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Facebook Eavesdropping Through the Microphone for Marketing Purpose

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The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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Abstract

Background. As long as Facebook has existed, advertisements (ads) have been present in the application in one way or another. The ads have evolved and become more sophisticated over the years. Today, Facebook creates groups with members having specific attributes and advertisers requests groups for whom Facebook shows the advertisement. Besides this, Facebook receives information from other sources such as browser cookies and ad pixels. All information that Facebook receive or collect is used in their algorithms to target relevant advertisement for each user.
Objectives. To examine the possibility of Facebook eavesdropping through the microphone for marketing purposes and identify eventual keywords mapped between a spoken conversation and advertisement.
Methods. Five controlled experiments were performed with two test phones and two control phones. The first four experiments included the Facebook, Messenger and Instagram applications and the fifth experiment also included the Wish application. All four phones were treated equally beside the test phones being exposed to spoken conversations containing randomly chosen products, companies and brands. The content of the applications was compared to see whether advertisement was adapted to the spoken conversation in the test phones but not in the control phones.
Results. The results of Facebook eavesdropping are gathered by looking at the ads on Facebook, Messenger and Instagram, and also on the popular products on Wish. No sponsored advertisements were present on the Facebook and Instagram application. Messenger contained ads indicating that Facebook might analyse the content of private messages to adapt advertisement. After adding the Wish application to the research, the results regarding the sponsored advertisement was still the same. Some products in the Wish application could be identified as picked-up from spoken conversations but we concluded that the products most likely were present by coincidence. Other contents in the Facebook news feed were analysed, however, the content analysed did not contain any evidence that Facebook eavesdrops on spoken conversations for marketing purpose.
Conclusions. The experiments conducted were not sufficient enough to trigger sponsored advertisement. Therefore, no indications were found that Facebook is eavesdropping through the microphone or not.

Keywords: Eavesdrop, microphone, advertisement, privacy.

Sammanfattning

Bakgrund. Så länge Facebook funnits har annonser förekommit i applikationen på ett eller annat sätt. Annonserna har utvecklats och blivit mer sofistikerade under åren. Idag skapar Facebook grupper med användare som har specifika attribut och annonsörer begär grupper vilka Facebook visar annonser för. Utöver detta får Facebook information från andra källor, såsom cookies från webbläsaren och ad pixels. All information som Facebook tar emot eller samlar används i deras algoritmer för att rikta relevant annonsering till användarna.
Syfte. Att undersöka om det finns en möjlighet att Facebook avlyssnar genom mikrofonen i marknadsföringsändamål och identifiera eventuella nyckelord som kan kartläggs mellan en muntlig konversation och visad reklam.
Metod. Fem kontrollerade experiment utfördes med två testtelefoner och två kontrolltelefoner. De fyra första experimenten innehöll Facebook-, Messenger- och Instagram-applikationerna och det femte experimentet inkluderade också Wish-applikationen. Alla fyra telefonerna behandlades lika förutom att testtelefonerna utsattes för muntliga konversationer som innehöll slumpmässigt utvalda produkter, företag och varumärken. Innehållet i applikationerna jämfördes för att se om annonserna var anpassade till det muntliga samtalet i testtelefonerna, men inte i kontrolltelefonerna.
Resultat. Resultaten av Facebook-avlyssningen samlades genom att titta på annonserna i Facebook, Messenger, och Instagram, och även på de populära produkterna på Wish. Inga sponsrade annonser syntes i Facebook- och Instagram-applikationerna. Messenger-applikationen innehöll annonser som indikerar på att Facebook analyserar innehållet i privata meddelanden för att anpassa reklam. Efter att ha lagt till Wish-applikationen till forskningen var resultaten fortfarande desamma. Vissa produkter som visades i Wish kunde identifieras som upptagna från muntliga konversationer men vi drog slutsatsen att produkterna troligtvis var närvarande av en slump. Annat innehåll i nyhetsflödet analyserades, dock innehöll det inte några bevis på att Facebook avlyssnar muntliga konversationer i marknadsföringssyfte.
Slutsatser. Experimenten räckte inte till för att få sponsrad annonsering på Facebook. Därav framkom inga indikationer på att Facebook avlyssnar genom mikrofonen eller inte.

Nyckelord: Avlyssning, mikrofon, annonsering, integritet.

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Contents

List of Figures

List of Tables

Acronyms

OS	Operating System
ISP	Internet Service Provider
IP	Internet Protocol
MAC	Media Access Control
GPS	Global Positioning System
URL	Uniform Resource Locator

Chapter 1

Introduction

Social media applications allow people to share, among other things, interests, information and photos. Social media can be used for business purpose or solely private use. Today, business uses social media platforms for advertising their products, and they have never before been able to reach such a broad or defined audience [1]. Companies are now able to target advertisement to specific groups by using algorithms, web activity and other technology such as browser cookies [2].

Facebook is one of those social media platforms that allow users to share information and interests as well as enable businesses to come in contact with their consumers using advertisement. Some Facebook users have experienced that Facebook is spying on their verbal conversations through the microphone to fit relevant advertisements in the users' news feed [3, 4, 5]. The speculations seem to have started in 2014 when Facebook launched a new feature called "Identify TV and Music". According to Facebook, this feature uses the microphone for 15 seconds while writing a status update to identify background noise such as songs and TV shows. The purpose of the feature was to include the detected sound as tags to make the status update more personal and efficient to write. Users started to question whether it only listened for 15 seconds and not all the time. Almost a month after the feature was launched, Facebook answered that this is not the case [6, 7]. They state that the microphone is never used when the application action does not require it to fulfil its task. They also claim that they do not listen via the microphone to fit appropriate advertisements or change the appearance of the users' news feed [8].

During this research, Facebook announced that the feature "Why am I seeing this?" will be updated within a couple of months. This feature will allow users to see a more detailed description of why the specific advertisement is present. Facebook hopes that this update will inform the users to why a particular ad is shown. They hope in turn that users will understand that advertisements are not targeted based on spoken conversations. However, they are aware that this will not result in all speculations regarding microphone eavesdropping being eliminated [9].

The applications examined in this thesis are Facebook, Messenger, Instagram and Wish, all owned by Facebook Inc. except the latter which is owned by ContextLogic Inc. Today, the apps that are owned by Facebook collects, among other things, submitted personal information and activity- and location-related information to decide what advertisement will be displayed [10]. Users, in general, are not fully aware of

the actions an application can perform based on what users have (un)consciously given consent to or provided.

This thesis tends to examine the likelihood of Facebook eavesdropping through the microphone on its users for marketing purposes. Five controlled experiments with certain variables were performed and analysed. Experiments 1-4 are looking at the presented advertisements and other content in the Facebook, Messenger and Instagram applications to see if Facebook eavesdropping may occur. Experiment 5 examines whether Facebook may share this information in advertisement purpose to the Wish application, which in turn may target advertisement based on this information.

1.1 Motivation and Problem Statement

Some users have observed that targeted advertisements in the Facebook news feed come from Wish. According to them, they have only spoken about some of the products in the Wish advertisement [3]. They also state that the eavesdropping occurs even when the microphone is not in use, i.e. the user is not having a voice conversation via Facebook Messenger[1] or recording a video to upload [3, 4, 5].

The statements coming from Facebook and some of the users contradict each other and, therefore, we want to examine if there is a possibility that Facebook is eavesdropping. If the results indicate that Facebook is most likely listening and uses that information for marketing purpose, it becomes a privacy issue that must be addressed somehow. If the results do not show suspicious events, eavesdropping may still occur, but our approach does not discover it. It can also be that the information that Facebook gathers about its users in combination with their algorithms are sophisticated enough to associate relevant advertisements. The data used in the algorithms come from, e.g. the Facebook profile, browser cookies and friends actions [11]. Therefore, users may experience that Facebook is eavesdropping on their private conversations when they do not.

Today, privacy is a concern to a different extent for many users, and to the best of our knowledge, no scientific papers are focusing on Facebook eavesdropping on users through the microphone. There is, therefore, a research gap within this topic, and this thesis tends to explore it more in depth.

[1] A Facebook-connected application used for instant messaging, voice calls, play games and data sharing.

1.2 Aims and Objectives

This thesis tends to investigate if the variables chosen for this research[2] have an impact on Facebook eavesdropping on spoken conversations through the microphone and use the information for marketing purpose. If advertisements are present, eventual keywords from these, and the spoken conversations will be compared and matched to identify which of them may be picked up by the Facebook application and eventually shared with the Wish application. To achieve these aims, five controlled experiments will be conducted using two test phones and two control phones that have the applications installed. The test phones will be exposed to recorded dialogues, and the control phones will be isolated. The experiments will compare the content in the applications between the test phones and control phones, and see if the content varies depending on the different independent variables.

1.3 Research Questions

Following research questions are specified based on our aim and objectives and are set as guidelines to fulfil this aim.

RQ1. Is Facebook eavesdropping on spoken conversations to use them for marketing purpose, and if so, how does the variable(s) used influence the outcome?
The examined operating systems (OS) are Android and iOS. All other variables used are mentioned in table 4.1.

RQ2. Can keywords from spoken conversations be identified, and if so, are there any common traits for them?
Recordings of conversations containing random products and brands will be played for the two test devices in all experiments. Keywords that are identified from these conversations will be mapped towards eventual advertisement in the applications. If keywords can be matched, they can be identified as eventual picked up keywords. Keywords in the recorded conversation are mentioned a different number of times to see if the frequency has an impact on the result.

1.4 Thesis Outline

Chapter 2 covers the history of Facebook, Messenger, Instagram and Wish, as well as their data and privacy policies. Chapter 3 describes the related works to this specific research. In chapter 4, a detailed description of the method is provided. Chapters 5 and 6 presents the results, together with an analysis and discussion. The final section, chapter 7, concludes the thesis outcome and presents future work.

[2]Microphone access, a Facebook contact network, the mobile operating system, the Wish application and two recorded conversations.

Chapter 2

Background

Facebook Inc. was founded in 2004 by Mark Zuckerberg, Eduardo Saverin, Dustin Moskovitz, Andrew McCollum and Chris Hughes [12]. The application was then known as "thefacebook" and was only accessible by students with a Harvard email address [13]. By the time, the application started to spread to other universities and changed the name to "Facebook". Facebook was then made available for the rest of the world in September 2006 [14]. At the end of 2018, Facebook had 2.32 billion users that were active each month [15]. Facebook Messenger was a part of the Facebook application at first, and in April 2014 the apps were separated from each other into two standalone applications. Today, 1.3 billion people use the Messenger application to communicate with others by using, among others, instant messaging and phone and video calls. [16, 17].

The Instagram application was launched in October 2010 by Kevin Systrom and Mike Krieger. Apple announced that Instagram was selected as the App of the Year only one year after the launch. The application continued to grow and was released for Android users in April 2012, and was a short time after that acquired by Facebook. In March 2016, the Instagram application had about 200.000 active advertisers each month that grew to over 1 million active advertisers the following year [18, 19]. The number of users using the application increased rapidly, and in June 2018 Instagram was estimated to have 1 billion active users each month, of which 500 million of them are daily users [18].

ContextLogic Inc., Wish's parent company, was founded in 2010 by Peter Szulczewski and Danny Zhang, and Wish was created shortly after that. The purpose of the Wish application was to generate a customised shopping experience with the help of machine learning. The app asked users to create wish-lists of wanted products and connected these to e-commerce advertisement. In 2013, the founders realised that mostly low-priced goods were bought and that they could make more money by selling these directly from the manufacturers in the application. By 2015, Wish spent approximately $100 million on Facebook advertisements and was the most prevalent advertiser on both Facebook and Instagram. In 2017, Wish was the 6th biggest e-commerce company in the world claiming to have 300 million users [20, 21]

2.1 The Facebook Advertisement Evolution

Facebook has used advertisements since the start of the application, and they were back then called *Facebook Flyers*. These were only used by students to communicate with each other about, e.g. upcoming events. Two years later in 2006, Microsoft became the exclusive provider of banners, advertisements and sponsored links. The posters were then more known as *Facebook Ads* and not Flyers. In 2008, advertisers could more easily advertise their products by creating and managing their pages. Facebook also introduced *Facebook Connect*, which allowed users to sign in with their Facebook accounts on different applications and third-party websites. The next year, in 2009, Facebook introduced targeted advertisement options, allowing the advertisers to use geographical locations and language-based targeting. *Sponsored Stories* were introduced in 2011 for desktop devices and made the advertisements relevant to the user based on what the user of the application had marked with the like button [22].

The year after, the news feed contained mobile advertisements for the first time. At this time Facebook started with what they call *Social Graphs*, which is a graph that maps relationships between objects and users. The content of the graphs consists of what the user and its contacts like, comments on, views, and so on. Non-sensitive data from these graphs were then provided to advertisers, making it easier for them to target the appropriate audience [22].

In 2013, the news feed also contained advertisements in video format. The same year, Facebook introduced *Lookalike Audience*, which helped advertisers to find new customers with similar characteristics as their current ones. The sharing of data of the advertisers' customers to Facebook made the mapping possible, and Facebook then displayed the advertisements for matched users. During the same time, *Re-targeted Advertisements* started to appear. This method takes advantage of the cookies left in a users computer after, for example, visiting or submitting data on a third-party website. A cookie can contain various information about the client and server (often encoded) stored in key-value[1] pairs. When Facebook receives these cookies, it helps them find products that users have interacted with from advertisers. Based on these products, Facebook can re-target advertisement about them [22]. *Dynamic Product Ads* were presented in 2015, allowing advertisers to select already viewed products by the user, instead of the most popular ones. In 2016, the Messenger application also contained Facebook advertisements [23]. For this research, no additional significant advertisement news or updates was found.

2.2 Facebook Data Collection

Today, Facebook uses its algorithms to map advertisements towards a targeted group and to collect data Facebook, Messenger and Instagram are using the same approach. The applications also share data between the Facebook companies *Facebook Payments Inc.*, *Onavo*, *Oculus* and *Oculus Ireland Limited*, *WhatsApp Inc.* and *What-*

[1] A key can, for instance, be "Username" and its value "JohnDoe".

sApp Ireland Limited, *Masquerade* and *CrowdTangle* [24]. The following presented facts are from the official sites of Facebook and Instagram, where information about advertisement and policies exists [10, 11, 25]. From now on, the term Facebook will be used to refer to both the Facebook and the Messenger applications, as long as they are not explicitly separated.

2.2.1 Four Main Data Collection Categories

There are four main categories from where Facebook collects data. These categories are:

- The user's activity across Facebook companies and products.
- The user's activity with other businesses.
- The user's activity on other websites and apps.
- The user's location.

Facebook has only given examples within these categories, and therefore they may collect other data not mentioned.

In the first category, Facebook state that they collect information from the users' activity across Facebook companies and products to fit appropriate advertisements. Data obtained originate from Facebook and Instagram profiles[2], pages both the user and its friends like, as well as places the user has checked in to using Facebook or Instagram.

In the second category, they describe their relationship with other businesses. Businesses collect submitted information about the user when it interacts with them. Interaction can, for instance, be by purchasing products, using coupons, or signing up for newsletters. Data is then shared between the business and Facebook, for Facebook to fit appropriate advertisements to the users.

The third category contains analyses of activities on third-party websites and applications. An analysis of these events is possible due to some sites using Facebook Ads pixels. When the user visits these websites, they place a cookie in the user's device that belongs to Facebook. Facebook will then access this cookie and based on what content is inside it will adopt the advertisements. The content of a cookie can, for instance, reveal visited websites, device information, and what products have been added to the shopping cart or purchased. The tracking of cookies is present even though the user is not signed in or do not yet have a Facebook account. Besides the cookies generated by the Facebook Ads pixels, Facebook also collects data from third-party cookies that exist in the user's browser [11, 26, 27]. When it comes to mobile applications, Facebook can see whether the user has downloaded apps that share data with Facebook.

In the fourth and final category, Facebook keeps track of the user's location and fits advertisement from businesses which target individuals at a specific or nearby

[2]Profile information that they use is information that the user provides, such as age, gender, residence, relationship status, education and workplace.

place. The area can be reached by looking at where Facebook users connect to the internet, where the phone is located (by having enabled location services) and where users have checked in using the Facebook or the Instagram application [11].

Posting advertisements on Instagram and Facebook can be done separately or together [28, 29]. Both applications share the collected data about each user and have the same data policy. These applications are also owned by the same company and therefore we believe that they may use the same algorithm(s) for targeting the most appropriate audience. The only thing that differs is the type and amount of users on each application.

2.2.2 Data in Facebook Advertisement Settings

On a Facebook account, it is possible to reach the ad preferences by going to *Settings→Ads*. All facts presented below are information found under this setting. The Ads Settings contains several sections of topics that are related to advertisements and data collection [30, 31].

Your Interests

This section contains the user's associated interests from interacting with advertisements, pages, and topics that are related to them. The interests are divided into groups that are displayed in separate tabs, such as *Sports and Outdoors*, *Education*, and *Technology*. Removing interests associated with the account is possible. However, these are just marked as removed and moved to the *Removed Interest* tab.

Advertisers

This section lists the advertisers that have a connection to the currently signed in account. The tabs where the advertisers locate are listed below with a short explanation:

- *Who use a contact list added to Facebook:*
  A contact list can, for example, include information such as an email address or a phone number that the user has provided to other companies.
- *Whose website or app the user used:*
  These sites and apps include those using the Facebook Ads pixel.
- *Whom the user has visited:*
  These are visible when the user has visited the companies' stores.
- *Whose ads the user has clicked on:*
  Advertisements from companies/products that the user has clicked on.
- *Whom the user has hidden:*
  Not shown companies/products due to clicking the remove/hide button.

Your Information

This section contains two tabs with a bit more personal information about the user. In the first tab, *About you*, one can manage some of the provided information from

the personal profile. The type of information that can be disabled is relationship status, employer, job title and education. However, all of the provided information cannot be disabled for sharing, such as age, location and gender. In the second tab, *Your categories*, Facebook has divided its users into categories based on actions, locations, interests and personal information. Users can belong to several categories at the same time. The amount and type of categories usually differ for each user and can, for instance, be a close friend with football fans, WiFi-user, international traveller, and away from family. The gathered categories mentioned come from the authors' accounts.

Ad Settings

Under this section, the user can choose what data is allowed to use for advertisement. This section has three subsections, and the first two can be set to either allowed or not allowed and the third subsection to only friends or no one. An explanation of the subsections are listed below.

- *Ads based on data from partners:*
  In this section, the user can set whether data or activities from advertisers, app developers and publishers outside the Facebook Company Products can be used to show relevant ads.
- *Ads based on the user's activity on Facebook Company Products that you see elsewhere:*
  In this section, the user can set whether advertisements are shown based on the user's advertisement preferences on applications and websites that are not part of Facebook Companies.
- *Ads that include the user's social actions:*
  Here, the user can set whether social actions on advertisement are seen in a friend's news feed. Actions that are applied are likes, follows, comments, shares, application usage, check-ins, recommendations and events joined.

Hide Ad Topics

In this section, it is possible to hide advertisements that touches the topics *alcohol*, *parenting* and *pets*.

2.2.3 Data Policy

How data is collected in the applications has been described with the help of four primary data collection categories in section 2.2.1. How the users influence the advertisements and how they can control them is seen under ads settings described in section 2.2.2. The advertisement system takes advantage of all of the collected data (including categories) to match with advertisers targeted groups. It enables Facebook and Instagram to show the user advertisements that may be relevant without disclosing the user's identity. According to Facebook, they do not sell any information to advertisers, and that this includes information that can identify you as a user [11].

The applications' data policy contains additional details on what data is collected, as well as how. The data gathered is then of use when targeting advertisement and matching users to groups and categories. Both Facebook and Instagram share the same data policy, and all of the following information is collected from their sites [10, 25].

Location-related Information

Mentioned before is that the applications keep track of location-related information to fit the appropriate advertisement. Additional information found is that the apps also retrieve location information by viewing the metadata on uploaded images and videos. They also look at the IP address, the user's residence (submitted in the profile), places the user likes to go to and the user's friends use of Facebook Products.

Activity-related Information

The data policy states that Facebook and Instagram collect information about how the user uses their products. If one chooses to upload, sync or import data from a device, such as the mobile contacts, Facebook will help the user to find their accounts. Interaction and other activities can be tracked from, e.g. pages, accounts, groups, hashtags and the contact network. The information that is collected is listed below.

- Type of content viewed and interacted with, such as posts and videos.
- Features used, such as the camera.
- Actions taken, such as commenting on a post.
- Interaction with people or accounts, such as making a post on a friends wall.

The time, frequency and duration of all the activities are also tracked. They can, for example, find out which users that the user communicates with the most. Besides collecting data about users and their actions, they also use information that others provide about them. They can do this because they analyse information, communication and content of other users actions that they might relate to a user.

Network-related Information

The network-related information that is collected when connecting to Facebook Companies and Products can for instance be:

- IP address.
- Name of the Internet Service Provider (ISP).
- Time zone.
- Language.
- Connection speed.
- Information about other devices located nearby, or on the same network.

From each device that is connected they also collect signals, such as Bluetooth signals, beacons, cell towers and information about surrounding Wi-Fi access points.

An approximate geographical location can come from, for example, the IP address, connection speed and devices located in the same network. The language and location used in the device can indicate that the user may be interested in companies from these countries. All the above makes it easier to fit appropriate advertisements.

Device-related Information

The device-related information that is collected when connecting to Facebook Companies and Products can for instance be:

- Operating system.
- Hardware and software versions.
- Name of the mobile operator.
- Mobile phone number.
- Battery level (if the device runs on batteries).
- Available storage space.
- Signal strength.
- Browser type.
- Application and file names.
- Application and file types.
- Plugins.

Besides collecting information about the device used, they also collect how the person interacts with the device when using the applications. Interactions with the device can, for instance, be mouse movements. Based on these movements, Facebook can determine whether it is a human or a bot using the application. The device also sends information about whether the application is foregrounded or lies in the background.

Facebook collects unique identifiers from the devices. These are, for example, device IDs or other unique identifiers from games, applications or accounts that one uses. If Family Device IDs are present, Facebook will also collect these.

2.3 Wish Privacy Policy

Services that are operated by ContextLogix includes *Wish*, *Geek*, *Mama*, *Cute*, *Home Design* and *Décor & Local*. All of these services use the same privacy policy. The policy contains, for example, how and what information is collected. This is divided into separate categories which consists of information collected automatically and information that is provided by the user and third-party sources [32]. The following information is gathered from their privacy policy [32].

2.3.1 Wish Data Collection

Information Provided by the User

Information that is submitted by a user using the Wish service can for example be:

- Name
- Email address
- Payment Method or Financial Account Information
- Shipping address
- Phone number
- Social network account credentials

Information Automatically Gathered

When using Wish, or any of their other services, they automatically collect data about how the user uses them and information about the devices used to access the services. Data that is automatically collected can for instance be:

- *IP address and Unique Device Identifiers*:
  The IP addresses and MAC addresses of the devices that access the services are collected. Additional unique identifiers such as advertisement IDs and other device attributes such as OS and browser type are also collected.
- *Location information*:
  Both Wish and their services collect information about the users' location from their computer or mobile device. However, they need a user's permission to obtain the exact GPS location information.
- *Social network account and profile data:*
  Account and profile information from social network accounts that are used to sign in to the Wish application are collected.
- *Usage Data, such as:*
  Weblog data, referring and exit pages and URLs, platform type, number of clicks, domain names, landing pages, pages and content viewed and the order of those pages, the amount of time spent on particular pages, the date and time the user used the services, the frequency of using the services, error logs, and other similar information.

Information from Third-Party Sources

For Wish to understand how users interact with their application, it uses Google Analytics and other information providers. To get a better picture of the user's interests and online activity, they collect information stored in cookies and related technologies such as tracking pixels, local shared objects and web beacons. Wish uses other services, such as Facebook, to serve targeted advertisements about their services, companies or products. Wish also offers the ability to interact with social plugins from social media sites, which may allow them to receive data from or about the user. In some cases, Wish may collect information about interactions with social plugins, such as a Twitter Follow button. They may also receive additional information from those sites.

Chapter 3

Related Work

This Masters thesis builds on the fact that there exists, to the best of our knowledge, no scientific papers focusing on Facebook eavesdropping through the microphone on users of the application. Facebook claims that they do not eavesdrop through the microphone for marketing purpose. As stated before, there are many speculations around the subject, and unfortunately no academic publications on the topic. There are however, many articles published which have examined the privacy on social network applications, among them Facebook. These articles mainly investigate users and their awareness of information sharing and their privacy concerns. Besides the research regarding privacy, a large portion of the related work that focuses on Facebook eavesdropping listed here is in the form of news feeds.

3.1 Privacy-Related Research

Computer scientists, lawyers, philosophers among others have their own standards and perspectives when it comes to privacy. This is something R. Gellman and P. Dixon [33] mention in their book. The word privacy is a right and it has many different meanings for different people. It can e.g. be a human right, a moral right or a legal right. Online privacy evolves as rapidly as technology and it is therefore hard to define what online privacy is or what it means.

The definition of privacy and data protection can also be found in S. Fischer-Hübner's book [34] *IT-Security and Privacy*. She explains that the first definition of privacy was seen in the article *The Right to Privacy* written by the two lawyers Samuel D. Warren and Louise D. Brandeis in 1890. They defined the word as *the right to be alone*. However, due to the many perspectives on privacy, it is hard to accurately define the concept in a single sentence that captures the essence of the concept in digital contexts [35]. Despite this, an often used description of privacy in academic settings is Alan Westin's attempt to define the concept [36];

> *"Privacy is the claim of individuals, groups and institutions to determine for themselves, when, how and and to what extent information about them is communicated to others."*

Alan Westin included this definition in his book *Privacy and Freedom*, which was published in 1967.

3.1.1 Privacy Settings

A research performed by Y. Liu et al. [37] measures the differences in desired and actual privacy settings on Facebook. From their survey, they concluded that users' expectations in privacy settings only matched 37% of the time. If incorrect, they almost always expose more information than expected to other users. When analysing the exposed information, they found that 36% of all content that is uploaded is accessible with default privacy settings.

E. Van den Broeck, K. Poels and M. Walrave [38] have conducted a survey which examined Facebook use, privacy concern, as well as the application of privacy settings on Facebook. This survey had 508 participants in ages between 18-65 where approximately 50% represented female participants. The participants were separated into three categories depending on age; emerging (age 18-25), young (age 25-40) and middle adulthood (age 40-65). By analysing the results from the survey, it was concluded that there exist clear differences between the age groups in terms of privacy concern, Facebook use, and privacy protection. The study also found that older users, despite their privacy concern, know less about privacy settings on Facebook, and uses them less than emerging adults. The research also states that these users are vulnerable in the online environment because their information which they have shared can be disclosed to audiences that they unconsciously chose.

M. Bartsch and T. Dienlin [39] tested four different hypotheses by analysing the result from an online survey with 630 participants, in which all of them were Facebook users. The analysis of the results from the survey confirms all of the hypotheses. The analysis showed i.a. that Facebook users who spend more time online and that change their privacy settings more frequently have higher levels of online privacy literacy.

A model was created by L. Nemec Zlatolas et al. [40] to gain a better understanding of privacy issues and how they influence self-disclosure in social networking sites. The model produced contains several privacy variables from which the authors found relationships. To find these relationships, a survey was conducted with 661 participants and a structural equation modelling was used to evaluate their model. The aim of their developed model is to gain a holistic view on the issue regarding self-disclosure on the social networking site Facebook, as well as which of the chosen privacy variables have a significant impact on self-disclosure.

E. Litt [41] examines the relationships between users' age and gender and their use of technological privacy tools on social network sites. Furthermore, the author investigates how background factors, motivations and social network site experiences relate to their use of these tools. From the tools investigated, the most common is to change the privacy settings, which less than two-thirds of the interviewed participants do. The remaining third part only engages with one or none of the technological tools.

3.1.2 Privacy Threats

S. K. Satyanarayana et al. [42] presents different types of attacks that can be mounted via Online Social Networks, as well as defence mechanisms against these attacks. The authors F. Erlandsson, M. Boldt and H. Johnson [43] also presents different privacy threats and proposes protection mechanisms against these threats. For one of the privacy threats presented, previously not documented, a proof-of-concept implementation has been made. This threat was exploited by creating a data extraction tool that harvests publicly available information from Facebook's Graph API. The result from the proof-of-concept was a social interaction graph from an open group on Facebook. When analysing the graph, it shows that even though privacy settings are strict, some information can still be retrieved. The information gathered are names, profile IDs and the accounts' interactions with the group. This research shows that regardless of how strict the users' privacy settings are, it may still be possible to create social interaction graphs with limited resources and thereby profile users.

3.2 Facebook-Related Research

In a study performed by F. Pi [44], the author manually analysed 34 applications on a Nexus 5 phone, running Andriod 8.1 (Oreo), to find out how many of them send data to Facebook. The analysis showed that 23 out of the 34 applications send data to Facebook. Among these applications, one can see Spotify, Shazam, Skyscanner and TripAdvisor. The sharing of information occurs even if the person does not have a Facebook account, and if it does, the person does not have to be signed in.

C. B. Hanson [45] did a content analysis of sponsored messages in the Facebook news feed. The results showed that 11.44% of the messages in the Facebook news feed were sponsored. Over 80% of the sponsored messages were from smaller companies, and the categories most often seen were apparel/accessories and leisure.

3.3 Facebook Eavesdropping Speculations

The year 2018, the Cambridge Analytica whistleblower, C. Wylie [5], discusses the rumours about Facebook listening through the microphone to target advertisement. He says that he does not think that Facebook is eavesdropping on conversations because natural language processing would be too hard to scale. He believes that it is possible for Facebook to listen to the environmental context to adapt advertisement based on its surroundings. It means that Facebook would use the microphone to target ads based on locations and not on the content of users' conversations.

In Global News, T. Kohut [4] publishes an article where she interviews people regarding microphone eavesdropping from tech giants. Mike Campbell, Carlos A. Gutierrez and Rachel Berman are all Facebook users, and they are certain that Facebook is eavesdropping through the microphone. However, a director at the University of Alberta, John Pracejus, claims that the algorithms already have such a vast amount of information that they can predict what people are thinking or talking about.

In an article written by T. Mears and H. Mirsky [3], Mears claims to have been exposed to microphone eavesdropping by Facebook . The article describes how this event happened twice in a short period. In both scenarios, she received targeted Wish advertisement in the Facebook news feed. The content of the ads were unusual products she talked about the day before the shown advertisements.

Chapter 4

Method

This chapter will present the overall process used to answer the two research questions. It will explain the process in detail, and everything around it, which will make it reproducible. The selected methodology for answering the questions is to conduct controlled experiments, we believe this to be the most suitable method. This because experiments provide well-structured research that will result in a reliable and unbiased outcome. Another reason for choosing this method is that we have great control over the environment, test data and external variables, that affect the outcome.

In short, five experiments are carried out where the first four experiments will contain four cell phones, one recorded dialogue and Facebook, Messenger and the Instagram applications. The fifth experiment will include one additional application, the Wish application. The tests will play a recorded conversation mentioning randomly chosen companies and products for two cell phones, which have the Facebook and the Messenger applications installed and signed in with different accounts. The other two phones will be located in a quiet environment and have the same applications installed with different accounts. The Instagram application will be downloaded on all phones after the played conversation. The advertisement seen in Facebook, Messenger and Instagram, and the products in the Wish application will be compared to each other after a set amount of time. The outcome will provide a likelihood of Facebook eavesdropping through the microphone to fit advertisements. If the results from experiments 1-4 shows that Facebook may be eavesdropping, the final experiment will also provide a likelihood of Facebook sharing picked up information with the Wish application.

4.1 Experiments

In this section choices that affect the experiments are motivated, the approach of preparation and execution is described, as well as how data was collected and analysed.

4.1.1 Justification of Selections

Applications

The Facebook and the Messenger applications are commonly used together, and Messenger is included in this research because it also contains advertisement and

can have microphone access. In contrast to Facebook, Messenger only includes a limited number of ads in the inbox and the story, and from our observations, there is only one at the time. It is possible to sign in on Instagram with the Facebook account, which makes it easy for us to analyse the advertisements displayed on this application as well. We believe that if Facebook is eavesdropping it is possible that targeted commercials are displayed in the Instagram application as well. Facebook own and share data between these three applications, and this is why these are included in this research.

The Wish application was selected due to some of the accusations pointing towards the advertisement from Wish in the Facebook application [3]. The final experiment will, therefore, examine if targeted advertisements in the Facebook news feed from the Wish application is present or if the products seen in the Wish application are changed due to the spoken conversation. If so, it may be that Facebook is eavesdropping and sending data to Wish for Wish to adapt products and advertisement, or that Wish is eavesdropping.

Cell Phones and Operating Systems

Cell phones and operating systems that are still used today were chosen to make the research as significant as possible. A total of four cell phones were collected, and two of them acted as test phones, and the remaining two acted as control phones. They were divided into test and control phones to be able to compare them and thereby ensure that the triggered advertisements are most likely based on the spoken conversation and not on other factors. The phones were two iPhone 7 (iOS), one Sony Xperia Z5 (Android) and one Nexus 5X (Android), further information about the phones and versions are found in Appendix A.1. We were unfortunately not able to get hold of two equal Android phones and OS versions, though this would be optimal when collecting data and analysing the results. iOS and Android were used as operating systems in the cell phones because they are the most used OS in mobile phones today [46]. The purpose of using two different OS was to see if the outcome will differ.

Recorded Dialogue and Content

As mentioned before, Facebook tracks device locations with multiple techniques such as IP address and cell tower connections, and these variables can not be affected in a controlled manner. The Wish application also collects information regarding the geographical location of the device. If the conversations would be in English, we believe that there might be a mismatch in Facebook's or Wish's algorithms due to us being located in Sweden and this would compromise the results. Therefore, the Swedish language was used in the conversation.

In order to find relevant, varying, and avoiding biased topics randomly selected advertisement-friendly companies, products and brands were mentioned in the spoken conversations. For the international companies and brands the list *The World's Largest Public Companies* from Forbes containing 2000 companies was used [47]. For

the Swedish companies and brands, a list of companies listed on NASDAQ Nordic was accessed [48]. These sources were used because they are famously known and reliable. From these sources, companies that belong to various fields, such as technology and telecom, were chosen to increase the range of the products. We wanted a wide range of products because if Facebook or Wish are eavesdropping and use keywords, the probability that these keywords will be included in their algorithms and the recording is higher. The chosen companies and products are listed in Appendix B.1.

This research was executed in Sweden, and due to the location, both Swedish and international companies and products were included. These were randomly selected with the help of a random number generator to increase the credibility of the experiments and to avoid getting biased test data. The process of collecting companies and products was repeated until enough was chosen to cover a 15 minutes long dialogue with them as keywords. This length was chosen because we believe that this length is sufficient for Facebook or Wish to collect data if the application is eavesdropping. To create the second script that was used in experiment 5 together with Wish; the content of the first scenario in the first script was modified. To adjust the content existing products or services were replaced to products that are sold by Wish. To choose these, the product range was viewed in the application and once again a random number generator was used to select some of the products. To increase the likelihood of future matching results not being a coincident, some of the products were described with specific colours or other attributes that had not been seen in the application when viewing the product range.

To have control over the test data, two scripts were written that were read out loud and recorded. The recording facilitated the execution of the experiments, and it provided the same test data for experiment 1-4. Another recording was used for experiment 5, and it was played seven times during the process. The dialogues were recorded with other cell phones than the ones used in the experiment. These devices then played the recording for the test phones. To make the conversations seem authentic between two parts, we tried to adapt it to common real-life scenarios which, in turn, gave the dialogues and the keywords a natural flow. These conversations are seen under Appendix B.2 and B.4.

Accounts

There was a limitation in Android which affected the decision of email provider. To access Google Play Store[1] and download applications, the user needed to have a Gmail account. For each experiment to have the same prerequisites, Google was used as the email provider. The type of accounts created for all tests were Gmail accounts, Apple IDs for the iOS phones, and Facebook accounts. The remaining applications used in the experiments use the Facebook login. For the Gmail accounts and the Apple IDs, settings were as restricted as possible, and the Facebook accounts had default settings. It was motivated by trying to minimise the other accounts impact

[1]This is where users download applications. It corresponds to App Store on iOS devices.

on the Facebook account or eventual data being shared to it.

Experiment 1-3 used newly created accounts, and experiment 4 and 5 used the same accounts as in experiment 3. The amount of content in the applications did not increase in test 1 and 2, and only small adjustments were seen in experiment 3. It made us believe that the lifetime of an account can have an impact on the content displayed in each application. It is the reason why the accounts were reused from experiment 3. It was also noticed that the content did not remain, nor was any additional content added if the accounts were inactive. It motivated us to create a scheme where decided how to, and when to, interact with the applications during experiment 5.

The provided personal information in the accounts was specified as similar as possible to ensure that they belonged to the same targeted group when it comes to advertisement. It means that everything except the birth date and the names was equal, which can be seen under Appendix C.4 in table C.1. The birth dates were within the same month and year, and the names were common Swedish names. The dialogue played for the test phones consisted of two females having a conversation and, therefore, the gender of each account was female. The information provided by us about the accounts were slightly different as well to not raise suspicions of the accounts being bots.

In experiment 3, all four cell phones added a contact network with the same 16 Facebook friends. The same friends were chosen to give each account the same prerequisites and to avoid manipulating the outcome. Among these friends were the authors of this thesis and their close family and friends. Adding close friends allowed the authors to compare the eventual advertisement with their interests and activity.

Interactions with the Applications

Interactions were made in experiment 5 in all applications by scrolling the feed. Otherwise, the interactions mainly focused on the Facebook application because this is the application which allows you to interact in many different ways. The type of actions performed was chosen because we thought that they would not affect the type of advertisement shown. The interactions with Facebook was to upload profile and cover photos, have chat conversations, write status updates, modifying personal information, among others. The interactions are described further in Appendix D.2. The goal of interacting with the applications was to trigger additional content in the applications and thereby get sponsored advertisement.

Data Collection

The time before collecting the result from experiment 1-4 was set to 3, 24 and 46 hours after the recording had finished. These periods were chosen because we believe that if Facebook collects information from the microphone, they will also have to process the data and delay the advertisements not to act suspiciously. We also believe that a total of 46 hours is sufficient for Facebook to process data and display

advertisements. During the research about the subject, we read that most of the ads from similar tests were present either the same day or the day after [3]. This in combination with own experiences motivated the time span between the dialogue and the analysis of the applications. We chose to have 46 hours and not 48 hours for the final analysis because it was prioritised to start each experiment at 10:00 on Mondays or Wednesdays. It means that there was a 2 hour time limit to analyse the results and prepare the next experiment.

In experiment 5, the phones were analysed on Monday to Friday at 13:20, and on Sundays, they were analysed at 21:30. The applications were analysed each day except on Saturdays because we had no access to the phones during that day.

4.1.2 Experimental Approach

Five controlled experiments have been conducted. The first four experiments contained four phones, the Facebook, the Messenger and the Instagram applications, one recorded dialogue and some variables that were tested on. The fifth experiment included another recorded conversation and the Wish application.

The variables included, microphone access on both Facebook and Messenger and a contact network on Facebook, are shown in table 4.1. In the fifth experiment, Wish did not have access to anything on the cell phones[2]. The first experiment did not take any variables into account, the second experiment allowed microphone access, the third experiment allowed a contact network without microphone access, and the remaining experiments used both variables together.

Table 4.1: *The variable combination for each experiment in the Facebook and the Messenger applications.*

Device and OS	**Variables**	**Experiment**				
		1	**2**	**3**	**4**	**5**
Nexus 5X (Android)	Microphone access		x		x	x
	Contact network			x	x	x
	Wish application					x
iPhone 7 (iOS)	Microphone access		x		x	x
	Contact network			x	x	x
	Wish application					x
Sony Xperia Z5 (Android)	Microphone access		x		x	x
	Contact network			x	x	x
	Wish application					x
iPhone 7 (iOS)	Microphone access		x		x	x
	Contact network			x	x	x
	Wish application					x

The experiments included independent and dependent variables. The independent variables are those that can be controlled and tested. These variables will affect the outcome, i.e. the dependent variables. The independent variables for the experiments

[2]The Wish application asks for permission to use the camera, contacts, storage and location.

are microphone access, a contact network, the Wish application, OS, the recorded dialogue and the frequency of its keywords, application interactions, account lifetimes and the periods before examining the phones. The dependent variables in the experiments are the advertisements on Facebook, Messenger and Instagram, as well as products in the Wish application.

Required Materiel and Software

The materiel required for the experiments were the following:

- Two test phones: iPhone 7 (iOS) and Nexus 5X (Android).
- Two control phones: iPhone 7 (iOS) and Sony Xperia Z5 (Android).
- Four SIM-cards with cellular network access (4G).
- Facebook, Messenger, Instagram and Wish applications.
- Recording of conversations (test data): Script 1 for experiment 1-4 and Script 2 for experiment 5.
- Unique Gmail and Facebook accounts for each phone in experiments 1-3.
- Access to two quiet rooms.

Table 4.2 below contains the permissions that have to be granted for the applications to perform specific tasks during the experiments. Table A.1 under Appendix A.1

Table 4.2: *Permissions that have to be grated during the experiments.*

Permission to Access	**Experiment**					**Reason**
	1	2	3	4	5	
Microphone		x		x	x	It is one of the variables to be tested for experiments 2, 4 and 5. Access was given on Facebook and Messenger.
Camera		x		x	x	Access to the camera had to be permitted to grant Facebook and Messenger access to the microphone.
Image storage					x	To be able to upload pictures to Facebook, it has to access the image storage.

lists the versions of OS and software used in each of the experiments. The OS versions stay the same, and some of the versions of the applications vary in the experiments. The versions are, therefore, represented in four different tables. We can not say why some of the applications sometimes had downgraded versions even though the same steps in each experiment were equal. The Instagram versions in experiment 5 only show the version before playing the first dialogue. The Instagram application was uninstalled between the played dialogues and therefore, its versions varied. Table A.2 under Appendix A.2 contains all Instagram versions throughout the experiment.

4.1.3 Preparation

The first step in the preparation stage for the experiment was to write a script in Swedish containing both Swedish and International companies, brands and products. A random number generator was used that provided a number that corresponded

to the company's rank. The scope was limited to companies who work with the goods and services market for private individuals. To select products from the chosen companies, the home page of each company was visited to find what products and services they offer. If there was more than one product or service available for the goods and service market, the same generator was used to select a product/service. The companies and products chosen from Forbes [47] are seen in table B.1 under Appendix B.1.

For the Swedish companies and brands, a list of companies listed on NASDAQ Nordic [48] was accessed. To sort the list accordingly, the filters listed below was chosen.

- **Select:** Main Market
- **Market:** STO
- **Segment:** Large Cap and Medium Cap
- **Sector:** Industrials, Consumer Goods, Consumer Services, Telecom, Financials and Technology

The same approach in finding companies and products as with the international companies was used. In addition to the randomly chosen companies, the Swedish insurance company *if* was also included. They were chosen as they offer insurances with Nordea, and we have observed a lot of insurance commercials on Facebook. The companies and products from the Swedish market are seen in table B.1 under Appendix B.1.

The keywords and the whole script is available under Appendix B.2 and B.3. One can see that the frequency of the different keywords varies; this was intentional. This because we also want to find out if the rate has an impact on the outcome.

4.1.4 Execution

Experiment 1-4

Before executing the experiments, a test case was performed on all four cell phones including the setup and configuration phases. The steps that were not tested was to create Facebook accounts, download the applications and play the recorded dialogue. This to avoid any impact on the results of the actual experiments. The steps were written down and executed to specify them thoroughly and to ensure that each step was feasible. The test case helped us to achieve the same approach in the method for experiments 1-3. Before explaining the execution steps, the configuration of the cell phones and the Gmail and the Facebook accounts are described.

The iOS devices were configured with the steps seen in Appendix C.1. The Android devices had slightly different steps for configuration, which are seen in Appendix C.2. Steps performed once the phones had been configured are described in Appendix C.3. The Gmail accounts that were created for each cell phone in the experiments are listed in table C.1 in Appendix C.4. The Facebook accounts were created with the Gmail addresses and their configuration is seen in Appendix C.5.

The steps in the execution of experiment 1 are seen in table D.1. Experiment 2, 3 and 4 were conducted with the exact same steps as in experiment 1. The only differences in these experiments compared to experiment 1 are the following:

Experiment 2:

Date: *27th of February until the 1st of March*
Variables: *Only microphone access*

Experiment 3:

Date: *4th of March until the 6th of March*
Variables: *Only a contact network*

Experiment 4:

Date: *6th of March until 8th of March*
Variables: *Microphone access and a contact network*
Other: *Reused accounts from experiment 3*

The variables tested were then enabled; these are the variables in table 4.1. A factory reset was performed on each phone before experiment 1-3 to ensure that they started with unmodified settings, no stored data or applications. It was noticed in these experiments that the accounts had to become more active to display content. Therefore, it was decided not to perform additional resets and create other accounts in the remaining tests.

Experiment 5

After experiment 4, two weeks were spent on planning and preparing for the final experiment. During this period, all four phones were isolated and turned off. A scheme of the time of execution on each day's interaction with the phones was created, which is seen under Appendix D.2.

The first scenario in the first script was modified to suit the Wish application. Some of the products that mentioned specific companies, brands and models were replaced by more generic products with particular attributes. It resulted in the second script, seen in Appendix B.4. All four phones downloaded the Wish application, and the Facebook accounts were used to sign in. This time each user had to choose what type of products they like to shop. The alternatives were male or female products, and female products were selected.

The Instagram application was uninstalled on all cell phones before playing the recording for the test phones. It was done to ensure that it would not be the Instagram application that eavesdrops. The Messenger and the Wish applications were backgrounded, and Facebook was foregrounded on all cell phones. The test and control phones were separated from each other without locking the screens, and the dialogue was played for the test phones. Once the recording had finished, the Instagram application was downloaded on all cell phones and once again signed in. All phones were put in a quiet environment.

An analysis was performed once a day from Sunday to Friday. On Monday to Friday, it was conducted at 13:20 and on Sundays at 21:30. The analysis of the Facebook application was done by scrolling and viewing the news feed and the ad settings. All sections were analysed in the Messenger application, as well as the Search & Explore tab on Instagram. In the Wish application, the *Popular* tab was examined.

The interactions made during the week 1-4 can be seen under Appendix D.2.1, D.2.2, D.2.3 and D.2.4. It was motivated by trying to increase the amount of content and increase possibility of getting Wish advertisement in the Facebook news feed. All photos uploaded on the Facebook accounts were taken with their corresponding cell phone. It was possible to view meta-data about the images on the Android phones, and they did not reveal any location information. It was not possible to view the same information on the iOS devices without downloading an additional application. However, location services were turned off on all cell phones, and we believe that this may affect whether location information is provided in picture meta-data or not.

Chapter 5

Results and Analysis

The following results are presented for each experiment, as well as analysed. It, in turn, answers our research questions.

5.1 Experiment 1

After each recording had finished, all four cell phones were analysed after 3, 24 and 46 hours and the results were equal. The test phones and their corresponding control phones were compared towards each other. In all three applications where advertisements can be present as well as the advertisement settings on Facebook was analysed. As a result, no ads were present in any of the applications. After the recording during each analysis, the advertisement settings in the Facebook application were not modified by either Facebook or us.

5.2 Experiment 2

In this experiment, microphone access was allowed on the Facebook and the Messenger applications. The cell phones were analysed in the same way as in experiment 1 and the same result was displayed after 3, 24 and 46 hours. Meaning, no advertisements were seen in all three applications, and the advertisement settings were unchanged by Facebook and us. The news feed on all cell phones has been empty so far. However, in this experiment both Android phones state that each account needs at least 15 friends on Facebook for the news feed to populate. For this reason, the upcoming experiments will have at least 15 Facebook friends on each account.

5.3 Experiment 3

In this experiment, a contact network that existed of the same 16 friends on each phone was created. The content after analysing the applications was different after each period. We did not make any changes in the advertisement settings, neither did Facebook. Advertisements were also not seen in the news feeds of the applications. However, pages were present in the Facebook news feed that were generated by the feature "Popular on Facebook". These pages were only Swedish and were mostly well-known TV-channels and newspapers. Table 5.1 shows the number of posts from different pages after each period.

Table 5.1: *The number of popular posts in each phone after each period.*

Device	**3h**	**24h**	**46h**	**Total**
iPhone 7 (test)	3	5	4	12
iPhone 7 (control)	0	1	2	3
Nexus 5X (test)	3	2	2	7
Sony Xperia Z5 (control)	2	4	6	12

The different pages shown in the news feeds were:

- TV-channels: *TV4* and *SVT*.
- Newspapers: *Aftonbladet*, *Expressen*, *Kvällsposten* and *Djurbibeln*.
- Political parties: *Socialdemokraterna*.

Table 5.2 describes the frequency of the posts in each phone after each period.

Table 5.2: *The frequency of popular posts from each page seen in the news feed.*

iPhone 7 (test)

Page	**3 h**	**24 h**	**46 h**
TV4	1	2	2
SVT	2	3	2
Aftonbladet	-	-	-
Kvällsposten	-	-	-
Expressen	-	-	-

iPhone 7 (control)

Page	**3 h**	**24 h**	**46 h**
TV4	-	-	-
SVT	-	-	-
Aftonbladet	-	1	-
Kvällsposten	-	-	1
Expressen	-	-	1

Nexus 5X (test)

Page	**3 h**	**24 h**	**46 h**
TV4	1	-	-
SVT	2	-	-
Aftonbladet	-	1	-
Kvällsposten	-	-	1
Expressen	-	1	1
Djurbibeln	-	-	-
Socialdemokraterna	-	-	-

Sony Xperia Z5 (control)

Page	**3 h**	**24 h**	**46 h**
TV4	1	1	2
SVT	-	1	2
Aftonbladet	-	-	-
Kvällsposten	-	-	-
Expressen	-	-	-
Djurbibeln	1	1	1
Socialdemokraterna	-	1	1

The results show that the pages and the number of posts are quite different when comparing the control phones with the test phones. It is evident on the iPhone devices where the test phone only contained TV-channel pages and the control phones only contained newspapers. The number of posts was also significant in the iPhones since the test phone held a total of 12 posts and the control phone just had 3.

The Android phones also had some differences, where the control phone contained TV-channels during the entire period, but the test phone only had them at 3 hours. When it comes to newspapers, the test phone had 3 of the major newspapers in Sweden, that provide both national and international news. The control phone had one newspaper, Djurbibeln, that is not well-known by the whole population of Sweden and only contains news related to animals. The control phone also had a page for a political party called Socialdemokraterna in Sweden, which is the party holding the majority of the votes in the election 2018.

5.4 Experiment 4

The accounts created in experiment 3 were used in this experiment as well. The Facebook and the Messenger applications were now also allowed to access the microphone. The results in this experiment were similar to the results in the previous test, where no changes in the advertisement settings were made by either Facebook or us. The result also showed no targeted advertisements in the news feed. This time, the same and additional pages in the Facebook application were observed and also a small change in the Instagram application.

5.4.1 Facebook

The frequency of the posts in the Facebook application varied, and they are presented in table 5.3 below.

Table 5.3: *The number of popular posts in each phone after each period.*

Device	**3h**	**24h**	**46h**	**Total**
iPhone 7 (test)	4	7	9	20
iPhone 7 (control)	5	3	5	13
Nexus 5X (test)	2	2	4	8
Sony Xperia Z5 (control)	7	10	9	26

The type of pages was the same as in experiment 3, together with seven additional pages. The other pages are the following:

- TV-channel: *SVT Humor* and *Kanal 5*.
- Newspaper: *Dagens nyheter*, *KIT* and *Sportbladet*.
- Actor: *Morgan Alling*.
- City: *Malmö stad*.

Table 5.4 describes the frequency of the posts in each phone after each time span. The newspapers Aftonbladet, Kvällsposten and Expressen, are not included in the Nexus and the Sony Xperia tables because the pages were no longer visible in the news feed.

Table 5.4: *The frequency of popular posts from each page seen in the news feed.*

iPhone 7 (test)

Page	3 h	24 h	46 h
TV4	2	3	4
SVT	2	2	2
Aftonbladet	-	-	-
Sportbladet	-	-	-
Kvällsposten	-	-	-
Expressen	-	-	-
Dagens nyheter	-	-	1
KIT	-	-	-
Malmö stad	-	1	1
Morgan Alling	-	1	1

iPhone 7 (control)

Page	3 h	24 h	46 h
TV4	-	1	1
SVT	-	-	-
Aftonbladet	1	-	-
Sportbladet	-	-	1
Kvällsposten	1	-	-
Expressen	3	-	-
Dagens nyheter	-	1	2
KIT	-	1	1
Malmö stad	-	-	-
Morgan Alling	-	-	-

Nexus 5X (test)

Page	3 h	24 h	46 h
TV4	1	1	1
SVT	-	-	-
SVT Humor	-	-	-
Kanal 5	1	-	-
Sportbladet	-	-	-
Dagens nyheter	-	-	1
KIT	-	-	-
Djurbibeln	-	1	1
Socialdemokraterna	-	-	-
Morgan Alling	-	-	1

Sony Xperia Z5 (control)

Page	3 h	24 h	46 h
TV4	2	3	2
SVT	1	2	2
SVT Humor	1	1	1
Kanal 5	-	-	-
Sportbladet	-	-	1
Dagens nyheter	-	-	-
KIT	1	1	1
Djurbibeln	1	2	1
Socialdemokraterna	1	1	1
Morgan Alling	-	-	-

In this experiment, we looked into what the friends of the accounts like on Facebook and found that two of them like TV4 and one of them likes Sportbladet. There is also a connection between the rest of the pages and the accounts' friends' contact network. From the additional seven pages added in experiment 4, two of them, Morgan Alling and Malmö stad (Malmö town), are less popular pages. In one of Morgan Alling's posts, he wrote about a lecture he held in a small town in Sweden, called Gislaved. What is significant is that 5 out of 16 contacts either originate from or live in Gislaved. This information is visible in their profiles when visiting them.

Now that the feature Popular on Facebook seems to target based on other aspects than popularity within the country, we chose to look up the number of likes on each Facebook page seen in this experiment. The result is seen in figure 5.1. Morgan Alling's page has among the lowest number of likes of all popular pages. Note once again that the only pages that have a direct connection with the contact network of the accounts are TV4 and Sportbladet, the rest have a connection through the friends' contact network.

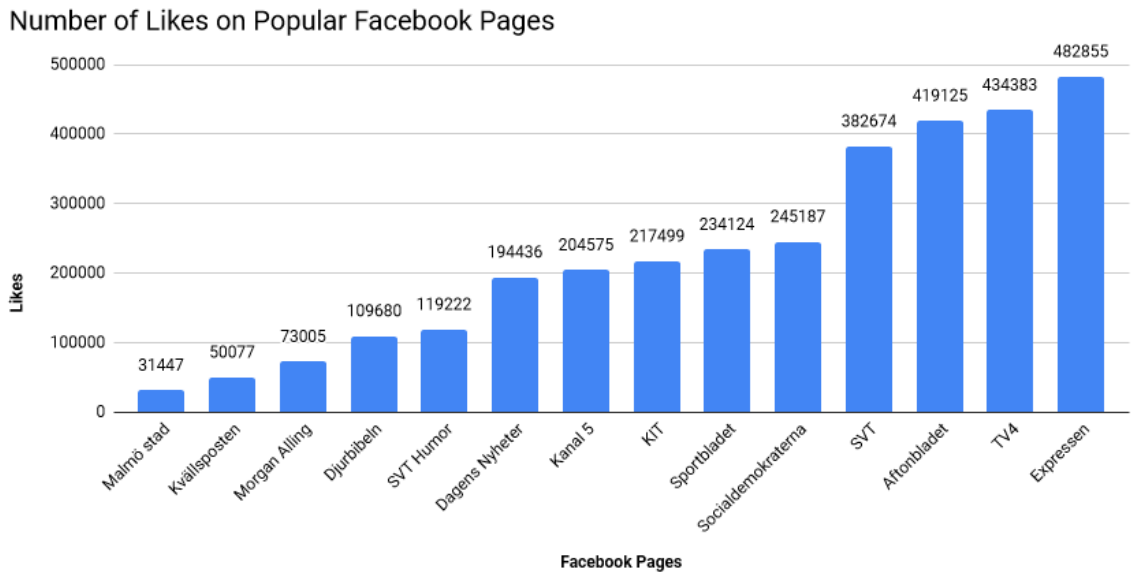


Figure 5.1: *The number of likes on each of the recommended Facebook pages.*

Malmö stad is the popular page with the least likes, and it is probably displayed in the news feed because all active sessions in each account have set the location to Malmö. This even though the experiments were performed 200 km from Malmö. Once again, this page does not have anything to do with the overall popularity in Sweden, despite it being the third largest city in the country. It indicates that the current location of the accounts has an impact on the Popular on Facebook feature.

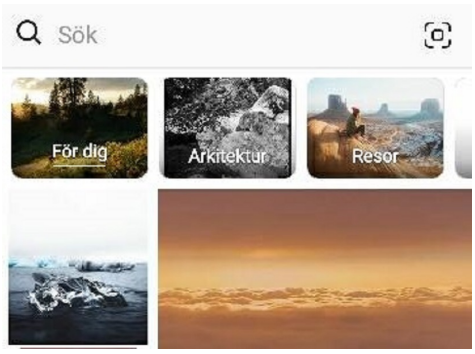
The result from this experiment shows that the iOS test phone gets most posts from popular TV-channels. The two least popular pages in the iOS test phone are Morgan Alling and Malmö stad. The majority of the posts on the iOS control phone are from popular newspapers, and it only got two posts from a TV-channel. The Android test phone did not get as much on its news feed as the rest of the phones. It seemed odd, and it was the only phone that was prompted to add more friends on Facebook, which is seen in figure 5.2 below. A translation of the message is "You have 16 Facebook friends! Add at least 15 additional friends to see more posts and photos here in the news feed. Find friends".

Figure 5.2: *The message is seen in the Facebook application on the Nexus phone.*

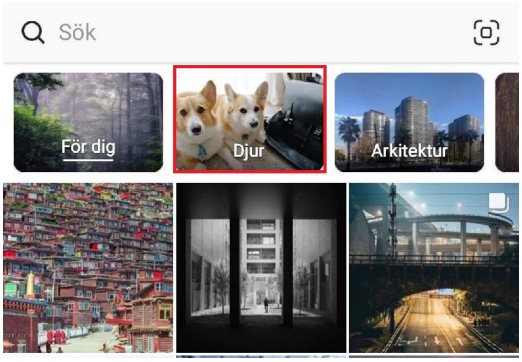
Despite the Android control phone not being exposed to the recorded dialogue, it contains the most significant amount of posts on the news feed. The posts are mostly from different TV-channels and newspapers, and it is the only phone containing posts from a political party.

5.4.2 Instagram

The topics in the *Search & Explore* tab in the Instagram application have been in the same order in all previous experiments so far, starting with *Arkitektur* (Architecture) and followed by *Resor* (Travels). In this experiment, a change was found in the Android test phone after 46 hours. It was the first time another topic than the default ones was displayed. According to Instagram, "on Search & Explore you can find photos and videos that you might like from accounts you don't yet follow. You may also see curated topics we think the Instagram community will enjoy" [49]. They also state that "posts are selected automatically based on things like the people you follow or the posts you like" [50]. Figure 5.3 shows a comparison between the default Search & Explore tab seen in all of the other phones and the Search & Explore tab on the Android test phone.



(a) *The Search & Explore tab on all phones in all experiments.*



(b) *The Search & Explore tab on the Android test phone in experiment 4.*

Figure 5.3: *The difference in the Instagram applications in the Search & Explore tab marked with a red box.*

Besides from having *Djur* (Animals) as a topic, some of the pictures and videos now included dogs. The dialogue played for this phone contains the words "djur" (animal) and "häst" (horse). The word horse was mentioned six times, and the word animal was mentioned three times (this includes concatenations of the word) which can be seen in table B.2 in appendix B.3. Besides this, the feed on Instagram was empty throughout all experiments, and no advertisement was received.

5.5 Analysis of Results in Experiment 3 & 4

The first two experiments had the same results, which means that no advertisement was present and the applications did not contain any other relevant content. Experiment 3 and 4 gave more results that can be further analysed. Therefore, this section will only focus on these two experiments.

5.5.1 Amount and Changes of Posts

The accounts in experiment 3 were used for three days and the same accounts were used in experiment 4 for three additional days. This means that the accounts had

been used for 6 days when experiment 4 had finished. When experiment 4 started, the accounts allowed Facebook and the Messenger to access the microphone. The results from the experiment indicate therefore that the lifetime of the account or the microphone access affects the content in the news feed. It can also be a combination of the two of them. Table 5.5 below shows changes in the number of posts from each page in experiment 4, compared to experiment 3. These numbers are calculated from the results in table 5.2 and table 5.4.

Table 5.5: *The change in the number of posts throughout the whole period in experiment 4, compared to experiment 3.*

	iPhone 7 (test)	**iPhone 7 (control)**	**Nexus 5X (test)**	**Sony Xperia Z5 (control)**
Total:	+8	+10	+1	+14

The increasing number of posts varies, and what is significant is that the Android test phone only increases with one post when the Android control phone increases with 14. The number of posts on the iPhones increase with a similar amount; 8 and 10.

5.5.2 Changes in Posts

The increase or decrease of posts from specific pages between experiment 3 and 4 are seen in figure 5.4, 5.5, 5.6 and 5.7. These numbers are calculated from the results in table 5.2 and table 5.4.

Android Phones

Viewing figure 5.4 shows that the test phone displayed seven additional posts and six posts disappeared from the Facebook news feed. One of the posts that disappeared is from a TV-channel page, and the remaining posts come from newspaper pages. The additional posts are spread through all of the topics. The changes occurred most often after 24 and 46 hours, 30.8% respectively 46.2%.

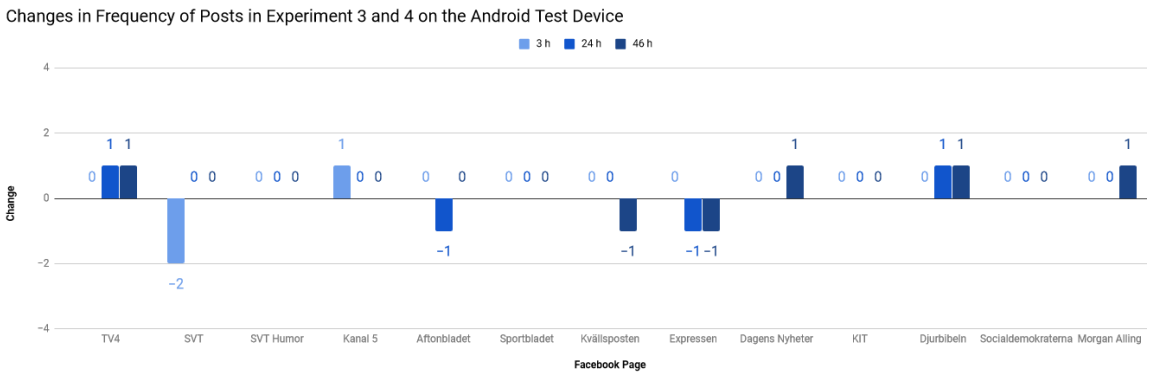


Figure 5.4: *The changes in the frequency of posts on the Android test device in experiment 4, compared to experiment 3.*

Figure 5.5 shows 14 additional posts from the news feed in the control phone, which are spread through the different topics. No posts disappeared from the news feed. The changes occurred most often after 3 and 24 hours, 35.7% respectively 42.9%.

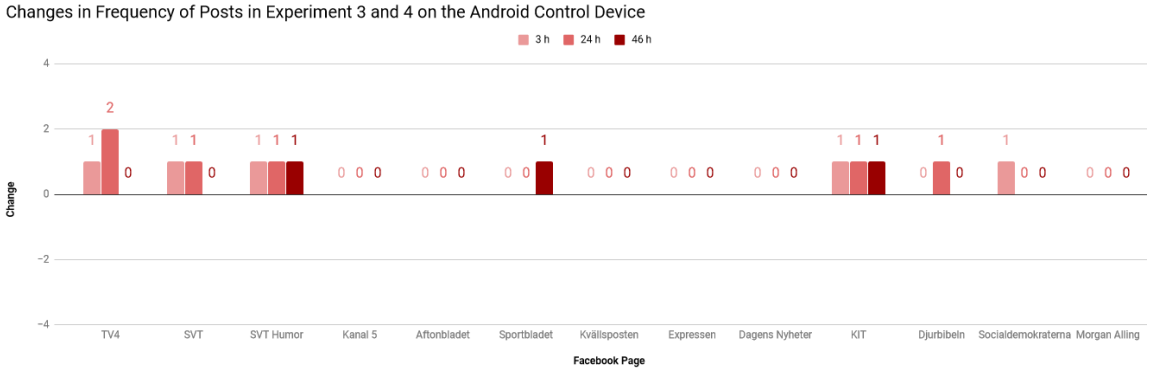


Figure 5.5: *The changes in the frequency of post on the Android control device in experiment 4, compared to experiment 3.*

iOS Phones

Viewing figure 5.6 shows that the test phone displayed nine additional posts and one post had disappeared from the Facebook news feed. The posts that disappeared is from a TV-channel page. The other posts are mainly from a TV-channel page, TV4, and Morgan Alling and Malmö stad. The changes occurred most often after 24 and 46 hours, 40.0% respectively 50.0%.

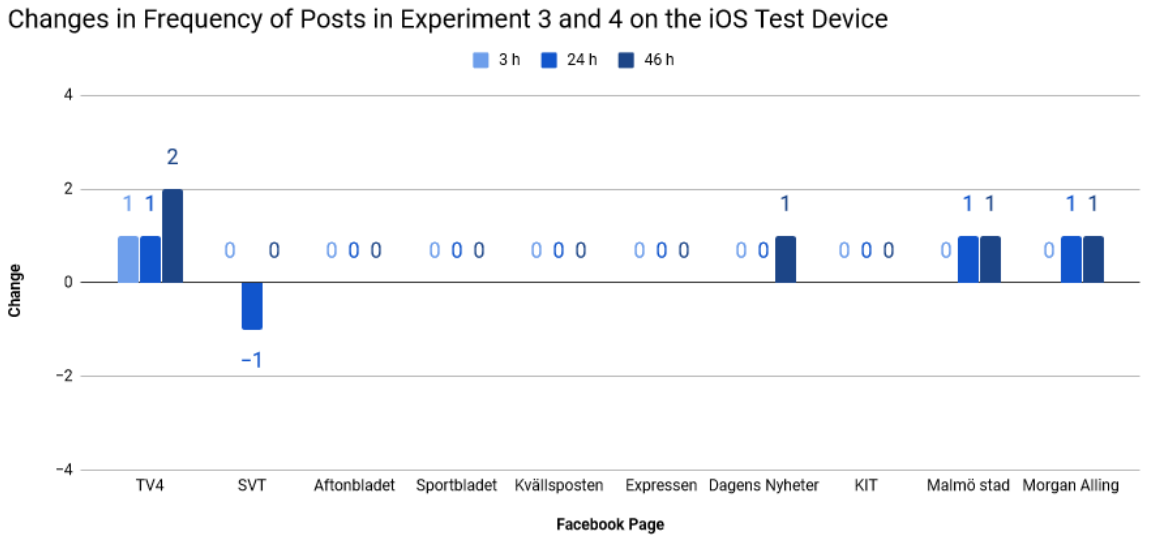


Figure 5.6: *The changes in the frequency of posts on the iOS test device in experiment 4, compared to experiment 3.*

Figure 5.7 shows 13 additional posts, mainly from newspaper pages, in the news feed of the control phone. Three posts disappeared from the news feed belonging to the newspaper pages as well. The changes occurred most often after 3 and 46 hours, 31.3% respectively 43.8%.

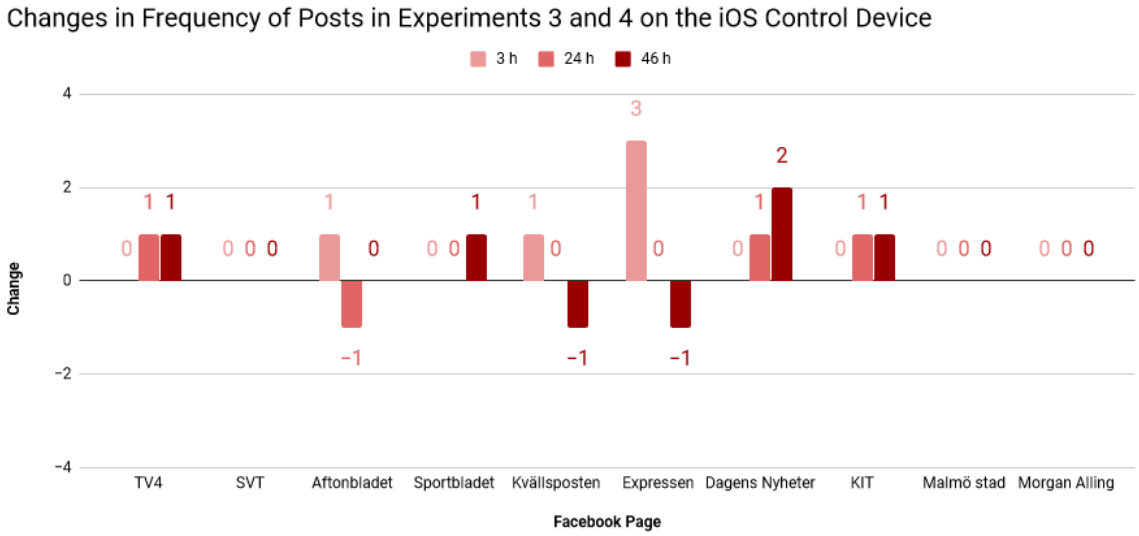


Figure 5.7: *The changes in the frequency of posts on the iOS control device in experiment 4, compared to experiment 3.*

5.6 Experiment 5

Before executing the experiment, both iOS phones and the Android control phone did not have any posts on the Facebook news feed from the Popular on Facebook feature. The Android test phone had two posts from the feature, one from *SVT Humor* and one from *Veckorevyn*, which is a famous female magazine. The Android test phone still had the topic *Animal* as the first recommended topic under the Search & Explore tab on Instagram.

5.6.1 First week

Facebook

The occurrence of popular pages in the Facebook news feed varied during the first week, which is seen in table 5.6. At first, there were no or just a few posts in all four phones. The number of posts significantly increased on Friday, compared to the rest of the week. This time some pages have not been displayed in the previous experiments. These are the following:

- Radio/TV show: *UR*.
- Newspaper: *Veckorevyn*, *Uppskattat* and *Matbibeln*.
- Former athlete: *Aron Andersson*.
- Entertainment: *Worldstar Sweden*.

The only popular page connected to the accounts through friends like was Uppskattat. The rest of the pages were connected one step further away. The amount of likes on each page varies between approximately 50,000 to 450,000. Table 5.6 presents the occurrences of pages on each phone during each day.

Table 5.6: *The occurrence of popular pages in the news feeds on each phone during week 1.*

iOS (test)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	-	1	1	-	1	1
SVT Humor	-	-	-	-	-	-
Sportbladet	-	-	-	-	-	-
Dagens Nyheter	-	-	-	-	1	-
Uppskattat	-	-	-	-	-	-
Worldstar Sweden	-	-	-	1	1	1
Aron Anderson	-	-	-	-	-	1
Total:	**0**	**1**	**1**	**1**	**3**	**3**

iOS (control)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	-	-	-	-	-	1
SVT Humor	-	-	-	-	1	-
Sportbladet	-	-	-	-	1	-
Dagens Nyheter	-	-	-	-	1	-
Uppskattat	-	-	-	-	-	1
Worldstar Sweden	-	-	-	-	-	-
Aron Anderson	-	-	-	-	-	1
Total:	**0**	**0**	**0**	**0**	**3**	**3**

Android (test)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	-	-	-	-	1	1
SVT Humor	1	-	-	-	1	1
UR	-	1	-	-	2	2
Sportbladet	1	-	-	-	-	-
Veckorevyn	1	-	-	-	-	-
Dagens Nyheter	-	-	-	-	1	1
Matbibeln	-	-	-	-	1	1
Total:	**2**	**1**	**0**	**0**	**6**	**6**

Android (control)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	-	-	-	-	-	-
SVT Humor	-	-	-	-	-	-
UR	-	1	-	-	-	-
Sportbladet	-	-	-	-	-	-
Veckorevyn	-	-	-	-	-	-
Dagens Nyheter	-	-	-	-	-	-
Matbibeln	-	-	-	-	-	-
Total:	**0**	**1**	**0**	**0**	**0**	**0**

The iOS test phone had a total of 9 posts during the whole week, and the iOS control phone had 6. The Android test phone had a total of 15 posts, and the Android control phone had 1. In both cases, the test phones had more posts than the control phones. However, the difference in the number of posts is more significant between Android phones.

The advertisement settings on Facebook had not been modified by Facebook nor us until Friday. During the analysis on Sunday, it had been changed by Facebook. Facebook added Wish and Wish Local to the list of advertisers who share data about the user on all four cell phones. A screenshot from *Advertisement Settings* → *Advertisers* is shown in figure 5.8.

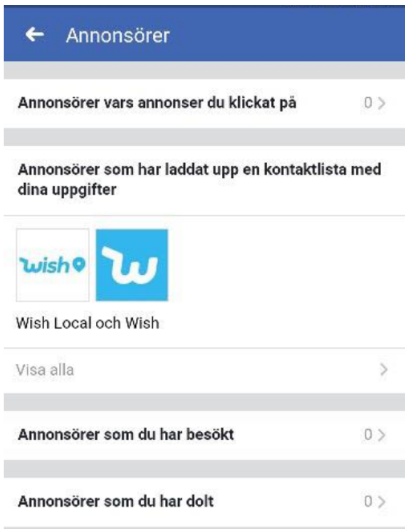


Figure 5.8: *Advertisers in the advertisement settings on the Facebook application.*

Messenger

Advertisement on the Messenger Inbox has been present on the Android control phone from the beginning of the experiment. However, none of them can be related to the dialogue. The other cell phones did not have any advertisements present.

Instagram

The topics in the Search & Explore tab varied throughout the experiment. The overall results from these changes seemed to be randomised and therefore each week's result is presented in Appendix E.1. The first week's result is listed in Appendix E.1, table E.1. No additional changes were observed in the Instagram application.

Wish

The popular tab in the Wish application had several posts on Bluetooth headphones, a different type of bag and smartwatches in all four phones. It indicates that these products are present in the application for the majority of new accounts. This assumption is based on the fact that both test phones and control phones contained the same products but in a different order. On Thursday, the Android test phone received a recommendation of a face serum in the popular tab. When looking up this serum on a separate computer, it says that it is an anti-ageing serum. Figure 5.9 shows a screenshot of the product in the feed.

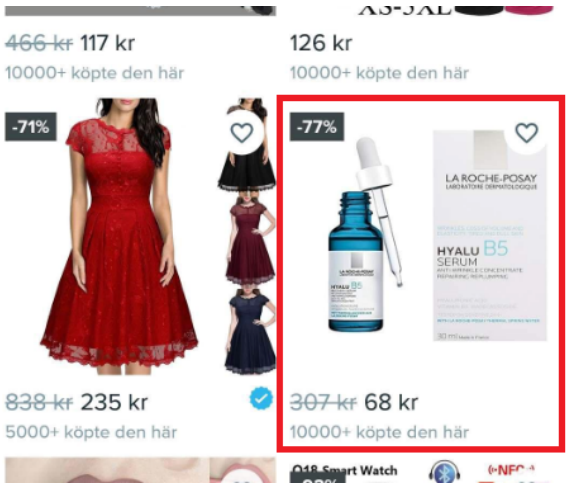


Figure 5.9: *The serum shown in the Wish application on the Android test phone.*

This product was not present in any of the other three cell phones, nor was it displayed again. The dialogue played for the phone, in Appendix B.4, contains a short section where it discusses skin care. In this section, the words "anti-age" and "antirynkkräm" (anti-wrinkle cream) were mentioned once each. It was the reason why the specific post looked interesting, together with the reason that no other skin care products have been present on any of the phones.

5.6.2 Second week

Facebook

Pages that occurred in the news feed from the Popular on Facebook feature that had not been present before are the following:

- TV: *Öppet arkiv* and *SVT Barnkanalen*.
- Food recipes: *Zeinas kitchen*.

None of the popular pages is directly connected to the accounts, nor has the accounts' contact network liked them. The amount of likes on each page varies between approximately 35,000 to 165,000. The occurrences of popular pages on each phone during each day are presented in table 5.7.

Table 5.7: *The occurrence of popular pages in the news feeds on each phone during week 2.*

iOS (test)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
Sportbladet	-	-	-	-	-	-
Uppskattat	-	-	-	-	-	-
Zeinas Kitchen	1	-	-	-	-	-
Total:	**1**	**0**	**0**	**0**	**0**	**0**

iOS (control)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
Sportbladet	1	1	1	1	1	1
Uppskattat	-	1	1	1	1	1
Zeinas Kitchen	-	-	-	-	-	-
Total:	**1**	**2**	**2**	**2**	**2**	**2**

Android (test)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	1	-	-	-	-	-
SVT Humor	1	1	-	-	-	-
SVT Barnkanalen	-	1	-	-	-	-
Öppet Arkiv	1	-	-	-	-	-
Sportbladet	1	-	-	-	-	-
Uppskattat	1	-	-	-	-	-
Zeinas Kitchen	-	1	-	-	-	-
Total:	**5**	**3**	**0**	**0**	**0**	**0**

Android (control)

Page	Mon.	Tue.	Wed.	Thu.	Fri.	Sun.
SVT	-	-	-	-	-	-
SVT Humor	-	-	-	-	-	-
SVT Barnkanalen	-	-	-	-	-	-
Öppet Arkiv	-	-	-	-	-	-
Sportbladet	-	-	-	-	-	-
Uppskattat	-	-	-	-	-	-
Zeinas Kitchen	-	-	-	-	-	-
Total:	**0**	**0**	**0**	**0**	**0**	**0**

The iOS test phone had a total of one post during the whole week, and the iOS control phone had eleven. The Android test phone had a total of eight posts, and the Android control phone had zero. In all cases except for the iOS control phone, the number of posts has decreased significantly compared to the previous week. The iOS control phone has the same posts from Tuesday to Sunday, and there are no posts in any of the other phones from Wednesday and forward. What also is significant is that the Android control phone had no posts at all and the iOS test phone only had 1. It may be possible that these are now seen as bots or illegitimate users by the application even though it is used frequently.

During week 2, each account liked a comment made by a friend on one of Sportbladet's posts. Two days after this like, each account's news feed contained posts that were present due to it being a "similar post that you have interacted with". These are not present in table 5.7. All of these posts came from Sportbladet, and the number of posts was 1-2 on each phone on Friday and Sunday.

The advertisement settings on Facebook had not been modified by Facebook nor us in this week. The accounts still had Wish and Wish Local on the list of advertisers who share data about the users.

Messenger

Advertisement in the inbox of the Android control phone was still present, and it emerged on the iOS control phone on Wednesday, but none of the ads could relate to the dialogue. The new phones had no advertisement.

Instagram

The deviating topics from the previous week and their order between each day during the second week are listed in Appendix E.1, table E.2. No additional changes were observed in the Instagram application.

Wish

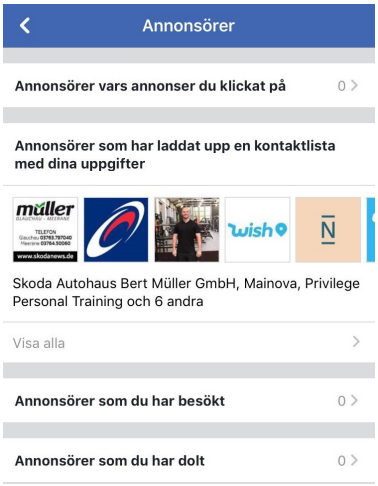
There have been no differences in the type of products displayed for the test and control phones throughout the week. New products shown that can be related to the script are sneakers, but they are present in all phones and most likely not targeted.

5.6.3 Third week

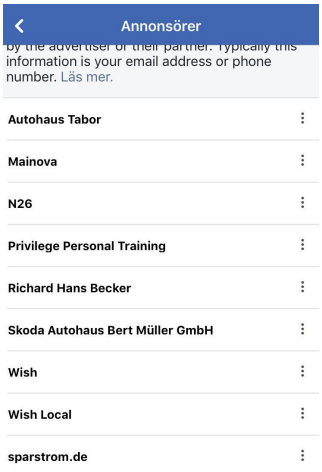
Facebook

In the third week, no posts from the Popular on Facebook feature were present. The only posts that appeared came from the feature "similar posts that you have interacted with". Twelve posts on all phones were shown, eleven of them were present on Monday to Wednesday, and the final post appeared on Sunday. All posts came from "Sportbladet".

On Monday, several German companies appeared in the Facebook Ads Settings on the iOS control phone. These were shown under *Advertisers → Advertisers who uploaded a contact list with your information.* This is seen in figure 5.10 below.



(a) *Images of the companies that have uploaded a contact list of the account.*



(b) *A list of the companies that have uploaded a contact list of the account.*

Figure 5.10: *The Facebook advertisement settings in the iOS control phone's account.*

These companies were not present in the iOS test phone even though it acted in the same way as the iOS control phone, besides not being exposed to the recorded dialogue. It is, therefore, not possible to answer to why they appeared nor why they were present on only one of the iOS phones.

The next events in the Ads settings occurred before analysis on Sunday. In all four phones, *Wish* and *WISH-TV* were added to *Your interests* → *Your top interests*. In the iOS control phone, two of the advertisers that share a contact list, Richard Hans Becker and sparstrom.de, were removed from the advertiser list.

Messenger

Advertisement in the inbox of both control phones was still present during the week. The other phones had no ads in the Messenger inbox.

Instagram

The deviating topics from the previous week and their order between each day during the third week are listed in Appendix E.1, table E.3. No additional changes were observed in the Instagram application.

Wish

There have been no significant differences in the type of products displayed for the test and control phones throughout the week. However, one product appeared in the Wish application on the Android test phone in the middle of the week. It was an anti-wrinkle and anti-age facial moisturiser. The product is seen in figure 5.11 below.

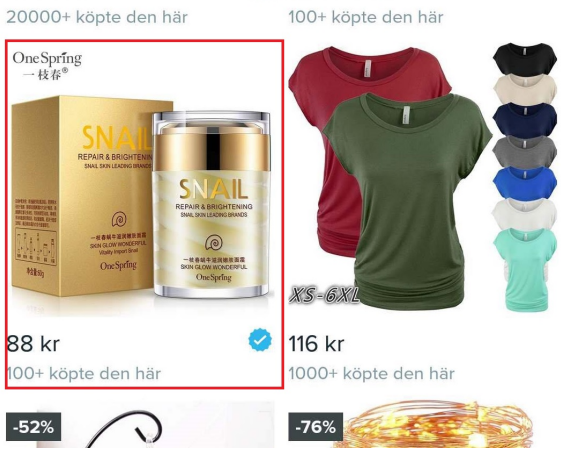


Figure 5.11: *The facial moisturiser shown in the Wish application on the Android test phone.*

This result is similar to the result from the first week. As mentioned there, the dialogue played for the phone, in Appendix B.4, contains a short section where it discusses skin care. In this section, the word "anti-age" was mentioned once, and

the word "antirynkkräm" (anti-wrinkle cream) was also mentioned once. On Friday, the same anti-age serum seen during the first week of the experiment, figure 5.9 was displayed on both Android phones.

5.6.4 Fourth week

Facebook

In the fourth week, no posts from the Popular on Facebook feature were present. The only post that appeared came from the feature "similar posts that you have interacted with" during the Monday analysis. This post came from "Sportbladet". The same German companies were still present in the Facebook Ads Settings on the iOS control phone.

Messenger

Dialogue D.3.4, communicated via the Messenger application mentioned the cosmetic company Kicks twice, once by the author and once by the other account. This dialogue was performed on Wednesday at 10:00 and the day after during analysis, commercial from Kicks appeared in the Messenger application on the Android control phone. This advertisement is displayed in figure 5.12 below.

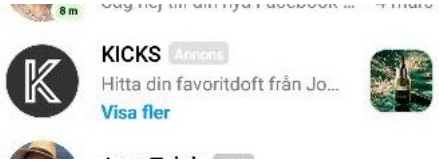


Figure 5.12: *The advertisement from the Kicks company in the Messenger application.*

This advertisement was present during the analysis on both Thursday and Friday, but on Sundays analysis, it had been replaced. The iOS control phone still had the same advertisement in the Messenger inbox as before, and it has no relation to the written or spoken dialogues.

Instagram

The deviating topics from the previous week and their order between each day during the fourth week are listed in Appendix E.1, table E.4. No additional changes were observed in the Instagram application.

Wish

During the last week of analysis, no relevant type of product was displayed on the Wish application.

Chapter 6

Discussion

This chapter will discuss the chosen method and how it affects the validity. It also discusses the different outcomes in the experiments, as well as the research in general.

6.1 Previous Phone Activity

It is hard to state whether the previous activity of the cell phones can impact the outcome, if so, this would be a validity threat. Even though factory resets have been performed, there might be some information left. Things such as hardware identifiers do not change when a software reset is made, and this might be one of the parameter shared with Facebook and other applications.

If the previous activity affects the outcome, this might explain why we got "Djurbibeln" as a popular page on the Android control phone in experiment 3 and on both Android phones in experiment 4. This can for an example be that the previous owner of the phone had a Facebook account where he/she liked Djurbibeln's Facebook page. Another possible scenario is that Facebook has identified this device to have an owner who is interested in animals in general. Djurbibeln is according to us not popular and of interest for the whole Swedish population. This page is not liked by any of the accounts' contacts either.

6.2 Method

6.2.1 Test Data

Our scripts mentioned several products in a short period. In some of the related works, they used another approach and focused on only one product and repeated this several times. Our approach was chosen because we wanted to have test data that simulated a real-life scenario and conversation. We also wanted future results to be accurate and not dependent on one coincidence. If we would repeat one product and it would show up, it would not be as reliable as if several products mentioned would have been displayed in the advertisement. We also chose to say the keywords different amount of times to see if this had an impact on the result.

To increase internal validity, the products and brands were chosen randomly. The sources where these were generated from are well-known and accessible for everyone. In all experiments, both the test phones and control phones were exposed to the same

events (besides the playing of the recording) and environment at the same time. One factor that can threaten the external validity and was taken into consideration is surrounding noise. The phones were isolated during all of the experiments. The only time when the test phones had to be exposed to sound was during the playing of the recordings. At this time, they were set in a quiet room to ensure no additional sound would be picked up.

6.2.2 Creation Date of Accounts

All emails and Facebook accounts in experiment 1-3 were created the same day as the experiments started, with the same settings. One speculation we had is that the creation date would impact the content in the applications because Facebook or the other applications might see them as bots. Based on the results, this may not be the case. This conclusion is based on the fact that the same accounts were used in experiment 3-5 and we got most content in experiment 3 and 4. Experiment 5 that had the most extended lifetime and most activities on the accounts was also the experiment that had the least posts in the news feed. It contradicts our speculation that higher lifetime and more activity on an account would result in more advertisement. We still do not understand why posts on experiment 5 decreased so drastically.

The use of the same accounts and more activity in experiment 5 resulted in almost no posts visible at the end of the experiment. We believe that the equal lifetime and interactions at the same time in all cell phones may have made Facebook identify the accounts as bots and thereby not providing additional content in the applications. However, experiment 1-3 also showed that advertisements were not present in newly created accounts with almost no interactions. Therefore, this is something to have in mind when creating similar research.

6.2.3 Interactions with the Applications

All actions performed in experiment 5 were chosen not to affect the outcome of the advertisements. Therefore, we carefully chose not to perform actions that would change the interests that Facebook has mapped to the user. This could be validated by looking into the advertisement settings, which had no interests during the whole research. Things that were liked or chat conversations performed does not threaten the validity of the research because we carefully selected topics and content that are not related to the content of the recorded dialogue. We also liked Wish's Facebook page and some of their posts, however, we made sure that these posts contained nothing that could be related or similar to the content of the recorded dialogue.

6.3 Reliability of Results

The iOS phones used in this experiment had the same model, application and OS versions and they have been in the same environment except when playing the recorded dialogue. When it comes to the Android phones, they had different models, OS and application versions and they were also in different environments only when the recorded dialogue was played. Besides this, all application activities have occurred at the same time with the same content in all four phones. Due to the differences in the Android phones, we believe that the comparisons between the test phone and the control phone are not as reliable as the outcome from the iOS phones. Another issue is that Facebook seemed to identify the Android test phone as an inactive user or a bot throughout experiment 1-4, which makes eventual comparisons of the outcomes inaccurate.

A threat to the external validity is that the content in the applications will most likely not be the same when replicating the experiments containing a Facebook contact network. The reason why is that the Facebook friends of the experimental accounts will not be the same if another person tries to redo the experiment with their friends. However, we believe that the likelihood of similar results when replicating the experiments is high. This means that the result will show posts from the *Popular on Facebook feature* and *Similar posts that you have interacted with* and not sponsored advertisement, as well as the risk of Facebook identifying the accounts as illegitimate users. If we ignore the contact network variable, Facebook can make changes in their services that affect the content in or the appearance of the application(s). However, we still believe that the likelihood of similar results is high.

6.4 Experiment 1 & 2

The result in experiment 1 was something we expected even before experimenting because we did not allow microphone access and we did not have any contacts on the accounts. Due to these restrictions, we believe that Facebook would not eavesdrop, because it would be illegal to access the microphone without permissions. In experiment 2, the accounts allowed microphone access, and the result was the same as in experiment 1. Since none of the accounts has a contact network, Facebook would not be able to claim that advertisement is shown based on a friend's interests and it would, therefore, be too obvious if they would eavesdrop.

We believe that due to the accounts not having a contact network, Facebook might consider them as illegitimate users. Another option is that the information in, and the usage of the account is not sufficient for Facebook to recognise the accounts as legitimate. For this reason, Facebook might ignore the accounts due to them suspecting the users of being bots.

6.5 Experiment 3 & 4

6.5.1 The Facebook Application

In all experiments, the iPhones are identical, and the accounts created for each of them are also similar except the name and the day of birth. In table 5.1, and table 5.3 we had expected to have a similar number of posts in the news feed despite the minor differences in the iPhones and their accounts. Because of the significant difference in the number of posts, it may indicate that Facebook picks up sounds from the microphone to see whether the user of the account is legitimate or not. The same tables show that the Android devices had more posts on the control phone than the test phone. It contradicts the assumption that Facebook listens through the microphone to identify active users.

Experiment 4, which allowed microphone access and had a contact network, showed that additional popular pages were presented in the Facebook news feed compared to experiment 3. We used the same accounts for experiment 3 and 4, and we can, therefore, not answer whether the increase of posts is because of the lifetime of the accounts, the microphone access or both of them. This time, we payed attention to two of the added pages, Morgan Alling and Malmö stad, and mainly the content in Morgan Alling's posts about a lecture in Gislaved. From this displayed post, we assume that the Popular on Facebook feature targets users based on friends information as well, such as their residence. It means that popular pages are not only based on the current location, nor on what the majority of the Swedish users like and are interested in. The Morgan Alling post was only seen on the test phones and not on the control phones. We cannot identify anything in the recorded dialogue that may be associated with him, the content of his post or Gislaved. However, both authors originate from this district and have the same accent as people in Gislaved. If Facebook is eavesdropping, they may recognise this accent.

6.5.2 The Instagram Application

Until experiment 4, the content under Search & Explore was unchanged, and it seemed to be based on topics that Instagram believes their community enjoys. After 46 hours in experiment 4, the default topics in Search & Explore were changed, and an animal topic was added to the Android test device. It was suspicious because it was the phone exposed to the dialogue that received this topic and the script mentioned the word "animal" several times.

6.6 Experiment 5

6.6.1 Content Decrease in the Facebook Application

From the previous experiments we assumed that the longer the lifetime of the account and how active they were, the more content would be displayed in the Facebook news feed. We had not yet analysed any sponsored posts, which was the main purpose of this research, and therefore we tried to use the applications in a controlled manner.

Despite the tries to trigger additional content, the content decreased during the whole experiment. The only explanations we can think of are:

- Facebook might provide help for new users to get started with the application(s) by providing suggestions of pages. After some time, Facebook thinks that the user does not need more help.
- The application activity might have had the opposite effect. We noticed that after we liked a friend's comment in one of the page's posts, only this page started to emerge in the news feed in all phones except the iOS control phone, which had other posts as well. Facebook might have seen the users as independent and disabled other recommendations from that moment on.
- As we have mentioned before, Facebook might consider the accounts to be bots, and therefore did not spend any additional resources on providing recommendations.

6.6.2 Facebook Advertisement Settings

During the third week of experiment 5, the advertisement settings in the iOS control phone was modified. New companies were added to the section of companies which had uploaded a contact list with the user information. The added companies came from various areas, such as cars, banks and water and electricity distribution. One thing that the new companies had in common is that they operate in Germany. The occurrence of these companies in the advertisement settings is suspicious because none of the accounts has uploaded information to any application besides the ones used in this research, Wish and Wish local. The experiments were performed in Sweden, and we think that none of these companies is well-known by the Swedish population. Some possibilities may explain this outcome:

1. The companies provide false information about the account.
2. Some of the applications used in this research share information with other companies.
3. There is a bug in the Facebook application.
4. Someone provided the email address used in the experiment and additional false information to the companies.

6.6.3 Messenger Application

The Messenger application on the Android control phone got advertisement from the Kicks company during the last week of experiment 5. The only phones that got advertisements in the Messenger inbox during the fifth experiment were both control phones. However, the iOS phone had the same advertisement during the whole experiment, while the Android phone had different. If the iOS device would have had changing advertisement, Kicks might appear there as well. We believe that this advertisement was present due to the content of the written dialogue. This indicates that Facebook may trigger on strings containing advertisers' company names or keywords that may be related to these companies. However, since the experiment finished after this week, we had no possibility to further examine this.

6.6.4 Popular Content in the Wish Application

On Thursday in the first week of the experiment, a blue facial serum was displayed in the Android test phone and not in the other phones. We became suspicious since this was the first week of the experiment. In the middle of the third week, another anti-age serum was displayed on the same phone. However, on Friday, the blue serum appeared on the Android control phone as well. It made us think that the appearance of these serums probably was a coincidence. We did not see the latter serum in any other of the phones, but we only had one remaining week of the experiment and could not examine this further.

6.7 Research Questions

This section answers our research questions by analysing the outcomes from the experiments. The research questions are repeated below.

RQ1. Is Facebook eavesdropping on spoken conversations to use them for marketing purpose, and if so, how does the variable(s) used influence the outcome?

RQ2. Can keywords from spoken conversations be identified, and if so, are there any common traits for them?

6.7.1 Research Question 1

No sponsored advertisements from companies were found. To get advertisements, the accounts probably need to become more active and have a more extensive contact network, which the experiments did not cover. Additional interaction with the applications were not viable due to it most likely influencing the outcomes and complicating the method of reproduction. Due to the tests not being sufficient enough to trigger sponsored advertisements, we found no indications of Facebook eavesdropping on their users through the microphone for marketing purpose.

The results presented were pages in the Facebook news feed that came from the Popular on Facebook feature. The results were only present in the Facebook application, and not in the Instagram application. The Android control phone and the iOS control phone were the only ones that had one advertisement each in the inbox of the Messenger application.

6.7.2 Research Question 2

Since no sponsored advertisement was present, we could not identify any keywords from the conversation on Facebook or the Messenger applications. In the Instagram application, the topic animal was present on the Android test phone during experiment 4. However, during experiment 5 all other phones except the iOS test phone changed the default topics, but none of the control phones had the animal topic. Animals are a common interest for people, and we can not say if this was picked up from the spoken conversation.

The popular products in the Wish application contained an anti-wrinkle serum in the Android test phone during the first week of analysis in experiment 5. This serum was not present in any other phone until on Friday during the third week. It makes the product recommendation most likely a coincidence. During the same week, another anti-wrinkle facial serum was shown on the same phone. This serum was not displayed in any of the other phones during the remaining time of the experiment. This serum may or may not be there by coincidence.

6.8 Observation on Our Device

When planning for the fifth experiment, we analysed the Wish privacy policy and data collection. We discussed possible interpretations of the policies. One of the discussions we had was whether Wish could advertise for other companies and products. One of us stated (in Swedish) that this could mean that Wish, for example, advertises GANT shirts. The following day, one of the authors got Wish advertisement about GANT shirts in her Facebook news feed, shown in figure 6.1. The recording of

Figure 6.1: *The Wish advertisement present in the Facebook news feed.*

the dialogue that was played for the test phones contained this brand. However, the recording was not present on the device that received the Wish advertisement of the GANT shirt. The owner of the device does not own any GANT clothes or have the interest of doing so; therefore there had been no web activity of this in the device or over the Wi-Fi network.

This result was not a part of any of the experiments, and it was not triggered in a controlled environment. Therefore, it means that this outcome cannot be taken into consideration when summarising the overall results, but could be of interest for future work.

6.9 Contribution

To the best of our knowledge, this is the first research which examines whether there is a possibility of Facebook eavesdropping on their users through the microphone for marketing purpose. Therefore, this research examines this research gap and sets a good foundation to how this kind of research can be performed. Because this research started with very basic accounts and settings, other researchers can read this report and easily extend the research. Researchers that are interested in future work can also get a good overview on what can be done differently in order to fill the research gap. The developed methodology could also be adapted and reused to examine other applications than the ones used in this research; Facebook, Messenger, Instagram and Wish.

Chapter 7

Conclusions and Future Work

This research could not find any indications of Facebook eavesdropping on their users through the microphone. The experiments performed were not sufficient enough to trigger sponsored posts in the Facebook news feed or the Instagram application. Without the sponsored advertisements it is not possible to answer our research questions. The ads in the Messenger application indicated that Facebook might analyse private messages and adapt advertisements based on the content. It is vaguely described in their data policy; they do not mention whether they only collect meta-data or the content of messages.

Our research did not manage to get sponsored advertisements on the Facebook news feed. Our recommendation is, therefore, to use already created Facebook accounts that have sponsored ads in the news feed or to create new accounts that are more active and have a more extensive contact network that can trigger sponsored advertisement to appear. When sponsored ads are present, the next step is to use a spoken conversation. In our research, we chose to create authentic real-life scenarios which repeated many products and brands a few times, but another approach would be to focus on fewer products and brands and repeat them more times. If this succeeds, another future work would be to analyse the network traffic that is sent to and from Facebook.

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Appendix A

Versions

A.1 OS and Application Versions

Table A.1: *OS and Software versions in the experiments.*

Experiment 1

Device	Software	Version
iPhone 7 (both)	iOS	12.1.4
	Facebook	209.0.0.33.90
	Messenger	202.0
	Instagram	81.0
Nexus 5X	Android	8.1.0
	Facebook	209.0.0.39.91
	Messenger	203.0.0.21.91
	Instagram	81.0.0.15.91
Sony Xperia Z5	Android	7.1.1
	Facebook	209.0.0.39.91
	Messenger	203.0.0.21.91
	Instagram	81.0.0.15.91

Experiment 2

Device	Software	Version
iPhone 7 (both)	iOS	12.1.4
	Facebook	209.0.0.33.90
	Messenger	204.0
	Instagram	82.0
Nexus 5X	Android	8.1.0
	Facebook	208.0.0.38.104
	Messenger	204.0.0.14.119
	Instagram	82.0.0.13.119
Sony Xperia Z5	Android	7.1.1
	Facebook	208.0.0.38.104
	Messenger	203.0.0.21.91
	Instagram	82.0.0.13.119

Experiment 3 and 4

Device	Software	Version
iPhone 7 (both)	iOS	12.1.4
	Facebook	210.0.0.37.117
	Messenger	204.0
	Exp. 3 Instagram	82.0
	Exp. 4 Instagram	83.0
Nexus 5X	Android	8.1.0
	Facebook	210.0.0.43.119
	Messenger	204.0.0.14.119
	Exp. 3 Instagram	82.0.0.13.119
	Exp. 4 Instagram	83.0.0.20.111
Sony Xperia Z5	Android	7.1.1
	Facebook	210.0.0.43.119
	Messenger	204.0.0.14.119
	Exp. 3 & 4 Instagram	82.0.0.13.119

Experiment 5

Device	Software	Version
iPhone 7 (both)	iOS	12.1.4
	Facebook	210.0.0.37.117
	Messenger	204.0
	Instagram	In A.2
	Wish	4.16.5
Nexus 5X	Android	8.1.0
	Facebook	210.0.0.43.119
	Messenger	204.0.0.14.119
	Instagram	In A.2
	Wish	4.28.0
Sony Xperia Z5	Android	7.1.1
	Facebook	210.0.0.43.119
	Messenger	204.0.0.14.119
	Instagram	In A.2
	Wish	4.28.0

A.2 Instagram Versions in Experiment 5

Table A.2: *Instagram versions for experiment 5 between all played recorded dialogues.*

iOS phones		
Before	**Recording**	**After**
83.0	**1st**	85.0
85.0	**2nd**	86.0
86.0	**3rd**	87.0
87.0	**4th**	88.0
88.0	**5th**	88.0
88.0	**6th**	89.0

Android test phone		
Before	**Recording**	**After**
83.0.0.20.111	**1st**	85.0.0.21.100
85.0.0.21.100	**2nd**	85.0.0.21.100
85.0.0.21.100	**3rd**	87.0.0.18.99
87.0.0.18.99	**4th**	87.0.0.18.99
87.0.0.18.99	**5th**	88.0.0.14.99
88.0.0.14.99	**6th**	88.0.0.14.99

Android control phone		
Before	**Recording**	**After**
82.0.0.13.119	**1st**	85.0.0.21.100
85.0.0.21.100	**2nd**	86.0.0.24.87
86.0.0.24.87	**3rd**	87.0.0.18.99
87.0.0.18.99	**4th**	87.0.0.18.99
87.0.0.18.99	**5th**	88.0.0.14.99
88.0.0.14.99	**6th**	88.0.0.14.99

Appendix B

Spoken Conversations and Keywords

B.1 Companies and Products

Table B.1: *International and Swedish companies and products chosen for script 1.*

International

Company	Product
American Express	SAS Amex Classic
Siemens	Dishwasher
HP	Cartridges
Samsung	Galaxy Watch
Toyota Motors	Yaris
Royal Dutch Shell	CityDiesel
Amazon	Philips Flite Hyprlite
	Headphones
McDonald's	Large Coffee
	Hash brown
	McToast
Spotify	Family Premium account

Swedish

Company	Product/Service
Telia AB	Telia video meeting
Electrolux	Dishwasher
Mekonomen	Car service
Oriflame Holding	Ultimate Lift SET
Nordea	Mortgage loan
if	Car insurance
	House insurance
	Horse insurance
Boozt	GANT Twill Cap
	Replay Bag
	Timberland Bradstreet PT Oxford (shoes)
	Puma Thunder Spectra (shoes)

B.2 Script 1 in Swedish for Experiment 1-4

Scenario 1: Möts i fikarummet.

Nemen hej, vad kul att se dig. Det var längesen, har du börjat arbeta här?

Hej, ja det var det verkligen! Det är faktiskt min andra arbetsvecka denna veckan.

Jasså, jag har inte sett dig på morgonmötena ännu. Har hört att tekniken strulat lite för en del personer som inte kunnat komma åt vår Telia videomöten. Har det gjort det för dig med?

Ja det var faktiskt precis det som strulade i morse. Jag kunde inte alls koppla upp mig och förstod inte heller vad som orsakade själva problemet.

Vi har precis börjat använda Telia Videomöten för våra distansmöten och det har krånglat en del. IT-personalen undersöker problemet så vi får hoppas att de löser det snart. Annars lär de väl kontakta Telia.

Jag trodde först att det var fel på endast mina hörlurar då ljudet inte fungerar. De är rätt gamla och jag skulle behöva köpa mig ett par nya. Jag har kollat lite på Philips hörlurar på Amazon men det är inte lätt att välja då det finns ett stort utbud. Jag vet däremot att jag vill ha ett par trådlösa med Bluetooth.

Jag har faktiskt ett par Philips hörlurar som är trådlösa och man kopplar upp sig med via Bluetooth. Jag tror att de heter Philips Flite Hyprlite. Men jag är inte säker eftersom det var längesedan jag köpte dem. Men de har i alla fall fungerat bra de månaderna som jag använt dem.

Tror du att hörlurarna finns att köpa på Amazon fortfarande? Jag skulle verkligen behöva ett par nya och om du rekommenderar dem är det ju perfekt.

Sist jag kollade fanns hörlurarna fortfarande kvar i både svart och vitt, sen finns det flera andra Philips hörlurar som också verkar bra. Så kolla först om det kanske finns nyare modeller, och om inte, fungerar Philips Flite Hyprlite jättebra. Förresten, vilken avdelning arbetar du på nu?

Jag arbetar på HR-avdelningen och just nu är det ganska hektiskt eftersom HP-skrivaren har slut på bläckpatroner och vi har inga extra liggandes på kontoren. Leveranstiden verkade vara rätt lång på bläckpatronerna, men jag ska kolla hemma om jag kanske har några bläckpatroner eftersom vi också har en OfficeJet HP-skrivare.

Vår avdelning har också en HP-skrivare, vet dock inte om det är OfficeJet. Men vi har nog några bläckpatroner liggandes som du kan låna innan beställningen kommer fram, jag kan komma förbi ditt kontor med dem efter lunch.

Ja men det låter jättebra, jag sitter på andra våningen så du kommer se mitt kontor från trapporna. Jag ber om ursäkt för att min mage kurrar så högt. Jag skippade frukosten eftersom barnen tog lång tid på sig imorse.

Min mage brukar också kurra om jag missar frukosten. Jag hade glömt att handla frukost igår och därför hämtade jag frukost på McDonald's på vägen till jobbet.

Åh det är alltid gott med lite frukost på McDonald's, jag brukar alltid beställa kaffe

med två McToast, de är så goda.

Jag håller med, så smidigt att ta drive-in:en på McDonald's om man inte hunnit fixa frukost. Jag brukar också beställa en stor kaffe och två McToast, men idag beställde jag även en Hash Brown eftersom jag var extra hungrig.

Det var längesen jag åt en Hash Brown men de är också jättegoda. Det skulle passat bra till kaffet som jag tog ur automaten i morse.

Det hade den gjort! Förresten har ni hittat ett boende här i närheten? Det brukar vara väldigt svårt att få tag i.

Vi var ute i god tid med att leta boende och till slut köpte vi villan som ligger ca 10 min med bil härifrån.

Jag och min partner har också funderat på att köpa en villa, men vi vet inte vilken bank som är bäst att vända sig mot när det gäller huslån.

Vi fick faktiskt bra ränta på vårt huslån på Nordea, vänd er dit om ni inte kontaktat dem än. Nordea samarbetar även med försäkringsbolaget if och de erbjuder tillsammans billig hemförsäkring och bilförsäkring. Om ni har några djur så erbjuder if även bra djurförsäkring, vi har kollat på det en del och skulle behöva försäkra dotterns häst.

Vi har ännu inte kontaktat Nordea, men vi ska ta en titt på dem och if till helgen. Min dotter har också en häst, men vi har vår djurförsäkring hos ett annat försäkringsbolag för tillfället. Om ni får ett bra erbjudande på försäkringen tycker jag absolut att ni ska försäkra er häst. Vår häst fick opereras förra året och vår försäkring ersatte oss med över 50 000 kr. Vad kostade if:s bilförsäkring då? Vi funderar på att byta den också.

Vad roligt att även din dotter har en häst, alltid roligt att de har ett intresse och lär sig ta ansvar i tidig ålder. Vår häst har aldrig råkat ut för en olycka, men man vet aldrig vad som kan hända. Då är det skönt att ha en försäkring, speciellt när ni fick spara så mycket på egna kostnader vid olyckan. Vad gäller bilförsäkringen på if så är kostnaden helt individuell, det beror på vilken bil modell man har och även årsmodellen på bilen. Vilken bil har ni?

Vi köpte en begagnad Toyota Yaris från 2015. Vi köpte den för att Yaris-modellen är billigare i drift. Den går nämligen på 50% eldrift och 50% på diesel. Vi har aldrig haft en Toyota innan men jag och min familj är väldigt nöjda hittills.

Toyota har verkligen fått in finare modeller på bilarna. Men jag känner inte till Yaris-modellen. Har ni fått nyttja bilförsäkringen något?

Jag tycker att Yaris är en av de finare modellerna som Toyota har. Vi har inte behövt nyttja bilförsäkringen än då vi bara haft den i ett år, men det är snart dags att lämna in den på service. När vi köpte bilen ingick service i 5 år på Mekonomen så vi ska boka tid där nästa vecka. Vi ska också passa på att byta vindrutetorkare eftersom de vi har är alldeles för slitna. Vi har aldrig åkt till Mekonomen innan men vad jag har läst på internet så ska de vara väldigt duktiga och fixa det mesta, bland annat då att byta vindrutetorkare. När jag kollade på Mekonomens hemsida stod det även att om man bokar service denna månaden så får man ett presentkort på 100 kr att

tanka på Shell för.

Det låter som väldigt bra erbjudanden, skönt att ni fick presentkortet på Shell. Det är alltid bemannat där och alla som arbetar på Shell är supertrevliga. Vi brukar alltid tanka där och då använder vi deras CityDiesel. Den dieseln är mer miljövänlig än den vanliga dieseln, därför tycker jag att ni kan kolla in CityDiesel om ni inte redan har koll på det. Er Toyota Yaris lät intressant, skulle jag kunna ta en titt på den efter jobbet?

Ja självklart. Jag hade gärna kollat på er nya villa också, så jag kan skjutsa hem dig om du inte kört till jobbet med din egen bil.

Ja det hade varit trevligt, jag åkte in med bussen imorse. Jag kan komma förbi ditt kontor vid klockan 16.

Scenario 2: Möts efter jobbet.

Här är min Toyota Yaris.

Åh vad fin! Den ser verkligen familjevänlig ut. Det ska bli kul att åka med i bilen och se hur det känns att sitta i den. Gillar verkligen den modellen i svart, de brukar bli smutsiga ganska snabbt men din ser ren ut.

Ja du har rätt i att den svarta färgen gör att den ser smutsig ut snabbt. Jag var faktiskt och tvättade den på Shell igår kväll efter jobbet. De hade rabatt på tvätten på miljöbilar och eftersom den har 50% eldrift så fick jag ett rabatterat pris.

Det var en bra deal. Förresten vad är det för radiostation som spelas? De har väldigt bra musik låter det som.

Jag har kopplat upp min mobil trådlöst via Bluetooth för att kunna spela musik. Just nu så har jag startat Spotify där jag streamar från en spellista som heter "Discover Weekly". Jag tycker det är så smidigt att man kan streama musik direkt från appen in i bilen, det är synd att det är så dyrt bara, jag får betala 99 kr i månaden för det och vi kan bara vara en åt gången som lyssnar.

Hur många är ni som delar på Spotify? I vår familj har vi anmält oss för ett Premium Familjekonto på Spotify. Det kostar 149kr/månaden och vi kan vara 5 stycken i familjen som lyssnar genom Familjekontot samtidigt.

Det verkar ju vara jättebra, konstigt att jag inte hört om det innan. Vi är nämligen 4 st i familjen så ett Familjekonto på Spotify hade varit perfekt. Ska du förresten med till årsmötet i Stockholm om två veckor, eller ska du sitta med via Telia distansmöte?

Jag har blivit erbjudan att följa med till det här årsmötet. Jag har nyligen införskaffat ett American Express kreditkort med SAS EuroBonus som jag kan betala resorna med och sedan få ersättning av jobbet. Genom att använda American Express samlar jag poäng och får billigare flygresor med SAS.

Jag har aldrig ägt något American Express kreditkort och är lite nyfiken på hur det skulle fungera med bonusar. Vår familj flyger rätt mycket med SAS också så om man hade haft SAS Eurobonus hade det kanske lönat sig. Jag gillar också att när man reser utomlands så brukar de ha en taxfree på planet.

Ja det har de och det är riktigt smidigt. Sist jag flög med SAS köpte jag ett Ultimate Lift Set från Oriflame i flygshoppen. De har ofta ett stort utbud på Oriflame och jag är verkligen nöjd med deras produkter. Mitt Ultimate Lift Set börjar dock ta slut, men jag såg att Oriflame har 50% rabatt på deras officiella hemsida. Känner du att du behöver använda en anti-age kräm så rekommenderar jag verkligen Ultimate Lift Set från Oriflame.

Jag har länge letat efter en bra antirynkkräm så jag kanske ska passa på att beställa ett Ultimate Lift SET från Oriflame's hemsida om de nu har rabatt. Min dotter är väldigt intresserad av skönhet och hon använder mycket produkter från Oriflame. Hon fyller 16 nu i maj och jag vet inte vad jag ska köpa till henne eftersom hon är mer insatt än jag.

Vad roligt att hon har koll på sånt, slipper du ha det. Hoppas du löser problemet med att hitta rätt present. Även min son och min man fyller år om två veckor, skiljer bara några dagar mellan deras födelsedag. Jag har kollat en del på Boozt då min man behöver ett par nya skor och min son har önskat sig lite accessoarer därifrån.

Min partner har precis köpt nya skor från Boozt och han beställde ett par från Timberland och modellen heter Bradstreet PT Oxford, de är jättefina. Han gillar också märket Puma som har kommit ut med en ny skokollektion nu i vår. Annars har de ju massor av skor att köpa på Boozt så du kommer nog hitta ett par som passar till din man.

Jag har faktiskt kollat en del på både Timberland och Puma skor. Han har ett flertal skor i dessa märken och han är alltid nöjd. Jag ska ta en titt på Bradstreet PT Oxford modellen, men jag vet att han även kollat lite på Puma Thunder Spectra modellen. Thunder Spectra modellen liknar dock ett par han redan äger, därför ska jag kolla in Timberland skorna.

Leveranstiden på Boozt är snabb så du har ju lite tid på dig att fundera. Har du funderat på vad du ska köpa till din son då? Du nämnde att han vill ha accessoarer från Boozt och jag köpte nyligen en bra väska till min dotter därifrån. Om du inte har kollat in det så finns det fina i Replay märket.

Ja det är skönt, brukar ta mellan 1-3 arbetsdagar. Jag har kollat efter olika typer av accessoarer på Boozt, han har nämligen nämnt att han gärna vill ha en Twill Cap från GANT och en ny väska till skolan. Jag ska ta och kolla in Replay och se om de har bra väskor.

Ja GANT har fina kepsar och just den TWILL CAPen finns i många olika mönster och färger. Annars är det väl jättebra med en ny väska, och vi gillar som sagt Replay mycket. På tal om present till ens partner, så önskade sig min partner en Samsung Galaxy Watch i födelsedagspresent, men den kostar betydligt mer. Han är iallafall väldigt nöjd med sin Galaxy Watch och det är en fördel att den är kompatibel med iOS och Android så han kan använda den med sin jobbtelefon och den privata. När jag beställde klockan fanns den bara kvar i roséguld, men han gillar den färgen med.

Ja min man är ju mer av en Samsung användare och han hade nog uppskattat en Samsung Galaxy Watch, däremot tycker han endast om klockor som är i färgen svart eller silver. Nu börjar vi närma oss min villa, du kan se den borta i hörnet till vänster.

Du kan parkera mitt framför infarten.

Vilket trevligt område ni flyttat till och villorna ser relativt nya ut också. Här var det väldigt mycket byggmaterial på er tomt, håller ni på att renovera villan?

Ja vi håller på att byta fasad samt renovera köket. Det var länge sedan det gjordes om. Jag har dock inte bestämt mig angående vitvarorna som ska in i köket. Jag har redan en diskmaskin som är 60 cm bred, men jag skulle vilja lägga in en som är 45 cm bred med. Tyvärr erbjuds inte den diskmaskinen vi redan har i den mindre storleken.

Jag vet att både Siemens och Electrolux har diskmaskiner i den mindre storleken som ska vara väldigt prisvärda.

Jag har kollat en del på både Siemens och Electrolux och de enda kraven jag har är att den ska ha kort torktid, samt ha minst energiklassen A++.

När vi kollade på diskmaskin hemma hos mig kollade vi väldigt mycket och jämförde Electrolux och Siemens. Till slut valde vi att köpa en Electrolux diskmaskin och jag minns att den fanns i rätt bredd för dig samt att energiklassen var tillräcklig. Jag kan kolla upp vilket modellnummer det är så kan jag visa dig nästa gång vi ses på jobbet. Annars kanske det bästa är att gå till butiker som säljer diskmaskiner från både Siemens och Electrolux för att få personlig rådgivning.

Tack så mycket för alla tips och för skjutsen hem. Du får komma förbi med familjen så fort renoveringen är klar. Du får ha det bra sålänge så ses vi imorgon på jobbet!

Varsågod och tack själv för sällskapet. Vi ses imorgon, hälsa familjen.

B.3 Table of Keywords and Frequency in Script 1

Table B.2: *A list of keywords and its frequency mentioned in the first script.*

Keyword	Frequency
Videomöte (video meeting)	2
Distansmöte (remote meeting)	2
Trådlös (wireless)	3
Bluetooth	3
Hörlurar (headphones)	6
HP-skrivare (HP printers)	3
Bläckpatroner (cartridges)	4
Frukost (breakfast)	6
Kaffe (coffee)	3
Bil (car)	10
Villa (villa)	6
Bank (bank)	1
Huslån (mortgage)	2
Försäkringsbolag (insurance comapny)	2
Bilförsäkring (motorcar insurance)	5
Djurförsäkring (animal insurance)	2
Försäkring (insurance)	5
Häst (horse)	6
Eldrift (electric drive)	2
Diesel (Diesel)	3
Service (service)	3
Vindrutetorkare (windscreen wiper)	2
Musik (music)	3
Streama (stream)	2
Familjekonto (family account)	3
Kreditkort (creditcard)	2
Skor (shoes)	7
Accessoarer (accessories)	3
Väska (bag)	4
Klocka (watch)	2
Kök (kitchen)	2
Vitvaror (white goods)	1
Diskmaskin (dishwasher)	5

Keyword	Frequency
Telia	4
Amazon	2
Philips	3
Philips Flite Hyprlite	2
OfficeJet	2
McToast	2
Hash Brown	2
Nordea	3
if	5
Toyota	6
Yaris	6
Mekonomen	3
Shell	4
Spotify	4
Discover Weekly	1
American Express	3
EuroBonus	2
SAS	5
Ultimate Lift Set	4
Oriflame	6
Boozt	6
Timberland	3
Bradstreet PT Oxford	2
Puma	3
Thunder Spectra	2
Replay	3
GANT	2
TWILL CAP	2
Samsung	3
Samsung Galaxy Watch	3
Electrolux	5
Siemens	4
CityDiesel	2

B.4 Script 2 in Swedish for Experiment 5

Scenario 1: Möts i fikarummet.

Nemen hej, vad kul att se dig. Det var längesen, har du börjat arbeta här?

Hej, ja det var det verkligen! Det är faktiskt min andra arbetsvecka denna veckan.

Jasså, jag har inte sett dig på morgonmötena ännu. Har hört att tekniken strulat lite för en del personer som inte kunnat använda de gröna hörlurarna vi fått från företaget. Har det inte fungerat för dig med?

Ja det var faktiskt precis det som strulade i morse. Jag kunde inte höra något alls i hörlurarna och förstod inte heller vad som orsakade själva problemet.

Företaget har kontaktat leverantören av hörlurarna och de ska återkomma med nya hörlurar till oss.

Jag trodde först att det var fel på endast mina hörlurar. Jag har kollat lite på andra gröna hörlurar på Wish som är trådlösa med Bluetooth. Det är inte lätt att välja då det finns ett stort utbud på Wish. Jag vet däremot att jag vill ha ett par trådlösa med Bluetooth och de ska helst vara gröna, eftersom grönt är min favoritfärg.

Jag har faktiskt ett blåa trådlösa hörlurar som man kopplar upp sig med via Bluetooth. Jag tror faktiskt att jag köpte dem från Wish. Men jag är inte säker eftersom det var längesedan jag köpte dem. Men de har i alla fall fungerat bra de månaderna som jag använt dem.

Tror du att hörlurarna finns att köpa på Wish fortfarande? Jag skulle verkligen behöva ett par nya och om du rekommenderar dem är det ju perfekt. Det skulle ju vara ännu bättre om de finns i den gröna färgen.

Sist jag kollade fanns hörlurarna fortfarande kvar på Wish med olika färger, sen finns det flera andra hörlurar som också verkar bra. Så kolla först om det kanske finns nyare modeller, och om inte, fungerar mina blåa hörlurar jättebra. Förresten, vilken avdelning arbetar du på nu?

Jag arbetar på HR-avdelningen och just nu är det ganska hektiskt eftersom vår skrivare har slut på bläckpatroner och vi har inga extra bläckpatroner liggandes på kontoren. Leveranstiden verkade vara rätt lång på bläckpatronerna, men jag ska kolla hemma om jag kanske har några bläckpatroner eftersom vi också har en skrivare.

Vår avdelning har också en skrivare, vet dock inte vilket märke. Men vi har nog några bläckpatroner liggandes som du kan låna innan beställningen kommer fram, jag kan komma förbi ditt kontor med dem efter lunch.

Ja men det låter jättebra, jag sitter på andra våningen så du kommer se mitt kontor från trapporna. Jag ber om ursäkt för att min mage kurrar så högt. Jag skippade frukosten eftersom jag inte hade några matlådor att lägga den i och ta med till jobbet.

Min mage brukar också kurra om jag missar frukosten. Jag hade glömt att handla frukost igår. Det är väldigt smidigt att ta med frukosten i matlådor, jag packar även ner lunchen i matlådor och äter det på jobbet.

Åh det är alltid gott att starta dagen med frukost på jobbet, därför ska jag se till

att köpa med mig flera matlådor så att de inte tar slut.

Jag håller med, en annan sak som är smidig är att ta med kaffet i en termos. Termosen håller kaffet extra varmt under en längre tid. Blir det stressigt behöver man inte oroa sig för att det svalnat. Jag har två termosar hemma som jag turas om med. Den ena termosen är gul och den andra termosen är röd, så det är ingen som tar fel.

Det låter som en väldigt bra ide, borde också skaffa mig termosar i olika färger, en till vardera familjemedlem.

Gör så! Förresten har ni hittat ett boende här i närheten? Det brukar vara väldigt svårt att få tag i.

Vi var ute i god tid med att leta boende och hittade en hyresrätt med en liten trädgård samt en balkong.

Skönt med trädgård! Dock är det mycket som behöver skötas. Gräset ska klippas, löven ska krattas och blommorna ska vattnas.

Det har du helt rätt i, vi har redan haft det i åtanke och har ännu inte beställt en röd vattenslang och vattenkanna, en självstyrd gräsklippare och en kratta till att klippa och kratta upp gräset.

Vi hittade vårt för ett bra pris på Wish. Kolla in deras hemsida, jag garanterar att de har röda vattenslangar och vattenkannor för ett bra pris.

Vet du hur man gör med parkering här i stan? Det ingår nämligen inte hos oss och vi är osäkra på vart vi ska ställa bilen och hur man betalar för det.

Ja, man betalar via en app som finns att ladda ner och parkeringar ska finnas utanför er.

Okej vad bra! Har du och din partner en bil också?

Vi köpte en begagnad Toyota Yaris från 2015. Vi köpte den för att Yaris-modellen är billigare i drift. Den går nämligen på 50% eldrift och 50% på diesel. Vi har aldrig haft en Toyota innan men jag och min familj är väldigt nöjda hittills.

Toyota har verkligen fått in finare modeller på bilarna. Däremot måste man köpa en GPS vid sidan av då den inte ingår i basutbudet. Har ni hittat någon GPS ännu? Annars kan ni kolla in Wish.

Jag tycker att Yaris är en av de finare modellerna som Toyota har. Enda nackdelen är det med GPS:en då det är en extra kostnad vi sidan av. Vi har bara haft bilen i ett år och det är snart dags att lämna in den på service. När vi köpte bilen ingick service i 5 år på Mekonomen så vi ska boka tid där nästa vecka. Vi ska också passa på att byta vindrutetorkare eftersom de vi har är alldeles för slitna. Vi har aldrig åkt till Mekonomen innan men vad jag har läst på internet så ska de vara väldigt duktiga och fixa det mesta, bland annat då att byta vindrutetorkare. När jag kollade på Mekonomens hemsida stod det även att om man bokar service denna månaden så får man ett presentkort på 100 kr att tanka på Shell för.

Det låter som väldigt bra erbjudanden, skönt att ni fick presentkortet på Shell. Det är alltid bemannat där och alla som arbetar på Shell är supertrevliga. Vi brukar alltid tanka där och då använder vi deras CityDiesel. Den dieseln är mer miljövänlig

än den vanliga dieseln, därför tycker jag att ni kan kolla in CityDiesel om ni inte redan har koll på det. Er Toyota Yaris lät intressant, skulle jag kunna ta en titt på den efter jobbet?

Ja självklart. Jag hade gärna kollat på er nya lägenhet också, så jag kan skjutsa hem dig om du inte kört till jobbet med din egen bil.

Ja det hade varit trevligt, jag åkte in med bussen imorse. Jag kan komma förbi ditt kontor vid klockan 16.

Förresten jag måste bara påpeka hur fin du är i håret. Du ser ut att äga en bra plattång.

Tack så mycket! Den är riktigt bra och smidig, då den fungerar som en plattång och locktång i ett. Jag kan visa dig vilken plattång som skulle kunna passa bra till ditt hår senare.

Ja det hade varit snällt om du kan rekommendera en plattång! Jag har inte så bra koll på hårvård generellt, och plattänger verkar det finnas så många utav. Men vi kan ta det efter jobbet! Hej så länge.

Scenario 2: Möts efter jobbet.

Här är min Toyota Yaris.

Åh vad fin! Den ser verkligen familjevänlig ut. Det ska bli kul att åka med i bilen och se hur det känns att sitta i den. Gillar verkligen den modellen i svart, de brukar bli smutsiga ganska snabbt men din ser ren ut.

Ja du har rätt i att den svarta färgen gör att den ser smutsig ut snabbt. Jag var faktiskt och tvättade den på Shell igår kväll efter jobbet. De hade rabatt på tvätten på miljöbilar och eftersom den har 50% eldrift så fick jag ett rabatterat pris.

Det var en bra deal. Förresten vad är det för radiostation som spelas? De har väldigt bra musik låter det som.

Jag har kopplat upp min mobil trådlöst via Bluetooth för att kunna spela musik. Just nu så har jag startat Spotify där jag streamar från en spellista som heter "Discover Weekly". Jag tycker det är så smidigt att man kan streama musik direkt från appen in i bilen, det är synd att det är så dyrt bara, jag får betala 99 kr i månaden för det och vi kan bara vara en åt gången som lyssnar.

Hur många är ni som delar på Spotify? I vår familj har vi anmält oss för ett Premium Familjekonto på Spotify. Det kostar 149kr/månaden och vi kan vara 5 stycken i familjen som lyssnar genom Familjekontot samtidigt.

Det verkar ju vara jättebra, konstigt att jag inte hört om det innan. Vi är nämligen 4 st i familjen så ett Familjekonto på Spotify hade varit perfekt. Ska du förresten med till årsmötet i Stockholm om två veckor?

Jag har blivit erbjudan att följa med till det här årsmötet. Jag har nyligen införskaffat ett American Express kreditkort med SAS EuroBonus som jag kan betala resorna med och sedan få ersättning av jobbet. Genom att använda American Express samlar jag poäng och får billigare flygresor med SAS.

Jag har aldrig ägt något American Express kreditkort och är lite nyfiken på hur det skulle fungera med bonusar. Vår familj flyger rätt mycket med SAS också så om man hade haft SAS Eurobonus hade det kanske lönat sig. Jag gillar också att när man reser utomlands så brukar de ha en taxfree på planet.

Ja det har de och det är riktigt smidigt. Sist jag flög med SAS köpte jag ett Ultimate Lift Set från Oriflame i flygshoppen. De har ofta ett stort utbud på Oriflame och jag är verkligen nöjd med deras produkter. Mitt Ultimate Lift Set börjar dock ta slut, men jag såg att Oriflame har 50% rabatt på deras officiella hemsida. Känner du att du behöver använda en anti-age kräm så rekommenderar jag verkligen Ultimate Lift Set från Oriflame.

Jag har länge letat efter en bra antirynkkräm så jag kanske ska passa på att beställa ett Ultimate Lift SET från Oriflame's hemsida om de nu har rabatt. Min dotter är väldigt intresserad av skönhet och hon använder mycket produkter från Oriflame. Hon fyller 16 nu i maj och jag vet inte vad jag ska köpa till henne eftersom hon är mer insatt än jag.

Vad roligt att hon har koll på sånt, slipper du ha det. Hoppas du löser problemet med att hitta rätt present. Även min son och min man fyller år om två veckor, skiljer bara några dagar mellan deras födelsedag. Jag har kollat en del på Boozt då min man behöver ett par nya skor och min son har önskat sig lite accessoarer därifrån.

Min partner har precis köpt nya skor från Boozt och han beställde ett par från Timberland och modellen heter Bradstreet PT Oxford, de är jättefina. Han gillar också märket Puma som har kommit ut med en ny skokollektion nu i vår. Annars har de ju massor av skor att köpa på Boozt så du kommer nog hitta ett par som passar till din man.

Jag har faktiskt kollat en del på både Timberland och Puma skor. Han har ett flertal skor i dessa märken och han är alltid nöjd. Jag ska ta en titt på Bradstreet PT Oxford modellen, men jag vet att han även kollat lite på Puma Thunder Spectra modellen. Thunder Spectra modellen liknar dock ett par han redan äger, därför ska jag kolla in Timberland skorna.

Leveranstiden på Boozt är snabb så du har ju lite tid på dig att fundera. Har du funderat på vad du ska köpa till din son då? Du nämnde att han vill ha accessoarer från Boozt och jag köpte nyligen en bra väska till min dotter därifrån. Om du inte har kollat in det så finns det fina i Replay märket.

Ja det är skönt, brukar ta mellan 1-3 arbetsdagar. Jag har kollat efter olika typer av accessoarer på Boozt, han har nämligen nämnt att han gärna vill ha en TWILL CAP från GANT och en ny väska till skolan. Jag ska ta och kolla in Replay och se om de har bra väskor.

Ja GANT har fina kepsar och just den TWILL CAPen finns i många olika mönster och färger. Annars är det väl jättebra med en ny väska, och vi gillar som sagt Replay mycket. På tal om present till ens partner, så önskade sig min partner en Samsung Galaxy Watch i födelsedagspresent, men den kostar betydligt mer. Han är iallafall väldigt nöjd med sin Galaxy Watch och det är en fördel att den är kompatibel med iOS och Android så han kan använda den med sin jobbtelefon och den privata. När

jag beställde klockan fanns den bara kvar i roséguld, men han gillar den färgen med.

Ja min man är ju mer av en Samsung användare och han hade nog uppskattat en Samsung Galaxy Watch, däremot tycker han endast om klockor som är i färgen svart eller silver. Nu börjar vi närma oss min lägenhet, du kan se den borta i hörnet till vänster. Du kan parkera mitt framför infarten.

Vilket trevligt område ni flyttat till och villorna ser relativt nya ut också. Här var det väldigt mycket byggmaterial på er tomt, håller ni på att renovera?

Ja vi håller på att byta fasad samt renovera köket. Det var länge sedan det gjordes om. Jag har dock inte bestämt mig angående vitvarorna som ska in i köket. Jag har redan en diskmaskin som är 60 cm bred, men jag skulle vilja lägga in en som är 45 cm bred med. Tyvärr erbjuds inte den diskmaskinen vi redan har i den mindre storleken.

Jag vet att både Siemens och Electrolux har diskmaskiner i den mindre storleken som ska vara väldigt prisvärda.

Jag har kollat en del på både Siemens och Electrolux och de enda kraven jag har är att den ska ha kort torktid, samt ha minst energiklassen A++.

När vi kollade på diskmaskin hemma hos mig kollade vi väldigt mycket och jämförde Electrolux och Siemens. Till slut valde vi att köpa en Electrolux diskmaskin och jag minns att den fanns i rätt bredd för dig samt att energiklassen var tillräcklig. Jag kan kolla upp vilket modellnummer det är så kan jag visa dig nästa gång vi ses på jobbet. Annars kanske det bästa är att gå till butiker som säljer diskmaskiner från både Siemens och Electrolux för att få personlig rådgivning.

Tack så mycket för alla tips och för skjutsen hem. Du får komma förbi med familjen så fort renoveringen är klar. Du får ha det bra sålänge så ses vi imorgon på jobbet!

Varsågod och tack själv för sällskapet. Vi ses imorgon, hälsa familjen.

B.5 Table of Keywords and Frequency in Second Script

Table B.3: *A list of keywords and its frequency mentioned in the second script.*

Keyword	Frequency
Gröna hörlurar (green headphones)	2
Blåa hörlurar (blue headphones)	2
Trådlös (wireless)	3
Bluetooth	4
Hörlurar (headphones)	6
Skrivare (printer)	3
Bläckpatroner (cartridges)	5
Bil (car)	10
Kaffe (coffee)	2
GPS (GPS)	3
Service (service)	3
Vindrutetorkare (windscreen wiper)	2
Diesel (Diesel)	3
Plattång (hair straightener)	4
Eldrift (electric drive)	2
Spotify	3
Familjekonto (family account)	3
SAS	5
Boozt	6
Skor (shoes)	7
Accessoarer (accessories)	3
Bradstreet PT Oxford	2
Thunder Spectra	2
Väska (bag)	4
Galaxy Watch	3
Kreditkort (creditcard)	2
Klocka (watch)	2
Kök (kitchen)	2
Vitvaror (white goods)	1

Keyword	Frequency
Wish	6
Matlådor (lunch box)	3
Termos (thermos)	6
Röd vattenslang (red water hose)	2
Vattenkanna (watering can)	2
Gräsklippare (lawn mower)	1
Kratta (rake)	2
Toyota	6
Yaris	5
Mekonomen	3
Shell	4
Spotify	4
CityDiesel	2
Locktång (hair curler)	1
Ultimate Lift Set	4
American Express	3
Thunder Spectra	2
EuroBonus	2
Oriflame	6
GANT	2
TWILL CAP	2
Timberland	3
Puma	3
Replay	3
Samsung	3
Diskmaskin (dishwasher)	5
Siemens	4
Electrolux	5

Appendix C

Account and Phone Setups

The italic words represent choices made during the setup.

C.1 iOS Devices

The following steps were performed to configure the iOS devices and create Apple IDs at start-up:

1. *Swedish*
2. Select Your Country or Region: *Sweden*
3. Quick Start: *Set Up Manually*
4. Choose a Wi-Fi Network: *Use Mobile Connection*
5. Data & Privacy: *Continue*
6. Touch ID: *Set Up Touch ID Later*
7. Create a Passcode: *Don't Use Passcode*
8. Apps & Data: *Set Up ad New iPhone*
9. Apple ID → *Forgot password or don't have an Apple ID* → *Create a Free Apple ID* → Enter a birth date → Enter first and last name → Email Address: *Use your current email address* → Enter email address → Enter password → Choose and answer the security questions (three) → Terms and Conditions: *Agree* → Synchronise with iCloud: *Don't Merge*
10. Sign in with the newly created Apple ID
11. Terms and Conditions: *Agree*
12. Keep Your iPhone Up to Date: *Install Updates Manually*
13. Location Services: *Disable Location Services*
14. Screen Time: *Set Up Later in Settings*
15. iPhone Analytics: *Don't Share*
16. Meet the New Home Button: *Customise Later in Settings*
17. Display Zoom: *Choose a View* → *Standard*
18. Welcome to iPhone: *Get Started*

C.2 Android Devices

C.2.1 Android Test Phone (Nexus 5X)

The following steps were performed to configure the Android test phone:

1. Hi there: *Swedish (Sweden)*
2. Connect to Wi-Fi: *Use mobile network for setup*
3. Copy apps & data: *Set up as new*
4. Create Google Account (These steps are described further down)
5. Protect your phone: *Not now*
6. Give your new Assistant permission to help you: *No thanks*
7. Google services:
   - Backup & Storage: *Off*
   - Help apps find location: *Off*
   - Send system data: *Off*
   - Keep me up to date with news and offers from Google Play: *Off*
8. Anything else?: *No thanks*

C.2.2 Android control phone (Sony Xperia Z5)

The following steps were performed to configure the Android control phone:

1. Welcome: *Swedish (Sweden)*
2. Important information:
   - I am aware of the Important information: *On*
   - I am aware that data charges may apply: *On*
   - Yes, I want to help improve Experia by sharing Diagnostics: *Off*
3. Internet connection: *Mobile network and Wi-Fi*
4. Welcome to your Xperia: *Set up as new*
5. Get connected: *Use cellular network for setup*
6. Create Google Account (These steps are described further down)
7. Unlock with fingerprint: *Skip*
8. Google Services:
   - Automatically back up device data: *Off*
   - Use Google's location service to help apps: *Off*
   - Help improve Android experience: *Off*
9. Meet your Google Assistant: *No thanks*
10. Xperia services: *Not now*

C.3 Phone Settings

The following steps were performed after phone setup:

- On all four phones:
  - Disable Wi-Fi and Bluetooth, due to the applications collecting this information to track locations.
  - Access the Gmail application (Androids) or https://mail.google.com (iOS) to verify the Gmail accounts.
- On iOS phones:
  - Set the screen lock to never.
  - Go to Settings and verify the Apple-ID.
  - When downloading free apps on App Store, the account had to fill in payment information. The payment type was set to *None* and the billing address was filled in with junk to cover the mandatory fields.
- On Android phones:
  - Set the screen lock to 30 minutes.
  - Turn off automatic updates of applications and OS.

C.4 Gmail Accounts

Table C.1: *The Gmail accounts for each cell phone.*

	First name	**Last name**	**Gender**	**Day of birth**	**Email address**
Account 1 Android control phone	Karin	Karlsson	Female	1st of January 1978	karinkarlsson.e1@gmail.com
Account 2 iOS control phone	Stina	Berg	Female	5th of January 1978	stinaberg.e1@gmail.com
Account 3 Android test phone	Anneli	Bengtsson	Female	10th of January 1978	annelibengtsson.e1@gmail.com
Account 4 iOS test phone	Caroline	Persson	Female	15th of January 1978	carolinepersson.e1@gmail.com

The creation and its settings for the Gmail accounts were the following:

1. Sign in: *Create account* → *For myself*
2. Fill in first name, last name, day of birth and gender from table C.1
3. Choose your Gmail address: Fill in the email address from table C.1
4. Create a strong password: Fill in password
5. Add phone number?: *Skip*
6. Privacy and Terms:
   More options:
   - Web & App Activity: *Don't save my Web & App activity in my Google Account*
   - Ads Personalization: *Show me ads that aren't personalized*
   - YouTube Search/Watch History: *Don't save my YouTube Search/Watch History in my Google Account*

- Location History: *Don't save my Location History in my Google Account*
- Voice & Audio Activity: *Don't save my Voice & Audio Activity in my Google Account*

I agree to the Google Terms...: *On*
I agree to the processing of my information...: *On*

The only difference between the accounts in the experiments is the email addresses, where the number is changed depending on the experiment performed.

C.5 Facebook Accounts

The following steps show the configuration of the Facebook accounts.

1. *Create new account*
2. Allow Facebook to access contacts: *Deny*
3. Allow Facebook to call and manage phone calls: *Deny*
4. Fill in the first and last name from table C.1
5. Fill in the birth date from table C.1
6. Fill in gender from table C.1
7. *Register with email address* (not phone number)
8. Fill in the email address from table C.1
9. Fill in the password
10. *Register without uploading contacts on the phone*
11. Confirm the Facebook account by typing in the verification code that is sent to the Gmail account

Appendix D

Execution Details

D.1 Experiment 1 Execution

The execution steps in experiment 1 are presented in table D.1 below.

Table D.1: *The steps of execution in experiment 1.*

	25th of February 2019
09:00	A quiet environment where the experiment was performed was accessed. Each phone was reset and configured. **Android Devices** The created accounts during the configurations were the iOS accounts Account 2 and Account 4, seen in table C.1. A factory reset was once again performed on the cell phones and two new Gmail accounts for the Android phones, Account 1 and Account 3, were created during the next configuration. **iOS Devices** The Apple IDs for each phone were created during their configuration. **All Devices** The Facebook and the Messenger applications were downloaded and all Facebook accounts were created on each phone through the application. To download the applications without connecting it to a WiFi, the download was started and the date on the phone was set to 3 months forward. This made the downloading process start. When all applications were installed, the date was set 3 months back. No microphone access was enabled nor was a contact network created in this experiment, as described in table 4.1.
10:00	Only Messenger was set to run in the background and Facebook was foregrounded in all cell phones. The cell phones were not locked and the control phones were separated from the test phones. The microphones of the control phones were covered and they were then separated from the test phones and put in a quiet room. The recording of script 1 in Appendix B.2 was then played for the test phones.
10:20	All cell phones were gathered and Instagram was downloaded on each phone. To sign in to Instagram, the Facebook accounts were used. Only Facebook, Messenger and Instagram were set to run in the background before locking the phones. The phones' microphones were then covered and all devices were isolated in a quiet environment until the first analysis.
13:20	In the first analysis, the sections in each application that were examined were: 1. The *News Feed* and *Ad Settings* in the Facebook application. 2. All of the tabs in the Messenger application. 3. The tabs *Home* and *Search & Explore* in the Instagram application. The content examined were compared between the test phone and its corresponding control phone to identify anomalies. All phones were also compared towards its own appearance before the experiment. All anomalies were documented using screen shots that were sent as a picture message to our private cell phones. After the analysis, only Facebook, Messenger and Instagram were set to run in the background. The phones' microphones were then covered and the devices were isolated in a quiet environment until the second analysis.
	26th of February 2019
10:20	This analysis was conducted in the exact same way as the first analysis on the 25th of February, 13:20.
	27th of February 2019
08:20	This analysis was conducted in the exact same way as the first analysis on the 25th of February 13:20.

D.2 Experiment 5 Schedule

A detailed explanation of the steps conducted in experiment 5.

D.2.1 Week 1

Monday 25th of March

- 08:30:
Insert new SIM cards on all four phones.
Take a photo of a carrot with a black background on all four phones.

- 08:45:
Download Wish on all phones and uninstall Instagram.
Log in to Wish with each Facebook account.
Choose women products to be displayed.

- 09:00:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:15:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Tuesday 26th of March

- 08:45:
Update the profile picture on Facebook with the image of the carrot.
Scroll in the news feed.

- 09:30:
Write and upload a post on Facebook containing: "Nu börjar våren närma sig.".

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

- 15:00:
Open the Wish application and scroll among products in the Popular tab.
Do not look for anything specific and do not click into products.

Wednesday 27th of March

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

- 13:30:
Like Wish's Facebook page on each account.

Thursday 28th of March

- 09:00:
Zerina starts the first chat conversation containing chat dialogue 1 with all four accounts. The content of the dialogue is present under Appendix D.3.1.

- 09:30:
Edit profile information on Facebook with the following:
Residence → Karlskrona
Home town → Karlskrona
Education → Blekinge Institute of Techonology.

- 11:30:
Scroll in the news feed of Facebook and search for the word "Vas" in the Wish application.
Press on the same randomly chosen picture on all four phones and view the product description.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Friday 29th of March

- 10:00:
Search for the word "Ljusslinga" (Light strand) in the Wish application.
Press on the same randomly chosen picture on all four phones.
Scroll down and view the product description.
Go to the Related tab and scroll.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Sunday 31st of March

- 21:30:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

D.2.2 Week 2

Monday 1st of April

- 09:00:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:15:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Tuesday 2nd of April

- 09:00:
Take a picture on a teabag on all four phones and change the cover image on Facebook to this picture.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Wednesday 3rd of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

- 14:00:
Scroll in the news feed on Facebook and like a comment of a post.
Scroll under popular on Wish without pressing on any products.

Thursday 4th of April

- 08:30:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 08:45:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 09:00:
Louise starts the second chat conversation containing chat dialogue 2 with all four accounts. The content of the dialogue is present under Appendix D.3.2.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Friday 5th of April

- 09:00:
Like the same two posts from Wish that are seen in the Facebook news feed on each account.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Sunday 7th of April

- 21:30:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

- 21:45:
Write and upload a post on Facebook containing: "Det har varit en stressig vecka men jag hoppas att det blir bättre imorgon.".

D.2.3 Week 3

Monday 8th of April

- 09:00:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:15:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Tuesday 9th of April

- 10:30:
Write and upload a status on Facebook containing: "Jag ska strax gå ut och gå en långrunda i det fina vädret. :)".

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Wednesday 10th of April

- 09:00:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:15:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 10:00:
Zerina starts the third chat conversation containing chat dialogue 3 with all four accounts. The content of the dialogue is present under Appendix D.3.3.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Thursday 11th of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Friday 12th of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Sunday 14th of April

- 21:30:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

- 21:45:
Write and upload a post on Facebook containing: "Har haft en väldigt trevlig helg med många besök!"

D.2.4 Week 4

Monday 15th of April

- 09:30:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:45:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Tuesday 16th of April

- 10:30:
Scroll in the Facebook news feed and comment on a post from Wish containing clothes: "Det här ser bra ut!".

- 11:30:
Search for the word "Miniräknare" in the Wish application and click on the same item containing a calculator.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Wednesday 17th of April

- 09:00:
Have Wish and Messenger in the background and Facebook in the foreground on all phones.
The screens should not be locked.
Start the recorded dialogue for the test phones and isolate the control phones.

- 09:15:
Collect all the phones and download the Instagram application.
Sign in with the Facebook accounts.
Isolate all four phones in a quiet environment.

- 10:00:
Louise starts the fourth chat conversation containing chat dialogue 4 with all four accounts. The content of the dialogue is present under Appendix D.3.4.

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Thursday 18th of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Friday 19th of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

Sunday 21st of April

- 13:20:
Analyse the phones: the Facebook news feed, the ad settings on Facebook, the Messenger application, the Instagram Search & Explore tab and the Popular tab on Wish.

D.3 Experiment 5 Chat Dialogues

D.3.1 Dialogue 1

This dialogue was written the 28th of March between Zerina's Facebook account and the other four accounts. The red colour respresents Zerina's text and the blue represents the other accounts' text.

Hej! Det var längesedan jag hörde av dig. Är allt bra med dig?

Hej Zerina! Ja allt är bra med mig, hoppas allt är bra med dig också. Jag hörde att du skaffat **hund** för inte så längesedan.

Ja det stämmer. Jag och min sambo har köpt en **Jack Russel** som nu är 5 månader gammal.

Vad mysigt. Men det innebär väl mycket jobb att ha en **hund**?

Ja det gör det. Men det går bra. Vad gör du nuförtiden?

Jag söker jobb inom **sjukvården** då jag snart är klar med min **sjuksköterskeutbildning**. Jag har bara ett halvår kvar av studierna.

Vad spännande. Det verkar fortfarande vara brist på **sjuksköterskor** så det finns nog gott om jobb.

Ja det verkar finnas en hel del faktiskt. Men jag måste gå nu, jag har beställt mat på **OnlinePizza** och de kommer med min **pizza** nu. Vi får höras av snart igen. Ha det så bra så länge!

Det får vi göra. Ha det så bra du med!

The text marked in bold can be seen as keywords in these dialogues. The translation of these are seen in table D.2.

Table D.2: *Translated keywords from chat dialogue 1.*

Swedish	Hund	Jack Russel	Sjukvården	Sjuksköterskeutbildning	Sjuksköterskor	OnlinePizza	Pizza
English	Dog	Jack Russel	Healthcare	Nurse education	Nurses	OnlinePizza	Pizza

D.3.2 Dialogue 2

This dialogue was written the 4th of April between Louise's Facebook account and the other four accounts. The red colour respresents Louise's text and the blue represents the other accounts' text.

Hej! Det var kul att stöta på dig inne på **Willys**, synd att jag hade lite bråttom. Hur är det med dig?

Hej Louise! Det var det verkligen, allt är bra med mig hur är det själv? Såg att du fixat **naglarna**, väldigt fint! Vart brukar du göra dem?

Skönt att höra, allt är bra med mig! Jag gör **naglarna** hemma hos en vännina faktiskt.

Väldigt fina i alla fall! Har du hört om det nya **caféet** som öppnat i stan? Vi kanske kan mötas upp och ta en **fika** ihop.

Nej jag måste ha missat det. Självklart kan vi göra det, hade varit trevligt med en **fika**.

Jag har varit på det **caféet** en gång innan, och de hade jättegoda **bakelser**!

Jag går på **LCHF**, men jag kan nog hitta något att äta ändå.

Ja det finns nog något för alla där!

Jag måste iväg och hämta min dotter nu. Vi får höras av angående **fikat**, ha det bra så länge!

Det får vi göra, vi hörs!

The text marked in bold can be seen as keywords in these dialogues. The translation of these are seen in table D.3.

Table D.3: *Translated keywords from chat dialogue 2.*

Swedish	Willys	Naglarna	Caféet	Fika	Bakelser	LCHF
English	Willys	Nails	Cafe	Have coffee	Pastries	LCHF

D.3.3 Dialogue 3

This dialogue was written the 11th of April between Zerina's Facebook account and the other four accounts. The red colour represents Zerina's text and the blue represents the other accounts' text.

Hej igen Zerina! Förlåt för jag inte hört av mig, men har haft mycket att göra i skolan.

Hej *namn*! Det är ingen fara, jag har också fullt upp på jobbet och hemma. Hur går det för dig med utbildningen då?

Det går bra, men det är mycket att göra. Vi läser just nu vår sista medicin**kurs** och har precis blivit klara med en **kurs** om palliativ vård.

Okej, skönt att det kanske är lite lugnare nu.

Ja det är det. Hur går det med **hunden**?

Jo det går bra faktiskt, vi börjar komma in i rutin med promenaderna och andra saker.

Vad bra. Det är väl promenaderna som tar längst tid att vänja sig vid antar jag. Det är ju väldigt jobbigt när vädret är dåligt också.

Ja det är ju det, men vi trivs ändå mycket med att ha en **hund** i hemmet.

Tänkte bara kolla en sak med dig också. Sist när jag beställde från **OnlinePizza** fick jag inte alls en god **pizza**. Vilken är den bästa **pizzerian** i stan?

Vi äter faktiskt aldrig **pizza** här hemma så det är svårt att säga. Jag kan kolla med lite vänner och se vad de tycker.

Ja gör det är du snäll! Jag vill inte chansa mer och köpa mat jag inte är nöjd med. Nu kommer mina gruppkamrater tillbaka så jag måste fortsätta jobba på vårt arbete. Men vi får höras av någon annan dag och kanske ta en **fika**. Ha det så bra!

Du får också ha det så bra så hörs vi av framåt!

The text marked in bold can be seen as keywords in these dialogues. The translation of these are seen in table D.4.

Table D.4: *Translated keywords from chat dialogue 3.*

Swedish	Kurs	Hund(en)	OnlinePizza	Pizza	Pizzerian	Fika
English	Course	(The) dog	OnlinePizza	Pizza	Pizzeria	Have coffee

D.3.4 Dialogue 4

This dialogue was written the 17th of April between Louise's Facebook account and the other four accounts. The red colour represents Louise's text and the blue represents the other accounts' text.

Hej igen Louise! Ska vi boka in **fikan** som vi sa sist?

Hej *namn*! Ja det kan vi göra. Jag vet ett bra **fika**ställe nere i centrum där man kan sitta i lugn och ro och prata. De har även bra **fika** för oss som går på **LCHF**. När kan du ses?

Det låter kanon! Nästa vecka kan jag hela veckan efter klockan 16.

Men ska vi säga klockan 18 på tisdag, så kan vi mötas på torget?

Ja, det blir bra! Innan dess måste jag bara gå in på **Kicks** för att köpa en **mascara**.

Okej, **Kicks** ligger ju i närheten av **fika**stället så det hinner du nog. Jag hade faktiskt också behövt en ny **mascara**, så jag följer gärna med!

Ja gör det, då kanske vi kan ses en kvart tidigare?

Ja, det låter bra. Hur är det med familjen?

Det är bra med alla, min son ska börja på **karate** nästa vecka och det ser han fram emot jättemycket.

Vad roligt! Min ena dotter går också på **karate**, och deras tränare har tidigare tränat folk som vunnit SM-guld.

Jag läste det i en tidningsartikel häromdagen. Man får hoppas att våra barn blir lika framgångsrika någon dag.

Ja. Nu ska jag åka hem på lunch i alla fall. Men vi ses på tisdag. Ha det bra så länge!

Ja det gör vi. Detsamma!

The text marked in bold can be seen as keywords in these dialogues. The translation of these are seen in table D.5.

Table D.5: *Translated keywords from chat dialogue 4.*

Swedish	Fika	LCHF	Kicks	Mascara	Karate
English	Have coffe	LCHF	Kicks (company)	Mascara	Karate

Appendix E

Results

E.1 Instagram Search & Explore Topics in Experiment 5

The default sequence of topics that were observed in the Search & Explore tab is the following: *Architecture*, *Travels* and *Furnishing*. The tables listed in this section contains the changes of the first three topics presented in the Search & Explore tab. The asterisk symbol (*) is used when the value is the same as from the day before, and the dash symbol (-) stands for no change from the default values.

Table E.1: *Deviating topics in the Search & Explore tab on Instagram, week 1.*

	iOS (test)	**iOS (control)**	**Android (test)**	**Android (control)**
Monday	-	1. Nature 2. Art 3. Architecture	1. Animals 2. Architecture 3. Travels	-
Tuesday	-	*	*	-
Wednesday	-	*	*	-
Thursday	-	*	1. Science and Engineering 2. Animals 3. Comedy	1. Nature 2. Architecture 3. Travels
Friday	-	*	*	1. Nature 2. Art 3. Architecture
Sunday	-	*	*	*

Table E.2: *Deviating topics in the Search & Explore tab on Instagram, week 2.*

	iOS (test)	**iOS (control)**	**Android (test)**	**Android (control)**
Monday	-	*	1. Science and Engineering 2. Animals 3. Nature	1. Nature 2. Architecture 3. Travels
Tuesday	-	*	1. Science and Engineering 2. Animals 3. Comedy	*
Wednesday	-	*	*	*
Thursday	-	*	*	*
Friday	-	*	*	*
Sunday	-	*	1. Science and Engineering 2. Comedy 3. Architecture	1. Nature 2. Architecture 3. Art

Table E.3: *Deviating topics in the Search & Explore tab on Instagram, week 3.*

	iOS (test)	**iOS (control)**	**Android (test)**	**Android (control)**
Monday	-	*	1. Science and Engineering 2. Animals 3. Comedy	1. Nature 2. Architecture 3. Travels
Tuesday	-	*	1. Science and Engineering 2. Comedy 3. Architecture	*
Wednesday	-	*	1. Science and Engineering 2. Animals 3. Comedy	*
Thursday	-	*	*	*
Friday	-	*	*	*
Sunday	-	1. Art 2. Nature 3. Architecture	*	*

Table E.4: *Deviating topics in the Search & Explore tab on Instagram, week 4.*

	iOS (test)	**iOS (control)**	**Android (test)**	**Android (control)**
Monday	-	*	*	*
Tuesday	-	1. Nature 2. Art 3. Architecture	1. Science and Engineering 2. Comedy 3. Architecture	1. Nature 2. Architecture 3. Art
Wednesday	-	1. Art 2. Nature 3. Architecture	*	*
Thursday	-	*	*	*
Friday	-	*	*	*
Sunday	-	*	*	*

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