

1. THE BACKGROUND TO EFFECTIVE SCIENCE COMMUNICATION WITH THE PUBLIC

1. INTRODUCTION

To be effective with any audience, communication must be an interactive process. As Sless and Shrensky show in Chapter 6, science communicators who think only of the message and not of the 'audience' are likely to fail. Communication is essentially as much a matter of listening as it is of talking and, to be effective, each party must have some understanding of the other. In this chapter, I shall review what we know about the ways in which the general public views science and scientists and I shall consider some impediments to understanding which, if overlooked, may prevent effective scientific communication.

There is no doubt that communicating science is difficult. Were this not so, there would be no need for any of the chapters in this book. Indeed, there would be no one to write them! All of the authors are in the business of trying to make science more understandable. This chapter is about the public perceptions of science, and so we must immediately make some assumptions about the people we are addressing.

Let us assume, for the moment, that the 'public' is a Western group of people of various socio-economic and cultural backgrounds. This public is male and female, with all the complexities of personality, age and experience now embraced by the term 'gender'. The public has, on the whole, some rudimentary education in science. We know immediately that the form and extent of this education is country-dependent. Some (often female) have had some biology lessons but little or no physics and chemistry. Many remember little of their school science. Most have little knowledge of the earth sciences and most are increasingly conscious of ethical, ecological and environmental issues. The structure of this public looks immensely complex and variable.

Why, then, does world-wide research in the Western world - and in many Asian countries formerly occupied by colonial powers - keep finding the same overall picture? For the past twenty years at least, research coming from the area of science education has revealed a public that is fearful, mistrustful and ignorant of simple scientific principles. Why has education failed to address these problems and what should science communicators know in order to be more effective?

The research spanning two decades is immense. It encompasses the ways in which people learn, how and why people change their ideas, the nature of schooling itself. The theory of 'constructivism' has illuminated some of the reasons why people choose not to pursue science and fail to remember what they have learned - but that is not the whole answer. We know, for example, that part of the problem is

that women relate to science less well than men and that science careers are less common amongst disadvantaged groups. It is important also to recognise that science is not “common sense” and that misconceptions abound. This chapter will review only those areas of research which relate directly to the informal learning of science. It is not possible here to address the problems of curricular structure and the nature of schooling. These have, in any case, been addressed at length elsewhere (see, for example, Cobern, 1998). To begin, let us examine the image of science and scientists as revealed by countless participants in the ‘Draw-a-Scientist’ test.

2. THE POPULAR IMAGE OF SCIENCE

The ‘Draw-a-Scientist’ test was devised by Chambers (1983) to investigate how children imagined a scientist. Not surprisingly, the most common image is of a middle-aged white male wearing glasses and a white coat. He frequently has facial hair and is often bald on top. He is surrounded by symbols of science that are usually chemistry apparatus - test tubes, flasks and so on. Since the early 1980s the test has been repeated all round the world for various purposes and with varying degrees of criticism as to its validity and meaning (for example: Butler Kahle, 1987; Finson, Beaver and Cramond, 1995; Lannes, Flavoni & De Meis, 1998; Jarvis, 1996; McAdam, 1990; Schibeci, 1986). The test is, according to many critics, flawed in that it encourages participants to perpetuate a ubiquitous media image of scientists - either the stereotypical mad professor of the movies or the friendly adviser who is advertising the most suitable washing powder. There is, without doubt, some substance to this criticism and if all were well elsewhere in the world of science communication we might ignore this phenomenon.

There is a darker side to this image, however, which we need to note. Very often, the drawings depict eccentricity bordering on madness, with an indication of evil intent. The drawings produced by female senior high school students (Figure 1) illustrate this inherent lack of responsibility towards humanity, and attendant cruelty to animals. It is not just *scientists*, therefore, who are depicted in this way – it is *science itself*. Whatever its origins – and one might conjecture that the stereotype goes back all the way to Dr Frankenstein and beyond (Turney, 1998 - it illustrates the underlying beliefs of the general public about who scientists are and what they are about. They are white middle-to-upper-class males, middle-aged, socially inept, at best eccentric and at worst downright evil. The nutty professor images portrayed by so many television science presenters merely confirm what everyone believes.

Can the ‘Draw-a-Scientist’ test be taken too far, and too much concluded from its results? Let us examine in some detail what it says about science. First and most obvious, science is seen as masculine. This masculine nature of all science, especially the physical sciences, has been much documented but is still hotly debated by many within science and outside it. As a ‘seeking after truth’, say the critics, how can science have any sort of gendered identity? Yet, as Fox Keller (1985, p.55) explains, members of the Royal Society of the 17th Century which formed the foundation of Western Science explicitly stated that their science was

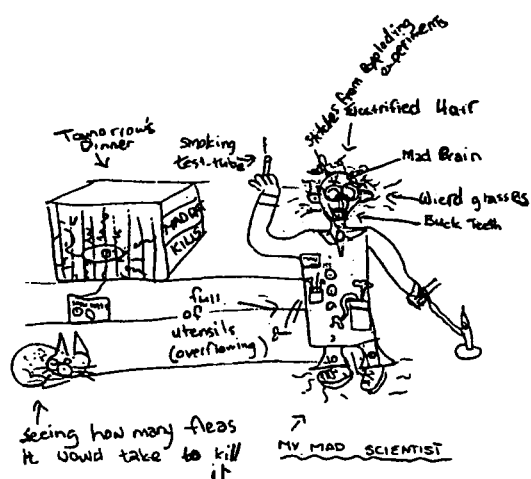
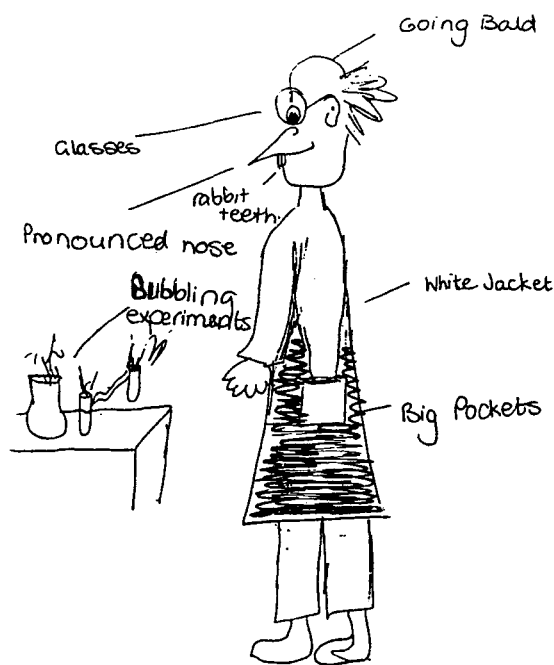


Figure 1. Drawings of scientists by 17 year-old female science students in Australia

'masculine and durable', seeking to capture and control a 'female' Nature in ways not hitherto sought. Their science was founded on virtues of objectivity, strength and rigor. It therefore sought truth in a particular 'value-free' way, asking particular questions which were decided and defined by its practitioners. Other, perhaps equally legitimate questions, were never raised because they were of no importance to the scientists themselves.

It is easy to see that the history of science is male-dominated. For all sorts of reasons, few women participated in its endeavours. Passing quickly to the end of the 20th Century, however, we find superficially a very different picture. Western Science is now perceived by many – including large numbers of university students – to offer equal opportunities to women and men and equal voices in the world of science.

Things have changed since the beginning of science and if too much emphasis is put on encouraging females to take part in science, it could end up by disadvantaging males. (Female Australian science student, 1998)

Science has not been equally accessible for women until recently... Now there is no difference. Women have the same opportunities as men and should take full advantage of them. I believe there are only men in the top positions because women haven't had enough time to occupy those places. (Male Australian science student, 1998)

Has the picture really changed that much? Kelly (1985) outlined four senses in which science might be described as masculine. The first was in terms of numbers—those who practise it are mainly male. At the end of the 20th century, the numbers have certainly changed in many countries at the school and undergraduate levels. A closer look at the distribution of male and female participants, however, indicates that the biggest increase in female students has occurred in the biological and environmental sciences with the physical and earth sciences lagging far behind. For example, in Australia at least, female participation in undergraduate engineering appears to have reached a plateau at 14%. As one goes higher up the scale of all science careers, the proportions alter dramatically in favour of males.

This bias is less true, however, of many European and Asian countries in which women reportedly form a much higher percentage of the scientific workforce. So perhaps the relative numbers are a cultural rather than a scientific issue, requiring specific initiatives in English-speaking countries to coax more women into taking up long-term careers? This may be true. We need, however, to look at how 'science' is described in some of these countries and what work is defined as 'scientific' before reaching a conclusion (see, for example, Ancog, 1998; Hermawati, 1998.) There is evidence also that despite improved participation rates, women in European science still struggle for equality of opportunity.

Kelly's second area of masculinity was in the packaging of science. She quoted science curricula, textbooks, applications and so on as coming from a male world and describing a male world. By 2000, much had been done to address this issue. Yet an examination of current popular physics texts reveals an overwhelming bias in favour of masculine examples. Those few that feature women are often

stereotypical. The textbooks are still, in graphics and language, presenting to a male audience.

The language of science is an area that has attracted considerable criticism. Jargon is endemic in all disciplines but the language of science is *itself* inherently masculine. There has been a move in recent years to re-write texts to be more gender inclusive, including more examples of a 'gender neutral' type. Research into this issue indicates, however, that so-called gender neutral nouns ('an athlete', 'a builder', 'a cyclist') are assumed by female readers of science texts to be male. From my own observation, when a group of 14-year old girls were given a physics problem involving a bird, it evoked responses from all 30 students which referred to the bird as 'he'. Reasons for this are not well understood – but truly gender inclusive terms have been shown to be 'you', 'we', or examples of particular people by name, irrespective of their sex.

Kelly's third area of masculinity was that of practice. Those who instruct students, from school through to postgraduate study, set benchmarks of 'good' and 'bad' science, act as role models and define what science expects of its practitioners:

Do they praise the loudest 'pops' when children are making hydrogen or the most beautiful soap bubbles? These seemingly insignificant choices set the tone of the lessons and influence the image of science presented to the class as harmful or caring. (Small, 1984, p. 30)

Last, Kelly quoted biological factors. Many of these have largely now been refuted. There is still debate, however, about the differences inherent in male and female brains (e.g. Moir and Moir, 1998). What these differences are is not yet well understood, but the evidence from the world of science is clear. Science is, at present, unappealing to most women and to many men. Its masculine character has developed as a social construction reflecting a patriarchal society. There are many examples, historically and at the present time, of overtly male practices and discrimination in science. The more subtle question of the nature of science itself has, however, also been explored, by feminist scholars such as Belenky, Clinchy, Goldberger and Tarule (1986) who describe 'women's ways of knowing' quite different from those of men. Women, according to these scholars, prefer amongst other things to consider problems holistically. They value intuition and prefer non-hierarchical interactions.

This presents a problem for science if it is still to be regarded as intrinsically objective, abstract and value-free. The sad result will be that it will always remain the domain of a few men of a particular type. The importance of factors such as intuition will continue to be denied, even though it is well established that, in the actual practising world of science, researchers frequently follow their instincts. Indeed, Fensham (1993) reports that a series of British television interviews over seventeen years with Nobel scientists revealed that although six laureates denied the existence of scientific intuition and five were doubtful, the remaining seventy two of those interviewed 'readily acknowledged its existence' (p.16). Fensham goes on to comment that 'the eleven (denials and doubters) then went on to refer to experiences of the same kind as the seventy-two'.

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