

Coherency of Viewpoints Among Fluoridation Partisans

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INTRODUCTION

The sociology of scientific knowledge in recent years has forged a new perspective on the relationship between scientists and knowledge. The previous image was of rational searchers for the truth who uncovered unproblematical facts and developed theories to account for them. This positivist picture remains the dominant one among scientists, and is perpetuated for example in textbooks, popular histories and media accounts of science.

The new sociology has focussed on the social processes involved in the creation, establishment and reassessment of knowledge claims. Studies of 'shop-floor' dialogue between scientists show that 'facts' are the subject of continual social negotiation. There is no direct validation in the 'real world'. Rather, all scientific knowledge reflects processes of selection and negotiation whose relation to any hypothetical objective reality can remain a matter for debate.¹

One of the areas in which this perspective has been applied is scientific disputes.² Disputes cannot be concluded simply by reference to definitive experiments, since claims about the validity and interpretation of experiments are themselves dependent on social negotiation. In claims and counter-claims about what is scientific knowledge, various resources may be brought to bear, including arguments about the way the experiment was carried out, the status of the experimenters, and claims about what is correct method. In this picture, rhetoric about scientific method, rather than being treated as an accurate reflection of the way research is or should be carried out, is analysed as a resource or tool in negotiations about what counts as scientific knowledge and who is a reputable scientist.

So far, this sociology of scientific knowledge has been applied largely to processes inside the scientific community. When it comes to looking at scientific

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controversies which are intermeshed with wider social issues, such as nuclear power or genetic engineering, it is more common for analyses to be made at the macro level of group politics or structural analysis,³ without delving into the processes by which knowledge is assessed and solidified. One of the problems with this approach is that in public debates, claims about scientific knowledge are closely associated with other types of claims involving ethics, politics and economics. For example, disputes about the hazards of low-level ionising radiation are closely tied to issues of who creates the hazards and who is exposed to them.

In this paper, struggles over knowledge and authority in a public controversy are examined by looking at the viewpoints of some key figures in the fluoridation debate in Australia.⁴ The most important finding is an extreme polarisation of views between these proponents and opponents of fluoridation which applies not only to assessments of scientific knowledge but also to assessments of other issues which are raised in the debate. I argue that the debate itself is the primary process by which these extreme viewpoints are made coherent.

In the next section, the context of the fluoridation debate worldwide and in Australia is outlined briefly. Then, in the main body of the paper, the views of key figures in the Australian fluoridation debate are discussed. Finally, some implications for the study of scientific controversy are drawn.

THE FLUORIDATION DEBATE

In the early decades of this century, a search for the cause of mottling of teeth (dental fluorosis) in certain communities led to the identification of fluoride in local water supplies as the causative factor.⁵ Fluorine is a highly reactive element; in water it takes the ionic form fluoride. Investigators noticed that tooth decay (dental caries) seemed to be lower in communities with high levels of mottling. Further study of the association of fluoride and caries in humans and animals was carried out. In the United States, it was proposed at the end of the 1930s that fluoride be added to public water supplies low in fluoride, to raise the level to about one part per million (ppm) in order to reduce tooth decay in children. (Only a small fraction of present-day water supplies worldwide have 1 ppm or more of fluoride 'naturally'. Most have less than 0.2 ppm.)

Several trials were begun in the United States, the first ones beginning in 1945, in which one community's water supply was fluoridated and another's, serving as a control, was not. The US Public Health Service endorsed fluoridation in 1950, and support also came shortly thereafter from the American Dental Association and the American Medical Association. In the 1950s a large number of communities in the US began fluoridation and, somewhat later, some communities in other countries followed suit. Most studies of fluoridation have claimed large decreases in tooth decay, a typical figure being 50%.⁶

Shortly after large-scale introduction of fluoridation commenced, opposition began to occur. The opponents argued that fluoridation might cause various health problems, notably allergic and intolerance reactions, chronic fluoride poisoning (which could be manifested as skeletal fluorosis), genetic damage and possibly cancer.⁷ They also opposed fluoridation on the ethical ground that it was compulsory medication with an uncontrolled dose for a non-contagious disease. More recently, some opponents have presented technical studies arguing that the

benefits of fluoridation may have been greatly over-estimated by proponents.⁸

Fluoridation has been perhaps the most intensely debated public health measure in recent decades. In many US communities referenda have been held, more often than not resulting in the defeat of fluoridation.⁹ Elsewhere decisions have been made administratively, often favouring fluoridation in the US but not necessarily in other countries. Today, addition of fluoride to public water supplies is widespread in countries such as Australia (covering about 66% of the population), New Zealand (65%), the United States (53%) and Canada (37%). In most other countries the coverage is much lower, such as in the United Kingdom (9%) and in Europe as a whole (1%).¹⁰ With a few exceptions, in non-industrialised societies fluoridation is considered either unnecessary because tooth decay is not a major problem or impractical because water supplies are not centrally administered.

In Australia, as in other English-speaking countries, the fluoridation issue has been a major public controversy for several decades. The National Health and Medical Research Council, an advisory body made up of ad hoc expert committees, has made recommendations in favour of fluoridation since 1952.¹¹ Following the early recommendations, the idea was studied by dental and health bodies in different parts of the country. Because of Australia's federal structure, there has never been an attempt to introduce fluoridation nationally. Decisions have been made at the state level and, more frequently, at the level of individual cities and towns.

Mainly due to the initiative of individuals, a few Australian towns were fluoridated in the 1950s. Most capital cities have since fluoridated: Canberra (1964), Hobart (1964), Sydney (1968), Perth (1968), Adelaide (1971), Darwin (1972) and Melbourne (1977). The only capital city remaining unfluoridated is Brisbane.

The decision-making process involved has varied considerably, ranging from administrative decision to extensive political manoeuvring and public debate. In most cases, public debate about fluoridation is minimal in any given area in the years after a decision pro or con, but the issue is kept 'on the boil' by proposals to fluoridate additional towns, such as Geelong in Victoria in recent years.

There have been many people involved in the fluoridation issue in Australia, including dentists, politicians, public servants and many 'members of the public'. My interest in this study is focussed on the use of scientific knowledge in the public debate, and I have examined the views of knowledgeable professionals who have played an important role in the issue. 'Professionals' here refers mainly to scientists, dentists and doctors. The number of such individuals who have played an important promotional or oppositional role is quite small, and has been further reduced by deaths.

A reasonably complete sample of key figures in the cities of Canberra and Melbourne was interviewed, with a few from elsewhere. This coverage was achieved by initially contacting some well-known figures and also contacting state health departments and branches of the Australian Dental Association, and obtaining further names by the process of snowball sampling.

Fluoridation was introduced in Canberra (Australian Capital Territory) in 1964 by administrative decision with almost no public debate, whereas Melbourne (Victoria) was not fluoridated until 1977, after two decades of political struggle. Thus there is a stark contrast between the political contexts of the introduction of

fluoridation in these two cities, and so by interviewing key figures from each of them, it was hoped that any divergence of opinion that might have resulted from these differing contexts would be uncovered.¹²

The full list of those interviewed is given in Table 1. The interviews were carried out between September 1986 and February 1987. Three were conducted by telephone, the others face-to-face.

Table 1. Names and identification of fluoridation partisans interviewed.

Proponents

Lloyd Carr, Special Advisor (Dental), Commonwealth Department of Health, Canberra; Chairman, National Health and Medical Research Council (NH&MRC) Working Party on Fluorides in the Control of Dental Caries.

Graham Craig, Associate Professor, Department of Preventive Dentistry, University of Sydney; Member, NH&MRC Working Party on Fluorides in the Control of Dental Caries.

Jean Currie, School Dental Section, Australian Capital Territory Health Authority, Canberra.

Gerald Dickinson, orthodontist, Melbourne; formerly Chairman, Australian Dental Association (Victorian Branch) Fluoridation Committee.

Bruce Levant, dentist, Melbourne; formerly Chairman, Australian Dental Association (Victorian Branch) Fluoridation Committee.

Jack Martin, Professor of Medicine, University of Melbourne; Member, NH&MRC Working Party on Fluorides in the Control of Dental Caries.

Noel Martin, Professor, Department of Preventive Dentistry, and Dean, Faculty of Dentistry, University of Sydney.

Gavin Oakley, dentist, Melbourne; formerly Chairman, Australian Dental Association (Victorian Branch) Fluoridation Committee.

Elsdon Storey, Professor in Child Dental Health, Department of Preventive and Community Dentistry, University of Melbourne.

David Thornton Taylor, orthodontist, Canberra; formerly Chairman, Australian Dental Association (ACT Branch).

Keith Traynor, dentist, Canberra.

Opponents

Mark Diesendorf, formerly Principal Research Scientist, Division of Mathematics and Statistics, Commonwealth Scientific and Industrial Research Organization, Canberra.

Leslie Kausman, formerly pharmaceutical chemist, Melbourne; formerly Secretary, Anti-Fluoridation Association of Victoria.

John Polya, formerly Associate Professor, Department of Chemistry, University of Tasmania.

Geoffrey Smith, dental researcher and consultant, with experience in general practice, Melbourne.

Philip R.N. Sutton, formerly Senior Lecturer, School of Dentistry, University of Melbourne; author of *Fluoridation: Errors and Omissions in Experimental Trials*.¹³

Glen Walker, Chairman, Anti-Fluoridation Association of Victoria; Chairman, Freedom from Fluoridation Federation of Australia; formerly owner and then Chairman of Directors of a metal finishing supply company; author of *Fluoridation: Poison on Tap*.¹⁴

The number of opponents interviewed is relatively small but constitutes an almost complete coverage of scientists, dentists, doctors and other technical workers who have been prominent in the debate in major cities. Only two other individuals from Melbourne and Canberra are obvious candidates for the list of opponents: Arthur Amies, formerly Dean of the Melbourne University Dental

School, now dead; and Edward Dunlop, surgeon, Melbourne, who declined to be interviewed. Since quite a number of proponents were interviewed, no attempt was made to obtain complete coverage of this group. Even so, those knowledgeable about campaigns in other states informed me that there were few to contact in Perth, Adelaide or Brisbane. Because of the long and active struggle over fluoridation in Melbourne, there seems to be a high density of partisans there.

Of the individuals in Table 1, only one, Taylor, said he did not play an important role in the decision-making or debate on fluoridation. Several, perhaps most notably Oakley and Walker, are inveterate campaigners.

Questions were asked about the introduction of fluoridation in the relevant area, about the reasons for fluoridation, about assessment of alternatives to water fluoridation, about reasons for opposition to fluoridation, about why there is little fluoridation in Europe, and about appropriate decision-making procedures concerning fluoridation. The interviews were open-ended, the questions often serving as a lead-in to general comments.

One of the initial motivations for the interviews with these individuals was to prepare a history of fluoridation in different parts of Australia. It soon became apparent that such interviews were an unreliable way to add to such a history. On the other hand, it was striking how the viewpoints of the pro- and anti-fluoridationists were unified into coherent wholes. It is to this coherency that I now turn.

COHERENT VIEWPOINTS

The viewpoint of every person interviewed was highly coherent, and indeed mobilised, either in total support or total opposition to fluoridation. This included both technical issues concerning the benefits or risks of fluoridation and ethical and political issues.

The proponents were unanimous in crediting fluoridation with massive reductions in tooth decay. While figures of the order of 50% reduction are standard in the technical literature, two dental practitioners volunteered that the reduction in decay they had personally observed in children's teeth would be of the order of 90% if both the number and seriousness of cavities were taken into account. By contrast, only one of the opponents accepted that any reductions had been conclusively shown to be due to water fluoridation. (None ruled out that water fluoridation *may* have resulted in reductions in cavities.) They pointed to flaws in the experimental trials and also pointed to the decline in caries in unfluoridated cities such as Brisbane.

The opponents argued that there are health hazards from fluoridation to at least a small fraction of the population, such as intolerance reactions. They said that the possibility that fluoridation increased the cancer death rate could not be ruled out (though as yet the evidence was not fully conclusive).¹⁵ By complete contrast, the proponents denied that there was adequate evidence to demonstrate hazard to a single individual from fluoridation. The studies which purported to show such hazards were dismissed as unsubstantiated, poorly done or biased.

Concessions from these monolithic perspectives were so infrequent that they are worth itemising. Smith, an opponent, said that an optimal intake of fluoride as a decay preventive has been well established. Polya, another opponent, said that fluoride *may* play some useful role in preventing decay, via individual doses for

those who are not sensitive. Taylor, a supporter though not a leading proponent, noted that there is only a factor of three between 1 ppm of fluoride in water which is optimal and 3 ppm which can cause unacceptable mottling of teeth, and that this factor of three is small compared to the usual factor of 100 between recommended use and harmful effects. These were the only conspicuous 'concessions' towards the opposition views on benefits and risks raised in all the interviews.¹⁶

One feature of the coherency of viewpoints is a total dismissal of alternatives to the policy endorsed. One of my questions was "To what degree and why was water fluoridation promoted in preference to major campaigns for: widespread use of fluoride tablets; fluoride in school water supplies; fluoride in table salt; topical applications of fluoride; improved oral hygiene; and better diet". Almost without exception the proponents dismissed each of these alternatives as impractical, ineffective or even undesirable. It was said, typically, that fluoride tablets work but few people persist in giving them to their children, that school water supplies do not provide a full coverage (missing pre-school children in particular), that excessive intake of salt is undesirable for health reasons, that topical (surface) applications are too expensive and do not reach the entire community, that improved oral hygiene is of limited importance for tooth decay (though benefiting gums), and that achieving better diet, while desirable, is very unlikely to occur.

The reasons against these alternatives were not surprising, since objections have been raised to each of them in the literature.¹⁷ What was striking was the total rejection of all alternatives coupled with the total endorsement of water fluoridation. For example, fluoride tablets were rejected as not providing the coverage of the community that water fluoridation does. But since some communities reject water fluoridation, it might be thought that tablets would be appropriate in these places, since they avoid the objection of compulsion. Again, fluoride in table salt avoids compulsion, and has been effectively implemented in Switzerland. Yet the advantages of the alternatives in overcoming some of the primary objections to fluoridation were never mentioned by proponents.

The proponents agreed that strong efforts had been made to improve oral hygiene and diet. There were divergent opinions about whether diet had actually improved, but agreement that little could be done to dramatically alter the decay-producing aspects of Western diets and agreement that fluoridation was still necessary.

One of the findings of the sociology of scientific knowledge is that scientists express different evaluations of evidence and knowledge through the use of different types of language. When knowledge claims are accepted, they are typically referred to as having derived from objective examination of material reality. The language used here is called the 'constitutive' or 'empiricist' repertoire.¹⁸ An example would be, "The early studies showed that fluoride in water significantly reduces tooth decay". When knowledge claims are challenged, it is common for the human aspects of the claims to be exposed. The language here is called the 'contingent' repertoire. For example, "The early investigators selected their figures in a way which favoured fluoridation, while actually some towns with high fluoride had higher decay".

I expected that advocates on each side would use the constitutive repertoire when describing their own position and the contingent repertoire when describing the other side. As indicated in the following paragraphs, this did occur regularly, but in addition, the contingent repertoire was often used by proponents and opponents

in describing views and behaviour on *both* sides. This seems to be a product of the intensely political nature of the debate, which means that the operation of 'political' factors is more overt and recognised on both sides.

Most interviewees claimed their stand was based on the scientific evidence, while denying that there was any rational basis for a contrary view. The proponents regularly described the opponents as a fringe minority. Carr said that opponents such as Amies and Sutton were in the corner of a field, and that credence should be given to those in the centre, including the World Health Organisation, health authorities and parliaments. When asked to account for the opposition of particular prominent figures (I specifically mentioned Amies and Dunlop), several proponents simply said they couldn't understand it and that they never had understood what motivated anti-fluoridationists.

Arthur Amies was the most prominent opponent of fluoridation in Victoria for many years before his death. In view of his position as Dean of the Dental School at the University of Melbourne, both proponents and opponents said Amies was responsible for greatly delaying the introduction of fluoridation in Melbourne, where nearly one-fifth of Australians live. The frequency and variety of contingent explanations for Amies' stand were fascinating. It was explained to me by different proponents that Amies' views were coloured by his wife's diabetes; that he was strongly against dentistry in the United States, for example because of the ease of obtaining honorary doctorates, and saw fluoridation as American in origin; and that he had a philosophical preference for treating the individual rather than using mass treatment. By contrast, Kausman and Sutton, opponents who knew Amies, attributed his opposition to knowledge.

Some proponents and opponents interviewed made highly derogatory comments about each other, but only about those on the other side. Some or all of those on the other side were called unscientific, discredited and occasionally much stronger things such as liars and fools. Some very specific examples were offered to justify this sort of language. Only some interviewees made such derogatory characterisations; these arose spontaneously in the interviews.¹⁹

Although the participants interviewed always attributed their own stand to knowledge (the constitutive repertoire), most of them were quite open in describing why they had become involved with the topic, and in most cases this explanation relied on the contingent repertoire. This difference is understandable in terms of a distinction between arguments for or against fluoridation and reasons for being involved in the debate. The arguments (for or against) are seen by most interviewees as scientific, while involvement in the debate is seen as political, which may legitimately be described using the contingent repertoire.

Most proponents, without being asked, explained their own support for fluoridation and their involvement in the debate as being a result of their experience, as dentists or dental researchers, with massive decay problems, most commonly in the 1950s. The dentists recounted their experiences in extracting numerous teeth, sometimes the entire dentition, from child after child under general anaesthesia, with tears from the child, parents and even the dentist. It was their experience of the human suffering of tooth decay that led to their support for a preventive measure.

The opponents expressed a much more varied set of motivations. Diesendorf had previously been involved in campaigns on a number of environmental and health

issues, including opposition to compulsory mass chest x-rays programmes which have certain similarities to fluoridation. Sutton said he became involved after Amies asked him to look at figures on fluoridation trials. Walker had come across fluoride in his metal finishing supply company and found it highly dangerous.

Contingent explanations came into their own in responses to the question “How do you account for the failure to fluoridate in some other countries, especially in Europe?” This question was prompted by evidence that there is very little water fluoridation in Europe. There have been some pilot fluoridation operations, and at one time the Netherlands was 50% fluoridated. But fluoridation in the Netherlands has been stopped and there are no large fluoridation plants in Europe. Detailed information about the reasons for lack of fluoridation in Europe is hard to obtain, and so this question provided a type of Rorschach ink blot test on which people could supply speculations about the lack of fluoridation. A couple of respondents mentioned some sources for their information, which was mostly about Scandinavia;²⁰ a number of respondents on the other hand admitted their comments were speculative.

Explanations offered by proponents were uniform in insisting that health concerns were not the reason for lack of fluoridation. Carr for example said that countries have not avoided fluoridation on the basis of health, and therefore by exclusion there must be political reasons. Political factors were most commonly mentioned, specifically the organised efforts of anti-fluoridationists. Other reasons suggested were legal obstacles, popular opposition to centralised measures (due to the experience of fascism), the low status of European dental professionals, the use of other methods to prevent cavities (such as fortnightly treatment of people showing a tendency towards decay), a lower level of tooth decay, and higher levels of fluoride in the water naturally. It was mentioned by a couple of respondents that the parliamentary vote against fluoridation in the Netherlands had immediately followed a claim on television by an American anti-fluoridationist that fluoride causes cancer.²¹ In this context Oakley said “It is nothing to do with science – it’s all politics”. This was a common view.

Opponents, in their explanations, gave much more weight to rational consideration of evidence by European authorities. Kausman said European countries had been guided by scientific advisors. Walker said that the failure to fluoridate in Europe was because their scientific communities were better educated, more inquiring and objective. But most opponents put rational considerations in the context of contingent factors. Polya and Diesendorf each suggested that medical and scientific bodies in some countries may have been more cautious, especially of a US-based idea.²²

In describing the introduction of fluoridation in Australia, many of those interviewed had a great deal of information, and both proponents and opponents gave detailed accounts which usually included a strong component of contingent factors. Here I only give a couple of examples of how a ‘fact’ raised on one side can be deconstructed by the other side.

Oakley mentioned that a local newspaper had published an anti-fluoridation article which said that there had been a 63% increase in hospital admissions for kidney problems, which the author attributed to fluoride.²³ Oakley was writing a response; he checked with the hospital and found that the reason for the increase was that there were more dialysis machines available.

Storey in a letter to the *Melbourne Age* criticised Sutton's opposition to fluoridation.²⁴ Storey noted that the judge in the Strathclyde (Scotland) court case on fluoridation had said that Sutton had made no criticism of the important Tiel-Culemborg (Netherlands) study. Both Sutton and Walker spontaneously brought up this issue, noting that Sutton in his testimony had only been asked whether the Tiel-Culemborg study was an important one. He had replied yes, but had not been asked anything further about the study; in other words he had not been asked if he had any criticisms, which he did have.

To an outsider, these may seem like minor points, not really affecting the major issues at stake. But to those involved, small errors or alleged misrepresentations by the other side reflected the general inadequacy of those against whom they were debating.

While a few interviewees recollected the satisfaction of disputing a technical point raised by the other side, more common was an experience of the intensely political nature of the debate. This was generally regarded as undesirable, and certainly seen as frustrating by nearly everyone concerned, since they believed that there was a 'truth' which favoured their position. Dickinson said he would have respect for opponents if they raised constructive criticisms, but this was not the case and eventually he dropped out of the issue because of the emotionalism involved. Polya was unique in being openly derogatory of non-scientist partisans involved on both sides. He characterised the proponents as having latched onto the idea of fluoridation and then being tied to it with religious fervour, while many of the opponents were Luddites often with fundamentalist connections. Polya thought that there was no real science involved in the debate since there was no peer group for scientific argument, and that he had joined a political rather than a scientific debate.

It is common in controversial issues for partisans to attempt to associate their cause with favourable images. Proponents regularly refer to 'controlled fluoridation' (because the concentration of fluoride in the water supply is controlled) while opponents refer to 'artificial fluoridation' (and note that the dose of fluoride to people who drink fluoridated water is not controlled). The claim that fluoridation is artificial or unnatural is a staple of the anti-fluoridation repertoire. What was striking in the interviews was the number of proponents who without prompting described water with added fluoride as more natural than its previous unfluoridated state. Craig said that water fluoridation is chosen to mimic nature, to supplement depleted water. Currie said that water reservoirs for urban areas are over-purified compared to natural water supplies, and that fluoridation is not really adding anything but rather putting the level up to natural levels. This seemed to be a common perception of fluoridation by proponents, not just an argument of convenience. The disagreement about what is called natural shows that this concept is one which can be challenged and struggled for: it does not spring unambiguously from 'nature'.

Perhaps the most dramatic evidence of the coherency of viewpoints across all aspects of the fluoridation issue came with views expressed about ethics and individual rights. A standard objection to fluoridation is that it is a violation of individual rights, being compulsory mass medication for a non-contagious disease, and indeed this objection has been central to the opposition. It shapes the scientific claims of both sides. Proponents regularly deny that there has been a single

documented and authenticated case of damage to an individual's health from water fluoridation. If it were acknowledged that, for example, fluoridation caused harmful effects in even just one out of a million people, then this would have to be weighed against benefits in the form of reduced tooth decay. The argument would be one of health costs versus health benefits. But if there are no health costs, the argument is shifted to a different ground: there is no apparent reason to object, and opposition seems irrational. Craig for example admitted that some value judgements (left unspecified) are involved in the fluoridation issue, but said concerning the issue of relative risks that there are *no* demonstrated risks.

Some opponents think the individual rights argument is so important that they would oppose fluoridation even if there were no health risks. The attitude of proponents to the individual rights argument is vastly different. Traynor said that fluoridation, like chlorination, is a health measure beneficial to the community, and individuals can not do anything about it. Oakley took the measured view that liberties are not absolute and that people should submit to reasonable laws for overall benefit, provided safety is assured. Dickinson said that it is ethical to *have* fluoridation: when there is a widespread disease causing pain and cost, there is a need for community health measures, such as seat belts. Thus the rights issue, a central one to most opponents, carried little weight with proponents, or was actually turned to their advantage.

A key question in the interview was "What do you think is an appropriate decision-making procedure on fluoridation?" Here the views of proponents and opponents diverged again, along lines congruent with their stance on fluoridation. In Australia, the Tasmanian Royal Commission (1968)²⁵ and the Victorian Committee of Inquiry (1980)²⁶ have been the two most important inquiries into the issue; both strongly endorsed fluoridation. With a few exceptions, most overseas commissions and inquiries have also supported fluoridation. Opposition to fluoridation has been more effectively expressed, in the United States at least, in referenda. When members of the public are given an opportunity to express opinions on fluoridation, for example in a 'public debate' involving public meetings, petitions and letters to newspapers, opponents of fluoridation are frequently much more successful than they are in formal inquiries.

Proponents without exception favoured a path in which expert bodies played a major role, advising a government which then took action implementing the specialist expert advice. They opposed referenda. The proponents were uniformly reluctant to support any direct public involvement in decision-making except that which is implicit in the election of representative government. For example, Carr said that government, which is the voice of the people, should decide, and that the government should not take a decision without consulting the experts (health authorities, National Health and Medical Research Council, university professors). Traynor said there should never be a referendum on a public health issue because members of the public are not qualified to offer an opinion. Levant opposed referenda but favoured a public education campaign before or after the decision to tell the public what had been done and why.

The views of proponents on decision-making about fluoridation are compatible with their own situation and conclusions: most expert bodies have favoured fluoridation; they (the proponents) favour fluoridation; and many of them are the very experts whom they consider should be relied upon to play a major role.

The opponents²⁷ supported community participation in decision-making on fluoridation, usually by referendum. Walker said that experts can put their case to the people before the vote. Polya said that people should be free to choose their own medicines and health measures, provided that choice does not disadvantage others; he suggested that fluoridation should not proceed even with support in a referendum, drawing the analogy that there should not be a referendum on religion even though one religion may be best for the community.

The opponents still left an important role for science and expert opinion, but contrary to the proponents they thought that a full range of experts would not necessarily support fluoridation. For example, Diesendorf saw value in specialist knowledge but opposed a technocratic elite making decisions for the public: community decision-making was necessary since political and ethical issues were involved. Sutton favoured referenda in practice but thought that in an ideal world fluoridation would be a scientific issue decided by appropriate scientists, including statisticians. Smith did not mention referenda, but commented that it is dangerous to legislate to enforce something that is supposed to be a scientific issue, and that politicians should understand that no scientist has the ultimate truth.

The more diverse range of views of the opponents on decision-making can be interpreted as reflecting two conflicting tendencies. On the one hand, they are likely to favour referenda because this has been an effective way by which fluoridation has been stopped. On the other hand, most of them hesitate to rule out the role of experts, since that is where their own role in the issue lies.

Rounding out the picture was the regularity with which proponents and opponents criticised the decision-making approach favoured by the other side. Proponents dismissed referenda, claiming that anti-fluoridationists would win because it is easy to scare people with allegations about poison and cancer, and anyway, people usually vote no in any referendum. Two of the opponents denigrated formal inquiries. Sutton commented that judges are for judging the law and are not equipped for judging science, and that they rely on the opinion of advisors and witnesses whose credibility depends partly on reputation. Polya said simply that inquiries are set up not for science but to keep people quiet. In each case the decision-making procedure favoured by the other side is undermined using the contingent repertoire.

SOURCES OF COHERENCY

The views of partisans in the fluoridation debate who are knowledgeable about the technical issues involved show a remarkable coherency which cuts across the common division between scientific and non-scientific issues. Whether the topic is the benefits of fluoride, the hazards of fluoride, alternatives to water fluoridation, reasons for lack of fluoridation in Europe, the naturalness of fluoride in water, the ethics of fluoridation or the most desirable methods of decision-making on technical issues, the partisans line up on opposite sides of the fence in a completely predictable fashion.

One possible explanation for this coherency of viewpoints is that the partisans held, prior to encountering the fluoridation issue, a set of attitudes about health risks and benefits, ethics and decision-making, which they have applied to the fluoridation issue and expressed in the course of the debate. I argue here that this explanation is both implausible and virtually untestable.

Probing this explanation, it may be asked: why are there no individuals prominent in the debate who have studied the issue carefully and decided that while the benefits of fluoridation are large and the hazards negligible, nevertheless on ethical grounds the measure should be opposed? Why has no prominent fluoridation partisan found the benefits to be overestimated and the hazards to be of concern but nevertheless concluded that the benefits outweigh the costs and that the decision should be made via expert committees? If knowledgeable individuals with these or other such mixtures of views do exist, they have not become prominent in the Australian fluoridation debate.

In the current and recent social climate, and speaking very generally, concern about the hazards of trace substances is characteristic of environmentalists, support for individual rights over collective benefits is characteristic of the political right, and support for direct citizen participation in decision-making is characteristic of the non-statist left. It seems most unlikely that anti-fluoridation partisans would have originally come to the issue with this mixture of orientations and that pro-fluoridation partisans would have had precisely the opposite orientations. In short, it is implausible that prior sets of attitudes explain the observed coherency of views.

It may be asked: why not test this point by asking partisans their views on seat belt legislation, compulsory AIDS testing, nationalised health insurance and a variety of other issues? The trouble is that for most of the partisans, the issue of fluoridation is much more significant in their lives – in some cases it is the central social issue – than the other areas to which it might be compared. As a result, personal stands on fluoridation will tend to shape views on related issues, in order to reduce cognitive dissonance.²⁸ For example, views on individual rights linked to the fluoridation issue are likely to influence views about seat belt legislation rather than vice versa.

In order to test whether views on fluoridation reflect prior sets of attitudes, one would have had to examine attitudes on a range of issues prior to an individual's involvement in the fluoridation debate. This implies examining virtually everyone, in some cases before the fluoridation debate even arose (since some partisans were involved with the issue from the beginning). Thus this explanation for coherency of viewpoints is virtually untestable, at least for the case of fluoridation.

I argue that a more plausible explanation of coherency of viewpoints is the influence of the fluoridation debate itself on the partisans. Because there has been an intense public debate on fluoridation, any person with claims to expertise who speaks publicly on the issue comes under strong pressure to support one side or the other. Because most authorities (at least in English-speaking countries) favour fluoridation, any expert who voices even moderate criticism tends to be taken up by opponents as supporting their cause. Anyone who conspicuously spurns partisanship on either side is unlikely to find professional or emotional support from either side. This seems likely to create a pressure to join either one side or the other, or to drop out of the issue.

In the camps of both proponents and opponents there are processes which encourage the coherency of viewpoint. In the fluoridation committees of the Australian Dental Association, the explicit aim is to promote fluoridation. Those actively involved in such committees scour the literature to find relevant evidence and arguments, and in their speaking engagements they quickly learn the most

effective responses to various questions. Anyone who has debated an issue in public knows that it is difficult to stick to only a portion of the issue, especially the technical part. Other issues are raised in questions and, if the cause is to be promoted, effective answers need to be given.

The intense and all-consuming nature of the campaign for many of those involved is seldom apparent to people on the outside. There are talks to be given to public meetings, community groups, radio and the press, enquiries from members of the public to be answered, letters to write to newspapers, submissions to make to politicians. This applies to activists on both sides. Oakley of the proponents and Walker of the opponents seemed among the most persistent and indefatigable of partisans. Interestingly, each one expressed the view that the activists on their side were an embattled few, with little money and insufficient people willing to take an open stand.²⁹ It is precisely this situation of a small group of partisans making enormous efforts in the face of perceived apathy that is conducive towards the moulding of a coherent overall perspective. Some of the scientists involved were not so active in the day-to-day struggle; nevertheless, their views were no less coherently organised around the issue, so far as can be seen from the limited sample.

Another factor promoting uniformity of viewpoints is the reliance on overseas material by both proponents and opponents. Certainly endorsements by dental and medical associations overseas are regularly cited by proponents, while critical work is cited by opponents. But it is not clear how much the use of this material actually influences the coherency of positions; certainly not all material is used, and all of it must be adapted for Australian conditions and audiences.

One factor which both reflects the coherency phenomenon and helps maintain it is the lack of informal personal contact between proponents and opponents. It would seem that the most regular contact between those on opposite sides occurs during hearings or debates on fluoridation, for example before local councils making decisions on the matter. There seems to be little free discussion of the issues. Symptomatic of this is the comment by Sutton that no one in the Melbourne University School of Dentistry approached him to talk about fluoridation during his ten years there, although the School included many supporters of fluoridation such as the prominent proponent Storey.

While contact between partisans on opposite sides is uncommon, interaction of those on the same side is frequent and can be intense. Consultation can occur to check facts, prepare arguments, coordinate talks or letters to newspapers and journals and so forth. It is not surprising that interaction between sympathisers is common. Some of the opponents reported receiving considerable correspondence from around the world, naturally most of it from other opponents.³⁰

Does it make sense to analyse separately the views of partisans on science, ethics and politics? My conclusion from interviews with Australian fluoridation partisans is that it does not. The coherency of viewpoints most plausibly derives from engagement in a public debate on an issue with both scientific and political dimensions. To resist pressures for coherency within the debate would mean not so much individual cognitive dissonance but rather social dissonance: attacks from both sides and pressures to take a stand.³¹ For the technically knowledgeable partisans discussed here, it makes little sense to isolate views on the benefits or hazards from views on individual rights, because views on the whole array of issues are made coherent by

the debate itself.

The partisans themselves often distinguish between science and politics, usually in a way which aids their own argument. The distinction which they make can best be described as socially constructed. For the purposes of social analysis of partisan viewpoints, it seems much more useful to deconstruct this distinction and to consider viewpoints on a whole range of topics. In this way there is less illusion that views are separately formed on the 'merits' of the case in science, ethics and politics; rather, what seems to happen is a global judgement made in the context of a polarised issue and a resultant coherency of views which cuts across the distinction between scientific and non-scientific factors.

EPILOGUE: AUDIENCES

Scientists present to the world an image of objectivity, using the public version of the constitutive repertoire. But some science journalists and sociologists of science occasionally expose the 'backstage'³² features of scientific behaviour to a wider audience, and this exposure of the contingent side of science tends to undercut attempts by scientists to portray their work as different from other social and political activities.

Unlike most scientists, partisans in the fluoridation debate are used to having their views on the topic under public scrutiny, whether in talking to public meetings, to the media, to Rotary Clubs, to patients or to colleagues. The partisans are 'on stage' to a much greater degree than most scientists precisely because of the controversial nature of fluoridation.

Even comments made in passing sometimes can be made public, quoted out of context and used against the speaker. I was told that Amies eventually refused to talk to the press because of being misquoted and only provided written comment which was to be used in entirety or not at all. In-house comments, if leaked to those on the other side, can be very damaging. Anti-fluoridationists in 1968 obtained a copy of a talk by United States fluoridation proponent F.A. Bull given in 1951 to a meeting of state dental directors, and they have quoted allegedly damaging comments by Bull ever since.³³

Because fluoridation partisans are 'on stage' to a much greater extent than other professionals, they are much less likely to make any concessions. Eventually some of them may find themselves *always* arguing the case for or against, even when among friends. One never knows who may change sides and provide a damaging exposure of private conversations.³⁴

All this makes it difficult for the social scientist to obtain a full picture – that is, a picture including any personal views at variance with public rhetoric. Outsiders will only be taken into the confidence of partisans and told of any doubts by the insiders if they are seen as entirely sympathetic or unthreatening. For someone planning to analyse the views of both sides, this raises obvious obstacles.

The usual strategy of the social scientist is to adopt a stance of 'neutrality'. This technique may suffice to establish a degree of confidence in those interviewed when the issues are not highly public and intensely political. But for the fluoridation controversy there seems to be no such thing as neutrality. A social scientist may attempt to remain neutral and indeed may not care strongly about the issue, but what the social scientist says and publishes on the issue inevitably becomes an intervention in the debate.

Since the weight of scientific authority strongly supports fluoridation, a 'symmetrical' analysis of the partisans, revealing the coherence of 'scientific' and 'non-scientific' views on the issues, would seem inevitably to aid the opponents more than the proponents. Only an acceptance of the scientific validity and objectivity of the case for fluoridation would satisfy proponents; anything short of this aids the credibility of opponents (at least in countries like Australia, where the key authoritative bodies support fluoridation without reservation). Such an acceptance clearly would be incompatible with the project of the sociology of scientific knowledge.

If a kind of Heisenberg uncertainty relation applies to social science, so that it is impossible to study an issue without disturbing it, the magnitude of its effects is enhanced when studying controversial issues. One way to reduce the problem is to write very cautious social scientific analyses and publish them in esoteric social science journals. This reduces the 'disturbance' to the public debate being studied but also puts a constraint on the conclusions reached and the audience to which they are presented.

As soon as a draft of this paper (without this final section) was sent to the interviewees, it clearly identified me as someone who treats scientific criticisms of fluoridation as worthy of discussion, and therefore as someone whose writings presumably would be more useful to the opponents than to the proponents. So it is not surprising that all but one of the opponents offered written comments (many quite critical) on the draft, whereas the only response from the proponents was the written request from two of them not to be associated with or included in the article in any way. This pattern of response indicates that further investigation by interviewing these same individuals has been made much more difficult and uncertain value. Fortunately, this situation does not present an insuperable obstacle to further study, since many of the stands by these partisans are recorded and continue today to be expressed in articles, letters to newspapers, public addresses and debates.

As the social scientific analysis of science is developed, it can be used as a resource in public disputes. This means that the audience for social science is much more than simply other social scientists: partisans will take advantage of anything they can.³⁵ One prospect is that researchers using the sociology of scientific knowledge may avoid tackling issues in which a 'symmetrical' analysis would help a cause with which they are unsympathetic. Social scientists also can respond by retreating into uncontroversial issues or obscure language, or alternatively by confronting the issue head-on.³⁶

Being reflexive means applying one's theory to one's own work. In exposing the backstage behaviour of scientists, this can mean exposing the backstage behaviour of social scientists. In doing this, social scientists' implicit claims of being 'scientific' and above the debate being studied are jeopardised. Whether researchers decide it is worth risking this occupational hazard in order to deal with socially important issues is something that the further applications of the sociology of scientific knowledge will reveal.

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Notes

1. See, for example, G.N. Gilbert and M. Mulkay, *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse* (Cambridge, Eng: Cambridge University Press, 1984); B. Harvey, "The Effects of Social Context on the Process of Scientific Investigation: Experimental Tests of Quantum Mechanics", in K.D. Knorr, R. Krohn and R. Whitley (eds.), *The Social Process of Scientific Investigation* (Dordrecht: D. Reidel, 1980), pp. 139-163; B. Latour and S. Woolgar, *Laboratory Life: The Social Construction of Scientific Facts* (London: Sage, 1979); Mulkay and Gilbert, "Putting Philosophy to Work: Karl Popper's Influence on Scientific Practice", *Philosophy of the Social Sciences* (1981), 11: 389-407; T.J. Pinch, "The Sun-Set: the Presentation of Certainty in Scientific Life", *Social Studies of Science* (1981), 11: 131-158.
2. See, for example, H.M. Collins, "The Seven Sexes: a Study in the Sociology of a Phenomenon, or the Replication of Experiments in Physics", *Sociology* (1975), 9: 205-224, and "Son of Seven Sexes: the Social Destruction of a Physical Experiment", *Social Studies of Science* (1981), 11: 33-62.
3. See, for example, D. Nelkin (ed.), *Controversy: Politics of Technical Decisions* (Beverly Hills: Sage, 1979).
4. There is a large amount of social science research on fluoridation. For reviews see P.J. Frazier, "Fluoridation: a Review of Social Research", *Journal of Public Health Dentistry* (1980), 40: 214-233; A. B. Motz, "The Fluoridation Issue as Studied by Social Scientists", in N.D. Richards and L.K. Cohen (eds.), *Social Sciences and Dentistry: A Critical Bibliography* (The Hague: A. Sijthoff, 1971), pp. 347-366. Most of this work relies on a positivist view of science; there have been no previous studies of coherency of viewpoints, and indeed there are very few studies which treat the views of proponents as problematical.
5. The most engaging account of the search for the cause of mottling and the introduction of fluoridation is D.R. McNeil, *The Fight for Fluoridation* (New York: Oxford University Press, 1957). See also F. J. McClure, *Water Fluoridation: The Search and the Victory* (Bethesda: US Department of Health, Education and Welfare, 1970).
6. Comprehensive discussions of fluorides and tooth decay include E. Newbrun (ed.), *Fluorides and Dental Caries* (2nd ed.; Springfield, Illinois: Charles C. Thomas, 1975); J.J. Murray and A.J. Rugg-Gunn, *Fluorides in Caries Prevention* (Bristol: Wright, 1982); D.F. Striffler, W.O. Young and B.A. Burt, *Dentistry, Dental Practice and the Community* (3rd ed.; Philadelphia: W.B. Saunders, 1983).
7. The most authoritative critique of fluoridation is G.L. Waldbott, A.W. Burgstahler and H.L. McKinney, *Fluoridation: The Great Dilemma* (Lawrence, Kansas: Coronado Press, 1978). See also D. Rose and J.R. Marier, *Environmental Fluoride, 1977* (Ottawa: National Research Council of Canada, 1977) and J. Yiamouyiannis, *Fluoride: The Aging Factor* (Delaware, Ohio: Health Action Press, 1983). For a political analysis see W. Varney, *Fluoride in Australia: A Case to Answer* (Sydney: Hale and Iremonger, 1986).
8. J. Colquhoun and R. Mann, "The Hastings Fluoridation Experiment: Science or Swindle?", *Ecologist* (1986), 16: 243-248; M. Diesendorf, "The Mystery of Declining Tooth Decay", *Nature* (1986), 322: 125-129, and "A Re-examination of Australian Fluoridation Trials", *Search* (1986), 17: 256-262.
9. R.L. Crain, E. Katx and D.B. Rosenthal, *The Politics of Community Conflict: The Fluoridation Decision* (Indianapolis: Bobbs-Merrill, 1969).
10. For Australia (1984 figures) see Commonwealth Department of Health, *Fluoridation of Water* (Canberra: Australian Government Publishing Service, 1985), p. 94; for the United States (1983 figures) see *ibid.*, p. 96; on Canada (1979 figures) see D.M. Myers, V.D. Plueckhahn and A.L.G. Rees, *Report of the Committee of Inquiry into the Fluoridation of Victorian Water Supplies* (Melbourne: Government Printer, 1980), p. 78; for New Zealand (1980 figures) and Europe see E.J. Farkas, "Water Fluoridation in Eleven Countries", *Social Sciences and Medicine* (1982), 16: 2155-2158.
11. Commonwealth Department of Health, *op. cit.* (ref. 10), pp. 34-41.
12. An excellent account of the politics of fluoridation in Victoria is given by B.W. Head, "The Fluoridation Controversy in Victoria: Public Policy and Group Politics", *Australian Journal of Public Administration* (1978), 37: 257-273.

For other states there are no equivalent accounts though Varney, *op. cit.* (ref. 7), provides considerable documentation, especially for New South Wales.

Carr described the introduction of fluoridation in Canberra as a process in which the four relevant Commonwealth ministers (Health, Australian Capital Territory, Works, Attorney-General) each took advice from their departments which in turn consulted their experts. After discussion in Cabinet, the government took a decision.

Traynor described a different side to the Canberra decision. Traynor was the dentist of Harold Holt, the federal Treasurer. The federal president of the Australian Dental Association suggested to Traynor that he discuss fluoridation for Canberra with Holt. Via Holt, a visit was arranged between the Minister of Health and Traynor along with Peter Lazar, Director of the Dental Health Education and Research Foundation. Later Lazar and Traynor met with Prime Minister Robert Menzies, who was favourable. (Earlier, they had approached the shadow minister of health, who was agreeable.) Shortly afterwards, Menzies put the motion for fluoridation in Parliament.

A somewhat different sequence is given by J. Killen, *Killen: Inside Australian Politics* (Sydney: Methuen Haynes, 1985), pp. 89-90.

13. P.R.N. Sutton, *Fluoridation: Errors and Omissions in Experimental Trials* (2nd ed.; Melbourne: Melbourne University Press, 1960). See also Sutton, *Fluoridation, 1979: Scientific Criticisms and Fluoride Dangers* (Melbourne: Philip R.N. Sutton, 1980).
14. G.S.R. Walker, *Fluoridation: Poison on Tap* (Melbourne: Glen Walker, 1982).
15. On fluoride and cancer see J.B. Bundock, D. Burk, J.R. Graham and P. J. Morin, "Fluorides, Water Fluoridation, Cancer and Genetic Disease", *Science and Public Policy* (February 1985), 12: 36-46.
16. Outside the interviews there may be other concessions.
17. For discussions see the references in note 6.
18. Collins and Pinch, "The Construction of the Paranormal: Nothing Unscientific is Happening", in R. Wallis (ed.), *On the Margins of Science: The Social Construction of Rejected Knowledge* (Keele: University of Keele, 1979), pp. 139-178; Gilbert and Mulkay, "Warranting Scientific Belief", *Social Studies of Science* (1982), 12: 383-408; Mulkay and Gilbert, "Accounting for Error: How Scientists Construct their Social World when they Account for Correct and Incorrect Belief", *Sociology* (1982), 16: 165-183.
19. I.I. Mitroff, *The Subjective Side of Science* (Amsterdam: Elsevier, 1974) found in his interviews with top scientists that many of them made derogatory comments about their intellectual opponents.
20. A. Frandsen (ed.), *Dental Health Care in Scandinavia – Achievements and Future Strategies* (Chicago: Quintessence Publishing Company, 1982).
21. This account is presented in "Fluoridation: the Cancer Scare", *Consumer Reports* (July 1978), 43: 392-396.
22. While it is not the object of this paper to make a judgement about the beliefs of interviewees, it may be of interest to note the views of two leading Europeans involved in the fluoridation issue there. Elof Petterson, a leading proponent in Sweden, said oral health was no better in northern Europe than in English-speaking countries, that political structures varied a lot from country to country, that anti-authoritarian attitudes were not responsible for stopping fluoridation, that European waters did not have higher levels of fluoride, and that there were more intensive dental practices in Scandinavia at least. His explanation of the lack of fluoridation in Europe was that there was a strong commitment to treatment rather than prevention in European dentistry, which made it difficult to build support for water fluoridation (E. Petterson, letter to B. Martin, 11 February 1987).
Hans Moolenburgh of the Netherlands has been a leading opponent of fluoridation: see his *Fluoride: The Freedom Fight* (Edinburgh: Mainstream, 1987). He commented that Europe does not have a lower level of caries, that European countries make decisions much like other democracies, and that dental pressure for fluoridation was as intense as in the English-speaking countries. He attributed the lack of fluoridation to scientific and popular resistance, the latter perhaps stimulated partly by suspicion of any measure reminiscent of fascist totalitarianism (H.C. Moolenburgh, letter to B. Martin, 30 October 1986).
23. P. Speller, *Regional Progress* (Melbourne), 15 October, 1986, p. 8.

24. E. Storey, letter, *The Age* (Melbourne), 27 September 1986, p. 12.
25. M.P. Crisp, *Report of the Royal Commissioner into the Fluoridation of Public Water Supplies* (Hobart: Government Printer, 1968).
26. Myers *et al.*, *op. cit.* (ref. 10).
27. With the possible exception of Smith, whose comments concerned the role of scientists.
28. L. Festinger, *A Theory of Cognitive Dissonance* (Stanford: Stanford University Press, 1957).
29. As pointed out by Varney, *op. cit.* (ref. 7), the proponents in Australia are backed by the dental and medical professions, the federal and most state governments, and several major industries. But from the point of view of pro-fluoridation partisans, this does not translate into volunteers to carry out the day-to-day 'legwork' on the issue.
30. The argument here is compatible with standard ideas in social psychology: see, for example, G. Cvetkovich, S.R. Baumgardner and J.E. Trimble, *Social Psychology* (New York: Holt, Rinehart and Winston, 1984), pp. 176-209; and K.J. Gergen and M.M. Gergen, *Social Psychology* (New York: Springer Verlag, 1986), pp 158-191. Attitudes which are based on direct experience (such as attending meetings, speaking or writing letters in the fluoridation debate) are more likely to be salient and central to attitude structures, and more likely to effect reduction in dissonance with related but peripheral attitudes.
31. To my knowledge, Geoffrey Smith is the only one of those interviewed who has been publicly criticised by both proponents and opponents.
32. Relevant here is the analysis by J. Meyrowitz, *No Sense of Place: The Impact of Electronic Media on Social Behavior* (New York: Oxford University Press, 1985). Behaviour, previously defined in relation to physical settings, today reflects behavioural settings often set by media such as television. Meyrowitz argues that this has affected the messages transmitted and in turn homogenised the audiences. A key theme in this analysis is the impact of making 'backstage behaviour' available for public viewing. For example, family comedy shows on television reveal to children a picture of how adults behave when children are not present.
33. *Proceedings of the Fourth Annual Conference of State Dental Directors with the Public Health Service and the Children's Bureau*, 6-8 June 1951, Washington, D.C. For commentary see Waldbott *et al.*, *op. cit.* (ref. 7) pp. 264-268.
34. John Colquhoun, formerly Principal Dental Officer, Department of Health, Auckland, a long-time supporter of fluoridation, changed his mind about the measure after a world study tour in 1980: see J. Colquhoun, "New Evidence on Fluoridation", *Social Sciences and Medicine* (1984), 19: 1239-1246.
35. For example, the scholarly paper by M. Wollan, "Controlling the Potential Hazards of Government-Sponsored Technology", *George Washington Law Review* (July 1968), 36: 1105-1137, which includes an analysis of the promotion of fluoridation, was referred to me by a Canadian critic of fluoridation.
36. One approach is the weak programme in the sociology of scientific knowledge. See D. E. Chubin and S. Restivo, "The 'Mooting' of Science Studies: Research Programmes and Science Policy", in K.D. Knorr-Cetina and M. Mulkay (eds.), *Science Observed* (London: Sage, 1983), pp. 53-83.

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