CHAPTER 12

Narratives and the Water Fluoridation Controversy

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Introduction

Water fluoridation is a simple, effective, inexpensive, and safe public health intervention for preventing tooth decay. It is not a new practice. The first Canadian experiment with water fluoridation occurred in 1942 when a health board recommended the practice in Brantford, Ontario. Soon after, many other municipalities embarked on a similar public health plan. By 1953, more than 1000 communities, large and small, had either

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begun a fluoridation practice or had approved such a plan (Stadt 1954). Now, fluoridated water is fairly widespread, particularly in Canada and the United States, where fluoridated water is available for about half the population. In Canada, fluoridated water was available to about 14 million people in 2017 (PHAC 2017).[1]

At its inception, water fluoridation was readily embraced. It was a major public health achievement, highly economical (Ran et al. 2016), and also not necessarily artificial. Fluoride can be found naturally in water supplies, and its varying quantities are associated with different effects. Early twentieth-century research into tooth mottling identified high levels of fluoride in water as the cause, but also found that even individuals with mottled teeth appear resistant to tooth decay (McKay 1925). It was later shown that smaller amounts of fluoride in water, about 0.7 mg/L, can still provide a good level of prevention against cavities while avoiding the mottling problem (see also Arnold, Jr. 1943). Such early research led to municipal governments intervening to bring fluoride levels to that optimal level, either by adding fluoride to water, or by removing fluoride in cases where natural levels are higher than necessary.

But since its early history, there have been moments of resistance to fluoridation, either by elected officials in municipal councils or in the population, expressed in referendums. And while one might be able to comprehend risk-averse attitudes among populations in the 1950s who faced a rapidly changing world with technology taking over even the most mundane of human experiences such as drinking water, water fluoridation remains controversial to this day. Relatively recently in Canada, several cities have held elections that resulted in voters choosing to stop water fluoridation (Perrella and Kiss 2015; Kiss et al. 2018). Between 2012 and 2017, almost 40 communities across Canada have ceased water fluoridation (PHAC 2017). More have considered the issue, and there appears to be little abatement in the pace of such anti-fluoridation opposition. There are anti-fluoridation movements all over Canada. This leads to the main question of inquiry: What does it take to move a public against water fluoridation?

[1] Levels vary considerably across sub-regions. Manitoba and the Northwest Territories rank high with 68 to 73% of their populations having access to fluoridated water (naturally occurring or added), while at the other extremes are New Brunswick (9.62%), Newfoundland and Labrador (1.59%), Yukon (no water fluoridation), British Columbia (1.26%), and Québec (2.49%) (PHAC 2017).

This is an important question given the current lack of universal public insurance for dental care in Canada[2] and the potential for a lack of fluoridation to exacerbate existing inequalities in oral health (Chari et al. 2022). But there is a more general concern relating to public health interventions, which can be expensive and sometimes risky. If the public can get riled up to oppose water fluoridation, which is relatively inexpensive, effective, and safe, then what can we expect when members of the public face more significant and imperative health threats? Consider, for instance, the anti-vaccination movement, or socially conservative parents who oppose their daughters receiving the human papillomavirus vaccine. In a far more contemporary sense, consider those who doubt the efficacy and safety of any of the COVID-19 vaccines approved or any health mandates (e.g., masking) that governments and organizations impose on their publics. The list goes on. Few other areas of health science—and public policy—get people more impassioned and politicized than public health, and among them, water fluoridation holds a special place.

What is remarkable in all this is that support for water fluoridation normally begins favorably. Over time, the few surveys that are available show that when people are simply asked about their views of water fluoridation, there is often clear support. The following are examples spanning nearly 50 years that show the percentage of respondents in favour of water fluoridation:

- National U.S. survey, 1973, 67% (Nunn et al. 1973).
- United Kingdom, 1977 to 2007, a review of 11 surveys shows support ranging from 56 to 79% (Catleugh, Delves and Bellaby, n.d.).
- Yates County, NY, 1997, 84% (Health Counts in Yates! n.d.).
- New Zealand, 2009, 58% (Whyman et al. 2016).
- Canada, 2009, 62% (Quiñonez and Locker 2009).
- West Midlands, UK, 2010, 67% (National Health Service, West Midlands 2010).
- Michigan, 2013, 70% (Marketing Resource Group 2013).
- Waterloo Region, 2013, 60% (Perrella and Kiss 2015).
- Calgary, 2021, 68% (Kanygin 2021).

[2] It should be noted that there is significant movement in this policy area. A 2022 agreement between the minority Liberal government and the smaller New Democratic Party included expanded access to dental care as a key element (Thompson 2022).

Consistently, the majority of the public seems to support water fluoridation, often at high levels. But when the same public is agitated, it can turn skeptical or force a water authority to cease fluoridation. How does this opinion reversal happen? What does it take for a favourable position to flip? That is the key question being explored here.

The context in which public opinion can shift in a consequential way is the main vehicle used to oppose—or cease—water fluoridation: a plebiscite. The public is often asked in the form of a vote to take an unambiguous side: To fluoridate or not to fluoridate? This is important to point out as the context of the discourse within an elected council is qualitatively different than one held more widely among the electorate. Elected officials can debate and interact with experts to decide such matters by weighing the evidence. Elected officials can change their mind in such a context, too. And while debates within official chambers can be charged with emotions, for sure, they are not always just about facts; ideology and interpretations matter. But the dynamic of a popular election on the topic elevates more prominently psychological forces, as most citizens are not required to be as engaged in any one political topic. They are not required to witness the questioning of experts. They are not required to review reports. Their general lack of sophistication and knowledge about public affairs (Delli Carpini and Keeter 1996; Fournier 2002) ill-equips them to engage with matters of a more technical nature, such as water treatment.

Partly for this reason, people are susceptible to heuristics and narratives. Through mental shortcuts and gripping images, people can be persuaded to hold an opinion independent of any factual basis (Hochschild and Einstein 2015). They can also be swayed to hold some doubt over a matter about which they had not fully considered. As it pertains to our study, people who would hold favourable views of fluoridation could then become more doubtful after having been exposed to opposing narratives, or when narratives prime certain features that place fluoridation in a more negative light. More technically, the public can be moved if faced with a narrative that follows "emphasis framing" (see Chapter 1; see also Cacciatore et al. 2016). They may not be fully convinced of opposing arguments, but particular emphasis frames may raise the level of doubt to make them more risk averse. Consequently, when asked in a referendum, they feel more comfortable to err on the side of caution: Better to vote against water fluoridation. It is this possibility that we explore.

Fluoridation Narratives

Much of the debate about water fluoridation revolves around its "safety" or its "toxicity." However, this debate is often confused. What does it mean for a substance to be "safe?" In reality, any substance, natural or synthetic, can be extremely unsafe at some level. But toxicity is less about the substance than about its dose (Gardner 2009; Kiss 2015). This is true of many commonly consumed products. Here are some examples of common substances and their median lethal dose (LD_{50}) per kilogram:

- Caffeine, 192 mg (Boyd 1959);
- Nicotine, 6.5-to-13 mg (Mayer 2014);
- Vitamin C, 11,900 mg (Nelson 2018).

When toxicologists say something is "safe," they mean it is safe *at that dose*. In the case of water fluoridation, the optimal level of fluoride for people to consume is 0.7 mg/L on a daily basis. This provides fluoride's well-documented preventative properties while avoiding any of its potential risks. This amount is well below an unsafe dose. The LD_{50} of sodium fluoride (the most common form of fluoride) is 52 mg/kg (Environmental Health and Safety 2001). And fluoride toxicity has happened! Normally, this occurs from groundwater wells containing fluoride flowing from granite. In some cases, such as in India, fluoride concentrations can reach as high as 70 mg/L, but "crippling" skeletal fluorosis has occurred in areas with fluoride concentrations at much lower levels of 2.8 mg/L (Gupta and Ayoob 2016: 15). Water treatment facilities can extract excess fluoride from water to reach the optimal level of 0.7 mg/L, far below known levels of toxicity.[3] The foregoing is not meant just to be a technical discussion of the nature of toxicology or to highlight that water fluoridation can help protect the public from toxic levels of the substance; instead, it is to highlight the way in which technical discussions of "risk" and "safety" depend on a nuanced understanding of dose and exposure, which are often lost in a loaded, emotionally charged, and often simple public debate.

[3] There are other potential harmful effects at lower doses. For instance, risk of fluorosis (bone disease) can occur when ingesting at least 6 mg of fluoride a day (WHO 2017), which is still difficult to reach as this requires drinking at least eight litres of water.

How do people determine what is risky or safe? Often, science plays a minimal role (Kahan et al. 2011). Instead, perception of risk is shaped by how an issue is discussed and how that interacts with personal world-views. When an issue involves the deliberation of wide publics, there are opportunities to articulate a wide range of perspectives, some factual, some exaggerated, and some invoking various frames or normative points of view. The wide accessibility of online resources can even render more prominent marginal perspectives. As noted by Shanahan et al. (2011), the contemporary context over policy discussion and change has fewer gatekeepers, with members of the public able to access online information and interpretations. This can create a chaotic context that renders policy narratives as effective summaries of different arguments. The question asked here is: Which narratives are more able to move public opinion on water fluoridation?

Some narratives are common in fluoridation debates. To begin, there is a more strictly technical, or scientific, argument. When public health professionals or dentists are asked about the safety and effectiveness of fluoride, few go much beyond just stating that, yes, it is effective, and, yes, at low doses, it is safe. Enough said. But this narrative competes with others.

A common factual counter-argument is that the substance has been linked to bone disease (skeletal fluorosis) and even bone cancer (Clemmesen 1983). While correct, this requires a much higher dose. Bone disease is more likely to occur if one consumes over a long period (about 10 years) water containing fluoride above the recommended amount.[4] It is also factually correct to say fluoride is safe at low doses. But debates rarely engage in the finer technical points. Instead, the public is faced with two competing and equally convincing arguments about the toxicity of fluoride.

Furthermore, when discussing fluoride as a chemical, opponents often use the term "hydrofluorosilicic acid," a compound commonly used for water fluoridation. Certainly, it is natural for individuals, especially those without a chemistry background, to react with some shock to hear that

[4] There are different studies on what constitutes a high dose. Li et al. (2001) find bone fractures more likely to occur with long-term (minimum 25 years) consumption of water that contains 4.32 ppm of fluoride. Pratusha et al. (2011) raise that threshold as high as 10 ppm.

an “acid” is added to their drinking water. And rightfully so. Hydrofluorosilicic acid, with a pH level of 1.2, is corrosive (Heneke and Carson 2001). But lost in the discussion is that when this acid is added to drinking water, it dissolves and breaks apart, leaving behind the fluoride ions needed for dental protection (Urbansky 2002). This is an important point as one of the largest challenges in this debate is to explain its complex chemistry.

The above factual argument and counter-arguments must also compete with normative (or moral) frames. The debate on whether to fluoridate sometimes takes a turn on whether it is the right thing to do, independent of its safety. One common pro-fluoridation narrative views society as a community in which individuals look after each other, even if that requires some state intervention (Beauchamp 1985; Kaul v. City of Chehalis 1954; Perrella and Kiss 2015). To protect individuals—especially children—against tooth decay, adding a small amount of fluoride to water seems like a small price to pay, in terms of both the degree of liberty that is infringed and also the actual cost to taxpayers.

The counter argument to this favourable frame invokes liberty (Carstairs and Elder 2008). There have been several attempts to bring this argument to court challenges, although in most cases, courts rule against those who argue fluoridation infringes on constitutionally protected individual rights (Block 1986; Pratt et al. 2002). Does the state have the right to add chemicals to our water, without our consent? Constitutional law aside, people may question the legitimacy of a state that adds “chemicals” or “drugs” to water. If people want to consume such chemicals, it should be a personal choice, they argue. They add that since fluoride is available in toothpaste, it is up to individuals—and parents—to control their own personal exposure and that of their children. This more libertarian frame is often used as a non-technical argument about the morality of water fluoridation.

Combined, these diverse narratives sort along two dimensions. One dimension is based on fact, where on the one hand fluoride can be said to be safe, albeit at low doses, and on the other hand fluoride can be said to be toxic, albeit at high doses. The second dimension is based on a moral or normative frame, where one pole represents libertarian views that the state must not add chemicals to water without our consent, while the opposing pole represents a communitarian frame, whereby society, and by extension, the state, sometimes needs to impose standards for our collective benefit.

Together, these dimensions form a four-cell typology, displayed in Fig. 12.1. The top-right quadrant represents those who view water fluoridation as safe and believe the practice provides a public good. The bottom-right quadrant can be described as libertarians, as they regard water fluoridation as safe, but oppose it on the principle that it infringes on personal rights. The top-left quadrant represents those, such as "eco-warriors," who doubt the safety of water fluoridation, but still believe in the principle of a public good and the necessity of state intervention. They just think fluoride is hazardous. These same individuals also generally question the safety of genetically modified food and believe in an organic diet. Finally, the bottom-left quadrant describes those who doubt the safety of fluoride, and also question the legitimacy of state intervention.

The bulk of the opposition to water fluoridation is a coalition of three of the quadrants, all but the top-right. Anti-fluoridation campaigns have invoked the fluoride-as-hazard and fluoridation-as-infringement arguments, often together. Keep in mind: Water fluoridation is widely practiced, and there usually is support for it. But public deliberation can agitate this support and cause it to oppose the practice. This suggests that support is not deeply rooted; people can be persuaded to doubt their

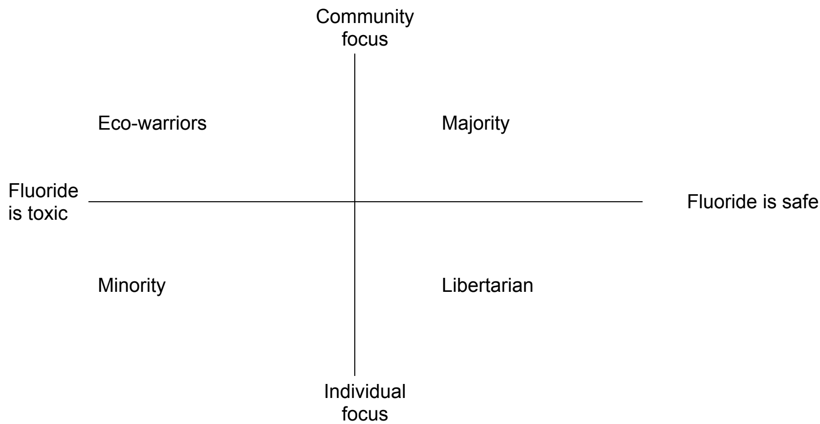

Fig. 12.1 Typology of factual and moral narratives (*Source* Authors' own source)

support for fluoridation, and with enough people changing their mind, opposition can grow significantly.

But not all narratives can be assumed to weigh equally. It is plausible that some are more effective. But which ones? Is it the factually based argument that suggests fluoride is hazardous? Is it the moral argument that emphasizes individual rights and questions the role of the state? Is it both combined? What happens when people are faced with competing narratives, favourable and unfavourable? Do they cancel each other out, or is one more persuasive? In sum, which narratives, or combination of narratives, are more likely to shift opinion?

In addition, are some people more susceptible to particular narratives? This possibility is explored by considering whether certain cognitive characteristics are more likely to yield greater susceptibility. In particular, the following is considered: (1) knowledge, specifically about science and fluoride; (2) trust (or skepticism) in science; and (3) political attitudes, specifically ideology. Let's briefly consider each of these three main dimensions.

First, as noted in much of the literature, citizens have low levels of knowledge about politics (Delli Carpini and Keeter 1996; Fournier 2002). Their grasp of science is no better (Durant et al. 1989). Consequently, when faced to deliberate over a policy matter that requires some knowledge of science, and specifically, over some knowledge of fluoride as a chemical and its properties, citizens are either prone to not understand or are susceptible to inaccurate and sometimes false perspectives. As noted by Martin (1991), "… claims do not have to be scientifically correct in order to be persuasive. The claims about fluoridation and cancer were effective politically, even though many scientific refutations were published" (141).

Second, it is evident people are mobilizing against scientific reason. Anti-vaccination movements, alternative health fads and climate-change denial are three current examples of skepticism. These, along with opposition to water fluoridation, frustrate efforts to develop effective science-based health policy, regardless of sound and irrefutable scientific research. As noted by Camargo and Grant (2015), many such movements grow out of individuals listening to each other, not to science, as the scientists often are ill-equipped to communicate complex matters to the general public (see also, Collins and Evans 2008, 2014). Such belief systems sometimes can be fairly constrained, resisting opposing views, as was demonstrated by some during the COVID-19 pandemic (Miller

2020; see also Wood et al. 2012). Therefore, one would expect that when confronted by a variety of narratives, skeptics are less likely to be swayed by factual evidence.

Third, it is evident that much of the anti-science movement, particularly as it relates to vaccinations, climate change, and (more recently) anti-masking, shows an ideological bent. It seems much of the skepticism toward many public health measures comes from those of the right, and those who support—or identify with—parties (and leaders) of the right. This has been confirmed by some research (Dillard et al. 2021; McCright et al. 2013; Kirst et al. 2017). Perhaps the most prominent representative of such science skepticism is none other than former U.S. president Donald Trump, who has spoken out against masks during the COVID-19 pandemic, not to mention climate change.[5] However, it should be noted that opposition to public health practices does not always have a distinctive ideological flavor. Certainly, some orientations can explain such opposition. For instance, school programs to have teenage girls vaccinated against the human papillomavirus often face resistance from parents who feel this program challenges their authority, or that the practice presses against traditional beliefs about gender norms (Perrella and Kiss 2015; see also Kahan et al. 2015; Kiss et al. 2020). But opposition to water fluoridation, in particular, can stem from both traditional, right-wing views and those who situate themselves on the left. As noted by Carstairs and Elder (2008), libertarians, environmentalists, "naturalists," and those who oppose corporate capitalism may see each other as allies in opposing fluoridation.

Data and Methods

In order to determine how narratives can affect support for fluoridation, experimental questions were administered through an online survey, conducted in April of 2017, to respondents in both Canada and the

[5] Trump has since changed his mind in one respect by encouraging parents to have their children vaccinated, although many of his supporters continue to spread an anti-vaccination perspective (D'Antonio 2019).

United States.[6] A total of 3854 respondents were gathered,[7] and each was asked to indicate their support for fluoridation on a scale of 1 ("extremely opposed") to 7 ("extremely supportive"). Prior to registering their support, we presented respondents with one of 10 experimental treatments. These were structured to prime a variety of four considerations, or prompts, each drawn from the same dimensions illustrated in Fig. 12.1. In addition, one group of respondents served as a control, where they were simply asked to score their view of water fluoridation without having been exposed to either a fact- or normative-based prompt. The goal is to determine if any prompt, i.e., narrative, is able to shift public opinion away from some default position.

In the first dimension, "fact," respondents were given two prompts: (1) "Health Canada[8] recommends 0.7 mg/L of fluoride in water to prevent tooth decay"; (2) "The risk of skeletal fluorosis (bone disease) rises when people consume 10 mg of fluoride a day for about 10 years." The second dimension featured two moral-based prompts: (1) "Low income children are often at risk of getting cavities because their family cannot afford dental care"; (2) "Governments sometimes add medicines or chemicals in drinking water without people's consent."

Four questions contained only one of the four prompts listed above. Six other questions exposed respondents to a blend of narratives. Some received conflicting prompts: one favourable to fluoridation (or positive) and one opposing (or negative). Some received two reinforcing prompts: one factual and the other a frame. The idea was to cover as much variety as possible in order to simulate the competitive and informational diversity that would characterize an actual fluoridation plebiscite campaign. The total list of questions appears in Table 12.1.

Of these prompts, it is expected that those that prime facts are less effective than those that emphasize moral frames (Druckman and Bolsen 2011). As previously noted, arguments based on science or fact compete against more normative frames. This will be displayed by comparing mean scores of each experimental group against the control.

[6] The survey, administered by Dynata, was made possible through financial support from the Laurier Institute for the Study of Public Opinion and Policy.

[7] The total number of respondents reached was higher, 4241, but 387 were excluded for not providing responses. Among the valid entries, 2,105 respondents were from the United States and 1749 from Canada (1240 in English, 509 in French).

[8] The American version referenced the Centers for Disease Control.

Table 12.1 List of question groups

Experimental group	*Question wording*
1: Factual, positive	Health Canada recommends 0.7 mg/L of fluoride in water to prevent tooth decay
2: Moral, positive	Low income children are often at risk of getting cavities because their family cannot afford dental care
3: Factual, negative	The risk of mild forms of skeletal fluorosis (bone disease) rises when people consume 10 mg of fluoride a day for about 10 years
4: Moral, negative	Governments sometimes add medicines or chemicals in drinking water without people's consent
5: Factual and moral, both positive	Health Canada recommends 0.7 mg/L of fluoride in water to prevent tooth decay. Also, low income children are often at risk of getting cavities because their family cannot afford dental care
6: Factual and moral, both negative	The risk of mild forms of skeletal fluorosis (bone disease) rises when people consume 10 mg of fluoride a day for about 10 years. Also, governments sometimes add medicines or chemicals in drinking water without people's consent
7: Moral, positive, and negative	Low income children are often at risk of getting cavities because their family cannot afford dental care. Also, governments sometimes add medicines or chemicals in drinking water without people's consent
8: Factual, positive, and negative	Health Canada recommends 0.7 mg/L of fluoride in water to prevent tooth decay. Also, the risk of mild forms of skeletal fluorosis (bone disease) rises when people consume 10 mg of fluoride a day for about 10 years
9: Moral, positive, and factual, negative	Low income children are often at risk of getting cavities because their family cannot afford dental care. Also, the risk of mild forms of skeletal fluorosis (bone disease) rises when people consume 10 mg of fluoride a day for about 10 years

(continued)

Table 12.1 (continued)

Experimental group	*Question wording*
10: Factual, positive, and moral, negative	Health Canada recommends 0.7 mg/L of fluoride in water to prevent tooth decay. Also, governments sometimes add medicines or chemicals in drinking water without people's consent

Source Authors' own source

Following these questions, respondents were randomly assigned to one of two questions that specifically focuses on ways to describe the actual chemical commonly used to add fluoride to water. As noted, critics of fluoridation often refer to hydrofluorosilicic acid as the ingredient added to water, hoping people would become scared at the thought of their drinking water containing any sort of acid. Also noted is the fairly complicated chemical process involved when hydrofluorosilicic acid is added to water. If this process is left insufficiently explained, it is likely people will oppose fluoridation. To test this, the first question simply stated: "One of the ways that water utilities add fluoride to the local water supply is to add hydrofluorosilicic acid to the water supply." The second question contained more information: "One of the ways that water utilities add fluoride to the local water supply is to add hydrofluorosilicic acid to the water supply. This chemical dissolves and separates into two parts, fluoride and water."[9] Of the two, the second question appears more benign, and respondents are expected to be less opposed to fluoridation when given the more factually complete description. This will be evident by noting changes in mean scores of support for water fluoridation.

Questions from the first iteration are examined further to determine whether their persuasiveness, or susceptibility, depends on any of the three key attributes discussed earlier, namely knowledge of science, skepticism toward science, and ideology.

Regarding knowledge of science, an argument can be made that people who are knowledgeable are expected to be more swayed by

[9] The chemical reaction is a bit more involved (see, for example, Haneke and Carson 2001). But the main point is not to explain fully the chemical process, but to leave respondents with a sense that the chemical (and the resultant reaction) is far more benign than the "acid" name suggests.

factual accounts, while those who are less informed are expected to be more affected by normative frames. However, and as noted in this volume, there is evidence to suggest otherwise, whereby even among the highly educated we can see the presence of motivated reasoning that impedes what would otherwise be labeled rational thought (Hochschild and Sen 2015; Kahan et al. 2012; Kraft et al. 2015). To test this hypothesis, respondents were disaggregated into groups based on their scientific literacy. Four questions were used. The first was a "True or False" question that asked respondents whether "Lasers work by focusing sound waves" (correct answer is *false*). The second asked respondents to indicate whether sound or light travels faster (correct answer is *light*). Another two questions measured knowledge about fluoride, specifically. The first asked: "Is it true or false that fluoride occurs naturally in many water sources like rivers and lakes?" (correct answer is *true*). The second asked: "Is it true or is it false that fluoride only prevents cavities by being applied directly to the teeth?" (correct answer is *false*).[10] The four responses were combined into a 0-to-1 index, where those who answered all questions correctly scored a 1, while those unable to provide a correct answer to any question scored a 0.

Our second susceptibility test considered skepticism, or trust, toward science. It is expected that those more skeptical of science—particularly science related to public health—to be less supportive of fluoridation, but also more likely to be swayed by negative normative prompts. The survey contained a question that asked: "Does science solve or cause problems?" Respondents were offered a seven-point scale ranging from 1, to indicate "science replaces older problems with new ones," to 7 to indicate "science overcomes problems." This measure was rescaled to 0-to-1 to render it consistent with the others.

The third test of susceptibility considered ideology. The survey contained a question that asked respondents to situate themselves on an ideological spectrum. Canadian respondents were asked to assign themselves a score from 1, to indicate the extreme left, to 7, to indicate the extreme right. American respondents were given the same scale, but

[10] In both cases, when processing responses to the two science-knowledge and the two fluoride-knowledge questions, respondents who indicated that they either "Did not know" or "Refused" to answer were assumed to not know the correct answer, thereby assigned a score of 0.

the extremities were labeled “extremely liberal” and “extremely conservative,” respectively. In both cases, responses were rescaled to a 0-to-1 scale. Here, it is expected that those who are more to the right to be less supportive of water fluoridation, and their support more likely to be further bolstered by normative (particularly libertarian) frames. However, as suggested by McCright et al. (2013), those on the left are more likely to support the science behind public health. They are expected to be more likely swayed by the communitarian moral frame. It is therefore plausible that those in the centre will be more supportive than those close to either extreme.

The effect of our different experimental narratives and their potential to move opinion when one takes into account scientific knowledge, trust in science, and ideology is analyzed by comparing mean scores of each of the 10 experimental groups against the control. Regression models are also generated whereby the 10 experimental groups are entered as dummy variables with the control group acting as the reference. Also included in the regression models are control variables for country, gender, income, education, and age.[11]

Results

As noted at the onset, support for water fluoridation is generally positive. But when agitated, support can drop to the point where public health authorities may be forced to either cease water fluoridation programs, or pull back from even considering it. Our sample also shows a baseline level of support. Respondents indicated their support for water fluoridation using a score of 1 (extremely opposed) to 7 (extremely supportive), with 4 designated for a neutral, “not sure,” response. Overall, support among those in the placebo, or control, group leans on the positive side, with a mean score of 4.5 out of 7. A third of respondents chose the neutral “not sure” (see Fig. 12.2). Even if that neutral category is discounted, far more

[11] Country is a dummy variable whereby 1 for Canada and 0 for the United States. Gender is also a dummy variable whereby women are scored a 1. Income is measured with a question that asks respondents to select one of nine different incomes, with the lowest category selected by those with an income of less than $25,000, and the highest category selected by those with an income of more than $500,000. The education variable has 10 categories, from “some elementary school” all the way up to “completed graduate school.” In both cases, the variables were recoded to a 0-to-1 scale. Respondent ages in the sample run from 18 to 81, which was also rescaled to 0-to-1.

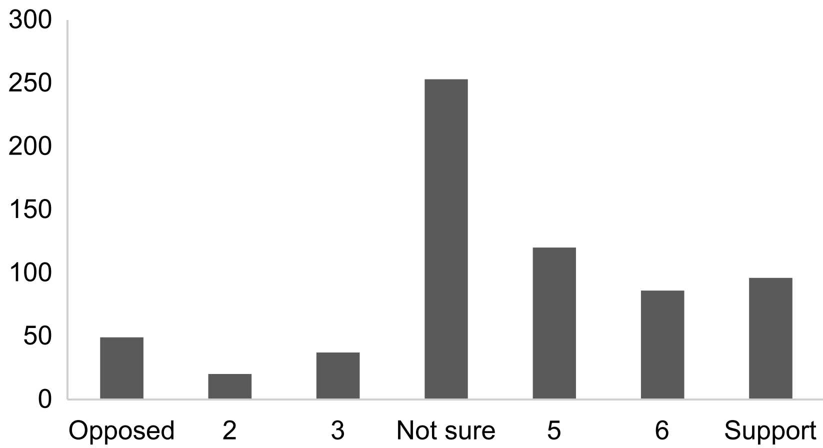

Fig. 12.2 Support for water fluoridation (control group) (*Source* Authors' own source)

respondents land on the positive end ($n = 302$) than on the opposed end ($n = 106$). Clearly, we see here what was seen elsewhere: Opinion toward water fluoridation is not, by default, negative. It is decidedly positive. From this baseline of support, it is possible to examine whether certain narratives are more likely to push or pull support one way or another.

Effect of Narratives

Figure 12.3 displays three series, all showing difference in level of support from the control group. The first series is for the entirety of the dataset. The other two separate results for Canada and the United States. The 10 different narratives are sorted based in descending order from those that move opinion in the "total" series more toward supporting fluoridation, down to those that move opinion in the opposite direction.

One evident pattern is the higher number of negatives than positives. Six out of ten scenarios show lower support compared to the control group. A second notable finding, and an unsurprising one, is the 0.77-point decline in support occurring when two negative prompts are paired together. In contrast, a pairing of two positive prompts improves support by 0.17 points, a difference that is only marginally significant at $p < 0.10$

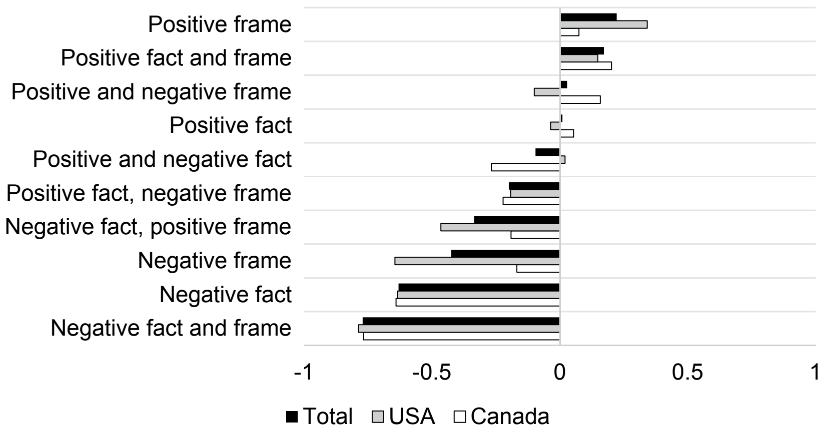

Fig. 12.3 Distance from control group (*Source* Authors' own source)

(see Table 12.2). A third key observation is the ability for a negative prompt, be it fact or frame, to pull down support, even when paired against a positive prompt. However, in Table 12.2, when the experiments are tested with a battery of statistical controls, only two such contrasted pairings yield significant results: Group 9 (negative fact, positive frame) and Group 10 (positive fact, negative frame). These patterns hold generally for the two countries when examined separately. A fourth key finding is the strength of the bone-disease prompt. Unlike what was expected, the negative-fact narrative may be even more effective than the negative-normative narrative. The largest coefficients in Table 12.2 are for Group 3 (negative fact, $B = -0.637$) and Group 6 (negative fact and frame, $B = -0.757$), while Group 4, which was exposed only to the negative moral frame, produces a coefficient of $B = -0.441$.

It does appear, however, that there are some differences between Canada and the United States. A combined positive and negative frame (Group 7) strengthens support for water fluoridation in Canada, but has the opposite effect in the United States. However, this difference fails to reach significance.

Overall, one general conclusion is that support for water fluoridation is not bolstered by reassuring factual arguments. Even when a positive fact is paired with supportive moral arguments, public opinion seems unaffected. What seems effective, however, are negative narratives, be they

Table 12.2 Effect of 10 experimental narratives

	B	*Std. Err*	*Beta*	*Sig*
Experimental group				
Positive fact	0.075	0.122	0.012	0.539
Positive frame	0.204	0.118	0.033	0.084
Negative fact	−0.637	0.122	−0.098	0.000
Negative frame	−0.441	0.122	−0.068	0.000
Positive fact and frame	0.215	0.120	0.034	0.072
Negative fact and frame	−0.757	0.121	−0.118	0.000
Positive and negative frame	0.050	0.120	0.008	0.677
Positive and negative fact	−0.063	0.120	−0.010	0.598
Negative fact, positive frame	−0.304	0.121	−0.048	0.012
Positive fact, negative frame	−0.246	0.122	−0.038	0.044
Country	−0.128	0.060	−0.036	0.033
Gender	−0.147	0.059	−0.042	0.013
Income	0.647	0.152	0.079	0.000
Education	0.971	0.126	0.135	0.000
Age	0.882	0.127	0.114	0.000
Intercept	3.642	0.121		0.000
Adj. R-sq	0.083			
S.E.E	1.682			
N	3485			

Source Authors' own source

about the toxicity of fluoride or about the state's legitimacy to impose fluoridation. As suggested earlier, public support for fluoride may not be solidly grounded and seems easily budged. This becomes even more important when considering the second iteration of experiments.

In the second round, respondents were assigned to one of two groups. The idea here is to determine if their opinion on water fluoridation changes based on the contentious reference to the chemical compound hydrofluorosilicic acid. Opponents to water fluoridation often refer to this compound in their public statements with the hope that members of the public will turn skeptical of fluoridation because of the fear that this involves adding an acid to water. But, as noted earlier, what is not always discussed is how hydrofluorosilicic acid dissolves and breaks down when added to water. It is expected respondents will become less skeptical by this more benign (and lengthy) explanation of a common water fluoridation process.

It should be noted that this second experiment appears in the survey immediately after the first. Therefore, most respondents reach this point after having already been primed by whatever prompts they had received in the prior question. What this next iteration simulates is a context of ongoing debates: They receive one narrative, and then they receive another, potentially more complex one. What happens next? Does it shift opinion at all?

Overall, the two experimental groups differ. Those who were given the simpler "hydrofluorosilicic acid" prompt scored slightly lower than those given the more benign and longer prompt, 4.13 and 4.28 out of 7, respectively. This difference is statistically significant, but overall the gap is very small. This likely reflects the very diverse sample, with most respondents having been exposed to different narratives in the first experiment. When compared to results from the first iteration, the less benign prompt appears to pull down support, pretty much across all the groups. Figures 12.4a and b show differences in support levels from the first iteration to the second. Negative values suggest respondents become less supportive of fluoridation after this second round of prompts. Here, a decline in support is visible, even among respondents who in the first iteration were in the control group. Among those who received the simpler prompt, their support of fluoridation declined by 0.31 points (see Fig. 12.4a). The longer and more informative prompt does little to change opinion; among respondents who were exposed to the more benign prompt about how hydrofluorosilicic acid reacts in water, changes are more subtle (see Fig. 12.4b). These results challenge any notion that citizens would grow to support fluoridation if they were given more information about the chemical process. It appears they may not.

Scientific Literacy

Perhaps factual narratives fail because of a lack of scientific knowledge. There is no expectation for ordinary citizens to understand the chemistry of water fluoridation, just as they need not know the chemistry of dish soap. But it might help. Knowledge of science, maybe even a little, may make one more likely to accept, or at least listen to, a scientific argument for fluoridation. To test this, the sample is disaggregated into groups based on their level of scientific literacy.

The survey included questions that measure how much people know about science, in general, and about water fluoridation, more particularly.

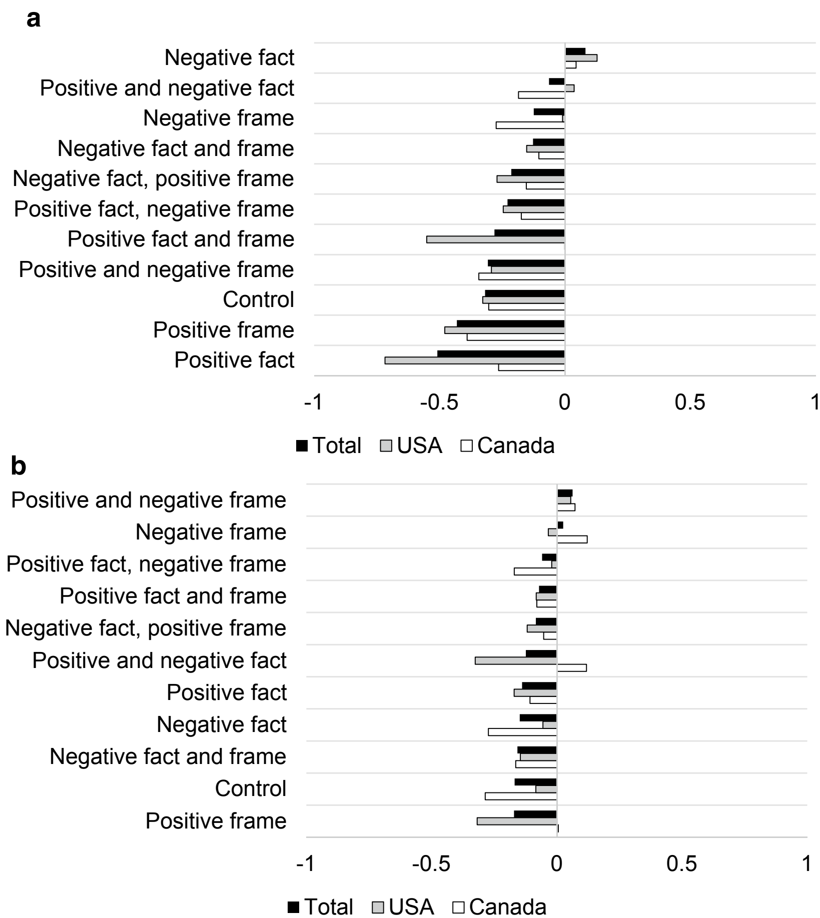

Fig. 12.4 (**a**) Simpler hydrofluorosilicic acid prompt; (**b**) Complex hydrofluorosilicic acid prompt (*Source* Authors' own source)

Overall, on a range of 0 to 1, the sample scored an average of 0.46, with standard deviation of 0.26. It should be noted that about 40% of the sample scored no better than 0.25, and a little over one-third scored 0.50, which produces a slightly positively skewed distribution. Hence, this distribution was collapsed into three categories. Scores from 0 to 0.25 are the "low" category; those who scored 0.5 are the "middle" category;

and those who scored higher are in the "high" category. The mean scores across the 10 experimental groups are examined for each of these three subsets.

The first subset considers respondents with the lowest level of scientific knowledge. Again, as seen in previous scenarios, the presence of the negative frames, for the most part, outweighs the effect of any other positive prompts (see Fig. 12.5a). But the effects of the narratives are more limited. In Table 12.3 (Model 1), only Group 3 (negative fact) and Group 6 (negative fact and frame) show significant results. Group 2 (positive frame) and Group 10 (positive fact, negative frame) are marginally significant at $p < 0.10$. Overall, the negative frame matters more than any factual account for this low-knowledge group. This holds overall, but in separate country-specific regression models (not shown here), Americans' views of fluoridation improve if offered a narrative that features only the positive frame, but among Canadian respondents, views sour when presented either with a negative fact alone, or if combined with a negative frame.

The next subset examines those with mid-level knowledge. Results, shown in Fig. 12.5b, are similar to what appears in Fig. 12.5a, repeating the same pattern seen elsewhere, with narratives more likely to pull respondents away from supporting fluoridation than toward supporting it. The largest changes, however, are the two negative narratives (Groups 3 and 6). There seems to be some potential for positive narratives to increase support for fluoridation, but according to Model 2 of Table 12.3, these two groups show no significant effects.

Among the high-knowledge subset, remarkably, almost all experimental groups show weakening support for water fluoridation, regardless of narrative, especially among Americans (see Fig. 12.5c). Not all of these effects are statistically significant, however. In Model 3 of Table 12.3, support for fluoridation weakens in the presence of any negative prompt, be it factual or normative, alone or in combination. Those who are more scientifically literate do not grow more supportive of fluoridation when provided factual accounts about the chemical's safety. Instead, the mention of any negative perspective, be it factual or normative, is enough to raise doubts among them. Why that occurs is unclear. Perhaps our measure of science literacy does not go far enough, and just reflects those with enough fluency to be attentive to different perspectives of the water fluoridation discourse, but not scientifically sophisticated enough to weigh the evidence, and thus, may be prompted toward being cautious.

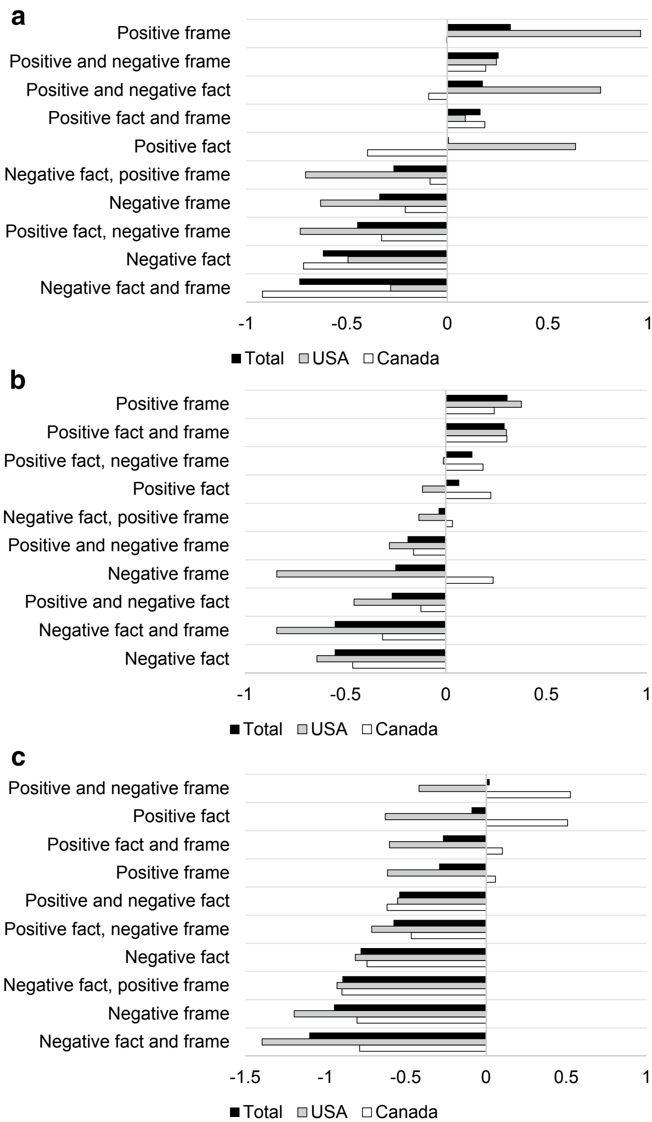

Fig. 12.5 (**a**) Low knowledge; (**b**) Mid-level knowledge; (**c**) High knowledge (*Source* Authors' own source)

Table 12.3 Effect of narratives considering scientific knowledge

	Model 1: Low knowledge				*Model 2: Mid-level knowledge*				*Model 3: High knowledge*			
	B	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*
Experimental group												
Positive fact	0.124	0.220	0.019	0.573	0.003	0.233	0.001	0.989	−0.003	0.272	0.000	0.990
Positive frame	0.386	0.207	0.065	0.063	0.244	0.229	0.040	0.287	−0.351	0.268	−0.052	0.191
Negative fact	−0.536	0.212	−0.088	0.012	−0.594	0.242	−0.090	0.014	−0.648	0.279	−0.092	0.021
Negative frame	−0.278	0.214	−0.045	0.193	−0.235	0.253	−0.034	0.353	−1.049	0.283	−0.146	0.000
Positive fact and frame	0.308	0.221	0.048	0.163	0.262	0.227	0.043	0.248	−0.371	0.252	−0.060	0.141
Negative fact and frame	−0.692	0.212	−0.113	0.001	−0.627	0.241	−0.095	0.009	−1.053	0.285	−0.145	0.000
Positive and negative frame	0.313	0.209	0.052	0.136	−0.230	0.243	−0.035	0.344	0.144	0.262	0.022	0.582
Positive and negative fact	0.266	0.216	0.042	0.218	−0.284	0.243	−0.043	0.242	−0.484	0.250	−0.079	0.054
Negative fact, positive frame	−0.020	0.226	−0.003	0.930	−0.011	0.237	−0.002	0.964	−0.992	0.253	−0.160	0.000
Positive fact, negative frame	−0.367	0.212	−0.060	0.083	0.076	0.253	0.011	0.763	−0.763	0.262	−0.118	0.004
Country	−0.348	0.112	−0.097	0.002	−0.149	0.119	−0.041	0.211	−0.266	0.133	−0.073	0.046
Gender	−0.261	0.108	−0.074	0.016	0.002	0.116	0.001	0.988	−0.088	0.135	−0.024	0.513
Income	0.948	0.294	0.107	0.001	0.825	0.308	0.096	0.008	0.804	0.321	0.100	0.012
Education	0.462	0.228	0.065	0.043	1.032	0.245	0.142	0.000	0.986	0.281	0.131	0.000
Age	0.898	0.236	0.114	0.000	0.564	0.250	0.072	0.024	1.594	0.277	0.202	0.000
Intercept	3.917	0.225		0.000	3.666	0.243		0.000	3.852	0.276		0.000
Adj. R-sq	0.088				0.058				0.122			
S.E.E	1.63				1.748				1.707			
N	1032				968				744			

Source Authors' own source

Science Skepticism

Our next test examines the effect of skepticism toward science. Overall, the sample seems to have a great deal of trust in science. On the 0-to-1 scale, the mean score is 0.74, with more than half of the respondents scoring above 0.65. Unlike our measure of scientific literacy, our measure for skepticism is far less symmetrical, making it impractical to divide up the sample into three segments. Therefore, the sample is divided into two groups: lower trust (scores of 0 to 0.50) and higher trust (higher than 0.5).

First, comparing the two groups shows that, indeed, those who are more skeptical of science show a lower level of support for water fluoridation, yielding mean scores of 3.96 to 4.61 ($t = -10.151$, $p < 0.001$). This confirms our expectation. Whether each group displays differences in susceptibility is our next focus.

Among those with low levels of trust toward science, negative narratives—alone or in combination with positive narratives—appear more likely to weaken support than positive narratives are able to raise it (Fig. 12.6a). This is confirmed in Model 1 of Table 12.4, where the only significant effects are found for Groups 3, 4, and 6. Unlike our expectations, narratives need not be a frame. Any negative narrative can make this group more opposed.

Similar results are obtained among those with a higher level of trust for science. However, there is some indication that positive narratives can strengthen support for fluoridation (see Fig. 12.6b). Model 2 of Table 12.4, however, suggests that the most promising narrative is the communitarian one (Group 2), but here, results are only marginally significant ($p < 0.10$). Overall, even among this more trusting group, negative narratives outweigh the positives.

Ideology

The final test looks at ideology, which is divided into three general subsets: left, centre and right. The expectation is that those in the center should show higher levels of support compared to those further away, either on the right or the left. When each group's mean level of support for water fluoridation is examined, expectations appear to be met, but not convincingly. Those on the left scored a mean of 4.3; those on the right scored 4.7; and those in the centre scored 4.2. Those in the centre appear

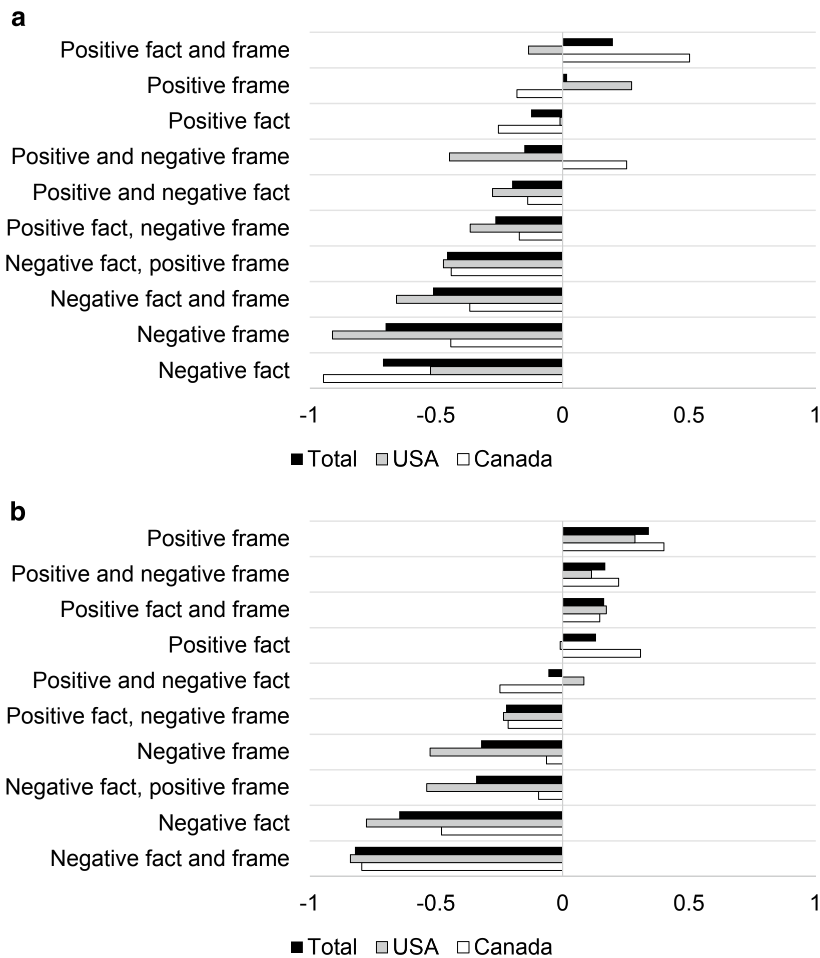

Fig. 12.6 (**a**) Lower trust in science; (**b**) Higher trust in science (*Source* Authors' own source)

to score lowest, but its score is statistically indistinguishable from that of the left. Those on the right, however, show greater support for fluoridation, and its score is statistically different than that of the left or right ($F = 28.124$, $p < 0.001$). Furthermore, the fact that those on the right

Table 12.4 Effect of narratives considering skepticism toward science

	Model 1: Lower trust				*Model 2: Higher trust*			
	B	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*
Experimental group								
Positive fact	−0.122	0.224	−0.019	0.586	0.198	0.152	0.031	0.194
Positive frame	0.046	0.224	0.007	0.838	0.283	0.145	0.047	0.052
Negative fact	−0.775	0.225	−0.122	0.001	−0.592	0.153	−0.093	0.000
Negative frame	−0.730	0.227	−0.113	0.001	−0.308	0.154	−0.048	0.046
Positive fact and frame	0.232	0.220	0.037	0.293	0.211	0.151	0.034	0.163
Negative fact and frame	−0.595	0.237	−0.087	0.012	−0.752	0.150	−0.121	0.000
Positive and negative frame	−0.168	0.220	−0.027	0.445	0.225	0.152	0.036	0.139
Positive and negative fact	−0.248	0.239	−0.036	0.300	−0.039	0.145	−0.007	0.790

	Model 1: Lower trust				*Model 2: Higher trust*			
	B	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*
Negative fact, positive frame	−0.391	0.222	−0.062	0.078	−0.299	0.152	−0.047	0.048
Positive fact, negative frame	−0.289	0.226	−0.045	0.201	−0.230	0.153	−0.036	0.133
Country	0.019	0.113	.005	0.867	−0.177	0.075	−0.051	0.018
Gender	−0.009	0.111	−0.003	0.935	−0.222	0.074	−0.064	0.003
Income	0.791	0.301	0.089	0.009	0.512	0.182	0.066	0.005
Education	0.702	0.244	0.094	0.004	0.914	0.155	0.129	0.000
Age	0.954	0.241	0.121	0.000	0.880	0.157	0.116	0.000
Intercept	3.318	0.226		0.000	3.891	0.151		0.000
Adj. R-sq	0.049				0.089			
S.E.E	1.729				1.653			
N	1052				2184			

Source Authors' own source

scored highest challenges some of the notions that anti-fluoridationists are conservatives.

The next step is to look at each ideological group to determine which narratives are most effective. Those on the left (see Fig. 12.7a) seem evenly split between scenarios that raise support for water fluoridation, and those that diminish it. But unlike expectations, those on the left are not necessarily more persuaded by communitarian narratives. Groups that contain a positive frame either show no significant effect, or they appear ineffective to counteract negative narrative. For instance, when the positive, communitarian, frame is paired up with a negative fact, support declines, which is significant at $p < 0.10$ (see Model 1 of Table 12.5). It should be noted that the sample size ($n = 460$) is a constraint on statistical power, and this may explain why what is visible in Fig. 12.6a may not yield significant results in Table 12.5.[12] Consequently, results here are not conclusive.

Those ideologically moderate (i.e., at the "centre") roughly show a similar pattern, but not nearly as split (see Fig. 12.7b), with the bulk of results resembling most previous results, whereby negative narratives seem more effective. But there are more instances when opinion improves over the control group. Respondents in Group 5 (combined positive fact and moral frame) show strengthening of support (B = 0.363, $p < 0.05$), while a similar boost appears for Group 2 (B = 0.331), although this is marginally significant at $p < 0.10$.

On the right (Fig. 12.6c), there is virtually no effect at all, except for negative prompts, regardless of whether they appear on their own or combined, even when combined with a positive prompt (see Model 3, Table 12.5). Results generally confirm expectations, where those on the right were expected to be moved by negative frames. Coefficients are highest for Groups 3 and 6.

Conclusion

If public health authorities wish to learn one thing from results reported here, it is that water fluoridation is one of those topics best managed

[12] The highly divergent pattern for Canadian and American respondents in Group 2 (positive frame) is not significant when tested in separate regression models for each country.

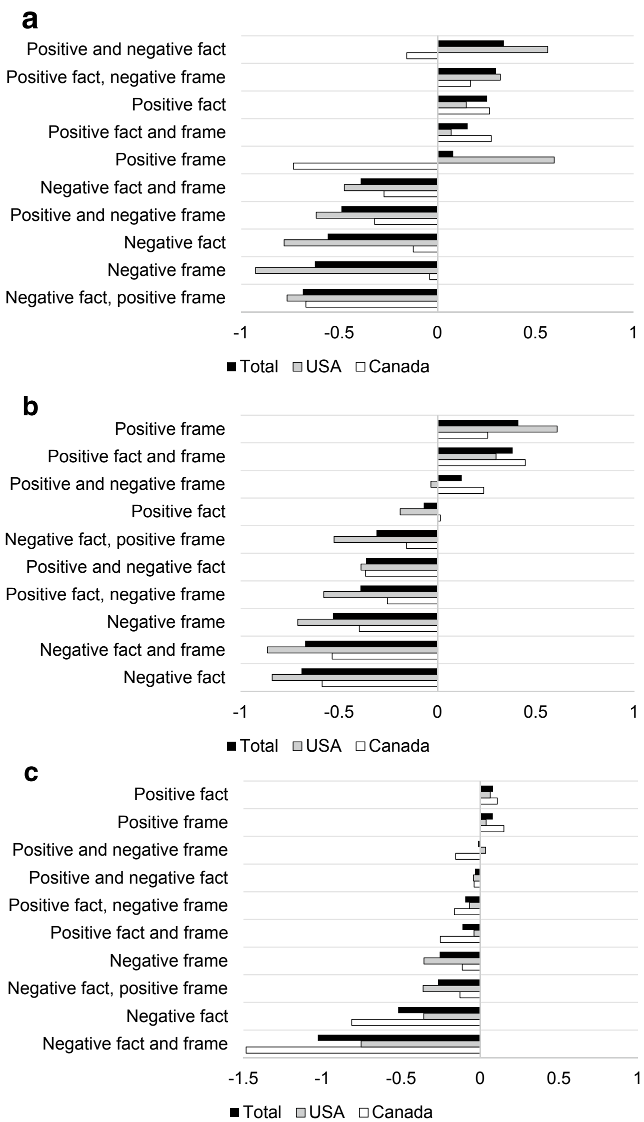

Fig. 12.7 (**a**) Ideology, Left; (**b**) Ideology, Centre; (**c**) Ideology, Right (*Source* Authors' own source)

Table 12.5 Effect of narratives considering ideology

	Model 1: Left				*Model 2: Centre*				*Model 3: Right*			
	B	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*
Experimental group												
Positive fact	0.252	0.408	0.032	0.536	−0.033	0.178	−0.006	0.854	0.097	0.213	0.015	0.648
Positive frame	0.229	0.394	0.031	0.562	0.331	0.175	0.057	0.059	0.004	0.213	0.001	0.986
Negative fact	−0.685	0.399	−0.091	0.087	−0.679	0.174	−0.118	0.000	−0.556	0.224	−0.082	0.013
Negative frame	−0.613	0.374	−0.090	0.102	−0.521	0.186	−0.083	0.005	−0.249	0.220	−0.038	0.258
Positive fact and frame	0.290	0.398	0.039	0.466	0.363	0.178	0.061	0.041	−0.070	0.207	−0.011	0.737
Negative fact and frame	−0.365	0.357	−0.057	0.307	−0.761	0.194	−0.116	0.000	−0.975	0.211	−0.156	0.000
Positive and negative frame	−0.368	0.407	−0.047	0.366	0.166	0.183	0.027	0.364	−0.017	0.206	−0.003	0.935
Positive and negative fact	0.335	0.388	0.046	0.389	−0.407	0.183	−0.066	0.027	−0.029	0.207	−0.005	0.889
Negative fact, positive frame	−0.708	0.375	−0.103	0.060	−0.151	0.193	−0.023	0.434	−0.244	0.201	−0.042	0.226
Positive fact, negative frame	0.310	0.455	0.034	0.496	−0.428	0.177	−0.073	0.016	−0.093	0.210	−0.015	0.660
Country	−0.634	0.197	−0.143	0.001	0.037	0.092	0.011	0.687	−0.026	0.108	−0.007	0.812
Gender	−0.212	0.190	−0.050	0.266	−0.083	0.090	−0.025	0.357	−0.149	0.105	−0.044	0.157
Income	0.215	0.460	0.024	0.640	0.686	0.236	0.086	0.004	0.820	0.264	0.104	0.002
Education	2.040	0.399	0.247	0.000	0.680	0.198	0.097	0.001	0.617	0.225	0.086	0.006
Age	1.798	0.394	0.201	0.000	1.074	0.203	0.140	0.000	−0.029	0.213	−0.004	0.892
Intercept	2.859	0.374		0.000	3.448	0.187		0.000	4.342	0.217		0.000
Adj. R-sq	0.155				0.083				0.048			
S.E.E	1.907				1.592				1.669			

	Model 1: Left				*Model 2: Centre*				*Model 3: Right*			
	B	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*	*B*	*Std. Err*	*Beta*	*Sig*
N	460				1363				1128			

Source Authors' own source

without too much engagement from the public. This is not an expression of doubt in the ability of democracy to deliver good governance, but the inability of democratic deliberations to manage discourse so that decisions are weighed on factual accounts. When deliberations are open to the public, they are open to a variety of interpretations and narratives. And the result, as we've seen both in actual practice and in the experimental survey design reported here, is for the public to grow wary. This is reflected by taking a big-picture view of all the results presented here. By counting all of the experimental groups that yield a significant effect at the 0.10 level in Tables 12.2 to 12.5, the 33 negative outcomes (i.e., coefficients) overwhelm the six that are positive. It is clear support for fluoridation can get knocked off balance, pressuring elected officials to follow the public will, whether that will is guided by science or not.

The problem is not just that deliberations are dominated by normative frames. As reported, narratives based on the negative fact that fluoride can cause bone disease are effective, far more than reassuring facts about its safety at low doses. Results also do show the negative factual narrative as more effective than the negative normative narrative. When paired, results show support for fluoridation weakens when negative facts are paired with a supportive factual or moral narrative. Of all the results presented in Tables 12.2 to 12.5, the most frequent significant results are those experimental groups that exposed respondents to negative facts or negative facts paired with negative moral frames. A close second is the group exposed to the libertarian negative frame, while third place (six times out of nine results) involves the group exposed to negative facts paired with a positive moral frame.

The potential for moral narratives to be as effective against factual accounts is apparent in some cases, but unexpectedly. For instance, it was expected for those with high levels of scientific knowledge to be more swayed by factual accounts. Instead, negative frames appear at least as effective. Even among those who show high levels of trust for science appear split on their susceptibility to factual versus normative narratives.

One could argue, then, that one way to challenge anti-fluoridationists is to mount an effective factually based counter narrative. Perhaps, but when the second round of experiments is considered, the more technically elaborate—and supposedly more benign—explanation of the chemical process involving hydrofluorosilicic acid does little to offset any fear. Once the public is even a bit fearful of something, the instinct of risk aversion predominates.

Arguably, one limitation here is the design of the experiment. While respondents were exposed to one of 10 different narratives (and combinations of narratives), the *dose* of each of these narratives was fixed. In reality, it is plausible that one side of a debate can assemble more resources and expend more energy to mount a stronger campaign. Such an asymmetry is likely in the context of fluoridation. The benefits of fluoridation, as important and impactful as they may be, are diffuse. Therefore, incentives for citizens to cooperate in its defense are small (Olson 1965). Instead, we are unlikely to see a groundswell of support behind a pro-fluoridation initiative, but are more likely to be left with a tyranny of an active and poorly informed minority.

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