Investigating Views of Science and Humanities: Tertiary Educated Adults on Complementary and Alternative Medicines

Investigating views of science- and humanities-tertiary educated adults on complementary and alternative medicines

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Abstract: This qualitative study explored the understandings of people with a university education in science and those without a university science background about the evidence base relating to Complementary and Alternative Medicine - a controversial multibillion-dollar industry on a global scale. The findings indicated that science- trained and non-science-trained respondents alike valued scientific rigor and testing in relation to health care but also used subjective kinds of evidence in justifying their views and decisions about CAMS. In addition, both science and humanities graduates engaged with evidence in similar ways as defined by 'habits of mind'. These findings are discussed in relation to their implications for science education and engagement with scientific ideas, including scientific literacy and the belief systems that people bring to their understanding of science.

Keywords: Complementary and alternative medicine; evidence; evidence-based medicine

Introduction

There have been numerous advances in medical treatments worldwide over the last fifty years, with extraordinary successes in the eradication of diseases previously resulting in the deaths of millions of people (Andre et al. 2008). Much of this success is attributed to the scientific basis of modern medical treatments, particularly the development of evidence-based medicine (EBM) and drugs that are rigorously evaluated (Schlipköter and Flahault 2010). Citizens in developed Western countries are exposed to unprecedented levels of science education, and this might be expected to lead to choice of medical treatments supported by scientific evidence - but the literature suggests this is not always the case. In many Western societies there is something of a controversial backlash against modern medicine, with some advocating medical treatments outside mainstream Western scientific-based treatment.

In this study we explore the views of highly educated science and non-science trained Western adults on some health treatments that are outside the mainstream in Western medicine: specifically hypnotherapy, homeopathy, aromatherapy, naturopathy and traditional Chinese and Indian health treatments. We are here referring to these treatments collectively as complementary and alternative medicines (CAMs). In doing this we acknowledge the differences between them, that these treatments may be alternative and/or complementary only in contexts outside their traditional use, and that the range of definitions of CAMS can include a much wider range of treatments than being considered here and span much broader conceptions of integrated, wholistic health management.

The rationale for this study is twofold. First, there is a need to research public engagement with both the claims of CAM advocates, and the scientific evidence base for the efficacy of CAMs (Baugniet et al. 2000; Trevelyan 1996). This is necessary, it is argued in the present work, because many claims of CAM proponents are contentious, and have implications for people's health care decisions. According to some authors, use of CAMs has the potential to undermine well-established (and highly successful) public health and national health funding policies in Western contexts (e.g., Singh and Ernst 2008). Debates about the claims of CAMs versus scientific-based medical treatments will persist, especially given the pressure on public health

budgets and the need to limit what health interventions to fund. Hence, exploring people's views about evidence claims in relation to CAMs has the potential to inform discussion about this issue.

The second reason for conducting the study is to contribute to our understanding of scientific literacy, and we suggest here that CAM use is an interesting example of a socio-scientific issue (SSI) that can provide insights into people's scientific literacy. In an article exploring scientists' habits of mind in relation to religious beliefs, Coll, Taylor and Lay (2009) posed the question of whether scientists really think in different ways to non-experts. This extremely important question, relating as it does to the impact of science education on people's reasoning and use of evidence and decision-making, remains unresolved. We suggest that the way science and non-science trained adults engage with evidence warrants further research.

Scope and research questions

This study thus explores the views of highly educated Western adults with access to both CAMs and EBM, on the use of these particular CAMs. We are focusing within a Western context; and using a well-educated sample as users of CAMs in Western countries are typically highly educated (Harris, Cooper, Relton and Thomas 2012). This study seeks to examine what evidence is used, and how it is used, to inform decision-making about CAM use (or lack thereof) by two cohorts of participants – those with a university education in science, and those with a university education in the humanities.

The research questions guiding this study are:

- What kinds of evidence do people with a university education in science compared to people without university science training invoke in justifying their views of CAMs?
- How do people with university education in science, compared to people without university science training, engage with the evidence they invoke?

Literature Review

Given the research questions and rationale outlined above, three bodies of literature are reviewed. These relate to the reasons why people use CAMs, what constitutes evidence in relation to CAMs, and literature on scientific literacy.

Why People use CAMs

Some educated Westerners choose CAMs over modern medical scientific-based treatments, even in the face of what the medical profession views as incontrovertible evidence of successful mainstream treatment options (Passarelli 2008). Advocates of such CAMs often see modern treatments as highly invasive, or fear the side effects of drugs – chemotherapy with its dramatic side effects being an exemplar (Joseph et al. 2012). In any cohort of society there will be some who, as a result of mistrust of authority figures (e.g., as a consequence of well-publicized medical disasters like thalidomide), might want to go their own way. Equally, if a cancer patient is told there are no available treatment options left, a perfectly rational choice might be to try CAMs. The popularity of CAMs has also been attributed in part to patient dissatisfaction with the evidence-based biomedical model of health care. Some CAM advocates argue evidence-based medicine (EBM) does not address the subjective components of human experience essential to good health, and fails to consider health from a more humanistic viewpoint (Goldenberg 2006). Studies reviewed by Thompson and Feder (2005) suggest that people turn to CAMs because of persistent symptoms and concerns about side effects of conventional medicines, and favour a less invasive approach to their health care.

Literature suggests CAM users hold a wholistic view of health, are less healthy than non-users, and view CAMs as congruent with their broader personal values and belief systems (Astin 1998). Furthermore, two large-scale international surveys report that a strong predictor of belief in CAM is belief in magic and the paranormal (Lindeman 2010; Saher and Lindeman 2005). These studies suggest CAMs might be attractive to people with a preference for intuitive thinking activated by personal experience. The authors argue that any increase in rational health knowledge would probably be held in conjunction with, rather than replace, intuitive knowledge that is resistant to change. In a more recent large study, Stoneman, Sturgis, Allum and Sibley (2013) identified a large sub-group characterised by what they termed a 'dissonant' orientation, which was optimistic and supportive of conventional medicine and science, yet also believed in the efficacy of homeopathy.

Evidence Claims

The heart of the debate about the use of CAMs seems to lie in disagreement about their efficacy. Proponents argue it is more holistic in nature and often as effective, or more effective, than science-based medical treatments (see, e.g., Trevelyan 1996). It does appear that CAM advocates and the established medical system hold different views as to what constitutes 'evidence'. There seems to be a mismatch between the widespread use of CAMs and the scientific EBM approach that is communicated as the central plank of official health policy in many countries. A recent meta-analysis of CAMs reported that 50% of adults and 20% of children in Australia reportedly had used a CAM previously, and about 25% of adults had consulted CAM practitioners (Harris, Cooper, Relton, and Thomas 2012). Figures were slightly lower in the US but reported CAM use was still high (40% adults and 11% of children), and also high in the UK (25% of adults). These data suggest the use of CAM is quite widespread, despite concerns of public sector medical authorities.

The issue as whether or not someone should use CAMs is clouded by what appears to be mixed messages from health authorities. As an illustration, whilst the medical profession ostensibly opposes the use of CAM, in the UK the British National Health Service (NHS) has approved the public funding of homeopathy – albeit not without controversy (House of Commons Science & Technology Committee 2010). This type of debate is widespread, and in Australia, for example, nearly AUD$69 million has been spent since 1991 on research into the effectiveness of CAMs, and the current strategic plan of the Australian National Health and Medical Research Council (2012) includes examination of alternative therapy claims.

Hence, the debate about evidence claims for CAMs should not be seen as a simple argument about who is right and who is wrong, and how we might change the mind of an ill-informed public; health authorities themselves are actively engaged in debates of CAM use versus scientific-based medical treatments. It is, then, a genuine SSI with potentially dramatic implications, and with profound implications for science education.

Use of Evidence in Decision-making about CAM Use

Of central importance in discussion of health decisions, treatments and medicines in relation to CAM is what constitutes evidence. How do people engage with evidence to make health decisions and on what basis should they use various treatments? Kolstø (2001, 302) says that science values evidence that is 'public, inter-subjective and open to validation', particularly statistical evidence establishing causal relationships.

The past few decades have seen a dramatic rise in the use of scientific EBM, with treatment decisions nowadays based on highly codified systems such as the Oxford Levels of Evidence (Howick et al. 2011). This hierarchy of evidence explicitly prioritizes (preferably multiple) randomized, controlled trials as the so-called Gold Standard of evidence, followed by cohort studies, case series and mechanistic reasoning (Yore et al. 2007).

Evidence-based medicine underpins the funding and provision of health care in many developed countries. For example, although homeopathy is currently (and contentiously) funded by the NHS in the UK, a recent inquiry argued for its removal from the NHS on the basis of 'insufficient evidence' (i.e., using EBM principles) for its effectiveness (House of Commons Science & Technology Committee 2010). Similarly, the Australian Medical Association (2012) has argued that CAMs should only be funded if their safety and efficacy is established by EBM approaches.

As might be expected, this conception of evidence and the hegemony of EBM has been criticized by CAM advocates, who raise philosophical objections to its epistemological foundations (see e.g., Barry 2006; Goldenberg 2006, 2010; Loughlin, Upshur, Goldenberg, Bluhm, and Borgerson 2010; Upshur, Van Den Kerkhof, and Goel 2001). To counter some of the criticisms leveled at the what opponents consider a narrowly focused definition of 'evidence' in EBM, a broader taxonomy of what counts as health-related 'evidence' has been proposed (Upshur et al. 2001), which includes qualitative evidence at both personal and general levels. Goldenberg (2006, 2630) condemns the authority of scientific evidence and clinical trials that are the hallmark of the EBM movement as 'the latest expression of ''scientism'', modernity's rationalist dream that science can produce the knowledge required to emancipate us from scarcity, ignorance, and error'. Goldenberg says that the complex social process of health care decision-making cannot be rationalized, that patient's individual self-understanding and experiences comprise a legitimate source of relevant medical knowledge and that modern health care should rely on 'diverse notions of evidence' reflecting humanities and social science traditions as well as those from the pure and natural sciences. In a similar vein, Barry (2006, 2646) contends that CAMs by their very nature are not amenable to evaluation by randomized trials, and advocates the acceptance and use of anthropological forms of evidence such as 'transcendent, transformational experiences; changing lived-body experience; and the gaining of meaning'. These 'experiences' as a form of evidence do not sit well with the validity and reliability concerns of EBM.

In summary, the literature reveals two antithetical arguments about what should count as evidence on which to base health care decisions and use of CAMs. These are the scientific evidence-based approach privileging double-blind trials and similar codified and systematic methods, and an explicitly non-scientific approach based on experiential and individual kinds of evidence.

Theoretical Basis to the Inquiry: Socio-Scientific Issues, Scientific Literacy, Scientific Attitude, & Scientific Habits of Mind

Earlier we suggested that CAMs usage is an example of a socio-scientific issue (Çalik et al. 2013). Such issues fall into two broad types: those where a relevant professional group feels the debate is settled and the problem is public lack of understanding about the issue or evidence claims; and a second category of issues where there is not necessarily a clear path forward. We argue here that the use of CAMs falls into the first category; with the odd exception noted above much of the medical profession does not support the use of CAMs *in place* of EBM treatment.

The capacity to engage in debates about SSIs is a component of scientific literacy (Laugksch 2000), which is a key goal of science education worldwide (Coll and Taylor 2009). A precise definition of scientific literacy is yet to be agreed, but Dillon (2009), drawing upon the work of Roberts, indicates there are two broad conceptualizations or visions of scientific literacy: Vision I that looks inward at science itself (its products such as laws and theories, and its processes such as hypothesizing and experimenting), and Vision II which looks outward at situations in which science has a role, such as decision-making about socio-scientific issues (Roberts 2007b, 9). It is this latter vision that underpins the present work, because of its links to SSIs.

We have argued above that the kinds of evidence that people use in health care decisions are important, but here we posit that how people *engage* with and process that evidence is also a crucial part of the picture. This we believe is related to the nature of science (NOS) – something the literature notes as a crucial component of scientific literacy (see e.g., Dillon 2009; Laugksch 2000; Roberts 2007a,b). Like scientific literacy, the literature on NOS is vast, but most commentators say to achieve an understanding of NOS requires people to have some knowledge of how scientists accrue evidence or data, how they interpret data, and how they reach and justify conclusions (Lederman, Abd-El-Khalick, Bell, and Schwartz 2002). Coll and Taylor (2004), along with Coll, Taylor and Lay (2008) suggest that understanding how scientists think is a key element of NOS, and thereby scientific literacy. Gauld (1982, 2005) provides an interesting insight into scientific thinking. In his critical review of the literature, he coined the term 'scientific attitude', which he defined as scientific thinking where 'no idea, conclusion, decision or solution is accepted just because a particular person makes a claim, but is treated sceptically until its soundness can be judged according to the *weight of evidence* which is relevant to it [added emphasis]' (Gauld 1982, 110).

This scientific attitude, Gauld (2005) says, arises from what he referred to as 'scientific habits of mind' (SHOM). The extent to which these habits of mind are the specific or sole provenance of people with a strong scientific education has been raised in the literature. Gauld (2005) himself suggested that 'scientific' habits of mind are not necessarily peculiar to science, but are common to all scholarly activity. This is supported by Çalik and Coll (2012), who contend that these habits of mind are important for everyone in negotiating the increasing range of socio-scientific issues in our lives.

In summary, the literature indicates many modern citizens report the use of CAMs, and that there is a need to better understand the reasons why people choose to use or not use CAMs. The work reported here draws upon SHOM to evaluate evidence claims that people use when making choices about health care.

Methods

To investigate the research questions relating to kinds of evidence that people trained in science vs. the humanities at a tertiary level invoke in justifying their views of CAMs, and the ways in which they engage with this evidence, this study employed an idiographic focus on individuals' subjective experiences and thoughts relating to CAMs. We adopted a qualitative methodology using one-to-one in-depth interviews to explore and report the richness and variation in individual participants' perspectives.

The study involved a purposeful sample of participants selected on the basis of their science background (or lack thereof). The sample comprised 25 tertiary-educated participants; 16 participants with tertiary education to at least Bachelor's level in a science field (9 male, 7 female) and who were employed as secondary and tertiary level teachers and 9 participants who had no science education beyond high school, but held at least Bachelor's degrees in the humanities (4 male, 5 female). This group also comprised secondary and tertiary teachers. The participants were 22–60 years old, and came from different educational institutions in Australia, New Zealand and the United Kingdom (Table 1). The sample and nature of this inquiry precludes generalisation; the intention here is to use qualitative means of inquiry to provide an in-depth understanding of complex issues (Lincoln, Lyneham and Guba 2011; Guba and Lincoln, 1994).

Table 1 here

Interview Protocol

A 22-item list of propositions was given to participants prior to the interviews, comprising statements such as 'There is good evidence that homeopathy can cure serious illnesses' and 'The same standards used to evaluate the effectiveness and side effects of medical drugs should be applied to herbal medicines and other alternative medicines'. Participants indicated the extent to which they thought these propositions were true by circling one of four response codes ranging from 'almost certainly untrue' to 'almost certainly true' in a Likert-type format. This step was used *solely as a trigger for subsequent discussion* (hence we have not numerically summarized the data – see Coll and Taylor 2004), as we asked participants to talk through and explain their views to solicit rich qualitative data. The interviews were audiotaped and transcribed verbatim.

Data Analysis

The interview transcripts were coded manually, and a conceptually clustered matrix was constructed (Maykut and Morehouse 1994). Verbatim responses to each interview question were inserted into a different sheet of a single Excel workbook, using participants' names and coding/memo keys as additional headings. The data file was read through multiple times in an iterative process, using different perspectives to detect and scrutinise emerging themes.

For each proposition in the interview schedule, the data were coded in relation to two broad themes relating directly to the research questions:

Theme 1: *The kinds of evidence that each participant invoked in support of their views.*

Theme 2: *The different habits of mind, as described by Çalik and Coll (2012), apparent in responses of each participant to that proposition.*

Once coding was complete, the codes were compared across science and humanities participants to explore any qualitative similarities and differences in the two groups. All quotations below are reported using pseudonyms.

Results

The results are presented below, organized under the two themes that framed the analysis. There are extended verbatim quotations, in order to show as transparently as possible (given the limitations of any intersubjective dialogue) their perceptions and arguments.

Theme 1: Rationales for views: different kinds of evidence

Respondents varied with respect to the kinds of evidence they invoked in support of their beliefs. The evidence referred to by respondents in explaining their views fell into five major categories, which are used below to organize the responses.

Scientific research

In keeping with their experience and education in the methods of scientific inquiry, many science graduates' responses referred directly to the desirability of scientific testing in relation to health care initiatives. Specifically mentioned was a need for 'empirical evidence':

> Conventional medicine is based on a methodology which is rigorous... based on empirical evidence... If I had a serious illness I'd go the conventional medical way. If that wasn't proving to be successful, then one would perhaps be tempted to look at other approaches. […] the process that a drug has to go through before it gets onto the market is really quite rigorous. You know, double blinded tests and you know phase trials and

> from my understanding of it is that first of all you look at a drug and see if it's got any side effects if you give it to healthy people and then from there on is a fairly rigorous program involving large numbers of people testing the effectiveness of the drug. (Bonnie, Science Graduate (SG))

Respondents also saw value in repeated trials, something they clearly viewed as more convincing in terms of evidence, and as part and parcel of EBM approaches to health care:

> Until you do all the studies all the... medicine goes through, amazing amount of studies and you know trials and things they have to go through before they can actually say, "Yes this pill will do this" and have minimal side effects um... yeah the alternative medicine field hasn't really been put under such rigorous scrutiny. (Dylan, SG)

Consistent with this, CAMs were seen as lacking in this respect since it was deemed they had not undergone such rigorous testing and thus lacked proof of efficacy: "I think herbal medicines are... perhaps not quite quantified enough and not scientifically studied enough" (Evan, SG).

Some of the science-educated respondents dismissed CAMs as akin to superstition, and likely to result in dire consequences:

> ...So if you want to go out and grind up in that way and put it on your warts or your sunspots, be prepare to accept the consequences rather than give science the opportunity to go through the comprehensive and in-depth testing...I do not think that herbal medicine at this point in time we know enough about to confidently apply them. (Brad, SG)

Respondents expressed apprehension about using CAMS that had not undergone rigorous testing, and felt that CAMs lacked evidence of efficacy:

> …other alternatives, homeopathy, acupuncture, chiropractor again, they don't undergo the sort of rigorous scientific testing that normal medicine does. So I would be quite nervous about using those …I'm a firm believer of anything that's going to be tried on me has undergone testing rigorously…Yes...I do know that they must employ the scientific method to test these drugs. (Sarah, SG)

The respondents routinely referred to the 'scientific method', where scientists ostensibly adhere to a set methodological approach to gather evidence, an approach deemed superior to 'anecdotal evidence':

> It's pretty hard to refute [scientific method] as a method for evaluating any sort of treatment I think because it's rational, that's the logical way of doing it, you can use large numbers of people; you let the numbers establish the effectiveness of any treatment …I've a friend whose whole career just about, is these alternative medicines… he obviously got enough of a result from his patients to continue to believe in it, but that's anecdotal, really. If you're looking again at large scale research support, there isn't any as far as I know... (Tommy, SG)

Although the humanities participants did not generally refer as explicitly to scientific methods such as double blind trials as an evidence base, several also considered there was a need for scientifically rigorous testing for CAMs:

> the idea of herbal treatments you know, is really, again just needing more scientific rigour and more institutional rigour in making sure that all the boxes are ticked before medicines are released to the public (Kyle, Humanities Graduate (HG))

Interestingly, even the rigorous testing regimes did not mean that such evidence should be deemed irrefutable, but the concern seems to be related to long-term potential side effects not being picked up during such rigorous testing, rather than thinking CAMS were superior:

> Medical drugs have been subject to rigorous testing...That doesn't mean they're fool proof though… they test them on animals and then they do human trials and then they eventually let them out on the wider populace if they haven't had any serious problems with them, but sometimes conventional medical drugs can be publicly available for a whole generation before they realised it actually caused some horrible consequence… I suppose the testing is not just to prevent side effects or death, but also to test that they work… otherwise the government wouldn't allow them to be sold as a conventional drug as opposed to a herbal remedy. (Kate, HG)

These respondents, like their scientific-educated counterparts, saw research about drug efficacy as key, something they felt meant the EBM drugs were likely more reliable:

> I think so much research is put in to medical side of things, which makes you…which makes me think that they're more trustworthy, but then I suppose on other hand you can't completely disregard herbal medicines because they may have the benefits. (Steph, HG)

A consistent theme was that CAMs needed to be tested in the same way as EBM drugs if they were to be seen as efficacious:

> they should go through the same similar strength of testing because it is just fair. I mean you can't assess two different things for the same outcome and use different standards. (Leslie, HG)

The notion of evidence was seen in stark terms; we either have the evidence or we don't – with evidence here conceptualized in scientific terms:

> I mean if it's the case of people putting their trust in various things, you would expect that that trust is based on something. …it seems to me either you have rigorous standards for this sort of thing or you don't. (Doug, HG)

Personal experience

Somewhat in contrast to the above lauding of the value of using scientific method/s as the only reasonable evidence for the evaluation of conventional drugs and CAMs, several respondents from both science and humanities backgrounds reported using a range of CAMs such as hypnotherapy, acupuncture, naturopathy and so forth. They justified this choice in part on the results of personal experience. Some science respondents were cautiously open to the efficacy of homeopathy based on positive personal experiences (I=Interviewer; R=respondent):

> I: Has that personal experience actually made homeopathy more convincing?
>
> R: It has, but in my mind, I don't have the evidence to justify the weight loss and there are so many other contributing factors apart from the homeopathy drops that I'll never know whether or not they did have an effect. (Pat, SG)

Another participant cited personal experience of the CAM actually achieving the result desired, cessation of smoking:

> R: I stopped smoking by hypnotherapy… I tried to give up, I tried for about three years... really tried and had a bet with my mates and I bought every single thing that was on the market and I tried acupuncture as well. Acupuncture didn't work for me but hypnotherapy worked… One twenty minute session. Never touched a smoke since and I used to be two packets a day... (Dylan, SG)

In contrast, on the basis of his personal experiences, George (HG) described Bach flower herbal remedies as "a joke":

> R: I was about 20…someone advised me to see a homeopath… he gave me the Bach remedies. And I realised after a while that it was basically an elaborate sort of con.

Anecdotal evidence

Anecdotal evidence was frequently cited as a reason for belief in particular health interventions. Some of the science respondents appeared to be willing to give credence to anecdotal accounts as a source of evidence for health care treatments. For example, despite his strong endorsement of a scientific evidence base, Tommy also invoked anecdotal claims as 'good evidence' in support of his views on hypnotherapy:

> I know people who gave up smoking after they had hypnotherapy. I don't know what the effect is, I don't know how hypnotherapy works, but it worked for them. So that's good evidence…that's people that I know, one minute they're smoking and the next they are not. (Tommy, SG)

Other respondents with science training also invoked reported anecdotal evidence, albeit with caveats, when discussing their views on CAMs. This anecdotal evidence suggested they would at least be open to trying CAMs, when other approaches failed. There is an element of 'it's worth a try' when conventional EBM approaches haven't worked, meaning there's not a lot to lose:

> R: People I know who have acupuncture swear by it. I don't have acupuncture but if I felt there was enough need I might. So if people tell you about something from their, you know, anecdotal experiences about something that for you counts as…
>
> I: Evidence?
>
> R: Evidence. I would be likely to investigate it further (Bea, SG)

The humanities graduates frequently referred to similar anecdotal accounts, as exemplified by Steph's explanation of her willingness to try homeopathy: "I've definitely like heard about it and its benefits and it's something that I'll be willing to try" (Steph, HG).

Respondents referred rather tentatively to anecdotal evidence in justifying their views on hypnotism, but expressed reservations about accepting anecdotal accounts as real 'evidence' more broadly:

> R: Well, I guess it's only anecdotal that I've heard of people who have given up smoking after being hypnotised.
>
> I: Yeah, this is second hand evidence in a sense, yeah?

> R: Yeah, yeah…. I don't have the evidence before me. All I can do is guess at what I think is most likely. (George, HG)

It seems that the respondents did not view such evidence as being quite the same as EBMs, somewhat qualifying their answers: "I have some hearsay evidence that hypnosis is fairly powerful but this question says there is good evidence… I don't know" (Jim, SG).

Media and general reading

Similar to the notion of reported anecdotal evidence from associates or friends, in some cases the media and general reading was deemed a form of 'evidence' for respondents from both educational backgrounds:

> I: Do you have any experience of acupuncture…?
>
> R: No, I only read about it. I have all the books, the atlas of it and stuff like that. I mean I've seen documentaries, but no, no other experience.
>
> I: But they were quite convincing were they, the documentaries?
>
> N: Yeah, they were. (Naomi, SG)

Open-mindedness again surfaced, and a combination of past experience, anecdotes and media reports seemed to sway some respondents to consider the use of CAMs:

> R: I used to grow herbs and be very interested in the medicinal values and purposes…I read a lot about natural medicines and a number of my friends went into that area. So I think there is definitely a lot more in it. (Kerrie, HG)

Historical Use of CAMs

Some respondents, again from both science and humanities backgrounds, also cited the long history of use of CAMs as reasons for their views, along with obvious respect for medical traditions of other cultures:

> R: I think it's an old method and there is a lot of accumulated wisdom into doing that. So based on that, really, not based on any scientific evidence or anything [...] For example Chinese medicine, it has years and years of wisdom of practice, but just because they are in the forefront these medical drugs, you know they are very famous, pharmaceuticals from them you know, so I don't think they are better because they are more tested. (Naomi, SG)

There was apparent impatience with the perceived arrogance of Western dominance of modern medicine and treatments, along with the notion that some modern medicines have their origins in different cultures or settings:

> R: We've got – over 2,000 years' worth of Chinese medicine you can't just ignore it, it's going to be good and a lot of these herbal medicines that, for example, they used to have come across, and this is still used today quite effectively in standard medicine. (Paul, SG)

This notion of respect for non-Western cultures was echoed in other comments, where the long history of Asian medicine, particularly with regard to herbal remedies, was seen as too important to ignore:

> We are probably in terms of Western medicines applying scientific principles that are fairly recent and I think we can learn a great deal from oriental medicine – and I'm not being specific with Chinese – I believe oriental medicine which is lasted for thousands and thousands of years and similarly aboriginal medicine. (Brad, SG)

Summary of Findings for Theme 1

In summary, in relation to theme one, there was no indication from the participants of either a critical acceptance of CAMs or outright rejection of EBM. Respondents from both scientific and non-scientific educational backgrounds talked of a need for scientific rigor and wide-scale testing of medicines in general (including CAMs) to establish their safety and efficacy. Similarly, respondents from both science and non-science backgrounds reported trying a range of CAMs, but in contrast to the oft repeated references to the desirability of testing efficacy, simultaneously seemed to be willing to accept reported anecdotal evidence and history of use as counting for something in these kinds of decisions. Despite typically holding the view that there is no scientific support for the efficacy of CAMs, the use of such treatments was not dismissed, but it seemed to be confined to circumstances in which there was not a lot to lose; that is, when EBM approaches had failed.

Theme 2: Habits of Mind

The coded data from the interviews related to several of habits of mind as defined by Çalik and Coll (2012), which are summarized below.

Objectivity

If defined in this context as strict adherence to tenets of EBM, then none of the participants expressed this consistently. As is evident from the quotations above, different forms of subjective anecdotal evidence were cited by respondents, including several with science training. One of the science respondents explicitly recognized her own bias towards the medical profession:

> Yeah, that's my own sort of bias I guess. I think that... yeah the medical ones are sort of peer reviewed more than herbal medicines are. By the medical and scientific community – I think that's my bias 'cos I come from there. (Fiona, SG)

Mistrust of Authority

There were very few science respondents who expressed mistrust of authority in relation to mainstream health provision, which relates coherently to the acceptance by the science respondents of the value and worth of scientific testing outlined above. One of the science respondents did not trust the quality of the service provided by mainstream doctors, contrasting this unfavourably with homeopaths:

> And that's where the homeopathy... they tend to look more at the whole person and they tend to... delve a little bit deeper than just the surface, because today… lots of the doctors, they have to get five patients through in an hour…and they just prescribe, prescribe, prescribe… whereas your homeopathic medicines, they actually need to understand the person so that they can address the underlying issues, not just the superficial issues. (Dylan, SG)

Paul (SG) provided a slightly different example of this particular habit of mind, mistrusting some claims of the medical industry because of suspicions about the motivations of the claimants:

> I think it comes back to this medical industry driving it, and then what research is done; and a lot of testing is done by the people that are manufacturing the stuff.

Mistrust of the motivations of mainstream medical authority was also expressed by one of the humanities respondents, Anna, who argued that people are more likely to place blind trust in conventional medicine than in CAMs:

> I: So what do you think about the possibility of somebody setting themselves up as a, you know, herbalist or a naturopath or whatever and selling things…when actually there's no evidence that it's going to do any good?
>
> R: I think one needs to put a little bit more trust in people because I think we tend to find that there is a lot of intelligent, you know, people that choose those things, actually spend a lot of time thinking about it and researching it. And the people that go to conventional medicine don't, and they go there blindly trusting without knowing; and even I know that's a generalisation, and obviously there's always a chance that someone would get sucked into something that isn't genuine. But, you know, my experience of the people that seek alternative medicine is that they don't go there with that open trust of "please fix me", like they would on a modern, you know, in a conventional doctor. (Anna, HG)

While not expressing mistrust of the motives of the medical industry directly, two of the humanities respondents ostensibly mistrusted both the efficacy of current testing regimes, and the extent to which they felt some doctors were informed about the medicines they were prescribing:

> I don't think the standards applied to conventional medicine are high enough…I think that some medicines come on the market and 20 years later, the long-term effects are discovered. So, there should be greater standards of monitoring for those, and herbal medicines should have those greater standards as well. (George, HG)
>
> I don't think doctors know a lot about medicine. They do very little study in the pharmacology… So I think they are probably pretty uninformed about medicines in general let alone the natural medicines. (Kerrie, HG)

Open Mindedness

Open mindedness to CAMs was apparent across respondents from both the sciences and humanities backgrounds. This in a way reflects a suspension of disbelief in CAMs, with the argument commonly being that they *might* work but that we just do not know enough about them, hence cannot disprove them as legitimate ways to treat illness. This argument appears to relate to the provisional nature of scientific knowledge expressed by many of the science respondents:

> Just as in any branch of science they don't already have the answers… therefore you can't be dismissive of alternatives unless you've proven them to be wrong. (Tommy, SG)

> I think there are certain things in medicine that we just haven't yet explored. And if I have a serious illness and I was told a certain thing by medic guys and GPs, I still would explore any other avenue I could. (Pat, SG)

> Although I'm from a science background I'm still open minded, no one has all the answers so... we should always consider all the possibilities no matter how, low percentage chance of success there might be, but just put it on the table but not necessarily do it. (Anthony, SG)

Similarly, some of the humanities respondents suggested that science does not have all the answers, and thus according to them this means we can learn from alternatives:

> Medicine plays a big part in certainly improving, you know, health due to the science, however, a lot of the science also comes from natural remedies and things like the, you know, the Brazilian rain forest probably have a lot of things that could yield to us. Things like ayurvedic medicine [a Sanskrit-based holistic view of disease and treatment] in Sri Lanka and India. I believe they are probably based on some very good medical background in relation to the herbs they use. So, yeah, I think we have a lot to learn from indigenous societies and also just other societies in relation to natural medicines… it probably doesn't have the rigorous studies behind it. That does not mean that it does not work though. (Kerrie, HG)

> That doesn't mean that I think that there is anything wrong with conventional treatments. But yeah, it just means that it doesn't have all the answers… (George, HG)

Scepticism

Some respondents from science and humanities backgrounds expressed skepticism about the claims of conventional medicine:

> I would always be very cautious about taking drugs of any sort. I know that there are times, but it would be – I would see it as something that was in extreme situation and for a short time and that you would always be looking for other approaches, other methods and ways because, again, if you're taking that and you don't know what you're really dealing with… if I was well and conscious enough, I will be reading it, researching it, and I'd be extremely cautious about taking it. (Anna, HG)

Similarly, skepticism about the efficacy of CAMs was apparent in some respondents, including humanities graduates:

> R: It's not the one where they give you tiny little drops of stuff is it?
>
> I: That's the ones where they give you tiny little drops of stuff and –
>
> R: Right, right. (Ironically laughs): It's a flawed understanding I think of the way humans react to things. (Kyle, HG)

Interestingly, some skepticism about alternative approaches was evident even for those reportedly *using* CAMs:

> Medical science researchers aren't stupid and neither are the pharmaceutical companies – if they had fallen upon an alternative approach that was successful then surely that would be in the domain…. It seems to me just a little bit of hocus pocus there and I

> mean there is a huge amount of money involved in all of this and the public at large spend vast sums every year buying herbal remedies and we are I suppose, herbal gullible in that respect. I do take... glucosamine sulfate in the belief that it is going to stop my knees from running out because I do a bit of running…(Bonnie, SG).

Rationality

All the respondents offered rational arguments for their views, as is apparent in many of the quotations outlined above. One of the humanities respondents (Anna) held arational beliefs in the metaphysical belief system espoused by Steiner philosophy. However, within the bounds of this arational point of reference her arguments were eminently rational:

> R: I think conventional medicine is wonderful and it does fantastic things in certain areas – in lots of areas, but then equally, in lots of others, it can't – I don't feel it can sort of touch it because it's working only on the physical level, so it's assuming that you only have a physical body. And, for me, it's not that simple … I would say that we have a physical body, an etheric body, an astral body and an ego, so all those combinations of bodies working together in a human being can come across all sorts of problems and conflict. So if you're just dealing with the physical body, modern science medicine is fantastic. But, unfortunately, there's lots of other influences and issues that come up that it can't, you know? So, you know, I'm not anti-modern medicine at all, it's just knowing when it's the right time to use it. (Anna, HG)

In summary, in relation to theme two, the 'scientific' habits of mind proposed by Gauld (1982) and as employed more recently by Çalik and Coll (2012), were expressed by a range of scientifically and non-scientifically trained participants in this study.

Discussion

Regarding the first research question about different kinds of evidence, tertiary science education does not seem to have made a qualitative difference to the way that participants in this study engaged with evidence about CAMs. Respondents with tertiary science training and those without it alike used subjective kinds of evidence in justifying their views and decisions about CAMs. This suggests that regardless of the place of evidence-based medicine in health policy, interpretivist views of what counts as evidence for CAMs (e.g., Barry 2006; Goldenberg 2006, 2010; Loughlin et al. 2010; Upshur et al. 2001) are being used by the general public, even by people (like Tommy) who understand and are deeply committed to the principles of EBM.

We would argue along the lines of Bailin, Case, Coombs and Daniels (1999) and Ennis (1993) that what is needed is the kind of critical thinking that allows health consumers to assess the credibility of the different kinds of evidence relevant to CAMs. We concur with the argument of Kolstø (2001) that mutual understanding concerning the advantages and limitations of scientific and anecdotal kinds of evidence is necessary. We would also emphasize that this understanding is not possible without a deep understanding of the scientific method as applied to EBM, as well as clear understanding and acknowledgement of its limitations. But what to make of people like Tommy and Dylan, who despite criticizing the lack of a strong scientific evidence-base for CAMs, have tried them or accept anecdotal evidence for their worth? This may well relate to the habit of mind of open-mindedness, which is more or less equivalent to suspension of *dis*belief – the flip side of suspension of belief: if something has not been disproved then it should not be discounted. However, further research into this finding would be of value.

So what does all this mean for science education, both at school and higher education? It highlights, as pointed out by Kolstø (2001), the importance of background knowledge, including knowledge about the nature of science and scientific knowledge. It also points to the need for

explicit teaching about the epistemology of science, including an ability to assess quality of data and adjudicate between different interpretations of data (Ryder 2002). To this end it provides yet more reason for incorporating into both school and university science education the kind of dialogic reasoning and argumentation, using case-based socio-scientific issues to allow students to experience the nature of science and develop scientific literacy advocated for some years by a range of researchers (e.g., Zeidler, Sadler, Simmons, and Howes 2005).

However, scientific literacy, and understanding of the nature of science are not enough – also important is the relationship of the science to belief systems and habits of mind. As pointed out by Lederman (1992), developing an understanding of the nature of science is not a simple matter and conceptualization of science is mediated by religious and other belief systems (see also Zeidler, Walker, Ackett, and Simmons 2002). Moreover, these belief systems, especially at the level of metaphysical paradigms as expressed by Anna, may be extremely resistant to change (Johnson 2011).

As argued by Johnson (2011), education should encourage students to explicitly re-examine and redefine their beliefs, and this may be particularly fruitful in the context of science education, where belief systems can filter the kinds of knowledges and information valued by science educators. This could help make more visible to students the relationship between the specifics of the science and their beliefs in a given teaching and learning context.

This leads us to the second research question about the ways in which people engage with the evidence relating to CAMs. Anna's strong commitment to CAMs reflected her belief in the fourfold anthroposophical view of humans that was held in conjunction with a strong commitment to mainstream science. Her accommodation of a paranormal belief system and conventional science; of exercising rationality within an a-rational framework, is fundamentally parallel to scientists accommodating rationality within an overarching a-rational more mainstream faith-based framework (see e.g., Coll, Taylor, and Lay 2009). So, conventional scientific testing of the physical effects of CAMs is not in a sense relevant to the paranormal aspects of Anna's framework for health care decisions. Hence it is unlikely that anything science can show will change her views while she holds those beliefs.

As belief in the paranormal has been shown to be negatively correlated with analytical cognitive style (Pennycook, Cheyne, Seli, Koehler, and Fugelsang 2012), future research might fruitfully explore the relationship of this cognitive style to rationality, the extent to which deploying an analytical cognitive style can be facilitated in relation to socio-scientific issues, or under what conditions it might be expressed, taught and practiced.

Furthermore, the results of this study suggest that the term 'scientific habits of mind' may be misleading in its implication that these habits of mind are particular to science (as noted by Gauld). We could not establish qualitatively different ways of thinking in terms of the 'habits of mind' specific to respondents who had tertiary science training. This supports the previous contention by Gauld (1982) that the habits of mind explored in this study are not specifically the province of science specialists. These results raise important questions for science education about whether there is anything special about ways of thinking and engaging with evidence scientifically that separates it from critical thinking applied in other spheres of endeavor. If so what is it, how do we put our finger on it and most importantly how do we communicate it to our students and to the public?

Hence, there is a need for further studies, to try to tease out the relationship between habits of mind, understandings of scientific literacy including the nature of science and their interplay with belief systems that people bring to health care decisions and other socio-scientific issues. It may also be valuable to undertake quantitative studies to explore whether there are quantitatively detectable trends, rather than qualitative differences, in the kinds of evidence that people with and without science backgrounds accept in relation to CAMs and the ways that they engage with that evidence.

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Table 1: Participant background

Pseudonym	*Profession*	*Discipline Area*
Anthony	Teacher	Science
Neville	Teacher	Science
Andrew	Teacher	Science
Bonnie	Teacher	Science
Cheryl	Teacher	Science
Dylan	Teacher	Science
Evan	Teacher	Science
Fiona	Teacher	Science
Bea	Retired teacher	Science
Tommy	Lecturer	Science
Brad	Lecturer	Science
Jim	Lecturer	Science
Pat	Lecturer	Science
Paul	Lecturer	Science
Sarah	PhD student	Science
Naomi	PhD student	Science
Anna	Teacher	Humanities
Wendy	Teacher	Humanities
Leslie	Pre-services teacher	Humanities
Stephanie	Pre-services teacher	Humanities
Doug	Lecturer	Humanities
Kerrie	Lecturer	Humanities
Kyle	Lecturer	Humanities
Kate	Lecturer	Humanities
George	Lecturer	Humanities

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