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Whenever a new, potentially controversial technology enters public awareness, stakeholders suggest that education and public engagement are needed to ensure public support. Both theoretical and empirical analyses suggest, however, that more information and more deliberation per se will not make people more supportive. Rather, taking into account the functions of public sense-making processes, attitude polarisation is to be expected. In a real-world experiment, this study on synthetic biology investigated the effect of information uptake and deliberation on opinion certainty and opinion valence in natural groups. The results suggest (a) that biotechnology represents an important anchor for sense-making processes of synthetic biology, (b) that real-world information uptake and deliberation make people feel more certain about their opinions, and (c) that group attitudes are likely to polarise over the course of deliberation if the issue is important to the groups.

Keywords: attitudes, deliberation, group polarisation, information uptake, symbolic coping, synthetic biology

1. Introduction

Synthetic biology is still a new scientific development and research on public perception is rare. Preliminary results from representative survey studies conducted in 2008 and 2009 in the US (Pauwels, 2009; Kahan et al., 2009) and in the UK (Royal Academy of Engineering, 2009) suggest that in both countries at least two thirds of respondents have not heard "at all" about synthetic biology, and about 20% have heard "a little." It is clear that a minority of respondents say that they have heard "something" or "a lot" about synthetic biology. Media reporting on synthetic biology has increased over the years (see Gschmeidler and Seiringer, this issue) but overall it seems safe to say that synthetic biology has hardly entered public awareness.

In the meantime, synthetic biology has become more important in academia and the first products approach commercial reality. Regulators fear that the relationship between synthetic biology and the public might be troubled.[1] When it comes to ideas about what to do (see Schmidt et al., 2008; Torgersen, 2009), these typically reflect two prominent conceptualisations of a problematic science and the public relationship (for a review see Bauer et al.,

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2007). One perspective traces the shaken relationship back to a lack of public knowledge, assuming that if only the public knew more about science and technology they would love it. Another perspective, which in part developed as a critique of the aforementioned "deficit model," locates the deficit not so much in the public but rather in institutions and experts. In the latter view, the problem is a crisis of trust and confidence. Typically, the panacea is seen in public engagement – mostly in the form of deliberative activities such as citizen panels, consensus conferences and similar formats. While calling to account different causes of a potentially difficult relationship, both views share an implicit hope, namely that public education or engagement will lead to an improved relationship, and ultimately to supportive public attitudes.

In the face of such hopes, it is imperative to consider empirical research on the relationship between knowledge and attitudes, and deliberation and attitudes, respectively. Studies addressing the relationship between public knowledge and attitudes provide mixed and sometimes contradictory results. A recent study using meta-analytic methods (Allum et al., 2008) finds a small positive correlation between general attitudes towards science and general knowledge of scientific facts, controlling for a range of possible confounding variables. While this general relationship varies little between countries, there is considerably more variation between different domains of science and technology. The positive relationship between knowledge and attitudes is weaker or even absent when it comes to specific science and technology applications, such as, for example, attitudes towards genetically modified (GM) food. For such applications, polarisation among more informed individuals has been observed (Martin and Tait, 1992).

Little is known about the effects of deliberation on attitudes in the domain of science and technology. Proponents of citizen deliberation argue that participation in deliberative forums, conventions, and panels, has a positive impact on citizens' attitudes and behaviours (see Carpini et al., 2004, for a general review of deliberation effects). The presumed benefits include more informed and reflective judgments, a greater sense of political efficacy, and an increase in the frequency of political action. One approach that explicitly addresses both knowledge and deliberation is deliberative polling (Fishkin and Luskin, 2005). It consists of "exposing random samples to balanced information, encouraging them to weigh opposing arguments in discussions with heterogeneous interlocutors, and then harvesting their more considered opinions" (p. 287). In this approach, the central question is whether opinions following balanced deliberation differ from opinions voiced in traditional opinion polling. This approach departs from the ideal of deliberative democracy and identifies the necessary conditions for the development of such considered opinions (e.g., balanced information uptake, in-depth deliberation with heterogeneous rather than homogeneous others, intervention of moderators to "tame" outspoken and encourage silent discussants). However, these conditions are more the exception than the rule in everyday life, where people tend to communicate with like-minded family, friends and peers (Lazarsfeld and Merton, 1954; Rogers and Bhowmik, 1970); where they often are more interested in the confirmation of their views than in thorough analyses of all available information (Klayman and Ha, 1987); where groups tend to focus on information that is already commonly shared, downplaying unique information held by individual group members (Stasser and Titus, 1985); and where social dynamics determine that some voices are more likely to be heard than others.

Because people want to appear in a positive light they tend to adhere to group norms, and in addition, rather than surveying all of the relevant arguments, groups tend to be selective in their pursuance of limited lines of argumentation. Such normative and informational factors are likely to make deliberation in real-world groups result in attitude polarisation (Moscovici and Zavalloni, 1969; see Sunstein, 2000, for a review). Attitude polarisation[2] describes a group dynamic regularity according to which members of a deliberating group predictably move toward a more extreme point in the direction indicated by the members' pre-deliberation tendencies. Both risky and cautious shifts occur, depending on the group's average views before the discussion (Stoner, 1968). Group polarisation is a real-world phenomenon that is non-trivial because of its emphasis on a counter-conformity effect; groups shift away from the average attitude rather than toward it (Isenberg, 1986). The group polarisation effect is stronger when people think of themselves as having a degree of solidarity and a shared identity (Abrams et al., 1990), a condition that occurs mostly when people discuss with like-minded peers. Gastil and Dillard (1999), for example, analysed attitude changes at public forums in seven studies on political issues. While overall the aggregate attitude changes following face-to-face discussions were negligible, both liberal and conservative participants' views had polarised. It is also important to note that if there is, on average, no pre-deliberation preference (either the group consists of opposed subgroups or the members of the group are indifferent), then polarisation is less likely to occur (Sunstein, 2000).

In summary, research on knowledge and deliberation suggests that more of these factors will not necessarily make people more supportive of a technology. Rather, both perspectives suggest that attitude polarisation may occur. However, this research assumes that people start out with more or less knowledge or with positive or negative views. But what happens if people discuss new and unfamiliar issues – such as synthetic biology – when they have no prior knowledge or preferences?

Even if the public have not come into contact with a specific technology, it would be erroneous to assume them to be "empty vessels." A new technology such as synthetic biology will be compared to other technologies that are perceived to share important characteristics. The new will be "anchored" (Moscovici, 2001) in more familiar representations, so that the prior experience (Torgersen and Hampel, this issue, talk about "frozen experiences") becomes relevant for the understanding of the new. Hence, the question is: what will synthetic biology be compared to? Scientists and experts both fear that synthetic biology might reignite past debates on genetic engineering and hope that the anchoring technology might be nanotechnology, which at least in Europe, has retained a comparatively positive image (Schmidt et al., 2008; Torgersen, 2009).

Finally, it is important to ask why people should learn about and discuss science and technology at all (Wagner, 2007; Wagner et al., 2002). It appears naïve to assume that everyday people are internally motivated to learn about everything new that they come across. Rather, it is likely that there also are external pressures for people to develop opinions (for example, they are required to hold opinions in conversations, in voting, or when asked to respond to survey or interview questions). For such purposes, everyday people need to "symbolically cope" with new technology (Wagner et al., 2002), that is, they need to develop at least a rudimentary understanding that provides evaluative confidence. If hard-pressed to form an opinion, people in real-life contexts will turn to the media and to conversations with like-minded people. In fact, knowledge acquisition and deliberation will often go hand in hand; people will discuss with others the new things they have learned and they will learn new things while discussing with others. Lay understandings of scientific developments are therefore not primarily reproductions of facts, but above all, they are elaborations for social groups serving to maintain the stability of their local world (Wagner, 2007). The interpretation of technologies will tend to be integrated into larger frames of values and the political agenda of social and political groups (Bauer and Gaskell, 1999; Kasperson et al., 1988). Consequently, it can be hypothesised that, by discussing a new technology, people will become more certain in their opinions but not necessarily more supportive of a technology.

While the lack of familiarity with synthetic biology represents a problem for survey research which addresses opinions on this development, it presents the opportunity to conduct a qualitative experiment addressing the role of information uptake and deliberation in evaluating an innovation. In the following we present the results of a study conducted in 2008, addressing the following questions: (1) to what extent do biotechnology and nanotechnology serve as "anchors" for public sense-making of synthetic biology? (2) Does information uptake and deliberation with like-minded peers make people feel more certain about their views? (3) How does information and deliberation affect group evaluation? Will attitude polarisation occur? And finally, (4) how will the groups' shared identities influence the process of information uptake and attitude formation?

2. Method

Research design

Newspaper articles about synthetic biology were presented to eight groups of the Austrian lay public. These groups formed focus groups which allowed for quantitative and qualitative analyses (for more details see Kronberger et al., 2009). The newspaper articles were written by four Austrian science and health journalists who were each asked to write one article, sticking to the format and style of the newspapers they usually work for (three daily newspapers and one weekly magazine, covering both high quality and tabloid formats).[3] To write the articles, the journalists were offered seven press releases but were free to use additional information. The press releases were prepared by five international scientists and covered their ongoing work on synthetic biology.[4] In addition, two published press releases were also provided to the journalists, allowing for a more comprehensive representation of the field.[5]

Group selection

The strategy for group selection was to invite different natural groups who meet on a regular basis, share a common identity (such as being members of an organisation or NGO), and hence are likely to represent relevant real-life conversation partners for each other when discussing new and unfamiliar issues. Furthermore, group selection was based on the hypothesis that biotechnology represents an important "anchor" for public sense-making of synthetic biology.[6] Consequently, we identified groups we expected to hold specific views related to the GM debate. Such views can be more or less "ego-involving" (some issues are more important to people than others), with such ego-involvement primarily resulting from real group membership (Sherif and Sherif, 1967). The more a topic is linked to a group's interests, a shared past and a projected common future (Bauer and Gaskell, 1999) the more involved group members' views of the issue will be. In total, we invited eight groups. Four of these groups were expected to hold uninvolved attitudes (for these groups, no assumptions about opinion valence were made). The remaining four – presumably involved – groups were expected to be either supportive or critical of biotechnology (see Figure 1 for an overview).

Highly involved groups were presumed to attribute importance to biotechnology on the basis of scientific, economic, environmental or religious group interests. A student and an economic interest organisation were selected for their expected supportive interest, and an environmental and a developmental-religious group were chosen for their presumed critical stance. Four additional groups were invited that, while sharing a clear sense of solidarity as a group, were not presumed to hold specific interests – and as a consequence "involved attitudes" – towards biotechnology. These included a human

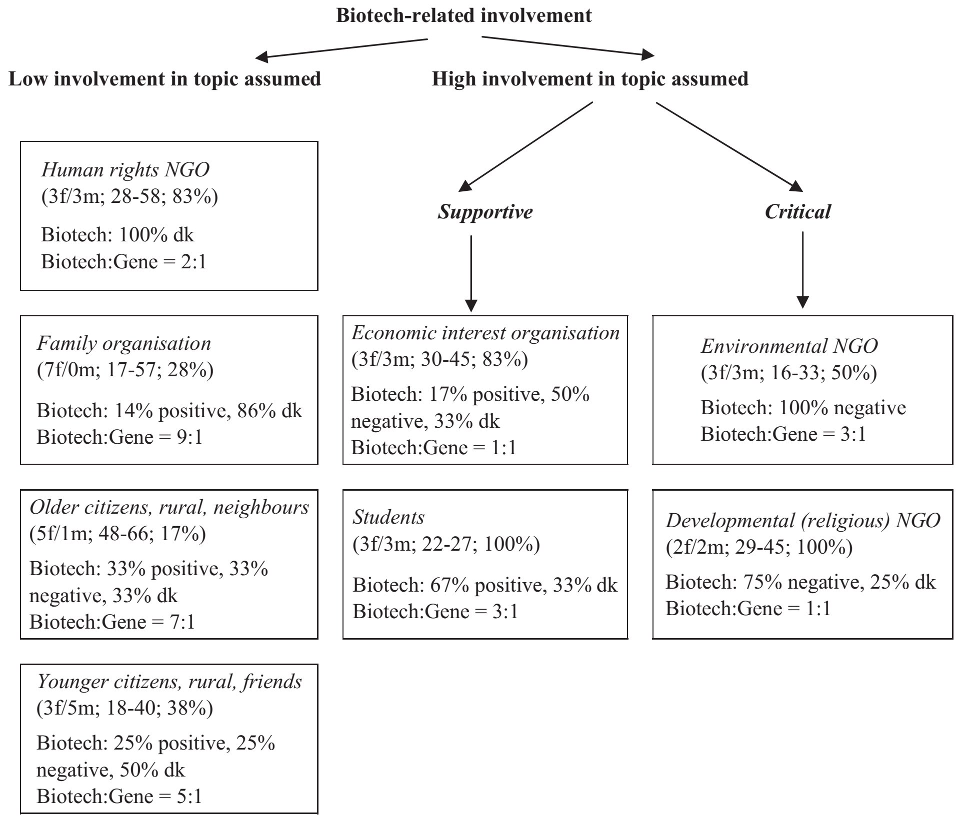

Figure 1. Group selection and group characteristics.
Note: Information in parentheses indicates information on group composition (gender; age range; percentage of participants qualified for university entrance or holding a university degree). “Biotech” indicates the percentage of participants holding positive or negative views about biotechnology (“dk” includes both “I don’t know” and “will have no effect” responses). “Biotech:Gene” indicates the proportion of biotechnology vocabulary to gene vocabulary.

rights NGO, members of a family organisation, a group of neighbours living in a rural area, and a younger group of friends living in a rural area. The two rural groups were included to counterbalance the urban groups.

For each group 6 to 9 individuals were invited, with a total of 49 Austrian lay persons participating in the meetings. Figure 1 gives detailed information on the characteristics of the groups. Overall, male and female participants were equally distributed across the low versus high involvement groups ($\chi^2 = 1.39$, $df = 1$, ns). However, participants in low involvement groups tended both to be older ($F = 5.76$, $df = 1$, $p < .05$; $M_{low} = 38.59$, $SD = 15.85$; $M_{high} = 29.55$, $SD = 8.62$) and to have lower education ($\chi^2 = 9.37$, $df = 2$, $p < .01$) than participants in high involvement groups. There are no differences on any of these variables between participants in presumed critical and supportive groups.

Procedures

We recruited participants by identifying a contact-person for each group who motivated other group members to participate. The groups convened in locations that are natural meeting points in their lives. Upon arrival at the group discussion, participants were welcomed and presented with the topic of synthetic biology; beforehand, they were told that the discussion would be on "new technologies." At this stage, no group was able to provide a definition of synthetic biology. After engaging in free association with the term "synthetic biology," each participant was asked to indicate his or her intuitive view on a graphic display including an evaluative dimension (positive–negative), and a dimension of opinion certainty (uncertain–certain). Next, participants were provided with copies of the four media articles (participants read a minimum of one and a maximum of four articles), and after the reading phase, the moderators encouraged a discussion on synthetic biology within the group.[7] Moderators did not tell participants the rationale for group selection and they were careful to mention biotechnology only if already referred to by the group. All groups were probed for both supportive and critical views. At the end of the discussion participants repeated the graphic evaluation exercise and filled out a questionnaire. About two weeks after the discussion, participants were contacted by telephone for a follow-up interview.

3. Results

Is synthetic biology "anchored" in biotechnology?

As mentioned before, group selection was based on the hypothesis that synthetic biology is anchored in biotechnology. In order to test subsequent assumptions, it is therefore important to show in a first step that such anchoring occurs in all groups; that the high involvement groups take sides while the low involvement groups are more reluctant to evaluate biotechnology; and, finally, that the presumed critical groups are more pessimistic about biotechnology than the supportive groups.

Indeed, all groups showed signs of anchoring synthetic biology in biotechnology as measured by the proportion of gene* to biotech* vocabulary (Kronberger et al., 2009).[8] While in the press releases the proportion of gene to biotech vocabulary was 17 to 1, it was 2 to 1 in the media reporting, and reversed in the group discussions to a proportion of 1 to 3. This means that overall, the discussion moved away from descriptions of processes and findings of synthetic biology to a broader discussion anchored in representations of biotechnology. While scientists were cautious to use vocabulary related to biotechnology, for the general public it was a natural way to talk about this novel technology. As a consequence, all groups related synthetic biology to issues such as "designer babies," animal or human cloning, gene-manipulated food, or the genetic enhancement of human beings, although none of these topics were mentioned in any of the newspaper articles. Furthermore, all groups explicitly defined synthetic biology as a branch of biotechnology. Nanotechnology, a potential alternative anchor, went virtually unmentioned in the discussions.[9] Figure 1 shows the proportions of biotech to gene vocabulary for each group.[10]

To address the question of whether the groups held the expected views on biotechnology, participants were asked whether biotechnology will improve life, have no effect, make life worse or if they "don't know." Figure 1 shows the results for each group. There were clear differences between low and high involvement groups ($\chi^2 = 12.17$, $df = 3$, $p < .01$) with the latter being less likely to give "don't know" or "no effect" responses (two thirds in the low involvement groups). Furthermore, presumed supportive high involvement groups indeed were more optimistic, while critical high involvement groups were more pessimistic about biotechnology ($\chi^2 = 9.70$, $df = 2$, $p < .01$). The economic interest group was less optimistic about biotechnology than expected but, overall, the groups cover the range of presumed views reasonably well.

Table 1. Change of opinion certainty and opinion valence from before to after the discussion

	Opinion certainty			Opinion valence		
	df	*F*	η^2	*df*	*F*	η^2
Within subjects						
Change (before – after)	1	13.24**	.26	1	1.33	.03
Change × age	1	2.06	.05	1	2.00	.05
Change × sex	1	.43	.01	1	1.15	.03
Change × education	1	1.12	.03	1	.30	.01
Change × group	7	3.47**	.39	7	8.33**	.61
Error (change)	38			38		
Between subjects						
Age	1	1.82	.05		.95	.02
Sex	1	3.44	.08		1.32	.03
Education	1	.66	.02		.03	.00
Group	7	2.58*	.32		4.66**	.46
Error	38					

Note: ***p* < .01; * *p* < .05.

Change of opinion certainty and valence

If in everyday life evaluative confidence is a central goal (Wagner, 2007; Wagner et al., 2002), then information uptake and deliberation with like-minded peers should make people feel more certain about their views. In contrast, information and deliberation should not necessarily make people more supportive but rather reinforce the dominant group evaluation in either direction (attitude polarisation). Given that biotechnology can be considered an "anchor" for synthetic biology, we assume that preferences on the more familiar (biotechnology) will influence the evaluation of the novel (synthetic biology).

To test whether discussing synthetic biology made participants feel more certain about their opinions, we calculated a mixed ANOVA model with repeated measures, with time as a fixed factor and the covariates sex, age and education (see Table 1 for the results).

Did certainty of opinion change after the discussion, and was the degree of change comparable in the different groups? The results indicate a significant main effect; the deliberation process did indeed make people feel more certain about their opinions. Sex, age and education did not influence the degree of change. However, a significant CHANGE × GROUP interaction indicates that some groups became more certain than others. Before the discussion, low and high involvement groups reported comparable levels of opinion certainty (F = 1.35, ns, η^2 = .06; $M_{uninvolved}$ = 149.98, SD = 35.43, $M_{critical}$ = 143.05, SD = 35.43, $M_{supportive}$ = 125.43, SD = 61.06; the scale ranges from 0 to 200 with lower numbers indicating more certainty). After the discussion, both the supportive and critical high involvement groups felt more certain than the low involvement groups (F = 3.41, $p < .05$, η^2 = .13; $M_{supportive}$ = 62.66, SD = 35.60; $M_{critical}$ = 60.40, SD = 53.50; $M_{uninvolved}$ = 97.87, SD = 51.14). Figure 2 depicts the results.

In a next step, we calculated a mixed ANOVA with repeated measures to test for changes in the groups' evaluations of synthetic biology (see Table 1). The results indicate that, on average, there was no significant change in evaluation from before to after the discussion. This means, that information and deliberation did not generally lead to more positive or negative attitudes. However, as expected in terms of the polarisation hypothesis, there is a significant CHANGE × GROUP interaction. While some groups remained neutral, others became more positive or negative.[11] Again, the degree of change did not differ for participants of different age, education or sex. A series of one-sample t-tests shows that before the

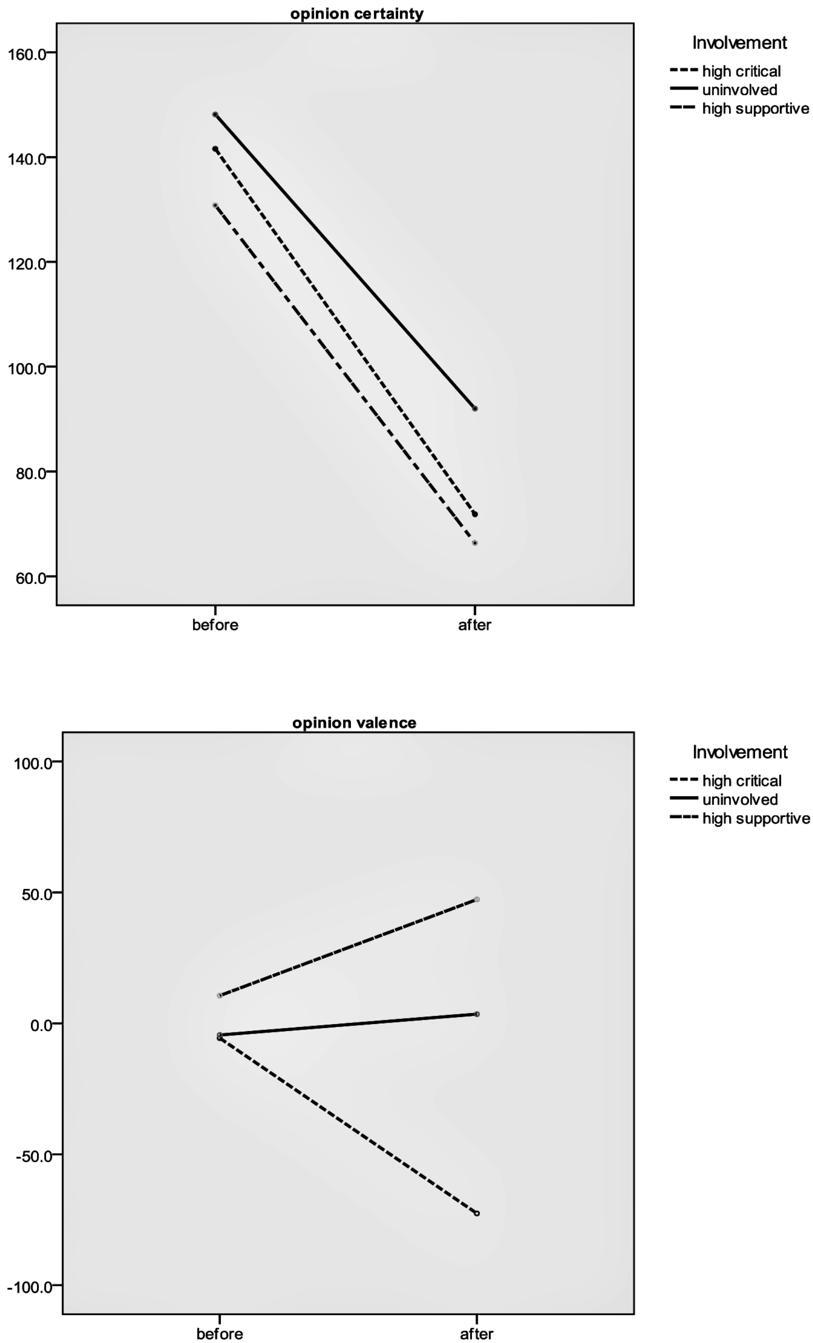

Figure 2. Opinion certainty and opinion valence in uninvolved, highly involved critical and highly involved supportive groups before and after the discussion.
Note: Values indicate estimated means controlling for age, sex and education. For opinion certainty, the scale ranges from 0 to 200, with lower values indicating more certainty. For opinion valence, on a scale ranging from –100 to 100, positive values indicate positive evaluation while negative values indicate negative evaluation.

discussion, on a scale ranging from −100 to 100, none of the eight group means differed from the neutral scale midpoint of zero (t*s* between −1.21 and 1.21, all ns). After the discussion, three out of the four low involvement groups remained undecided or ambivalent about synthetic biology (the group means do not differ significantly from the neutral scale midpoint). Only the older rural group became slightly more supportive ($t = 2.39$, $p = .06$). In contrast, among the high involvement groups polarisation was apparent: after the discussion all four group means were significantly different from the neutral scale mean. The student ($t = 3.52$, $p < .05$) and the economic interests group ($t = 2.81$, $p < .05$) became more supportive while the religious-developmental ($t = -2.88$, $p = .06$) and the environmental NGO groups ($t = -17.56$, $p < .01$) moved towards the critical pole (Figure 2). Hence, in the course of deliberation, groups with specific interests became both more certain and more extreme in their views on synthetic biology. The groups without biotechnology-related interests, in contrast, remained uncertain and avoided taking sides.

Individual opinions

The evaluation before and after the discussion took place in the presence of peers, so one might wonder whether the discussion affected privately held opinions as well. In the survey, participants were asked whether synthetic biology would make life better or worse, as they were asked for biotechnology. There are clear differences between high and low involvement groups' opinions ($\chi^2 = 41.40$, $df = 6$, $p < .01$). Despite having spent an evening discussing, in the uninvolved groups, about 70% of participants were reluctant to evaluate synthetic biology; the proportion of such "no effect" or "don't know" responses was lower in the high involvement groups (20% in the critical and 42% in the supportive groups). In the critical groups all remaining participants assumed synthetic biology would make life worse, while in the supportive groups all remaining participants thought it would improve life. The results suggest that, although some avoid taking sides in private, most participants report attitudes in the expected direction. The polarisation of opinion not only affected publicly voiced opinions but privately stated opinions as well.

To check whether these effects are stable, participants were contacted for a follow-up interview two weeks after the group discussions. Out of the 49 participants, 35 could be reached. Of these, 11% did not evaluate synthetic biology. For those who had an opinion, the pattern is in line with the previous results: in the low involvement groups, 60% indicated a supportive, 33% a critical and 7% a neutral view. In the supportive groups, 89% were optimistic and 11% neutral. In the critical groups 100% were pessimistic. At least on a short-term basis, the polarised group opinions stabilised.

What happened during information uptake and deliberation?

At the outset, all groups were unfamiliar with synthetic biology and were offered the same information. How did the groups evaluate these media inputs and how did they come to form their views? In the following we present qualitative analyses of what happened during media information uptake and deliberation.

Media evaluation. Both the student group and the economic interest group described the articles as neutral in tone, but complained of fear-mongering elements (particularly, a reference to terrorism). The same articles were evaluated as "euphoric" in both biotech-sceptic groups. The religious-developmental group described the articles as "advertisements"; the environmental group missed a thorough discussion of ethical aspects and safety issues and complained of too much commercialisation. The human rights NGO shared the view that the articles were positive in tone and deplored the missing discussion on whether it is acceptable to create artificial life. Meanwhile, this group also stressed that it would not prefer the media to focus on negative aspects either; what is needed is critical and balanced reporting. In the three remaining groups, participants "admitted" that in everyday life they would not read such articles. Too much information creates unnecessary distress, and there are more interesting sections in newspapers, the reasoning goes. The texts were evaluated as too difficult and chock-full of technical terms. In all these groups, the articles were perceived to express neutral to positive views about synthetic biology. In summary, the same texts were evaluated quite differently in the various groups, with different aspects arousing the groups' interest and suspicion.

Interestingly, the groups hardly differed in terms of the factual content taken away from their readings. Synthetic biology was unanimously understood as being related to biotechnology. Potential benefits (e.g. in the domain of medicine or fuel/energy production) were readily acknowledged and there was considerable agreement on risks such as the possibility of new forms of "bio-terrorism," the contamination of nature with artificial life-forms, detrimental long-term effects, the disturbance of the ecological equilibrium, and the risks of commercialisation. On ethical grounds, all groups were sceptical about the manipulation of life itself.[12] Despite these shared views, group evaluations polarised. What happened?

Groups moving towards a positive evaluation of synthetic biology. Groups which remained supportive of synthetic biology include the student and economic interest groups. The student group expressed supportive attitudes towards science and technology in general, even before reading the newspaper articles. The economic interests group, which depicted Austria as a technology-averse country that faces the risk of falling back against other countries economically, saw it as an imperative to support any technology. Overall both groups agreed that synthetic biology provides "fantastic" opportunities. Even if future risks cannot be foreseen, it would be disastrous to stop research and development. Progress must go on, the reasoning goes. What is needed is control and legal efforts to minimise potential risks. The argument of terrorist or military abuse was rebutted by reference to the vast amount of weapons of mass destruction, which are available with or without synthetic biology.

Groups moving towards a negative evaluation of synthetic biology. Opponents of synthetic biology (environmental and religious-developmental NGOs) acknowledged potential benefits but argued that the technology would not solve the problems it promised to solve, such as environmental problems or poverty and illness in developing countries. More than anything else, these promises were interpreted as marketing ploys. While it was acknowledged that the applications of synthetic biology sound promising (especially medical applications), it was doubted that those promised help will indeed be those benefiting from synthetic biology.[13] If there was a real interest in fighting diseases such as malaria among the wealthy nations, the reasoning goes, the problem would have been solved long ago. There was also scepticism about the commercialisation of synthetic biology; companies were expected to take great risks in pursuit of fast profits. Finally, danger was seen in developments behind closed doors that cannot be overseen and influenced by civil society.

Groups that have not come to a clear evaluation of synthetic biology. Like the other NGOs, the human rights group was concerned about transparency. For this group the main danger was uncontrollable developments and globalisation, as control is more difficult in some countries than in others. Group members were also taken by surprise by some of their own supportive views of synthetic biology. The group concluded that it is not the technology which is the problem but human beings using technologies in dangerous ways. The group found it difficult to oppose medical applications, and highlighted that cutting research is risky in that this would force synthetic biology behind closed doors, making control even more difficult. The remaining uninvolved groups stressed that there are both positive and negative aspects to synthetic biology, but that, in fact, they lack knowledge and interest. As mentioned above, several participants said they would not read articles on the subject in everyday life.

4. Conclusion

The current contribution set out to investigate information uptake and deliberation on an innovation (synthetic biology) in natural social groups. The results suggest that biotechnology represents an important anchor for sense-making processes of synthetic biology; that real-world information uptake and deliberation make people feel more certain about their opinions; and that group attitudes are likely to polarise over the course of deliberation if the issue is important to the groups. Importantly, attitude polarisation can occur, even if people have not yet formed clear preferences and the technology is free of "stigma" (Kunreuther and Slovic, 2001). Anchoring the new in more familiar technologies, which are perceived to be similar, allows the groups to quickly make sense of the innovation. Clearly, information on scientific innovation thereby does not "trickle down" to the public. Rather, based on values and interests, groups of the public actively engage in re-constructing the novel from their perspective.

Our study can be criticised on a number of grounds. First, one might hold that we did not choose the "right" groups. The discussions took place in a single country (Austria), participants were few in number and the sample was not representative. However, we would argue that at this stage, small-scale studies addressing sense-making processes add more insight than further representative studies showing that the majority of people have not heard of synthetic biology. Patients' groups, teachers or bio-hackers may hold differing views than those held by the sampled groups, but we expect the processes to be similar. It also is possible that synthetic biology is anchored in other technologies in other countries, but again, the processes of sense-making should not be fundamentally different. Based on their values and on whether the topic relates to their concerns, groups will take up information and discuss the topic in ways that make polarisation more or less likely. Finally, one might hold that groups organised as NGOs or neighbour networks may not be that typical for modern societies and their new forms of (online) social organisation. The manifold forms of new media and the vast availability of information on the internet could decrease the likelihood for group polarisation to occur. A look at the available literature suggests that there is little reason to assume that social influence in cyber communities is likely to decrease (for reviews see Spears et al., 2002, and Sunstein, 2000) but the question certainly merits being followed up in future research.

It may further be argued that we did not offer the "right" kind of information in the provided newspaper articles. Although we ensured that the articles were not scientifically incorrect, we did not make any efforts to ensure that they were balanced. We were interested in information that represents a real-world basis for collective symbolic coping (Wagner et al., 2002).

Finally, it may be argued that we did not engage participants in the "right" kind of deliberation. Participants were not exposed to maximally heterogeneous views. Again, we were interested in real-world deliberation among peers rather than in ideal situations (i.e. where each side is presented equally). We do not think that either form of deliberation is better or worse. What is needed is a better understanding of different forms of deliberation, how they work and what functions they fulfil. If variation in conditions influences the result, this points to the need for considered design of public engagement activities. We agree with Felt and Wynne (2007) that efforts should be made not only to discuss different formats of public participation (consensus conferences, citizen panels, etc.) but rather to clarify the goals, assumptions, and expected effects of making groups of the public deliberate. By designing public engagement exercises (choosing the "right" bases of information, the "right" respondents and the "right" forms of deliberation), the results of public engagement can be critically influenced.

In summary, this contribution suggests that more information and deliberation per se will make groups of the public neither more supportive nor more critical about a technology. Information is not taken up in a neutral and uninterested way. Rather, stakes and values related to a group's social identity influence the ways groups collectively examine innovations and align their evaluation with their more general views. In this research, groups expected to differ in some important ways were picked out and compared. If we want to gain a more comprehensive and systematic understanding of how processes like information uptake and deliberation work within and across societies, however, there is a need to further develop our models on how social and individual sense-making processes interact and how relevant groups of the public and their core values can be identified.

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Notes

1 For example, in 2009 the European Group on Ethics was asked to issue an Opinion (http://ec.europa.eu/european_group_ethics/docs/opinion25_en.pdf).

2 The term "attitude polarisation" is somewhat misleading. It does not denote polarisation *within* a group but *between* groups.

3 The journalists were reimbursed for their work. In line with the style of the editorial houses, both the weekly magazine article and the high quality press articles contain more words than the other articles (*Standard*: 705 words, *Salzburger Nachrichten*: 353 words, *Österreich*: 286 words, *News*: 1009 words).

4 In order to cover the field in a systematic way, subfields of synthetic biology were distinguished. The classification was based on Benner and Sismour (2005), O'Malley et al. (2008), and Schmidt (2009), and conducted with support from colleagues in the SYNBIOSAFE project (http://www.synbiosafe.eu). Fifteen scientists representing these fields were invited to write a press release on their recent work. Five scientists, covering the fields of metabolic engineering, minimal organisms, and *in silico* research, participated in the study.

5 These latter texts were released in 2008 by the J. Craig Venter Institute and by the Institute for OneWorld Health, Amyris Biotechnologies, and Sanofi Aventis.

6 We assumed biotechnology to be a more likely anchor than nanotechnology.

7 If not introduced by the group itself, researchers asked questions on the following aspects: definition and evaluation of synthetic biology; evaluation of the newspaper articles; benefits, risks, and moral aspects; and trust and evaluation of the involved actors.

8 We analysed both the frequencies of gene vocabulary (such as *gene*, *genome*, *genetic*, *DNA*, etc.) and the frequencies of biotech vocabulary (such as *genetic engineering*, *genetic manipulation*, *genetic modification*,

biotechnology, *cloning*, *Dolly*) for all three types of communication (press releases, media articles, group discussions).

9 Nanotechnology was mentioned only twice, namely in the environmental NGO and the student group.

10 Note that the critical groups did not move more towards a biotechnology discourse than the other groups. Rather, the difference is between high and low involvement groups; the biotech:gene proportion is more balanced in the high involvement groups than in those groups without a particular interest in the topic.

11 On a scale from –100 to 100 (with positive values indicating support), the group means before and after the discussion are: Uninvolved groups: *Human rights NGO* (before $M = -6.40$, $SD = 59.69$; after $M = -3.03$, $SD = 39.12$); *Family organisation* (before $M = -5.13$, $SD = 11.25$; after $M = 3.11$, $SD = 13.02$); *Older citizens* (before $M = 12.47$, $SD = 25.16$; after $M = 22.93$, $SD = 23.54$); *Younger citizens* (before $M = -5.66$, $SD = 18.40$; after $M = 0.81$, $SD = 45.87$). High involvement supportive groups: *Economic interest organisation* (before $M = 18.38$, $SD = 45.88$; after $M = 41.63$, $SD = 36.27$); *Students* (before $M = -2.13$, $SD = 14.22$; after $M = 48.08$, $SD = 33.49$). High involvement critical groups: *Environmental NGO* (before $M = -2.40$, $SD = 14.10$; after $M = -84.55$, $SD = 11.80$); *Developmental-religious NGO* (before $M = -22.08$, $SD = 48.18$; after $M = -60.60$, $SD = 42.15$).

12 While the manipulation of bacteria per se mostly was considered unproblematic, the manipulation and creation of animal or human life was unanimously met with scepticism. Thereby, religious justifications were virtually absent.

13 The developmental-religious group did not invoke the religious dimension but rather focused on the concern of social welfare.

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