Microchip implants and you
A study of the public perceptions of microchip implants

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Abstract

As technology advances with time, new devices are invented and old ones used in innovative ways. Microchips have been increasingly minimized to the point where they can now fit on a fingernail. When encased in a bio-friendly coating and equipped with the appropriate in- or output technology, new modes of natural digital interaction can be explored. This thesis studies how the general public perceives microchip implants as a digital interaction tool, as well as which features of microchip implants are important to them. Three different scenarios of implanted microchip use were created and used in eight semi-structured interviews. The results showed skepticism towards the technology due to worries about security and privacy, and a lack of knowledge of this technology. Benefits included keeping better track of health and making everyday actions easier, as well as excitement about this new technology.

Keywords: Microchip, implant, biohacking, privacy, health tracking, embodied interaction

1. Introduction

A common feature for the advancement of technology is miniaturization, and with miniaturization comes the interjection of computers in more and more aspects of our lives. The first electronic digital computers took up space equal to a large room, now it can fit in the area of your fingernail (Ullah, 2012). There is no doubt that the technological advancements during the last decade has matched and even surpassed what our forefathers imagined was possible. This has led to new possibilities regarding self-expression and convenience-oriented solutions for those with the skills to take make use of the technology themselves in a DIY fashion. Implant is the term commonly used to describe the devices that supplement or replace a part of a living being (Khan, Muntimadugu, Jaffe, & Domb, 2013). From children's shows like Inspector Gadget to action movies like RoboCop, implants to enhance human abilities have long been a topic of fantasy and desire. The science fiction narratives of the 80’s and 90’s has inspired technology that exists today, and while it may not allow you to pull a helicopter rotor out of your head, it can improve impaired senses ("Cochlear implant", 2017), allow us to sense magnetic fields (Hameed, Harrison, Gasson, & Warwick, 2010), and even save lives (Denning et al., 2010). This ubiquitous presence of technology that is aimed at assisting us in our daily lives, from turning on or off lights with a mobile phone to keeping us alive, has some academics considering whether we are currently living in a post cyborg age where humans and digital devices are evolving side-by-side (Lupton, 2012). While it is clear that we have come a long way in our road of technological discovery, there has always only been a matter of time before we start improving ourselves by placing non-vital technology inside of us rather than making use of it on the outside.

In the last decade we have started this journey with baby steps, and implanted technology is very much still in its infancy. A community of people interested in being on the vanguard of this trip has come to call themselves Grinders ("Grinder (biohacking)", 2017).
Heffernan, Vetere & Chang (2016) conducted a study with 17 participants in an effort to find out what is being implanted, and why. The types of implants ranged from magnets to microchips to entire battery-powered devices, with an even broader range of reasons for insertion. While there now may be an understanding of why the select few at the forefront have decided to experiment with their bodies and these novel technologies, as time passes even further it is fair to expect these hobbyist implanters to become experts - creating a new market for a larger audience (Heffernan et al., 2016). Because of this Heffernan et al. (2016) also points out that future research should look into the public perception of micro implants. By analyzing the doubts, hopes, beliefs, and values of micro implants - important factors for use and development can be identified, which lets the developers know how to tackle the issues that may crop up in the user group. As interaction designers and researchers this is a budding field that without a doubt will come to require our attention and expertise in the future.

1.1 Validation of study

This study is important to the field of HCI as it will give a glimpse of the public perceptions that will certainly be of import for the design and research of future microchip implant interactions, now that it has been identified as an input/output device option. In order to narrow down an otherwise broad field that is to be studied in a short amount of time, this thesis focuses on alternative digital interface interactions with microchip implants; specifically public perception. Since the subject of microchip implants are still on the rise, people generally either know a lot about them (profession experts or microchip implantees) or not at all (general public). The general public is chosen as the group of which I aim to study as they are less likely to have preconceived positive or negative attitudes towards microchips than what the experts have.

Research questions:
Regarding the use of microchip implants as digital interaction tools:
   1. What concerns and benefits do members of the general public identify?
   2. Which features of microchip implants are important to members of the general public?

2. Related research

The vast majority of research into the field of technological implants is focused on the medical aspects of implants. This is due to the long history of implants being first used for medical reasons. It is only in the last decade or so that there has been a noticeable increase in the hobbyist implant movement. As such the related research section covers some fringe areas of implants, for example medical implants and the use of one’s skin as an interface, before tackling the hobbyist section of implantable devices.

2.1 Skin-adjacent interfaces

As the miniaturization of technological devices continues, new challenges for interaction arise when they are integrated as wearables or insertables. The devices themselves often
suffer little from miniaturization, while the greater challenge lies in user input options. Traditional user interaction interfaces are limited by human factors, such as being able to see small screens or type on small keyboards. The ability to use a very small keyboard may vary slightly between one user and another, but there is eventually a hard limit on how small a user interface can become and still have a high usability among the general public. As such, the alternative is to instead design a novel way of interacting with a device that also works

Figure 1: The skininput prototype by Harrison, Tan & Morris (2010)

with the miniaturized device. Ni & Baudisch (2009) created a prototype of a gesture based interaction system that would be used with a wearable or implantable device. In their study they identified the most suitable input technologies as gesture and touch, based on the diversity of available input options even when minimized. They also concluded that a gesture based interaction device could sufficiently allow for system navigation in a number of directions or allow for text input in the form of single-gesture letters. Using the skin as an interface for interaction makes sense, given that we own around 2 square meters of it. Harrison, Tan & Morris (2010) created a prototype (see figure 1) that uses sensors on a wearable device to register the sound waves that are created when the user taps their fingers on the arm that is carrying the wearable. They found that the system identified the correct area tapped on between 81.5% and 95.5% of the experiments depending on placement of the prototype, a promising result for skin-to-device based interaction. The system could even detect some difference in what material the sensor equipped arm tapped on with about an 87.1% accuracy. During a trial in which the participants walked on a treadmill the accuracy remained high at 86.7% and 100% for the females and males respectively. Harrison et al. (2010) also created three proof-of-concept interfaces that make use of their prototype in
conjunction with a pico-projector attached to the upper arm. These interfaces allowed the user to navigate a projected menu or use a projected keypad to call a phone number.

A similar technology is a class of devices called Skintillates, created by Lo, Lee, Wong, Bui & Paulos (2016). This technology is a wearable interactive device that is attached to the skin much like the decal-style temporary tattoos often used among children. Skintillates can be active or passive on-skin displays, and can contain capacitive and resistive sensors. These sensors would allow the user to control electronic devices or remind the user about keeping their posture straight when they sit un-ergonomically. The devices are very thin, with an average thickness of 36μm. Skintillates with miniature LEDs increase the thickness in the areas where the LEDs are placed to 500μm. If applied to skin in combination with a Bluetooth module, the wearer can control applications on a mobile device or even use the tattoo as an interface for playing simple games.

2.2 Medical implants

The devices used for recording and transmitting personal medical data are commonly used by medical professionals in hospitals, using wired devices. The first pacemaker implant was implanted in a Swedish man as early as in 1958 (van Hemel & van der Wall, 2008); however experiments with external pacemakers go back as far as 19th century Britain (McWilliam, 1889). With the advancement of technology comes the miniaturization of physical parts, increased measurement accuracy, faster wireless communication technology, and greater processing power (Andreu-Perez, Leff, Ip, & Yang, 2015; Heffernan, Vetere, & Chang, 2016). These technological advancements have resulted in medical devices that can be created small enough to be implanted into the human body and communicate wirelessly up to a range of 5 meters (Denning et al., 2010). Medical devices that are implanted in this way are called implanted medical devices or IMDs for short. Examples of IMDs that make a vital difference in the health, safety, and quality of life for its users are implanted defibrillators that keep the cardiac rhythm controlled; and implantable brain neurostimulators that is sometimes used in patients with Parkinson's disease to combat the tremors associated with it when medication for the disease eventually stops working (Andreu-Perez et al., 2015).

There are also IMDs that aid sensory input, for example the cochlear implants that can be a significant help for someone who has experienced a severe loss of hearing. While these implants may not be of the same life-or-death caliber as a pacemaker, they are important additions that bring major benefits for the user’s mental health quality of life (Contrera et al., 2016). IMDs are not without flaws however. Due to the wireless nature of IMDs such as pacemakers they can be susceptible to remote attacks that could endanger not only the patients personal information, but also the health and safety of the patient by intercepting data and reprogramming the device (Halperin et al., 2008).

2.3 Biohacking

There are a massive number of devices with sensors that track and record different aspects of your life, with the goal of aggregating the data for the user to peruse. The website Quantified Self contains a list of almost 600 tools in several different fields, with the majority of them being free to use ("Quantified Self Guide", 2017). The field of quantified self and its users
even has meetups and conferences to share their knowledge among the community (Lupton, 2014). There are, of course, drawbacks to measuring multiple bodily functions with different devices. It has been pointed out that some devices are occasionally cumbersome, can interfere with everyday tasks, and even make the users even more aware of their bodily limitations - all of which can cause frustrations (Buse, 2010; Freund, 2004; Lupton, 2012; Ruckenstein, 2014). Some of these frustrations can be alleviated through the miniaturization of technology; as in the case with the Zio patch (see figure 2) study (Barrett et al., 2014). This smaller wearable patch could stay on for weeks, more successfully detecting arrhythmias than the standard Holter monitor - a device which is far more unwieldy and difficult to use, and is thus typically only used for 24 hours. Natural user interfaces (NUI) is another field which shows promising relevance to the studies in quantified self (Nair, 2016). By transferring some of the functionality from the devices themselves onto in-home surfaces, keeping track of your health becomes an easy to use everyday task, rather than keeping track of multiple devices individually.

![Zio patch](image)

*Figure 2: Zio patch (Barrett et al., 2014)*

Other types of technological tools consist of much simpler features, such as magnetic implants. These magnetic implants are more cumbersome to implant than microchips, requiring incisions and stitches, and may be rejected by the body regardless of how well it heals up. After implantation and acceptance by the body they require little to no maintenance however. There have also been prototypes created that make use of these kinds of implanted magnets. Hameed, Harrison, Gasson, & Warwick (2010) created such a prototype (see figure 3) and experimented with the possibility of using an ultrasonic rangefinder with a coil that created magnetic fields around the finger with the magnetic implant. This device would record information about distance to objects, translate this information into electrical signals that would run through the coil, creating magnetic fields of varying frequency. The implanted magnets would then vibrate in accordance with the frequencies, and with some practice the user could feel the distance to objects through the vibrations in their fingers. Hameed et al. (2010) also experimented with translating text into vibrations with the varying frequencies representing letters in Morse code. The result was a practical and intuitive way of reading text, with the drawback of information being slow to process due to the subjects being unfamiliar with Morse code.
In addition to magnets, the more common implants are RFID/NFC microchips, but also entire custom made devices with its own power source can be implanted (Heffernan et al., 2016). Heffernan et al. (2016) summarized the use of these implants as:

- Supporting human connections
- Extending sensorial input
- Alternative digital interface (interact with digital artifacts, access and authentication inputs, storage and sharing of information)
- Capture biometric data in the form of body temperature

Supporting human connections were done by implanting magnets in one fingertip and between two knuckles on one hand, with your partner mirroring these implants on their hand so that when you hold hands there is a measure of interlocking between the two people. Extending sensorial input is related to the use of magnets in the section above, using them to navigate with ultrasound in addition to simply being able to feel magnetic fields created by other magnets or live cables or machinery through an ultrasonic sensor. The microchips implanted in this study were used for a number of different things, with many of the respondents in their study having multiple microchips. Some used them to unlock the front door of their home, or paying at coffee shops that provided the necessary terminal for wireless payment. Others used it to open specific pre-programmed web pages that they wanted quick access to, or had implanted a microchip able to record biometric data in the form of body temperature. The custom made device that one respondent had implanted measured temperature, but unlike the microchip alone that had no memory to store data the device carried a battery that allowed it to capture data every five seconds - which it then sent to a smartphone for storage. These hobbyist implanters as Heffernan et al. (2016) calls them, is predicted to play a vital role in increasing the interest and viability of future microimplants that will be available to a greater section of the public. As such it is of equally great importance for HCI researchers and practitioners to realise the potential of this technology and start working towards a future where it is no longer science fiction to control your surroundings with “only” your hands.
3. Method

This section details the methodological considerations that were made during the process of writing this thesis, such as choosing method for data collection and how said data collection was performed. Also discussed is the sample of respondents and what considerations were made when working with the data collected, in addition to how all of these choices affect the thesis. Finally, a brief section covers the ethical considerations that were made.

3.1 Data collection

Since the research question is specifically aimed towards understanding the public perception of microchip implants, the choice of method should reflect the need to accurately collect the individual attitudes of the respondents. While quantitative methods such as surveys are able to collect such data, I found it important to be able to ask follow-up questions to what the respondents answer to questions. Asking follow up questions allows for a deeper understanding of the reasoning (Patton, 2002) of the respondents and opens up for discussion about topics that are of relevance but not identified beforehand. As such, the method used for data collection was semi-structured interviews.

3.2 Interviews and sampling of respondents

Before the interviewing process started three scenarios and an interview guide (see appendix 1) were created. This was done in order to make sure that all of the important topics related to the research area were discussed. Eight semi-structured interviews were conducted. Six of the respondents were interviewed face-to-face, while two were interviewed over the phone and via Skype respectively. Seven out of the eight respondents were Swedish, so the scenarios used in the interviews were translated to English for the English speaking respondent. All of the respondents reported that they had little to no knowledge about microchip implants, and as such they were identified as non-experts and belonged to the general public. The interviews lasted between 20 to 35 minutes each, and they were recorded with the permission of the respondents in order to facilitate the transcription and subsequent data analysis. The respondents were selected by convenience sampling, and were selected by contacting friends and acquaintances of the author either via online social media or asking them face to face. There were three men and five women aged 22-37, with a median age of 26. For further details, see table 1.

<table>
<thead>
<tr>
<th>Respondent overview</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent 1 - Man</td>
<td>26</td>
</tr>
<tr>
<td>Respondent 2 - Woman</td>
<td>24</td>
</tr>
<tr>
<td>Respondent 3 - Woman</td>
<td>22</td>
</tr>
<tr>
<td>Respondent 4 - Man</td>
<td>29</td>
</tr>
<tr>
<td>Respondent 5 - Man</td>
<td>31</td>
</tr>
<tr>
<td>Respondent 6 - Woman</td>
<td>23</td>
</tr>
<tr>
<td>Respondent 7 - Woman</td>
<td>26</td>
</tr>
<tr>
<td>Respondent 8 - Woman</td>
<td>37</td>
</tr>
</tbody>
</table>

*Table 1: Respondents in the study*
3.3.1 Scenarios
The scenarios created centered on existing use cases that Heffernan, Vetere & Chang (2016) identified in their study of hobbyist implantees. The narrative in two of the scenarios are characterized as second person narrative, while the third scenario can be characterized as third person narrative. They were initially written in Swedish as most of the respondents were Swedish; however the scenarios had to be translated to English when an interview with a non-Swede was booked. Scenario 1 gives examples of how microchips can be used for access and authentication, scenario 2 details the use of microchips for sharing and storing of information, and scenario 3 describes how microchips can be used to record body temperature. These scenarios can be found in table 2.

Scenario 1 You are visiting a good friend you have not seen in a while. When you are on your way home you decide to shop for cooking supplies. Once at the cash register, you notice that your friend put his hand to the card reader instead of inserting his credit card. When both of you have paid for your items, your friend explains that there is a microchip in her hand that can be used instead of a debit card in stores that have a wireless card reader. When you arrive at your friend’s apartment she unlocks the door by placing her hand on the door handle. The door handle seems to also have a microchip reader to lock or unlock the door.

Scenario 2 You are listening to a presentation about a company and the lecturer explains what job vacancies they have currently. One of the jobs seem particularly interesting so you go up and introduce yourself and ask some questions. The lecturer encourages you to apply for the job, and opens the Web page for the application on your phone by putting his left hand to the back of the phone. When you ask for the contact details of the person responsible for hiring, the lecturer places their right hand to the back of the phone and a new contact that belongs to the recruiter shows up on the phone.

Scenario 3 A friend of yours has started to keep track of various aspects of their lives, including their body temperature. They want to keep track of their health, metabolism, and menstrual cycle. Since they will begin to travel a lot as a part of their new job, and it also means uncomfortable work times, they chose to plant a microchip in their hand that can read body temperature and transfer the data to their mobile phone. There, the data is stored in an app that can display graphs and statistics of temperature over time. That way they can learn more about their body, including where their body is in the circadian rhythm, when they are ovulating, and if their eating habits causes problems with their metabolism.

Table 2: The three scenarios used in the English interviews

3.3 Data analysis
The data gathered from the interviews were transcribed which resulted in a total of 25 pages of text. Due to the large amount of qualitative data, a thematic analysis method was chosen in order to condense the data and enabling the identification of recurring ideas and attitudes (Bryman, 2012). Analysis of the data began by reading through the transcriptions several
times in order to familiarize myself with the data. The data was then condensed to their essences, which was later colour coded and organized into themes based on the patterns that could be discerned among the condensed data. Table 3 show some examples of what my data analysis looked like.

<table>
<thead>
<tr>
<th>Excerpt from transcription</th>
<th>Condensation and colour code</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respondent 2</strong></td>
<td><em>And maybe it’s also sensitive to hacking?</em></td>
<td>worried about security</td>
</tr>
<tr>
<td><strong>Respondent 8</strong></td>
<td><em>The only thing I was thinking of was scenario nr 3, the woman who was gonna travel a lot for work and was gonna keep track on her health, that would be the most safe thing to use a chip for.</em></td>
<td>Scenario 3 most safe, has nothing to do with money</td>
</tr>
<tr>
<td><strong>Respondent 7</strong></td>
<td><em>This (scenario 3) is a scenario I can more easily see the benefits in. It’s not just simple to be simple. I think it’s great; it makes everything about health easier.</em></td>
<td>Prefers S3, good for health</td>
</tr>
</tbody>
</table>

*Table 3: Thematic analysis process*

### 3.4 Method criticism

As with most qualitative methods that involve interpretation, the data analysis being biased or misinterpreted can always be questioned. By giving examples of the data analysis process above I hope to shine a light on and refute any concerns about biased analysis. Another factor to consider is the limited sample size. While eight respondents is a decent amount of respondents for a thesis of this size, it only tells the story of a small number of people’s perception of microchip implants. As such, the thesis should be read with this in mind. Additionally, since the participants are relatively homogenous and of roughly the same age it is possible that this could result in a more limited range of responses than what could be found with a broader variety of respondents. Finally, it is possible that the scenarios used in the interviews have influenced the respondents into restricting responses only to the themes of the scenarios. While some respondents clearly brought up ideas that were not similar to the use cases in the scenarios, it is still a consideration to keep in mind as it could have had an effect on the other respondents.

### 3.5 Ethical considerations

The interviews were conducted in accordance with the public agency of Vetenskapsrådet, meaning that all of the respondents were properly informed that they would be anonymous in the thesis, they had the right to cancel the interview at any point without consequences, they were informed about what the thesis aimed to study, how long the interviews were estimated to take, how and what their contribution to the thesis would be, and finally that the
information they share would only be used for this thesis. Additionally, they all approved of having the interviews recorded.

4. Result/Analysis

The results of the data collection were analysed by condensing and coding the data, and later arranging these into themes based on patterns that recurred. These are the themes that were prominent in the data; Safety and Privacy, Health, Natural progression in technology and Not wanting to be first, The unknown, and Use of microchips. As such, each of these themes will be presented below. For the purpose of clarification, I use the terms microchip, microchip implants and microimplants interchangeably without any differing definition. All quotes made by Swedish respondents have been translated to English by me, and as such they are subjected to a certain amount of linguistic interpretation in their translation. This has always, of course, been aimed at staying as close as possible to their original meaning.

4.1 Natural progression in technology & Not wanting to be first

Most of the respondents noted that microchip implants felt like a futuristic technology, something straight out of a science fiction movie. The progression from debit card to microchip for payment was compared to a similar change during the last two decades, from paying mainly with cash to paying with a debit card. While this technology was considered futuristic in the scenarios, two of the respondents specifically mentioned that they would like to see the functionality of the microchips increased. One of those respondents gave the example of including storage capabilities compared to a USB memory stick, arguing that more and more data capabilities can be fitted into smaller units as time has progressed. Another respondent argued that it probably would take some time for many stores to adopt the technology that would allow paying with a microchip payment system, and that this would be a factor to consider for adopting that kind of technology for him personally.

*It always takes some time before these kinds of systems are up and running properly and everything has access to it. So I don't know, depending on how many functions I can use it with it might take a while before I would adopt it.* - Respondent 5

The reluctance to be one of the first people to adopt a microimplant was common among all of the respondents, with most of them stating that they want to see how the technology plays out, not wanting to deal with consequences and implications that are yet unknown. The majority of the respondents specifically expressed skepticism towards microimplants, and while they identified many positive aspects there was also an implied - and sometimes explicit – reluctance due to the potential negative aspects. This was especially important with regards to the potential weaknesses a new technology such as this can contain.

*But then you would have to weigh out the good and the bad, and I think right now, the good doesn't outweigh the bad. Because it's something so new, and I*
think a lot of people are still scared of it, and because it’s so new I think a lot of people can take advantage of it. - Respondent 2

Another key aspect for waiting to get an implant that all of the respondents mentioned was the importance of feeling that the procedure itself of implanting a chip had to be safe, with one respondent particularly mentioning that he wouldn’t want any permanent traces of having a chip - scarring for example - should he decide to have it removed.

4.2 The unknown

When asked how much they knew about microchip implants, six out of the eight respondents described that they had very little or basic knowledge, the remaining two describing that they had some knowledge. This was reflected in the vast majority of the interviews, with most of the respondents describing outright that they didn’t know what the possibilities and consequences of this technology brought with it. One respondent in particular pointed out that technology in general is very finicky and has a tendency to break down, which they then applied to the microchip implant technology.

I mean I see the problems with, say, how people react when their phone doesn’t work the way it’s supposed to. Or when their debit card doesn’t work. No matter how smooth something is - the second something is wrong, everything is screwed - because it’s connected to the microchip. - Respondent 7

The same respondent continued to explain her skepticism to microimplants from this perspective, saying that she is a worrying kind of person and would probably worry about what would happen if the microchip didn’t work if it was used as a replacement for a debit card and/or a key for her home. This was a sentiment that was shared with three other respondents as well, where they all questioned if the microchip could break and if so, how easily does it break. Similarly, a few respondents questioned if and how this would interfere with other technologies, for example if you had a microchip for payment and wanted to use a different method of payment. If the microchip is set to pay when close to a terminal, reaching forward with a debit card in that hand could cause interference in that the microchip is chosen as a payment method before registering the debit card. Other similar questions was related to how the user decides what information goes into the chip and how to change it. A lot of these doubts and hesitations were attributed to the fact that this technology wasn’t very wide spread currently, with three participants explicitly stating that it was a bit scary or made them uncomfortable even after reminding themselves that implanted technology such as pacemakers and cochlear implants have been worked on and implanted for a long while now.

Logically I can say that “of course, we're already doing this”. We're already doing surgical interventions in our bodies, implanting things simply to make things better. So to me, if I'm gonna try to explain it, I think I feel like this because it's not something that is a thing currently. It hasn't established itself in my mind as something you actually do. It's just too new. - Respondent 6
Despite this, five of the respondents said that they saw a lot of potential with the microchips, especially for uses related to the third scenario, one of the reasons being that there was less risk of a critical failure that would have a significant negative impact since the microchip in the third scenario only handled body temperature readings.

4.3 Safety & Privacy

There was a clear discrepancy in opinion on whether the microchip would be safer to use or not. While many argued that it would be safer to have a chip in the way that it would be harder to have debit cards and keys physically stolen or accidentally losing or forgetting them, all of the respondents also expressed worry about the potential of having your information hacked in some way. Additionally, although the microchips in the scenarios were not described as having a GPS or tracking function, some of the respondents worried about the risk of being tracked or monitored. Interestingly, when asked about what other functionalities they could consider to be useful in a microchip, two of the respondents mentioned that it would be useful to have a sort of GPS tracker in it to find people who have gone missing, either for a long time or just when on a night out with friends. However, both of them also acknowledged that this was a questionable use from an ethical standpoint.

Yeah I had a thought, but then the ethical part of me kicked in and said “this won’t work”. I was thinking “oh you can track people with this!”, but then “that might not be the best use though”. That might be a downside with having the chip, you become easy to track. - Respondent 6

Three of the respondents mentioned that they felt like they would lose some sense of control by implanting a chip. Because they didn’t know exactly how this technology would work out when it became more mainstream, two of the respondents specifically mentioned that there is a lot of responsibility on the ones that provide the services and microchips, and meant that this would move control from them to the providers. One of the two respondents also stated that they’d like to remain in control of the data on the chip and what it can track before he would consider getting one.

Yes if I could control what functions, specifically what this microchip will keep track of. And if it was possible to update security codes and stuff, like a computer system that I can keep track of a bit more. But I don’t know how comfortable I would be if I handed over that part to someone else. I want full control so to speak, over what this chip tracks. - Respondent 5

Again, many of these worries hailed from the uncertainty and lack of knowledge about what microchips could and could not do, and who had access to it. Seven out of the eight respondents questioned safety or privacy at some point during the interviews, and all respondents had questions and doubts about the microchip and its potential. The only respondent out of those seven that didn’t think it would be a major issue argued by the fact
that hackers exist everywhere there is technology, and that the risk would probably be similarly low for the everyday user as the risk of getting your debit card skimmed at an ATM.

### 4.4 Health

Six of the eight respondents were very positive to the use of microchip in the third scenario; the other two didn’t specify either good or bad things about it. The overall feeling about collecting health statistics was that it felt like a much safer use compared to having the microchip store what some respondents called crucial information, arguing that if the microchip were to stop working it wouldn’t lock them out of their house or place the user in an awkward position of not being able to pay at a store.

> Yeah, it’s supporting, not crucial. It’s not something I need, it’s something that supports. So in a worst case scenario what would happen if it didn’t work is “oh well, I can’t check my body temperature” or “I don’t know what my blood pressure is right now”. I don’t know how to explain it better than this being more supportive than being a crucial technology. - Respondent 7

Another point that was brought up was the ability to make it easier to keep track of your health by implementing several different sensors to track different aspects such as heart rhythm, temperature, etc. Combined with regular logging of these statistics, it could prove a great benefit in assisting health professionals with diagnosing and treatment. Another perk of this was brought up by one of the respondents who mentioned that it would give the user a sort of certificate that something was wrong that might otherwise be dismissed as an imagined issue by doctors. The issue that was used as an example was PMS in women, since this has been a heavily discussed issue in the last couple of years.

> I hear from a lot of people, both from people close to me but also in articles or people who’ve written posts, that there are so few that believe you when you tell them that it makes a difference - and that nowadays you need to show proof that there is something wrong before you can get help. - Respondent 3

Another respondent also argued that being able to see patterns in your bodily responses would be a very practical way of being able to self-assess your health, making it easier to notice when you need to, for example, correct bad habits. In contrast, another respondent had previously been very ill for a period of time and still attended regular check-ups, and simply didn’t want too much detailed information about their health. This respondent meant that knowing too much about the actual health values would cause them to worry and stress out about it - which could affect their health negatively - even when they otherwise felt fine. However, they weren’t opposed to the idea of tracking values such as pulse or sleep patterns, values that wouldn’t necessarily cause them to personally stress or worry about. Another respondent mentioned that this type of microchip would make it easier to keep track of your health for both the kind of people that regularly visit the gym, and the people who don’t have a gym membership. Similarly, respondent 5 argued that he didn’t really use health apps on
his smartphone if it meant he had to insert information manually. If the app tracked data and inserted it automatically, however, it made it a lot smoother to use. For many of the respondents it was very important that the implantation process itself also didn’t cause any health issues.

As long as it’s risk free I guess I wouldn’t have a reason to say no to getting one. And by that I don’t mean pain free but risk free, so you don’t have to replace the chip very often and have to go in for check-ups. Basically that it works without hassle, or other things like it doesn’t start itching or exhibiting other small complications. - Respondent 1

Another respondent experienced apprehension in regards to the perceived insertion methods, stating that the imagined feeling of a microchip underneath the skin and the needle used for insertion made her skin crawl. Other respondents also described some hesitance towards the insertion of microchips, where some understood it as an operation with incisions and stitches. Once it was explained that they could easily be inserted using a needle similar to the insertion of birth control implants, they exhibited a more relaxed view on the procedure. Overall the respondents expressed far fewer concerns and a generally more relaxed attitude towards a health- and biometric oriented microchip implant, than towards the microchip uses in the other two scenarios.

4.5 Envisaged use of microchips

When asked what they would use a microchip for if they ever got one, three respondents wanted some sort of medical or health tracking system, a more advanced version of the one presented in scenario three. This was either because it felt like the safest use case or because the other scenarios didn’t feel useful to them. One respondent would have preferred a microchip as a digital business card because it would make him stand out among others who use physical business cards. Another respondent wanted to use a microchip as an authenticator for increased security compared to passwords, since the microchip would be personal enough to replace passwords. Additionally he could imagine using it for tracking certain aspects of his health. One respondent specified that she wanted to use it for transactions and possibly as an access node for entry into the school, mainly because that’s where she saw the greatest benefit of having a microchip compared to the uses in the other scenarios. A fifth respondent didn’t want a microchip at all, claiming that there was too many risks and unknown factors which only made her see the downsides of it. The last respondent only wanted a microchip that could perform multiple different actions, as he saw little use in being able to only pay with it or only getting temperature readings from it.

I’d never get a chip that only does one of those things. I want a chip that works for most things. I’d like to have statistics about my body, measure my body temperature. I wouldn’t imagine that they are gonna add those kinds of sensors for my apartment so I can lock my door with it, they’re not gonna change the locks because I get a chip in my hand, so that feels unnecessary. I wouldn’t need
to bring my wallet, sure, but I still need to bring my ID if I’m buying alcohol, so that won’t make much of a difference. - Respondent 1

Respondent three also touched upon this, briefly mentioning that some of the uses in the scenarios are better than others depending on who the people using them are and what they are used for. Some of the respondents also commented on the fact that having multiple microchips felt excessive and undesirable. One microchip should be enough; otherwise it wouldn’t be worth it. When asked if the respondents could identify new uses for microchips that they’d like to see, a lot of ideas were generated, some of which may have been briefly mentioned in an earlier theme.

4.5.1 Identification
The idea of using microchip implants for identification was brought up by two respondents, with slightly differing purposes. Using microchips as an ID could be used to identify people where you might not be able to otherwise, such as for accidents.

For identification issues, like “we’ve found someone who’s drowned but they’ve been so long in the water that we don’t know who it is” or similarly. – Respondent 7

Alternatively, it would make a big difference in solving crimes if there was a way to, for example, register who enters and robs a shop. The latter case was quickly second guessed and argued against by the same respondent, due to the issues with ethics and personal integrity this use case would provide. The other of the two respondents came up with a similar idea of using it as an ID to pull up medical information quicker when you’re at a hospital.

4.5.2 Medical
Four respondents had ideas of how a microchip implant could assist with medical aspects. As mentioned earlier, if the microchip tracked multiple things it could provide the user with some proof that they aren’t making up an illness, that there are actually things happening inside of their body that influences them. One of the other three respondents also noted that they would like a lot more information about the biological changes in their body, for example caloric intake, and sleep habits. The last two respondents had very similar ideas. Both imagined a scenario where the microchip keeps track of a number of biological markers and if they deviate too much from the standard it would send a signal to their phone to call for help.

I’ve been out hiking a lot when I was younger, a lot of it in the forest and a lot of it on my own. My parents would always worry about me being out so much on my own and worry that something would happen and I’d be unresponsive so I couldn’t call an ambulance. If you had a microchip that kept track of your temperature if you become hypothermic, and it kept track of heart rhythm - which shouldn’t be too hard to keep track of for a microchip - it could
automatically make contact with my phone and call an ambulance. - Respondent 4

This falls in line with what was previously mentioned regarding the desire for microchips to contain more than one function.

4.5.3 Tracking
A subject that was controversial among one of the two respondents that came up with this use case was the ability for a microchip to send the user’s location to someone else. While one user came up with this idea and instantly argued that while it could be very useful, it was also highly unethical and potentially dangerous if someone were to abuse it. The other respondent acknowledged that others would probably find it too close to surveillance, but argued that he had nothing to hide and that no one would find the details of his life interesting enough to be of any issue to him. Instead he explained that to him, the greater advantage in fighting crimes with the use of a technology like this would outweigh the potential surveillance, he just didn’t consider it an issue for him whatsoever.

It would be nice to have a tracker so that if you were to disappear people can track you, like www.find[respondents name].com. That would be great. It could be used in a bad way too, but so can everything, so I don’t mind. More tracking for everyone. You could send this information to the municipality or to the police too if you’ve got a tracker in everyone. That way they could get information about who was at what place at which point in time and solve all crimes. – Respondent 1

It is worth mentioning that although two out of eight respondents brought up tracking as a feature they would suggest for potential use, it was still considered a security- and personal integrity issue by the other respondents who briefly touched upon the subject.

4.5.4 Miscellaneous
The remaining ideas were more convenience-oriented solutions. All three ideas were spawned by different respondents. One respondent wanted a good solution to his tendency to turn off the alarm without getting up from bed in the morning, which meant that he sometimes overslept.

Sometimes I have a hard time waking up in the morning, so I imagine that you would have to do something with the alarm and the chip in your hand to turn it off. Something simple like that, cause I have this ability to always reach my phone and turn it off and go back to sleep. But if you really have to go to the kitchen and place your hand on something, that could be useful. – Respondent 5

A second idea was to give the microchip some sort of feedback potential to remind the user of an item in your schedule that was coming up. The third idea was acknowledged to be a lot more advanced than what current technology could achieve, which was to incorporate a
mobile phone into the body in some way. This idea was simultaneously questioned by the respondent who came up with it, due to the fact that the lack of a screen would make interaction difficult and a lot less versatile.

5. Discussion

As the results show, the perceptions of microchip implants and the potential uses for them are very broad. Where some respondents saw little value in tracking biometrics, others found that use case to be the most interesting and relevant one. This is hardly surprising when considering how different the lives and use of technology can be across generations, or even within a group of friends. What is interesting to take note of is that every single respondent mentioned that the health and safety of the implanting procedure was important. It is understandable that there is inherent apprehension to the process of inserting a foreign object subdermally when there is no real medical need for it. Some of these feelings could have been due to the limited knowledge that the respondents had about the implantation process, as many of the respondents imagined that it was a more invasive surgery than it necessarily needs to be. With this said, the few venues that do perform microimplants are often cited as charging too much money from the hobbyist Grinders as reported by Heffernan et al. (2016). Instead they opt to either ask knowledgeable people in their community that have experience inserting, insert themselves through DIY tutorials, or go through the insertion process at Biohacking or Grinder conventions. Even with the best of intentions the risks for infection, bodily rejection of implant, excessive scarring, et cetera, is increased if not made by medically educated professionals in a suitably sterile environment. I would argue that this is due to the fact that, as one of the respondents said, this just isn’t a thing yet. Once technology improves and more people acquire microimplants, a market will be established where new standards will be set, causing prices to decline as a consequence.

As for the security issues brought up by the respondents, it is not possible for a microchip to actively track your location unless it has the technology for it built into it and is connected with an outside device that can transmit this data further. I argue that the frequency of this concern mentioned among the respondents is partly due to tracking and surveillance being a consequence of microchip implants in science-fiction media, and partly due to lack of knowledge about what this type of technology can and cannot do. This is even somewhat confirmed by many of the respondents themselves, describing a feeling of skepticism to a technology they know little of. That’s not to say that microchips are impervious to harmful outside manipulation - in fact even pacemakers are susceptible to remote attacks from up to five meters away (Halperin et al., 2008). So far, the tools needed to do this are expensive, but it is clear that wireless security will be a topic for future research.

The use cases that the respondents suggested - Identification, Medical, Tracking, and the miscellaneous use cases - are all examples of how diverse a relatively similar group of people can be. In my experience working with the data, the most overall favorable use of a microchip was the ones that were related to biometrics and tracking health. This isn’t completely surprising when you consider the recent rise in popularity of devices and products aimed at tracking different aspects of your life, such as the Fitbit, sleep trackers, and even DNA tests to
analyze your genetic composition and history. Uses for microchips that included identification and tracking were a lot more controversial, no doubt due to the perceived risk to their personal integrity, not to mention the historical connotations that “permanently” placing an identifying marker on yourself has. In addition to this, media does a good job of vilifying these two themes. I suppose a thriller movie would be over in the first 10 minutes if the antagonist could be found and apprehended if everyone in that society had microchip implants with trackers. The remaining novel use cases were aimed at simplifying everyday lives further by taking everyday interactions and integrating the interactions with them into the chip in some way, such as adding phone-like aspects to implants. Prototypes that in some way have begun its work towards alternative, smaller, interaction interfaces can be seen in the projector and arm-tapping interface by Harrison et al. (2010); the magnets implanted in the tragi to be able to hear sounds from human-made magnetic vibrations (Heffernan et al., 2016); and the gesture based subdermal interface device by Ni & Baudisch (2009). If we consider a future where microchip implants are commonplace, they would both be highly personal and require some individual knowledge on how to use and reprogram them; or they would be very general, this-model-fits-you, types of microchips. The more beneficial of the two above scenarios would depend on the user, but generally the first one would allow for greater personal control, something that a few respondents imagined they would lose.

Despite the concerns that the respondents expressed, all of them agreed that this seemed like a natural progression in technology. Even so, they did not want to be among the first ones to adopt it. In addition to what has already been discussed, I strongly feel that a core reason for this is the misinformation and lack of knowledge that surrounds this field. If people know what microchips and micro implants could and could not do, they would have the ability to perform a more accurate risk analysis instead of trusting the gut feeling influenced by a decade old movie collection. Currently this is a field of research that is heavily driven by private individuals with a passion in technology and interaction. It is our responsibility as professionals to allocate resources to perform safe, ethical, and honest research. It is my hope to read more scientific reports about this subject in the future.

5.1 Limitations
Because of the limited number of respondents, generalization of the data is not possible in this study. Since there is often a great variance in opinion and attitude among any group of people, this subject would require a much larger sample size of respondents in order to make a definite conclusion regarding generalization. Considering the very basic and straightforward description of the scenarios, there is also a risk for prejudiced responses due to lack of knowledge. This is something that could have been combated by taking a more educational approach to the interviews by adding a demonstration of the microchips in action - or include a more descriptive introduction of the microchip implant process and its abilities before handing out the scenarios. In essence, these are limitations that would have been diminished or non-existent in a study with a wider timeframe.
6. Conclusion

This study aimed to find out what concerns and benefits members of the general public identify with regard to the use of microchip implants as digital interaction tools, and which features of these are important to them. Many of the benefits involved keeping track of health by measuring biometrics, while there also were concerns about health related consequences from the implanting procedure itself. In general, microchip implants for transactions was understood as being safer than using a debit card, since it was pointless to rob someone that didn’t carry cash or cards. On the other hand, there was a clear concern about being hacked or in other ways have their information stolen digitally. Another major issue was the lack of knowledge about this technology, something that had resulted in misinformation and skepticism for the technology. With this said, the most important features would end up being safety aspects, both in terms of technical and health related safety. As microchip implants become less niche and more widespread, more work needs to focus on exploring these safety aspects.

It is clear that there is a large knowledge gap among the general public on this topic that is also considered to be a natural progression of current technology. This knowledge gap is something that can change as time passes and more people implant themselves, however, it may be a slow process that HCI researchers and practitioners can assist with by using their skills to educate and further study this field. More importantly, the fact that people are implanting themselves “as a hobby” shows us that research and development in this area are not evolving in a safe way. In the end this is something that could potentially harm microchip implants as a technology, should something negative happen to a hobbyist implanter. Micro implants are a promising technology, but a lack of standards and regulations could also simply add fuel to the fire among the sceptics that already associate microchips with science fiction villains.

6.1 Future research

Based on the results of this study I would suggest constructing a comparative study of the attitudes in the general population between people who have been given extensive information about how microchips work and those who have not been educated in this. With enough participants conclusions could be drawn about how big a difference, if at all, knowledge has on the perceived safety of using microchips and if there are other attitude changes to be found. There is also a potential value in arranging a workshop where the participants get to try out various simulated implants in order to investigate what uses for microchips they could imagine with some hands-on knowledge about them. There are potential innovative ideas and products still waiting to be identified and built within this field, since it is still relatively unexplored en masse.
References


Intervjufrågor

*Regarding the use of micro implants as digital interaction tools:*

1. What concerns and benefits does members of the general public identify, and
2. Which features of micro implants are important to members of the general public

Syftet med den här studien är att skapa en uppfattning om de åsikter folk har om implanterade mikrochip som verktyg för interaktion. Intervjun kommer ta ca 20 minuter. Denna studie följer vetenskapsrådets etiska riktlinjer, vilket innebär att din medverkan är helt frivillig och du kan välja att avbryta medverkan när som helst. De svar du ger kommer inte heller att användas i något annat syfte än att ligga som underlag för en del av min uppsats. Din medverkan i studien är anonym, och det slutgiltiga resultaten kommer inte att kunna härledas tillbaka till dig som person av utomstående parter.


Introducera scenarien

Ålder
Kön
Vad vet du om microchip?

Vad får du för spontana reaktioner på scenariot?
Vad tänker du om personerna i scenarierna som hade skaffat mikrochip?

Har du några funderingar om mikrochip nu när du läst scenarierna?
Skulle du kunna tänka dig att skaffa ett mikrochip?

- Varför/Varför inte?
  - Vad är det största hindret för dig i att skaffa ett mikrochip?
  - Vad skulle krävas för att du skulle göra det?
  - Vad skulle du använda det till om du skaffade ett sådant mikrochip?

Finns det något annat du skulle kunna tänka dig att ett sådant mikrochip skulle vara användbart för?
Ser du något problematiskt med mikrochip?
Vad ser du som de största fördelarna med mikrochip?