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Article

Synthetic biology in the Science Café: what have we learned about public engagement?

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ABSTRACT: Engaging the public on emerging science technologies has often presented challenges. People may hold notions that science is too complicated for them to understand and the venues at which science is discussed are formal and perceived as inaccessible. One approach to address these challenges is through the Science Café, or Café Scientifique. We conducted five Science Cafés across Canada to gauge public awareness of synthetic biology technology, its potential applications, and to evaluate the effectiveness of the Science Café platform as a knowledge-translation tool. Café participants were excited about the potential benefits of synthetic biology technology, but also concerned about the potential risks. And while participants trusted scientists to carry out their research, there was limited confidence that regulators would ensure public safety. Science Cafés as a forum for science to meet society were viewed positively for the relaxed atmosphere, small crowd size and informality of the venue. We conclude that Science Cafés are an effective upstream engagement platform for discussing emerging science technologies.

Context and objectives

Engaging publics in new and emerging science technologies has often presented challenges. People may hold pre-conceived notions that science is too complicated and specialized for them to understand.[1] Venues at which science is discussed with the public often take place at formal settings, such as universities and museums, which may be intimidating for some.[2] One approach to address these challenges and improve science communication is through the Science Café, or Café Scientifique. These cafés are live forum events that host conversations between scientists and the public about current science topics.[3] They are open to everyone and no scientific knowledge is necessary to participate. Science Cafés take place in public gathering places such as coffee shops, bars, restaurants, bookstores and galleries.[4] These informal venues offer an opportunity to engage members of the public who might not attend a formal lecture.

Such informal settings may be appropriate arenas for learning about and discussing emerging and potentially controversial technologies like synthetic biology. This technology spans earlier technology forms, from genetic engineering — which introduces genetic variations in existing biological systems — to more complex approaches involving the construction of new biological parts and systems which do not occur in nature. The process of engineering biology on that far end of the spectrum could result in a 'man-made organism', such as that announced in 2010 by Craig Venter, when he unveiled the first synthetic cell completely comprised of man-made instructions that could replicate.[5] Not surprisingly, such scientific advancements have generated charges of 'playing God' and tampering with nature.[6,7,8] However, in general, there is a paucity of studies on public views of synthetic biology.[9] The few studies extant indicate most people are not aware of this emerging field in the United States[10,11] or in Europe.[12]

In the U.S., a poll of 1000 adults was conducted by Hart Research Associates and the Synthetic Biology Project at the Woodrow Wilson Institute in 2010. They found that 26% of adults had heard about synthetic biology and two-thirds think that synthetic biology should move forward, with more research to study its possible effects on humans and the environment.[13] Additionally, the survey revealed that more attention needs to be paid to addressing biosafety and biosecurity risks of this technology and that government and industry need to engage the public more about the science, its application and its benefits and risks.[13] In Europe, the Biotechnology and Biological Sciences Research Council (BBSRC) embarked

on a Synthetic Biology Dialogue, which involved engaging members of the public with specialists in science, application and governance of synthetic biology. Their June 2010 report revealed that the public found synthetic biology to be both exciting and scary and stressed both public consultation and regulation is necessary as the technology develops.[14]

The controversies around biotechnology and genetic engineering have pushed the discussion of emerging technologies upstream, as has been the case, for example, with nanotechnology or synthetic biology. This paper explores informal public discussions on synthetic biology in a public café setting as a window into exploring public interest, expectations and concerns at this early stage of technology development. How do such venues fare as settings for public engagement on this specific issue and what expectations and concerns emerge? We first summarize the Science Café arena as a setting for public engagement on science and technology. We then present our findings based on audience surveys and observations.

Science Cafés in context

The Science Café concept originates in the 19th century salons of Europe. Small groups of people gathered over drinks to discuss science and philosophy topics of the day. In 1998, a revival of the Café movement took place when a group called "Café Scientifique" led by British science journalist Duncan Dallas, began holding events in Leeds, England.[2] Since then, more than 130 independent Science Cafés have started around the world and are currently being held in Europe, Australia, North America, South America and Southeast Asia.[4] In Canada, many universities and government agencies have initiated Science Café series in numerous cities and a list of current and past events are posted on the Canada Science Café website.[15]

A typical Science Café format is approximately 90 minutes in duration and involves both expert speakers (the scientists) and a moderator. The moderator introduces the Café concept, the topic and the speaker(s). Each speaker presents for 15–20 minutes without any visual aids, such as PowerPoint. A 15-minute break is given to allow participants to refresh their drinks and generate questions. The moderator then opens the floor for discussion, mainly in a question-and-answer format. This typically lasts 40–50 minutes. After the Café officially ends, many participants stay and continue discussion.

The popularity of Science Cafés around the world and their success at engaging people in the discussion of science has been documented in at least one book and numerous newspaper and journal articles.[1,4,16,17,18,19] While the interest in Science Cafés demonstrates that the public has a desire to learn about or engage with science, little is known about participants' views of the Café or their perception of the Café experience. This presented an opportunity for us to examine both public views towards emerging biotechnologies and public perceptions about the Science Café format for discussing such issues.

We conducted Science Cafés in five cities across Canada to gauge public views of synthetic biology technology and its potential applications, along with assessing the effectiveness of the Science Café platform for discussing this emerging technology. Synthetic biology is a novel research area and refers to both the design and fabrication of biological components and systems that do not already exist in the natural world and the re-design and fabrication of existing biological systems.[20] The potential applications of this technology are immense, ranging from the creation of new fuels, ingredients for medicines, foods and cosmetics, to bio-remediation. Other potential applications include manufacturing bioweapons for military purposes. The dual-use nature of this technology combined with limited public outreach and awareness makes synthetic biology an excellent topic for Science Café discussion.

Methods

We participated in synthetic biology Science Cafés in five cities across Canada between 2009 and 2011 as co-organizers (table 1). Four Cafés were held at a pub setting and one was held at a Discovery Centre. Promotion for these Cafés included advertising in community newspapers and distributing posters around local neighbourhoods. The number of participants at each Science Café ranged from 27 to approximately 150. We followed the typical Science Café format, employing a moderator and two or three synthetic biology expert speakers. These speakers included scientists, social scientists and bioethicists/legal

experts. Following the Café, we asked participants to fill out a survey in order to assess their views of synthetic biology and the Science Café format for discussing the topic. The survey covered six areas:

1) Participation in the synthetic biology Science Café
2) Previous knowledge of synthetic biology technology
3) Response to the synthetic biology expert presentations
4) Views of synthetic biology technology
5) Comments on synthetic biology technology
6) Comments on Science Café format

Surveys from all five Cafés were gathered and analyzed as a group since we were not interested in cross-site comparisons. We also performed cross-tabulations on all fully completed surveys to examine how different occupations and knowledge awareness levels related to perceptions of synthetic biology benefits, risks and regulator trust levels. Lastly, we recorded a list of questions posed by the participants during each Café session to examine recurring question themes about synthetic biology technology.

Date	Location	Title
October 27, 2009	Toronto, ON	Engineering the Future: Synthetic Biology
September 29, 2010	Montreal, QC	Synthetic Biology: Should we be re-engineering evolution?
November 23, 2010	Calgary, AB	Reinventing nature using synthetic biology—are there limits to how far we should go?
March 15, 2011	Saskatoon, SK	Brave New World or Franken-Future? The New Science of Synthetic Biology
May 4, 2011	Edmonton, AB	Synthetic Biology: Engineering the Building Blocks of Life

Table 1. List of Science Café Locations.

Results

We received in total 191 fully or partially completed surveys from the five Science Cafés. The results for each section of the survey are outlined below:

1) Participation in the synthetic biology Science Café

The attendees at the Science Cafés consisted of a mix of high school and university students, participants from NGO groups, government workers and teachers/educators. We asked participants their primary reason for attending the Science Café by completing the following sentence: "*I am participating in the Science Café on synthetic biology because…*" The vast majority of participants (69%) indicated "learning more about synthetic biology" was the primary motivator for participation in the Science Café. The "Other" reasons for participating focused on exploring synthetic biology for business/commercialization ideas.

2) Previous knowledge of synthetic biology technology

We also asked participants two questions regarding their previous knowledge of synthetic biology technology. The first question asked was "*Please indicate your knowledge of synthetic biology prior to attending this Science Café.*" The second question was "*Please indicate how you learned about synthetic biology.*" Almost half (49%) of responses given for question one indicated that participants had "minimal knowledge" of synthetic biology. This response of "minimal knowledge" generally came from the "public

citizen" and "other" demographic. Thirty-nine percent (39%) of participants had some knowledge and 12% were very knowledgeable. Most participants obtained their knowledge of synthetic biology from the Internet and other sources. These "other" sources included educators from both secondary and post-secondary institutions and friends and colleagues.

3) Response to the synthetic biology expert presentations

We asked participants a series of questions to evaluate their response to the expert presentations. Overall, the feedback we received was positive. Ninety percent (90%) of participants agreed that the presentations were both informative and understandable and that the Science Café improved their knowledge of synthetic biology. However, 10% of participants commented that some of the talks were a bit too technical for a general audience. While over three-quarters (77%) of participants were very excited about the potential benefits of synthetic biology, 63%, commented that they were also concerned about the risks and social-ethical challenges of this emerging technology.

4) Views of synthetic biology technology

The views section of the survey was divided into two parts. We asked participants which synthetic biology application areas they found most promising and which ones were most concerning. We also asked whether or not they viewed regulators as ensuring public safety in the case of man-made micro-organisms and whether scientists can be trusted to carry out their research as long as appropriate regulations are in place. Participants overwhelmingly responded that the use of synthetic biology for medical applications, biofuels and environmental remediation were promising. However, almost all participants felt that developing synthetic biology for potential military applications was very concerning (figure 1). About 20% of participants did not have any comment on whether the applications of synthetic biology are promising or concerning.

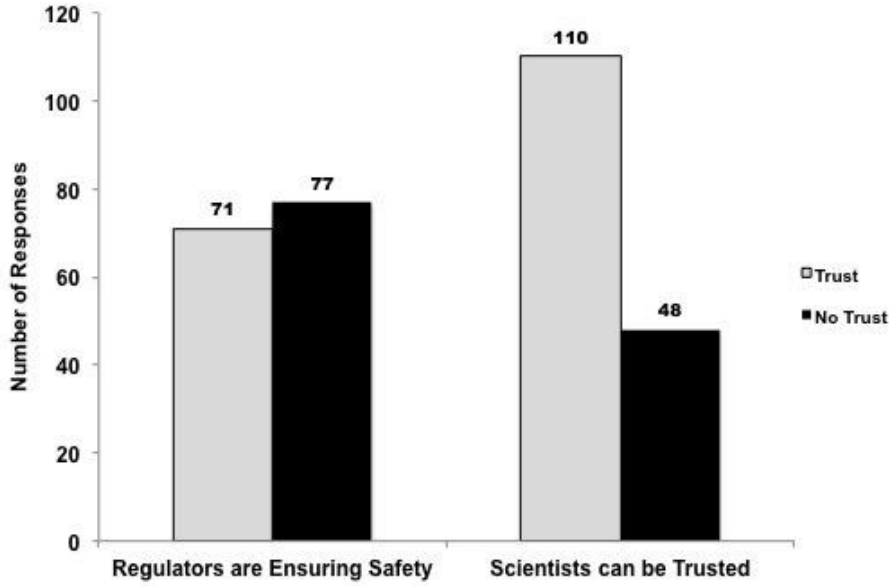

Figure 1. Views of potential synthetic biology applications.

We asked participants if they agreed or disagreed that "*regulators are ensuring public safety in the case of man-made organisms" and if "scientists can be trusted to carry out their research on man-made organisms as long as appropriate regulations are in place*." Views regarding whether or not regulators are ensuring our safety were split, however most participants agreed that scientists could be trusted to carry out their research with proper regulations in place (figure 2).

A total of 148 surveys were entirely filled out. We ran three cross-tabulations that compared occupation and knowledge level with the potential benefits of synthetic biology, the potential risks of synthetic biology and trust in regulators. We combined scientific researcher, industry representative and university/college professor into an "Academic" category and public citizen/other into a "Public Citizen" category. We also combined "very knowledgeable" and "some knowledge" into the "Knowledgeable" category and "minimal knowledge" into the "Not Knowledgeable" category. All groups were equally excited about the potential benefits of synthetic biology (figure 3a). All groups were also equally concerned about the potential risks of synthetic biology, although the "Academic" category expressed less concern over the potential risks compared with other groups (figure 3b). Finally, while student audience members tended to express trust in regulators, all other groups did not trust regulators to ensure public safety in the case of man-made micro-organisms (figure 3c).

5) Comments on synthetic biology technology

The following question was posed to participants as part of the survey: *Should synthetic biology be a primary area for further scientific development? What reasons would you have for a positive or negative answer? If you think this is to be encouraged, what do you think is the best way to do so?*

We received 119 comments regarding the development of synthetic biology. Overall, most comments were positive and encouraged the advancement of synthetic biology as long as appropriate regulations were implemented. Some participants were excited to have synthetic biology applied to health technology, environmental, energy and food challenges while others expressed caution with this technology. In particular some participants suggested that it was too early to consider synthetic biology a primary area for scientific development. Various reasons were given, including the minimal knowledge both scientists and society have about this technology, underdevelopment of biosecurity measures and the ethical implications of "playing God." Those participants supportive of synthetic biology development indicated that engaging the general public, increasing funding and encouraging/supporting post-secondary students and researchers would be the best ways to facilitate further development.

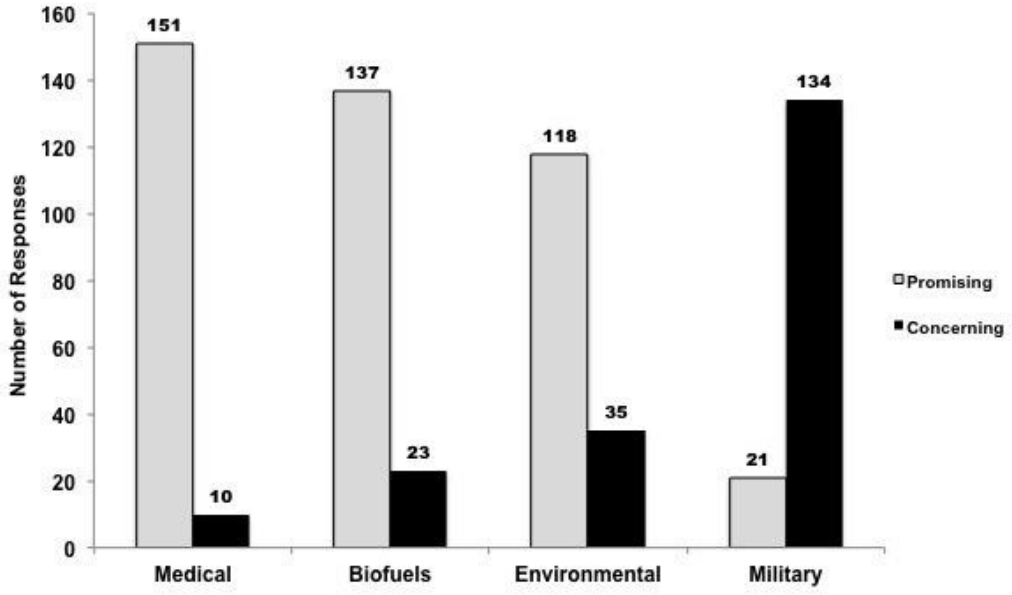

Figure 2. Views of synthetic biology regulation.

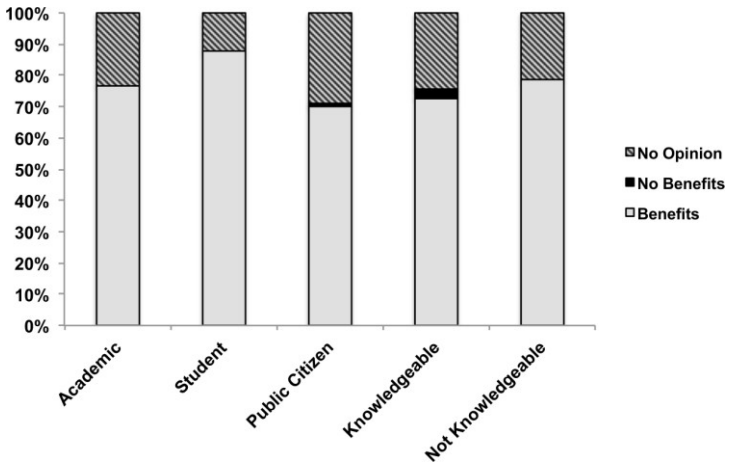

Figure 3a. Potential benefits of synthetic biology by occupation.

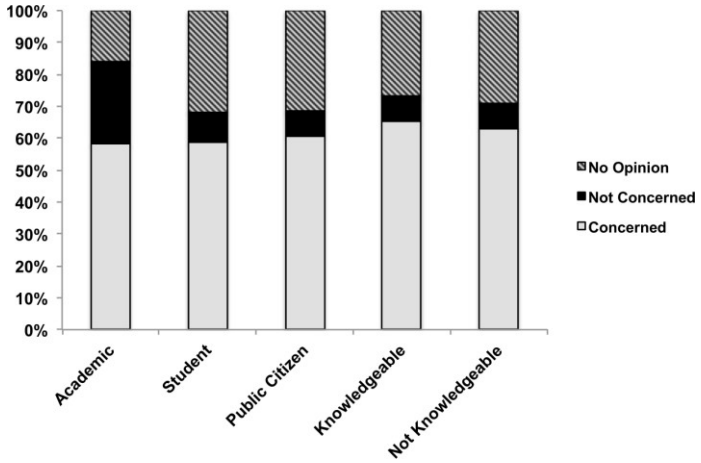

Figure 3b. Potential risks of synthetic biology by occupation.

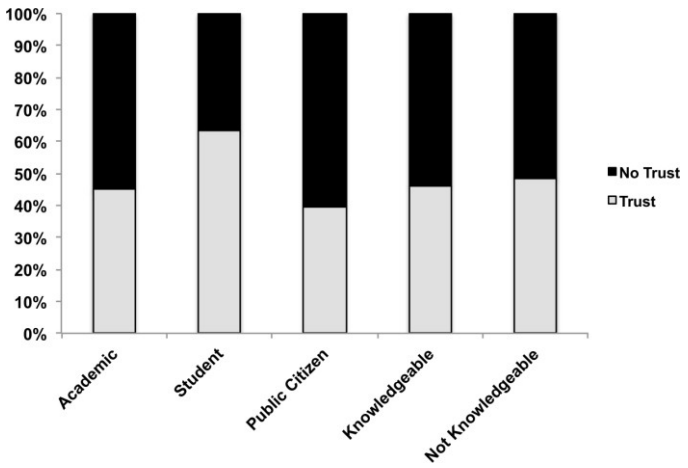

Figure 3c. Trust in regulators by occupation and self-described knowledge.

6) Comments on Science Café format

We asked participants two questions about the Science Café format: *how likely do you think you might be to attend a future Science Café and how likely would you recommend an event like this to others?* The results were overwhelmingly positive, with 77% of participants commenting that they would attend another Science Café and 100% indicating they would recommend a similar event to others. We also asked participants what they thought of the Café format and venue for discussing the topic. The majority of responses highlighted the relaxed and pleasant atmosphere, small crowd size, informality of the venue, accessibility, and non-intimidating environment. Some participants also commented that the Science Café stimulated their interest to learn more about the topic. One participant commented that "…these type of information discussion are key in the progression of any groundbreaking technology. Transparency and public awareness is vital when considering a field of research as potentially controversial as this." Another commented: "the Café format is a brilliant idea for discussing a controversial subject such as synthetic biology. I learned a lot tonight and I felt comfortable expressing my opinion."

Participant questions

A total of 28 questions were asked during four of the five Science Café events.[22] Three themes emerged in these questions that were asked at almost every Café:

1) What is synthetic biology? Is it really just genetic engineering?
2) How long will synthetic biology really take? Is it held up by research or by technology?
3) How transferable is synthetic biology technology especially for developing countries?

Other questions raised involved concerns about environmental safety, especially in the event of an unintentional release, while others expressed worries about human safety and biosecurity.

Discussion and conclusion

Public views of synthetic biology

The results from our five synthetic biology Science Cafés provided us with an understanding of how a small sample of Canadians view this emerging technology. Approximately half of our participants had some knowledge of synthetic biology technology. However it is important to note that the participant demographic observed at some of our Science Café venues may have been overrepresented by more highly-educated individuals. Participants were excited about the benefits, yet concerned about the potential risks, especially when it involved accidental releases or military applications. While participants trusted scientists to carry out their research, there was limited trust that regulators would ensure public safety. Participants' occupation and knowledge of synthetic biology did not influence how they felt about the potential benefits of synthetic biology. However, lay citizens were most concerned about potential risks in comparison to other groups. All groups, except students, had little confidence that regulators would be ensuring safety.

In a broad comparison, the results from our Science Café surveys reflect the views uncovered in both the U.S. and Europe. Various comments from our participants highlight the fact that publics need to be consulted in the entire process, from research to regulation. One participant commented that "there needs to be more of an effort to explain in lay terms what the real benefits and risks might be. And there needs to be more public input. There needs to be 'public interest' scientists involved."

Science Café platform as a public engagement/knowledge translation tool

The goals of a Science Café are to promote public engagement with science and provide a forum for scientific inquiry for the general public. The reason for the success of this format can be attributed to a few factors. The informality and accessibility of these events are key to effective knowledge-translation. The non-competitive, friendly atmosphere encourages discussion. Science Cafés are also inexpensive to organize and hold, locally relevant, and attract a mixed audience. There are also reciprocal benefits to both the venue and the scientist. On an otherwise quiet night, a pub or café can generate additional

revenue. From a researchers' perspective, engaging the public can aid in promoting their research and increase funding opportunities, as scientists can no longer rely solely on government support.[4] Combined, these factors make Science Cafés a practical option for encouraging public engagement.

Despite the reciprocal benefits to science and the public, there is reluctance among scientists to engage in communication activities with the public. A recent study by Mizumachi et al.[21] examined early career scientists' attitudes towards engaging with the public in a Science Café venue. They found that these scientists hesitated to interact with the general public. Scientists thought that preparing for and participating in the Science Café was "troublesome and time-consuming," and that they 'could not perceive any benefit'. However, the authors suggest that apprehension about dialogue with the public may be the biggest barrier for scientists who do not participate. We suggest these intrinsic barriers need to be removed or reduced in order to facilitate effective communication with the public.

We used a Science Café format to bring discussions about an emerging and potentially controversial technology out of the laboratory and into the public realm. This allowed people to learn about what the technology can do and to express their views about it. Our case study highlights that Science Cafés are an effective platform to engage publics in dialogue about new and emerging technologies. Due to the Cafés interactive nature, we were able to obtain viewpoints that may not have been captured through other public engagement approaches. Our participants also viewed the Science Café as a positive experience. We surmise that our experience of engaging publics using a Science Café platform is an informative way to capture public views and public perceptions towards new biotechnologies, and a comfortable way for the publics to learn about them.

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