# SHARING SCIENCE: KNOWING THE AUDIENCE

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Have we neglected to communicate key ideas about how science is different from other types of knowledge building, and so unwittingly sustained a communication gap between 'science' and 'the public'? This paper explores five broad principles for developing communication strategies that address the substance of science while still meeting the challenge of varying the tone of the message for six different sectors of the New Zealand public.

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## The scope of the paper

This paper shares some insights drawn from recent research that was commissioned by MoRST to provide information about what the New Zealand public knows, thinks, and feels about science (Hipkins, Stockwell, Bolstad & Baker 2002). I see the suggestions that are outlined here as one contribution to dialogue amongst those of us who face the challenge of communicating about science with a public that is, at least in some quarters, increasingly sceptical about the 'messages' we may wish to share.

In shaping the research approach our team was influenced by the argument that there is a distinction between science *promotion* and science *communication*. The former has *persuasion* as its central goal, and its essence has been criticised as 'sloganizing' (Irwin 2001). The latter ideally implies a two way sharing of ideas and concerns. However as our research participants shared *their* ideas and concerns, we became aware of what appeared to us to be some key factors that underpin the distrust (and in some cases disinterest) that can hinder effective two-way communication. In particular, it seemed to us that familiarity with science can lead us to take for granted certain ideas and associations that are by no means as obvious to some other members of the public. When science communicators and 'the public' talk past each other, lines of communication may break down, even where there is goodwill on either side.

The research has identified some widely held ideas *about* science that may hinder two-way dialogue. Many people appear to rely on their common sense judgements as a guide to the plausibility of scientific research. Have we neglected to communicate key ideas about how science is different from other types of knowledge building, and so unwittingly sustained a communication gap in this area? This paper explores that possibility. I argue the case that clear simple information about questions of science methodology could be critical to avoiding miscommunication. Such questions could include:

- Why was the study designed this way?
- How can people be confident that the study was 'fair'?
- Why was this type of evidence sought?
- What features of the data are of most interest and why?
- Are there other ways to answer the same question?
- If so, why has this way been chosen in this case?

Following a brief overview of the research approach, the paper outlines key features of six sectors of the New Zealand public that were identified by the research, with each sector representing a somewhat different 'audience' for science communication. As a result of a similar sector analysis that was carried out in the UK, the OST/Wellcome Trust (2001) researchers suggested that a different 'tone of voice' (p. 330) would be needed to communicate with each of the different groups. However, they also saw it as important that the 'message' should remain essentially the same. In this paper I draw on the factors that differentiated the New Zealand sectors in our research to suggest possible strategies for addressing tone of voice issues. However I also suggest that another type of 'audience knowledge' is needed to address the *substance* of the message. Such knowledge entails an appreciation of the manner in which people interact with science information materials to build personal meanings. In this respect there would seem to be more similarities between sectors than differences. The paper attempts to take account of both the tone and substance aspects of decision making by suggesting five key principles for effective communication that could help to achieve a balance between differences of tone and similarity of substance.

## Brief outline of the research

Both quantitative and qualitative research methods were used in the research. The quantitative component was carried out via a telephone survey of 801 people, chosen to be representative of New Zealand's adult population. Agree/disagree continuums were used to elicit responses to a range of statements about personal interest in various science contexts, and attitudes towards and ideas about science and science- related issues. Some statements were drawn from similar research that had already been carried out in the United Kingdom (OST/Wellcome Trust 2000) with modifications to better match New Zealand contexts where appropriate.

Previous UK research found that communication activities may effectively inform the public about a science issue but still fail to allay mistrust of scientists (Wellcome Trust 1998). We proposed as a tentative hypothesis that such continuing distrust might partly result from a lack of broad understanding amongst the general public of how science ideas are investigated, debated, and resolved within the science community itself. That is, aspects of the *nature of science* are as important to science communication as are the relevant science concepts. This tentative hypothesis was used to develop some of the questions in the telephone survey, and it also informed the shaping of the material for discussion in the focus groups that formed the qualitative component of the research. The research approach was also influenced by our view that *contexts* are likely to impact on shaping responses to ideas. For example we felt that many people, if confronted with a wide open question about the 'benefits of science and technology' would struggle to shape an instant response. To avoid this possibility the survey began with a broad sweep across ten different areas of science and technology, soliciting interest in and perceptions of benefits of these. Thus a broad range of contexts for science and technology was 'seeded' before other questions began.

The qualitative component utilised a reconvened focus group methodology (Wellcome Trust 1998) to explore ideas about, and attitudes to, science in the specific context of cell phone safety. This context was selected because a considerable volume of existing research could be accessed, and scientific opinion about the questions at issue seems to be broadly in agreement. Notwithstanding this volume of information, a wide range of opinions on the issue has been publicly aired. We also saw it as advantageous that this context does not entail the ethical debates that pertain in other issues such as GM, because we were seeking to clarify thinking about science itself. Four small groups of participants were chosen to represent different sectors of society. These groups represented low-income earners, mothers of preschool children, young urban professionals, and teachers with an interest in science respectively. Each group discussed scientific evidence related to the question of potential health risks from cell phone use. These discussions took place during two, two-hour sessions that were two weeks apart.

## The sector analysis

A factor analysis of the telephone survey data identified six segments in New Zealand society, each with a distinctive profile of attitudes and beliefs about science. Despite the different mix of statements used, the profiles of most of these segments showed notable similarities to those identified in previous research in the UK (OST/Wellcome Trust 2001). We chose different sector names to reflect the differences that did exist between the identified sectors in the UK and NZ. An abbreviated summary of the key characteristics of the six New Zealand segments follows.

### Confident Science Believers – 25% of sample

This is the most highly educated and renumerated group, with a high level of intrinsic interest in science, and an appreciation of the benefits it brings to society. Their theoretical understanding of science is somewhat better than that of other segments. They are a gender-balanced group.

### Educated Cynics – 16% of sample

This group is similar demographically to Confident Science Believers, but with a small male bias. They are likely to be in business roles, and nearly a quarter of the group have had formal science training. Despite this their theoretical understandings of science match the average. They show less interest in science and a lower level of expressed appreciation of the benefits of science and technology than other segments. They do not see a need for government control of science, nor do they see a strong need for scientists to have to justify and explain their research to the public.

### Concerned Science Supporters – 18% of sample

People in this segment are interested in and appreciate the benefits of science and technology, but are concerned about its consequences and consider it important that the government keep control on science. With average levels of education, their view of science is somewhat naïve. The group shows a small female bias.

### Confused and Suspicious – 14% of sample

People in this sector believe that science is out of control, and that the government needs to keep control. They do not have a strong appreciation of science's role in achieving economic success. They put faith in common sense, which can be a barrier to understanding the complexities of the scientific world. This group has a small female bias and lower levels of income.

### Uninformed Individualists – 14% of sample

This is a younger segment, with a male bias. Students and those in semiskilled occupations predominate. Despite an interest in new technologies, their understanding of science is relatively unsophisticated. They are less likely to see a need for control over scientists, nor the need for scientists to be independent of business interests.

**Left Behind – 13% of sample**

This group is older than the average, less well educated and with the lowest levels of Internet access. They do not understand the complexities of new science and technology areas, nor are they interested in learning about them. They strongly disagree with anything that interferes with nature, such as cloning. There is a strong female bias in this group and many are retired.

The sector analysis suggested that *education* is a key factor in shaping attitudes to and interest in science. Correlated with that, but secondary to it, are levels of income and gender. *Age and experience* and *attitudes to authority* also impact significantly on attitudes to science. It may be that as people get older they take more account of life's contingencies, and accordingly become more tolerant of uncertainty and more aware of complexity in cause/effect relationships. There was no clear ethnic differentiation within these segments – New Zealanders do appear to share broadly similar values with respect to science.

While this sector analysis provides useful information that could help communicators to modify their tone to suit their audience, other insights that emerged from the research are potentially more helpful for shaping the substance of the message. Some of these insights are briefly outlined in the five sections that follow. Each section draws on a different aspect of the research findings to suggest one broad principle that could provide guidance for finding a balance between tone and substance decisions.

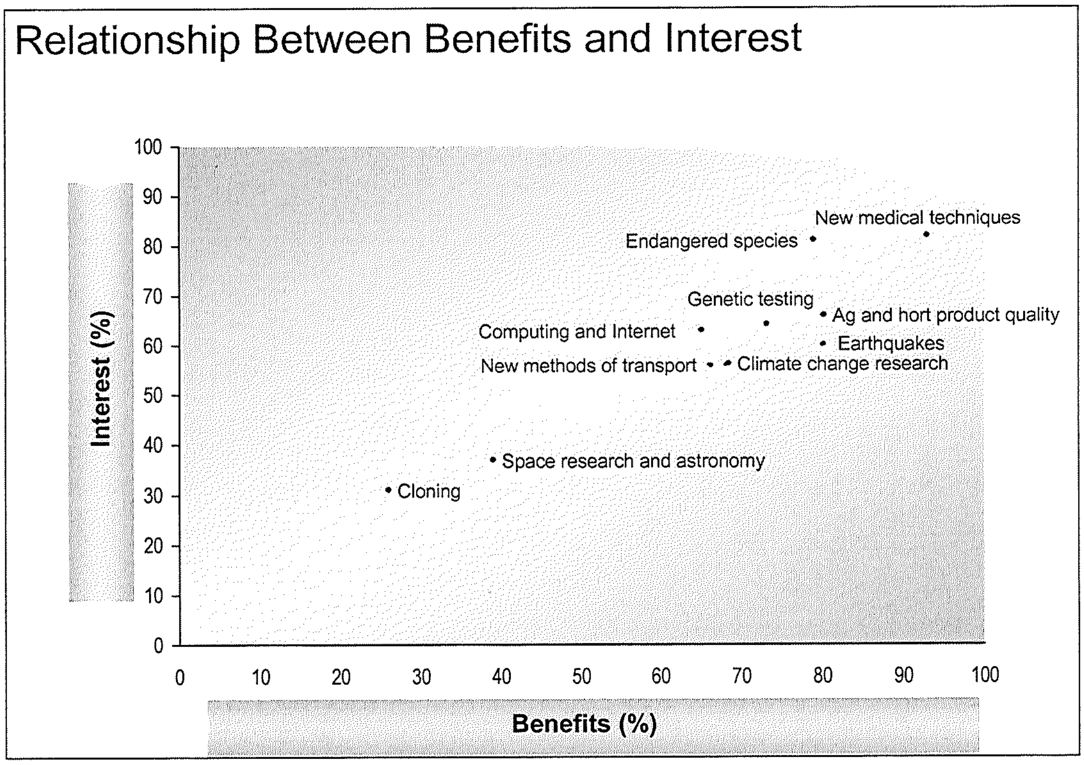
## Principle One:

## Find the right 'hooks' to interest people in your area of work

Interest in science is higher amongst the New Zealand public than some might suppose - 73 percent of the telephone survey respondents reported an enjoyment of finding out about new ideas in science. As in the previous OST/Wellcome Trust (2000) UK research, we found a strong correlation between interest in a particular science area and perceptions of its benefits to society. The graph on the next page shows this correlation for the ten contexts that were probed in the telephone survey.

For areas of research that can be related directly to health and/or endangered species, the identification of productive 'hooks' to public interest and attention should be relatively straightforward. Both are areas where the benefits of such research make 'common sense' – that is people can relate them to their own lives, values and feelings. Communicators working in other areas of science may initially need to develop a strategy to more effectively clarify the benefits of their research field, especially in relation to people's everyday lives.

The sector analysis provided some information that could help to adjust the tone and emphasis of the 'hooks' that are chosen. Table one summarises sector differences that emerged during the research. Some insights from the qualitative component have been matched to the sector data where appropriate. Inferences that we have drawn from, but extended beyond, the actual research data have been differentiated by the use of a third column in which potentially useful approaches to 'hooks' have been suggested.




## Principle Two:
## Address issues of trust in an open manner

Our study suggests that levels of *distrust* of science/scientists are not as high as some might suppose, although this is certainly an issue that all communicators need to address. Twenty-one percent of all respondents to the telephone survey justified their belief that the government should keep tight control of scientists' work by expressing doubts about the ethical behaviour of scientists, as exemplified by the following verbatim quote:

> Scientists will eventually make their ideas too big and think too wide. They'll destroy the planet. New Zealand shouldn't put too much effort into science stuff. (Hipkins et al. 2002, p.22)

However a different 16 percent of respondents expressed their distrust of the government's ability to perform that role, as captured in the following verbatim quote:

> If you keep too tight a control on science you inhibit innovation. You stop scientists being able to think laterally and outside the square. Control is more appropriate at the application stage than the research stage. (Hipkins *et al.* 2002, p.23)

Focus group participants often referred to past dishonesties in some reporting of smoking related health research and this appears to have had a definite impact on attitudes towards trust of science and/or scientists. This effect has been referred to as the 'tobacco-ization' of attitudes to science - see for example Milloy (1999). This made our participants highly suspicious of slick 'public relations' approaches to the promotion of science, and they were likely to conflate science and business interests. This is illustrated in the comments that follow table one.

| Sector name | Characteristics of sector interest in science and technology | Suggestions of 'hooks' to interest |
|---|---|---|
| Confident science believers | Highest levels of reported personal interest<br>Most likely to look beyond immediate benefits to wider questions about science and technology (e.g. in the area of space research) | Any science context could potentially hook the interest of this group – particularly where links to benefits are elaborated |
| Educated cynics | Lower than average levels of interest<br>Lowest levels of interest in environmental issues<br>Higher than average interest in new methods of transport | The hooks need to be stronger than for the Confident Science Believers<br>Development of links to business opportunities might 'hook' this group |
| Concerned science supporters | Higher than average interest in new technologies but average level of perception of benefits<br>Demographic profile suggests many mothers of young children could be in this group – focus group demonstrated mothers' high levels of interest in their children's welfare and learning opportunities | Specific exploration of benefits, especially where these may not be immediately obvious<br>Development of children's educational materials could help to 'hook' some in this group? |
| Confused and suspicious | Show comparatively high levels of interest in environmental and medical sciences, despite their concerns<br>Higher than average belief that science and technology are difficult to understand | An open focus on societal issues could help 'hook' this group<br>Make strong links to everyday issues and concerns |
| Uninformed individualists | Below average interest in science and technology generally but higher than average interest in personally keeping up with new technologies<br>Younger demographic profile and male bias | Strong technological focus might help 'hook' this group |
| Left behind | Older group, more interested in health, food and endangered species<br>Most likely to think that science and technology are too difficult to understand | Choose 'hooks' to which they can relate at a direct personal level<br>Make strong links to everyday issues and concerns |

**Table One: Sector differences for interest in science and technology**

> Well I pretty much agree with everybody else. I don't believe we are told the truth [about the findings of cell phone safety research] and I would imagine, but I don't know for sure, but I would imagine cell phone companies actually know that they cause harmful effects on people. But they hire PR companies to downplay that sort of thing (Hipkins *et al.* 2002, p.78, focus group participant).

> Sometimes it depends who's paying, who controls the outcome....you run into government classifications that is the Secrets Act. Whoever pays the money sometimes calls the tune. Scientists might want to release something which is not in the public interest, but the big business says no (Hipkins *et al.* 2002, p. 35, telephone survey respondent).

In view of this suspicion, it would seem judicious to be as open as possible about sources of funding and the nature of any vested interests in scientific research. On its own, such information is not likely to allay entrenched suspicions but it is one piece of the puzzle that has to be unlocked when opening a public dialogue that can lead to meaningful two-way *communication* (as opposed to one-way *promotion* of a science area).

Sector differences in views about science and attitudes of trust are summarised briefly in table two. As this summary shows, it does seem likely that distrust is linked to a limited understanding of how scientific knowledge is validated with reference to existing theoretical constraints and peer review processes. Providing accessible and interesting information about the processes of control that constrain scientists' work is an important challenge for communicators. Doing so in a manner that clearly sets outs the grounds for having confidence in science findings, while at the same time avoiding the impression of PR 'spin', is a tone challenge that I believe we all need to take into account.

It is reassuring that scientists are generally regarded as trustworthy sources of information – particularly those who work in the public sector (71 percent trust for public sector scientists, 62 percent for private). This contrasts with a 45 percent *distrust* of lobby groups, a 48 percent distrust of journalists, and a 67 percent distrust of politicians as information sources. Decisions about who will be selected to convey ideas and messages to the wider public need to balance a number of factors including:

- clarity of communication;
- transparency about issues of vested interest, peer validation, and consensus issues within the science community; and
- knowledge of whose word is most likely to be trusted.

The tone of the message will be critically important in this area of communication.

| Sector name | Characteristics of sector views about science and trust |
|---|---|
| Confident science believers | Highest levels of trust in both scientists and government institutions<br>Most confident of their own understandings of how science knowledge is built |
| Educated cynics | Sector tends to be more trusting of scientists than of government<br>High levels of distrust in some information sources, especially lobby groups |
| Concerned science supporters | Show less understanding of science knowledge building processes than the above two sectors<br>Higher than average belief that science is out of control, despite recognition of its benefits<br>Mixed feelings about the trustworthiness of scientists |
| Confused and suspicious | Very strong endorsement for the view that some scientists should not be linked to government and/or business interests<br>Most likely to conflate government interests with business interests?<br>High levels of distrust of scientists, especially those in the private sector<br>Strong desire to see tighter controls on the work of scientists<br>Place their faith in common sense and do not see anything different about science as a type of knowledge building process |
| Uninformed individualists | Trust does not appear to be an issue for this group<br>This reflects a general apathy and lack of engagement with science issues? |
| Left behind | Similar views to the Confused and Suspicious but less likely than that sector to think that science is out of control<br>Higher than average trust of TV documentaries as an information source |

**Table 2: Sector differences to issues of trust in science and scientists**

## Principle Three:
## Be more open about areas of risk and uncertainty

In a recent address to a New Zealand science audience, Lord May, the chief scientific adviser to the UK government advocated open dialogue about areas of risk and uncertainty. In his view, debate about broader ethical and social concerns should be an important part of dialogue about socio-scientific issues. He suggested that it is a "great mistake to dismiss genuine worries about science and technology as merely the result of ignorance" (May 2002). Our research findings support this assertion and indeed stand in sharp contrast to reports from a recent UK based MORI poll. The UK research reported that 61 percent of respondents expect scientists 'to provide 100% guarantees about the safety of medicines' (MORI 2002). It may be that this discouraging response was an artefact of the way the question was worded. (We certainly found this to be an issue with some of the questions that were shaped to probe ideas about science in the NZ research.) Both the qualitative and quantitative components of the NZ research found a strong awareness of the complexity of making cause/effect linkages for health related issues. Such awareness, however, does not appear to be linked to relevant questions of *theoretical* interpretation and/or unanswered research questions but rather is grounded in *everyday* concerns and experiences of risk and uncertainty. The general tenor of this awareness is illustrated by the similarity of the comments made on separate occasions by participants in two different focus groups:

> What I was trying to point out is that they are so harping on about cell phone users' high risk of cancer. The cell phone users have a very fast pace of lifestyle. They eat a lot of fast food, their stress levels are way high. I used to work in the IT industry. I worked using a cell phone seven days a week, sitting on my bed with a headset on, on call, using a laptop 24 hours a day. That was my tool. It's a very stressful lifestyle. (Hipkins *et al.* 2002, p.85)

> I don't know...obviously if you were a high phone user you probably would get headaches, loss of concentration, burning and twitching, but not necessarily because the phone is damaging, just because you're working so bloody hard! (Hipkins *et al.* 2002, p.85)

Sixty-two percent of the telephone survey respondents agreed with the statement that 'it is not possible for scientists to be certain about any single cause for health problems such as cancer'. A slightly lower 53 percent agreed with the statement that 'when scientists say they can't be really clear about the actual threat posed by something risky, they are telling the truth'. In fact 12 percent of these respondents saw such an admission as evidence of *honesty*. On the other hand 15% of all respondents saw such uncertainty as a sort of 'hedging of bets' and therefore as a source of distrust. In view of these findings, the nature of (currently) unanswerable questions needs to be made as clear as is practical when addressing issues of risk and uncertainty.

Again, I see this as one key piece of a puzzle – not sufficient of itself but nevertheless important to the establishment of open dialogue. Tone issues to be addressed when communicating with different sectors of the public will be similar to those identified for issues of trust.

## Principle Four: Guard against assumptions that methodology is self-evident, or unimportant

It is easy to assume the 'obviousness' of something that is thoroughly familiar. Scientists may not see the necessity to describe certain details of their work that could actually turn out to be critical to effective communication. This poses challenges for them when they communicate about their work directly, but also for those of us who act as intermediaries between professional scientists and members of the wider public, including teachers as one group of communicators. This section attempts to address one area where assumptions of obviousness/unimportance may be unhelpful. I do not think that this is the only such area – for example I think that we often assume the obviousness of contextual information when a situation seems very familiar. However the dilemma described here was the aspect most vividly highlighted during our research project.

The telephone survey provided some support for our initial hypothesis that high levels of distrust in science are linked to a lack of understanding of the special characteristics of science as a type of knowledge building. The actual nature of the interaction between beliefs about and attitudes towards science was, however, more clearly illustrated in the focus group research. We found that participants made judgements about the *validity* of research methodology on the basis of 'common-sense' rather than 'science-sense' (i.e. the theoretical basis of the research design). The seeming 'disappearance of science' when considering the methodology pertinent to a specific inquiry has been noted by others (Tytler, Duggan & Gott

2001, p.356). For our participants, judgements about the plausibility of research were profoundly influenced by their beliefs about whether the approach taken made personal sense to them. Several examples will serve to illustrate the complex nature of the challenges that communicators face when dealing with this issue.

**Example One: The invisibility of a key theory/method link**

During the first focus group session participants read and discussed abbreviated summaries of six pieces of actual research related to the question of whether or not there may be health risks from personal cell phone use. One research project involved the exposure of nematode worms to low-level doses of microwave radiation and gathered data on subsequent changes in cellular activity. Almost all participants rejected this research as not plausible on the 'common sense' grounds that nematode worms are nothing like humans, so the changes that were observed are of no relevance to the issue. (The teachers' group responded differently. Four out of five rejected the research as implausible, but they cited genetic differences between cells of different species.) Thus the theoretical rationale for the research design – that a cell is a cell is a cell, at least at the most basic level of structure and function – did not seem to be appreciated by any of the focus group participants. When it was not related to one simple but key idea from basic cell biology, neither common sense nor science detail was a reliable guide to the plausibility of this research project.

**Example Two: Uncertainty about the validity of correlation studies**

Two of the six research summaries concerned epidemiological studies. In these cases the focus groups participants' common sense views appeared to be aligned with naïve views of what can count as a legitimate method for investigating a science question. It appears that vestiges of 'fair testing' ideas from school science may be implicated in this dilemma, a proposition that is elaborated in the full report (Hipkins *et al.* 2002). This type of common sense appears to involve the view that legitimate 'experiments' run forward in time (the retrospective nature of the epidemiological studies was regarded with suspicion) and that rigid control of variables necessitates identically sized control and target groups. These common sense judgements about science methodology were decidedly unhelpful for making decisions about these two research projects, albeit for quite different reasons than those that pertained for the nematode worms. It would seem prudent to pay particular attention to methodological issues when communicating about any type of research that involves retrospective correlation of data, or indeed anything other than a straightforward 'experiment' of the type typically practised in school science laboratories.

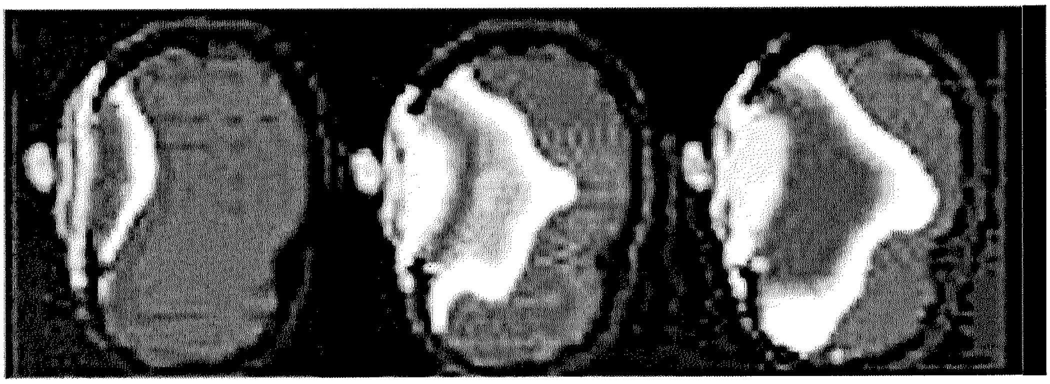
**Example Three: Seeing is believing – or is it?**

A common theme of science education literature is that much teaching, at both secondary and tertiary levels, fosters the development of an empiricist view of science. In such a view theory is seen as emerging from empirical evidence, provided this is gathered with sufficient rigor, and the actual nature of interactions between data and theory is neglected or even ignored. As in the case of the nematode worms, this creates issues when the theoretical basis of research design does not make 'common sense'. However it is also a problem where scientists disagree about the meaning of data because they bring different theoretical perspectives to bear on its interpretation, or when the validation of new theory causes shifts in ideas about an issue of concern to the public. In such cases empiricist views appeared to be directly linked to attitudes of distrust, as illustrated by the following telephone survey response.

> You can't trust them. They keep telling us things are beneficial, and then in a few years we find they are not. In other words, scientists are liars (Hipkins *et al.* 2002, p. 30).

Twenty eight percent of the telephone survey respondents who said they would not trust a claim that something had been 'scientifically proven' also said that they don't believe anything unless they can see it for themselves. This common sense view that 'seeing is believing' compounds issues of empiricism. For example, it leaves people who do not have the necessary science background particularly vulnerable to being misled by manipulated *visual* evidence. This emerged as an issue when focus group participants were shown a set of computer generated images of human heads that purported to be 'actual photos' of cell phone radiation penetrating human brains. The images came from a web site and the URL was provided with them, as shown in the box below.

**Example One: Thermal Images**



Senate Business and Professions Committee April 24, 2000: Senator Hayden presents actual photos of Radiation entering an Adult Brain, as well as the Brain of a 5-year old child: The depth of penetration is markedly more in the child than the adult. Proving radiation from cell phones penetrates the human brain.
**Source:www.thegeomancer.netfirms.com**

There were a number of visual and verbal clues that could have aroused suspicion but the first response of almost all participants was to take the images at face value, as in the following response:

> I think just the visual impact as well as the fact that the last one is a child. That gives you a fright. Well it does to me anyway. A small child having received that much radiation. The word 'radiation' too is very emotive, you know you think nuclear power and 'frying your brain' and all that kind of stuff. So yeah. So that makes a definite impact [before the discussion of fakery] (Hipkins *et al.* 2002, p. 97).

The response below was made by the same member of the 'mothers' group after a critical discussion of these images, and captures one possible avenue of communication:

> They've been teaching them [the participant's primary school-aged children] how to discern in terms of advertisements. What kind of information are they trying to get across? How are they hooking you in? So children are learning that sort of thing, so this is very relevant to children's education that they should be trying to interpret scientific information, that sources that...from issues like this [after discussion of fakery] (Hipkins *et al.* 2002, p. 97).

If research is not seen as plausible, then findings are likely to be rejected if they do not support current beliefs, and the growth of distrust seems an inevitable result. I think we all need to guard against assumed 'obviousness' of theory/evidence connections, especially as these relate to the design of a research project. Methodological decision making warrants careful attention. The following types of questions could be a good place to begin, and may in the first instance need to be directed to the relevant scientists if they do not provide this information to begin with:

- Why was the study designed this way?
- How can people be confident that the study was 'fair'?
- Why was this type of evidence sought?
- What features of the data are of most interest and why?
- Are there other ways to answer the same question?
- If so, why has this way been chosen in this case?

These questions may at first glance seem to be just an obvious application of the who/what/when/where journalistic rules of thumb. I see them as also having a second perspective. They are deliberately couched in everyday language and draw on common sense perspectives. The metaphor of 'fairness' is widely used in New Zealand society – in sporting contexts for example. Here it stands a signal to include decisions about aspects of an investigation that impart rigour and eliminate alternative explanations. Thus the questions are framed in a manner that attempts to span the potential void between common sense and science sense.

Given that members of every focus group brought a common sense perspective to discussions about science methodology, sector differences would not appear to be important when addressing this issue. Rather differences of tone could be related to the level of detail, and to the challenge of enticing interest whilst still providing sufficient information to discourage premature plausibility judgements. These challenges are addressed next.

## Principle Five:
## Relate *essential* detail to a framework of key organising ideas

One of the aspects of science that captures many of us is the elegance of the way fragments and details can come to fit together to make up a coherent whole. Unfortunately detail can be an obstacle to understanding when it becomes impossible to 'see the wood for the trees'. The previous section suggested that miscommunication might be related to a neglect of theoretical and/or methodological aspects of research. However this section extends the discussion to suggest that such details need to be carefully balanced against wider communications challenges.

I have described a situation in which the lack of a simple understanding that all cells are built of essentially the same component parts resulted in the rejection of one piece of scientific research as implausible. In the absence of this one simple but key idea as a framework on which to build, other details became an obstacle to the debate, as in the case of the teachers' knowledge of genetic differences. Fragments of remembered detail compounded the challenge. (For example one participant in the low-income focus group talked to us about 'dissolving mitochondria' at one point.) Some detail *is* important but it would appear to be critically important to establish very clearly the exact role that it is expected to play in informing understanding.

There is a second, quite different, aspect to this dilemma. During their focus group discussion, members of the young professionals group became acutely aware of the shortfall in information that typically occurs when science issues are reported in the mass media. However, with their insider knowledge of the PR industry, they also saw dilemmas in making any change in this situation. On the one hand, they acknowledged that they personally needed more detail than was provided by the research reports in session one for the purposes of debating the overall question of cell phone safety. On the other hand, they also believed that such detail would be most unlikely to be published in the mass media.

When weighing questions of content detail and presentation, attention to sector differences could provide a helpful guide to communication decisions. In this case it seems that levels of science education/understanding could be the most important differentiating factor. For this reason, table three below divides the sectors into just two clusters – those who are more likely to have received a sound education in science, and those who probably have not.

| Sector name | Recommendations for communication approaches |
|---|---|
| All sectors | Use clear straightforward language and avoid emotional words and hyperbole.<br>Use visual images where possible but also provide clues for the reading of any likely sources of visual 'evidence'.<br>Where consumer products are implicated, provide information about issues with the product (e.g. as for existing practice with medications – this suggestion came from the 'mothers' focus group).<br>Take information into people's homes as directly as possible but be circumspect in use of mass media.<br>Where possible, encourage scientists to allow their own voices to be heard. |
| More likely to be science educated:<br>Confident believers<br>Educated cynics | Internet access is very high in both sectors - use the Internet to provide detail that can be sought on a discretionary basis, but use mass communication strategies to draw attention to the issues and to the availability of such information. |
| Less likely to be science educated:<br>Concerned supporters<br>Confused and suspicious<br>Uninformed individualists<br>Left behind | Avoid detail that is not strictly necessary but ensure that important theoretical perspectives are not 'invisible'.<br>If possible, use focus groups to check for any unintended meanings that are constructed when people interact with the material.<br>Consider educational materials as a means of reaching parents of school age children. |

**Table three: Strategies for balancing detail and accessibility**

## Concluding comments

This paper has outlined five key principles for shaping effective science communication:

1. Find the right 'hooks' to interest people in your area of work;
2. Address issues of trust in an open manner;
3. Be more open about areas of risk and uncertainty;

4. Guard against assumptions that methodology is self-evident, or unimportant; and
5. Relate essential detail to a framework of key organising ideas.

There are clearly no easy or quick answers to the issues that have been raised in this paper. There are challenges for those of us who are involved in professional science or in science education as well as for other science communicators. Nevertheless it is encouraging that the largest sector of the New Zealand public are those who are willing and able to get involved with science issues, and that levels of interest in science are high across most sectors. I look forward to being part of a continuing dialogue with other scientists, teachers and other science communicators on the broad suggestions that I have made and on the issues that our research has raised.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## References


Hipkins, R., Stockwell, W., Bolstad, R. & Baker, R. (2002). *Commonsense, trust and science: How patterns of beliefs and attitudes to science pose challenges for effective communication.* Report to the Ministry of Research, Science and Technology. Wellington: New Zealand Council for Educational Research.

Irwin, A. (2001). Constructing the scientific citizen: science and democracy in the biosciences. *Public Understanding of Science, 10*(1), 1-18.

May, R. (2002). *Science and Politics: Melding facts and values.* Talk presented at Beehive. Wellington: www.rsnz.org/news/talks/scisoc/scipol.php

Milloy, S. (1999). Tobacco-izing telephones: Stewart Fist's latest folly. *The New Australian*, 29 Nov - 5 Dec, 1999. www.newaus.com.au/news143fist.html.

MORI (2002). Public expects the impossible from science. 2 April, 2002. www.mori.co.uk/polls/2002/science.shtml.

OST/Wellcome Trust (2000). *Science and the public: A review of science communication and public attitudes to science in Britain.* London: The Wellcome Trust.

OST/Wellcome Trust (2001). Science and the public: a review of science communication and public attitudes toward science in Britain. *Public Understanding of Science, 10*, 315-330.

Tytler, R., Duggan, S. & Gott, R. (2001). Public participation in an environmental dispute: implications for science education. *Public Understanding of Science, 10*(4), 343 - 364.

Wellcome Trust (1998). *Public Perspectives on Human Cloning.* Report prepared for the Wellcome Trust's Medicine in Society programme. London: The Wellcome Trust.