Heather J. Bray and Rachel A. Ankeny

Not just about "the science": science education and attitudes to genetically modified foods among women in Australia

New Genetics and Society, 2017; 36(1):1-21

Not just about "the science": Science education and attitudes to genetically-modified foods among women in Australia

Heather J. Bray and Rachel A. Ankeny

Faculty of Arts, University of Adelaide, Adelaide, Australia

Heather J. Bray (corresponding author)

Senior Research Associate, Department of History, School of Humanities, Faculty of Arts

University of Adelaide

Adelaide, South Australia, 5005, Australia

Email: heather.bray@adelaide.edu.au

Phone: +61 8 8313 5608

Rachel A. Ankeny

Professor, Department of History, School of Humanities

Associate Dean (Research) and Deputy Executive Dean, Faculty of Arts

University of Adelaide

Adelaide, South Australia, 5005, Australia

Email: rachel.ankeny@adelaide.edu.au

Phone: +61 8 8313 5570

Acknowledgements

This work was supported by funding from the former Australian Commonwealth Department of Industry, Tourism and Resources National Enabling Technologies Strategy's (NETS) Public Awareness and Community Engagement Program, administered by the Government of

South Australia, Science and Information Economy, Department of Further Education, Employment, Science and Technology (DFEEST). Rachel Ankeny was supported by an article fellowship from the Fay Gale Centre for Research on Gender at the University of Adelaide. Rachel Ankeny and Heather Bray were supported by the Australian Research Council (DP110105062 "What Shall We Have for Tea? Toward a New Discourse of Food Ethics in Contemporary Australia").

The authors are thank the women who participated in this study, Ms Jessica Loyer for assistance with manuscript preparation, the University of Adelaide's Department of History Writing Group for feedback and support, and to the anonymous reviewers for their helpful advice.

Abstract: Previous studies investigating attitudes to genetically-modified (GM) foods suggest a correlation between negative attitudes and low levels of science education, both of which are associated with women. In a qualitative focus group study of Australian women with diverse levels of education, we found attitudes to GM foods were part of a complex process of making "good" food decisions, which included other factors such as locally-produced, fresh/natural, healthy and nutritious, and convenient. Women involved in GM crop development and those with health science training differed in how they used evidence to categorize GM foods. Our findings contribute to a deeper understanding of how GM food, and the role of science and technology in food production and consumption more broadly, are understood and discussed amongst diverse "publics" and across different "sciences," and to research related to deepening public engagement at the intersection of science and values.

Keywords: Genetically-modified (GM) foods; genetic modification; community attitudes; deficit model; risk

Word count: 7999 (excluding abstract, references, and notes); 9473 (grand total)

Introduction

This paper aims to assist those who wish to foster improved public dialogue around the issue of genetically-modified (GM) foods by providing a complex and more realistic picture of the diversity of the associated values. We focus on women with different levels and types of science education, illustrating that decisions about GM food are rarely about one issue, and notably not just about "the science." This paper also makes a critical scholarly contribution to arguments about moving beyond a deficit model of the public understanding of science (Miller 2010), especially the oft-reported "relationship" between scientific literacy and attitudes to genetic modification. Building on the idea that there are multiple "publics" espousing diverse values and attitudes, we contend that a consideration of multiple "sciences" enriches understandings of and approaches to public engagement around controversial and emerging applications of science and technology, including genetic modification.

Attitudes to GM foods and the role of "knowledge"

Scholars and policymakers have been interested in attitudes to genetically-modified (GM) foods since they became globally available in 1994 (Kramer and Redenbaugh 1994). "Knowledge" of GM foods has been variably defined within the literature (Qin and Brown 2006), leading to inconsistent findings about the effects of knowledge on GM food acceptance (Rodríguez-Entrena and Salazar-Ordóñez 2013). Costa-Font, Gil, and Traill (2008) review numerous positivist, quantitative studies from Europe and the US, highlighting

that risk/benefit perceptions, individual values and attributes, and subjective and objective knowledge are all drivers of attitudes to GM foods. Frewer, Miles, and Marsh (2002) found a relationship between "education level" and perceptions of GM foods (see also Koivisto Hursti and Magnusson 2003). In contrast, Lea (2005) detected little difference in GM food beliefs between those with and without post-secondary school qualifications; she also found that more women than men agreed that they lacked knowledge about GM foods. Moerbeek and Casimir (2005) concluded that the ability to correctly answer ten biological questions was positively related to acceptance of GM foods; this effect was significantly stronger for men than women. House et al. (2004) examined the effect of both objective knowledge (the ability to answer four questions correctly) and subjective knowledge (whether the participant thought s/he was knowledgeable about GM foods), finding that subjective knowledge was a significant determinant of how willing consumers were to eat GM foods; similarly, Lusk et al. (2004) found that participants with more subjective knowledge or with initial negative attitudes were less influenced by new positive information about GM foods. In another study, the ability to correctly answer a small number of questions about biotechnology was not found to influence opposition or support for GM foods; however there was a significant proportion of indifferent respondants with little "knowledge" (Cristoph, Bruhn, and Roosen 2008).

Qin and Brown's qualitative study (2006) examined the effect of both product information (the gene source, outcome of the manipulation, and regulatory status) as well as process information (how the gene manipulation was done and consequences) on acceptance of GM salmon. Further examination of the effect of information (Qin and Brown 2007) showed that although participants felt more confident about understanding the impact of GM food on consumer choice and health, there were few changes in attitude. This study also suggests that

women's concerns about risk, rather than the effect of information, may explain the gender difference identified in some studies.

Results of studies of the effects of field of tertiary study (science-based versus other fields of study) are similarly contradictory and unclear. For instance Priest (2000) found that those with university-level science training were more positive about biotechnology applications than others. Deckers's (2005) analysis of conversations with scientists and non-scientists showed that views did not align simply with these categories of participants, but that the positions of both groups were complex and varied; in contrast, Saher, Lindeman, and Koivisto Hursti (2006) found that students of the natural sciences were more positive about GM foods than other types of students. Rodríguez-Entrena and Salazar-Ordóñez (2013) found that purchase intention was not directly related to educational discipline, but that high levels of GM food knowledge increased percieved benefits for those with non-science and technology education, but increased percieved risks among those with science and technology education.

Although this scholarship has informed and provided a starting point for the current study, the findings are inconsistent and unclear. More importantly, we take issue with many of the conclusions drawn, due to the frequent implicit (or even explicit) endorsement, as noted by Cook, Pieri, and Robbins (2004), of the "deficit model" of science communication, namely the idea that rejection of a technology is due to an information deficit within the intended users/consumers of that technology (Gregory and Miller 1998; Sturgis and Allum 2004). There have been several attempts to shift science communication and public engagement away from this flawed model, yet it persists in part due to the influence of mostly quantitative studies which can be performed on a larger scale with less cost and hence tend to be more efficient than qualitative approaches, but which also can reduce understanding to "knowledge" of the technology itself. At a deeper level, the ongoing reversion to a deficit

model reflects an inability in our field to address what Wynne (2008) calls the "elephant in the room," that is, "… what is the 'science' which we are supposing people experience …?" (21).

We do have some evidence that scientists themselves from different disciplinary backgrounds vary in their attitudes to GM foods. Fisher et al. (2005) highlighted differences between scientists within the same organization developing GM organisms: those working in plant and animal reproduction (and using molecular biology techniques) were more accepting than those working in disciplines requiring more holistic approaches such as "Land and Systems." Kvakkestad et al. (2007) found a lack of consensus on GM crops among scientists: molecular biologists were more likely to agree that GM crops present no unique risks and are useful, while ecologists and conventional plant breeders were more likely to agree that the environmental effects are unpredictable and hence GM crops might be problematic. They concluded that while the views of the scientists were not (strictly speaking) in opposition to genetic modification, they valued different aspects of scientific evidence. Wheeler (2009) also documented different levels of support for GM crops among agricultural professionals in Australia. However, there is scant literature on attitudes to GM foods among those in the health sector, such as medical practitioners and dieticians, although the Public Health Association of Australia's policy on GM foods suggests that the sector is concerned about risks to human health and a lack of evidence of safety; they contend that they will continue to advocate for state-based moratoria on the production of GM crops (Public Health Association of Australia 2013).

GM in Australia

As this study was performed in Australia, we provide some background on the current state of genetic modification in that context. Australia represents an ideal locale in which to

explore attitudes toward genetic modification as it neither has complete bans on GM crop growth or use in the food supply (as has been the case until recently in parts of the EU) nor is GM widespread, as is in the US; public opinions on and regulatory approaches to GM in Australia remain mixed. Australia is currently ranked thirteenth in the world in terms of the area of land sown with GM crops (James 2014), particularly cotton and canola. However shortly after federal regulatory approval of InVigor® canola for commercial release in 2003, moratoria were established in all canola-growing states due to anti-genetic modification campaigns, state-based political issues, and concerns about impacts on export markets where GM foods are banned (Tribe 2012). Moratoria on GM food crop growth were lifted in the states of New South Wales and Victoria (2008) and Western Australia (2010) but remain in South Australia and Tasmania. Activism against GM crops in Australia has been far more limited than in Europe and the US where activists damaged field trials in the 1980s (Hindmarsh 2008). The 2011 destruction by Greenpeace activists of a CSIRO field trial of GM wheat with altered nutritional value (Sadler 2011) represents an unusual form of direct protest in Australia. There continue to be popular concerns about the potential for cross-contamination between GM and non-GM crops, particularly organics, highlighted by a recent court case in Western Australia (Neales 2013).

Quantitative surveys conducted since 1999 by the former Commonwealth agency Biotechnology Australia (Eureka Strategic Research 2005, 2007; Milward Brown 2001, 2003; Yann Campbell Hoare Wheeler 1999) show support for GM food and crops decreased between 1999 and 2005, but rose in 2007, with 73% claiming to accept GM food crops, before falling again in 2010 (Cormick 2011). However, the Swinburne National Technology and Society Monitor indicates that Australians did not feel "comfortable" with GM plants or animals for food at any point between 2003 and 2013 (Marques et al. 2015). It is difficult to explain these patterns and inconsistencies, in part because these surveys rely on rather broad

questions that do not permit deeper analysis, though it is likely that framing effects (Tversky and Kahneman 1981) might well be part of the explanation.

Labelling of GM food in Australia is based on what a food contains (i.e., the final product), not how it is produced, commonly referred to as the "product/process distinction," as underscored by the explicit regulatory exceptions to labelling requirements.[1] Approval of GM products for sale by Food Standards Australia New Zealand is based on the principle of "substantial equivalence," where products deemed to have similar physical and chemical properties as their conventional counterparts are treated in the same manner with regard to health and safety, and subjected to little, if any, additional testing (Lockie et al. 2005). There are high levels of consumer support for the labelling of GM food (Dietrich and Schibeci 2003; Lea 2005), and various advocacy groups claim that current labelling is not sufficient to permit consumers to make knowledgeable food choices, especially to avoid the purchase and consumption of food made with GM components (Lea 2005). The contested community definition of what a GM food is–a final *product* containing modified DNA or a protein at a particular concentration versus something that has been *produced* using GM technology remains a major point of difference between supporters and opponents of GM foods (REF BLINDED).

Theoretical framework, methods, and research questions

Against this background, this paper explores attitudes to GM foods among Australian women with diverse levels and types of science education and different professional roles across the sciences, broadly defined. These results form part of a larger study examining women's

[1] The Australia New Zealand Food Standards Code - Standard 1.5.2 - Food Produced Using Gene Technology - F2012C00771 states that labelling is not required for (1) highly-refined foods and processing aids or additives where the modified DNA is removed during processing (including canola oil produced from GM canola plants); (2) flavours where the concentration in the final food is less than 0.1%; (3) unintentional presence where the ingredient is less than 1% of the whole food, and (4) any foods consumed at the point of sale (take-away, restaurants and cafes, etc.).

attitudes to GM foods. We focused on women in part due to their roles as "food gatekeepers," as women are responsible for the majority of household food purchasing decisions in Australia (Hewitt et al. 2013). By focusing solely on women, we sought to avoid dwelling on how or why women's perceptions may be different to men's, or on the role of gendering (Henwood, Parkhill, and Pidgeon 2008) in order to move to a deeper exploration of the interconnections between personal and professional roles (Tulloch and Lupton 2002) and perceptions of GM foods

We present results that relate to the impacts of science education and professional roles on assessments of risk, as this was identified as a gap in the literature, and on the intersection of scientific literacy with social values enacted through food choice. We acknowledge it is extremely difficult to disentangle personal and professional aspects of women's lives; we discuss this issue in more detail, along with the influence of caring status on attitudes to GM food, in another paper (REF BLINDED). We investigate whether women's attitudes are related specifically to GM foods as food products or to other aspects associated with the production of GM foods (such as concerns about the growth of GM crops), because of the critical product/process distinction.

Our methods are qualitative, but do not strictly rely on traditional "grounded theory" (Corbin and Strauss 1990a, b; Charmaz 2006). Instead, we utilize what has been described as the "generic inductive qualitative model" (Maxwell 2005; Hood 2007). This method incorporates process as well as description and interpretation in the formulation of research questions, purposeful sampling including demographic-based recruitment, and generalizability to like cases, cross-population or otherwise (e.g., to other locales). Analysis proceeds by focus on themes, rather than on the development of theoretical categories as in the case of grounded theory.

These methodological features are critical to the topic under investigation, namely women's attitudes toward GM food, but more importantly, were well aligned with our underlying theoretical framework, which aims to reject a deficit model approach to public understanding of science in favor of developing more in depth and effective analyses which in turn can help to support inclusive and deliberative approaches to public understanding of science. Our study emphasizes the need to understand attitudes on their own terms without imposing assumptions about what counts as "knowledge" or privileging it. This method permits generalizability beyond the population under investigation, which is important for qualitative work to be considered as relevant and useful beyond its immediate domain.

Accordingly, the research questions that drove our analysis were:

(1) How do level of education and professional roles in "science" shape the understanding of risk and the use of evidence for assessing risk associated with GM foods?

(2) Is avoidance or acceptance of GM foods related to ideas about consuming GM foods, or about broader issues and social values involved in their production (the product/process distinction)?

Our analysis draws on data obtained from three focus groups in Adelaide, Australia in early 2011.[2] Adelaide is the capital city of the state of South Australia with a large urban area (population of approximately 1 million) surrounded by numerous agricultural regions, making questions about agricultural technologies and food choice important not only as personal issues but also as matters of public policy. Adelaide is home to centers of GM crop research and development, although the state has a moratorium on commercial planting of GM crops until 2019.

[2] <HREC information blinded>

To address our research questions, we specifically recruited women with very high levels of knowledge about GM crops, women with high levels of science education, and women working in other types of settings or who were not currently working. We defined "science education" broadly to include not only basic science fields but also agriculture and health sciences. We included women with and without children in order to explore the relevance of roles as carers and food providers to attitudes as discussed elsewhere (REF BLINDED). Participants were recruited through university bulletins, flyers at university events, notices on general community noticeboards, and through community groups outside the University. The recruitment process, although potentially limiting participation to the "relatively engaged" and those who self-selected due to interests in GM or food, was considered appropriate for a small-scale study which aimed to explore a diverse range of pre-existing attitudes and values along with the underlying themes and rationales for these, rather than to quantitatively measure the frequency of particular attitudes or their precise associations with various demographic factors. Volunteers were screened before being assigned to a focus group to ensure a mixture of education levels in science, age (based on broad groupings such as Baby Boomers, Gen X, and Gen Y), and parenting status within in any one group (Kitzinger 1995). One focus group consisted solely of women working in plant science as we wished to explore the effects of higher levels of science knowledge and education on attitudes toward GM food as well as seeking not to unduly influence the conversations with participants with potentially less knowledge about genetic modification. In this group, volunteers nonetheless were screened in order to obtain diversity with regards to age and parenting status.

Each group was composed of seven to ten women. Group 1 (coded below as G1) included plant scientists, technical assistants, PhD students, a food scientist, and a bioinformatician. Group 2 (G2) included women with diverse professional roles such as researchers in health science, nutrition and marketing, as well as two women who were not currently working; in

this group, half had only high school education in science. Group 3 (G3) included seven women, five of which indicated that their highest level of education in science was high school; professional roles included administration, marketing, and allied health. Focus groups were held at the university because it is located in the accessible central business district and at lunch time to maximize diverse participation. At the start of each focus group, participants completed a basic demographic and food habits survey, the latter to allow participants to reflect on their food choices and purchasing patterns.

Discussions lasted approximately one hour; based on previous research using these methods, we have found an hour to be a sufficient amount of time for discussion while not prohibiting participation by working women. They were based on a series of open-ended questions and hypothetical scenarios (Ulrich and Ratcliffe 2007). Each group was facilitated by one of the researchers using the same script, with minor modifications for Group 1 due to their roles as scientists. We asked participants to discuss their food shopping and meal preparation habits and to identify the priorities which they viewed as guiding their food choices for themselves and other household members (where relevant). Follow-up questions included why they made particular choices and what information (e.g., labels) was used when making particular choices. In Groups 2 and 3, the participants were asked if GM foods were something they "watched for" when shopping, without the researcher providing any definition or explanation about GM. Participants were asked to explain their understandings of GM foods, and why they might choose to avoid them or seek them out. In Group 1, participants were asked how they would explain to others what GM foods were, and whether they consumed GM foods and would serve GM foods to family members. The hypothetical scenarios involved potential consumption of GM foods, with participants asked to reflect on how they would respond in each situation, allowing further exploration of the frameworks and values which women consider when choosing food and preparing it for others.

The focus group discussions were recorded digitally, transcribed and anonymized, and checked for accuracy against hand-recorded notes taken by one of the researchers. The transcripts were then treated as rich, narrative texts; analysis was performed by one researcher coding the transcripts for major themes relating to GM and foods, similar to the "open coding" method described by Corbin and Strauss (1990a; see also Holton 2007). Validity was checked by the second researcher by comparing these themes to those identified independently by her in the transcripts, and coding for consistency across the themes and groups.

The distribution of residential postcodes of participants ranged across the greater Adelaide metropolitan area and included inner metropolitan, outer metropolitan, and inner regional areas (as per the Australian Standard Geographical Classification) with household incomes ranging from AU$41,000-60,000 per year to greater than AU$100,000 per year. We do not view the lack of participation amongst the lowest-earning Australian socioeconomic bracket as overly limiting to our findings because we were not seeking representative or quantitative results, and were focused in part on women with higher levels of education which are typically correlated with higher levels of income.

The women in our study ranged in age, with 15 participants under 35 years of age and 10 participants over 35 years of age; the largest number of women were between 25-34 years of age. More than half (17) of the participants were in a de facto relationship or married; just under half (11) had children. The majority of women had a tertiary qualification, with 9 with a university degree and 11 with a postgraduate (masters or PhD) qualification (unsurprising given there was active recruitment of scientists, particularly for Group 1). Most of the participants worked full-time (16), and only two participants were not working.

A majority (22) of women in our study were responsible for preparing the shopping list and doing the shopping; a majority (19) were responsible for preparing the main meals. Most

participants (19) ate "some" meals in a restaurant or café each week; approximately half of the participants (12) ate take-away or pre-prepared meals each week, while 10 participants stated that the number of take-away or pre-prepared meals they ate each week was "none." Most participants responded that there were no special dietary requirements for themselves (15) or their household members (16).

Results

Unconcerned about eating GM food

All of the women who worked in plant science, and some who did not, were unconcerned about eating GM foods and did not specifically seek out GM-free foods:

> Whether it's modified genetically or not, doesn't concern me. I never look for that. (G1 F8)
>
> I wouldn't look for that—that wouldn't be the difference between buying something or not buying something. (G3 F7)

These women acknowledged that they probably regularly consumed foods containing GM ingredients with no adverse effects, linking this to their lack of concern:

> I only buy the regular one that I used to buy because I figure that I probably had been eating the genetically modified one anyway and it hasn't done me any harm, I may as well just keep eating it. (G2 F4)

Within this group of women there was curiosity and a willingness to try GM foods, particularly if they had increased nutritional value or improved taste (characteristics which are currently being investigated by researchers utilizing gene modification technologies), as suggested in one of the hypothetical scenarios (involving a nutritionally-enhanced GM banana):

> I'd probably even seek them out and try them [GM bananas]...[to] see if they tasted the same. (G1 F6)

However, there was still concern about additives and the nutritional value of foods:

> I don't really avoid any genetically modified foods or anything like that–more sort[s] of things that, you know, there is evidence that it's bad for your health, such as fat and sugar and high GI foods. (G2 F1)

In summary, those who were relatively unconcerned used their previous experiences of having no ill effects from consuming foods that they thought were likely to contain GM ingredients as the basis of their attitudes, and prioritized other attributes of food (such as nutritional content) as more important to avoid, stressing the idea that "evidence" exists in that case that fat and sugar, for instance, are in fact "bad."

Avoiding GM foods

Most of the women in groups 2 and 3, which included some women with postgraduate qualifications in nutrition and health science, indicated they would avoid GM food:

> I definitely would buy the one that was not GM. (G3 F6)

The women with less science education in these groups who said they would avoid GM foods did so because they felt that they did not know enough about them, had negative associations with GM foods that they could not explain, or described them as "unnatural":

> I wouldn't [buy GM foods] but it's because I don't know enough about it at the moment and it's scary. (G3 F1)

> I associate GM as being not as good for me and I don't know why, I just, that's just how it is. (G2 F5)

> It's kind of a perception that, you know, you get food from the lab or food from the garden and genetically modified to me is kind of food from the lab whereas food from the garden is the fresh, natural kind of stuff. (G3 F3)

However, some women who had high levels of science education and worked (or had worked) in scientific fields also avoided GM foods. These women had independently researched the topic and felt that there was not enough publicly-available evidence to demonstrate safety to humans and/or the environment, or preferred to support accredited and "sustainable" agricultural practices, viewing genetic modification as counter to them. They used scientific terminology and reasoning to explain their views:

> [I'm] certainly trying to avoid genetically modified food simply because I don't know whether they're good or bad; I don't think anyone has enough evidence or if they do they haven't published it for us to really make up our minds one way or the other. (G2 F6)

Thus although scientific information and reasoning were sometimes used by participants, there were commonalities among those who avoided GM foods, notably that they simply felt uncertain or more generally that they had a sense that these foods were "bad."

Food choice is complex

Genetic modification was just one among a number of characteristics of food that influenced purchasing and consumption; among all of the women in the study, there was surprising consistency about these factors, as described in detail below. Reading labels when choosing food was important for those who wanted to avoid GM ingredients. Although those who were unconcerned about eating GM food stated that they did not read food labels, the focus group

discussions revealed that they often used other proxy cues to identify foods that had their desired attributes.

Based on key themes, we identified four main types of food that were important for our participants: (1) "natural," predominantly described as "unprocessed"; (2) local; (3) "healthy"; and (4) additive-free food. However, participants' views differed about the category to which GM food belonged; their assignment of these foods to a particular category related most strongly to their professional roles and appeared unrelated to whether they were carers or food providers for others, and not to their scientific or other understandings of genetic modification.

"Natural"

Participants who were unconcerned about GM food and those who avoided GM food both expressed preferences for "natural" foods. These women either grew their own food, or sourced it directly from producers or farmers' markets to ensure it was "natural." Others expressed preferences for buying fruit and vegetables from greengrocers and meat from butchers rather than large retail supermarkets, again because of preferences for "natural" foods. Most women who expressed preferences for "natural" food claimed to "not eat a lot of processed food" or to not purchase food "in packets" (which are not clearly labelled, according to them). They placed different values on labels; some read them and others did not. In addition, some women who preferred "natural food" sought out food produced without synthetic herbicides and pesticides, although the importance of actual organic certification remained debatable for them. However for some, a preference for food produced without use of synthetic chemicals was not related to desires to avoid GM food:

> …I grow most of my own vegetables and I grow my own meat. … I know what's on those vegetables whereas every vegetable that…is available in the fruit and veggie shop has

been sprayed with one chemical or another or harvested too soon and then kept in this suspended state for months. To me…the nutritional value is more what I'm interested in. (G1 F1, unconcerned about eating GM food)

Local

A preference for locally-produced foods was another theme arising from the focus groups among both women who were unconcerned about and those that avoided GM foods. These participants sought out information on the place of origin when purchasing food, especially fresh food products. Reasons for this preference included food safety concerns particularly in relation to imported food, desires to support local producers, and reducing impacts on the environment resulting from food transportation:

I…try to buy local fresh produce when I do buy it but that's because I want to reduce petrol miles. If I can buy Australian grapes rather than Californian grapes of course I will, or I will not buy them at all because they come from California. Not against global trade but I just think because of the world population expanding as it is I think we really have to look to the future and I think there is a fuel crisis on the horizon so I think it's time to start now looking at local produce. (G1 F8, unconcerned about GM food)

One lot of labelling I look for is on, actually on, fruits and vegetables, especially now that apples are allowed in from China – so we shop a lot in the markets [the large Central Market in Adelaide's central business district], so you have to scurry around under the stalls because if you ask the people selling, "oh yes love yeah it's all Australian." Right, and then you look at the boxes that are shoved underneath and it says "Great Wall," you know. So these are you know Chinese and other, well I don't want to you know get too

> hard on Chinese, but buying locally is always good, but when China doesn't have a stellar record when it comes to looking after food purity. (G2 F2, who avoids GM)

Hence the value of "local" was commonly held among participants without any particular correlation to views on GM foods.

Healthy and nutritious

Women who were unconcerned about and those that avoided GM foods both expressed preferences for food that they viewed as "healthy," citing concerns about the sugar and fat content of particular types of foods. They felt that processed foods were especially "unhealthy" and either avoided purchasing them altogether or attempted to limit the amount that they purchased:

> I try to buy foods that have the least amount of processing as possible so that's really what I look for and what I eat and also what I buy. I also if I'm comparing products will try to find those that have the least amount of preservatives or artificial flavours and colourings and so I try to avoid that. I do like organic produce and try to find natural and organic products where possible, but I don't kind of have a rule that I kind of stick to those when I'm doing the shopping I tend to buy things that aren't organic as well but yes it's more around the processing side of things and try to buy things that have the least amount of processing. (G3 F3)

Free from additives

Women who were unconcerned about and those that avoided GM foods expressed preferences for food that was free from or low in additives such as preservatives. Participants felt that processed foods in particular contained additives and avoided purchasing them or attempted to limit the amount purchased:

> I look at the labels for nutrition. I don't like all the additives. I had a son who had to eat my food for a while and [laugh…he] had epilepsy and ADHD and all those things…so I had to watch. I felt that I had to watch what he eats. I kept chemicals away from [him]...(G1 F1, unconcerned about GM food)

> [When I look at labels, I look] specifically [at] just the breakdowns. The coding, the preservatives and additives. And just basically what's in the food. Because I've had family members that have had allergies in the past and whatnot and so I've had to be aware when making things and putting things together and whatnot. (G3 F2, avoids GM food)

Other factors in food choice

In addition to the above attributes, other factors such as price were important to the women in our study, especially for those who were students or on lower incomes. However most of the women were happy to pay extra to get the kind of food they wanted, which may be unsurprising given relatively high levels of average income among our participants. Buying familiar brands was an important strategy, particularly when purchasing food intended for other household members such as children. Convenience was a key factor in food choices, especially because many of the women were working full-time. In short, food choice was a complex domain in which many factors were traded against each other, with genetic modification being a relatively minor part of these decisions.

Issues related to the production of GM foods

In all three focus groups, discussions moved from ideas of personal risk associated with consuming GM foods to broader issues related to the production of GM foods and crops. In Group 1, composed of plant scientists, there was discussion about popular perceptions of risk

related to the environment and eating GM foods. Participants viewed these perceptions as incorrect, noting that the benefits of genetic modificaiton are unknown to most people:

> I find it interesting though that people are scared of that but there's so many other things like you know synthesised drugs that never existed before and things like that that we're happy to put into our body. I don't see how it's different to what's being done with genetically modified food, I think the difference is education and the media hype. [G1 F5]

> But the whole thing of added nutritional value and feeding the developing countries and stuff like that... for a lot of people that's a great thing and they realise that it's good but yeah a lot of people don't realise the environmental benefits from GM and I think as scientists, I guess we know this because we're involved in it, in the processes, and BT cotton is always put up as poster boy of GM but really it's not really explained. [G1 F4]

It is notable that these women in effect held a deficit model, stressing lack of knowledge or understanding about the science of genetic modification. These women described the production of GM plants as an extension of traditional plant breeding because both involved human manipulation. A key theme for this group was concern about community attitudes and media coverage:

> It [GM] has such connotations with it–you have the whole "Franken foods" and stuff like that…it's not like [that] at all. [G1F4]

> [responding to a comment about "genetic modification" being "wrong"] I'm not sure if it's actually the words "genetic modification" that's [sic] wrong, I think it's more the media hype that's gone along with that which has made it a naughty word. [G1F5]

Discussions in Group 2 and Group 3, which included those who avoided GM foods as well as some who were unconcerned, were much broader, including perceived risks associated with the consumption of GM foods, and the production of GM foods and crops. The risk of

"unknown effects" was an important reason to avoid GM foods both among those who felt they had little knowledge about GM foods and those who felt that they had "expert" knowledge:

> I'm not a geneticist but I'm someone who works in genetics and you know the truth is we don't know the function of the epigenetics, we're just learning about this...there are so many little things that go on that we're just trying to understand ourselves. (G2F9)

> I did a project on it when I was doing my uni degree, in our ethics subject...after learning about all the testing that's done for medicines and things like that, to find that they don't really have to test these crops, like, they grow them in a few fields but I'm not sure how much testing there is between that and it becoming a food. So yeah, I'd like there to be a lot of testing…because we don't quite know what we're messing with and if they're modified it wrong the plant might end up producing toxins or something. I guess there's a lot of unknowns and so I'm not happy knowing we're eating them because of that. (G3 F4)

Risks related to the production of GM crops were among other reasons provided for avoidance of GM foods. Purchasing GM food was linked to supporting the production of GM crops, which was problematic for some participants. Specific reasons included potential risks to the environment such as harm to animals and insects, increased amounts of pesticides in the environment and the potential for insect-resistance (with Bt cotton), and increased use of herbicides (with Round Up Ready™ cotton and canola). Participants were nervous about "terminator technology" and farmers losing their abilities to save their seeds between seasons. Discussion about the "ownership" of the technology (in particular by multinational companies) included concerns about secrecy and perceived lack of transparency by scientists involved in GM crop development:

> But they've got a pretty bad record too on divulging their research on their genetically modified foods. Foods have a fairly lax regulation...they don't have to show any experiments in humans or even in animals to show that the food is okay. And in the few cases they have done some animal experiments, the company itself, they've done things like five male and five female mice and come up with one of each group having some lesion which they've blithely said are not associated with the genetically modified food they've been given–fine, okay, well thanks very much, that sounds very rigorous. (G2 F2, said sarcastically)

Different understandings of evidence

Women with plant science roles had particular views about evidence, namely that no evidence of *harm* from genetic modification to date (in the scientific literature and in their own consumption experiences) served as a sufficient basis for them to be unconcerned about consumption of GM. They dismissed popular perceptions of potential increased risk of allergenicity in GM foods because "that's one of those furphies [Australian slant for untrue rumors] where the media has actually jumped on this type of idea and…people were allergic to all sorts of things" and felt there was no evidence that GM had any greater risk than other types of foods. They likened GM food to synthetic medicines and other products of science that were tested and safe, noting repeatedly that risks are managed from the level of transgenic event through to field trial and commercial release, using a rigorous set of containment rules. They felt that the evidence for positive aspects of GM crops and foods was not well known, and should be a greater focus (see also Cook, Pieri, and Robbins 2004). To the scientists involved in genetic modification research, no evidence of harm was considered to be evidence of safety.

In contrast, women with health science backgrounds expressed some interest in the environmental impacts of food production (and potential environmental benefits of genetic modification), but the lack of evidence of *safety* from testing of GM foods created unknowns for them that made them reject purchasing certain foods. They had a different conception than the plant scientists of what counted as evidence, and what conclusions to draw from available evidence. These participants talked about lack of safety testing in terms of human or animal feeding trials. Far from being uneducated, these women took on the role of "sceptical, scientifically-literate citizen" (as described by Tulloch and Lupton 2002). We suggest that these groups of women highly educated in science both value evidence to make their decisions, but value different types of evidence (Hicks 2015). In a similar way, women with little background in science also used absence of evidence of safety as a reason to avoid GM foods; however these women were not able to articulate which unknowns were particularly problematic for them; it was the unknowns about GM foods as a whole that concerned them.

Discussion

Despite this study's explicit focus on GM food, the strongest themes across the focus groups were preferences for food that is "natural" (as defined as minimally processed), locally-produced, healthy and nutritious, and additive-free. The preference for "natural" is similar to the findings of Lockie et al. (2005); however in our study, the presence or absence of GM ingredients was not a main factor in food choice. For some women, particularly those closely involved with the production of GM crops, GM foods could belong to any one of these categories; for example, GM food was not viewed as in direct opposition to "natural" food (see Deckers 2005). In contrast, women trained and working in health sciences were generally more concerned about the potential impacts of GM food on themselves and their families.

In all focus groups, discussions covered both the GM ingredients contained in food products, and the processes involved in the production and cultivation of GM crops. This highlights that both product and process are important for many of the women in our study, although Australia's current labelling regime does not mark out the latter category. Women who were highly educated in plant sciences, molecular biology, and related fields were as concerned about making "good" food choices as the other women in our study, with some producing their own plant and animal foods, and talked about considering the environmental impacts of their food purchases.

Our findings contribute to those that challenge still commonly-held ideas based on the "deficit model" of science communication (Sturgis and Allum 2004). In particular, our study shows that high levels of "science" education and knowledge do not necessarily generate more acceptance of technologies and genetic modification in particular. Although the finding that women who are plant scientists connected to the development of GM crops were mostly in favor of GM foods may not be surprising, the descriptions of how scientific information is used by women with different types of science backgrounds to make everyday decisions are novel. The contrast between use of evidence among women with health/nutrition backgrounds and those with molecular biology backgrounds is particularly notable: although both groups emphasized the role of evidence in shaping their views, they took different approaches, respectively stressing a lack of evidence of safety and a lack of evidence of harm. This difference underscores that knowledge alone is not what primarily shapes views on GM food, but that evidential standards are critical.

Additional issues that influenced purchasing decisions included issues relating to GM food/crops that are outside of Australia's regulatory and scientific arenas and overlap with broader social values. For example, concerns about the effect on farmers of "terminator technology" that prevents seed saving, the consolidation of power and intellectual property

by multinationals, and, in particular, environmental impacts from the use of agricultural chemicals in farming systems, were raised within groups 2 and 3. These findings parallel those of Deckers (2005) who found unease with modern farming practices in general amongst non-scientists who were concerned about genetic modification. For plant scientists, support of the technology was linked to its potential uses to do social good or support environmental sustainability. All of the women with high levels of science education, regardless of discipline, saw the issue of GM foods and crops as related to broader issues in agriculture and food production rather than an isolated and purely "scientific" issue.

In addition to echoing the findings of Fisher et al. (2005) and Kvakkestad et al. (2007) that scientists themselves have divergent views in part due to their disciplinary backgrounds, our findings provide suggestions about why different applications of science find more acceptance with the general public than others. In our study, both women with limited backgrounds in science and those with health science training used arguments based on the absence of evidence of safety to avoid GM foods; however they were unable to articulate which unknowns were particularly problematic for them, instead noting that it was the unknowns about GM foods as a whole that concerned them. We suggest that the responses of these women and avoidance of GM foods may be due to the community receiving more information about risks from the public health sector than other fields of sciences, particularly as messages about risk avoidance are prominent in Australian campaigns about sun exposure, alcohol and drug use, and so on; more research is required to explore this theme.

The close relationship between perceptions of risk and trust has been clearly noted in previous research (Frewer, Miles, and Marsh. 2002). Similarly, women in this study who differed in their perceptions of risk also expressed very different levels of trust in science. The plant scientists, unsurprisingly, had very high levels of trust in "the system," with one scientist providing detail about the biosecurity at a field site for her experiments. It should be

noted that the plant scientists in this study all worked within a public institution (cf. Kvakkestad et al. 2007 which found that type of funding influenced attitudes toward genetic modification). This level of trust contrasted with the levels among many of the women from the health sciences who did not trust large companies to provide accurate information (or any information at all), and others who criticized the food industry for its lack of transparency and profit motives. These women reflect a perspective where risks are seen as the "unexpected outcomes of the 'natural' collusion of science and commerce in extending profit further and wider within society," as described by Tulloch and Lupton (2002, 365). Although it is difficult to say whether this type of perception is more dominant among those within the health sector, there has been far more criticism of working with industry within the health sector (Nestle 2001) than agriculture. At present these trends are speculative and warrant further investigation.

Conclusions

Our findings raise a number of important considerations for future research about GM food/crops and more generally about public attitudes toward the roles of science and technology in food production and consumption. The highly educated women in our study had many questions that they viewed as remaining unanswered. They were engaged with issues related to genetic modification and looking for a higher level of discussion about their concerns (e.g., in Group 2, the need for more information on the role of epigenetics in relation to the effects of GM foods). Given that genetic modification science arguably is forty years old, it may be time for more sophisticated and broader engagement about genetic modification, against the backdrop of more complex considerations of values including those associated with food choice.

This study also shows that it is important to adopt a framework that does not assume a deficit model, and to use methodologies that do not indirectly reinforce it, such as narrow survey, polling, or quantitative techniques, or even qualitative approaches that presuppose certain categories or frames. Our preferred approach uses the generic inductive qualitative model, which is particularly useful for research into public attitudes about science and technology as it emphasizes process and analysis via themes, allowing development of understandings of attitudes on their own terms, which is critical since discussions often take unforeseen directions, as we have illustrated in the case of GM food.

The still-dominant deficit model of science communication, particularly among scientists, has consisted of "dumbed down" science messages that leave people with many concerns and questions. In addition, the focus on "just the science"–the area of discourse in which the dominant voices to date have felt most comfortable–has not allowed discussion of broader issues associated with genetic modification nor acknowledged diversity within scientific disciplines. While scientists from all fields value scientific evidence, it is clear that there are other values and evidence associated with decisions about GM crops and foods, different approaches to how evidence is weighed, and conflicts about what is taken to be the level of evidence required to warrant willingness to consume, or desire to avoid, GM foods. The two positions—a lack of evidence of harm and a lack of evidence of safety—are difficult to reconcile, but point to one key part of the issue, namely that there is no societal consensus about risk perception. Recognizing that both support for and opposition to GM food/crops are deeply intertwined with a wide range of social values, and are not primarily or only about "the science" associated with genetic modification, will enable the development of better public engagement practices with diverse publics and across different sciences.

References

Australian Academy of Science. 1980. *Recombinant DNA: An Australian Perspective*. Canberra: The Australian Academy of Science.

Charmaz, Kathy. 2006. *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis.* London: SAGE.

Christoph, Inken B., Maike Bruhn, and Jutta Roosen. 2008. "Knowledge, attitudes towards and acceptability of genetic modification in Germany." *Appetite* 51: 58–68.

Cook, Guy, Elisa Pieri, and Peter T. Robbins. 2004. "'The Scientists Think and the Public Feels': Expert Perceptions of the Discourse of GM Food." *Discourse and Society* 15: 433–449.

Corbin, Juliet and Anselm Strauss. 1990a. "Grounded Theory Research: Procedures, Canons, and Evaluative Criteria." *Qualitative Sociology* 13: 3–21.

Corbin, Juliet and Anselm Strauss. 1990b. *The Basics of Qualitative Research.* Thousand Oaks, CA: SAGE.

Cormick, Craig. 2011. "Australia: Understanding the Target Audience for Better Communication." In *Communication Challenges and Convergence in Crop Biotechnology*, edited by Miariechel J. Navarro and Randy A. Hautea, 131–155. Ithaca, New York and Los Baños, Phillipines: The International Service for the Acquisition of Agri-biotech Applications (ISAAA) and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Costa-Font, Monserrat, José M. Gil, and W. Bruce Traill. 2008. "Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy." *Food Policy* 33: 99–111.

Cousins, Y. L., B. R. Lyon, and D. J. Llewellyn. 1991. "Transformation of an Australian Cotton Cultivar: Prospects for Cotton Improvement Through Genetic Engineering." *Australian Journal of Plant Physiology* 18: 481–494.

Dietrich, Heather, and Renato Schibeci. 2003. "Beyond Public Perceptions of Gene Technology: Community Participation in Public Policy in Australia." *Public Understanding of Science* 12: 381–401.

Eureka Strategic Research. 2005. *Public Awareness Research 2005 Overview*. Biotechnology Australia. September 2005. http://www.industry.gov.au/industry/IndustrySectors/nanotechnology/Publications/Documents/Ausbiooverview2005.pdf.

Eureka Strategic Research. 2007. *Community Attitudes to Biotechnology Report on Overall Perceptions of Biotechnology and General Applications*. Prepared for Biotechnology Australia Eureka Project 4001. Accessed 16 November 2015. http://www.industry.gov.au/industry/IndustrySectors/nanotechnology/Publications/Documents/BiotechAustoveralperceptions.pdf.

Fisher, Mark, Bruce Small, Hein Roth, Mary Mallon, and Bryce Jerebine. 2005. "What do Individuals in Different Science Groups Within a Life Sciences Organization Think About Genetic Modification?" *Public Understanding of Science* 14: 317–326.

Frewer, Lynn J., Susan Miles, and Roy Marsh. 2002. "The Media and Genetically Modified Foods: Evidence in Support of Social Amplification of Risk." *Risk Analysis* 22: 701–711.

Genetic Manipulation Advisory Committee. 1999. *Annual Report 1998–1999*. Canberra: Commonwealth of Australia.

Gregory, Jane and Steve Miller. 1998. *Science in Public: Communication, Culture and Credibility*. New York: Plenum Press.

Henwood, Karen L., Karen Anne Parkhill, and Nick F. Pidgeon. 2008. "Science, Technology and Risk Perception: From Gender Differences to the Effects Made by Gender." *Equal Opportunities International* 27: 662–676.

Hewitt, Belinda, Janeen Baxter, Sharon Givans, Michael Murphy, Paul Myers, and Cameron Meiklejohn. 2013. *Men's Engagement in Shared Care and Domestic Work in Australia.* Report for Australian Government Department of Social Services. Accessed 16 November 2015. http://www.dss.gov.au/our-responsibilities/women/publications-articles/economic-independence/mens-engagement-in-shared-care-and-domestic-work-in-australia

Hicks, Daniel J. 2015. "Epistemological Depth in a GM Crops Controversy." *Studies in History and Philosophy of Biological and Biomedical Sciences* 50: 1–12.

Hindmarsh, Richard. 2008. *Edging Towards BioUtopia: A New Politics of Reordering Life and the Democratic Challenge*. Crawley: University of Western Australia Press.

Holton, Judith A. 2007. "The Coding Process and Its Challenges." In *The SAGE Handbook of Grounded Theory*, edited by Antony Bryant and Kathy Charmaz, 265–289. London: Sage.

Hood, Jane C. 2007. "Orthodoxy vs. Power: The Defining Traits of Grounded Theory." In *The SAGE Handbook of Grounded Theory,* edited by Antony Bryant and Kathy Charmaz, 151–164. London: Sage.

House, L., J. Lusk, S. Jaeger, W.B. Traill, M. Moore, C. Valli, B. Morrow, and W.M.S. Yee. 2004. "Objective and Subjective Knowledge: Impacts on Consumer Demand for Genetically Modified Foods in the United States and the European Union." *AgBioForum* 7: 113–123.

James, Clive. 2014. *Global Status of Commercialized Biotech/GM Crops: 2014. ISAAA Brief No. 49.* Ithaca, NY: International Service for the Acquisition of Agri-biotech Applications.

Kerr, Allen. 2011. "GM Crops: A Mini-Review." *Australasian Plant Pathology* 40: 449–452.

Kitzinger, Jenny. 1995. “Qualitative Research: Introducing Focus Groups.” *British Medical Journal* 311: 299–302.

Koivisto Hursti, U.K., and M.K. Magnusson. 2003. “Consumer Perceptions of Genetically Modified and Organic Foods. What Kind of Knowledge Matters?” *Appetite* 41: 207–209.

Kramer, Matthew, and Keith Redenbaugh. 1994. “Commercialization of a Tomato with an Antisense Polygalacturonase Gene: The FLAVR SAVR™ Tomato Story.” *Euphytica* 79: 293–297.

Kvakkestad, Valborg, Froydis Gillund, Kamilla Anette Kjolberg, and Arild Vatn. 2007. “Scientists' Perspectives on the Deliberate Release of GM Crops.” *Environmental Values* 16: 79–104.

Lea, Emma. 2005. “Beliefs About Genetically Modified Foods: A Qualitative and Quantitative Exploration.” *Ecology of Food and Nutrition* 44: 437–454.

Lockie, Stuart, Geoffrey Lawrence, Kristen Lyons, and Janet Grice. 2005. “Factors Underlying Support or Opposition to Biotechnology Among Australian Food Consumers and Implications for Retailer-led Food Regulation.” *Food Policy* 30: 399–418.

Lusk, J.L., L.O. House, C. Valli. S.R. Jeager, M. Morre, J.L. Morrow, and W.B. Traill. 2004. “Effect of Information about Benefits of Biotechnology on Consumer Acceptance of Genetically Modified Food: Evidence from Experimental Auctions in the United States, England, and France.” *European Review of Agricultural Economics* 31: 179–204.

Marques, Matthew D., Christine R. Critchley, and Jarrod Walshe. 2015. “Attitudes to Genetically Modified Food Over Time: How Trust in Organisations and the Media Cycle Predict Support.” *Public Understanding of Science* 24: 601–618.

Maxwell, Joseph A. 2005. *Qualitative Research Design: An Interactive Approach.* Thousand Oaks, CA: Sage.

Miller, Steve. 2010. "Deficit Model." In *Encyclopedia of Science and Technology Communication,* edited by Susanna Hornig Priest, 208–9, Thousand Oaks, CA: SAGE.

Milward Brown .2001. *Biotechnology Public Awareness Survey: Final Report.* Canberra: Biotechnology Australia.

Milward Brown. 2003. *Biotechnology Public Awareness Survey.* Accessed 16 November 2015. http://www.industry.gov.au/industry/IndustrySectors/nanotechnology/Publications/Documents/BiotechnologyPublicAwarenessSurvey2003.pdf.

Moerbeek, Hester, and Gerda Casimir. 2005. "Gender Differences in Consumers' Acceptance of Genetically Modified Foods." *International Journal of Consumer Studies* 29: 308–318.

Neales, Sue. 2013. "An Inconvenient Truth." *The Australian,* January 18. http://www.theaustralian.com.au/news/features/an-inconvenient-truth/story-e6frg6z6-1226556153378

Nestle, Marion. 2001. "Food Company Sponsorship of Nutrition Research and Professional Activities: A Conflict of Interest?" *Public Health Nutrition* 4: 1015–1022.

Priest, Susanna Hornig. 2000. "US Public Opinion Divided over Biotechnology?" *Nature Biotechnology* 18: 939–942.

Public Health Association of Australia. 2013. *Policy on Genetically-Modified Foods.* Accessed 16 November, 2015. http://www.phaa.net.au/documents/item/235

Qin, Wei, and J. Lynne Brown. 2006. “Consumer Opinions about Genetically Engineered Salmon and Information Effect on Opinions A Qualitative Approach.” *Science Communication* 28: 243–272.

Qin, Wei, and J. Lynne Brown. 2007. “Public Reactions to Information About Genetically Engineered Foods: Effects of Information Formats and Male/Female Differences.” *Public Understanding of Science* 16: 471–488.

Rodríguez-Entrena, Marcario and Melania Salazar-Ordóñez. 2013. “Influence of scientific-technical literacy on consumers’ behavioural intentions regarding new food.” *Appetite* 60: 193–202.

Sadler, Matthew. 2011. “Greenpeace Attacks Canberra GM Wheat Crop.” *Sydney Morning Herald*, July 14. http://www.smh.com.au//breaking-news-national/greenpeace-attacks-canberra-gm-wheat-crop-20110714-1hflf.html

Saher, Marieke, Marjanna Lindeman, and Ulla-Kaisa Koivisto Hursti. 2006. “Attitudes towards Genetically Modified and Organic Foods.” *Appetite* 46: 324–331.

Sturgis, Patrick, and Nick Allum. 2004. “Science in Society: Re-evaluating the Deficit Model of Public Attitudes.” *Public Understanding of Science* 13: 55–74.

Tribe, David. 2012. “Gene Technology Regulation in Australia: A Decade of a Federal Implementation of a Statutory Legal Code in a Context of Constituent States Taking Divergent Positions.” *GM Crops & Food* 3: 21–29.

Tulloch, John, and Deborah Lupton. 2002. “Consuming Risk, Consuming Science: The Case of GM Foods.” *Journal of Consumer Culture* 2: 363–383.

Tversky, Amos and Daniel Kahneman. 1981. “The Framing of Decisions and the Psychology of Choice.” *Science* 211: 453–458.

Ulrich, Connie M., and Sarah J. Ratcliffe. 2007. “Hypothetical Vignettes in Empirical Bioethics Research.” In *Empirical Methods for Bioethics: A Primer*, edited by Liva

Jacoby and Laura A. Siminoff, 161–181. Bingley, UK: Emerald Group Publishing Limited.

Wheeler, Sarah Ann. 2009. “Exploring the Influences on Australian Agricultural Professionals’ Genetic Engineering Beliefs: An Empirical Analysis.” *Journal of Technology Transfer* 34: 422–439.

Wynne, Brian. 2008. “Elephants in the Rooms where Publics Encounter “Science”?: A Response to Darrin Durant, “Accounting for Expertise: Wynne and the Autonomy of the Lay Public.”” *Public Understanding of Science* 17: 21–33.

Yann Campbell Hoare Wheeler. 1999. *Public Attitudes Towards Biotechnology.* Accessed 16 November 2015. http://www.industry.gov.au/industry/IndustrySectors/nanotechnology/Publications/Documents/AusBiopublicawarnessreport1999.pdf