen, 1998). In terms of individuals' attitudes, then, many deliberative theorists would suggest that deliberation gives people the tools to incorporate alternative opinions into their own.

Some research has shown that deliberation—or at least the exposure to information as part of the deliberation, as discussed in Chap. 3—increases factual knowledge and, thereby, presumably informed opinions. Across the world, Fishkin and Luskin have implemented "Deliberative Polls™," in which representative samples of the population are brought together to discuss public matters, question experts, and vote on critical issues. In the majority of cases, they have found evidence of increased knowledge and what seems to be well-informed consensus (Fishkin, Iyengar, & Luskin, 2005; McLean et al. 2000; see also, Price & Cappella, 2002). Other research suggests that participants may become more cooperative. Psychology research on small group discussions has demonstrated that face-to-face communication increases intragroup cooperation by allowing individuals to express their willingness to cooperate, gauge others' willingness to cooperate, and draw connections between their own interests and the group's interest (e.g., Bornstein, 1992; Bouas & Komorita, 1996; Sally, 1995; see Delli Carpini, Cook, & Jacobs, 2004) .

4.2.2 Deliberation's Downfalls: Motivated Reasoning and Polarization

The calls for skepticism regarding the effects of deliberation on attitudes are grounded primarily in social psychological theories. Skeptics of deliberation point to several psychological phenomena that suggest deliberation may do more harm than good. One psychological mechanism that runs counter to deliberative ideals is motivated reasoning, wherein individuals search for information that confirms their pre-existing beliefs in order to mitigate the cognitive dissonance (Festinger, 1957) that arises when information contradicts beliefs (Bodenhausen & Macrae, 1998; Schulz-Hardt, Frey, Luthgens, & Moscovici, 2000; Taber & Lodge, 2006). The concern this raises is that when individuals are exposed to alternative viewpoints through deliberation, they will double down on their pre-deliberation opinions, thus becoming more extreme in their views. This effect has been found in some studies that involved group or interpersonal discussion, albeit not structured deliberations (Mutz, 2006; Tetlock & Kim, 1987).

Other possible effects of deliberation that could be thought of as deleterious have also been considered by skeptics of deliberation. For example, some have cited research on group conformity pressures to suggest that although deliberation may cause individuals' attitudes within groups to move closer to one another, this consensus may be suboptimal if it is simply a reflection of the majority's

pre-deliberation opinions and not influenced by new and relevant information (Isenberg, 1986; Myers et al., 1980). The "consensus" reached through discussion may even be disingenuous as individuals wish simply to avoid conflict and maintain a positive image in the group (Davis et al., 1989). Further, as opinions within groups conform to one another, this may lead to greater divergence between groups. Empirical evidence exists showing these effects can occur in some instances (Insko et al., 1993; Schkade, Sunstein, & Kahneman, 2000; see Muhlberger, Gonzalez, PytlikZillig, Hutchens, & Tomkins, 2017 for a summary of the different types of attitude change that may occur via deliberation).

4.3 What Works, for What Purposes, Under What Conditions, and Why?

In line with the framework set forth throughout this book, we proceed in this chapter by considering what works to impact attitudes in deliberation and why. We tracked changes in students' attitudes toward nanotechnology over the course of the semester and examined effects that our experimental manipulations had on these attitudes to understand what features had impacts on attitudes or attitude change and why.

4.3.1 For What Purposes?

We begin by considering the purposes for which the deliberative engagement is occurring, as this is a fairly subjective yet crucial decision that sets the tone for how a deliberation might be structured and how the data will be analyzed. In a broad sense, deliberative theorists have debated for decades whether and how attitudes "should" change as a function of deliberation, as described above.

Regardless of whether or not there is a desired direction for attitudes to shift via the deliberation, there are certain outcomes that are by and large seen as adverse. Most deliberations are not conducted with the goal of getting people to ignore alternative viewpoints and double down on their original opinions or getting people to come to a consensus around an extreme viewpoint that is uninformed or problematic in some way. As such, it is usually desirable not only to estimate the degree to which "desirable" attitudinal processes have occurred but also the degree to which "undesirable" attitudinal process have occurred. In this chapter,[1] we

[1] In a separate manuscript that uses the data from Study 5, we develop a statistical model for parsing out the distinct types of attitude change and polarization, which may be of use to those concerned about multiple possible outcomes of deliberation (Muhlberger, Gonzalez, PytlikZillig, Hutchens, & Tomkins, 2017). Although the model is easily estimable using OLS regression, the model remains somewhat involved, so we do not use it in this chapter.

present results from basic analyses that straightforwardly examine changes in attitudes as well as attitude extremitization as a function of time and experimental condition.

4.3.2 What Works, Under What Conditions, and Why?

The experimental manipulations used in our studies were chosen broadly to reflect commonly varied features of deliberations and to examine their impacts on our primary dependent variables of interest (in this chapter, attitudes). A variety of experimental manipulations have been used in other research to examine how attitudes change in response to deliberation or discussion occurring under different contexts. Perhaps most common are examinations of the effects of face-to-face discussion. As we have already described above, the outcomes of face-to-face discussion have been shown to vary, ranging from increased cooperation to polarization. In Studies 2, 3, and 4, we manipulated whether students discussed their views toward nanotechnology in groups or simply reflected upon their views alone. In doing so, we were able to experimentally test the degree to which face-to-face discussion influenced students' attitudes and, if so, how.

In our studies, we separated the time when students learned new information about nanotechnology from the time when they discussed nanotechnology in groups. As such, we were able to isolate, to some degree, one of the reasons *why* discussion has the effects that it does. Researchers disagree regarding whether the effects of group discussion on changes in people's attitudes are due to social influence (e.g., conformity pressures), to learning new information, or some mix of these two factors. If the effects of group discussion on attitudes are due to social influence, we should expect attitudes to change after group discussion. This would suggest those organizing a deliberation should make sure to either enhance or diminish social interaction accordingly. However, if the effects are due simply to new information, attitude change should be concentrated after students learn new information, but not after group discussion. The implication would be that group discussion may not be necessary for attitude change.

The composition of attitudes that exist within discussion groups has been found to matter substantially as well, when it comes to predicting changes in attitudes. For example, if a majority opinion exists, opinions will tend to move toward that pre-existing majority opinion (Schkade, Sunstein, & Kahneman, 2000). But other aspects of the discussion, like the degree to which group norms place value on original or innovative arguments (Moscovici, 1985) or whether the discussion is aimed at reaching a particular decision rather than simply having discussion for discussion's sake (Smith, Tindale, & Dugoni, 1996), can determine the relative impact of minority opinions (e.g., Bettencourt & Dorr, 1998; Maass & Clark, 1984; Moscovici & Mugny, 1983; see also, Delli Carpini, Cook, & Jacobs, 2004; Mendelberg, 2002). Further, Gaertner and Dovidio have shown under the framework of the *common ingroup identity* model that encouraging interaction between subgroups within a larger group can facilitate cooperation and reduce intergroup bias (Gaertner & Dovidio, 2014).

In Study 5, we varied a facet of attitude composition within groups that has been hypothesized to be central in some previous work (e.g., Mendelberg, 2002): attitudinal homogeneity. Specifically, all students participated in group discussion during Assignment 3 in Study 5, and we manipulated whether or not the groups were comprised of like-minded individuals in terms of attitudes toward nanotechnology—i.e., some groups were attitudinally homogeneous, and others were attitudinally heterogeneous. By manipulating the attitudinal homogeneity of discussion groups, we were able to shed light on the conditions under which group discussion might lead to one outcome (e.g., increased consensus) versus another (e.g., increased polarization).

We also used individual-level personality variables to investigate potential moderators of the effects we examined, to advance understanding of *why* or for whom attitudinal homogeneity within groups might matter. For example, it may be expected that individuals in attitudinally homogenous discussion groups are the most likely to become more extreme in their views after deliberation, due to homogenous discussion resulting in more closed-mindedness to other opinions that do not fit with the group's view. If that is the case, the effect might diminish among individuals who are high on openness to experience (i.e., individuals who are more amenable to the idea of changing their views based on exposure to alternative perspectives). This would suggest certain personality variables like openness are important to track during deliberations.

Aside from the different ways in which group discussion can occur, variations in how deliberation occurs at the individual level have also been shown to influence attitude change. For example, analytical thinking plays an important role because although individuals who tend to think analytically are more likely to deliberate and make valid arguments (Cacioppo et al., 1996), they are also more likely to resist alternative views (Petty et al., 1995). When individuals are made to feel accountable in some way for their decisions, they are more likely to evaluate information objectively and deliberate in an effortful manner (e.g., Tetlock & Kim, 1987). Finally, through the activation of particular emotional states, individuals can be encouraged to seek out new information and interaction with others (e.g., Marcus, Neuman, & MacKuen, 2000). These findings suggest that by changing the way individuals engage with and process information during a deliberation, it may be possible to change the way their attitudes are influenced. In all of our studies, we manipulated the degree to which students were encouraged to think critically throughout the study. These manipulations allowed us to investigate the role of deliberative, analytical thought in driving attitude change over the course of the semester.

4.4 Results

We describe our results regarding attitude change and polarization in two sections. In the first section below, we examine the trends in students' attitudes toward nanotechnology over the course of the semester across each of the four studies. In the second section, we examine the effects of the experimental manipulations used in each study. We examine three types of attitude change: attitude shifts (taking into

account direction of change), absolute attitude change (attitude change regardless of direction), and attitude extremitization (attitude change in the direction of one's prior attitudes). We are particularly interested in absolute change and extremitization because these analyses give us some sense of the degree to which individuals are changing their minds and refining their opinions in general, as well as the degree to which attitude consensus versus polarization is occurring. The normative outcomes desired by most deliberative theorists entail some degree of attitude change—i.e., participants should be altering their attitudes based on new information learned during the deliberation; if their attitudes remain the same, then perhaps the expense of having a deliberation is wasted. However, if participants are simply becoming more extreme in their prior views, this would be counter to the ideals of most deliberative theorists—hence the importance of measuring extremitization.

We focus here on our broad measures of students' attitudes toward nanotechnology, as these measures are the most consistent across studies. Specifically, all studies contained an item measuring the degree to which students believed the benefits of nanotechnological development outweigh the risks or vice versa (using a Likert scale ranging from 1 to 5 or 1 to 7), as well as an item measuring how much regulation or deregulation students believed there should be regarding nanotechnological development (measured on a sliding scale from 0 to 100). Various other, more specific attitude measures are available within each study (see Chap. 2 and Supplementary Materials) but are not analyzed here.

We keep our analyses simple. To examine attitude shifts over the course of the semester, we use paired sample *t*-tests. We use one-way ANOVAs to gauge whether mean differences between experimental conditions are significant. We transformed student responses to the two attitude items into six dependent variables: Mean attitudes were simply the average score across individuals on each attitude item. Mean absolute change for each item was calculated as the mean absolute value of attitude change from the time of the manipulation to a given measure administered later (i.e., the average amount of attitude change regardless of direction). Finally, mean levels of extremitization, or movement in the direction of one's prior attitudes, were calculated the same way as mean absolute change except that movement in the same direction as one's prior attitude score (i.e., movement away from the midpoint of the scale) was positive and movement in the opposite direction of one's prior attitude score (i.e., movement toward or even past the midpoint of the scale) was negative (for individuals whose prior attitudes were exactly at the midpoint of the scale, movement in either direction was coded as positive). Overall, significant interactions between conditions were rare in our data and fairly weak when they did exist. We therefore present main effects.

4.4.1 Attitude Change over Time

Figure 4.1 illustrates mean attitude scores over the course of the semester for each study for both of our primary attitude items. Across all studies, students started with fairly optimistic views toward the benefits versus risks of nanotechnology but also

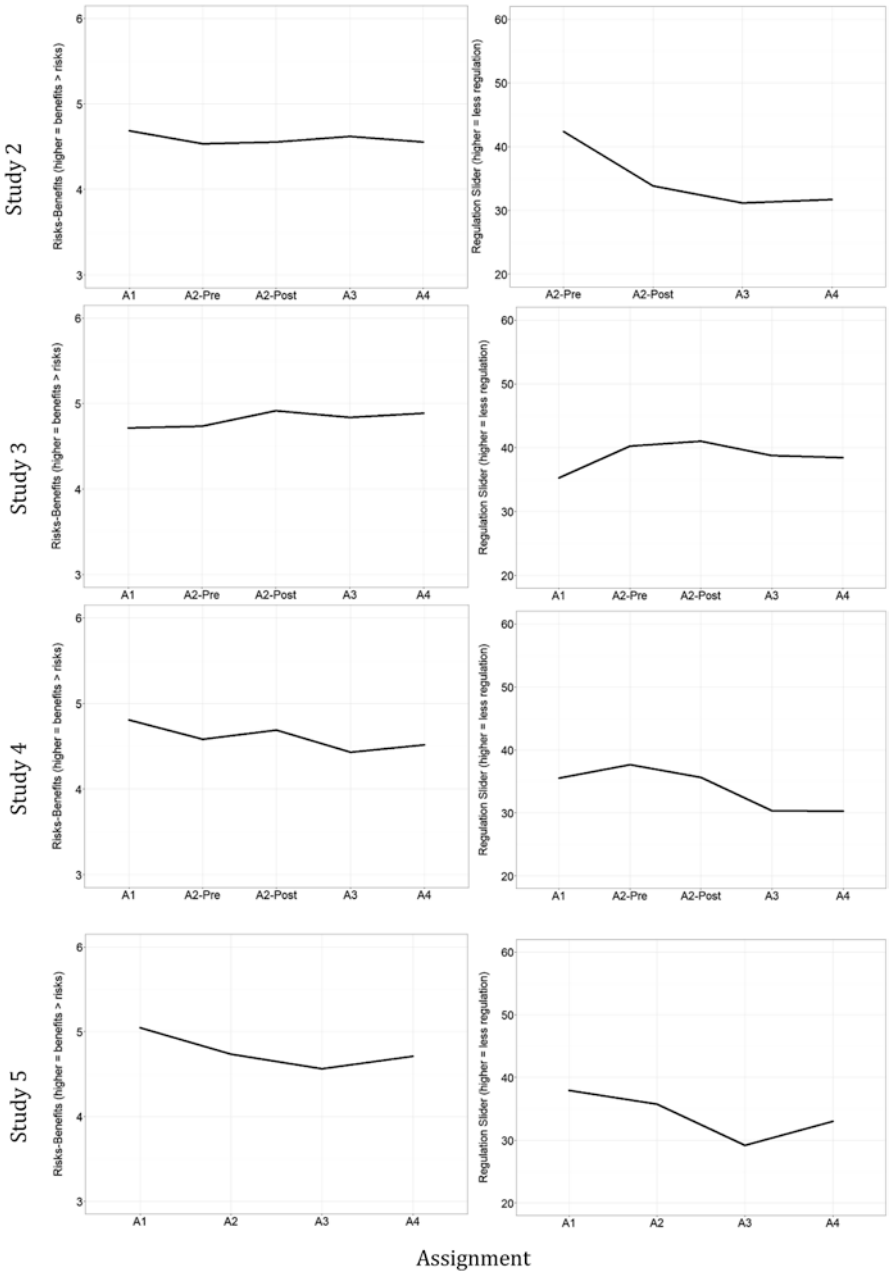

Fig. 4.1 Attitude shifts over the semester. Greater values on the y-axis for "Risks-Benefits" indicate greater valuation of the benefits over the risks of nanotechnological development; greater values on the y-axis for "Regulation Slider" indicate preferences for less regulation and more development of nanotechnology; for Assignment 1 in Study 2, the response options ranged only from 1 to 5 and so were rescaled to range from 1 to 7 such that 2, 3, 4, and 5 were recoded to 3, 4, 5, and 7, respectively; the Regulation Slider item was not asked during Assignment 1 in Study 2

generally favored regulation of nanotechnology rather than development (higher scores on the deregulation items indicate support for fewer regulations). Over the semester, significant changes in aggregate attitudes occurred but were modest. In all studies except Study 3, students generally became more cautious toward nanotechnology over the course of the semester, placing more weight on the risks (vs. benefits) of nanotechnological development and becoming more supportive of regulation (vs. deregulation).

A closer look at the changes over time indicated that, although the overall pattern was toward caution, in most cases, students first moved toward regulation and then rebounded toward deregulation by exhibiting a statistically significant shift between the last two attitude measures.[2] The shifts during the first few assignments and then the slight increase in a less cautious direction between the last two assignments could be interpreted as reflecting deliberative quality: as students learn more about nanotechnology, the allure of new technology may be somewhat eclipsed by new knowledge that there are risks involved. Then, as students have more time to think about the issues, they rebound a bit—taking on more moderate stances. However, the overall shift was still significant and toward feeling more cautious toward nanotechnology. Study 3 is the exception because students steadily became *less* cautious toward nanotechnology across all assignments. Nonetheless, across studies, aggregate attitude changes were by no means drastic.

Despite these trends, looking at aggregate patterns can be misleading. It could be that substantial attitude changes occurred in individuals, but the changes canceled out on average across persons. As such, we look to Fig. 4.2 for an illustration of how the mean absolute change in attitudes varied across each semester. Even when examining absolute change, there was no case in which we saw evidence of drastic attitude change. In all cases, mean levels of absolute change were low. Differences between time points within semesters, though, tended to be statistically significant, suggesting some time points exhibited significantly more change than others. In general (except for absolute change regarding the deregulation item in Study 2 and the benefit item in Study 3), most of the attitude change that occurred tended to take place between the first two assignments—that is, *prior to* being given any information about nanotechnology. This suggests that counter to what many deliberative theorists would consider "optimal," the largest one-time attitude changes occurred between the time people were initially exposed to the topic (when they were asked questions about nanotechnology and told they would be informed about and discuss the topic later) and actual exposure (possibly reflecting self-seeking of information) rather than during the main deliberative activities. According to the results in Studies 2 through 4 (except for the cases mentioned above), most participants changed their

[2] This pattern held for all cases except in Study 3 and in Study 2 with regard to the risks versus benefits of nanotechnology.

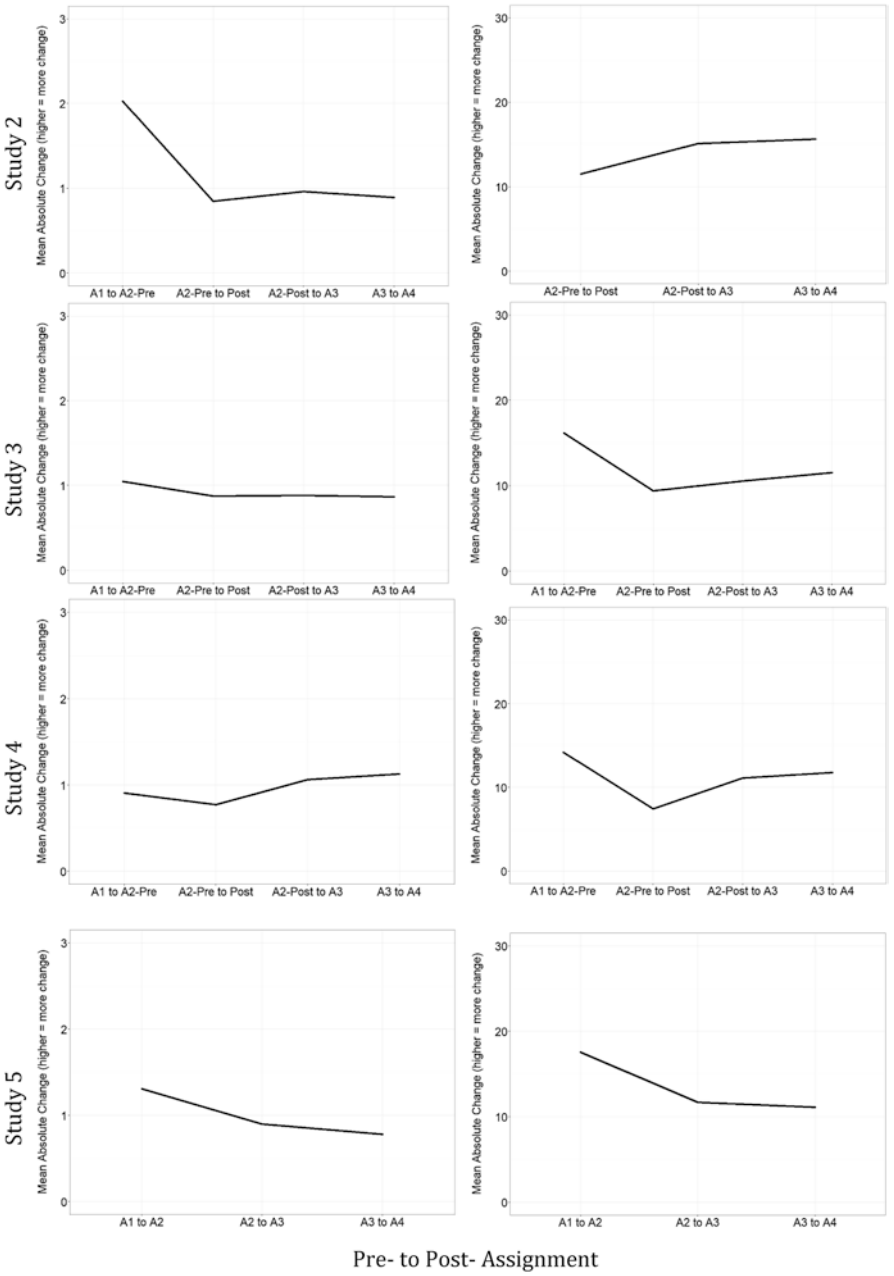

Fig. 4.2 Mean absolute change in attitudes over the semester. Greater values on the y-axis indicate greater levels of attitude change from the prior Assignment (regardless of direction); for Assignment 1 in Study 2, the response options ranged only from 1 to 5 and so were rescaled to range from 1 to 7 such that 2, 3, 4, and 5 were recoded to 3, 4, 5, and 7, respectively; the Regulation Slider item was not asked during Assignment 1 in Study 2

minds even before they were given detailed information about the topic or had the chance to discuss the topic with others in the context of our study.

Although the absolute change in attitudes during the deliberative activities was small, we would caution against too much pessimism for a number of reasons. First, although not overwhelming, the mean level of absolute change in attitudes across all time points and all studies is above zero, suggesting people are not entirely static in their opinions during the deliberative activities. Also, it is important to note here that low levels of attitude change are not necessarily counter to deliberative ideals, as some have argued that what is important is the development of respect for alternative opinions rather than changing one's own opinion (Cohen 1998). Arguably more important is the degree to which extremitization—the most deleterious potential outcome of deliberation—did or did not occur in our data. We turn to that next.

Figure 4.3 shows mean levels of attitude extremitization across our studies. These values were computed by averaging the extent to which people changed their attitudes toward a more extreme view relative to their last reported attitude (resulting in positive values) or toward a more moderate or opposite view relative to their last reported attitude (resulting in negative values). Zero reflects no change in attitude. Our data does not show substantial levels of attitude extremitization at any time point during any of our studies. Average levels of extremitization tended to hover around zero, suggesting that the extent to which individuals became moderate in their opinions was at about the same level as others became more extreme. When significant changes did occur in extremitization, it was such that students became more likely to moderate their opinions, not that they became more extreme. That is, there were several instances in which extremitization scores went from below zero at the beginning of the semester (indicating movement toward more moderate views) to approximately zero by the end of the semester (indicating no further movement).

Of course, it could still be the case that differences in attitudes, absolute change in attitudes, or extremitization varied by different conditions. As such, we turn to our analyses regarding the effects of our experimental conditions to obtain a clearer picture of how people's attitudes changed in our data.

4.4.2 Encouraging Critical Thinking

A key factor in any public deliberation is the degree to which participants engage in critical thinking. On the one hand, effortful thought, scrutiny, and consideration of alternative viewpoints are often believed to be essential to successful deliberation, in part because critical thinking should (according to pro-deliberation theorists) lead people to think more objectively. In some cases, this might mean individuals become aware of the weaknesses of their own views and strengths of others' views and

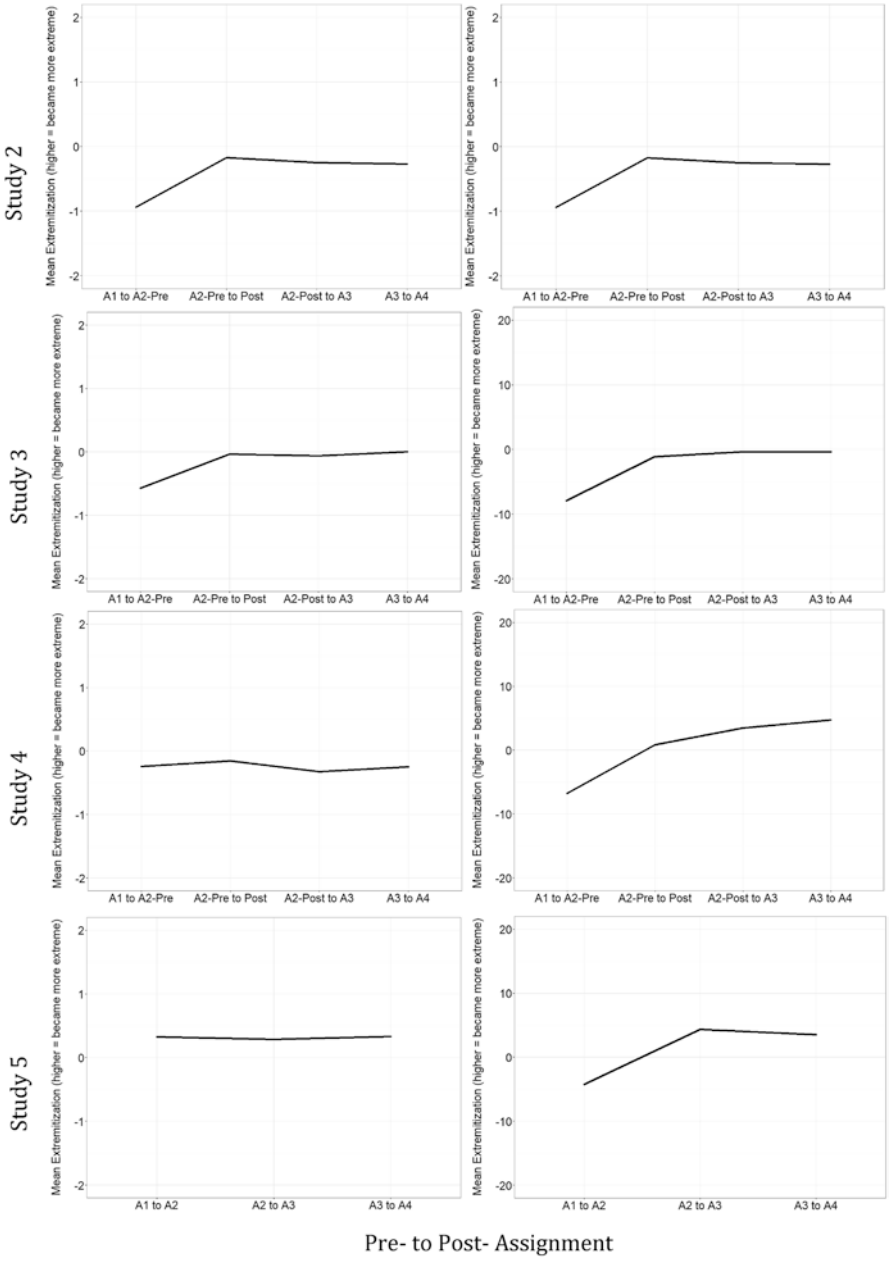

Fig. 4.3 Mean attitude extremitization over the semester. Greater values on the y-axis indicate greater levels of attitude change from the prior Assignment in the direction of being more extreme in the same direction as their attitudes in the prior Assignment (positive values indicate movement to a more extreme position and negative values indicate movement in the opposite direction; in cases where one's previous attitudes were at the exact midpoint of the scale, movement in either direction is considered extremitization and thus receives positive values); for Assignment 1 in Study 2, the response options ranged only from 1 to 5 and so were rescaled to range from 1 to 7 such that 2, 3, 4, and 5 were recoded to 3, 4, 5, and 7, respectively; the Regulation Slider item was not asked during Assignment 1 in Study 2

subsequently moderate their opinions. In other cases, research as well as sheer logic may come down concretely on one side of an issue, and so critical thinking may lead people to a specific point of view, which may even lay at the "extreme" end of the attitudinal spectrum. This may be desirable if the goal of the deliberation is more informed opinions rather than moderate opinions.

On the other hand, some research suggests critical thinking might lead to increased polarization rather than consensus. The argument here is that instead of leading to cool, open-minded consideration of alternative viewpoints, critical thinking may involve rationalization of one's previously held views and thus higher levels of attitude extremity (e.g., Kahan et al., 2012).

Table 4.1 contains the results of our analyses examining the effects of critical thinking prompts on attitude change and polarization regarding both dependent variables. Results are shown across all four studies and across all assignments following the manipulation within each study. That is, for each study the table shows the mean attitude score, mean absolute change in attitudes, and mean attitude extremitization during each assignment subsequent to the first administration of the critical thinking or alternative conditions (the first administration of the critical thinking manipulation is Assignment 2 in all studies). Note that in Study 2, there was an additional experimental condition beyond just the critical thinking and feedback (control) conditions called the information organization condition (mentioned in Chap. 2).

We start by describing the results regarding absolute change in attitudes and attitude extremitization because those are the most related to our expectations from the existing literature. In terms of differences in absolute change in attitudes, the modal outcome was no significant differences between conditions (this was the case in 66 out of 72 or 92% of comparisons). However, when significant differences did exist, they were mostly consistent. In Study 4 during Assignment 2-Post and Assignment 3 (for both the benefit item and the deregulation item) and in Study 5 during Assignment 4 (for just the deregulation item), being in the critical thinking condition was associated with *less* absolute change in attitudes. Thus, the majority of cases exhibited no significant differences between the critical thinking and feedback conditions, but when differences did arise, they suggested people were less likely to change their minds if exposed to the critical thinking prompts.

With regard to extremitization, the modal outcome was again no significant differences between conditions (just as with absolute change, this was the case in 66 out of 72 or 92% of comparisons). The majority of significant differences were evident in Study 3. Across all assignments in Study 3, being in the critical thinking condition was associated with attitude moderation (i.e., moving toward or past the midpoint on the scale) in terms of weighing the risks against the benefits of nanotechnological development, whereas being in the feedback (control) condition was associated with extremitization. There were a couple of marginal ($p < 0.10$) differences in the opposite direction in Study 4 (where those in the feedback condition moderated their opinions but those in the critical thinking condition did not), but the opposite effects were never as large as those found in Study 3, and critical thinkers never were found to become more extreme.

Table 4.1 Effects of critical thinking on attitude change and extremitization

			Risks-benefits			Regulation slider		
		Condition	Mean	Mean absolute change	Mean extremitization	Mean	Mean absolute change	Mean Extremitization
Study 2	*A2-post*	Feedback	4.89	0.65 [a^]	−0.05	31.45	12.48	4.52 [a^]
		Critical thinking	4.47	0.86	−0.08	33.59	9.78	5.34
		Information organization	4.33	1.02 [a^]	−0.36	36.13	12.17	−1.27 [a^]
	A3	Feedback	5.04[a^]	0.75	−0.02	29.05	15.27	3.71
		Critical thinking	4.36[a^]	1.02	−0.22	31.36	14.69	5.10
		Information organization	4.48	1.10	−0.48	32.47	15.31	−1.95
	A4	Feedback	4.96[a]	0.69	−0.09	29.24	17.06	3.24
		Critical thinking	4.21[a]	0.96	−0.31	31.21	14.40	5.25
		Information organization	4.48	1.02	−0.39	34.16	15.44	−2.26
	A5	Critical thinking	4.19	1.01	−0.22	33.93	13.69	0.51
		Information organization	4.48	1.02	−0.34	34.47	14.98	−2.68
Study 3	*A2-post*	Feedback	5.06^	0.90	0.18*	58.28	9.48	−1.45
		Critical thinking	4.77^	0.84	−0.24*	59.65	9.30	−0.83
	A3	Feedback	4.93	0.89	0.16*	60.38	10.97	0.32
		Critical thinking	4.75	0.88	−0.29*	62.10	10.09	−1.00
	A4	Feedback	5.08^	0.87	0.27*	61.19	12.32	0.02
		Critical thinking	4.71^	0.87	−0.24*	61.89	10.77	−0.70

			Risks-benefits			Regulation slider		
		Condition	Mean	Mean absolute change	Mean extremitization	Mean	Mean absolute change	Mean Extremitization
Study 4	*A2-post*	Feedback	4.71	0.93*	−0.32^	63.13	9.36*	0.68
		Critical thinking	4.67	0.63*	−0.01^	65.47	5.70*	0.98
	A3	Feedback	4.36	1.29*	−0.52^	69.05	13.95*	3.07
		Critical thinking	4.51	0.86*	−0.16^	70.48	8.59*	3.86
	A4	Feedback	4.60	1.26	−0.34	68.84	14.30	5.34
		Critical thinking	4.52	1.01	−0.16	70.80	9.48	4.13
Study 5	*A2-post*	Feedback	4.82	1.24	−0.67	35.94	16.21	−2.94
		Critical thinking	4.65	1.38	−0.72	35.54	18.83	−5.56
	A3	Feedback	4.71	0.96	−0.45	28.60	11.85	1.66
		Critical thinking	4.39	0.83	−0.43	30.08	11.53	−1.30
	A4	Feedback	4.88	0.88	−0.42	34.42	13.16*	−3.01
		Critical thinking	4.59	0.69	−0.17	32.18	9.24*	−0.85

Higher values for the "Risks-Benefits" column indicate greater valuation of the benefits over the risks of nanotechnological development. Higher values for the "Regulation Slider" column indicate preferences for less regulation and more development of nanotechnology; "Mean Absolute Change" indicates the absolute value of attitude change from A2-Pre to that assignment. "Mean Extremitization" indicates change in the direction of one's A2-Pre attitude score, with positive values indicating movement to a more extreme position and negative values indicating movement in the opposite direction (a score of 4 out of 7 indicates the midpoint for the Risks-Benefits item, and a score of 50 indicates the midpoint for the Regulation Slider item); in cases where one's A2-Pre attitudes were at the exact midpoint of the scale, movement in either direction is considered extremitization and thus receives positive values; mean differences were calculated using between-groups *F*-tests and pairwise comparisons with the Tukey HSD standard for statistical significance when there were more than two groups; * next to values indicates differences that are significant at the $p < 0.05$ level; ^ indicates differences that are significant at the $p < 0.10$ level; when there are more than two conditions, superscripts are used such that conditions with the same letter are significantly different from one another

When considering directional attitude change, for the most part, the critical thinking manipulations did not have an effect on attitude shifts in a particular direction. However, there are several instances of significant effects, and the direction of the effect is consistent in all cases but one. During Assignment 4 in Study 3, being in the critical thinking condition led to more negative attitudes toward nanotechnology (believing the risks outweigh benefits) than being in the feedback condition. This same relationship was evident in Assignments 2 and 4 of Study 3. However, average attitudes toward regulation of nanotechnology were never affected by the critical thinking manipulations.

Overall, then, any effects of critical thinking were somewhat sporadic, but when there were differences, participants sometimes became more negative yet while showing less attitude movement in the critical thinking conditions. Results generally suggest the primary effect of our critical thinking prompts on attitude change and variation is potentially moderation of attitudes but, more often, no effect. Despite not suggesting a single, widespread effect of critical thinking, our findings are notable. Our findings suggest that critical thinking is not universally causing people to refine (change) their opinions as deliberative theory purports, but it is also not causing polarization or extremitization.

4.4.3 Information Format

The formatting of information read by participants in a deliberation may seem like a trivial matter when it comes to their attitudes toward the topics at hand, but substantial variation exists across public deliberations in how information is presented, if at all. Researchers and policymakers—especially those focused on science and technology issues—often seek not only to measure public opinion via deliberations but also to inform and potentially guide it. As such, it is particularly common during deliberations over science and technology issues for information to be provided to participants that gives them a basic understanding of the topic. A reasonable concern for those who organize deliberations is how the *ways* in which they present information to participants might shift their opinions.

Throughout our studies, Assignment 2 served as a time for students to read background information about nanotechnology and nanogenomics, and in Studies 3 through 5, we manipulated the information as described in Chap. 2. The manipulations used in Studies 3 and 4 had to do with whether or not the risks and benefits of nanotechnological development were shown as alternative perspectives (pro-con condition) or simply in paragraph form without any clear division into opposing perspectives (topical condition). These differences in formatting have clear practical relevance, as the pro-con formatting was based off of the formatting used by the *National Issues Forum,* an organization whose specific aims include encouraging a shared understanding of issues across diverse views. It is often believed by many deliberation practitioners that by directly exposing people to opposing viewpoints,

they will see the potential weaknesses in their own views and strengths in others' views, and this will improve the quality of deliberation (Gutmann & Thompson, 1996, 2009; Habermas, 1989, 1996; Fishkin, 1991). However, it may also be possible that by explicitly presenting issues as split into groups of opposing views, the background information may be politicizing the issues and making it easier for participants to become polarized. Group distinctions may become more salient, which may diminish the potential for compromise (Bettencourt & Dorr, 1998).

As discussed in Chap. 2, Study 5 used the NIF format for all participants and implemented a weak versus strong background information manipulation, which varied the degree to which sources and evidence were provided to back up arguments, the use of opinion-based claims, and the extent to which the information was balanced. This manipulation allowed us to test a fairly straightforward set of competing hypotheses. On the one hand, it could be the case that overly positive information, despite being poorly supported and stated, led to more positive views toward nanotechnology. On the other hand, the overly positive information could lead to a backlash effect because of it being weakly supported, with participants becoming more cautious.

The results regarding information format in Studies 2 through 4 were sporadic. Some differences existed, but, for the most part, there was not a consistent effect of the information format. The most consistent results regarding information format occurred with regard to attitude shifts during Study 5, when the information varied in terms of "strength."

In Study 5, the strong information condition consistently led to greater concern about the risks of nanotechnology. A reasonable interpretation of this pattern of results might be that conditions in which people were exposed to more balanced and well-supported information led to greater concern regarding the risks of nanotechnology. This suggests the deliberative ideals of balanced, unbiased information may not necessarily yield polarization but may nonetheless lead individuals to view new technology more cautiously. However, none of these effects carried over to mean attitudes regarding deregulation. There were only small and inconsistent differences associated with mean absolute attitude change.

There are various other information formats that might have different effects on attitudes, and results may differ further depending on the topic. Here, the topic (nanotechnology) was fairly novel for most participants (see Chap. 3), and so it should be expected that the background information would have a substantial impact on how participants formed their opinions toward the matter. Several significant shifts were evident, and there were some differences by formatting condition that were somewhat telling. If anything, framing the issue in terms of opposing perspectives rather than using a more topical approach to laying out benefits and risks had a conservatizing effect on attitudes in the aggregate. However, these effects were small. This leaves room for examining possible mediators or moderators of these effects or for studies looking at why attitudes toward a novel issue like nanotechnology would not be substantially impacted by learning about the topic.

4.4.4 The Effects of Group Discussion

Group discussion is a central feature of deliberations and is particularly relevant to expectations regarding attitude change and polarization. Indeed, various scholars in psychology, communications, and political science have studied the effects of group discussion on attitude change, some even focusing specifically on the implications for public deliberation. All in all, the results of empirical work on the topic are mixed and suggest a range of possible outcomes of group discussion during deliberation as described earlier.

In our first few studies, we sought simply to examine if attitudes differed as a function of whether or not students discussed the issues with a group or not. As such, in Studies 2 through 4, we randomly assigned some students to discuss ethical scenarios related to nanotechnological development in groups and others to consider the ethical scenarios alone, on their own. In Study 3, some students were also placed in one of the two conditions using an online wiki forum, which we used simply as pilot data due to the lack of random assignment (see Chap. 2).

Surprisingly (given the extant literature on the subject), we found no significant effects on attitudes of being in a group versus being alone when considering the ethical scenarios except for a few marginal and contradictory differences. This could suggest that the primary attitude changes that occur during consideration of the ethical aspects of scientific and technological development are due mainly to thinking about the issues prior to discussion, rather than during discussion with others. This would cast some doubt over claims about the power of social influence over people's attitudes, at least when it comes to deliberation about science and technology. On the other hand, discussion with others may play a role in motivating people to read and consider new information in more ordinary contexts in which people cannot be told to sit and think about an issue.

4.4.5 The Features of Group Discussion: Homogeneity and Facilitator Activity

In Study 5, we wanted to delve into the features of group discussion that might affect attitudes and polarization. Although there were no significant differences between the alone and group conditions in Studies 2 through 4, group discussion is a central part of many public deliberations, and so we wanted to further explore if particular features of a group discussion affect participants' attitudes. Therefore, in Study 5, all students discussed the ethical scenarios of Assignment 3 in groups. We manipulated two features of the discussion: the attitudinal homogeneity of the group and the activities of the discussion facilitators who were instructed to lead the group in an active or passive manner as noted in Chap. 2.

Manipulating the homogeneity of the group was directly inspired by the existing psychology literature on small group discussions. A central aspect of the scholarly

disagreement over whether or not deliberation will lead to consensus rather than polarization has to do with the psychological consequences of encountering viewpoints that differ from one's own. To put it simply, those optimistic about the effects of deliberation suggest that being exposed to alternative viewpoints will lead people to develop an appreciation for other opinions, thus yielding lower levels of variability in attitudes, whereas those less optimistic about the effects of deliberation suggest people will become resistant and double down on their original opinions, thus yielding increased polarization and variability. Homogeneity, alternatively, may lead group members to reinforce one another's pre-existing opinions, or it may lead group members to realize the "one-sidedness" of their group's opinions and search for alternatives.

Surprisingly, across assignments, there were no cases in which attitudes, absolute change, or extremitization differed significantly across discussion conditions. Prior research suggests that, at the least, attitudes should move around more in heterogeneous groups, either because individuals are attending to alternative viewpoints and coming to more reasoned opinions or because individuals are doubling down on their original opinions (thus becoming more extreme in the direction of their original opinions). We found no evidence of extremitization *or* increased attitude movement in general when individuals were in heterogeneous versus homogeneous groups. Optimistically speaking, this means that we find no evidence of what has been feared by many skeptics—that is, polarization via motivated reasoning and resistance to alternative views. Yet this also means that deliberative theorists' hopes that exposure to alternative perspectives will lead people to acknowledge others' opinions and change their minds also are unrealized in our data.

The manipulations regarding the role of discussion facilitators were driven more by practical concerns. There is substantial variation in whether or not public deliberations utilize discussion facilitators, and among those that use facilitators, there is substantial variation in how those facilitators are instructed to guide discussion (if they are instructed at all). As such, we sought to shed light on the ramifications of an active facilitator relative to one who steps aside and lets participants guide the discussion.

In our data, we found no evidence of attitude differences between the passive and active facilitator conditions. Taking into account the null results regarding group homogeneity as well as the manipulations of whether or not students discussed the topics in a group at all, our findings regarding group discussion seem quite straightforward. We seem to be left with astonishingly little support for the hypotheses derived from existing literature.

4.4.6 A Potential Moderator of Homogeneity

Before we conclude that the dynamics of group discussion have no meaningful effects on attitudes, we briefly examine whether some aspect of personality might play a significant moderating role. In line with the overarching framework of this book, we would like to emphasize that although we observed only minor evidence of attitude

change and extremitization in our data in the aggregate, and although most of the effects of the experimental conditions were either weak, inconsistent, or insignificant, it is possible that we may have missed something by averaging over participants. As such, we look at how personality—specifically, openness—might have played a role in driving our findings. We focus particularly on the potential moderating role of openness on the effects of group homogeneity on attitude change and extremitization in Study 5.

We utilized a variable reflecting trait openness to experience that we measured during Assignment 1 in Study 5 as the average of students' responses to four items, each of which ranged from 1 to 7 (see Chap. 2 and supplemental materials). The variable was coded so that higher values indicated higher levels of openness to experience. We interacted this variable with the variable for the homogeneity condition to predict absolute attitude change as well as extremitization during Assignments 3 and 4 in Study 5. The goal was to see if the effects of group homogeneity depended on individuals' trait levels of openness to experience.

With regard to absolute attitude change, we found a significant interaction in the expected direction but only when the homogenous groups were positive toward nanotechnology. Specifically, we found that among students who scored low in openness, there was no significant difference in absolute attitude change between students who were in a heterogeneous group or in a homogeneous group. However, among students who scored high in openness, there was significantly more attitude change in heterogeneous groups than in positive homogeneous groups. Students with high openness in negative homogeneous groups showed a statistical trend in the same direction. In other words, the expectation from the existing literature—that group heterogeneity and exposure to alternative viewpoints would lead people to alter their opinions—was only supported among students high in openness. Importantly, though, this moderation was only evident with regard to risks versus benefits item assessed during Assignment 3.

With regard to attitude extremitization, interactions are significant when predicting responses to the deregulation item for both Assignments 3 and 4, but the interactions are not significant predicting the risks versus benefits item. The pattern of the interactions corroborates the role of openness as suggested above with regard to absolute attitude change. Among students low in openness, being in the heterogeneous condition is associated with greater extremitization, but among students high in openness, being in the heterogeneous condition is associated with less extremitization than being in the homogeneous conditions (although, only significantly so in comparison to the negative homogeneous condition). Said differently, in the heterogeneous condition, openness is associated with lower levels of extremitization, whereas in the homogeneous conditions, openness is associated with greater levels of extremitization. Individuals low in openness seem most likely to polarize in the face of alternative views, but it is those who are high in openness that seem most ready to "rally the wagons" and become more extreme in their views around like-minded others. This interaction is shown in Fig. 4.4.

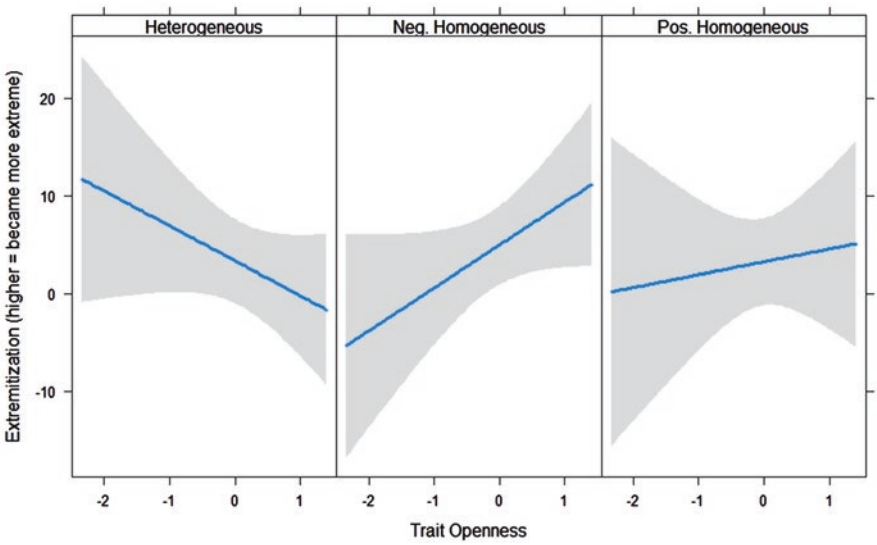

Fig. 4.4 Interaction between group homogeneity and openness predicting attitude extremitization. Greater values on the y-axis indicate greater levels of attitude change from the prior Assignment in the direction of being more extreme in the same direction as their attitudes in the prior Assignment (positive values indicate movement to a more extreme position and negative values indicate movement in the opposite direction; in cases where one's previous attitudes were at the exact midpoint of the scale, movement in either direction is considered extremitization and thus receives positive values); the left panel reflects the heterogeneous condition, the middle panel reflects the negative homogeneous condition, and the right panel reflects the positive homogeneous condition; trait openness is represented on the x-axis

4.5 Conclusion: What We Have Learned and Where to Go from Here

Gauging, and at times shaping, public opinion is often a primary goal of public deliberations regarding scientific and technological development. Scientists and investors need to understand public opinion and the factors that impact it in order to know how to develop their research or technology in a publicly acceptable manner. Policymakers need to understand public opinion in order to know what regulations the public wants as well as how the public might react as development progresses. Further, researchers, investors, and policymakers may be interested in easing the fears of an apprehensive constituency or warning an overzealous public of the risks of a particular research program or technology. Finally, compared to opinion surveys that allow respondents to breeze through questions about exotic issues without serious consideration, deliberation can offer an opportunity for scientists and policymakers to understand where public opinion might go as citizens are exposed to and learn more about new, frontline technologies and research areas. Public deliberations offer an ideal setting for researchers and policymakers to interact with the public in these

ways. However, as we have discussed throughout this book, the particular features of a public deliberation can have substantial implications for how participants view scientific and technological progress. In this chapter, we presented a brief smattering of results aimed at shedding light on the main effects of particular features of deliberation on attitude change and polarization. These results are far from exhaustive of the ways in which features of public deliberation might affect attitudes, and we encourage researchers and policymakers to dive deeper using our data as well as additional studies.

In general, we saw that in our studies, participants' attitudes toward nanotechnology varied somewhat over time but not greatly. In all but one study, students became more cautious about nanotechnology over time—but experienced a slight shift toward becoming more positive again by the end of the study. We did not identify any drastic attitude changes, but there were several manipulations that had notable impacts. Further, we may have missed something by averaging across the samples. Do some types of people change more than others? Are the effects of different features of deliberation universal across types of people? Indeed, we found that the various predictions from the existing literature regarding group dynamics in deliberative discussions were differentially supported depending on participants' trait openness.

The manipulations we implemented across our studies all demonstrated some level of consistency in the direction of their effects, but significant differences were sporadic and modest. The most consistent findings seemed to be that critical thinking prompts and information structured in terms of alternative perspectives moved participants toward more heavily weighing the risks of nanotechnology and to some degree led to less attitude change but in a direction of becoming less extreme when change did occur. However, even these findings were not entirely consistent throughout studies. This suggests that the features of deliberation we manipulated are indeed promising as potential subjects for further investigation, but it cannot be said that these features have large and ubiquitous effects on attitudes in the population studied. On the one hand, this means we have yet to uncover features of deliberation that consistently produce "positive" outcomes. On the other hand, it means the manipulations we implemented, which reflect commonly used features in prominent deliberations, did not result in the adverse outcomes feared by skeptics. Furthermore, as we showed with our investigation of trait openness, there are likely various mediators and moderators of the effects of the features we looked at, which can be examined using our data or in future studies.

Attitude change and polarization are issues that public deliberation organizers cannot afford to ignore. Polarization and gridlock on scientific and technological issues can put a complete halt to development, as can widespread public skepticism. Yet too much enthusiasm can lead policymakers to forgo the careful consideration necessary to form effective regulations. Public deliberations offer researchers and policymakers an opportunity to nip these potential crises in the bud. However, a scientific understanding of the effects of different features of deliberation is necessary in order to ensure that deliberation does not make things worse instead of better.

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