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Questioning researchers' evaluation of communication experiences: A combined interview- and media-based study of communicating socially contestable research

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Abstract

This case study examines researchers' experiences with – and several media's practices of – communicating a research project that is scientifically complex, potentially highly impactful and socially contestable: the NTNU Cyborg. The project's researchers study human cells as components connected to a robot interfaced with biological neural networks. Key goals of our study are to understand challenges tied to communicating interdisciplinary research that tends to be regarded as pushing ethical barriers, and to contribute to critical reflection on how communication practices and media coverage may strengthen a dialogue between citizens and research communities on social issues tied to science-in-the-making.

Keywords: cyborg, ethics, socially contestable research, media, public engagement in science

Introduction

This article is a case study of challenges tied to publicly communicating the *NTNU Cyborg* (<https://www.ntnu.edu/cyborg>), an ongoing project at the Norwegian University of Science and Technology (NTNU).¹ The cyborg project was initiated to stimulate cross-disciplinary collaboration at the university between researchers working in information technology and robotics on the one hand and neuroscience research on the other. The interdisciplinary research seeks to have a high impact on society through technological and medical advances. Working with human neural cultures, the research also raises several ethical questions, such as how acceptable it is that the researchers use a kind of biological material that produces consciousness in human beings (Hostiuc et al. 2019; Lavazza and Massimini 2018). Moreover, by developing a robot interfaced with neuronal networks (biological neurons grown in a petri dish), the project has a physical component, anticipated to be suited to communicate/promote the research to the media. We find that this "embodied", cross-disciplinary research project is well suited as an object for a case study that seeks to understand and discuss researchers' experiences with – as well as media's practices of – communicating scientifically complex and socially contested research. By drawing on perspectives from predominantly public participation models as well as contextual models of science communication and journalism - and by applying semi-structured interviews and textual/discourse analysis - our analyses seek to contribute to critical reflection within and beyond scientific communities on how communication practices and media representations may promote – or prevent – a dialogue between science and society on impactful and ethically challenging research.

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Rationale and objectives of the NTNU Cyborg project

The initiator of the cyborg project wanted a robot that goes around on campus (Initiator, interview, November 23, 2018). Not a conventional robot controlled by software only, but a combination of a software controller interconnected to biological nerve cells. An objective, then, was that it would function as a “show-off” and flagship project for the university. A goal was to stage a confrontational arena with a view to building together electronics and biology. In this way, it could be a wake-up call to people, not to be perceived as something that was critically transformative in itself, but rather as something that “points to a world that is very, very different from the one we have today” (ibid.).

The other main idea was the belief that there is considerable scientific knowledge to acquire via this coupling of information technology and biology - as well as nanotechnology - with respect to how the nervous system works (see Aaser et.al, 2017). An incentive was to improve upon the typically abstract computer models of neurons in Artificial Intelligence (AI), by harnessing biological neurons’ strengths in areas such as concept formation and learning.

The objectives of NTNU Cyborg are two-fold; on the one hand the project will create something physical that can promote the research and be used by the media, and on the other hand it poses deeper research questions in the intersection between its three main research areas – neuroscience, robotics, and computer science. Some of the basic questions are: How can researchers model in vitro neurons from humans? What kind of procedures do they need? What can they do with them? Can they compute something with them? Can they model some diseases in the neurons? Can they connect algorithms that can try to improve the condition of these neurons, rather than doing this on a person, in vivo (taking place in the living organism), or on some animal? Can they control parts of the robot with these neurons grown outside the robot?

Basic research questions of how neural networks function are core to the project, but the researchers expect that their research also will have applicatory value in medicine as well as in novel forms of artificial intelligence. This may for example involve creating an increased understanding of how one can regenerate damaged tissue, develop prosthetics, or help sufferers of Parkinson’s or other neurodegenerative diseases. The physical robot developed in the study is not solely conceived of as a show-off for the university. An aim is to enable more control of the physical robot by biological neural networks, but at this stage, nerve cells can only control simple processes. In addition to the physical robot, the researchers use *simulated* robots to investigate how nerve cells can produce a coherent behavior, and even learn better behaviors over time, in a simulated environment.

Research questions and objectives of communication study

In our study of a research project with a communication strategy and marketing purpose built into its design, we expect that the physical embodiment of the project in a robot/cyborg will have a significant impact on the mediation of the research, and especially so in terms of the mediation of the project’s scientific complexity, potential impact and social contestability. So, a question is: in what way? We pose the following research questions:

1. How have key project participants experienced media communication of a research project physically embodied in a robot/cyborg?
2. How has the cyborg project been covered by media?

The questions will accordingly be illuminated by analyzing the communication along two dimensions: 1. Project managers and researchers own experiences with mediation of the project and 2. Representations of the project in articles in newspapers and magazines.

Key objectives are to gain a critical understanding of social and ethical aspects in the communication of cyborg technology, and challenges tied to communicating research that tends to be publicly regarded as pushing ethical barriers.

Theoretical/analytical framework

We draw on theory that critically questions a dominant view of science popularization (Bucchi, 2004; Myers 2003; Hilgartner, 1990; Whitley, 1984). The dominant view (also known as the deficit model) takes for granted the existence of two separate discourses, one within scientific institutions and one outside of them. According to this view, scientific knowledge is transmitted linearly from scientific discourse to the public discourse of society. The dominant perspective sees scientists and scientific institutions as the authorities on what constitutes science, whereas the public is considered "a blank slate of ignorance on which scientists write knowledge" (Myers 2003, 266). According to this view, information is simplified and often distorted in popularization, while good transmission reduces 'deficits' in public knowledge and could inform better decisions and support for science.

Scholarly critique of this dominant view draws attention to how science is communicated in a range of contexts, whether e.g. in specialist articles, textbooks, the media or government policy documents. Scientists move between several repertoires in different genres and contexts, with different ways of speaking for different rhetorical purposes (Latour and Woolgar, 1979; Myers, 2003; Hilgartner, 1990). Informal language use cannot be ignored, and popularization in the public sphere may be regarded as advantageous to scientific knowledge acquisition and production. In this continuum model, popularization is viewed as a matter of degree, not as a two-stage transmission between separate discourses.

Emphasizing the limitations of the dominant view, Broks considers it to be based on simple assumptions taken from common-sense understandings of audiences, communication, the media, knowledge, culture and social interaction (Broks, 2006: 120). As a further concern, Hilgartner draws attention how the dominant view "sets aside genuine scientific knowledge as belonging to a realm that cannot be accessed by the public but is the exclusive preserve of scientists." (1990: 530). Alternative models of public communication of science emphasize the potential knowledge of audiences and citizens (lay expertise model) and the importance of seeking public input into science (public engagement or dialogue model) (Brossard & Lewenstein, 2010, see also Secko et al., 2013). Instead of attempting to account for public misunderstandings of science, proponents of the lay expertise and public engagement approaches argue that communication needs to acknowledge information held by communities facing scientific and technical

issues (e.g. Wynne 1992). Science and scientists need to develop an understanding and respect for cultural schemas through which people make sense of science and make it relevant to their lives.

A question, however, is if scientific researchers will adopt a more dialogical understanding of and approach to public communication. When the traditionally dominant view provides a vocabulary for separating 'genuine knowledge' from 'popularized knowledge' and for determining which popularizations are 'appropriate' and which are 'distortions', researchers may find that accepting and respecting expertise away from science may undermine their own epistemic authority in public. Although relatively recent research on science communication in Norway (Carlsen, Müftüoğlu & Riise, 2014; Hornmoen et.al, 2014) suggests that Norwegian researchers see public communication as important and are highly motivated to interact with journalists, one may ask to what degree this implies acceptance of journalistic modes of framing and popularizing stories 'on behalf of the public'. This question will be touched upon in our discussion of the Cyborg project researchers' reflections on experiences with media communication, and the concluding discussion, where we consider the modes of framing implicit in informants' accounts.

Our analysis of the media coverage of the project aligns with the contextual (or continuum) and lay expertise/public engagement models presented above. This implies acknowledging that there are variations in how science is framed and communicated by different actors in different contexts. In analyzing the media coverage, we draw on theories/literature on the framing in media communication of research that raises science-related and science policy-related debates (Nisbet, 2010; D'Angelo & Shaw, 2018). We adopt a typology of media framing in the communication of science-related issues that is suited to the purpose of identifying the frames that are used – and how they are applied – in the different articles we analyze. Nisbet's typology (2010, p.46) includes the following frames, with a short account (in parenthesis) of how these define science related issues: *social progress* (improving quality of life, or solution to problems), *economic development/competitiveness* (economic investment, marketing benefits or risks; local, national or global competitiveness), *morality/ethics* (in terms of right or wrong, respecting and crossing limits, thresholds, or boundaries) *scientific/technical uncertainty* (a matter of expert understanding, what is known versus unknown), *pandora's box/Frankenstein's monster/runaway science* (call for precaution in case of possible impacts or catastrophe. Out- of -control, i.e. action is futile, path is chosen, no turning back), *public accountability/governance* (research in the public good or serving private interests, responsible use or abuse of science in decision-making), *middle way/alternative path* (around finding a possible compromise position between polarized views) and *conflict/strategy* (as a game among elites, who is ahead or behind in winning debate).

We further draw on key literature about functions of science communication and science journalism (Fahy & Nisbet, 2011; Nelkin, 1995; Secko, Amend & Friday, 2013). The following functions are extracted from the literature and applied in the identification of primary communicative functions in the analyses of the media articles: *inform*, *promote*, *interpret/explain*, *control/monitor* (understood here as a critical monitoring the scientific institution/scientists on behalf of the public), *comment/influence*, and *entertain*.

Linked to the identification of communicative functions is the use of stylistic devices in science communication and journalism. Applicable to our analysis is Molek-Kozakowska's (2017) typology of newsworthiness in the international magazine *New Scientist*. Here, newsworthiness is constructed through linguistic realizations of (examples in parenthesis): "novelty (FIRST), superlativeness (MOST, BEST, OLDEST); proximity/relevance (YOUR, YOU) and impact (HUMAN, UNIVERSE, EARTH)" (Molek-

Kozalkowska: 2017, p. 905). Positive, even celebratory representations are typical of the use the stylistic features that she sees as stemming from popular journalism. In her sample, however, they tend to be mixed with characteristics of the scientific style, that is, terminological precision, tentativeness (often expressed with weak epistemic modality: e.g. MAY, COULD about degree of likelihood or commitment to truth) and informativeness. We also register such stylistic characteristics in our material.

To empirically ground our theoretical standpoint, we employ a case study approach where a combination of textual and interview sources allows us to develop categories for the media content and informant narratives around NTNU Cyborg to construct a valid analysis. The close reading enabled by this narrow empirical scope allow us to show how informants narrate their experiences with the media as well as to examine how their narrated experiences correspond to the representation of the project and its participants in the media articles, as shown in the discussion.

Methodological approach and material

We conducted 10 semi-structured interviews with project managers and researchers between September 2018 to January 2019 to document their experience with 'external' media communication. Interviews were audio recorded, transcribed, and coded for topics of analytic interest. Informants were recruited in consultation with leading researchers in the NTNU Cyborg project, and included senior researchers, PhD candidates, and representatives from other university leadership and administrative roles.

The interviews probe into the motivation behind the communication of the project and pose questions particularly focusing on the following from the interview guide:

- How have you experienced the communication of the project and the media attention it has received?
- Did you find that the journalists conveyed what the researchers see as the most important issues in the research?
- What are issues in the cyborg project with a particular social and ethical interest?
- Has the media focus and the public response in any way influenced the research in the project?

Analysis of the media coverage of the project was initiated by searches in the Norwegian media archive A-tekst, using the search terms "Kyborg" and "NTNU Cyborg", as well as names of project participants (anonymized here). The collected newspaper articles addressing the Cyborg project range from February 2016 to January 2018 and resulted in an initial sample of 18 articles, which was narrowed down to eight due to how the same article could be published in print and digital editions of a publication, or because the same article could be syndicated in several publications. The resulting sample consists of articles from different types of media, either magazines or newspapers, and they are published either by independent media houses (such as *Adresseavisen* and *Vårt Land*) or by - or in close connection to - a research institution (such *Gemini*, published by NTNU and SINTEF, a Norwegian research organization for applied research, technology and innovation). Analysis of the stories will take into consideration their form and function and how these properties relate to the type of publication the stories are presented in. The articles are subject

to an analysis that in addition to applying categories drawing on literature presented above, will apply categories discussed in critical discourse analysis (Fairclough, 1995, on agency - or process and participant types - and genre).

The media analysis charts the articles according to the following categories: the type of *media genre* the texts can be sorted under (e.g. news report, explanatory feature); the *framing* of the accounts (see categories of framing above); the main *topics* addressed in the stories; the amount and types of visible oral sources in the stories; the type of *agency* - who are "agents" or actors (those who initiate action/events) and "patients" (understood as a grammatical category of text participants that the action is directed towards/conducted on); and the main *communicative functions* of the articles as well and the salient *stylistic devices* applied in them (see categories of functions and devices above). The mapping of such categories enables critical analysis and discussion of how the media package elements of rhetoric, grammar and style so that certain understandings of the mediated research and its role in society are encouraged while others are discouraged. The mapping will also provide a ground for assessing whether the media representations support or contradict views that are expressed by the project participants in the interviews.

Findings, semi-structured interviews

The following table (table 1) compiles and juxtaposes perspectives on the communication and media coverage as expressed by key actors in the Cyborg project.

Table 1: Perspectives on the communication by key actors in the Cyborg project.

Role /date interviewed	Experiences with comm. of project	Journalists conveyed important research issues?	Issues with social/ethical interest	The public/ media attention impacts research?
Initiator 23.11.2018	Universities should provoke. The prediction was that the cyborg project would gain media attention, and it did. Important for profiling the institution and attracting students.	The initiator partly has "frustrating" experiences with media, particularly with incorrect citations, and lacking journalistic research.	The Cyborg-variant in the project does not involve implantation of anything. The project will probably give a proper experimental basis for neural cells. Where it will take us as a society, we do not know.	According to the initiator this is addressed by Responsible Research and Innovation (RRI) But he cannot see that media attention has influenced the research.
Professor of data science/ project coordinator 05.05.2018	The project has made their basic research visible to enterprises, politicians, decision makers. Would not have happened without the cyborg. Audiences working in gov. deps mainly interested in projects health potential.	Public service television wishes to illustrate the research through moving robots within short time frames. Not achievable for researchers: "We are not very visual, we have nerds and black boxes. Although we can show a self-driving car, we are rather into the algorithms of it."	People are concerned about Artificial Intelligence (AI). The researcher sees their fears as unrealistic, although he admits to contributing to a paradigm shift in how machines are able to learn by themselves.	Research not influenced by media's focus. Audiences lack interest in/knowledge of methods. On a personal level: Communication in media steals time from research

	More neuroscience could have increased impact.			
Associate professor in data science, former project coordinator 25.09.2018	Media were immediately interested in the robot: something you can see, touch, interact with, rather than an algorithm. The fact that this robot was connected to neural culture, triggered media interest. Few labs in the world experiment with this setting.	Journalists try to attract attention to areas that raise ethical questions or surprise the audience. Media would initially write headlines on a robot with a biological brain, which is not what we use: it is a group of neurons. A lesson learned: "It is important to check citations".	The project raises ethical questions: what ethical implications does the handling of neurons on a chip have? Is this just a matter of how many neurons we have? Communication is important to counter negative views in society on e.g. robots and AI. It is important to contest the belief that we are building Frankenstein with a brain. It is important that people understand that in the future there will be brain-machine interface, not to control our brain, but to help people with e.g. disability or neural disease to get better.	Media attention and communication activities did not change the way researchers did research or the type of research done. "We did not do the research as it was described in some media. So it is not that we had to change because what we were doing was somehow unethical. We were doing something else, so it was just to try to explain it better."
Researcher in neuroscience 05.11.2018	It is good that people get enthusiastic, but the neuroscientist is not comfortable with the Cyborg being given a troll face ² to attract media. There was a risk of trivializing the science. Her impression was that none of those working in the interdisciplinary teams liked that part.	The neuroscientist did not only have good experiences with the media, seeing them as having pre-defined stories. The journalistic media may come up with simplifying frames in which stamping the researchers as Dr. Frankenstein is not very far away.	If the neuroscientists are perceived as doing something that may push ethical barriers, they "may not have a license to work with the neurons". There is a risk that some media may contribute to that.	Media attention has not made researchers question their approaches or methods. But negative, misconceived media attention on "having a brain connected to some cyborg" may have increased the risk of cutting down the research activity.
Associate professor in Cybernetics 05.11.2018	The Robot, with its media appeal, has contributed to give the project a boost, although the robot in itself is not so relevant for much of the research in the project.	-----	It is important to maintain ethical standards and discussion of how our research is conducted and applied. Will the possibility of medically improving human beings actually be used to help those who need help – those who are ill – or will the research rather be applied to rich	The media attention may have influenced how the initiator formulates applications, possibly by emphasizing more the marketable aspects of communication.

² The Cyborg was given a troll face in early digital presentations of the project.

			and successful people who can pay for 'improvements'?	
Head of communication 05.11.2018	It really creates media attention and draws leading politicians and industry to NTNU. The Cyborg project has the right buzz-words: "artificial intelligence", "big data", "cyborg", giving sci-fi associations. The saleability is exhausting to involved reseachers	Journalists have somewhat missed what researchers find substantial in the research. The basic science is difficult to grasp, and journalists want angles that sell. They like to write about the robot on campus. In comm. such things need to look a bit "cool", and the 'home-made' robot had to be replaced by a commercial one.	On a general level at NTNU: in research there are ethical issues of privacy and of research involving animal testing.	It is rather irrelevant to research projects to be influenced by what the world thinks about them. The publics' feedback to the organization may be important, but not their feedback to science as such.

In addition to perspectives by key actors summarized in table 1, the four interviewed doctoral research fellows voiced opinions on the communication that in some respects added nuances to the perspectives from the established researchers. These are taken into consideration in the following analysis of consent and variation in the perspectives on the communication of the project.

Communication experiences

Most interviewees agreed that the embodiment of project in a robot increased media attention and the profiling of their research towards key societal actors and stakeholders such as industry and politicians. They experienced that a key function had been to influence and control the reputation of the NTNU research and to possibly attract further research support and acquire more research positions for the project. One research fellow also emphasizes how media communication is crucial for recruiting new students to studies in the research areas involved in the project.

In a more critical tone, one interviewee questions the packaging of the original robot with a troll face, seeing this image as having nothing to do with her research as a neuroscientist. Other interviewees also emphasize the remoteness of the media packaging of the project to the research carried out in the project.

Did the media cover important research issues?

When questioned closely about whether they found that the media covered issues they saw as most important in their research, a tendency was to point out how media would convey the research according to pre-defined angles and stories, partly based on misguided conceptions of what the cyborg project was attempting to do. Informants reported that a media interest in ethical questions contributed to the misconception that the robot was connected to a biological *brain* that was being cultivated and developed

by the researchers, rather than a neural network with no similarities with and capabilities on level with complex brains. Several interviewees point out how this misconception again could lead to unfortunate views of possible misuse of the research and therefore rejections of future research applications.

Interestingly, however, one of the researchers believes that the data scientists themselves may have contributed to the misunderstanding by referring to simulated neurons as "brains". Consequently, they are careful not to use the word 'brain' in media interviews. A research fellow in neuroscience, on her hand, believes that the promotion of the research through a cyborg may trigger a public reaction to the project marked by popular culture. Many people have a conception of cyborgs as dangerous creations with human traits who are capable of conquering the world. She also points out how the use of the cyborg as a focal point in the project most probably has contributed to drawing attention away from what the research in her field is attempting to do: to come up with treatments for actual diseases.

Issues with social and ethical interest?

Several of the interviewees believe that the biomedical component in the research is the most important for society, due to its potential for significant progress in medical treatment of various illnesses. They also emphasize the importance of improving our understanding of complex neural structures as a precondition for the progress of such treatment.

A main ethical issue arises from what several of the researchers see as mediated misconceptions about their research, and negative public views and myths about scientists developing creatures with brains. One researcher is anxious about the how public perceptions of neuroscientists as pushing ethical barriers may lead to new restrictions on research in neuroscience. An ethical concern, then, is sensationalistic and distorting mediation of their news. Explanatory communication that contests myths about brain-cultivation is seen as a remedy to counter negative public views.

We note, however, that some of the interviewees acknowledge uncertainty with respect to the implications this research will have for society. A research fellow in cybernetics confesses that: "all technology can be misused," but adds that "if we accomplish things with the medical part of the research, it will make up for any risks that can hit in the other direction" (PhD student in cybernetics, January 11, 2019). His supervisor is on his hand concerned about how possible medical applications resulting from the projects' research will only be used to help those who can pay for them.

Has media and public attention and response influenced research?

This is the question where there was the highest degree of agreement among the interviewees. Practically all of them claim that the media attention and public response has not had any influence on the research as such, e.g. by making them question their approaches and methods.

However, some point out how media communication has had, or may have, an impact on conditions and contexts for carrying out research, either by stealing their time from research activities, or by 'misconceived' media attention possibly increasing the risks of cuts in their research activity. On a more positive note, a

research fellow in neuroscience finds that external attention has made her reflect more on the philosophy and context of what she is researching.

The most significant impact that media attention has had, according to several interviewees, is how it has made them change their media communication strategy. Because of their experiences with somewhat misleading media framings, they have modified the way they approach the media. They may now seek to acquire some knowledge of whom they talk to, and accordingly adjust the language they use, e.g. by avoiding words that are technical or may cause misunderstandings. In this manner, the communication of the Cyborg project has been a *learning process* for the involved researchers.

Critical analysis of the media coverage

The analysis of the media coverage first charts the articles according to the categories introduced in the methods section above. Drawing on the findings presented in table 2 below, the analysis pays attention to similarities and differences in the various media's representations of the project. We discuss how stories frame their topics, and how they represent sources and agency, as well as the use of stylistic devices and the functions of the communication. We consider the extent to which the media representations support or contradict views that are expressed by researchers in their reflection on their experience with media coverage in the interviews.

Table 2: Media articles schematized according to content properties and functions.

Headline, Newspaper (NP) Magazine (M), Date published	Media genre(s)	Dominant frame(s)	Main topic(s)	Visible sources: type of/amount	Agent(s) (A)/ patient(s) (P)	Dominant communicative function(s) (CF)/ Salient stylistic device(s) (SD)
This Cyborg Troll Wants to be Your Friend, M, Under Dusken 09.02.16	News report	Social progress Morality/ ethics	Project presentation, Student involvement Ethical challenges Project's impact potential	1 main researcher 1 student assist. 1 ethics expert	A: Cyborg, researcher, students P: Students	CF: Inform SD: Novelty ('special cyborg') Proximity/relevance (personalization of Cyborg)
- We like to call us the future faculty, NP, Universitetsavis a 16.02.16	News report	Social progress Economic development	Presentation of new faculty for IT and electro-technology	1 faculty dean 1 former pro-rector	A: The new faculty P: "The future", business community	CF: Promote SD: Novelty, impact

I, Cyborg M, Gemini, 07.03.17	News reportage	Social (and medical) progress Morality/ ethics	Cyborg's unique construction project's knowledge potential medical impact potential ethical challenges	1 computer scientist 1 neuroscientis t 1 research fel-low cybernetics 1 student 1 social scientist	A: Cyborg, neurons, researchers, students P: Students, university employees, medical patients	CF: Inform, interpret/explain SD: Novelty, proximity/relevance , tentativeness
NTNU will make a real cyborg, NP, Adresse- avisen 08.03.17	News report	Social (and medical) progress Morality /ethics	Cyborg project's uniqueness Medical impact Knowledge potential Ethics	2 computer scientists 1 neuroscientis t 1 social scientist	A: Cyborg, neurons, researchers P: Students, medical patients	CF: Inform interpret/explain SD: Novelty, proximity/relevance
Research that tastes science fiction, NP, Adresse- avisen 17.03.18	News report	Social (and technological) progress Morality/ethics	Ethics, explanation of communication and learning processes in neurons	1 research fellow, neuroscience	A: Researchers , neurons P: Medical patients	CF: Inform, interpret/explain, SD: Novelty, proximity/relevance
The Cyborg may lead us to the future's computers, M, Teknisk ukeblad 24.04.17	News report	Social (and technological /medical) progress	Explanation of potential of using neural networks in data processing Potential of "brain- computer interfaces" for technology	1 computer scientist 1 research fellow computer science 1 research fellow cybernetics	A: Researchers , neurons P: No clear 'patients'	CF: Interpret /explain, inform SD: Novelty, impact
Technology that no one quite can understand NP, forskning.no 20.05.17	Explanator y feature reportage Social (and medical)	Scientific/ technological uncertainty Social (and technological) progress	Interaction between neurons and robot Potential of neurons Complexity of neurons Nanomagnet project	1 computer scientist	A: Cyborg, researchers, super computers P: Medical patients	CF Interpret/ explain, inform, entertain SD: Novelty, proximity (personalization), tentativeness

Our children, the machines NP, Vårt Land 26.01.18	Interpretive and explanatory feature reportage	Social (and technological) progress Scientific/technological uncertainty Morality/ethics Possibility for runaway technology	Man's fear of consequences/change due to new technology The need to treat non-human successors of humans as our 'biological children' Science fiction's impact on our view of robot scenarios Self-learning potential of cyborg Potentially reproductive, evolution-simulating robots	2 computer scientists 1 historian 1 novelist 1 research leader	A: Researchers, robots P: Potentially: Humanity	CF: Interpret/explain, inform, entertain SD: Novelty, proximity (personalization), impact, tentativeness
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Framing the topics in stories

The most dominant frame in the coverage is the progress frame. Admittedly, the entry point in several stories is to refer to cultural or popular cultural representations of robots or aliens, whether in titles ("I, Cyborg"), or in leads ("popular culture has fueled a fear of robots" in "Our children, the machines"), or initial paragraphs ("can sound like something Dr. Frankenstein did" in "Research that tastes like Science Fiction"). Opening with such references and allusions not only has an attention-grabbing function, it also paves the way for stories that do away with the cultural myths and emphasize the potential for increased knowledge in different research areas - to the benefit of society. In other articles, this predominant progress frame can be articulated already in the title (e.g. "The Cyborg can lead us to the future's computers"). Most articles describe different aspects of what the progress may consist of, such as new basic knowledge about neural networks, new medical applications, or technological progress - e.g. with respect to building computers. Different publications may highlight different areas of progress depending on their subject field and target audience. The technology-oriented magazine *Teknisk Ukeblad*, for example, will highlight possible technological innovations, whereas the student magazine *Under Dusken* emphasizes how students contribute to project development.

Coverage that stands out as distinct with respect to topic choice and framing is found in publications that provide space for a culturally contextualized or reflective journalism on research topics. Notable examples include a story in the online research newspaper *forskning.no*, and a story in the independent daily newspaper *Vårt Land*. The *forskning.no* story ("Technology that no one quite can understand") chooses scientific uncertainty as its most dominant frame in a dialogical narrative involving the reporter and a

computer scientist. The reporter in this way challenges the researcher to be open about what they do not know and explain what they are attempting to understand, e.g. how neurons connect with each other and do something 'sensible'. Although articles in other publications (*Adresseavisen*, *Gemini*) also may interpret and explain the research in a popularized discourse, they do not to the same extent challenge their sources with probing questions, such as:

If you do not need all the complexity – could you not have used a digital model of the neuron – a neural network in a normal computer?³

By its rather frequent use of technical terms, the article constructs its target audience as somewhat more acquainted with scientific and technical issues than the other publications do. Readers are also provided with grounds for reflecting on ethical sides of the Cyborg project by the researcher admitting to a certain lack of control when developing new technology. Ethical dimensions are more explicitly articulated in the *Vårt Land* article "Our children, the machines". This piece not only problematizes science fiction's impact on our view of robot scenarios. The story ends by quoting a researcher in computational neuroscience who voices concern about the possible development of self-learning and -reproducing robots and the possible loss of human control over them in certain situations. In this way, the piece invites the reader to further reflect on possible ethical challenges related to the project's prospect of developing self-learning robots by connecting computers to neural networks.

Other articles ("This Cyborg Troll Wants to be Your Friend", "I, Cyborg") tend to frame ethics in a more standardized manner. They do not confront the Cyborg researchers about ethical issues, but rather quote ethical experts in social sciences voicing concern about possible unfortunate scenarios, such as that people in need of technology implants being unable to afford them. When an expert suggests that a remedy is to 'gain people's trust' in that the development is to their benefit, one may critically question why no voices from the laity are included in this article ("I, cyborg"), or in any other article in our material. When presenting research of this kind, a broader deliberation on ethical dimensions could be stimulated if people's concerns were addressed directly in a dialogical discourse (see also the part on use of sources below).

Some of the researchers we interviewed expressed how a main ethical concern for them is what they saw as public (mis)conceptions of neuroscientists pushing ethical barriers, potentially leading to restrictions on their research. However, we find little evidence of such media distortions. Contrary to expressed views about simplifying media frames which may stamp researchers as Dr. Frankenstein, we find that the stories rather debunk such cultural myths, as noted above. Apart from one article in *Adresseavisen* ("NTNU will make a genuine cyborg") that writes about researchers building a simple brain, there is little support in our material for the expressed notion of media portraying a robot connected to a biological brain. Rather, when the word "brain" is used it is placed in quotation marks, implying that what the researchers develop is not to be conceived of as a human brain, a point that is typically underscored by the researchers quoted on this matter in the articles.

³ Arnfinn Christensen, "Teknologien som ingen helt kan forstå" [Technology that no one quite can understand], *Forskning.no* (May 20, 2017). Retrieved from <https://forskning.no/data-cellebiologi-informasjonteknologi/teknologi-som-ingen-helt-kan-forsta/346273>

We also note that researchers themselves may contribute to public concern about the direction the research may take, by the way they articulate their excitement about participating in the research. For example, the enthusiasm of a doctoral student in computer science, is quoted with utterances such as the these:

It is fun to make "something so crazy." (...) My personal goal with the project is to "integrate man in machine". It has been a dream since I was ten years old, and now I have the possibility to realize that dream (...). (In Nordseth, 2017)

But even though a few 'tabloid' quotes may occur in stories, and the visual entry point to articles may consist of images of different robot/cyborg configurations (whether depicted as a 'friendly troll', a 'home-made' robot, or a commercial and 'cooler' robot called Pepper), we generally do not find that the media distort or create misconceptions of the research. On the contrary, the coverage comes across as conscientious (and not only in publications closely connected to the NTNU, such as Gemini) by the way it highlights research challenges and potential for all the fields involved and for society. The framing of the topics gives little cause for the concern expressed by a neuroscientist interviewee that the use of the cyborg as a focal point in the project has contributed to draw attention away from her field's objective of developing treatments for diseases.

Sources, agency and communicative functions

The impression that the media coverage to a large extent has been conducted from a vantage point of the research project and the researchers and the institution involved in it, is strengthened when registering the types of sources that are used and their agency in the narratives. Computer scientists and neuroscientists are most frequently used, followed by doctoral and master students in the fields, and a few appearances from social scientists, ethics experts, a historian and a novelist – the function of these last voices being to contextualize the research according to cultural trends and values, and ethical norms. As noted, the absence of lay voices is striking in the coverage of the project, given its initiator's intention of a "confrontational arena", "a wake-up call to people", something that "points to world that is very different from the one we have today" (Initiator, interview, November 23, 2018).

If representatives of the public are accorded a role in the narratives, it is solely indirectly, as passive objects ('patients' in the grammatical sense) or as patients for prospective treatments. Notions of the public as potentially providing valuable input to a research field that faces ethical challenges and is rife with uncertainties, seem to be overlooked by the writers of these narratives. When the writers do not include such input, researchers miss out on feedback that could have altered or adjusted the widely shared view that the public had no influence on their research, or at least on their understanding of the research in a public context.

The project researchers, by contrast, are portrayed as active agents with a strong urge to understand complexity, innovate and have an impact on society. Main researchers in the project may even express a dream of contributing to a future scenario in which they can build biological computers of living cells in which learning processes take place. Textually, we note that an 'autonomous' robot or cyborg is already

constructed in parts of coverage, supported by statements given by the researchers themselves. In some of the media narratives, the cyborg or the neurons are portrayed as active agents with an ability to socialize (applies to the troll and Pepper, admittedly facilitated by algorithms) or an ability to learn (neurons). In describing them, the robots may be given humanlike traits through personalization (e.g. the troll who wants to be "your friend", robots called "our children"), and neurons may be "spoken to" by a researcher (Christensen, 2018) or accorded with an ability to "speak" to each other:

They talk with their neighbors, who talk with their neighbors again. In a way that is close to inexplicable, a large network of rather simple nerve cells becomes capable of learning how to perform actions. (Buset, 2018)

However, rather than considering such personalized expositions as creating misconceptions of cells having human characteristics or nourishing a view of researchers with ambitions comparable to Dr. Frankenstein, we see them as metaphorical uses of language common to the popularization of science. The function is to explain complex processes by using a colloquial vocabulary that readers in general are more familiar with. It is a way of bringing the research closer to the reader (proximity), a stylistic device to aid the communicative functions of informing about and interpreting/explaining the research that we see as dominating functions in our material. Together with frequent emphasis on the novelty of the research, the proximity device is also suited to draw the reader's attention to a complex research field that they may not have engaged with if such devices were not applied.

Summary and conclusions

This case study has examined researchers' experiences with – and several media's practices of – communicating a research project that is scientifically complex, potentially highly impactful and socially contestable: the *NTNU Cyborg*. A key goal has been to gain an understanding of challenges tied to communicating research that tends to be regarded as pushing ethical barriers. We have drawn on theoreticians that emphasize limitations to a traditionally dominant perspective on science communication as a transmission from experts to citizens in order to fill in deficits in public knowledge. By rather supporting public engagement and contextual models of science communication, our objective has been to contribute to critical reflection on how communication practices and media coverage may strengthen a dialogue between citizens and research communities on demanding social issues tied to science-in-the-making.

While some researchers could express ethical concerns, e.g. that medical applications resulting from the research would benefit only the economically privileged, the interviewees for the most part tended to see public distortions of their research as the main ethical issue arising from the media's coverage. And whereas one researcher could self-critically admit that the researchers themselves could have contributed to the media's alleged misuse of the word "brain" several interviewees criticized the media for creating public misconceptions of biological brains being cultivated in the project. One researcher found that the media attention inspired reflection on the context of what she is researching, but most of them found no influence

on the research as such. Rather, they were concerned that media communication could weaken conditions for carrying out their research.

Although some interviewees may signal an ability and interest in perceiving their project from a publicly contextualized perspective, our analysis of their communication experiences rather suggests that the researchers engage in forms of boundary work towards popularization/public representation of the cyborg project. Their dominant discourse ingrained in their speech echoes perspectives found in the dominant transmission/deficit model of science communication: The media are characteristically considered as frequent simplifiers and distorters of scientific research. Even though most of the interviewees do acknowledge that the robot embodiment had been advantageous for reputation management towards stakeholders and could attract more research support, a concern was still that the media coverage could lead to restrictions on the research through their distortions.

Interestingly, our analyses of the media's coverage of the project barely leaves an impression of a distorting intermediary with negative representations of the research. On the contrary, the media's frequent use of use of the progress frame highlighting the technological and medical potential of the research for society, to large extent creates an image of innovative research suited to promote the project. The articles debunk rather than create popular-cultural dr. Frankenstein-myths of ethically irresponsible research. Even if the media coverage spans from rather promotional stories in university publications to more culturally contextualized stories in independent publications, what comes across is a coverage that is conscientious towards the scientific community.

From a public participation perspective, we are concerned about how the Cyborg project participants' views on communication exposed in this limited case study mirror patterns that continue to dominate conceptions of media relations in scientific communities. For example, an account of the media relations of scientists based on comprehensive analysis of relevant surveys (Peters, 2013) suggests how most scientists perceive a duty to talk to the media about their research as part of their professional role. Although the scientist respondents in these surveys embraced the media functions of disseminating and marking science as relevant to society, they had more difficulties with the journalistic transformation of scientific knowledge and often associated it with distortion. According to Peters (2013), natural scientists see public communication as distinct from internal scientific communication, and do not allot the general public a role in the production and validation of knowledge.

Scientists' entrenched views of public communication may increasingly be challenged, as online communication facilitates dialogue and public involvement, and as funding bodies increasingly call for ethical commitment and social responsibility. The need for scientific specialists to take people's "common sense" or "good sense" into account in order to have their work realized and applied is likely to increase. We believe that conversation about science would be better served if researchers considered the public domain less as a separate sphere and more as a place to examine whether the experts' approach to problems is socially acceptable.

This is also a challenge for science journalists, who have frequently been criticized for being uncritical (e.g. Cassels. et.al, 2003, Hornmoen, 2003) and for emphasizing frames of progress and economic prospect (e.g. Nisbet & Lewenstein, 2002). A largely 'conscientious' journalism of the kind that was most prevalent in our material may maintain boundaries between science and society, rather than inspire engaged public deliberation on ethically challenging frontier research such as the Cyborg project. Instead of predominantly

situating controversial research within a traditional popularization paradigm, journalists should to a larger extent explore and develop a coverage of emergent science along the lines suggested by Secko et.al. (2013) in drawing on the public participation model: a journalism that may focus on processes of science and the consequences of choices made in the research.

We call for a more critical journalism on research projects of the kind analyzed in this study. Not a journalism that limits its efforts to the functions of promoting, informing and explaining. In a critical manner, it could include a monitoring control function. Above all, it could position the research in a wider cultural context, and – in a dialogical discourse – involve voices of the public that the research is ultimately intended to serve.

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Appendix

List of media articles about the NTNU Cyborg

Daniëlle Aker-Bjørke, "Dette kyborgtroll vil være vennen din" [This cyborg troll wants to be your friend], Under Dusken (February 16, 2016), pp. 12-13

Pål Buset, "Våre barn, maskinene" [Our children, the machines], *Vårt Land* (January 26, 2018), pp. 14 - 19

Arnfinn Christensen, "Teknologien som ingen helt kan forstå" [Technology that no one quite can understand], *Forskning.no* (May 20, 2017). Retrieved from <https://forskning.no/data-cellebiologi-informasjonsteknologi/teknologi-som-ingen-helt-kan-forsta/346273>

Kristoffer Furberg, "Vi liker å kalle oss fremtidsfakultetet" [We like to call ourselves the faculty of the future], *Universitetsavisa.no* (February 16, 2017). Retrieved from <https://www.universitetsavisa.no/campus/vi-likera-kalle-oss-fremtidsfakultetet/153846>

Svein Meland, "NTNU skal lage en ekte kyborg" [NTNU will make a genuine cyborg], *Adresseavisen* (March 9, 2017), pp. 10-11

Svein Meland, "Forskning som smaker science-fiction" [Research that tastes like science fiction], *Adresseavisen Pluss* (April 17, 2017). Retrieved from <https://www.adressa.no/pluss/nyheter/2017/04/17/Forskning-som-smaker-science-fiction-14584399.ece>

Linn Kristin Nordseth, "Kyborgen kan lede oss til fremtidens datamaskiner" [The cyborg may lead us to the computers of the future], *Teknisk Ukeblad* (April 24, 2017), pp. 83-85

Grete Wolden & Steinar Brandslet, "Jeg, Kyborg" [I, Cyborg], *Gemini* (March 7, 2017). Retrieved from <https://gemini.no/2017/03/jeg-kyborg/>