

Does the public understanding of chemistry differ from that of science in general?

Chemistry seems to have a reputation problem. Once a source of glamour in Nylon and plastics, since the 1960s, it is associated with the hard path of progress and singled out as the “ugly duck” of dangerous and dirty science. This seems to suggest that the public image of chemistry is far apart from the image of other sciences. I would like to argue that the image of chemistry and that of science (and engineering) more general is rather unproblematic and similar. By gaging differences in perceptions, we tap into the increased competition for attention and profile among the sciences.

In 2015 the UK’s Royal Society of Chemistry (RSC) conducted the project “Public understanding of chemistry”*. The project included two quantitative surveys, one among RSC members with 455 responses and another one of national opinions with 2,104 respondents. A key purpose of this project was to change how members of RSC thought of the public by confronting them with surprising facts and thus to disband with myths about the public’s view of chemistry. It is difficult to gage whether this part of the project was successful, but the mere intention is noteworthy. One of the worries of RSC members was that in English “chemist” has two meanings easily confused: it means a drug store where you buy shampoo, lipsticks or get a prescription drug typically known as BOOTS as the leading chain, and it refers to a chemical scientist. RSC members see themselves as the latter and resent being associated with a high street convenience store.

Chemistry has had a pumper ride in public imagination. From the beginning of the ecological movement in the 1960s, it is associated with pollution of water, air and soil, as in Carsen’s *Silent Spring*; with environmental disasters such as Seveso (Italy, 1976) which resulted in the highest known exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in a residential population; or in Bhopal (India, 1984), one of the world’s largest industrial disaster, releasing methyl isocyanate (MIC) into the urban environment and causing many deaths and life-long injuries. These developments of the past fifty years left chemistry a legacy of being associated with the “hard path of development” like physics [1] and a disadvantage over other sciences.

In the light of this legacy, we ask how distinct is this public understanding of chemistry compared to other sciences? In survey research, one can vary the questions wording; for example by replacing “chemistry” with “engineering” or “science” in whatever question one might want to ask. The result then shows whether responses are the sensitive to different concepts. In UK, where we have public perception data, very similar questions were asked in one occasion about “chemistry” and in another about “science” and “engineering”. In 2013 (May-July), the British Science Attitude (BSA) survey asked 1,747 British what they thought of some

recent developments [2]. In 2015 (February-March), the RSC commissioned a national survey of 2,104 respondents asking similar questions about chemistry [3]. Both surveys were high quality: face-to-face interviews of stratified-random samples of the population. The BSA had an additional feature, it involved half the respondents in a conversation about “engineering”, the other half about “science”. For our purposes I will focus on those few items which are more or less identical in both studies, one with focus on “chemistry”, the other with focus on “science”.

To determine similarities and differences requires criteria of comparison. We consider people’s sense of being informed on the matter, being confident to talk about it, and their sources of information. We gage the image of chemists and the position of chemistry in the hierarchy of sciences. Finally, we evaluate chemistry as an industry and a daily convenience.

Confidence to opine about chemistry

Table 1 shows that people feel better informed on “chemicals” than they are about “chemistry” or science R&D. Considering errors margin in these figures of 2-4%, there is very little difference how well people are informed; about 50% consider themselves well informed. This *table* also shows people confident to talk or understand matters: however, chemistry inspires less confidence than science and engineering. About 25% of British are comfortable to talk about “chemistry”, while 50% are confident on science or engineering. Chemistry seems to be more remote from public mind.

There is very little difference on how people inform themselves. While more people get their chemistry news from TV news or programmes, family and friends or radio; science is more accessed in TV news, quality newsprint and maybe at work.

Image of the chemist and chemistry

Both studies also asked about the virtues attributed to scientist. Respondents were asked: “Looking at these pairs of words or phrases, which one of each of these pairs comes closest to your current view of scientists?” The word pairs included interesting-boring and honest-dishonest. Not entirely surprising scientists have the very sober image of being interesting and honest people, the vast majority of British think so. However, chemists seem to be a bit less interesting (72% compared to 82% and 79%), but more honest (93% compared to 71% and 78%) in public eyes than scientists and engineers.

A way of revealing everyday understandings of a concept is by eliciting free associations, not only used by psychoanalysts on the couch. Associations reveal meaning that goes beyond the dictionary definition of a term. Thus we can contrast the “chemist” and “chemistry”. And indeed, the “chemist” is most

Table I - Being informed, being confident about and sources of information (error margin $\pm 2.2\%$ for $n \sim 2000$, $\pm 3.5\%$ for $n \sim 800$).

How well informed do you feel about in your everyday life?	Very well informed	Fairly well informed	Not very well informed	Not at all informed	Have never heard of it	DK	N
chemicals	9	46	31	10	1	4	2104
chemistry	6	35	42	12	1	5	2104
scientific R&D	6	39	44	11		1	1749
	Strongly agree	Tend to agree	N/N	Tend to disagree	Strongly disagree	DK	N
I don't feel confident enough to talk about chemistry	19	33	21	16	9	2	2104
I don't think I'm clever enough to understand science and technology	8	22	15	30	24	0	864
I don't think I'm clever enough to understand engineering	8	23	15	30	23	0	885
%	TV news	TV programmes	Quality newspapers	Friends, family	Radio	Work	N
Chemistry/chemicals	45	34	15	18	16	1	2104
Science	42	26	23	9	9	3	1749

often associated with the pharmacist (26%) dealing with prescriptions of doctors (22%), in drug stores (13%); there are residual notions of "men in white coat" (2.7%) and industrial employment (2.5%). "Chemistry" on the other hand elicits memories of school days (20%), of the science teacher (20%), of chemicals (13%) and medicine (7%), drugs (6%) and lab equipment (5%) and research (5%). There is a residual association with the periodic table of elements (3%). Chemistry has prominence as a metaphor for sexual attraction (3%) as strong relations between people.

Another feature of chemistry is its position among the sciences. Philosophy and public perceptions hold that not all sciences are equally "scientific", some are more prototypical; some are hard sciences as opposed to soft sciences. Our studies had people rate "how scientific is X", while X would vary from physics to sociology. We compare ratings from members of the RSC and from the general public as in *figure 1*. While for the general public medicine is the prototypical science, chemistry,

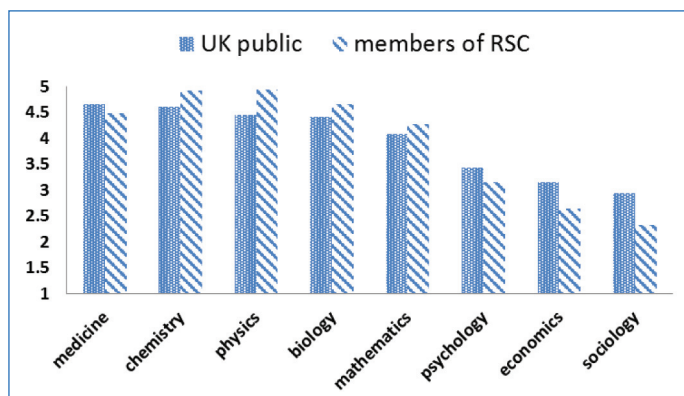


Figure 1 - The hierarchy of sciences according to members of RSC and the general public (rated on a scale of 1-5, where 1 = not at all scientific and 5 = very scientific).

physics, biology and mathematics follow closely. Medicine as the core of the social representation of science seems an enduring observation [4]. The public considers psychology, economics and sociology as "less scientific", whatever the specific meaning of "scientific" might be. By contrast, for members of the Royal Society, this hierarchy is slightly twisted: physics and chemistry are top, followed by the life sciences biology and medicine; further down the ladder are psychology, economics and sociology. It is remarkable that professional chemists as well as the general public reproduce a stereotype of "hard" and "soft" sciences.

Evaluation of chemistry

Finally, we look at how the sciences are evaluated. Here researchers generally use items that point towards utility (promise) and items that express concerns (reserve; see [5]). Items of both kinds correlate among themselves. People who recognise one promise of science tend to recognise others; and people who express some reservation also tend to refer to others.

We consider a battery of eight questions as shown in *table II*. Considering error margin of 2-4% points, there is little different on this perception, with three exceptions. On things learnt at school, 52% agree that science was useful for life, while only 31% who concede the same to chemistry. When asked whether "it is important to know in my daily life", 72% think this of science, a mere 55% would say the same of chemistry. Consistent with the image of the chemist above, also less (62%) think of chemistry as interesting compared to science (73%). While most things are equal between science and chemistry, its use in everyday life is more doubtful.

Table II - Different facets of attitudes towards "chemistry" and "science" (error margin 2-4%).

	Strongly agree	Tend to agree	N/N	Tend to disagree	Strongly disagree	DK	N	Agree rate
The benefits of chemistry are greater than any harmful effects	19	40	27	7	2	6	2104	0.59
The benefits of science are greater than any harmful effects	14	41	26	13	3	4	1749	0.55
On the whole, chemistry makes our life easier	28	49	15	4	1	4	2104	0.77
On the whole, science makes our life easier	28	53	12	5	1	1	1749	0.81
Chemistry R&D make a direct contribution to UK economic growth	30	42	17	3	2	7	2104	0.72
Scientific R&D make a direct contribution to UK economic growth	28	48	14	3	1	6	1749	0.76
Chemistry is a dying industry in the UK	3	10	25	27	21	14	2104	0.13
Science is a dying industry in the UK	2	12	12	38	29	8	864	0.14
The chemistry I learnt at school has been useful in my everyday life	8	23	21	23	21	5	2104	0.31
The science I learnt at school has been useful in my everyday life	18	34	14	24	9	2	1749	0.52
School put me off chemistry	10	14	23	28	21	4	2104	0.25
School put me off science	8	16	13	29	34	1	1749	0.24
Jobs in chemistry are interesting	20	42	21	7	3	7	2104	0.62
Jobs in science are interesting	26	47	18	4	2	4	864	0.73
It is important to know about chemistry in my daily life	16	40	21	15	7	2	2104	0.55
It is important to know about science in my daily life	24	48	14	11	3	1	1749	0.72

Sciences, a background of good will

In summary, we can say that while sourcing information very similarly, people feel less confidence to talk about chemistry than other sciences; chemists have a sober image of being less interesting, but more honest than scientists. Chemists are indeed associated with the pharmacy and men in white coats; chemistry elicits memories of lab equipment from school days, but also of sexual attraction by metaphor. Among the sciences, chemistry ranks top with physics, though for the public medicine is even more "scientific", and members of the professional body make sharper distinctions between hard and soft sciences. In terms of utility chemistry and science do not differ; what is doubtful is however the everyday relevance of chemistry. Overall, chemistry differs only marginally from the sciences when public appreciation is concerned. It seems that the public image of chemistry is not far apart from the general image of science; it seems protected from the halo of a solid reputation of science in British society.

Is Britain a special case? Probably not, the sciences are in relative good standing in most countries; what we can observe is a temporary fall from grace of some sciences in the eye of a public controversy. But in that fall, they profit from a general background of good will (see [6]).

*The project was led by Jon Edwards and managed by Chiara Ceci; Massimiano Bucchi (Trento University) and myself were part of their Scientific Advisory Board. I thank Jon Edwards for giving me access to the materials.

[1] Weart S.R., *Nuclear fear: A history of images*, Harvard University Press, Cambridge, **1988**, p. 323 and 341.

[2] *Public attitudes to science: Technical report*, Ipsos-MORI & BSA, London, **2014**.

[3] *Public attitudes to chemistry: Research report*, TNS & BMRB, London, **2015**.

[4] Durant J., Evans J., Thomas G., Public understanding of science in Britain: the role of medicine in the popular representation of science, *Public Underst. Sci.*, **1992**, 1, p. 161.

[5] Bauer M.W., Suerdem A., Relating "science culture" and innovation, *OCED seminar papers*, Gent, 19-21 Sept. **2016**, <http://eprints.lse.ac.uk/67933>.

[6] Bauer M.W., Pansegrau P., Shukla R., *The cultural authority of science – Comparing across Europe, Asia, Africa and the Americas*, Routledge Studies of Science, Technology & Society, vol. 40, Routledge, London, **2019**.

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