

Article

Analysis of North American Newspaper Coverage of Bionics Using the Disability Studies Framework

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Abstract: Bionics are a set of technology products that are constantly evolving. Bionics are proposed as body add-ons or replacement for many body parts (ears, eyes, knees, neural prostheses, joints, muscles, kidney, liver, cartilage lungs, discs, pancreas, dental pulp, skin, hippocampus, legs and hands), and functions such as speech. Two main applications of bionic products are discussed; one being for the restoration of body abilities to a species-typical norm and the other being the addition of abilities to the body that are not species-typical. Disabled people are one main group perceived to be in need of therapeutic interventions that use various bionic products. So far, therapeutic interventions are about restoration to the species-typical norm. However, therapeutic bionic products increasingly give the wearer beyond normal body abilities (therapeutic enhancements). Many so-called non-disabled people want the same enhanced body-abilities especially through non-invasive bionic products (e.g., non-invasive brain machine interfaces, exoskeletons). The media has the ability to shape public perceptions with numerous consequences. The purpose of this study was to provide quantitative and qualitative data on how bionic technologies and its users are portrayed in North American newspapers. Data was obtained from 1977 to 2013 from the *Canadian Newsstand complete* database which covers over 300 English language Canadian newspapers and two Canadian newspapers, one with national focus (*The Globe and Mail*) and one with local focus (*Calgary Herald*), and from 1980–2013 from one American newspaper with national reach (*The New York Times*). The study found (a) an almost always positive portrayal of bionics; (b) coverage of bionics mostly within a medical framework; (c) a predominantly stereotypical and negative

portrayal of individuals with disabilities; and (d) a hierarchy of worthiness between different assistive devices such as a reporting bias favoring artificial legs over wheelchairs. At the same time the study did not find any engagement with social and ethical issues that are already raised about bionics in the literature, such as the increasing desire for enhancements, the use of bionics for non-therapeutic purposes and the issues socially disadvantaged people might face in the wake of bionic advancements. We posit that the newspapers generate a bionic discourse culture that is problematic for disabled people and other socially disadvantaged groups and that they do not prepare readers for the challenges that bionic advancements will pose for the general population in the future.

Keywords: bionics; brain machine interface; newspapers; disabled people; therapeutics; people with disabilities; therapeutic enhancement

1. Introduction

The field of bionics is based on the union of living organisms and machines [1]. Bionics are proposed as replacements for many body parts (ears, eyes, knees, neural prostheses, joints, muscles, kidney, liver, cartilage, lungs, discs, pancreas, dental pulp, skin, hippocampus, legs and hands), and for functions such as speech [1–23]. Two main visions of bionic product use are discussed within and outside academia; one being to regain species-typical abilities and one to generate abilities beyond the species-typical.

1.1. Bionics and Disabled People

Disabled people are one main group seen to be in therapeutic need of various bionic products [24]. This group of disabled people includes injured soldiers and veterans [25]. The Defense Advanced Research Projects Agency (DARPA) USA has numerous active research projects related to bionics and prosthetics [25–31]. So far, treatment and rehabilitation need has been linked to a loss of abilities expected from a normal or species-typical body. However, increasingly bionic products used for therapeutic reasons can give recipients beyond species-typical abilities (therapeutic enhancement [24]). Artificial legs, one therapeutic device, have received a lot of attention recently in part due to the controversy surrounding the Paralympian and Olympian, Oscar Pistorius. He wanted to compete in the Olympics but was initially declined that option as his artificial legs were labeled as a techno doping device because they were classified as giving him an unfair advantage [32,33]. Although he is not outperforming the best Olympic athletes yet, it is expected that some bionic runner eventually will do so [34].

Bionic/artificial legs pose challenges within and outside the sports world, and for disabled people and non-disabled people alike. As for disabled people it influences for example the imagery/-portrayal of wheelchairs [35] and low tech prosthetics and for non-disabled people the challenge is how to react to a situation where the bionic leg person outperforms the species-typical leg person. We posit that many therapeutic bionic/artificial body part replacement or add-on that enable body abilities beyond

the species-typical will pose ability expectation challenges for people with species-typical body abilities and people perceived as having sub species-typical body abilities (disabled people).

1.2. Bionics and Non-Disabled People

Bionic/artificial body part replacements or add-ons are also used for non-therapeutic purposes and by non-disabled people. DARPA for example is not only focusing on injured soldiers and veterans but also on healthy, active duty soldiers [25] and non-invasive brain machine interfaces that add new abilities to the body are developed for therapeutic purposes and non-therapeutic purposes such as gaming [36]. Indeed bionic/artificial body part replacements and add-ons and other products that add new abilities to the body are desired by species-typical individuals [37]. Ability enhancements of the species-typical body in general [25,38–52] and enabled by bionics [53–60] are discussed extensively in the literature (sport and doping in sport related literature not listed).

1.3. Switching Sides

The Nuffield Council of Bioethics (UK) just proposed classifying non-invasive brain machine interfaces and other emerging neuro-technologies as medical devices [61] which raises the question of which of the ability enhancing bionic/artificial body part replacements and add-on products will eventually be dealt with under the label of medical technologies/devices and which won't.

Bostrom proposed to make cognitive enhancements available through public health care [62] which raises the question of which bionic products discussed outside of the medical realm will become part of the producer and/or consumer driven medicalization dynamic [63–70].

Our study used a disability studies lens which “refers generally to the examination of disability as a social, cultural, and political phenomenon in contrast to clinical, medical, or therapeutic perspectives on disability” [71] to investigate the content of the newspapers covered. We present in Section 3 qualitative and quantitative results addressing the following research questions: (a) which social groups (Section 3.1); (b) which bionic products (Section 3.2) are mentioned; (c) how are bionics, disabled people and their non-bionic assistive devices such as wheelchairs portrayed (Section 3.3); (d) what issues are mentioned in relation to bionics (Section 3.4) including whether enhancement is a topic mentioned (Section 3.5). In Section 4 implications of the results are discussed and in Section 5 we provide some thoughts as to future steps that should be taken to ensure that society is well equipped to deal with the progress in bionics.

2. Methods

2.1. Analytical Framework

We used a disability studies lens [71–73] and a framing analysis [74] as our analytical frameworks to investigate the newspaper articles. Structural [75], content [76] and issue-specific framing [77,78] are three ways of framing. According to Entman, “[to] frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described. Typically frames diagnose, evaluate, and prescribe, then, define problems-determine

what a causal agent is doing with what costs and benefits, usually measured in terms of common cultural values; diagnose causes-identify the forces creating the problem; make moral judgments-evaluate causal agents and their effects; and suggest remedies-offer and justify treatments for the problems and predict their likely effects” [79].

Disability Studies perceives disability as a social, cultural, and political phenomenon as opposed to a clinical, medical, or therapeutic phenomenon [71–73]. As such it is of interest to the disability studies field how disability is framed within given sources such as newspaper articles. From a disability studies perspective it is also highly relevant how a topic is framed, what reality is made salient, what is described as a problem, its cause and solution and which and whose cultural values are evident.

According to Entman frames have at least four locations in the communication process: the communicator, the text, the receiver, and the culture [79] (see also [80]). Our content analysis focuses on how the communicator (the newspaper) frames the topic of bionics. According to Collins *et al.* persuasion is one media effect and encompasses the message, who is used as a source and the “persuadability of media consumers” [81]. We use the disability studies lens to assess the effect and the consequences of the framing of bionics for disabled and non-disabled people. Concrete our study answered the following research questions: (a) which social groups (Section 3.1); (b) which bionic products are mentioned (Section 3.2); (c) how are bionics, disabled people and their non-bionic assistive devices such as wheelchairs portrayed (Section 3.3); (d) what issues are mentioned in relation to bionics (Section 3.4) including whether enhancement is a topic mentioned (Section 3.5).

2.2. Data Source

We accessed 300 Canadian newspapers published between 1977–2013 through the ProQuest database, “*Canadian newsstand complete*”, which we accessed through the University of Calgary library (21 September 2013). We furthermore accessed the articles of two Canadian newspapers, one with national focus (*The Globe and Mail*) and one with local focus (*Calgary Herald*) published between 1977–2013, through databases accessible through the University of Calgary library (2 May 2013 and 21 September 2013). Finally, we accessed articles of *The New York Times*, an influential American newspaper [33] from 1980–2013 through the University of Calgary library (21 September 2013). All databases were searched for the term “bionics” in the full text. The articles identified as containing the term “bionics” were further searched for keywords linked to the disability studies framework and the research questions of this study to generate quantitative data. The $n = 270$ *Calgary Herald* articles and the $n = 392$ *The Globe and Mail* articles found with the term “bionics” (2 May 2013) were downloaded as PDF documents and uploaded into ATLAS.ti[®], a qualitative data analysis software [82], for further qualitative examination. Certain articles from the *Canadian newsstand complete* database and *The New York Times* were downloaded as PDF from their ProQuest database and analyzed by reading the PDF.

2.3. Data Analysis

Two different groups or families were created in the ATLAS.ti[®] hermeneutic unit via the Family Manager function; one for the *Calgary Herald* and one for *The Globe and Mail* articles. Within the families, the articles were organized by year of publication. The Auto Coding function in ATLAS.ti[®],

was used to perform deductive coding of the material using terms fitting the disability studies framework and the research questions to search all articles for a given term (e.g., different social groups, the visibility of terms linked to impairment or disability, terms linked to social issues known to be of relevance to disabled people). We also performed inductive coding by reading through all of the articles and marking themes fitting the disability studies framework and the research questions as they were identified. Qualitative and quantitative data was generated from the coded data.

2.4. Limitations

We only looked for English language content. This means our study was not tailored to look at one province in Canada (Quebec) where the first language is French. Furthermore, we only looked at one US newspaper. Given the sources we investigated, our results cannot be used to generalize our findings whether for the whole of Canada, North-America or beyond. Furthermore, nowadays comments from readers are often posted on the webpages of newspapers. These comments are not present in the articles downloaded from the ProQuest database. This means our study was not equipped to look at the public sentiment toward various articles based on webpage comments. This might be a future research angle, along with looking at Canadian French language media content and other newspapers and other media sources. Finally, we only investigated the coverage of “bionics”. Articles that cover bionic products without using the term “bionics” in the text were not captured; for example in the *Canadian newsstand complete* $n = 1,029$ article have “Pistorius” in the text whereby of these only $n = 30$ have also bionic in the text. To give another example the terms “brain-machine”/“brain computer” were present in $n = 81/140$ articles of the *Canadian newsstand complete* but only in 3/6 articles of the *Canadian newsstand complete* containing the term “bionics”.

3. Results

3.1. Who is Mentioned?

Who is mentioned as a source and/or stakeholder is seen as one way to persuade the reader [81]. At the same time who is mentioned leads to different narratives and the salience of different realities linked to different social groups including the promotion of a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described. As such, one main focus of disability studies is to investigate who is mentioned in a given discourse, whether it involves disabled people and if yes how it involves disabled people.

Data from Table 1 indicates that the phrase “people with disabilities” and “disabled people”, which are often used to cover the social situation of disabled people are not used very often, if at all. However, terms that indicate a medical focus of disabled people are highly visible (amputee, patient, various terms containing impair*).

Disabled people are one invisible socially disadvantaged group however Table 1 furthermore reveals that other groups one could also classify as socially disadvantaged such as immigrants, “the poor” or Indigenous People are not visible either. On the other hand, the industrial complex (corporation, industry, business) and government are highly visible. Another visible group is the military complex (soldiers, veteran and military).

Table 1. Mentioning of groups in the newspaper coverage of bionics.

Codes	<i>Canadian Newsstand Complete n = 4,826</i>	<i>Calgary Herald n = 270</i>	<i>The Globe and Mail n = 392</i>	<i>The New York Times n = 492</i>
Aboriginal People/Indigenous	7/3/0	2/0/0	2/0/0	0/3/0
People/First nations				
Amputee	118	12	12	13
Business	1,296	49	89	138
Caregiver	4	0	0	9
Corporate	129	5	21	129
Cyborg	55	5	2	10
Family/ies	1,062/175	61	89	1,130
Government	425	32	50	38
Immigrants	22	2	5	6
Impair*	71	3	0	71
Industry	534	34	56	87
Inuit	17	0	0	0
Military	255	12	19	27
Nurses	33	3	8	3
Parents	125	28	36	71
Patient	323	27	33	60
People with Disabilities/disabled	8/27	0/1	0/0	1/5
people				
Physicians	46	4	8	19
Society	391	31	27	56
Soldier	171	10	12	24
The poor	38	3	4	12
Therapist	75	4	7	9
Veteran	348	23	32	35
Women	888	115	195	221

Table 1 gives only pure hit-counts but does not tell one what was covered and even whether all hits are relevant. Therefore, as to social groups we looked further into article that covered military, soldiers and veterans. Most articles that contained the terms military and bionics in the *Calgary Herald*, *The Globe and Mail* and *The New York Times* were false positive articles meaning they did not cover bionic products; for example some just covered television shows, or there were phrases such as “bionic wheat stalk” and “bionic mayor”; one false positive article covered ice skater Boitano’s microcomputer hardware project dubbed the Bionic Beaver. Of the relevant articles one *The Globe and Mail* article was concerned about a real-life Iron Man suit falling into military hands [83], one article covered therapeutic use of a bionic arm and $n = 2$ covered non-therapeutic use of various forms of exoskeletons. As to the *Calgary Herald* $n = 3$ articles covered non-therapeutic use of various forms of exoskeletons and $n = 3$ articles covered therapeutic use of bionic legs and arms. One article wrote about a British eye hospital creating a new breed of ‘bionic’ fighters describing eye surgery that added enhanced night vision to soldiers [84]. As to *The New York Times* of the relevant articles $n = 1$ covered therapeutic

application of exoskeletons, $n = 1$ covered non-therapeutic application of exoskeletons, $n = 1$ bionic arms (although not linked to the military part of the story), $n = 1$ therapeutic use of bionic arms and legs and $n = 1$ an artificial heart (although none a linked to the military use of bionics or by military personal but mention military on the side like being able to deal with the heart implant procedure because one was formerly in the military). One article from 1984 mentions that a 1972 analysis by the American Defense Intelligence Agency states that “the major impetus behind the Soviet drive to harness the possible capabilities of telepathic communication, telekinetics and bionics are said to come from the Soviet military and the K.G.B” [85].

In general given the existing discourse around bionics and the military especially for non-therapeutic reasons in the literature the newspapers ignored that angle mostly and in the few cases where it is mentioned it’s a sideline with no in depth analysis.

Of the articles that covered veterans and bionics, all focused on injured veterans such as the following articles in the *Calgary Herald* [86–88]. However, again, in depth analysis of use of the products was missing.

Of the 10 articles in the *Calgary Herald* that mentioned soldiers, 6 were relevant (meaning they talked about bionic products) of which three articles focused on injured soldiers and the other three articles [84,89,90] covered ability enhancement of healthy soldiers indicating that this could lead to a “new breed of ‘bionic’ fighters” [84]. *The Globe and Mail* articles were also split evenly with $n = 2$ focusing on injured soldiers and $n = 2$ focusing on enhancing abilities of healthy soldiers. One of these $n = 2$ articles from 1983 reported on the *Airland Battle 2000* [91] a document by the US Army that looked at the future of warfare and which envisioned bionic soldiers [92]. As for *The New York Times*, $n = 5$ were about injured soldiers and $n = 1$ was about the enhancement of healthy soldiers. However again, the enhancement aspect was mentioned without an analysis.

3.2. Which Products are Mentioned?

Assistive devices are of importance to disabled people. Therefore, from a disability studies perspective it was relevant to determine which assistive devices are mentioned.

Table 2 illustrates that bionic products that replace organs are mentioned however Table 2 also reveals that the scope of mentioned body organs is limited to heart, eyes and ears although bionic replacements for nearly every body organ/part are under development including the artificial hippocampus [1–23,93].

Table 2. Bionic and related products mentioned in the newspapers.

Codes	<i>Canadian Newsstand</i> $n = 4,826$	<i>Calgary Herald</i> $n = 270$	<i>The Globe and Mail</i> $n = 392$	<i>The New York Times</i> $n = 492$
Bionic organ	1	0	0	0
Arm	162	32	50	96
Brain	24	29	39	71
Brain computer	6	0	0	1
Cochlear implant	71	1	4	8

Table 2. *Cont.*

Codes	<i>Canadian Newsstand</i> <i>n = 4,826</i>	<i>Calgary Herald</i> <i>n = 270</i>	<i>The Globe and Mail</i> <i>n = 392</i>	<i>The New York Times</i> <i>n = 492</i>
Ear	104	18	24	58
Exoskeleton	21	3	1	7
Eye	84	56	70	136
Foot	3	38	50	114
Hand	62	58	88	157
Heart	726	39	59	104
Leg	82	42	36	79
Liver	45	2	8	8
Wheelchair	101	5	9	16

Devices that are to be replaced by bionics such as wheelchairs and non-invasive devices such as exoskeletons that could be used to perform some of the tasks of body parts such as legs and arms are also mentioned.

3.3. *How are Bionics, Disabled People and Their Assistive Devices Portrayed?*

The language used by newspapers is an indicator of the newspaper's mindset and influences the reader. How disabled people and their assistive devices are portrayed is one focus of disability studies scholars as disability studies questions the medical portrayal of disabled people and argues for a focus on the social barriers they face. The disability rights movement coined the term ableism [73] to highlight the species-typical ability expectations the so called abled bodied people have which leads the so called abled-bodied to label the ones without these abilities as defective as unhealthy in need of a medical fix and the disablism [94] often linked to this labeling.

Table 3 shows that newspapers are heavily weighted towards a medical depiction of bionics, which is evident in the social groups mentioned (amputee, patient nurse, caregiver, therapist and physician) and the high frequency of health terms (health, disease, impairment and treatment) used.

Table 3. Medical language evident in the newspaper coverage of bionics.

Codes	<i>Canadian Newsstand</i> <i>Complete n = 4,826</i>	<i>Calgary Herald</i> <i>n = 270</i>	<i>The Globe and</i> <i>Mail n = 392</i>	<i>The New York</i> <i>Times n = 492</i>
Amputee	118	12	12	13
Caregiver	4	0	0	9
Disease	321	24	21	41
Health	510	31	34	57
Impair*	71	3	0	71
Nurses	33	3	8	3
Patient	323	27	33	60
People with				
Disabilities/disabled	8/27	0/1	0/0	1/5
people				
Physicians	46	4	8	19
Therapist	75	4	7	9
Treatment	206	23	18	36

Another indicator of the overall medical mindset of the reporting is that although cochlear implants [95–110] are covered in the newspapers, the term Deaf culture, a marker for whether cochlear implants should be used and whether being deaf is a defect that must be fixed, is hardly mentioned (Table 4). Deaf culture was mentioned in only one newspaper article from *The Globe and Mail*, one article from *The New York Times* and not at all in the *Calgary Herald*. The article from *The Globe and Mail* explains both sides of a debate on whether or not deaf children should use cochlear implants. Proponents believe that deaf individuals should be able to use cochlear implants as “valuable tools” to gain more opportunities and abilities [111]. Those who are opposed specifically object to parents making the decision for their children to use cochlear implants as they view implant use as “child abuse” for many reasons. The reasons being the fact that using the implant requires a surgery, trying to “fix” a child that there is nothing wrong with, and taking the child away from Deaf culture which has its “own language (sign language), values, traditions and ways of behaving” [111]. Opponents fear that children who use the implant belong neither to the hearing world or the Deaf world [111]. Within the articles retrieved from the *Canadian newsstand complete*, the ratio between “cochlear implants” and “Deaf culture” was 10:1.

Table 4. Frequency of use of deafness related terms.

Codes	<i>Canadian Newsstand Complete</i> n = 4,826	<i>Calgary Herald</i> n = 270	<i>The Globe and Mail</i> n = 392	<i>The New York Times</i> n = 492
Deaf Culture	7	0	1	1
Cochlear implant	71	1	4	8

Another issue related to language is the portrayal of assistive devices that are in direct competition with bionics. Disability studies questions the negative language often used to portray assistive devices used by disabled people (e.g., confined to the wheelchair, wheelchair bound). To stay with the example of the wheelchair; 101 articles in the *Canadian Newsstand Complete* that mentioned bionics also mentioned wheelchairs. From a disability studies perspective, the negative portrayal of wheelchairs is problematic and is evident in discourses around artificial legs [33,35]. This negative coverage was also evident in the articles in the *Canadian Newsstand Complete* with the frequent use of the terms “wheelchair bound” [112–117], “confined to the wheelchair” [118,119] or “dependence on a wheelchair” [120,121].

Textbox 1: Negative portrayal of wheelchairs

“Gore, who played sports in high school and worked on the family farm before his fall, is eager to see prices drop and insurers decide that the expense of an exoskeleton outweighs the medical costs of keeping the disabled in wheelchairs”[112];

“to help people who use wheelchairs to stand and walk again”[122];

“Harder to quantify are intangible benefits, such as what it means for someone who has been in a wheelchair for decades to simply to be able to stand, walk around and look people in the eye again” [122];

“As soon as I was out of the wheelchair, I was teaching myself to walk again as well as swim” [115];

“That’s one of the reasons I was successful at it, because it was a new me, a new normal...

It gives me a huge sense of freedom that someone using a wheelchair will never have” [123];
 “He had a prosthetic leg, but usually opted to use a wheelchair because it was easier to get around. Walking with his artificial metal leg, which has a locked knee joint, was a challenge... Blake will soon have the freedom to walk where he chooses with a C-Leg Compact, manufactured by Otto Bock” [124];

“Amanda Boxtel stands from her wheelchair and takes a few tentative steps. She beams as the bionic skeleton she is wearing helps propel her legs forward. Bionic skeletons, known as exoskeletons, are the latest technology in the race to help paraplegics achieve the impossible and walk again” [125];

“After years spent learning to live and thrive in a wheelchair, Mr. Bobblitt has a new set of goals. ‘I don’t really focus on walking because you don’t want to get your hopes up,’ he said. ‘But just being able to stand up out of the chair and transfer to the bed or get something off the counter makes me wonder what else might be possible down the road” [126];

“I can’t image where I’d be without it, she says. It’s kept me out of a wheelchair and let me live a normal life” [127];

““Once you get into a wheelchair, it’s all part of this downward spiral,’ said Burgess, a former professor of physical education” [128];

“She says that without the operation she would have been bed-ridden or at least in a wheelchair and on sedatives all the time” [128];

“getting people out of wheelchair [sic]” [129] .

The above negativity of wheelchairs was linked to not being able to stand, not being able to look people in the eye, not being able to walk, lifelong cost of being in a wheelchair, wheelchair being a non-normal life, wheelchair being part of the problem juxtaposing the wheelchair with a device of liberation (C-leg or bionic exoskeleton). The framing reflects the dominant reality of the ability expectation of walking (legism [35]). The newspapers ignore an alternative narrative that questions the ability expectation of walking and the unwillingness of people to accommodate and accept non-walking alternatives such as wheelchairs and their users. The quotes reflect a narrative of perceiving the person in the wheelchair and their way of functioning as the problem *versus* perceiving leg-ism as the problem.

A positive portrayal of wheelchairs only occurred twice; “On February 18, Moore sat in a wheelchair for the first time... It’s such an incredible joy for me to get out of bed” [130]; and “An exoskeleton might give better access to nature and areas where wheelchairs have trouble, such as on grass, gravel and sand. On the other hand, Jaimie Borisoff, a paraplegic following a spinal cord injury 20 years ago, said he probably wouldn’t use it outside because he can go places much more quickly in a wheelchair” [125].

3.4. What Issues are Mentioned?

Another disability studies interest is to understand whether social issues are mentioned in regards to a given topic and if so, which issues are mentioned and whether they are linked to disabled people.

In general, Table 5 shows that not many social issues are mentioned in regards to bionics and of the ones mentioned many are rarely mentioned. “Cost” is the issue mentioned most. Content linked to the term “problem” could have covered various social issues. However only six out of 725 (0.83%) articles

with the term “problem” were found to present problems linked to the use of bionics. Three articles mentioned issues with the quality of devices (e.g., [131–133]) and one article from *The Globe and Mail* discussed tampering with bionic organs through the computers which control them, leading to untraceable murders [134]. One article from 2007 talking about Oscar Pistorius long before it became a hot media issue states: “Some little Frankenstein out there may devise a problem the [International Association of Athletics Federations] can’t handle, Mr. Gramantik said” [135]. One article in the *Calgary Herald* thematized the utility of bionic arms, “[t]he problem, explains Carey, is the success rate of complex, technologically advanced myoelectric arms that cost between \$30,000 and \$100,000. Currently, most of the patients that get fitted with one reject it and it ends up sitting on the shelf, said Carey” [136].

Table 5. Frequency of social issues mentioned.

Codes	<i>Canadian Newsstand</i> Complete <i>n</i> = 4,826	<i>Calgary Herald</i> <i>n</i> = 270	<i>The Globe and Mail</i> <i>n</i> = 392	<i>The New York Times</i> <i>n</i> = 492
Access	165	13	14	21
Afford*	32	4	13	21
Equity/equality	30/22	1/0	5/6	5/2
Income/cost	77/715	3/33	16/53	16/83
Discrimination	11	1	2	2
Stigma	7	0	0	2
Quality of life	54	6	4	3
Education	175	12	18	27
Employment	38	1	3	7
Problem	504	50	77	133

These six articles cover four different problems but the frequency of coverage is so low that it’s doubtful that the reporting had a significant impact.

However most of the times the term “problem” was used to highlight problems that bionic products will solve adding to an overly positive portrayal of bionics (textbox 2).

Textbox 2: Problems seen to be solved through bionics

As to articles in the *Calgary Herald*:

“The promise of microchip medicine lies not only in bionic body parts, but also long-term care for chronic problems” [137]; “to answer Japan’s most pressing economic and social problem: the plunging birthrate and rapid aging of the population, allowing people to work into their old age. “The suit will allow elderly people to fend for themselves much later into their retirement, and means that people do not become bed- ridden so soon in life” [138].

As to articles in *The New York Times*:

“In hospitals of the future “emancipated medical machines” will see problems and correct them expertly, with no need for human input. Doctors and nurses will supervise robots smart and dumb: the smart ones will perform surgery unerringly, while the dumb ones will do all the menial labor, cleaning floors, and lifting and turning patients, “freeing the warm hands of humans to better care for other humans in need” [139];

“Scientists and engineers have turned their tool-making and building skills to correcting the medical problems the body cannot fix. The result is a growing array of artificial body parts that are available for immediate use and many more in various stages of development around the world. From the top of the head to the bottom of the feet, it is becoming increasingly possible to use artificial parts to enhance vision and hearing, strengthen weakened bones, bolster or replace faltering organs, replace damaged joints, substitute for disabled nerves or improve appearance. Transplanting organs and other tissues from one human to another, or even from animals to humans, are other means to this end. But this avenue has been hampered by chronic shortages of donor organs, problems of compatibility and rejection, concerns about transmitting infections and other problems. Receiving artificial body parts has become so common that it no longer seems exotic. Each year, hundreds of thousands of Americans get artificial hips and knees, and tens of thousands receive heart valves, tooth implants, spine supports, eye lenses and other replacements. In addition, hundreds of thousands benefit from implantable devices that assist disabled organs or other body components but do not replace them. Examples of these include cardiac pacemakers and defibrillators to maintain regular heartbeats and rhythms, internal braces and splints to strengthen weakened or shattered bones and penile implants to treat impotence” [140];

“In the last five years, we’ve seen advances in many types of devices that are implanted into the body, or are external to it, that are taking over for impaired functions,” said Dr. Susan Alpert, director of the Office of Device Evaluation at the Food and Drug Administration, which regulates such products” [140];

“With advances that we are seeing in material science, miniaturization and electronics, one day we may see many new devices to replace or supplement body functions that are lost” [140].

The quotes exhibit a framing of bionic devices as positive, as tools of liberations, as tools to solve a problem caused by an ability-wise non-normative body. A framing of bionics that highlights problems caused by the devices or the narrative around the devices is absent. Cost is thematized as a problem external to the device.

3.5. The Issue of Enhancement

Although numerous issues linked to therapeutic and non-therapeutic enhancement applications of bionics is discussed in the literature, this topic was not thematized as problematic in the newspapers if they were mentioned in the first place. The enhancement theme only shows up in regards to soldiers and the military (see above coverage of soldiers, veterans and the military) and in relation to TV shows (Table 6) where the newspaper supplied information of show times instead of reflecting on the social issues of enhancements.

Table 6. Frequency of use of terms related to superpowers.

Codes	<i>Canadian Newsstand Complete</i> <i>n</i> = 4,826	<i>Calgary Herald</i> <i>n</i> = 270	<i>The Globe and Mail</i> <i>n</i> = 392	<i>The New York Times</i> <i>n</i> = 492
Bionic man	373	22	25	39
Bionic woman	1,166	70	142	98
Six million dollar man	357	19	22	19

The most talked about show is *The Bionic Woman* which appears in 33.49% of *The Globe and Mail* articles, and 23.26% of the *Calgary Herald* articles. Interestingly one article from *The Globe and Mail* discussed a child who was no longer considered “the black sheep” because of his physical impairment. Instead, children like him “become the envy” of their peers, because they are like “the *Six-Million-Dollar-Man*” from television [141].

4. Discussion

According to Entman, “frames call attention to some aspects of reality while obscuring other elements, which might lead audiences to have different reactions” [79] and frames in a news text are “really the imprint of power—it registers the identity of actors or interests that competed to dominate the text” [79].

4.1. Framing Potential Users of Bionics and Their Existing Assistive Devices

Our study revealed an overly medical portrayal of individuals with disabilities as patients who need to be fixed (Section 3.3.1). Articles connect wearing of bionics to a longer and healthier life as well as enabling a better quality of life. For example, a quote from *The Globe and Mail* states that, “the development of bionic fingers that can be controlled and moved by patients to act like real fingers is a major step forward, and could significantly improve the quality of life of those struggling with missing digits...” [142]. One article from the *Calgary Herald* discussed a company in Quebec that creates new prosthetic limbs stating that they give “...amputees a better quality of life” [143]. Furthermore, the newspapers leave the reader with the idea that the more bionics mimic the “real thing”, the more normal and valued it is [142]. One article from *The Globe and Mail* discussed a child who was no longer considered “the black sheep” because of his physical impairment. Instead, children like him “become the envy” of their peers, because they are like “the *Six-Million-Dollar-Man*” from television [141].

The framing of disabled people and bionics within a species-typical ability expectation reinforces a form of ability normalization that expects certain species-typical abilities [73,144]; something that many individuals with disabilities, the groups linked to them and disability studies scholars contest [145–155]. It takes the heat of the need to make the physical and social environment accessible [156,157] for people who are ability diverse.

However, the problematic coverage of disabled people does not come as a surprise and is thematized by many [158–169]. Upholding cultural diversity is according to the Canadian Radio-Television and Telecommunications Commission one of the key goals of Canada’s Broadcasting Act [170] whereby “cultural diversity refers to how different groups—like ethno-cultural

minorities, Aboriginal peoples and persons with disabilities—are represented in broadcasting” [170]. “Canadians from all backgrounds, and persons with disabilities, should also be able to recognize themselves in “mainstream” TV and radio programming” [170]. The Canadian Association of Broadcasters published in 2005 a tool how to measure The Presence, Portrayal and Participation of Persons with Disabilities in Television [171]. The Equitable Portrayal Code of the Canadian Association of Broadcasters states, “in an effort to ensure appropriate depictions of all individuals and groups, broadcasters shall refrain from airing unduly negative portrayals of persons with respect to race, national or ethnic origin, color, religion, age, gender, sexual orientation, marital status or physical or mental disability. Negative portrayal can take many different forms, including (but not limited to) stereotyping, stigmatization and victimization, derision of myths, traditions or practices, degrading material, and exploitation” [172]. However, our findings show a lack of implementations of such existing guidance.

Our study also revealed a negative portrayal of existing assistive devices used by disabled people. We posit that in order for a bionic device to be presented positively in the media, the writer does not need to use a medical lens or present a hierarchy in which bionic devices are more valued than say wheelchairs. In the same way that we do not tell people who use a car or a bicycle that they are deficient or that the bicycles is worse than the car why using a medical lens to portray the bionic wearer and why to demonize wheelchairs? An alternative narrative where a bionic device or any assistive device is sold as a tool like a car is also a possibility. There is no reason why one has to define oneself as defective in order to receive a tool.

We argue that it goes against the fundamentals of human security which includes self-identity security meaning that one can assume one is accepted independent of ones set of abilities [173]. Indeed the ability to experience self-identity security is essential in other narratives such as self-esteem of women, self-esteem of elderly people, of being bold, or of being overweight to just name a few [174–179]. Not accepting disabled people for who they are, demonizing certain assistive devices such as wheelchairs as evident in the newspapers and to pit wheelchairs against bionic legs we argue is detrimental for disabled people especially given the reality that certain assistive devices such as high tech bionic legs or exoskeletons are unavailable to the majority of disabled people due to the cost involved.

The burden of normality [180] has also been identified as an issue outside of the disability studies framework. Gilbert’s for example writes about the threat of a successful treatment to a patient’s identity [180] and changes in social networks of a person and other problems can arise with the ‘successful’ body change [181].

4.2. Framing of Bionics

Media are seen to play an important role in influencing both the demand and supply of medical treatments [182]. The framing of the topic of bionic was nearly exclusively positive fitting with the hyping of other health technologies [183–189].

The lack of engagement with potential problems fits with the fact reported by others that Canadian newspapers rarely report on “socio-economic influences frequently cited in the research literature (and reflected in TAHF) as being most influential in shaping population health outcomes” [190] and many other health policy related discourses identifying potential problems [191].

It also fits with the lack of engagement with potential problems that for example the term ethics was only mentioned in $n = 57$ of the $n = 4,826$ articles in the *Canadian Newsstand Complete* that covered bionics. As to *The Globe and Mail*, $n = 3$ articles contained the term ethics, one from 1983 on sport doping, one from 2003 on private health care and one from 2011 on a bionic suit. The *Calgary Herald* had $n = 4$ articles however in none was ethics mentioned in relation to bionics and *The New York Times* had $n = 8$ articles of which two were relevant one covering the area of sport and one mentioning Itskov 2045 Initiative, 2045 being the year by when Itskov believes one can upload content of a human brain into an Avatar [192].

The overly positive reporting on bionics and the lack of thematization of potential problems linked to bionics is all the more problematic given recent developments around the “health consumer”. People look increasingly for health information by themselves [191] and want to shape their own health interventions [193]. There is an increasing desire towards a “quantified self” (where people diagnose themselves) [194–197] and toward patient-driven healthcare and research models [194,198], health social networks, participatory medicine and consumer personalized medicine [199–202]. The more people look for information themselves the more they are susceptible to an overly positive coverage of a technology [203]. The more they want to shape an agenda the more they are in need of good information and the more detrimental are one-sided incomplete informations. Ford calls this educational vulnerability [204].

4.3. The Issue of Enhancement

The aforementioned “black sheep” quote from *The Globe and Mail* highlights an ever increasing truth that therapeutic interventions have the potential to give recipients beyond species-typical, body linked, abilities (therapeutic enhancement [24]). It is reported that given the choice between interventions that lead to species-typical abilities or that lead to beyond species-typical abilities that disabled people would choose beyond species-typical abilities [110]. Disabled people are seen to play a key role in mainstreaming and increasing the acceptance of body enhancements beyond the species-typical for the general public [205].

From a disability studies perspective the enhancement desire poses problems because it puts more emphasis on abilities and decreases acceptance of ability diversity [206] and because it also changes the meaning of health and related concepts, it alters the perceived need for healthcare interventions and increases the pool of people competing for healthcare dollars [24,207].

However, problems identified through a disability studies lens also impact non-disabled people; for example the ability expectation problem will impact the relationship between the enhancement-haves and enhancement have nots.

5. Conclusions

The Canadian Radio-television and Telecommunications Commission “recognized the influence of broadcasting on viewers in its 1986 policy statement: Broadcasting is a powerful medium to reinforce (sex-role) stereotyping and can be equally powerful to correct it” [159]. Many studies highlight the ability-role stereotyping rampant in the media [158,167–169]. Our study adds to the data in relation to

coverage of bionics by revealing ability-role stereotyping such as legism and the negative coverage of wheelchairs.

The study revealed also an overly positive portrayal of bionics with no coverage of possible negative aspects. This one sided narrative generates certain ability expectations influencing one's self-identity and how one is perceived by others and an overly positive bias toward the utility of bionics by disabled and non-disabled people. Given the high cost of bionic solutions and that individuals with disabilities and their families struggle financially and make up an over-proportional part of the poor in high [208–211] and low income countries [209,210,212] bionics will be unavailable to the majority of disabled people. Under Article 4-General Obligations State of the United Nation Convention on the rights of persons with disabilities State Parties are asked: "To undertake or promote research and development of, and to promote the availability and use of new technologies, including information and communications technologies, mobility aids, devices and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost" [213].

From a disability studies perspective the question is whether such one sided coverage of bionics will impact people's perceptions of priorities and goals related to assistive devices? Our study design does not allow us to answer the question, however others reported on the impact of news coverage on treatment demand and product priorities (e.g., [182,185]) which suggest that there might also be an impact of how bionics are covered.

Finally, it is troubling that the bionic coverage did not engage at all with the enhancement aspects of bionics and the consequences of enhancement. From a disability studies perspective this is problematic as enhancement enabling products influence ability expectations in such a way that makes it even more difficult to be accepted with one's non-enhanced abilities, which is an area the reader should be sensitized to. As is the coverage of bionics disempowers the readers as they are not given the knowledge they need to actively be involved in contemporary discourses of bionics and is not increasing the societal well-being of disabled people.

However, the finding is not surprising. It is well known that newspapers are influenced by their environment including ownership, funding, need for circulation, advertisement revenue and the readers preference for reading like-minded news [214–235]. This might account for how a topic like bionics is covered (medical, overly positive) and how disabled people are portrayed (medical, negative). Especially the reader's preference for reading like-minded news [235–237] is very problematic from a disability studies perspective as the main societal sentiment is to look at disabled people through a medical lens and as such it makes sense that many topics such as bionics are not linked to the social reality of disabled people. As Entman stated, "once a term is widely accepted, to use another is to risk that target audiences will perceive the communicator as lacking credibility—or will even fail to understand what the communicator is talking about. Thus, the power of a frame can be as great as that of language itself [79]. Indeed, we posit that a medical and negative portrayal of disabled people is what the reader expects.

If our finding makes sense given the influence, newspapers have to take into account how disabled people are getting their alternative message out. We posit no obvious answer exists to the question so far. One can ignore newspapers but no other 'one source' provides the reader with the knowledge we think they need. We posit despite the internet and social media and despite the increase in open access academic literature no easy solution exists for people to become knowledgeable on the issues

we covered in our study and for that matter on any given issue. Indeed the flood of information available can be very disempowering as no easy way exists for the reader to judge the quality of the information provided and to judge whether all aspect related to a given issue are mentioned. We posit that disability service organizations and disability rights organizations have to be enabled to function more as a collector and disseminator of content on emerging topics that would allow them to educate their memberships. As to newspapers it is needed to find new ways or implement existing ideas (e.g., [187,238–242]) to change reader, advertiser and owner behavior and other factors that lead newspapers to report in such a problematic fashion as reported in this study.

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Author Contributions

Gregor Wolbring generated and supervised the research project. Sonum Panesar did the research. Gregor Wolbring and Sonum Panesar wrote the article.

Conflicts of Interest

The authors declare no conflict of interest.

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