

# UNIVERSITY OF TWENTE.

Faculty of Electrical Engineering,  
Mathematics & Computer Science

## An innovative search interface for Gesture Dictionary

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# Abstract

## **Problem statement**

We live in a multicultural world. It becomes more and more diverse in terms of different cultures living in the same country, city, neighborhood or even apartment. We need to learn how to communicate with each other, sometimes even without words, using only gestures. But how to be understood correctly and convey the message in a non-offensive manner? To help people better communicate in multicultural epoch the German company Fragenstellerin developed the gesture dictionary application on an iOS platform<sup>1</sup>. To cover the bigger population of users, the next step for Fragenstellerin is to bring the Gestunary gesture dictionary application to Android platform. As the result of my work, the Fragenstellerin company will be able to make Gestunary accessible to the Android users, the number of which is 5 times bigger than the iOS<sup>2</sup>.

## **Approach**

The most important function of the dictionary is to allow the user to find the gesture efficiently. In this Master Thesis, I am designing an innovative search interface for the Android Gesture Dictionary. I am applying user-centered design method to the very popular modern industrial task of moving applications from one platform to another. In the first five chapters I analyze the user interface of the iOS Gestunary solution, collect user's reflections, research similar products and gesture coding schemes. In the rest of the chapters, my work deals with the analysis of the vision of potential users of Gestunary application. Finally, I research user preferences for gesture illustrations and perform feasibility study of automatic gesture recognition.

## **Results**

I developed an innovative search interface for the Gestunary application based on the user-centered design principles. I created gesture coding scheme, based on the literature research. In my research, I found out that users prefer color photos of gestures, compared to black and white drawings. I made some tests and found out that it is feasible to apply machine learning algorithms for automatic gesture search from images for future versions of the Gestunary application.

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<sup>1</sup><https://www.apple.com/nl/ios/ios-11/>

<sup>2</sup><https://www.idc.com/promo/smartphone-market-share/os>

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# Chapter 1

## Introduction

In this chapter I explain the topic of my master thesis.

### 1.1 Problem statement

In today's multicultural society mutual understanding becomes more and more important. At the moment, scientists consider that 70% of information transferred in communication is nonverbal [51]. Such assertion went under suspicion by Mehrabian and Ferris [37]. Later on, dr. Albert Mehrabian [36] admitted that these figures could be true for communication of feelings and attitudes. One of the components of nonverbal communication is gestures. In every culture, there is a set of gestures, which helps to communicate the information. Even though some gestures are universal for most of the cultures, there are many gestures, which have absolutely the opposite meaning [22].

Facing the growing interest from the businesses and tourists to be well prepared for cross cultural communication [17], the company Fragenstellerin developed the Gestunary application and placed it on AppStore<sup>1</sup>. The Gestunary iOS application (v 1.2.0) is a dictionary for gestures from around the world. In response to the fact, that as of the end of 2016, there were more 86% of Android users vs 13% of iOS users, the company decided to develop an Android version of the dictionary. The goal of this Master thesis is to make a step towards implementing Gestunary on the Android platform, creating the Innovative Search Interface for Gestunary.

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<sup>1</sup><https://www.apple.com/ios/app-store/>

### 1.2 Gestures and gesture dictionaries

Since ancient times there was an interest in gestures. Gestures were used in rhetorics to enhance the speaker's presentation [13]. But the first systematic analyses were completed only in 20th century. One of the first systematic analyses was created by Kendon [21], who classified gestures in 4 categories: gesticulation, pantomime, sign language and emblems. My subject of interest is emblems, as they are culturally codified gestures. Emblems are the kind of gestures which are included in the collection of Gestunary dictionary. Gesticulation, pantomime and sign language have very specific users and are out of scope of my master thesis.

According to the Oxford English Dictionary "gesture" refers to "a movement of the body or of any part of it" that is "expressive of thought or feeling [20]. Gestures are tightly coupled with speech and even when the person speaking is not observed by the opponent, the speaker still produces gestures [22]. At the same time, some gestures could be performed without talk. For instance, gestures which occur when the person is illustrating some concept or sign language gestures [34].

Gestures seems to be a universal characteristic of communication. At the same time there is a good evidence that each culture has own set of conventional gestures. Because the meaning of these conventional gestures is culture specific, people from other cultures are not always able to understand the meaning. Good examples of different meaning of similar gestures are the head nodding gesture. In ancient Greece nodding meant negation. The same meaning of this gesture is preserved in the south of Italy, Turkey and Bulgaria. At the same time, in the north of the Italy and in most of Europe nodding means agreement. There is a big variation in the meaning of pointing gestures even within one culture. In Naples there are at least five pointing gestures with with different meanings. For instance, "the index finger pointing with the palm down individuates a referent as being distinct from other objects and brings the referent into the centre of discourse focus. The index-finger pointing with the palm vertical, on the other hand, indicates a referent that is relevant to the current discourse but not in the centre of focus" [22], 6. The same holds true for Australian aborigines. For instance, "horn-hand pointing indicates the direction of the end point of a route" [22], 6.

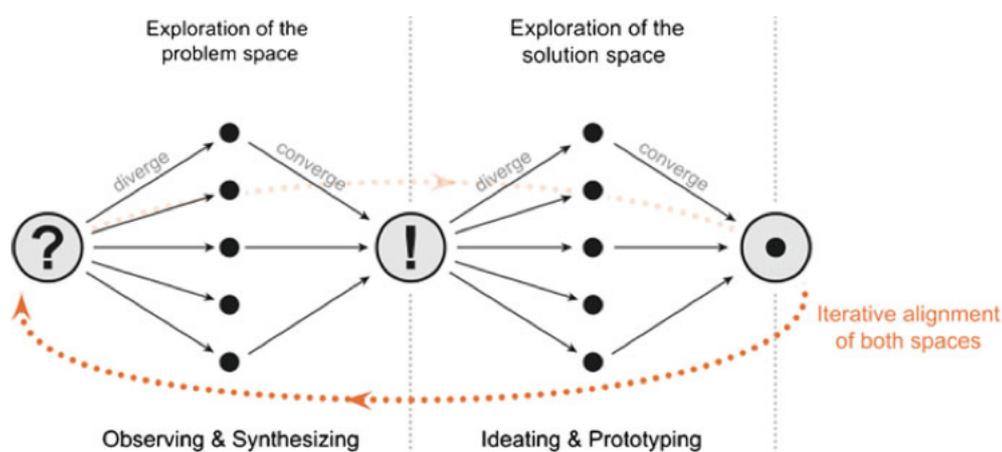
I describe the methods used to code gestures by different researchers. I also provide a brief history of gesture research and describe the method of annotation, that I used in my search interface for Gesture dictionary.

But how to search for the gesture? Gesture search could be implemented in many different ways. From the user perspective, the gesture could be described by words, by picture (be it a picture or a scheme) or by video. I review different gesture search methods and approaches to interface design.

## 1.3 Interface design method

### Method

The Android User interface, which I work on, should have good usability and good user experience. Usability - "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [58]. To achieve these qualities, I used the Human-Centered design method described in the "Ergonomics for human-system interaction Part 210: Human-centred design for interactive systems" [16] as a guidance and Design Thinking approach [29]. According to the standard [16] user experience is "person's perceptions and responses resulting from the user and anticipated use of product, system or service". Design thinking is a problem-solving method, which could be described by the following iterative workflow: 1) observe and synthesize, 2) ideate and prototype, 3) revise and refine. It is characterized by extensive research of the problem and then iterative development.



**Figure 1.1:** Design thinking process, adopted from Lindberg

### Team

All of the design and development was performed by myself, wearing many virtual caps. This constraint added interesting development challenges, on how to apply design and development methods designed for big teams in the team of one person. The standard recommends having diversity of qualifications in the design team. I had to apply different psychological techniques to switch from the one mode of thinking to another, to be able to design and develop the user interface.

### Users

In this Master thesis, I mostly test users, who travel for leisure and who work with people from different cultures. The reason for this choice is conditioned by the wide availability of the mentioned user groups and possibility to reach them for extensive user testing.

### 1.4 Introduction to Research questions

The main research question: how to create the innovative user interface for the Android Gesture Dictionary targeted at general population?

To find an answer to this question I need to find answers to the following research questions:

- How Gestunary for iOS currently implements search UI, what are the modern electronic gesture dictionaries and how do they implement search functionality?
- What is the user feedback on the search functionality and other UI elements of the Gestunary for iOS?
- What kind of ideas for the design of innovative search interface could be acquired from Heuristic Evaluations of Gestunary for iOS?
- What are the state of the art gesture classification and coding methods?
- What are the modern Android UI patterns for search interface?
- What are the usability problems of the Lo-Fi prototype of search interface?
- What are the usability problems of the Hi-Fi prototype of search interface?
- What are the usability problems of the Final prototype of search interface?
- What type of pictures users prefer as an illustration of gesture?
- Is it feasible to implement automatic gesture search using machine learning methods?

### 1.5 Structure of this Document

In **chapter 2** I present an overview of the Gestunary for the iOS application. I also review two related applications and describe their user interfaces and functionality. I conclude the chapter with ideas, that could serve as an inspiration for the Gestunary for the Android platform.

In **chapter 3** I present the results of user-based testing of Gestunary for iOS and results of System Usability Scale test. I list user pain points and prepare the grounds for Lo-Fi prototype design of innovative search interface (chapter 6).

In **chapter 4** I provide the results of Heuristic Evaluations of Gestunary for iOS. This adds more ideas for Lo-Fi prototype design.

## 1.5. STRUCTURE OF THIS DOCUMENT

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In **chapter 5** I research gesture classification, gesture dictionaries and the data representation in gesture dictionaries. I also research gesture coding schemes to find ideas for innovative search interface implementation.

In **chapter 6** I present the initial prototype and results of co-design session with the users. I also present the grounds for the design decisions, which I made in the initial prototype. Finally, I create a list of ideas which I implement in the Hi-Fi prototype in the next chapter.

In **chapter 7** I use results of the Lo-Fi user testing and present the enhanced prototype, developed based on co-design session. I also provide results of user test, of minor UI elements testing and SUS results.

In **chapter 8** I present the final UI prototypes, creates on the bases of the Hi-Fi prototype. I present results of application usability testing, as well as SUS test results.

In **chapter 9** I present results of gesture illustrations preference research. I also present feasibility study of gesture search using machine learning methods.

In **chapter 10** I present the comparison of user test results, SUS test results, discussion and suggestions for future work.

## **Chapter 2**

# **Gestunary for iOS and related applications**

In this chapter I describe Gestunary application and two related products: iOS application Gestures and Cultures and scientific web-based application DiGest.

### **2.1 Gestunary for iOS**

Gestunary is one of the first digital dictionaries for gestures in different cultures for iOS mobile platform. The dictionary represents gestures by static images, animations, gesture meaning descriptions and gesture origins. Related gestures are collected in groups. It is possible to search for gestures by keywords or browse through the list of gestures, which belong to different countries. At the moment the Gestunary user interface uses the English language.

#### **2.1.1 Stakeholders**

According to the Fragenstellerin company, the Gestunary stakeholders are business travelers, travelers, tourists, tourist industry, anthropologists, people who are inter-culturally on the road, people, interested in the subject of gestures and their friends.

#### **2.1.2 Dictionary gesture collection**

The gestures, which compose the base of the dictionary, are collected by the developers of the Gestunary. At the moment of writing, there around 250 gestures in the collection. Each gesture is represented by the color illustration and gesture

## 2.1. GESTUNARY FOR IOS

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etymology. Some gestures have additional information on similar gestures in other countries with a special stress on gestures with different meaning.

### 2.1.3 User Interface Description

#### Home

On the first start after the installation, the user is presented with the home page and a one-screen pop-up hint (Figure 2.1). Next time the application is started the user will see a random gesture illustration from the list of gestures (Figure 2.2 (a)).



**Figure 2.1:** one-screen pop-up hint.

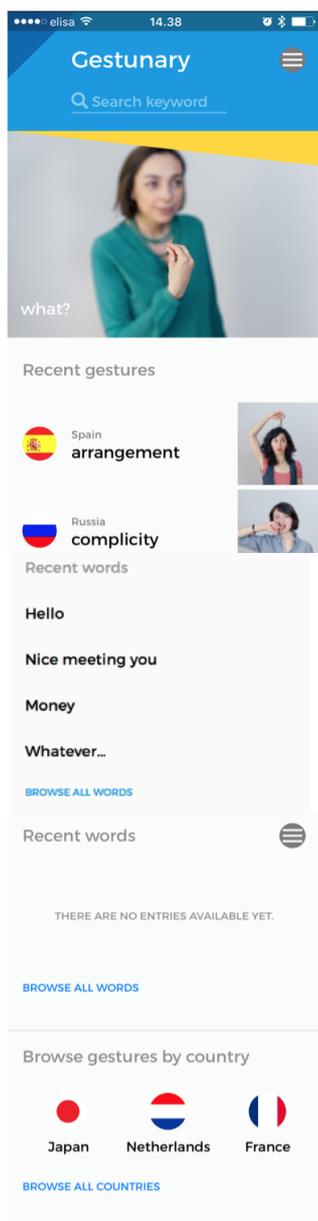
Above the image there is a textbox for searching keywords. Tapping on the magnifying glass and tapping in the textbox area calls up the keyboard and lets the user to enter the text. Below the image there are a few categories of dictionary contents, which could be accessed by scrolling the content.

Categories include:

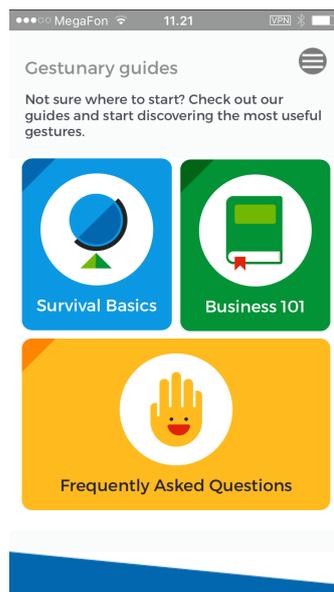
- lists of the recently viewed gestures and recently viewed words
- button to view a list of dictionary entries
- button to browse the dictionary by country
- button to view the list of all countries
- buttons to view Gestunary guides (Figure 2.2 (b))
- button to view frequently asked questions.

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Tapping on the buttons, gestures and country icons opens corresponding screens. In the top right corner of the screen, there is a hamburger menu icon, which stays in place while scrolling. Tapping on the icon calls up the menu screen. This icon is presented on all screens of the application and behaves in the same way on all screens.



a)



b)

**Figure 2.2:** Gesture screen illustrations.

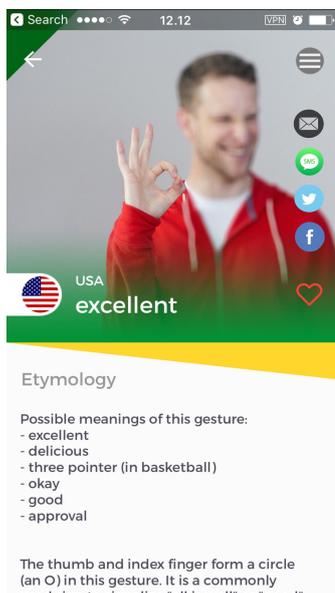
### **Gesture screen**

The Gesture screen describes a dictionary entry (Figure 2.3 (a),(b)). Tapping on the gesture image always takes the user to this screen. The gesture screen has the

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following elements:

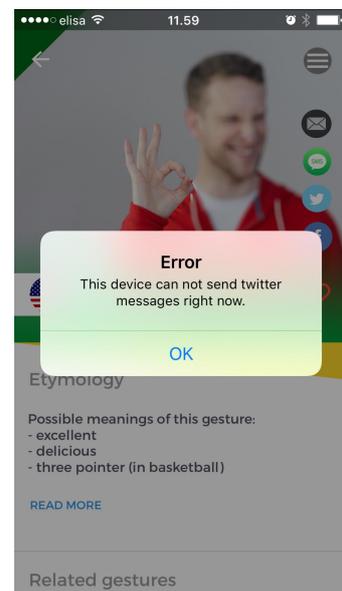
- An illustration of the gesture. Most gesture illustrations leave only a gesture part of the image in focus. The background and unimportant parts are blurred. Actions are illustrated by gray lines.
- An image of the country in which this gesture is used. This is a button which leads to the list of all gestures which belong to that country.
- An etymology section describes the meaning of the gesture.
- A list of related gestures from different countries.
- "Avoid in" section which lists countries where the gesture should be avoided.
- "Similar sign seen in" section lists countries where gestures often used with different meaning.



a)



b)



c)

**Figure 2.3:** Gesture screen description and Error pop-up

### Sharing icons

## 2.1. GESTUNARY FOR IOS

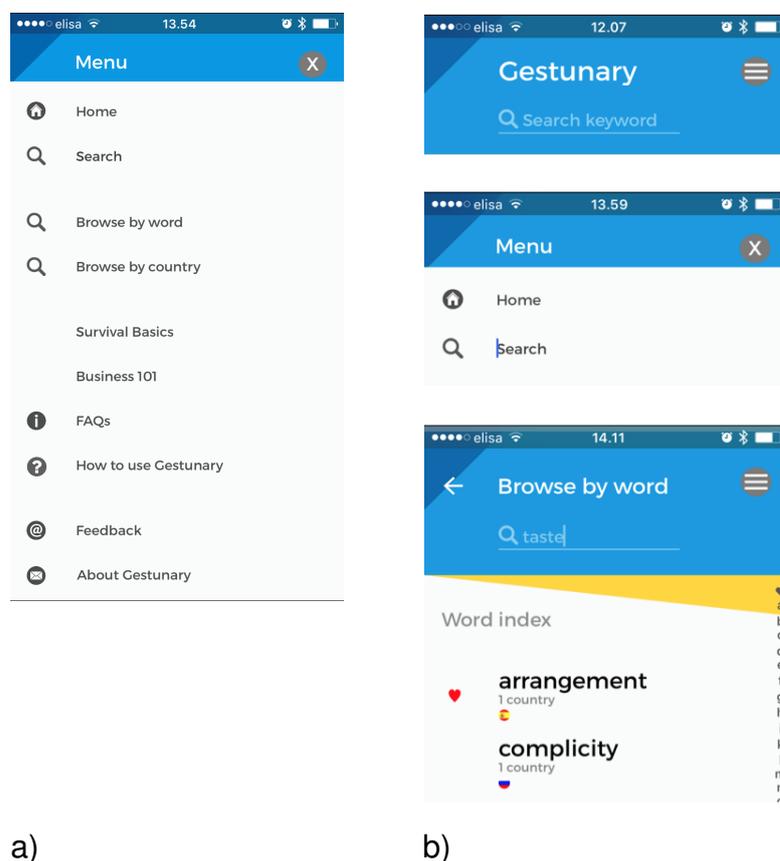
There are sharing icons on the gesture description screen. Sharing in the message opens an SMS application with the link to the application on the Apple App-store<sup>1</sup>. Tapping on the icons returns the error pop-up (Figure 2.3 (b)).

### Menu

The menu is implemented as a "hamburger" icon in the top right corner of the screen. Tap on the icon calls up a screen with the menu, presented in Figure 2.4 (a). The menu lets the user view listed items and perform a search.

### Search

Search has three entry points: from the Home screen, where it is called search by keyword, from the browse by word and from Menu, where it is a search text field (Figure 2.4 b)).



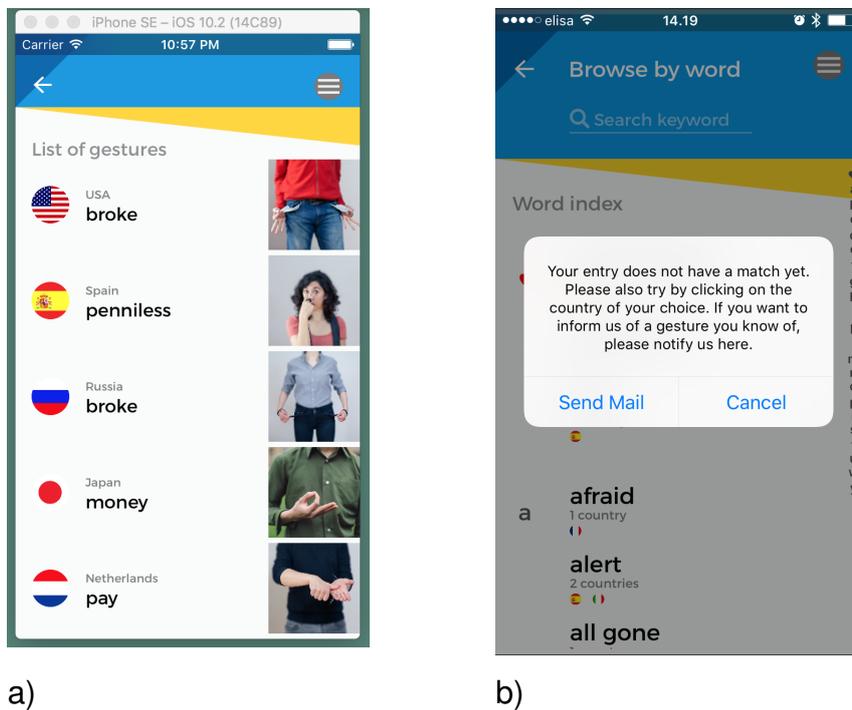
**Figure 2.4:** Menu contents and Search entry points.

Search results for the term "Money" are presented in Figure 2.5 (a). Search for keywords which are not in the dictionary (for example, "taste Italy") results in opening a notification popup (Figure 2.5 (b)). The user is suggested to send an e-mail with the gesture description (not a keyword list) to the authors of the application.

<sup>1</sup><https://www.apple.com/ios/app-store/>

## 2.1. GESTUNARY FOR IOS

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**Figure 2.5:** Search results for keyword money and in case the word is not found

### **Survival basics**

The Basic gestures link will lead to the category named Survival basics (Figure 2.6 (c)). At the moment it has six categories: eating, drinking, stupid, crazy, boring and nothing. Each category contains gesture explanations of this category from different countries. The number of countries varies.

### **Category Business 101**

The Business 101 category is similar to Survival basics, but lists a subset of gestures related to business (Figure 2.6 (a)). Tapping on a word leads to opening a screen with a subset of the gestures, illustrating this word (Figure 2.6 (b)).

## 2.2. IOS APPLICATION "GESTURES AND CUSTOMS"

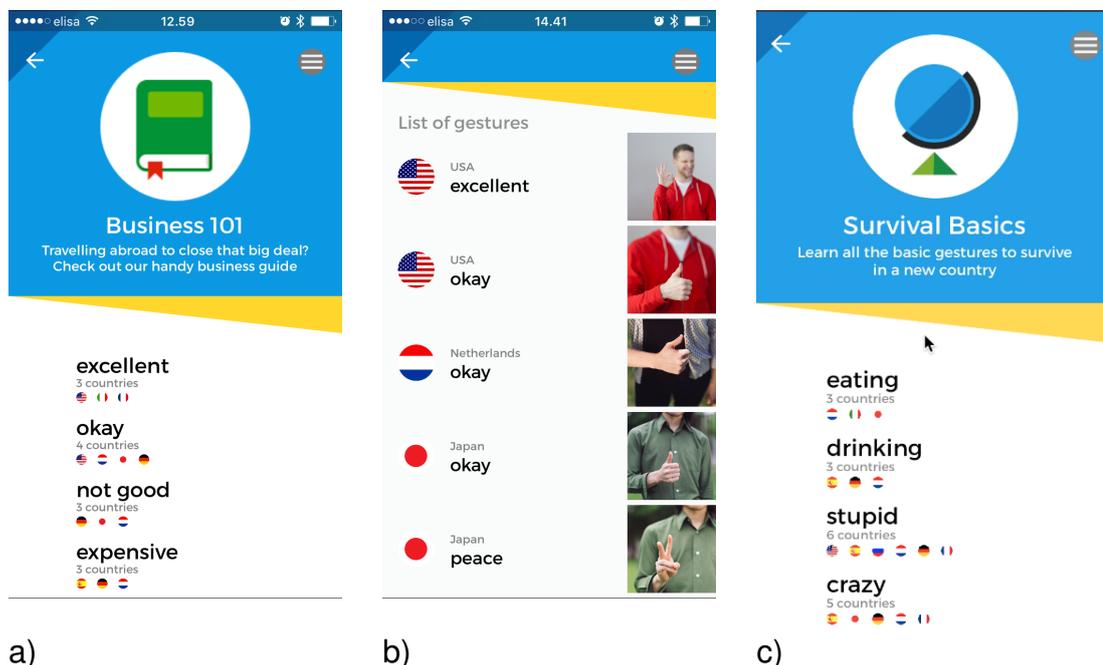


Figure 2.6: Category Business 101 and Survival basics.

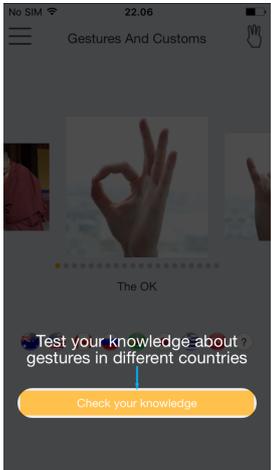
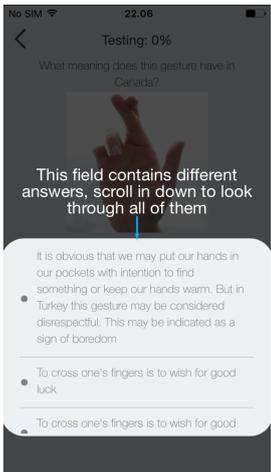
## 2.2 iOS application "Gestures and Customs"

Another gesture dictionary application is an iOS application Gestures and Customs [30]. The application is described as an entertainment application for travelers. It is possible to have the UI translated into 11 languages, including, besides European languages, Russian, Chinese and Korean languages. Gestures and Customs library includes less than 50 gestures. The application provides the following functionality for the user:

- The user can browse through a limited number of gestures by swiping through gestures.
- The user can also choose a quiz mode, where it is possible to try to guess the meaning of the gesture.

There is no gesture search functionality at all. On the first start, the application has very convenient help, which describes all the functionality of the application. The layout of the application lets users to view the gestures in an unordered list or view gestures in a slideshow. The slideshow is enhanced by the ability to swipe gestures from side to side. Figure 2.6 shows a few screenshots from the Gestures and Customs application together with the description.

## 2.2. IOS APPLICATION "GESTURES AND CUSTOMS"

Screen name	Description	Screenshot
Overlay with help	On the first start the application goes into education mode and guides the user through all UI options.	
Instruction	Quiz instruction.	
Quiz	The user is expected to tap on the correct answer. Tapping on the screen progresses the user to the next question. Pictures are repeated while questions are varied.	

## 2.2. IOS APPLICATION "GESTURES AND CUSTOMS"

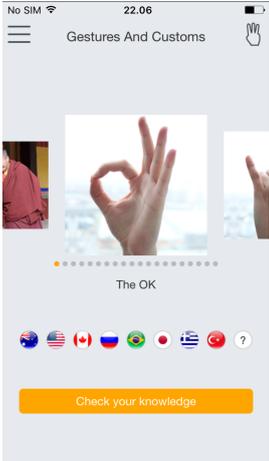
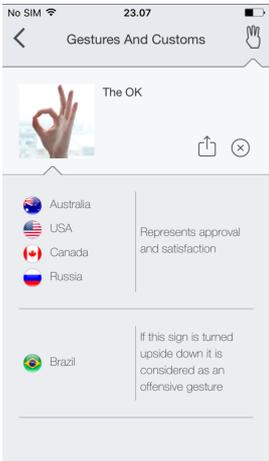
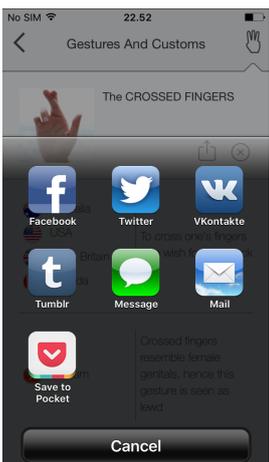
<p>Main screen</p>	<p>The user can swap through gestures.</p> <p>The flag icons below the picture illustrate in what countries the gesture is used.</p>	
<p>Gesture description screen</p>	<p>There is more information on the screen then fits it. To see more, one should swipe down.</p>	
<p>Share</p>	<p>Tapping on share icon opens an activity view<sup>2</sup> with a list of applications, available for sharing. The list does not include an option to add more applications.</p>	

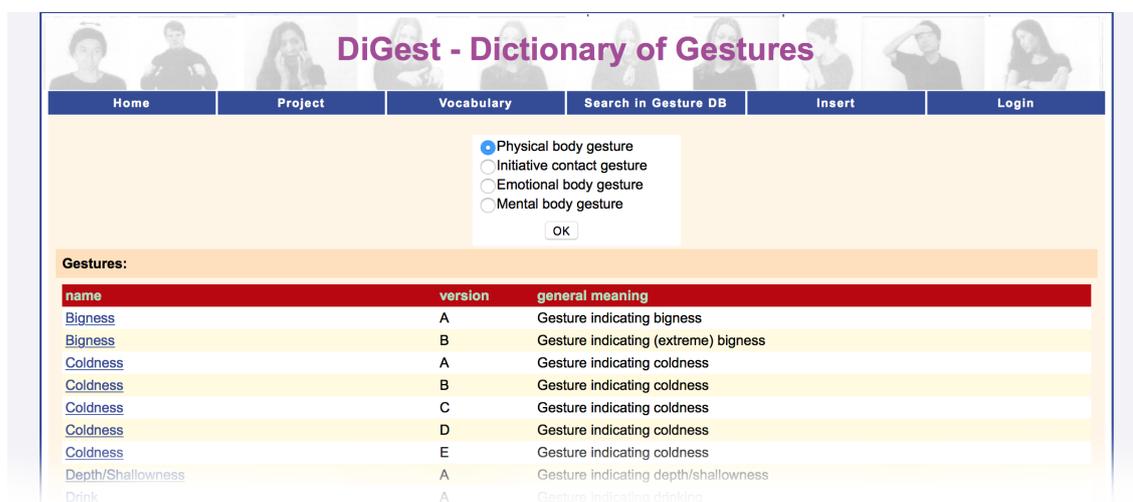
Table 2.6: Gestures and Customs application description

<sup>2</sup><https://developer.apple.com/ios/human-interface-guidelines/views/activity-views/>

## 2.3 Web-based application DiGest

DiGest is a web-based multimodal and multilingual dictionary of gestures [52]. At the moment it contains more than 300 gestures. Gestures are represented by images, a description of the gesture and an optional audio and video recordings. In addition it includes such additional layers of information as phonetic transcription and literal translations. The current version includes language and culture dependent content for American English, Slovak, Italian, and Mongolian. Entries for Japanese, Chinese, and Hungarian are being implemented.

The dictionary is targeted to students of inter-cultural communications and other people interested in the meaning of gestures in different cultures. In the beginning the project was based on the Picture Dictionary of Gestures of Ruikov [52]. The current organizational system of the dictionary follows the original structure of the book. The gestures are divided into four groups by the general meaning: "physical body gestures", "initiative contact gestures", "emotional body gestures" and "mental body gestures". These categories cover almost all possible gesture variants. The choice of gesture categories was directed by gesture semantics.



**Figure 2.7:** List of physical body gestures.

There is no search in the gesture database, but one can use a filter, to browse through four categories of body gestures (Figure 2.7). A user can browse through the list of gestures using next and previous buttons (Figure 2.8). Choosing a filter option results in the output of the list of gestures corresponding to gesture category (Figure 2.7). Each gesture in the list includes the name and general meaning in a few words. It is also possible to browse through the whole collection of gestures by clicking on the top-level link "vocabulary".

Figure 2.8 displays sample gesture illustration for the word "coldness". The ges-

## 2.4. COMPARISON

ture description includes general meaning, gesture action description, gesture action variations, related gestures and a number of attributes. Attributes could be selected for three different languages. Attributes include lexical orthographic, translation and usage context. The UI has an option to compare one gesture with two gestures with similar meaning, but from different languages.

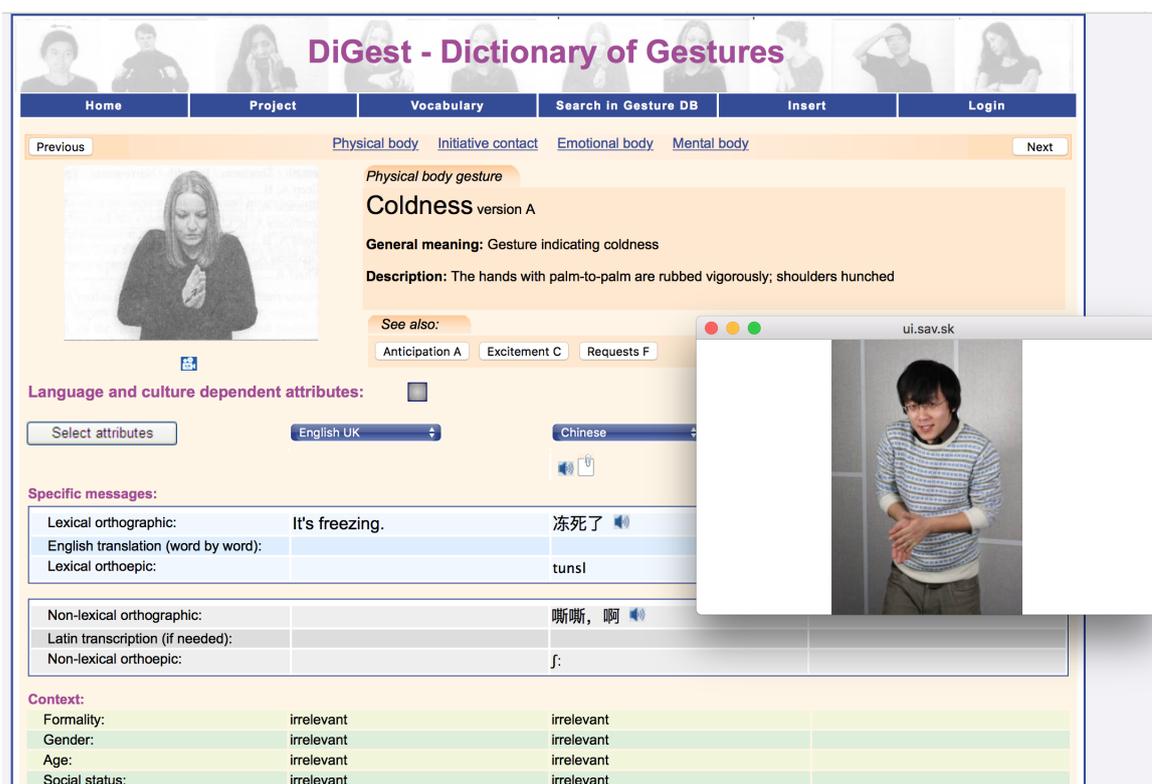


Figure 2.8: Sample gesture illustration coldness.

## 2.4 Comparison

In this section I compare the three applications and draw conclusions.

### Number of gestures

From the three analyzed products, the DiGest gesture collection has the highest number of gestures. The iOS Gestunary application has around 2500 gestures. The iOS application "Gestures and Customs" has less than 50 gestures. The web-based DiGest dictionary has several hundred gestures.

The Gestunary application is still in the development phase and will gradually build up the gestures library. It will be very beneficial for the application to expand the number of the described gestures.

### Illustration types

Study user preferences towards gesture type is one of my research questions in this master thesis. It is important for us to learn about different types of illustrations,

## 2.4. COMPARISON

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because users feedback about illustration types in Gestunary greatly varied3.3.4. The illustrations in iOS Gestunary application are mostly presented by full body color photos. Some photos have blurred elements which emphasize the gesture. Some gestures are animated. Pictures in the iOS application "Gestures and Customs" are plain color fragments of the body parts which illustrate the gesture. Most of the gestures are made only by palms. The web-based DiGest dictionary is illustrated by black and white photos, color photos and movies. The Gestunary presentation of full body image is much more informative compared to the photo of hands, used in the application "Gestures and Customs". The user can perceive more information about the gesture looking at illustrations in the Gestunary and the DiGest. For instance, the user can understand the body inclination, face expression and many other small details which are included in the gesture.

### **User Interface**

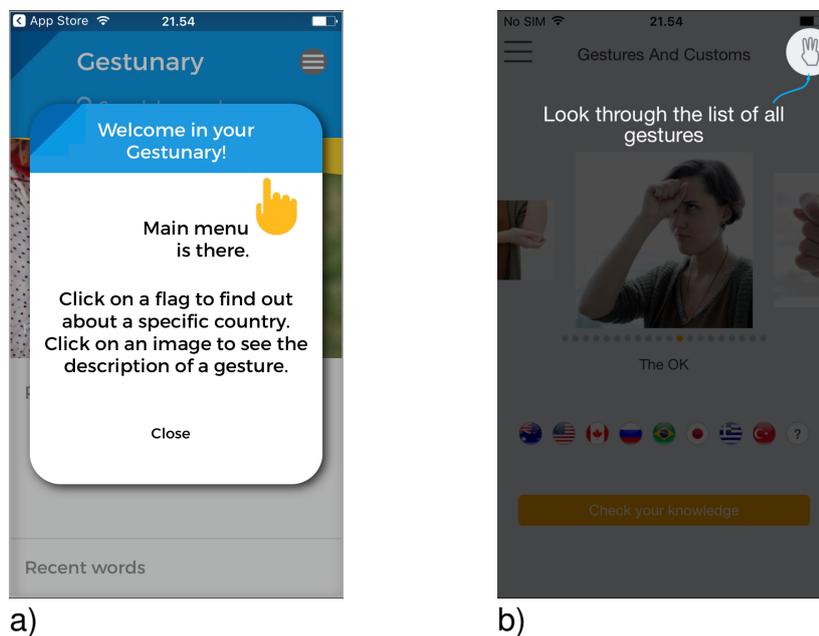
The user interface of the Gestunary application is vivid and bright compared to the "Gestures and Customs" and DiGest applications. DiGest is a research tool targeted at scientific researchers. This is reflected in the user interface of the database which clearly lacks entertainment component.

Both iOS applications do not strictly stick to the iOS guidelines. From the point of view of Nielsen's Heuristic Evaluation [41] this could bring unnecessary load on the user's memory and the need to get adapted to the unfamiliar user interface items placement and behavior.

After the first start of the application both programs display an overlay with a help screen (Figure 2.9). The overlay on start of the "Gestures and Customs" application walks the user through all UI elements of the application, while Gestunary describes only the home screen.

## 2.4. COMPARISON

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**Figure 2.9:** Help screen overlay.

Both, the "Gestures and Customs" application and the DiGest lack "search by keyword" functionality, while the Gestunary has it. There is no clear explanation for this fact. I could guess that one of the reasons, why the DiGest does not have search option is the complexity of the gesture coding system, which should be used to efficiently search for the gesture.

### Inspiration for the Gestunary

#### **Gamification**

From the standpoint of the tourist, the idea of the quiz from "Gestures and Customs" is interesting and fun. Adding a gamification component could add more attractiveness to the Gestunary application. Interviewed users expressed interest in adding a quiz (Appendix F, F).

#### **Audio**

One more useful and interesting idea to borrow might be adding audio tracks to accompany gestures. The importance of adding audio information to gesture illustrations is supported by McNeill [32].

#### **Browse through the whole collection with details opened**

The "gestures and Customs" and the DiGest application allow the user to browse through the whole descriptions of the gestures. The "Gestures and Customs" allow to swipe from left to right on the screen with the finger to see the next gesture. The DiGest application interconnects all collection with buttons "previous" and "next". It

## 2.4. COMPARISON

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seems to be a natural addition to the user interface, which is still lacking from the Gestunary.

### **Search functionality**

Both explored applications do not have search functionality. This gives Gestunary application a unique opportunity to add innovative search UI which has not yet been implemented in other applications.

# Chapter 3

## User-based testing of Gestunary for iOS

To develop a new search interface for the Gestunary I needed to perform user-based testing of the Gestunary for iOS with the first-time users of the application. The primary goal was to receive feedback from the biggest group of potential application users - tourists. In this chapter I present results of user-based testing of the Gestunary for iOS application and results of the SUS survey.

### 3.1 User-based testing

In this section I describe the protocol, test scenario, test setup description, and users, who participated in the testing. During user testing I used elements of think-aloud protocol and semi-structured interviews [24] motivating users to give more thoughts and information on related to tasks actions during and after the interview. Thinking aloud protocol is a discount usability method which could be used at almost any stage of development - from early prototyping to final polishing of the system [40]. The test plan is presented in the Appendix C.

#### 3.1.1 Test scenario

1. Introduce the Gestunary application (the introduction is listed in the Appendix C).
2. Find out in what country the user has not yet been to or the country, where the user might want to find more details about gestures. Ensure that the country is on the list of available countries.
3. Provide the users with the task list and specify the order of task performance.

### 3.1. USER-BASED TESTING

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The task list presented to users is below (in the order of importance and performance):

#### **Task list**

- Find a few gestures for the topic of your interest.
- How can you do that? Please try to find all possible ways to search for the gesture
- What search keywords will you use to find the gesture?
- Read gesture details. what do you think about gesture description?
- Find recent gestures
  - How do you understand gesture titles?
  - How do you understand "similar sign seen in" section
- How would you like to share the gesture?
- Share this gesture with someone
- You are in a foreign country. You saw a gesture of a person shaking his head. You want to understand what this person means with this gesture. How can you look it up by using Gestunary?
- Browse by country
- Browse by word
- Explore survival basics for Japan
- Explore business 101 for Japan

#### **Interventions**

Usually there are no interventions during the test but [24] mentions that interventions could be beneficial in acquiring maximum amount of feedback about the interface. According to Lazar [24], prompts and interruptions are often needed to stimulate the user to give more feedback. I used the opportunity to ask open ended questions to receive more insights into users mind.

### 3.1.2 Test setup and location

According to Lazar [24], user testing could be performed anywhere. The traditional set-up for usability testing is a two-room environment where one room is dedicated to user test and the other is occupied by moderators and other stakeholders who observe the user performing the test. Nevertheless, Lazar mentions that it is possible to perform user testing at users's home or work. He is stressing that "having a fixed usability laboratory is not a must for usability testing", but notes that the setup from the traditional room could be used to make video and audio recordings.

Lazar also notes that sometimes it is impossible to easily access users to do user tests face-to-face. In this case, it is also possible to perform remote usability testing. During remote testing users and evaluators could be separated in space and/or time. Nowadays there are many remote testing tools which are available for user testing. The easiest setup includes Skype program and desktop sharing option.

Lewis [27] also mentions advantages of remote usability testing. Advantages include possibility to work in familiar surroundings and access to the users who would otherwise be unreachable. The main drawback of remote testing, according to Lazar, is the difficulty in picking up non-verbal and interpersonal hints. Another drawback is that the researcher could miss the context of what is happening. To avoid this pitfall, Google, for instance, created a van to be able to travel and test wider population of users. Another drawback mentioned by Albert [1] is the limitations of the remote usability study, when researcher needs deep insights into the user. Albert [1] also mentions possibility for the prototypes to be stolen, since it is easy for the user to make screenshots.

I think that testing mobile applications remotely is very feasible and, sometimes, preferable to in-person testing, technique. In my experience, people, who shared information over Skype gave more insights into application compared to in-person tests. Lazar [24] mentions the importance of subtle nuances in facial expressions, sounds which the user can make. I find that most of these features could be also observed over Skype, given the reliable Internet connection.

Users were at home in their familiar settings. Two users used their own iPhones. One user tested the application using my iPhone. For the rest of the four users I shared the screen of the MacBook with iPhone emulator over Skype. Users were telling the operator what to do and the operator acted as a remote finger performing their gestures.

### Measurements

The results of Usability test measurements could be qualitative and quantitative. In the initial stages of development researchers usually collect qualitative, or for-

## 3.2. USERS

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mative data [24]. It is necessary to take into account that, for instance, "thinking aloud" protocol might affect task performance time, thus, making time measurements biased. Additionally, Nielsen [43] writes: "you don't have to measure usability to improve it".

The most popular quantitative measurements include task performance, time performance, and user satisfaction. It is also possible to measure the number of errors, time spent with help, an average time required to recover from errors. Nielsen [43] mentions that it is easy to get quantitative data wrong because it is easy to collect the data in the incorrect way. He suggests starting measuring quantitative data only when the product is mature enough.

I used qualitative measurements for testing, at the same time, observing if the users were unable to find desired gesture. According to Nielsen [40], it is not always needed to discover how much better the UI is, as long as we are satisfied that new version is better than the previous one.

### Note taking

According to Fitzpatric [12] it is important to have user citations word for word. I used Fitzpatric categories to make notes: painful problem, goal, obstacle, history, particular person mention, a task for the future.

## 3.2 Users

In this section I describe the rationale behind the number of users, required for the test and the users which participated in the test.

### Number of test users for qualitative tests

According to Lazar [24], there is no standard number of users which would be enough for testing. Lazar [24] writes that in reality, most usability tests will not be able to find most of the usability flaws. He mentions, that even 10 users might be not enough to discover 80% of the flaws.

Sauro [55] writes, that even on small size of the sample it could be possible to make statistical conclusions. He mentions, that the most important is that the population represents users from the target audience. According to [40], for thinking aloud protocol it is enough to have four(plus/minus one) subjects. The final number should be determined by the critical impact of the system, financial considerations and experimenter skills. Lewis [26] writes that in his early days in IBM there was a practice of testing the user interfaces with five or six users. Based on this information I aimed to find a minimum of five users and in the end, found seven users to perform the test.

### 3.3. RESULTS AND DISCUSSION

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#### 3.2.1 List of users

I chose users from my acquaintances, who are known to travel a lot, who speak English and who are interested in cultures. The age of the participants ranged from 25 to 50. All users are of Russian origin, some of them live abroad.

##### List of interviewed users:

**User 1**, 25, female, chemistry PHD student, travels in Europe and in the Middle East, lives in Russia

**User 2**, 30, Female, Ph.D., researcher in Nanotechnology field, travels a lot in Europe, lives in Europe.

**User 3**, 50, female, business lady, travels a lot, likes leisure travel, curious, likes to read just for curiosity, likes history, lives in Russia

**User 4**, 38, Female: software engineer, travels mostly to Italy, more than 4 times in year, live in Russia

**User 5**, 36, male, software tester, travels mostly to Italy, more than 4 times in a year, lives in Russia.

**User 6**, 45, female, married, business lady, linguist, engineer, travels a lot, partly lives in Switzerland.

**User 7**, 50, male, married, husband of User 6, psychologist, travels a lot, partly lives in Switzerland.

### 3.3 Results and discussion

In this section I describe results of the tests, list my findings and discuss limitations. To analyze qualitative data I categorized comments and find patterns [24].

#### 3.3.1 General acceptance of the application

Overall, the idea of the application was met very enthusiastically. Only one person out of seven was not interested in the application, until she found interesting information. None of the users were aware of such application and they had no idea it would have been possible to interpret gestures in foreign countries.

#### 3.3.2 User experience with gestures in different cultures

Users, who have been to Italy stressed out that Italians widely use gestures and sometimes it is very unclear what do they mean. Thailand visitors mentioned a

### 3.3. RESULTS AND DISCUSSION

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few situations, when it was not clear why the hosts acted strangely. Afterwards, reflecting on the events, they have been told that they made incorrect gestures. For instance, they pointed tips of their foot in the direction of another person and it turned out to be a very rude gesture.

#### 3.3.3 Usage scenarios

Since it is a new idea for users, there are no use-cases experienced in real life and described. All users tried to imagine in what circumstances they would need to use the application.

##### **Scenario 1:**

The user is at home and planning to travel to foreign country. The user has enough time to prepare for the trip. She would browse through gestures of the country she is traveling to. If she sees a gesture she does not understand, she would plan to check it up with local service in the hotel.

##### **Scenario 2:**

The user is interested in cultural phenomena. She would browse through gestures and descriptions out of curiosity. If she sees something interesting she would send a link to the application to her friends.

##### **Scenario 3:**

The user is going to the foreign country, but has no leisure time. She would browse through gestures on the plane, while on the air.

##### **Scenario 4:**

The user is already in the foreign country. She sees the gesture and does not understand it. She opens the application, searches by the movement description (for instance a list of key-words may include: a man, hand, had, hand rotating, index finger). She expects to see the gesture found by these keywords. In case the gesture is not found, she wants to send this description to the company developer of the application and receive explanations. She may want to share a description in the social network, if it is provided by the application.

##### **Scenario 5:**

The user is already in the foreign country. He would see the gesture on the street, he would try to make a picture of it or try to repeat it himself and make a picture of it and then post it in the social network, provided by the application, or will send it by e-mail to the application backend, to get the explanations.

### 3.3.4 Pain points

I analyzed user's comments and extracted user pain points. Below is unified user feedback on the application arranged by UI function of the application.

#### Search by keyword

Behavior of Search by keyword was different from user expectations. Users expected spelling correction, finding gestures specifying countries and multiple keywords. Users were very frustrated by the popup response they received. Not only because users did not get the gesture explanation results, but also because they were unable to report it. Some users were not able to send the message because the functionality did not work. Some did not want to expose their e-mail.

Below is a list of search queries users used to search for gestures:

- happy
- pizza
- hand
- hand head

#### Home screen issues

Three users out of seven did not recognize the hamburger icon as an icon for the menu. All users thought that space could be used more effectively on the home page. The solutions offered include using familiar iOS UI elements, adding the menu bar to the application and placing more information of one screen. Three users did not understand that the page could be scrolled, and there is more information below the last item displayed on the screen.

#### Gesture illustration

Out of four users with poor eyesight, three suffered from blurred pictures. Three users wanted to see the animation or 3D illustration of the gesture. Two users did not grasp the meaning of the gray lines on the image. Also, two users did not understand how the gesture is acted.

##### User's voice:

People with poor eye-sight:

- "blurred photos disturb me, I feel as if I am sick"

### 3.3. RESULTS AND DISCUSSION

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- "I do not like blurred photos, I feel dizzy"
- "I feel as if I am without glasses"

People with good eye-sight:

- "I like photos"
- "I like blurry photos - the gestures are clearly seen"

As a workaround for the blurred pictures users suggested to separate gesture and face by color. For instance, desaturated everything in the image except the gesture.

#### **Social sharing function in the application**

All seven users want to have the social sharing function. The users want to post their gestures, observations, comment and discuss it and read other comments from all over the world.

#### **Menu**

To all users the menu view looked unclear and too crowded. Two out of seven users had problems finding the menu. These users needed hints as they did not recognize the hamburger icon.

#### **Language**

All test users were not native English speakers and expressed a desire to have the application in their native language. At the same time none of the users had problems working with the application except for "etymology" term which describes gesture.

#### **Sharing gesture functionality**

All test users did not understand the reason behind displaying a number of application icons on the right part of the gesture illustration. All users wanted to have one icon (share), which will behave similarly to the "upload" icon in iOS. It will open a view with a list of applications that the user can choose to share the gesture. Some users said that they would want to share the link to the application with friends. One user said she might want to share the gesture on the FaceBook<sup>1</sup>.

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<sup>1</sup><https://www.facebook.com>

### 3.4. SYSTEM USABILITY SCALE (SUS) SURVEY FOR GESTUNARY FOR IOS

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#### **Favorites option problem**

Only one user found the location of the favorites list and understood the meaning of the favorites icon. The users were not sure why would one need to have it. Some thought that it could be for future reference, so that one can remember the gestures he recently looked up. One user expressed option that the icon meaning could be "not that I like this gesture, it is just that I want to remember this gesture" and suggested to use standard star icon, as in Microsoft Edge<sup>2</sup>. As stated earlier, three out of seven users are iPhone owners and they expected favorites to be marked with the star. The rest of the users also wanted to see the star, but Gestunary had favorites marked as a heart.

#### **Other observations**

In a debrief six users mentioned that they wished there was a possibility to make a photo of the gesture and get an instant answer from the program with the gesture meaning.

### **3.3.5 Discussion**

#### **Limitations**

All users of the user-based test were of Russian origin. This may have resulted in some cultural bias. Some gesture categories, like "Business 101" and "Survival" were not clear for the users.

#### **Instrumental limitations**

Two tests were performed over Skype with screen sharing. Data transmission experienced some delays, I had to repeat questions and users had to repeat their answers. The application was started on the computer in the emulator.

## **3.4 System Usability Scale (SUS) survey for Gestunary for iOS**

In this section I present the method and results of the System Usability survey of the Gestunary for iOS gesture search and list functionality. I will later compare the test results with SUS test results of the Gestunary for Android search functionality.

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<sup>2</sup><https://www.microsoft.com/fi-fi/windows/microsoft-edge>

### 3.4. SYSTEM USABILITY SCALE (SUS) SURVEY FOR GESTUNARY FOR IOS

#### 3.4.1 SUS method

The System Usability Scale [6] is an effective and cheap tool for evaluation of system usability and learnability [54]. The scale includes 10 usability related questions and corresponding 5 points Likert scale, ranging from "Strongly Disagree" to "Strongly Agree". The questions alternate positive and negative statements. The method for counting SUS score is described by Sauro [54]. The final score measures are illustrated in Figure 3.1. According to Brooke, values below 70 indicate usability issues, the usability of products scored above 70 and below 80 is acceptable, the score between 80 and 90 indicates good usability and the score above 90 classifies product usability as exceptionally good [6]. In addition to the overall SUS score, questions 4 and 10 specify Learnability measure and the rest - usability measure [28].

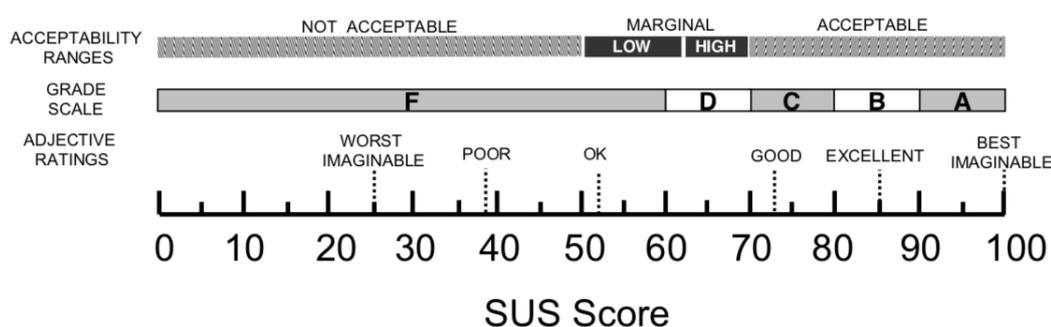


Figure 3.1: SUS score.

To get more information about the product usability we added seven-point Adjective scale for better reliability of results [6]. Users filled out the questionnaire after working with the system but before debriefing.

SUS questions are below:

1. I think that I would like to use Gestunary for iOS frequently.
2. I found Gestunary for iOS unnecessarily complex.
3. I thought Gestunary for iOS was easy to use.
4. I think that I would need the support of a technical person to be able to use Gestunary for iOS.
5. I found the various functions in Gestunary for iOS were well integrated.
6. I thought there was too much inconsistency in Gestunary for iOS.

### 3.4. SYSTEM USABILITY SCALE (SUS) SURVEY FOR GESTUNARY FOR IOS

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7. I would imagine that most people would learn to use Gestunary for iOS very quickly.
8. I found Gestunary for iOS very cumbersome (awkward) to use.
9. I felt very confident using Gestunary for iOS.
10. I needed to learn a lot of things before I could get going with Gestunary for iOS.
11. Overall, I would rate the user-friendliness of this product as...

#### 3.4.2 SUS users, protocol and results

##### Users

Totally 20 users filled out the questionnaire, as it is recommended to have at least 20 participants for reliable studies in quantitative measurements [44]. Kaikkonen [19] also mentions in her research that for statistically significant numbers a minimum of 95% of the usability problems might be found with 20 users. Users were recruited on different online resources<sup>3,4</sup> and through referral of acquaintances. The preference was given to users who:

- understand written English
- have experience with Apple iPhones
- have experience communicating with people from different cultures

##### Protocol

Before completing SUS survey the users performed the tasks, presented in Appendix D. Then the users filled out online SUS survey.

##### Results and discussion

The average SUS score is 71.5 which corresponds to the OK adjective. Learnability is equal to 96.9, and usability is 67. This means that users easily learned how to work with the application, but at the same time Gestunary for iOS usability could be enhanced.

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<sup>3</sup><https://buddyschool.com>

<sup>4</sup><http://glish.guru>

# Chapter 4

## Gestunary for iOS Heuristic Evaluations

### 4.1 Introduction

I performed Heuristic Evaluation of the Gestunary Application to identify more problems with the application in addition to the pain points, identified during user-based test. Spotting UI problems before the start of UI development for the Android will allow avoiding potential usability problems.

Heuristic Evaluation is a usability inspection method which requires relatively small time and does not require professional usability expertise [46]. The advantage of the method is its simplicity. The negative side is that, according to Nielsen, one expert reveals only 35 % of the problems [42].

### 4.2 Gestunary for iOS Heuristic Evaluations

I performed Heuristic Evaluations based on Nielsen's 10 heuristics [41] and iOS human-interface-guidelines<sup>1</sup>. Below is the list of Nielsen's 10 heuristics, which I used [41]:

1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention

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<sup>1</sup><https://developer.apple.com/ios/human-interface-guidelines/overview/themes/>

## 4.2. GESTUNARY FOR IOS HEURISTIC EVALUATIONS

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6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Help users recognize, diagnose, and recover from errors
10. Help and documentation

My procedure of Heuristic Evaluation included:

- going through the UI a few times and inspecting UI elements and dialogs according to Nielsen's 10 heuristics and iOS human-interface-guidelines attempting to complete the tasks, listed in Appendix A.

- recording results of the inspections in the template, created by myself. The template automatically marked issues with correct color and counted statistics on issues found.

The number of experts was limited to myself, but I have big experience in UI design and testing from my work in software development companies. Besides, I attempted the test procedure several times, taking a week timeout between tests.

### **[H1: Simple and natural dialog]**

Location: Home screen.

Description: "Keyword Not found" dialog does not help to find the word, the lexicon is very limited and lack of a word only disturbs.

As a workaround, it could be possible to add a clear link to the list of available words.

Severity: 4 = Usability catastrophe: imperative to fix this before product can be released.

### **[H2: Speak the user's language]**

Location: Home screen.

Description: language is limited to one option - English, some people from the target audience who can not speak English and will not be able to use the program.

As a workaround, it could be possible add a possibility to add new languages in the future and to choose language of the application on the first start of the program.

Severity: 3 = Major usability problem: important to fix, so should be given high priority.

### **[H4: Consistency]**

Location: Home screen.

Searching for keyword hi" returned irrelevant gestures: "broke (USA ), "fishy" (Spain), "proud" (Spain).

I suggest to fix search results.

## 4.2. GESTUNARY FOR IOS HEURISTIC EVALUATIONS

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Severity: 4 = Usability catastrophe: imperative to fix this before product can be released

### **[H4: Consistency]**

Location: Home screen.

Description: animated gesture image on Home does not change after hitting home button in menu

I suggest to fix search results.

Severity: 4 = Usability catastrophe: imperative to fix this before product can be released

### **[H5: Feedback]**

Location: "not found keyword" popup.

Description: tapping on "send mail" does not always give feedback, only keyboard pops up and search keyword clears out. This happens after the first attempt to send the message.

I suggest to fix the bug.

Severity: 4 = Usability catastrophe: imperative to fix this before product can be released.

### **[H7: Shortcuts]**

Location: Gesture screen.

Description: list of favorites is marked with the heart icon, but it should have familiar symbol, like a star.

I suggest to use the star icon instead of the heart icon.

Severity: 4 = Usability catastrophe: imperative to fix this before product can be released

### **[H5: Feedback]**

Location: Gesture screen.

Description: tapping on the icon to send mail or message results in non-informative popup, telling that the action is currently not possible.

I suggest adding a note to the user with information on what mail application should be used.

Severity: 3 = Major usability problem: important to fix, so should be given high priority.

## 4.3. RECOMMENDATIONS

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### [H7: Shortcuts]

Location: Gesture screen.

Description: many sharing icons which take space instead of the one shortcut  
I suggest to unite sharing icons in correspondence with the standard.

Severity: 3 = Major usability problem: important to fix, so should be given high priority.

## 4.3 Recommendations

Below are Heuristic Evaluations recommendations, based on Nielsen's 10 heuristics (1995) and iOS human-interface-guidelines.

1. The Menu should be standard for iOS platform.
2. The "Share" functionality should be implemented according to Human Interface Guidelines.
3. Make search by keyword functional, return relevant information.
4. Fix the bug with sending e-mail from the keyword not found popup. The text of the popup is not informative.
5. Fix the bug with not changing animated illustration image on the home screen.
6. On first start add a teaching help on how to use the application.
7. Change favorites heart icon to the star.

The data from the Heuristic Evaluation template is listed in Appendix A.

Number of Violations by Heuristic, Violations by Severity and a list of violations are listed in Appendix A.

### **Methodology limitations**

I was only one expert to perform Heuristic Evaluations. According to Nielson [46] one expert can not reveal all problem areas.

# Chapter 5

## Gesture classification and gesture coding schemes

The goal of this chapter is to find the place of the Gestunary in gesture classification schemes, proposed by different contemporary scientists and to find inspiration for gesture coding for the new Gestunary user interface.

I will start with a review of different classifications of gestures and relate them to Gestunary. I then review gesture dictionary arrangements and gesture coding schemes and finally discuss what could be used in Gestunary for Android search interface.

### 5.1 About gestures

In this section I describe gesture classifications introduced by modern scientists and define what kind of gestures are included in Gestunary collection.

### 5.2 Gesture types

Many researchers worked on gesture systematization and classification schemes to organize gesture collections. The first known classifications originate from AD 100 [10]. Most prominent gesture collections use emotions and body parts for gesture arrangement. A number of arrangement schemes from the 20th century, such as Wundt's [60] and Efron's applied only to hands. Most recent ones refer to the whole body [10].

Kendon [21] proposed to classify gestures from many perspectives, which include classification by:

- voluntary or involuntary types;

## 5.2. GESTURE TYPES

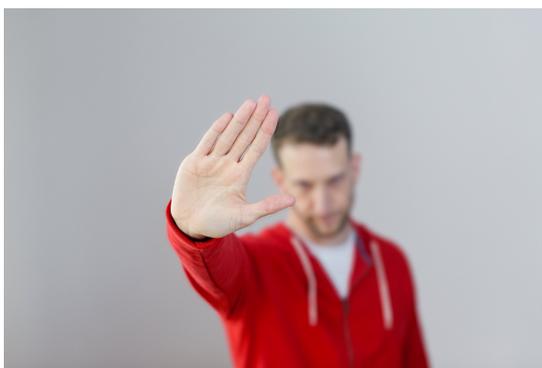
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- natural or conventional;
- by meaning (which could be indexing, iconic, metaphoric or symbolic);
- by gestures which refer to the outer world (objective) or inner world (subjective);
- whether they are more primal to speech (as in salutation) or not.

The gestures in Gestunary collection of gestures could be classified as voluntary conventional gestures. Gestunary includes gestures from the outer and inner world and mostly secondary to speech.

It is hard to clearly differentiate one gesture class from another. McNeill's "Kendons continuum" gesture classification system solves this problem. The gesture classes includes the following types (ranging from having no linguistic information to being fully linguistic): gesticulation, pantomime, emblems and sign language. Gesticulation is obligatory accompanied by speech. It helps to understand the message of the speaker but has no linguistic properties. Pantomime, in general, is gesticulation that is only optionally accompanied by speech. Emblems are culture-specific gestures, sometimes resembling objects or images. An example of the emblem could be an OK sign. Typically they do not occur together with speech. Sign language could be used without speech and fully possesses linguistic features [34]. Marianne Gullberg extended Kendons continuum adding the Mime type to the continuum, which involves torso and head movements [21]. The gestures in Gestunary are emblems.

Related to Kendon's continuum is a classification, introduced by Kreydlin [23]. Kreydlin splits gestures into three categories: speech-independent gestures, gestures which illustrate speech and gestures controlling communication. The last category of gestures is called regulatory gestures. The functional role of these gestures is to point out a start or the end of the communication and to support communication. An example of regulatory gesture could be raising an arm to attract attention. Gestunary dictionary includes gestures that illustrate speech and regulatory gestures, for instance - stop gesture from the USA.



**Figure 5.1:** Stop gesture in the USA

A few more gesture categories which are mentioned by many scientists include the following gesture types: metaphoric, iconic, deictic, butterworths and beats. Metaphoric gestures represent abstract concepts, for instance, freedom. Iconic gestures physically illustrate the speech. Beats are up and down movements which highlight the speech emphasizing the rhythm. Deictic gestures are pointing and indexing gestures. Butterworths are the gestures which occur when the person is trying to recall the word or concept [10].

Different names of the gesture semiotic types were unified by Allwood [2] in the MUMIN coding scheme<sup>1</sup>. He lists the following semiotic types for hand gestures: indexical deictic, indexical non-deictic, iconic and symbolic. Indexical deictic gestures are pointing gestures. Indexical non-deictic are presented by beat gestures. Iconic gestures express meaning by showing similarity to some object, for instance, showing the size of the object with two hands. Symbolic gestures are what many other scientists call emblems, these gestures are culture-specific. An example of the symbolic gestures is an OK sign. The gestures in Gestunary are mostly symbolic gestures.

### 5.3 Gesture dictionaries

In this section I want to examine best practices in gesture collection arrangements. Gestunary search results will depend on the types of information which is included in gesture description. I want to examine examples of gesture dictionaries to find inspiration for Gestunary.

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<sup>1</sup><https://cst.dk/mumin/resources/MUMIN-coding-scheme-V3.3.doc>

### 5.3.1 Gesture dictionary arrangements

Dictionaries are often arranged in the way of indexes, grouping categories and subcategories in alphabetical order. Categories and subcategories differ from one dictionary to another and depend on the author's preference and the type of gestures that the dictionary author collected. A number of gesture dictionaries arrange gestures by meaning. For instance, one example mentions the following categories: imperative, enunciative, substantive, interrogative, negative, numeral, demonstrative, personal pronouns, exclamatory or emotive gestures, expletive gestures. Other examples include social conventions, salutation to initiate or conclude contact, congratulations, emotional states and feelings, actions with respect to ourselves or others, questions and answers, insults. One more index is grouped by different subjects such as achievement, agreement, anger, fulfilling expectations, requests [11]. The next sample arrangement includes general gestures, which are used in daily life, slang gestures and children's gestures [15]. Other sample categories are children's gestures, gender specific gestures, communication, emotions, active and responsive reciprocal gestures, touching someone gestures, gestures that involve a standard object [11]. Finally, many well known gesture collections divide the gestures into categories according to the body parts and corresponding body part motion or position [11], [39].

Summarizing gesture dictionary arrangements I can list the following main arrangement categories which are most used: alphabetical arrangement of the whole collection, arrangement by the human activities, arrangement by emotions and arrangements by body parts.

Gestunary for iOS organize its collection in three ways: by name of the gesture, by country of origin and by category. Categories represent two subsets of the whole gesture collection: survival basics and business 101.

### 5.3.2 Gesture descriptions

The following categories are used in gesture descriptions [15], [11], [39]:

- name of the gesture in the book language and in the language of the country the gesture belongs to
- name transcription
- gesture application and semantics
- homonyms
- synonyms

## 5.4. GESTURE CODING SCHEMES

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- usage description,
- origins: region and environment
- the context of usage
- description of physical movement, time
- action description.

Gestunary includes information on gesture etymology, country of origin, information about related gestures and similar gestures with the different meaning.

### 5.3.3 Illustration types

A few gesture dictionaries have illustrations presented as drawings [5] or schematic cartoons [11]. Some gesture dictionaries utilize a mixture of pictures, photographs of the whole body or only parts of it. The photographs are black and white [15] or color. Some entries are illustrated by photographs which show only the key part of the body, participating in the gesture [11]. To illustrate actions some gesture dictionaries use lines [15], [11]. Gestunary illustrates gestures with color photos. Photos are mostly full body. In most cases the focus of the picture is on the gesture and the rest of the image is blurred (2.1.3).

## 5.4 Gesture coding schemes

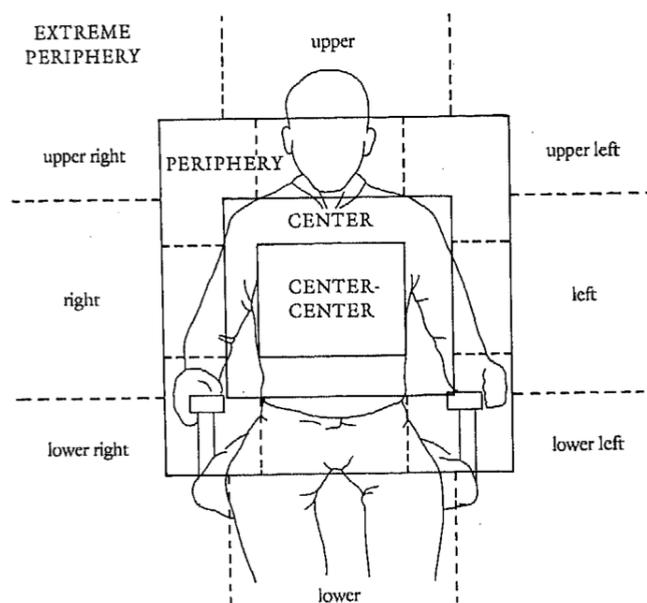
In this section I review gesture coding schemes to get inspiration for Gestunary search implementation. I review McNeill's gesture space concept and the MUMIN coding scheme and generate ideas for search interface.

### 5.4.1 McNeill gesture space

One of the most prominent researchers in the area of gesture analyses and annotation is David McNeil who wrote many books on the subject [32], [35], [34], [33]. Many other researchers built their annotation systems based on his ideas. McNeill distinguishes gestures by different features, including as palm/finger-orientation, hand-shape, movement, the position in the gesture space and viewpoints [33]. On the Figure 5.2 I present drawing of the typical gesture space of an adult speaker [33]. McNeill uses this gesture space illustration to annotate location of the gesture occurrence. He also points out that different cultures have gestures located in different areas.

## 5.4. GESTURE CODING SCHEMES

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**Figure 5.2:** Drawing of the typical gesture space of an adult speaker, adopted from McNeill

McNeill uses parts of the body to describe the gesture. For instance, describing the gesture of looking through the spectacles he codes hand placement as "at eyes". To differentiate body parts position and movements McNeill proposed the following coding scheme :

Palm and finger could be differentiated by direction:

- toward up/down/center
- away from/toward the body
- left or right from the center

Motion could be encoded as:

- away from/toward the body
- parallel to the front of the body/side of the body

### 5.4.2 MUMIN coding scheme

The MUMIN coding scheme [2] [3] is intended as a general instrument for the study of hand gestures, facial displays and body posture in interpersonal communication. The coding scheme provides attributes related to the shape, communicative functions of head movements, face expressions, body posture and hand gestures. In Table 5.1 I list behavioral attributes, used in MUMIN project.

## 5.4. GESTURE CODING SCHEMES

Head gestures	
Head	Single Nod (Down), Repeated Nods (Down), Single Jerk (Backwards Up), Repeated Jerks (Backwards Up), Single Slow Backwards Up, Move Forward, Move Backward, Single Tilt (Sideways), Repeated Tilts (Sideways), Side-turn , Shake (repeated), Waggle, Other
FaceInterlocutor	ToInterlocutor, AwayFromInterlocutor
General face	Smile, Laughter, Scowl, Other
Eyebrows	Frowning, Raising, Other
Eyes	Exaggerated Opening, Closing-both, Closing-one, Closing-repeated, Other
Mouth	Open mouth, Closed mouth, Corners up , Corners down, Protruded, Retracted
HeadRepetition	Single, Repeated
Body posture	
BodyDirection	Forward, Backward, Up, Down, Side, Other
BodyInterlocutor	ToInterlocutor, AwayFromInterlocutor
Hand gestures	
Handedness	SingleHand, BothHands
Trajectory	Forward, Backward, Up, Down, Sideways, Complex, Other

*Table 5.1: MUMIN coding scheme*

The modification of the MUMIN coding scheme is used to code gestures in NOMCO [48], the multimodal corpus of annotated videos, collected in Nordic countries. The most notable change from MUMIN is ignoring the gaze attribute, as not very reliable. One of the goals of the project is to implement automatic gesture recognition using machine learning methods.

Gestunary innovative search interface uses the MUMIN coding scheme an inspiration. McNeil's gesture space could also serve as an idea for the search interface.

### 5.5 Inspiration and Discussion

In this section I discuss arrangements which I have found in other gesture dictionaries, compare it with the current gesture arrangement in Gestunary and user desires and conclude what kind of gesture arrangements could be used for the Gestunary for Android search interface.

#### 5.5.1 Action descriptions

Currently Gestunary does not present any action descriptions of the gesture. Some of the users did not understand the gesture from the illustration and wanted to read action description. But Epstein [11] writes that it is hard to create action description of the gestures, because there are so many components to the gestures and they are hardly expressed with words. On the other hand, the gesture dictionaries from [11], [15] describe the gesture actions. I think that the user's opinion could be considered and additionally tested in the future and based on this information it will be possible to expand Gestunary functionality. At the same time, it could be more efficient and effective to add gesture videos in addition to or instead of illustrations.

#### 5.5.2 Gesture illustrations

Epstein [11] in his Gestunary uses sketches to illustrate the movement of the body parts. The benefits he lists are the ability to isolate the gesture and to clearly and schematically draw facial expression and other gesture components. On the other hand, Epstein points out that it is hard to find a good illustrator. He also indicates that the biggest problem is to specify what is important in the gestures. He also writes that it is hard to illustrate action on the photograph.

Looking at the gesture collection by Hamiru-aqui [15] I can observe that his gesture illustrations and gesture movement illustrations are similar to the Gestunary application with the one exception - the photos are black and white. The part of the body involved in the gestures is in focus, while the rest is blurred. If the part of the body is moving there are gray traces which indicate body part movement.

#### 5.5.3 The choice of body parts and actions for the Gestunary for Android

One of the main goals of the review of dictionary classifications was to find ideas for search interface for Gestunary. I used ideas Morris' set of body parts, McNeil's gesture coding scheme and Mumin's coding as an inspiration for Gestunary search

## 5.5. INSPIRATION AND DISCUSSION

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interface. In addition to the currently present grouping categories, I will add categories mentioned by the users (6.4.4). Inspired by the examined dictionaries and coding schemes I created a list of body parts and actions which I will use as a base for the Gestunary for Android Search interface (Appendix A).

# Chapter 6

## LoFi prototype and testing

In this chapter I present the process of developing a low-fidelity prototype for Gestunary Search UI, demonstrated to the users for evaluation and co-design.

To develop an initial prototype I needed to specify user pain points and user goals. To do this I created user personas and formulated a list of user tasks. Afterwards, I described guiding principles for UI design and design decisions. Next, I formulated the goals for my design. Then I proceeded to practical implementation of the UI. Next, I presented a low-fidelity paper prototype, evaluation results and co-design session with the users.

### 6.1 Defining User tasks

Nielson writes that usability is always about users and the tasks they accomplish. To better understand users and focus on them during UI design process [57] I will extract Gestunary personas from the user test of Gestunary for iOS. I will also review usage scenarios, listed in 3.3.3 to identify user tasks.

#### 6.1.1 Gestunary personas

##### **Katerina**

She is 25 y.o., a doctoral student researching data science. She travels a lot in Europe and in Middle East. She lives in Russia. When she visits other countries she is curious about gestures.

##### **Maria.**

She is 30 y.o., a researcher in the university of Bulgaria. She travels a lot in Europe and is very curious by nature. She picks up technological advancements very quickly. She is interested in other cultures. She speaks fluent English and Russian.

### **Irina**

She is 50 y.o., a business lady, linguist and engineer. She travels a lot, partly live in Switzerland. She usually does not have time to use any applications, when she is having fun at the tourist attraction. But she finds it boring to waste time on the plane and likes to read culture-rich sources.

### **Mihail**

He is 36 y.o., he is a software tester. He often travels with his wife, mostly to Italy, more than four times a year. The family lives in Russia. Mihail is very curious and is interested in gestures as well. He has poor eyesight and wears glasses.

### **6.1.2 User Tasks**

I based the task list on the usage scenarios listed in 3.3.3 and a task list created during User-based testing of Gestunary for iOS (3.1.1). Personals (6.1.1) helped us not to lose focus on user tasks.

- Find the gesture of interest by entering a key-word.
- Find the gesture of interest by browsing through gestures in a particular country of interest
- View a gesture illustration.
- Read information about the gesture of interest.
- Read related information for the gesture.

## **6.2 Grounds for ideation, UI design methods and guidelines**

In this section I describe the rationale I used to develop UI.

### **6.2.1 Shneiderman's 8 Golden Rules of Interface Design**

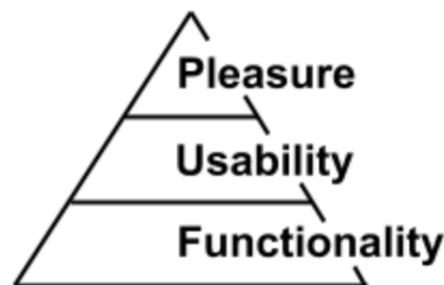
Ideation and development process of the UI were inspired by Shneidermans 8 Golden Rules of Interface Design [56].

1. Strive for consistency. It could be achieved by adherence to guidelines..
2. Enable frequent users to use shortcuts. This could be implemented through the favorites mechanism.

3. Offer informative feedback in case of wrong information
4. Design dialog to yield closure.
5. Offer simple error handling.
6. Permit easy reversal of actions.
7. Support internal locus of control.
8. Reduce short-term memory load.

### 6.2.2 Jordan's Hierarchy of Customer Needs

Design decisions were also guided by Jordan's Hierarchy of Customer Needs (Figure 6.1). This means that in the first place I am aiming to achieve correct functionality and satisfy basic needs of the application [18]. For Gestunary for Android the basic functionality is represented by the alphabetical index of the gestures because it was the most frequent approach the users applied to find gestures.



**Figure 6.1:** Hierarchy of Customer Needs, adopted from Jordan

#### List of basic functionality

- Find/browse through gestures in the alphabetic list
- Find/browse through gestures in a particular country
- Find/browse through gestures in a specific category

### 6.2.3 Usability heuristics as guidelines for UI design

It was practical and efficient to test design decisions against the metrics of usability heuristics [41], presented in section 4.2 and listed in Practical Heuristics for Usability Evaluation by Perelman [14]. For instance, in the interface prototype I decided to stick to guidelines rather than develop a new interface layout for a gesture

description view. This satisfied Neilson's requirements to use recognition rather than recall.

### 6.2.4 Intelligent Borrowing

Lewis [25] considers intelligent borrowing to be the foundation of good interface design. He mentions three pieces of advice which help with UI development. The first advice is to use patterns from the guidelines. The second advice is to examine existing applications. The final advice is to examine interaction patterns of other programs. The last two items are reviewed in chapter 2 and chapter 5.

## 6.3 Search interface UI patterns on Android platform

In this section I present the UI and interaction patterns, which served as inspiration and guidance for my design decisions.

### 6.3.1 Guidelines for the overall design - Android Material Design

Android Material Design guidelines<sup>1</sup> is an extensive set of recommendations for developers and designers. The design style is based on the paper and ink metaphor. I can see the screen as set of multiple layers of paper. These pieces of paper could change physical size but still preserve the feel of paper. I will be utilizing these guidelines in my design proposal.

In particular, I am interested in UI patterns for search and for presenting search results. Below are a few UI patterns which served as inspiration.

### 6.3.2 Android Search patterns

#### Android Search pattern on the example of Google play

Search is the base component in the Android operating system<sup>2</sup>. Even though the search back-end should be implemented by the developers themselves and depends on the data type, the search UI could be implemented using Android software development kit (SDK)<sup>3</sup>. To get an inspiration for Gestunary search I will review the Google Play application<sup>4</sup> the WhatsApp<sup>5</sup> and YouTube<sup>6</sup> work-flow patterns, as being

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<sup>1</sup>["https://material.io"](https://material.io)

<sup>2</sup><https://developer.android.com/guide/topics/search/index.html>

<sup>3</sup> <https://developer.android.com/guide/topics/search/search-dialog.html>

<sup>4</sup><https://play.google.com/store>

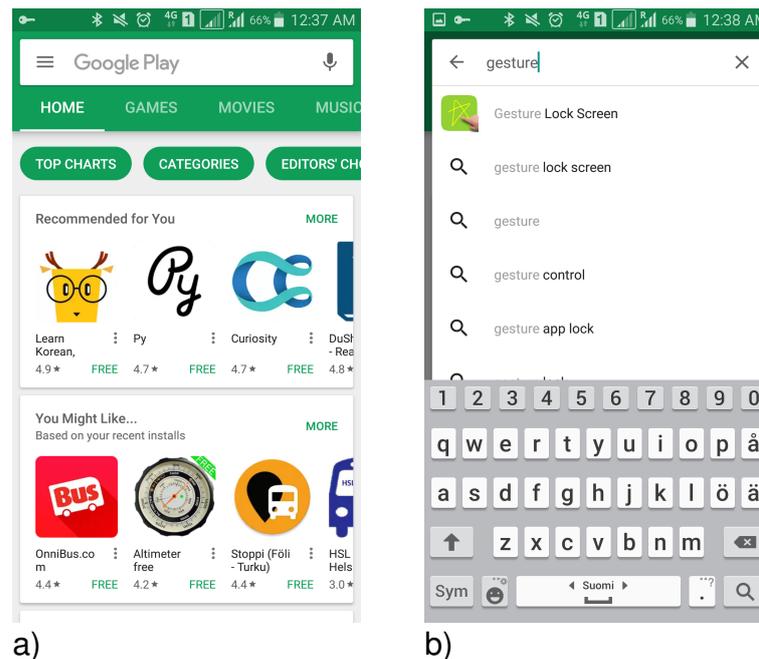
<sup>5</sup><https://www.whatsapp.com>

<sup>6</sup><https://play.google.com/store/apps/details?id=com.google.android.youtube>

## 6.3. SEARCH INTERFACE UI PATTERNS ON ANDROID PLATFORM

representative examples of the user experience on Android platform.

Figure 6.2 presents a search dialog example from Google Play application. The main application has a search term text box in the top of the screen. Tapping in the search text box opens the search dialog which looks like a piece of paper on top of the Google Play application.



**Figure 6.2:** Google Play Search pattern

The WhatsApp application (Figure 6.3) has a slightly different implementation of search UI. Instead of a search text box, it has a search icon which opens a search widget on top of the chat list. Text, entered in the search box is deleted by tapping on delete (cross) icon. Tapping on the arrow closes the search widget.

### 6.3. SEARCH INTERFACE UI PATTERNS ON ANDROID PLATFORM

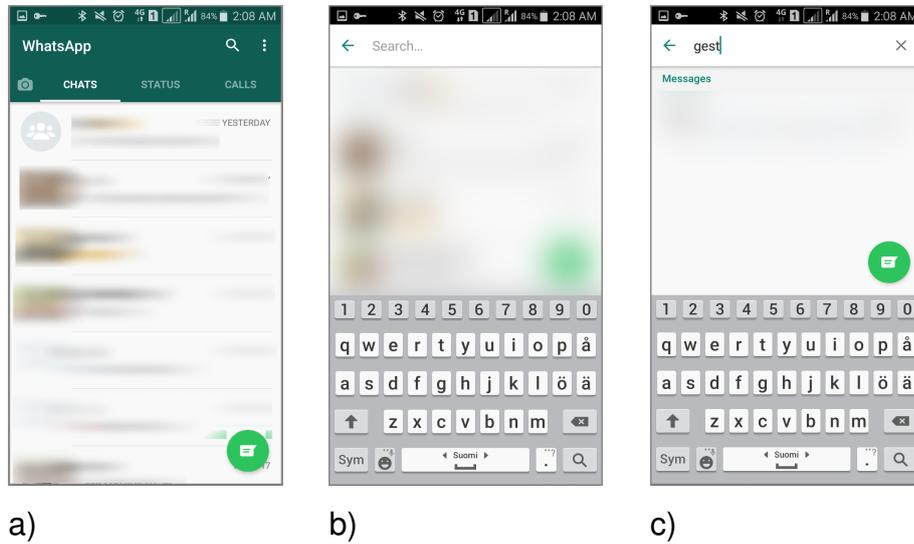


Figure 6.3: WhatsApp Search pattern

#### YouTube Search example

YouTube initial search pattern is similar to WhatsApp search (Figure 6.4). It has a search icon on the top of the view, tapping on which opens a possibility to enter the search term in the text box. Under the search string there is a list of recent search terms.

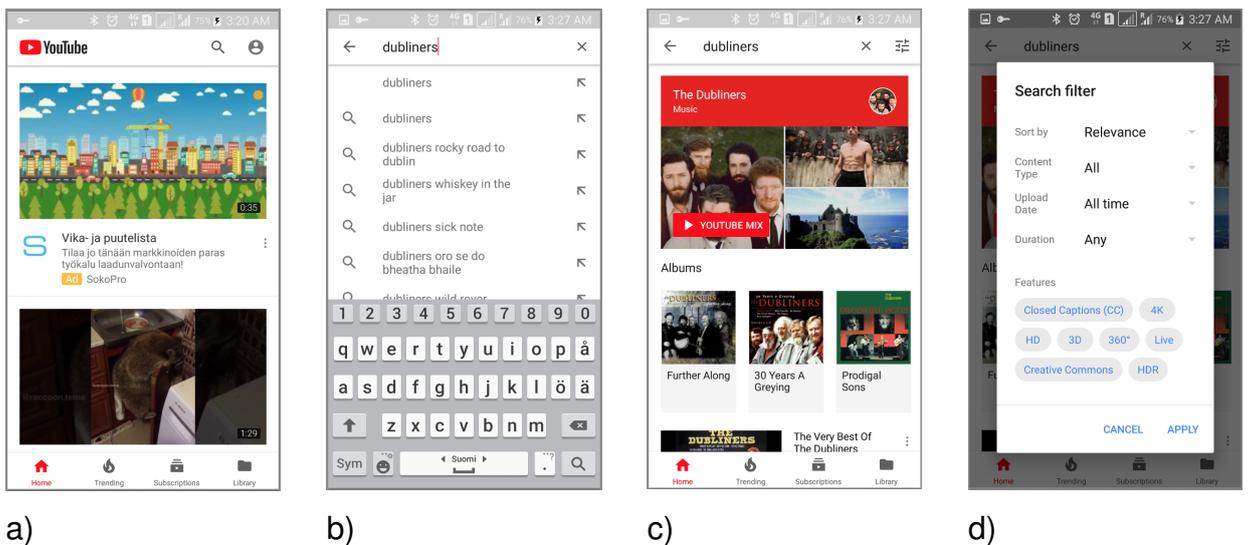


Figure 6.4: YouTube Search interaction flow

Another interesting UI pattern from YouTube is presented in Figure 6.4, c). The user can fine-tune search results. Selection of the recent search item on the previous step results in opening the views, presented in Figure 6.4. In the top right corner

of the view on the action bar there is a tune icon (7.9 b)<sup>7</sup>. Tapping on this icon opens a search filter dialog.

Filter behavior looks very intuitive for me. The drawback of the tune icon could be that it is similar to the setting icon and could be misunderstood by the users. It might be preferable to use the funnel icon (Figure 7.9 a) which looks familiar and does not allow ambiguity about the mining, but unfortunately, it is not in the set of the Android standard icons<sup>8</sup>. I also want to combine UI patterns from Youtube and WhatsApp to come up with a version of Search Interface.

### 6.3.3 Other UI elements decisions

In Appendix D I list examples of Android user interface elements which should be included in the Gestunary for Android. Decisions for UI components should be made for:

- Presentation of the information in lists
- Menu
- Error messages
- Help
- Navigation between sections

### 6.3.4 Lo-Fi prototype decisions for search interface and gesture description display

The Main function of the search interface is the ability to search for gestures. During the Gestunary for iOS user-based testing (3) I found out what kind of keywords users might use to find a gesture (3.3.4). Looking at the gesture space illustration by McNeill [33](Figure 5.2) gave us an idea to design a search interface where the user will be able to tap on the different body parts to create the search query.

Gesture description display should present the information in a convenient for the user way. From the User-based testing of Gestunary for iOS3 I know that the users not always were properly guessing that they need to scroll the section with gesture description, to reach for more information. I decided to use tab-based UI for gesture description screen. This will show the user all three possible information categories, related to the gesture.

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<sup>7</sup>[https://material.io/icons/#ic\\_tune](https://material.io/icons/#ic_tune)

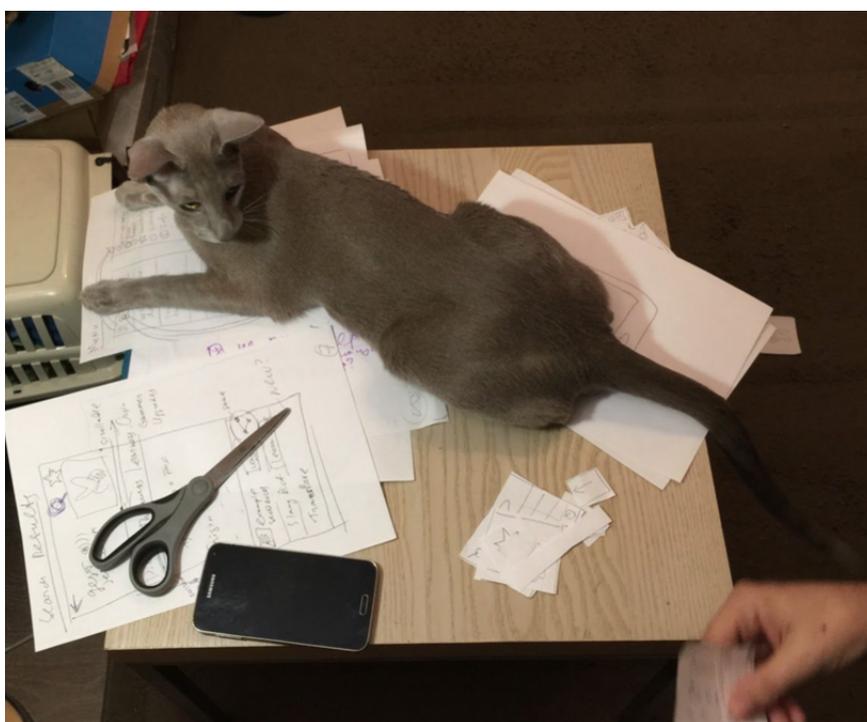
<sup>8</sup><https://material.io/icons>

### 6.4 User testing and co-design process and results

In this section I present the process and results of user testing and co-design sessions with the users. I included all UI elements in the testing, including application intro and advertisement placement, as it was interesting for the business goal of the application.

#### 6.4.1 Co-design

The goal of user testing was to identify problems with the proposed paper prototype and find solutions. I asked users to play around with paper, scissors and markers to work out their own ideas of UI enhancements.



**Figure 6.5:** Co-designer.

#### Utilized methods

I utilized concurrent think aloud and concurrent probing protocols for prototype testing. Nielsen considers thinking aloud method the most valuable usability tool. The disadvantage of the thinking aloud protocol is the unstructured nature of gathered data. It is necessary to keep in mind that gathered data could be biased, sometimes for an unknown reason [45]. Concurrent probing allows the researchers to ask follow-up questions.

The term co-design is often treated as a synonym to various terms, such as co-creation, empathic design and participatory design. Co-creation is a broader

## 6.4. USER TESTING AND CO-DESIGN PROCESS AND RESULTS

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term referring to any act of collective creativity whereas co-design emphasizes the participation of non-experts [53] [59].

### **Users**

Totally five users participated in the first iteration of co-design. All users travel a lot (more than 5 times a year) all over the world. There is no overlap with the users from the User-based testing of Gestunary for iOS3. The choice was also based on the user availability.

**User 1** , 31, Female, linguist, Spanish language teacher, travels a lot in Europe, lives in Russia.

**User 2**, 31, Male, Marketer, Ph.D. linguist student, polyglot, technical writer, travels a lot in Europe, lives in Russia.

**User 3** , 45, Female, IT department manager, programmer, travels a lot in Europe, lives in Russia.

**User 4**, 45, Male, IT department manager, programmer, travels a lot in Europe, lives in Russia.

**User 5**, 30, Male, Software developer, travels a lot in Europe, lives in Russia.

Users were from two families, thus representing two focus groups.

### **6.4.2 Test research questions**

#### **Questions for the UI design testing**

- Main question: How the users will accept the UI with Image search?
- How will the users accept tab-based layout for gesture description compared to Gestunary for iOS design?
- How will the users accept filter interface with hierarchical body parts choices?
- How will the users accept browse for gesture section?

#### **UI areas, not related to search**

- Splash screen
- Help
- Home screen and Menu
- Ads in free trial
- Trial vs. full version
- Discuss gesture - an alternative and addition to the "share" icon. This option was suggested by the users during User-based testing of Gestunary for iOS3

## 6.4. USER TESTING AND CO-DESIGN PROCESS AND RESULTS

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- Ability to post the gesture and wait for feedback from the author

**The user will need to perform the following tasks with the UI:**

- Search for a gesture
- Enter keywords text
- View a gesture description
- Read information about gestures
- Interact with the gesture (share the gesture or add it to favorites list)

### 6.4.3 Protocol

1. Users were introduced to the Gestunary application using the scenario from Appendix C (C)
2. Users were introduced to the goal of the test and introduced to the Gestunary for iOS application functionality.
3. Users were given initial paper prototypes and tools to design their own solutions - scissors, glue, paper, pre-drawn UI elements (Figure 6.6).



**Figure 6.6:** Co-design process

4. I reviewed a list of research questions and UI interfaces with users using thinking outloud method and semi-structured interviews.

### 6.4.4 Lo-Fi UI descriptions and user input

#### Splashscreen and Help

The splashscreen appears on the first load of the application. On a few help screens I describe what Gestunary is and Gestunary functionality. All five users consider it worth including. One claimed it is a good idea. One user suggested to have it "closed and hidden". Another user suggested that it could be "could be minimized into the menu".

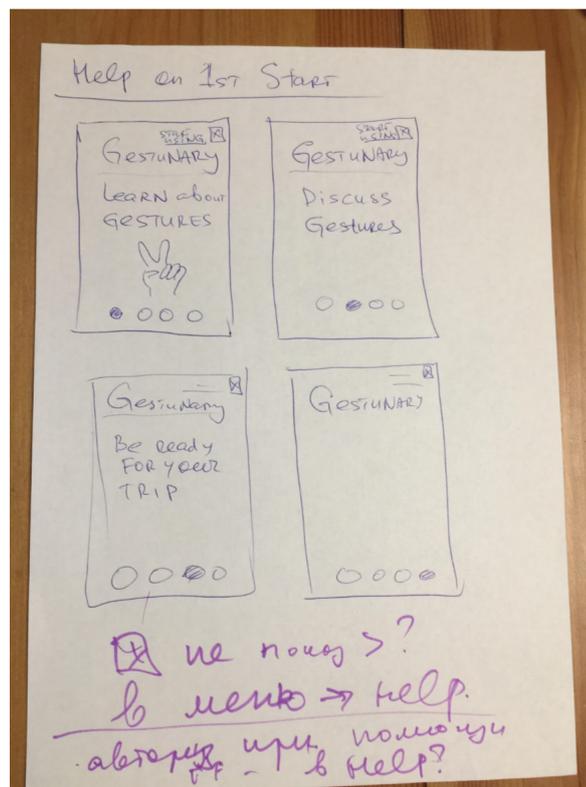


Figure 6.7: Splashscreen and Help

### Home screen and Menu

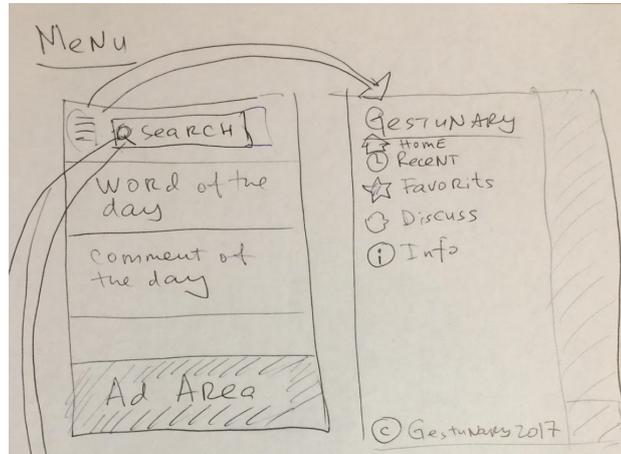


Figure 6.8: Home screen and Menu

### Keywords search and Search results

Text search prototype is presented in Figure 6.9. It was inspired by examples from GooglePlay (Figure 6.2), WhatsApp (Figure 6.3), YouTube (Figure 6.4). Tap in the search field calls up a keyboard. Search results return a list of gestures. Users feedback was "acceptable", "yes, that is a natural action", "that is how search woks".

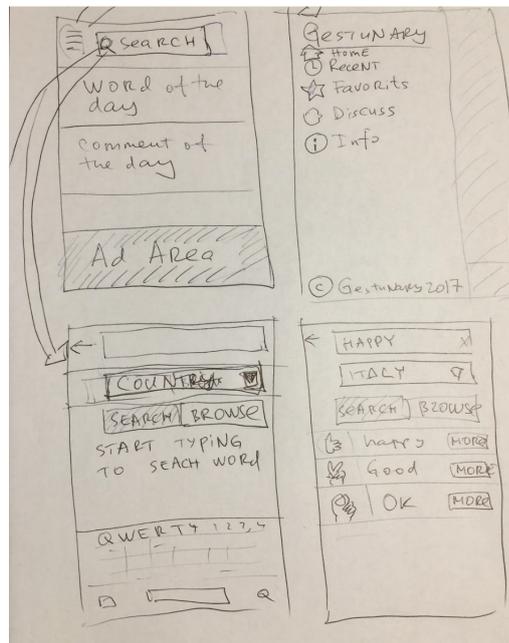


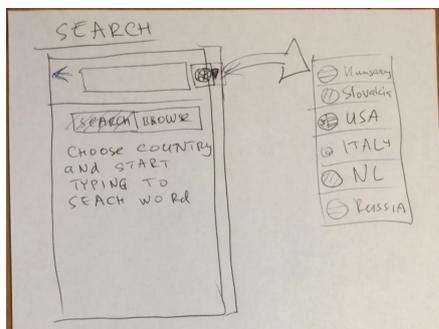
Figure 6.9: Search and Search results

### Choose country

I presented a few prototypes to the users. Variants included placing country list in the tabs or having it in the menu as an icon and a drop down list. As the result of

## 6.4. USER TESTING AND CO-DESIGN PROCESS AND RESULTS

the co-design I ended up on the prototype presented in Figure 6.10. Tapping on the country icon the user calls a pop-up with countries list.



**Figure 6.10:** Choose country

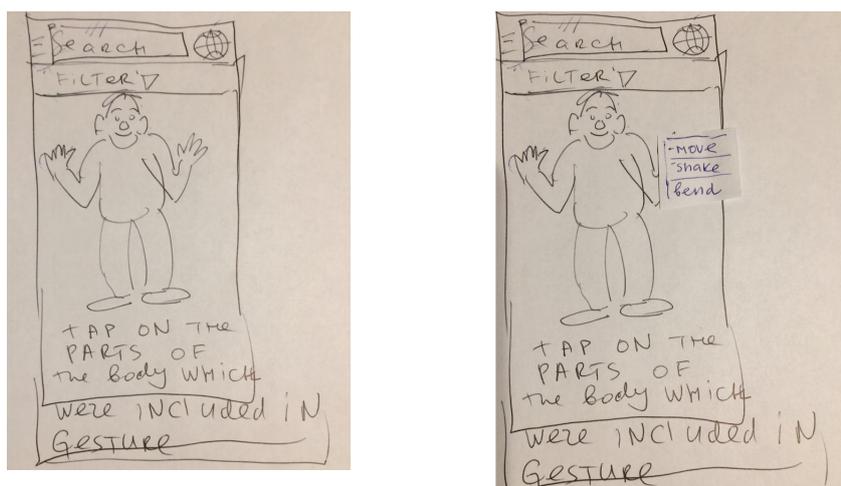
### Search for gesture by visual search

An illustration of the visual search is presented in Figure 6.11

1. (optionally) Choose country.
2. (optionally) Choose a filter to show body parts which participated in gesture.

All users appreciated the idea of having an image and selecting body parts on the image. Users were smiling and exchanging comments of appreciation.

The users suggested adding a drop-down option to specify an action which belongs to the body part. Thus, tapping on body part calls up a context menu which shows possible actions related to this body part, for instance, shake, move, point, bend, etc.



**Figure 6.11:** Search for gesture by visual search

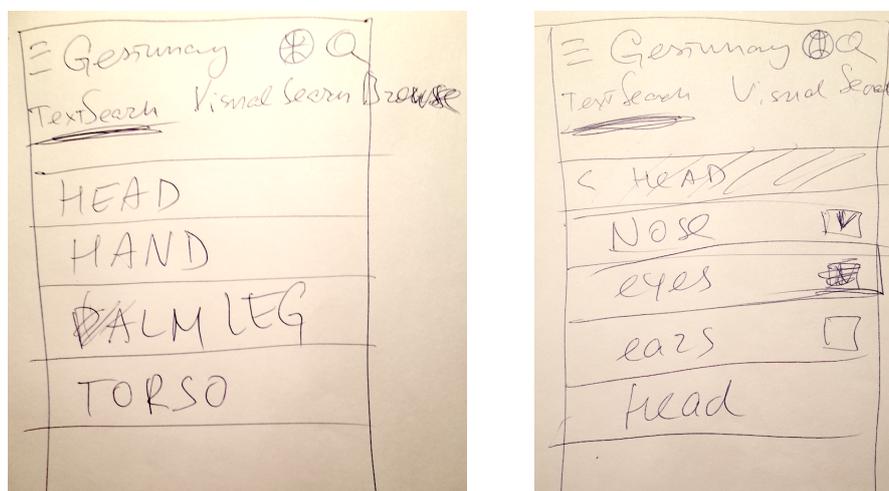
### Search interface with hierarchical body parts choices

It is possible to filter the list of gestures tapping on the name of the body part in the list (Figure 7.3). The user sees a list of top-level body parts. Tapping on each

## 6.4. USER TESTING AND CO-DESIGN PROCESS AND RESULTS

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body part opens another view with deeper level items. For instance, for the head, it will be parts of head (the list is presented in appendix A).



**Figure 6.12:** Search interface with hierarchical body parts choices 1

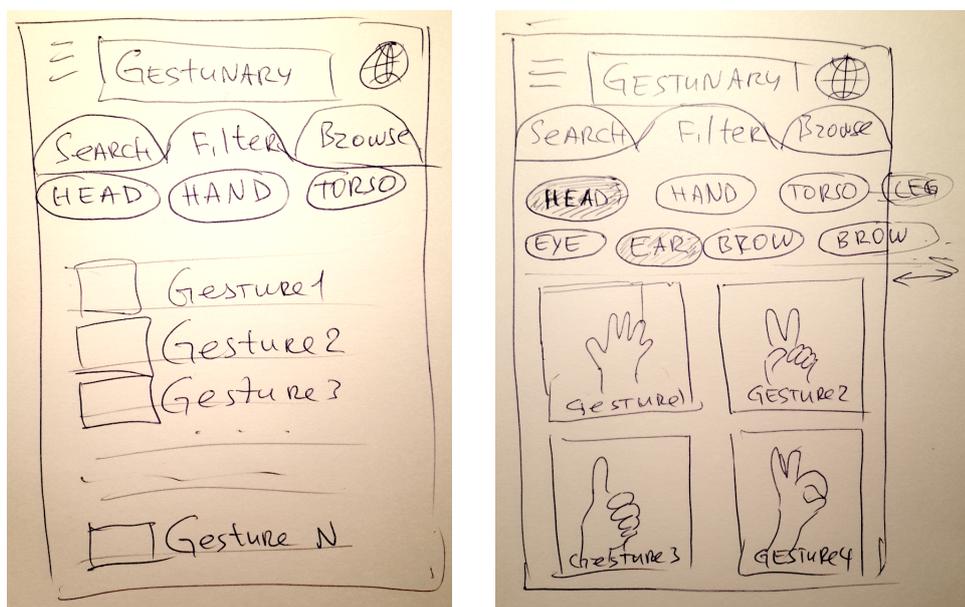
The users liked the idea but wanted to see the list of gestures at the same time as they see the filter. Together with the users I designed another version of the filter using the YouTube prototype and our mutual ideas (Figure 7.3).



**Figure 6.13:** Chip

Body categories are represented as the Android chip UI element (Figure 6.13)<sup>9</sup> and placed in the top part of the view. Below chips there is a list of gestures. Tapping on the top level chip opens a second level of chips.

<sup>9</sup><https://material.io/guidelines/components/chips.html>



**Figure 6.14:** Search interface with hierarchical body parts choices 2

### Gesture list representation

It is possible to list gesture items using cards<sup>10</sup> and lists<sup>11</sup>. Figure 6.14 illustrates both variants. Users preferred cards, as the gestures could be seen better and the gesture was the main point of interest for all of the users.

### Browse for gesture

Gestures are grouped in categories. Figure a) 6.15 illustrates category layout. The user can browse through gestures, tapping on any category. The list includes collections from the Gestunary for iOS application: list of all gestures in the alphabetical order, "survival basics" and "business 101" categories. The set of gestures could be filtered by country or displayed for all countries. One of the users suggested adding romance and restaurant category. All others liked presented now sections and one knew what is "survival 101". The rest of tested functionality is presented in Appendix F.

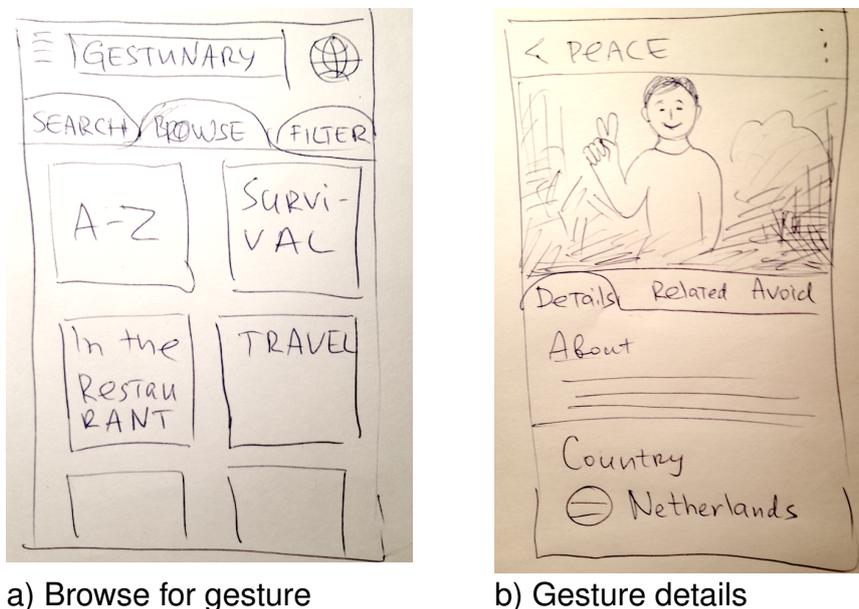
### Gesture details

Figure 6.15 (b) illustrates a gesture details view. The main differences with iOS version are inclusion of the tab view for gesture description, list of related gestures and list of countries where the gesture should be avoided. Users came up with similar designs when were trying to come up with a better solution than Gestunary

<sup>10</sup><https://material.io/guidelines/components/cards.html>

<sup>11</sup><https://material.io/guidelines/components/lists.html>

for iOS.



**Figure 6.15:** Browse for gesture and Gesture details

## 6.5 Results and discussion

In this section I present the results of the Lo-Fi prototyping and co-design. I also discuss the co-design process.

In this iteration I created the Lo-Fi prototype based on the Android Material Design guidelines. Additionally, I draw inspiration from state of the art applications on the Android platform and research on the representation of gestures in other gesture dictionaries (chapter 5).

### Visual search filter and action selection

The main points of interest in testing of the Lo-Fi prototypes with the users were to acquire feedback and input on the visual search option, as most of the other elements were used in standard Android applications familiar to the users. All users were very happy with the idea of being able to tap on the figure to select parts of the body which are included in the gesture movement. One of the users contributed the idea that on the long tap I will be able to show a menu with a list of associated with the gesture actions.

### Tab-based layout for gesture description

Users liked the proposed solution (Figure 6.15). They additionally gave feedback on gesture sharing and Facebook sharing (Appendix F).

### **Country selection and the icon**

This functionality was very clear and everyone understood the UI behavior. I can use the standard android icon in high-fidelity prototype<sup>12</sup>.

### **Filter with hierarchical body parts choices**

I co-designed a solution with chips (Figure 6.14). Users enjoyed the process and brainstorming.

### **Limitations**

All the users live in Russia and this could be the reason for cultural bias. On the other hand, search functionality and dictionaries exist in all cultures and I can not think of anything important to note the difference between the implementation of Russian dictionaries and dictionaries in European countries. I do not have any experience of working with Asian dictionaries and for future work, it might be needed to test the application with representatives of these cultures.

It might have been more useful to gather all users in one place. This might have given another insight into design solutions and be more efficient in terms of time. On the other hand, the users were at home, in a familiar place and this could also be the reason for the openness of the sessions and fruitful results.

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<sup>12</sup>[https://material.io/icons/#ic\\_language](https://material.io/icons/#ic_language)

# Chapter 7

## HiFi prototype

In this chapter I present the feedback from the users from the LoFi prototype iteration and implement enhanced prototypes using web-based prototyping tools and Android prototypes.

### 7.1 High-fidelity prototype

In this section I present high-fidelity prototypes of the Gestunary for Android.

#### 7.1.1 Design goals

The goal was to implement the following screens and functionality:

- search by keyword
- visual search
- filter by body parts
- browse categories
- view gesture details
- switch countries

#### 7.1.2 Tools

**Interaction prototyping**

## 7.1. HIGH-FIDELITY PROTOTYPE

---

I used a free version of Invision<sup>1</sup>, as the most usable tool to add interaction to raster prototypes. I also used Android Studio<sup>2</sup> for prototyping keyword search interface.

### Color palette choice

Material design guidelines provide a convenient online tool<sup>3</sup> for color selection. Using the tool it is possible to select appropriate color palettes for the application. It also lets the developer export ready to use color settings to be inserted in the code base. I used this tool for color palette selection.

### 7.1.3 Hi-Fi prototype 1

Here I will describe the proposed UI screens of the application. For the first Hi-Fi prototype I took the set of colors described in the guidelines of the color system for android<sup>4</sup>. The color sets are presented below:

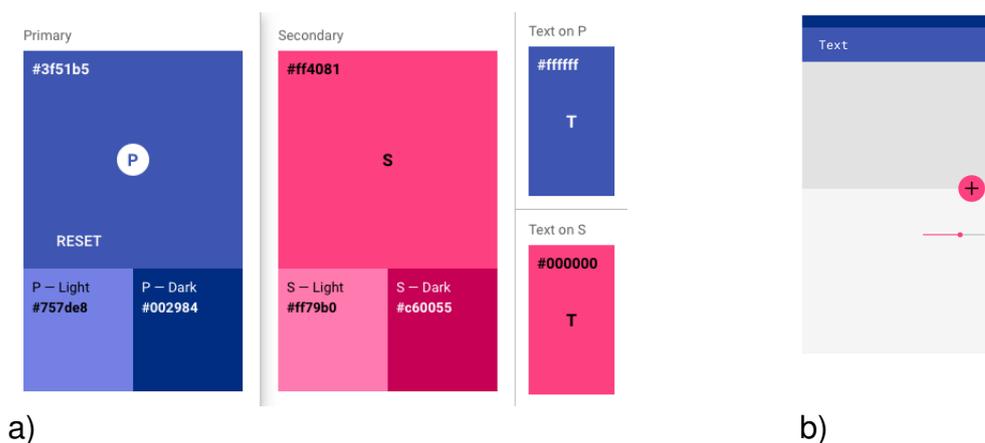


Figure 7.1: Color palette for the Hi-Fi prototype

### Help on start of the application

On the first start of the application, the user should see instructions for using the application.

### Gestunary main screen

After reviewing the intro slides the user gets to the Gestunary main screen which holds gesture search functionality. The main screen of the application will include a search string, and three tabs which will hold the body of information. I added three tabs which hold visual search, search by body tags and gesture browse functionality.

<sup>1</sup><http://invision.com>

<sup>2</sup><https://developer.android.com/studio/index.html>

<sup>3</sup><https://material.io/color/>

<sup>4</sup><https://material.io/guidelines/style/color.html#color-color-system>

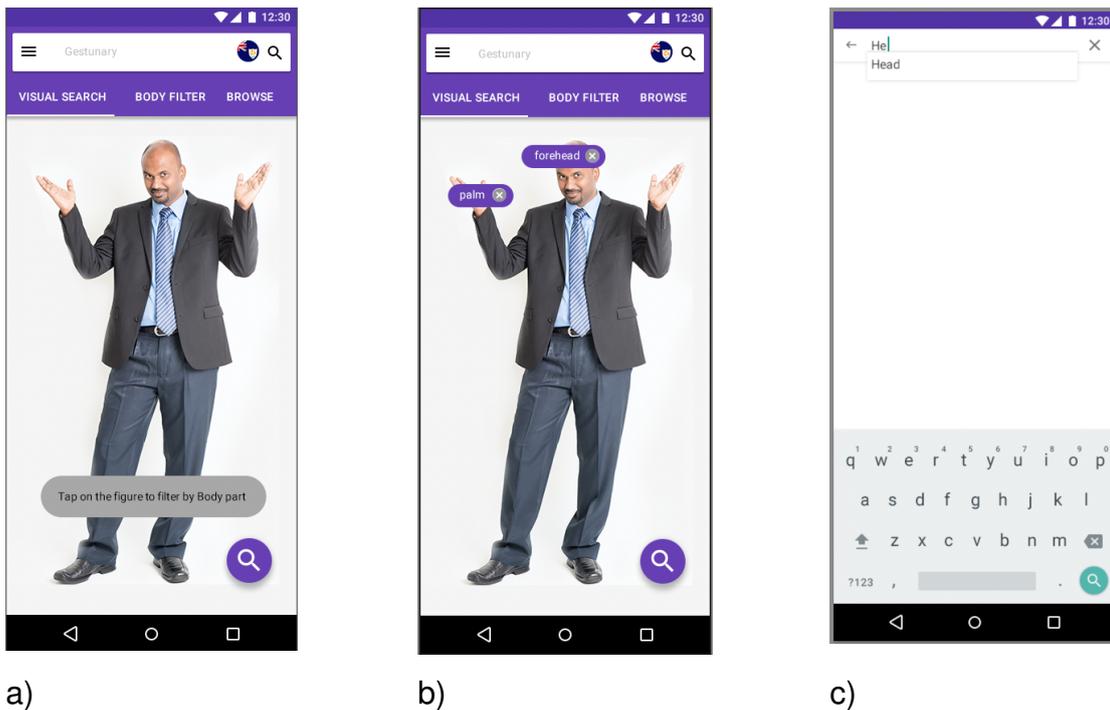
## 7.1. HIGH-FIDELITY PROTOTYPE

### Gesture search

This tab presents an innovative interface I am proposing for the Gesture dictionary. I propose a UI element where the user creates a search query not by entering text but by selecting body parts of interest on the image. Then the user can enhance the search query adding an action to the body part. This is implemented by holding the long tap on the selected body part. Proposed templates are presented in Figure 7.2, a), b).

### Text search

Text search is a key-word search. It is based on the standard Android UI search dialog, illustrated in Figure 7.2, c).



**Figure 7.2:** Visual search and Text search

### Browse tab

Browse tab contents will hold the same categories as displayed in Figure 2.2 b). Additionally, it will have a category "Gestunary A-Z" which will show all gestures in the Gestunary. The screenshot of the prototype is displayed in Figure 7.3.

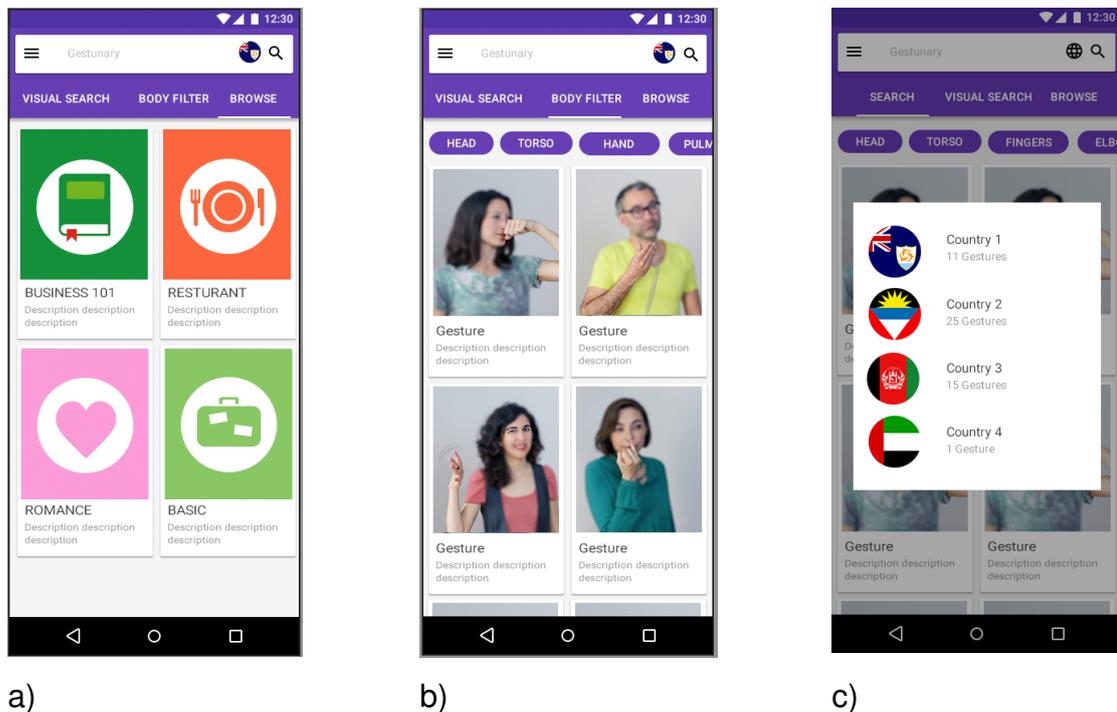
## 7.1. HIGH-FIDELITY PROTOTYPE

### Text filter tab

The text filter tab opens the filter, which helps to view gestures based on body parts (Figure 7.3.2). The user selects a part of the body by tapping on the chip<sup>5</sup>. Then the program displays the gestures which use this body part in the content part of the screen below the chips.

### Country choice dialog

The user can narrow down the choice of displayed gestures by choosing the country of interest. This filter is applied to any filter from the tabs. The prototype of the screen is displayed in Figure 7.3.



**Figure 7.3:** Search interface with hierarchical body parts choices

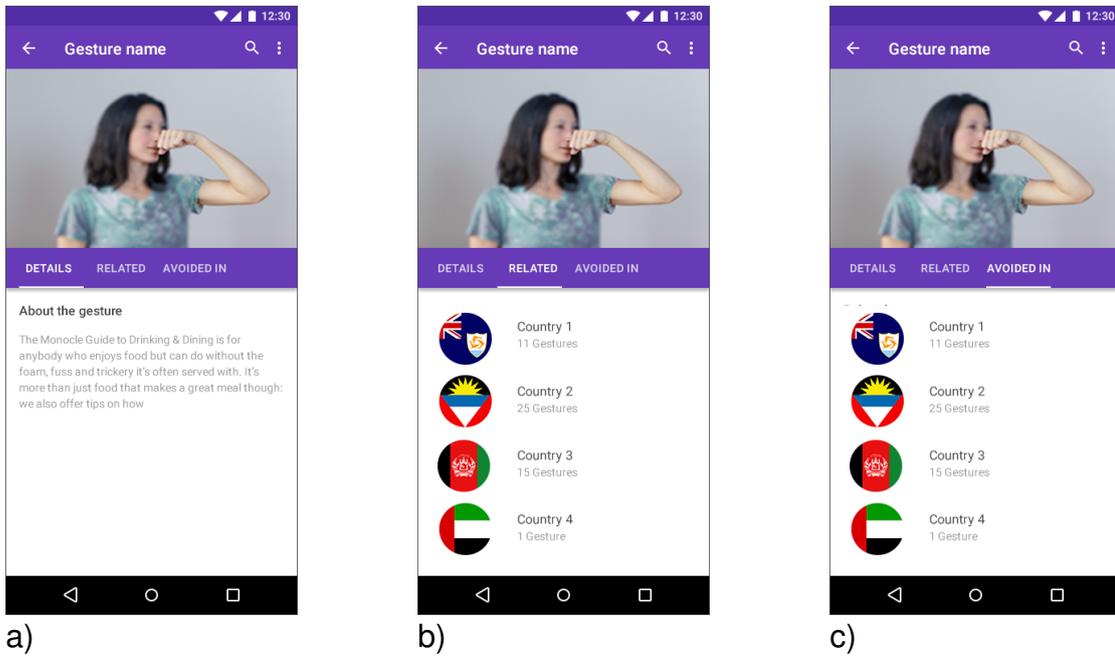
### Gesture description screen

Gesture descriptions are presented in three tabs (Figure 8.3). Each tab displays categories that are similar to those of Gestunary for iOS. The first tab displays the gesture description. This information piece was called "etymology" in the Gestunary for iOS. Many users were not able to understand the term and I propose a neutral term "details". The second tab "related" display the related gestures, similar to

<sup>5</sup><https://material.io/guidelines/components/chips.html>

## 7.1. HIGH-FIDELITY PROTOTYPE

the list of related gestures in Gestunary for iOS (Figure 2.2, a)). The third tab is dedicated to the list of countries where the gesture should be avoided and is called "avoid in".



**Figure 7.4:** Gesture description.

### 7.2 User-based testing of Hi-FI Search Interface

In this section I present the test plan and results of user testing of the Hi-FI Search Interface and other elements.



**Figure 7.5:** User testing.

#### 7.2.1 Android Gestunary search functionality UI test plan

The goal of the search UI user test is to find usability problems in general and to find ways for improvement. Only search/browse functionality is evaluated.

- I introduced myself, not telling that he is the author of the UI
- I described the product and explained that it is under development and I am currently presenting graphical templates
- I explained that we can quit the test at any time, that we test the system and not the user
- I explained how to think aloud
- I asked if the user has any questions
- I showed the users videos of the gestures and performed the test using scenarios (below), when appropriate I used interventions to ask questions.
- Then I perform the SUS test. I gave users online link to fill in the form.

## 7.2. USER-BASED TESTING OF HI-FI SEARCH INTERFACE

---

- In the follow up conversation I discussed user's observations about application and other experiences with gestures and different cultures.

### **Scenarios:**

1. You are in Italy. You saw a gesture (show 4 video illustrations of gesture). You want to understand what the person means with this gesture.

How can you look it up using Gestunary?

- Can you find this gesture using text filter?
- Can you find this gesture using a visual filter?
- Can you find this gesture using search field?

2. You are at a dinner in Italy. You do not know the local language.

- You want to show the waiter that the food is too hot
- You want to say thank you to the waiter
- You want to tell the waiter - enough

3. You want to be prepared for the trip. You want to look up forbidden gestures in Italy.

- How can you do that?

4. You are on the plane and want to browse through gestures in Italy to get familiar.

- Can you browse all gestures in Italy?
- Can you browse all gestures in the Gestunary out of curiosity?
- Can you select Italy as the country and browse restaurant gestures?

### **7.2.2 Users**

Target users were non-acquaintances, who travel and have experience working with different cultures. I found a number of online resources where users satisfied these criteria<sup>6,7</sup>. Users were professional and non-professional English teachers. I interviewed nine users over Skype and one user in person. Totally there were 10 users from all over the world.

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<sup>6</sup><https://buddyschool.com>

<sup>7</sup><https://glish.guru>

## 7.2. USER-BASED TESTING OF HI-FI SEARCH INTERFACE

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List of interviewed users:

**User 1:** 25 y.o., Female, graduate student, lives in Colombia, traveled all over the world, lived in Thailand and India

**User 2:** 40 y.o., Female, teacher, travels a lot in Europe, lives in Europe

**User 3:** 28 y.o., female, babysitter, traveled a lot across the country and met different cultures, lives in Indeanapolis, USA.

**User 4:** 50 y.o., Male, English teacher, Lives in Australia, originally from England, traveled a lot

**User 5:** 45 y.o., female, sociologist, traveled a lot, lives in Thailand.

**User 6:** 50 y.o., female, couch, traveled all over the world, lives in Scotland.

**User 7:** 27 y.o., female, English teacher, likes to travel, met many people from different cultures, lives in Kyrgyzstan.

**User 9:** 35 y.o., female, English teacher, likes to travel, travels to Italy mostly, lives in Russia.

**User 10:** 20 y.o., female, student, likes to travel, met many people from different cultures, lives in India.

### 7.2.3 User test results

#### General feedback

Users liked the application idea and a few users expressed an interest to install the application when it will be ready.

#### Citations

- "It will be an interesting addition to my classes"
- "It is an interesting idea! I love to test"
- "Gestures could be misunderstood"
- "I never had any problems understanding gestures but it will be interesting to see the app when it is ready"
- "great idea"

#### Overall UI feedback

"Text search tab seems to be unnecessary"

"nice idea to search by tapping on the picture"

"Can we change the color? Can we have an ability to choose the color of the application in settings?"

## 7.3. MINOR ELEMENTS TESTING

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### Visual search feedback

Eight users liked the idea of the visual image search. One user considers it an excessive UI element, but nice addition. One user did not like the idea of the image and suggested to use separate images of body parts instead of one image.

### 7.2.4 SUS results

SUS method is described in the section 3.4.

I tested six people. SUS score: 92.5 which corresponds to the adjective "excellent", learnability: 100, Usability : 90,6.

## 7.3 Minor elements testing

In this section I present the results of minor elements testing.

### 7.3.1 Visual search image preference testing

#### Motivation

I wanted to find out user's preferences for visual search illustration. For this purpose during the debriefing I showed four pictures to the testers and asked them for their opinion about the pictures. The images for the visual search filter were chosen from the ones at my disposal. I wanted to check preferences between the photo of a man, a woman and two robot drawings, as the most neutral variants.

#### Results

Figure 7.6 displays four pictures I presented to the users. I also list the number of votes, the users made for each of the images. The users liked the robot illustration from Figure 7.6 b). They characterized the image with such words and expressions: charming, smiling, funny, nice, playful, "waving his hand with greetings", "nice that he is waving his hand". The robot from 7.6 a) got second best ranking. Only two users liked the lady picture.

## 7.3. MINOR ELEMENTS TESTING

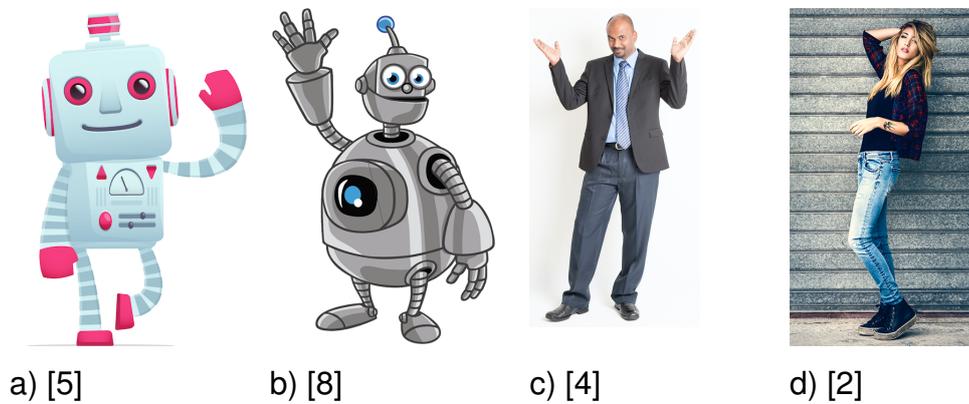


Figure 7.6: Visual search samples

### 7.3.2 User preferences for search results view

#### List or Grid

I wanted to test user preferences for displaying the of search results. For this purpose I created two graphical prototypes with a list and grid layout. I showed this images to the users asking to choose, which one they prefer: one of the images from Figure 7.7 or the layout from Figure 7.3.2, presented earlier in this chapter. All interviewed users didn't express a big preference towards one or another layout style.

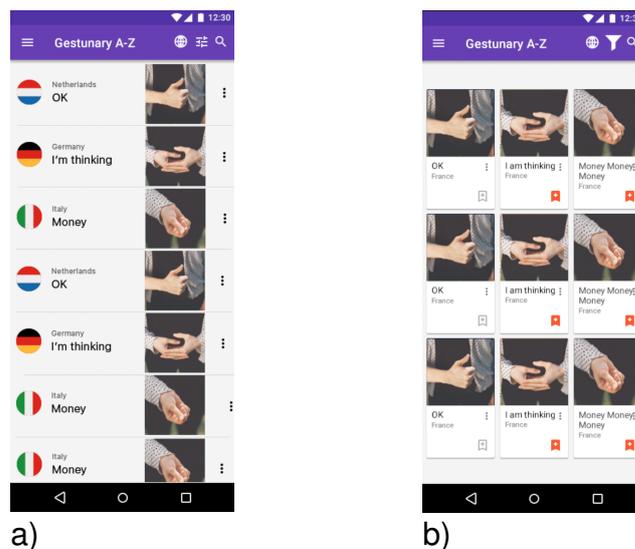


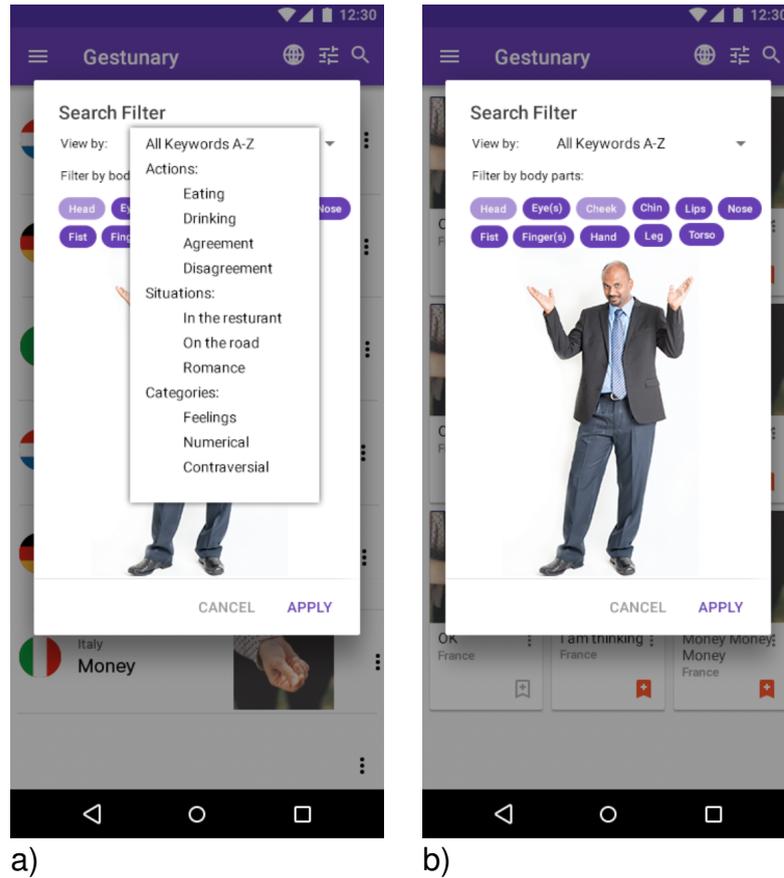
Figure 7.7: Test of search results display preferences

#### Filter dialog instead of tabs

### 7.3. MINOR ELEMENTS TESTING

I wanted to check the hypothesis that users might prefer the filter dialog, implemented in Youtube (6.4 ) over the tabs, presented in Figure 7.2, a).

The users did not completely got the idea of the filter. Eight out of ten users said that liked tab-based arrangement over filter.



**Figure 7.8:** Proposed enhancements for gesture search



a)

b)

**Figure 7.9:** Filter icon samples

### **Result**

Users did not understand the meaning of the "tune" icon (7.9 b)). All users understood the funnel icon in Figure 7.9 a) . Only one user understood the meaning of the "tune" icon, which in this particular context meant "filter"

I think that user preference towards tabs is motivated by the fact that the dialog was not dynamically implemented and users were not able to see it in action.

I will leave the grid layout I used in Figure and preserve the current tab view. I will also preserve tab with image filter.

## **7.4 Conclusions and discussion**

In this section I review what I have done during second iteration, report results and present plan for the next iteration. I have implemented high-fidelity prototypes using the Invision program. I used the prototype of Android application for text search. I performed user-based test and collected feedback required for implementing the final prototype.

### **7.4.1 User feedback on the Hi-Fi prototype**

**Image search feedback** The feedback was positive, users liked to tap on the image and select different terms. Nevertheless, one user did not like the image search and suggested to use a grid of icons which would display different body parts. Another user suggested using zoom for the face to be able to see the region of tapping.

**text search** Seven users said that see no real reason for this tab. User's voice: "I do not need this tab since it will be faster to type the search term in the text box", "why will I need to filter gestures using this options? It seems to be duplicate of the visual search".

**Image illustration for visual search** All users preferred the "iron" robot with the raised hand as a picture for visual search.

### **7.4.2 Plan for the final iteration**

The following changes are planned to be made:

- the color palette should be changed to reflect the color of the Gestunary for iOS since it is the client's desire.
- The image search illustration should be the "iron" robot.

#### 7.4. CONCLUSIONS AND DISCUSSION

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- Text search tab should be removed

# Chapter 8

## Final interface design and testing

In this chapter I describe the final prototypes of the Gestunary for the Android. I also present the results of the user testing, SUS testing and discussion.

### 8.1 Prototypes

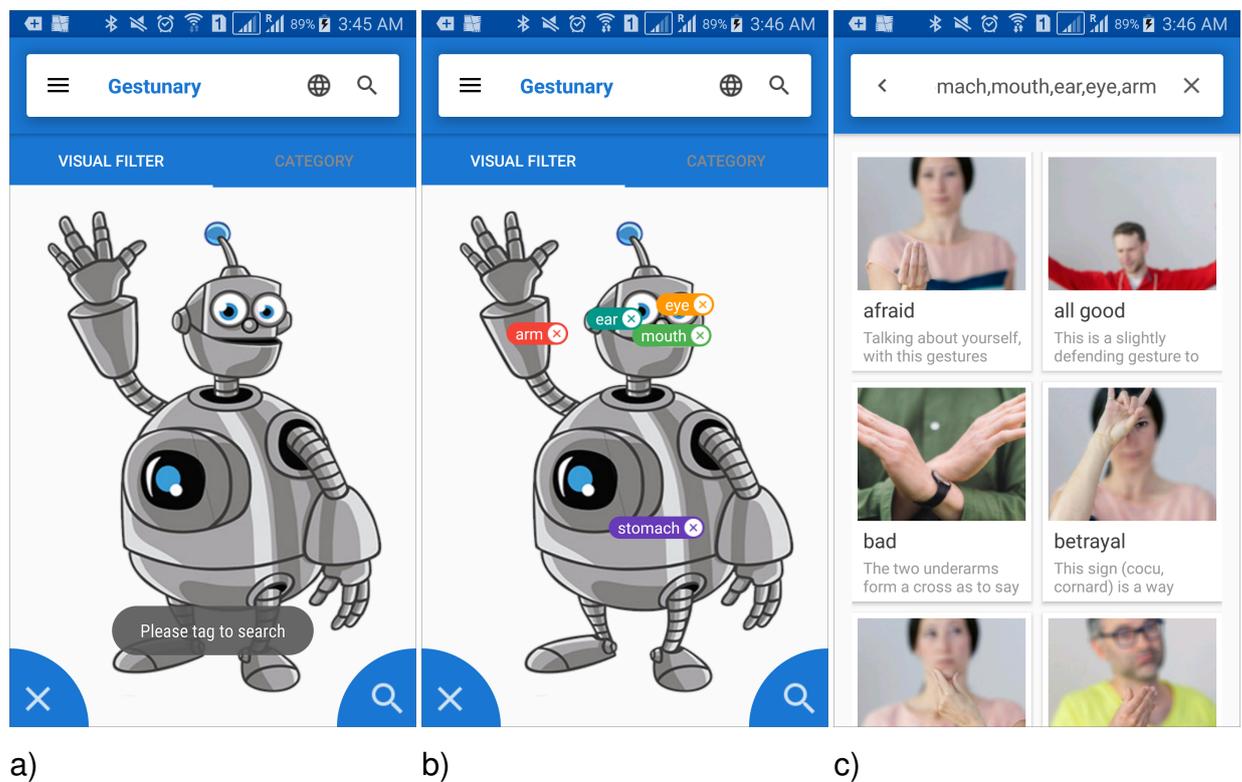
In this section I present the final prototypes of the application.

#### Gesture search

Figure 8.1 (a) and (b) present a final UI, based on user and client feedback. The list of the changes includes the following items:

- Removal of the Text filter
- Using the Robot image (Figure 7.7) for gesture filter
- Changing the color of the application to reflect the style of the Gestunary for iOS
- Using the different color for action chips
- Using the standard icon for country image
- Change of Browse tab name to Category

## 8.1. PROTOTYPES



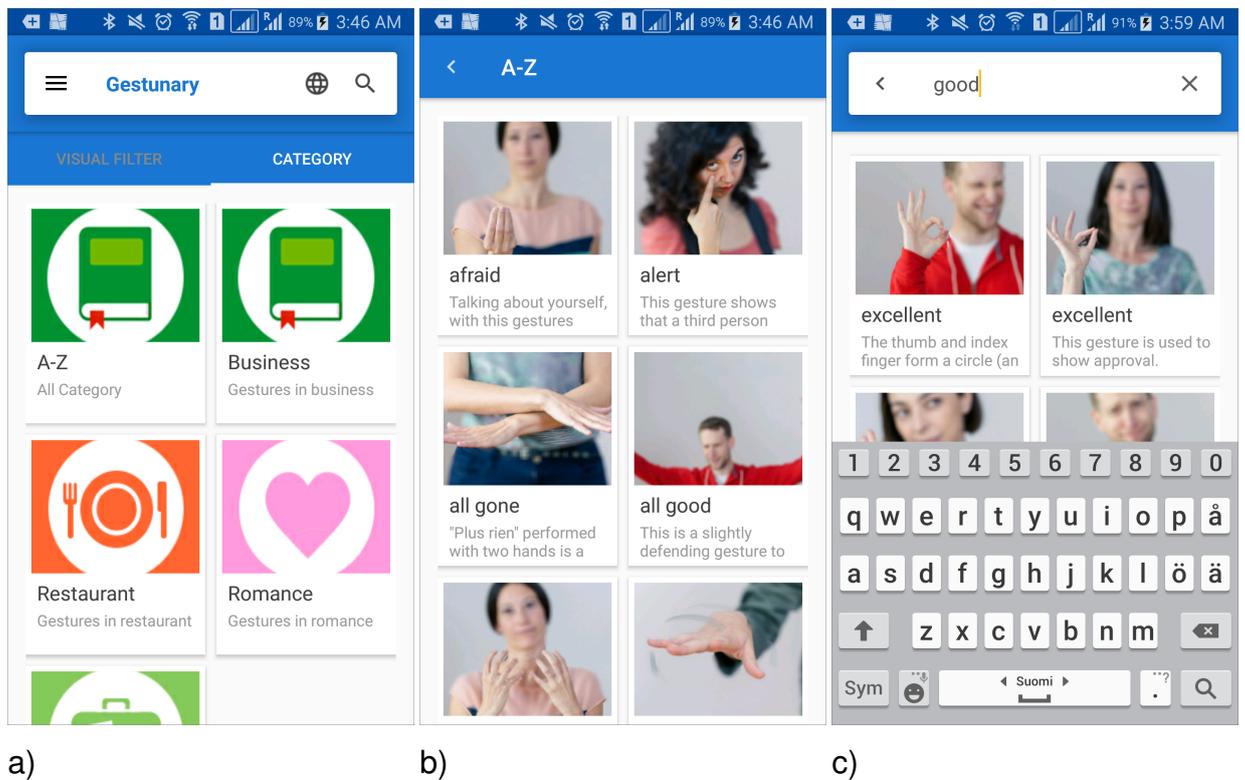
**Figure 8.1:** Visual search filter

### Category tab and text search

The category tab opens the view with the gesture collections (Figure 8.2, (a)). The Gestunary A-Z collection displays gesture collection for the selected country in alphabetical order. If the user has not selected any particular country the view will display gestures from all countries (Figure 8.2, (b)). Other categories include Business, Survival, Restaurant, Romance. The first two categories are from Gestunary for iOS. The latter two categories were suggested by users during user-based testing<sup>3</sup> and co-design (chapter 6).

Text search is a key-word search (Figure 8.2, (c)). It is based on the standard android UI search dialog, illustrated on Figure 6.2. As a result of the text search, it displays gestures which include any of the search keywords.

## 8.1. PROTOTYPES



**Figure 8.2:** Gestunary Browse Categories and Text search

### Gesture description screen

Gesture description is presented in three tabs (Figure 8.3). Each tab displays similar categories from Gestunary for iOS. The first tab displays gesture description. This information piece was called "etymology" in the Gestunary for iOS. Many users were not able to understand the term and I propose a neutral term "details". The second tab "related" display related gestures, similar to the list of related gestures in Gestunary for iOS (Figure 2.2, a)). The third tab is dedicated to the list of countries where the gestures should be avoided and is called "avoid in".

## 8.2. USER TESTING OF FINAL VERSION OF SEARCH UI

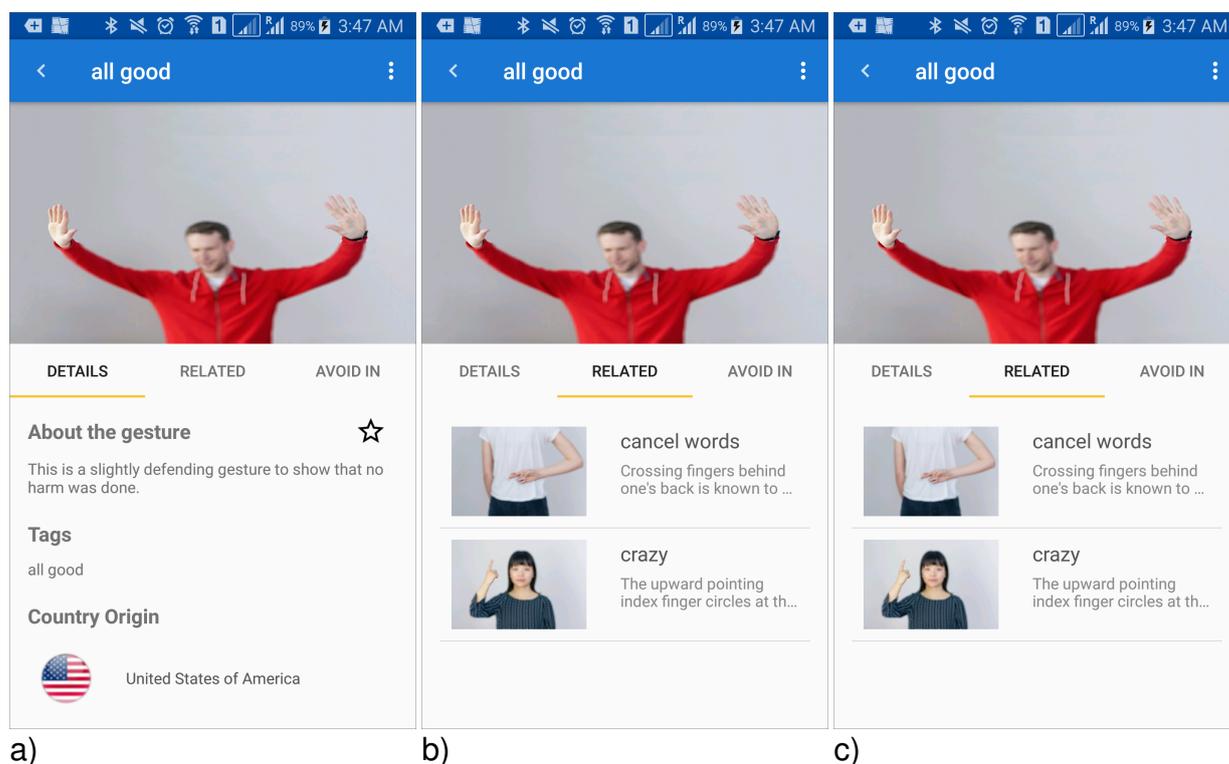


Figure 8.3: Gesture description.

## 8.2 User testing of Final Version of Search UI

In this section I present results of user testing of the final prototype. The goal of the usability testing is to identify final flaws in the user interface and to ensure that the flows spotted on the previous design iteration disappeared.

## 8.3 User-based testing

In this section I present the test plan and results of user testing. The test plan is presented in Appendix D.

The goal of the search UI user test is to find usability problems. Only search/browse functionality is evaluated.

### Protocol

- I introduced myself, not telling that he is the author of the UI
- I described the product and explained that it is under development and I am currently presenting graphical templates

## 8.3. USER-BASED TESTING

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- I explained that we can quit the test at any time, that we test the system and not the user
- I explained how to think aloud
- I asked if the user has any questions
- I showed the users videos of the gestures and performed the test using scenarios (below), when appropriate I used interventions to ask questions.
- Then I perform the SUS test. I gave users online link to fill in the form.
- In the follow up conversation we discussed user's observations about application and other experiences with gestures and different cultures.

I had prepared four self-made video gestures for the test.

### 8.3.1 Test Tasks

The main thing to test is how users will look up for gestures. The second thing to test is the overall usability and find UI improvement points for the search/browse functionality. Note the functions users would like to add. Time limit for tasks is three minutes.

#### **Scenarios:**

1. You are in Italy. You saw a gesture (show 4 video illustrations of gesture). You want to understand what the person mean with this gesture.

How can you look it up using Gestunary?

- Can you find this gesture using text filter?
- Can you find this gesture using visual filter?
- Can you find this gesture using search field?

2. You are at a dinner in Italy. You do not know the local language.

- You want to show the waiter that the food is too hot
- You want to say thank you to the waiter
- You want to tell the waiter - enough

3. You want to be prepared for the trip. You want to look up forbidden gestures in Italy.

- How can you do that?

### 8.3. USER-BASED TESTING

---

4. You are on the plane and want to browse through gestures in Italy to get familiar.

- Can you browse all gestures in Italy?
- Can you browse all gestures in the gestunary out of curiosity?
- Can you select Italy as the country and browse restaurant gestures?

#### **Analysis of the test results**

- Notes analyzed and results documented

### **8.3.2 Test setup and location**

For all users I used remote testing, sharing the screen over Skype. Users were telling me what to press on the screen and I acted as a remote mouse for them.

### **8.3.3 Users**

Target users were new unknown to me people with experience in communication with different cultures. I recruited users on the websites where I was able to find English language teachers<sup>1,2</sup>. Users were professional and non-professional English teachers. I interviewed six users from all over the world.

List of interviewed users:

**User 1**, 28 y.o., female, graduate student, lives in Germany, travels all over the world

**User 2**, 30 y.o., female, mother, stays at home, travels a lot in Europe, lives in Europe

**User 3**, 32 y.o., female, support and technical writer, traveled a lot, lives near London.

**User 4**, 55, male, English teacher, Lives in Thailand, traveled all over the world

**User 5**, 26, female, sociologist, traveled a lot, lives in the USA

**User 6**, 25, female, student, traveled a lot, lives in Canada

### **8.3.4 User test Results**

Overall users liked the application and were able to successfully perform all the tasks. All users liked the filter and were able to do necessary steps to find appropriate gestures.

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<sup>1</sup><https://buddyschool.com>

<sup>2</sup><https://glish.guru>

### 8.3.5 SUS test results

I tested all six people. SUS score: 98 which corresponds to the adjective excellent, Learnability: 100, Usability: 97.5.

## 8.4 Results and discussion

The general acceptance of the application was very good. Users were able to find gestures described in the tasks. Further comments included:

"Nice image of the robot", "great idea of the application", "I may use it in my job".

The remote procedure testing worked very well. The sound was good and the users gladly participated in research. Only once I had a glitch with Skype connection. One user turned out to be not fluent in English but in the end we were able to understand each other and she also gave positive feedback for the user interface. Each session took about an hour.

I think that with this test I proved that it is possible to implement the whole user-centered design cycle to the team of one person. Sometimes it was not easy to switch hats between creative work and coding, but introducing more strict scheduling helped. I also tried to put on different cloths to make it easier to switch between roles.

SUS score went up, compared to the results for Gestunary for iOS score and Hi-Fi prototype test. I think that even though SUS is considered a good measure of usability, in my case the score shows very slight grades of change. Users liked the application, the robot picture. It seems that this also affected the judgment.

# Chapter 9

## Additional research

In this chapter I present results of gesture illustrations preference research. I also present a feasibility study of gesture search using machine learning methods.

### 9.1 Gesture illustrations preference research

In this section I present results of research, dedicated to checking user preferences for gesture illustrations. The choice of illustrations include drawing, color and black and white photos. All photos are presented in two ways: fully focused and blurred. Blurred photos have an important part of the gesture in focus. I also present pictures which are used in the survey.

#### **Motivation**

I wanted to check Epstein's hypothesis [11] about the order of user picture preferences for gesture illustration. The highest preference Epstein gives to drawing. The next preference is black and white photos. The least preferable are color photos. In his own work, Epstein uses sketches to illustrate gestures in *An American Gestuary* [10]. McNeill also considers drawings superior to video stills. At the same time, he mentions that drawings should be created with "intelligence and sensitivity" [34].

An additional motivation was to test user preferences acquired during user-based testing of the Gestunary for iOS (3.3.4). Three people out of seven expressed negative emotions towards blurred illustrations of gestures.

As the method for testing user preferences in gesture illustrations I choose survey. Surveys are a very popular cheap research method to understand stakeholders and cover a wide audience. Surveys are good at getting shallow data, but bad at getting detailed information. According to Lazar [24], survey is a convenient method to quickly get many responses.

#### **The goal**

The goal of this survey is to test the preferences in understanding the meaning

## 9.1. GESTURE ILLUSTRATIONS PREFERENCE RESEARCH

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of gesture images. Gestures are represented by 5 different types of images:

- hand drawing by pencil
- black and white photograph
  - Untouched
  - The face and most parts of the photograph is blurred. Parts of the body which participate in the gesture are in focus.
- color photograph
  - Untouched
  - The face and most parts of the photograph is blurred. Parts of the body which participate in the gesture are in focus.

### **Test gestures**

The number of gestures to test the hypothesis was chosen to be 5. The number of questions was used to not overburden the user with questions and to ensure a higher response rate.

### **Illustrations**

The drawn pictures were partly traced from photographs. Photos were used from the depositphotos<sup>1</sup> photo bank and from the Gestunary photo library.

### **The target audience**

The target audience is any person from 12 y.o, who has experience in communications with different cultures, or who has traveled abroad. To filter out people, who do not have experience in communication with other cultures, I added a question on travel experience of the user [43]. I assumed that this question will tell us that the person had experience in communication with people from other cultures. I distributed the survey among people who traveled a lot. I also published the survey on a few web forums<sup>23</sup> which are attended by people from different countries, including big countries, such as USA or Russia.

In Table 9.1 I present the contents of the survey with questions and illustrations.

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<sup>1</sup><http://depositphotos.com>

<sup>2</sup><http://puttylike.com>

<sup>3</sup>

## 9.1. GESTURE ILLUSTRATIONS PREFERENCE RESEARCH

1. The pictures below illustrate a Spanish gesture which means "small", "a little". In your opinion, which one is conveying the gesture meaning in the best way?

1.



2.



3.



4.



5.



6.

Any except drawing

2. The pictures below illustrate a German gesture which means "crazy". In your opinion, which one is conveying the gesture meaning in the best way?

1.



2.



3.



4.



5.



6.

Any except drawing

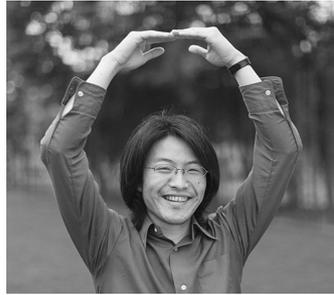
9.1. GESTURE ILLUSTRATIONS PREFERENCE RESEARCH

3. The pictures below illustrate a Japanese gesture which means "OK", good. In your opinion, which one is conveying the gesture meaning in the best way?

1.



2.



3.



4.



5.



6.

Any except drawing

4. The pictures below illustrate an American gesture which means "time-out". In your opinion, which one is conveying the gesture meaning in the best way?

1.



2.



3.



4.



5.



6.

Any except drawing

## 9.1. GESTURE ILLUSTRATIONS PREFERENCE RESEARCH

5. The pictures below illustrate a Russian gesture which means "silence". In your opinion, which one is conveying the gesture meaning in the best way?

1.	2.	3.
		
4.	5.	6.
		Any except drawing

6. Have you traveled abroad or met people from other cultures? (YES/NO)

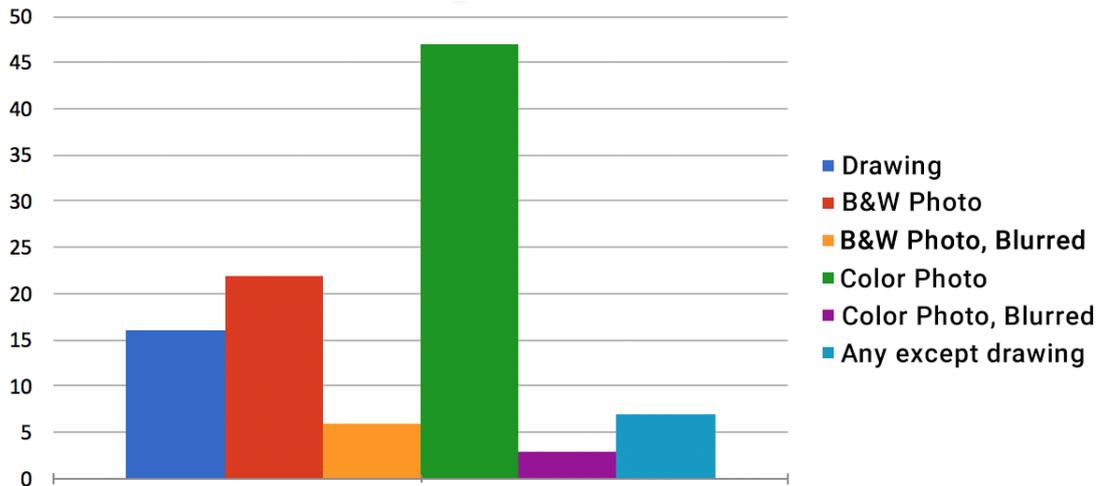
7. Please share any comments you may have.

Table 9.1: Gesture illustration survey

### 9.1.1 Gesture illustration research results

Totally, there were 29 participants. Three participants mentioned, that they have not traveled abroad. Overall, color photos were chosen in 47%. Drawings were preferred in 23%. There is a clear preference towards not blurred color photos over drawings, black and white photos and blurred photo versions. Figure 9.1 displays a chart, illustrating preference results percentage for every picture.

## 9.1. GESTURE ILLUSTRATIONS PREFERENCE RESEARCH



**Figure 9.1:** Image preference results

Below is the table which summarizes survey results.

	Drawing	Black and White Photo	Blurred Black and White Photo	Color Photo	Blurred Color Photo	Any except drawing	Check sum
Question 1	3	8	4	11	0	3	29
Question 2	4	7	2	12	1	3	29
Question 3	7	4	0	16	0	2	29
Question 4	6	4	1	15	2	1	29
Question 5	3	9	1	14	1	1	29
Popularity for all questions	23	32	8	68	4	10	145
Percentage	16%	22%	6%	47%	3%	7%	100%

**Table 9.2:** Gesture illustration survey results

From Table 9.2 it can be seen that the order of picture preference is the following: 1) color photo, 2) black and white photo, 3) drawing, 4) anything, but drawing, 5) blurred black and white photo 6) blurred color photo.

Interestingly, there was preference towards drawings in question 3 and 4. One of the possible reasons for the preference could be that these drawings, compared to the rest, are more stylized and concrete or the photos had some problems. Another reason could be that the quality of the photos is not as good as in the rest of the questions.

## 9.2. FEASIBILITY STUDY OF GESTURE SEARCH USING MACHINE LEARNING METHODS

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Based on the research results I recommend to change the blurred photos in the current Gestunary application to full color photos.

In the future it will be interesting to do similar research using more stylized pictures, executed in the style presented in dictionary of American gestures by Epstein [10].

### 9.1.2 Conclusion and discussion

My analysis of the users gesture illustrations preferences do not correspond fully to Epstein's recommendations. Only a small number of my drawings were preferred in the survey results, color photo had higher marks. I may attribute it either to progress in photo picture making or my skills in picture drawing. Epstein based part of his conclusions on using high quality gesture drawings, as in his book *Conventional Gestures* professionally illustrated by Alex Raffi.

It is possible, that I should have to formulate differently the question about user experience in communication with other cultures. From the notes, left by people in the survey, I can assume that in general, I reached the correct audience. The users were making culture-specific comments which indicated that they are my target audience. Unfortunately I could not be sure about the answers of the users, who left no comments.

## 9.2 Feasibility study of gesture search using machine learning methods

In this section I examine a feasibility of gesture search using machine learning methods.

### **Motivation**

Most of the users mentioned that they would like to identify the gesture by taking a picture or sending the picture to the program (3.3.4,10.4.1). I wanted to check a feasibility of automatic recognizing from the pictures, submitted by the user.

### 9.2.1 Dataset and Method

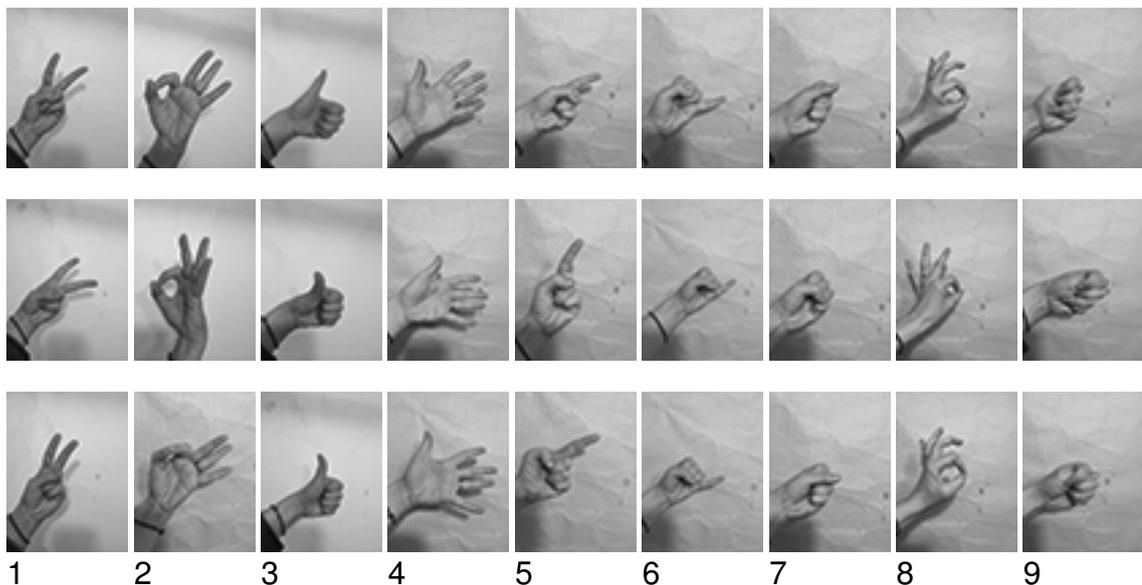
The machine learning process usually involves a few key steps which include data preprocessing, model selection, evaluation and training to find the best parameters for presented data and testing. [8].

## 9.2. FEASIBILITY STUDY OF GESTURE SEARCH USING MACHINE LEARNING METHODS

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### Dataset

The dataset I used is a collection of 627 photos which belong to nine different gesture categories. I made pictures of my hand. Each category holds around 60 images. Table 9.2 presents examples from the data set. For the purpose of this research I am testing only hand gestures. I am assuming that the application will instruct the user to take the picture of the hand on white color background from a particular distance. To train models I have to prepare the dataset of such pictures. The pictures are uniformly resized to the dimensions of 45 by 60 pixels and converted to gray scale. I need to make data uniform and easy to understand, so that I am able to find appropriate algorithm and find ways to work with this data. In real application is possible to make automatic preprocessing of data.



**Figure 9.2:** Gesture picture samples.

### Method

The task of searching gestures by picture could be performed using classification machine learning methods. The methods include, for instance, neural networks, decision trees, random forests, logistic regression and combinations of these models. Neural networks require a lot of computing power and other resources. The latter four methods are good enough for my purposes and resources at my disposal. Resources include the number of images, time to train the model and the time for image recognition itself by the trained model. Below I will compare methods and identify which method will be the most suitable and give the best result. The result is represented by the vector of probabilities of the photo showing a particular gesture.

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I will use supervised learning classification algorithms. Decision tree algorithm is a very popular supervised learning method because it's easy to understand how it works and easy to read results - the tree could be converted to a number of IF-THEN rules. Decision trees could be used for classification or regression problems. The base model of the algorithm is a binary tree [4]. Random Forests are an ensemble of decision trees. The algorithm could also be used both for classification and regression problems. Some of the benefits of Random Forests include dependence only on one or two parameters and that it is relatively fast to train and predict [9]. Logistic regression is one of the simplest classifiers. It is computationally efficient and simple to train because of a small number of coefficients [31]. Voting Ensemble learning uses the combination of different methods. It uses a Majority voting method which selects that value which got more "votes" from methods which compose ensemble [49].

### 9.2.2 Implementation, evaluation and model tuning

The image could be represented as a matrix of pixels, where the dimensions of the matrix is the size of picture in pixels. The value of every matrix element is a number between 0 and 5 (the value is equal to darkness of the pixel).

To prepare the images for analysis, I convert the matrix into a vector of pixels. This pixel vector is the input for my model. The output will be the result appropriate gesture class.

To measure how good my algorithm works I will train the model with a part of the dataset (80% of images), and using another part (20%) to measure accuracy score metrics. Accuracy score is the number of correct predictions made as a ratio of all predictions made. I used sklearn metrics package<sup>4</sup> to calculate accuracy score.

I will search for the best parameters of my models using the Grid Search method. This method gives me the possibility to change the number of parameters simultaneously and check how the changes will be reflected on the accuracy score<sup>5</sup>. To classify my data I used DecisionTreeClassifier, RandomForestClassifier, LogisticRegression and VotingClassifier from sklearn package [38].

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<sup>4</sup>[http://scikit-learn.org/stable/modules/generated/sklearn.metrics.accuracy\\_score.html](http://scikit-learn.org/stable/modules/generated/sklearn.metrics.accuracy_score.html)

<sup>5</sup>[http://scikit-learn.org/stable/modules/generated/sklearn.model\\_selection.GridSearchCV.html](http://scikit-learn.org/stable/modules/generated/sklearn.model_selection.GridSearchCV.html)

## 9.2. FEASIBILITY STUDY OF GESTURE SEARCH USING MACHINE LEARNING METHODS

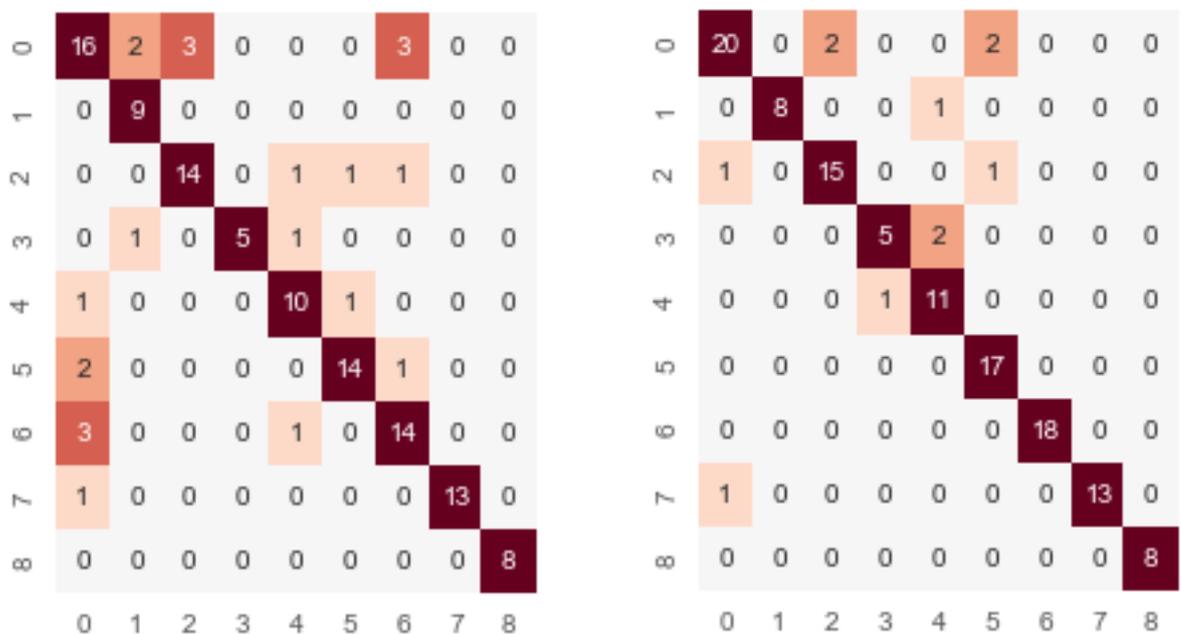
### 9.2.3 Results, discussion and future work

Table 9.4 shows accuracy score results using different classification methods. I compared the results using default model values and tuned models.

Parameters	Default parameters	Tuned parameters
DecisionTreeClassifier	0.77	0.78
RandomForestClassifier	0.91	0.96
LogisticRegression	0.95	0.96
VotingClassifier	0.96	0.98

Table 9.4: Results

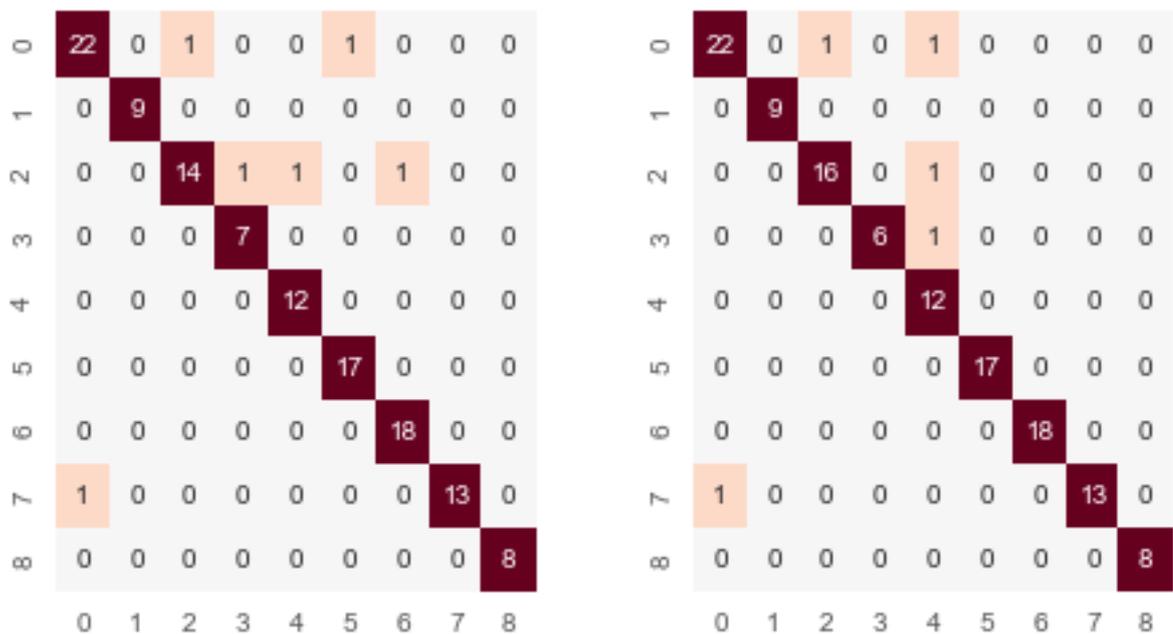
Figure 9.3 illustrates prediction errors for different gesture classes in a confusion matrix. The confusion matrix is easily understandable representation of the model accuracy. The X-axis present predictions, the y-axis presents accuracy. The number of predictions made by the algorithm is placed in the cells.



a) Decision tree confusion matrix, default parameters

b) Random forest confusion matrix, default parameters

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c) Logistic regression confusion matrix, default parameters

c) Voting ensemble confusion matrix, default parameters

**Figure 9.3:** Confusion matrix

I can observe from Table 9.4 that the decision tree classifier is not very suitable for my task. The Random forest classifier, which is an enhanced version of decision tree classifier, produces better results. Logistic regression produces even better results than random forest classifier, but prediction errors for picture classification occur on different pictures. Consequently, voting classifier may help to eliminate such errors.

To further check the feasibility of the gesture recognition, it is necessary to perform the following research and development:

- Evaluate the models on photos from other people.
- Implement the web server to return prediction results.
- Implement the android client to post pictures.

Looking at the rapid development of the online services which enable image recognition<sup>67</sup> I hope that in the near future it will be possible to recognize gesture by pointing the camera to the person and sending the image to the program.

<sup>6</sup><https://aws.amazon.com/rekognition/>

<sup>7</sup><https://visual-recognition-demo.mybluemix.net/train>

# Chapter 10

## Conclusions, discussion and future work

In this chapter I provide conclusions and discuss results. I also describe ideas for future work.

### 10.1 Iterations discussion

In this section I discuss the different iterations, benefits of lo-fi and hi-fi prototypes and my experience during development. During development of the prototype I created both high-fidelity and low-fidelity prototypes. It was noted, that users shared more information during the user test with the low-fidelity prototype, then during user testing of high-fidelity prototype.

According to Rudd [50] the benefits of low-fidelity prototypes over high-fidelity prototypes is less time required for prototype development, low development costs and ability to test many prototypes fast. Low fidelity prototypes are also good for proof of concepts. For high-fidelity prototypes it is the other way around. The benefit of high-fidelity prototypes is that it looks like the final product and could have complete functionality. The high-fidelity prototype could serve as a living specification for software developers. High-fidelity prototypes could also serve as marketing and sales instruments in pre-sales.

I find initial interviews and lo-fi iteration the key to the successful development of the application. I got many interesting ideas during those phases. Testing of Hi-Fi and final version were not as engaging, possibly due to less number of creative solutions, necessary at those stages. Nevertheless, user-testing at these stages is a necessary step to ensure good usability and user experience.

## 10.2 SUS test result comparison

In Table 10.1 I compare SUS scores from the User-based test of Gestunary for iOS, Hi-Fi version and final version of the search interface. The results could be biased because during user based test of Gestunary for iOS users were evaluating the whole application, while for SUS score of Gestunary for Android users were evaluating only search functionality.

	<b>Gestunary for iOS</b>	<b>Hi-Fi version</b>	<b>Final version</b>
<b>SUS score</b>	73	92.5	98
<b>Learnability</b>	96.9	100	100
<b>Usability</b>	67	90.6	97.5

*Table 10.1: SUS comparison*

## 10.3 Limitations

Most of the users were tested remotely and this brought limitations due to technical problems. I had to re-initiate Skype calls a few times to continue the interview. Sometimes the sound was not working reliably.

The users had to tell me what to do in the user interface. This helped me to understand user actions but could add bias to the user actions. Users were describing their behavior and experiences, but according to Blomberg [7] verbal reports often differ from real behavior.

I performed the whole project myself. This might have resulted in less usability problems identified during Heuristic Evaluations of Gestunary for iOS. I might have been less critical for my own design decisions, but this problem was solved by user-based testing.

One more limitation was the type of users I found for user-based testing. User-based testing of Gestunary for iOS and Lo-Fi testing were performed by Russian users and this might have resulted in cultural bias. Some terms, used in the Gestunary for iOS application were not clear for Russian users due to culture differences.

During user-based testing of Hi-Fi and Final prototypes users were mostly English teachers. The profession might have added bias to the users feedback.

## 10.4 Future work

In this section I list features which were described by the users as desirable.

### 10.4.1 Components, desired by users during user tests

#### **Adding video and sound**

McNeil [32] writes that gestures and sounds, which accompany the gesture, create a different experience for the observer. Thus, in my opinion it will be beneficial for the user to have the ability to hear the sounds which happen concurrently with the gesture. The most illustrative way will be to create a library of movies. In this case, the user will also be able to see the gesticulation in action.

Besides that, three users from seven (3) expressed interest in seeing animations or 3D models of the figures. The users reported that they had a hard time understanding how the gesture is acted, looking at the photos with gray lines, which symbolize movements.

#### **Gamification**

During exploratory interviews all users expressed interest in some kind of gamified component for the application. Most of the users suggested to have quizzes and tests. The users considered it fun and nice addition to the application. One option included competing with other users. A gesture quiz is implemented in "Gestures and Customs" iOS application.

#### **Illustrations**

During User-based testing of Gestunary for iOS (3), three out of seven users expressed preference towards gesture illustrations without blurred background. From the test performed in section Gesture illustrations preference research 9.1 I see that majority of users also preferred color photos to all other options.

#### **Gesture recognition from the photo**

Most of the users, when told about the idea development of an innovative search interface would started imagining that they would be able to make a picture of the gesture and the program will return gesture meaning. The users even looked a little bit disappointed when they heard that this function is not yet implemented.

Further research is needed to test IBM Watson<sup>1</sup>, Amazon Recognition<sup>2</sup>, Microsoft Computer Vision API<sup>3</sup> and possibly explore what could be other services. The price tag for these services is quite high so it will be beneficial to explore other options which would require less computer power.

It is also useful to perform additional research to test if it is worthwhile to add the whole hierarchy of behavioral attributes and actions from Mumin encoding scheme [2]. For instance, eyebrows, general facial expression, mouth openness could add information to the gesture interpretation.

#### **Paid version and advertisement**

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<sup>1</sup><https://www.ibm.com/watson/services/visual-recognition-2/>

<sup>2</sup><https://aws.amazon.com/rekognition/>

<sup>3</sup><https://azure.microsoft.com/en-us/services/cognitive-services/computer-vision/>

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The concept of the paid version was not accepted very well by the users. Some users suggested to introducing advertisements in the application to have an indirect way of making the application profitable. Additional research is required to test what kind of advertisement might bring more attention from the users.

### **Ability to post the gesture on the Facebook and discuss it**

From the usability test of iOS application I knew, that users want to discuss gestures and send new gestures to the application to get gesture meaning, in case they were unable to find the explanation. I wanted to add this functionality, but implementing this functionality inside the application would have been too cumbersome. Users gave an idea that they would be satisfied if there would be a Facebook group where they will be able to post and discuss the gesture with other users. Five users out of seven mentioned that they might be interested in discussing gestures with other users. This functionality should be further user tested.

### **Ability to download content locally**

Currently, the content of the dictionary is located on the server. Russian users expressed a desire to be able to download the content locally. The desire was motivated by the potential problems which could occur because of roaming costs. European and American users were not worried about roaming costs that much.

### **10.4.2 Text search**

At the moment of realization, I do not have any solution for misspelled words or synonym finding. It will be very beneficial for the user to implement these features.

## **10.5 Conclusions**

In this section I present conclusions of my work.

### **10.5.1 Answers to research questions**

The main research question was: how to create the innovative user interface for the Android Gesture Dictionary targeted at general population? As an answer to this question and as a main result of my Master Thesis I created an innovative gesture search method which allows the user to explain what parts of the body participated in the gesture by selecting these parts on the picture of the avatar. Then the user can further specify actions which those body parts perform. For instance, head could be nodding. After the user hits search button he will see another view with a list of gestures, filtered by selected body parts and gestures. The method could be applied on different platforms and media.

## 10.5. CONCLUSIONS

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To find the answer to the main research questions I had to find the answers to the following research questions:

- How Gestunary for iOS currently implements search UI, what are the modern electronic gesture dictionaries and how do they implement search functionality?

At the moment Gestunary for iOS implements only text search. I researched two other applications: "Gestures and Customs" and DiGest. These application do not have search capabilities at all but gave inspiration for future work on Gestunary application.

- What is the user feedback on the search functionality and other UI elements of the Gestunary for iOS?

I performed user-based testing and collected user feedback on the search functionality. This allowed me to create scenarios and collect user pain points for search interface prototyping.

- What kind of ideas for the design of innovative search interface could be acquired from Heuristic Evaluations of Gestunary for iOS?

During Heuristic Evaluations of Gestunary for iOS I confirmed findings by the users from the user-based test of Gestunary for iOS and identified the areas for future work on Gestunary.

- What are the state of the art gesture classification and coding methods?

McNeil proposed the gesture space which was used by the MUMIN authors who developed gesture coding scheme. I present modified version of the hierarchy of body parts and actions, corresponding to body parts, which I used in Gestunary for Android in Appendix A

- What are the modern Android UI patterns for search interface?

I researched typical UI patterns for search interface, which I then applied to design of the Lo-Fi prototype.

- What are the usability problems of the Lo-Fi prototype of search interface?

The users liked proposed search interface and provided ideas for enhancement. This research helped to formulate the list of ideas for Hi-Fi prototype.

- What are the usability problems of the Hi-Fi prototype of search interface?

The users expressed their preference towards proposed variants of the search interface and gave feedback on the UI. This resulted in the ideas for the Final prototype.

## 10.5. CONCLUSIONS

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- What are the usability problems of the the Final prototype of search interface?  
Users gave positive feedback on the Final prototype of search interface.
- What type of pictures users prefer as an illustration of gesture?  
My research shows user preference towards color untouched photos compared to black and white photos, drawings and enhanced color photos where only the gesture is in focus and the rest of the picture is blurred.
- Is it feasible to implement automatic gesture search using machine learning methods?  
It is feasible to implement gesture search using machine learning methods. Voting classifier gives the best accuracy score.

### 10.5.2 Final thoughts

This was a very interesting and challenging project. Despite the number of people involved in design and testing, the volume of literature on the subject of gestures I had to read and the number of interesting research topics to explore, I have successfully created a working prototype of the innovative search interface for Gesture Dictionary. At the same time I was solving the practical problem of porting software from one platform to another, utilizing modern methods of user-centered design. The proposed search interface could be implemented on different platforms and will help people from different cultures better understand each other. With the rapid changes in the world in the area of image recognition, it becomes practically possible to implement automatic gesture search by picture. It seems to be a very natural next step for this work.

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# Appendix A

## Heuristic Evaluations

Heuristic	Number of Violations
H1: Simple and natural dialog	2
H2: Speak the users language	1
H3: Minimize users memory load	3
H4: Consistency	9
H5: Feedback	1
H6: Clearly marked exits	0
H7: Shortcuts	4
H8: Precise and constructive error messages	2
H9: Prevent errors	1
H10: Help and documentation	4

*Table A.1: Number of Violations by Heuristic*

### Number of Violations by Severity

Severity Category	Number of Violations
0 = I don't agree that this is a usability problem at all	0
1 = Cosmetic problem only: need not be fixed unless extra time is available on project	0
2 = Minor usability problem: fixing this should be given low priority	3

3 = Major usability problem: important to fix, so should be given high priority	17
4 = Usability catastrophe: imperative to fix this before product can be released	7

Table A.2: Number of Violations by Severity

Guideline violated		Description	Solution	Severity
<b>[H1: Simple and natural dialog]</b>				
1	Home	Keyword Not found dialog does not help to find the word, the lexicon is very limited and lack of a word only disturbs	add a clear link to the list of available words, add words,	4
2	Gesture	In sections "similar sign seen, attention , often with different meaning there is no reference to the gesture with different meaning, tapping on the icon leads to the list of gestures.	Add descriptions or notification that there is no description at the moment.	3
Total 2				
<b>[H2: Speak the users language]</b>				

1	home	Language is limited to 1 option - english, some people who can not speak english will not be able to use it	add a possibility to add new languages in the future and to choose language	4
2	home	terms Etymology might not be understood by wide number of tourist people	call the section "Description"	3
total	2			
<b>[H3: Minimize users memory load]</b>				
1	Home	when I tap on the icon "back to home page" I always see a random image. This is so unexpected and looks as if something is wrong with the program or I hit something wrong - because I hit "back" but returned to different gesture	show the same picture on the home screen all the time so that I recognize "home"	3
2	Gesture	No gesture action description, it is not always clear how the gesture could be reproduced	Add gesture action description	3
Total: 2				
<b>[H4: Consistency]</b>				

1	Home	search keyword from the home page and search from the menu duplicate it's functionality, but have different names, function not clear	make search items consistent	3
2	Home	Searching for keyword "hi" returned irrelevant gestures: "broke (USA ), "fishy" (Spain), "proud" (Spain).	Fix search results.	4
3	Menu	The menu icon is inconsistent with iOS style and looks different from the application style.	Fix the icon to make it consistent with iOS guidelines.	3
4	Menu	Close button on menu list is inconsistent with iOS style and looks in other the application style.	Fix the button to make it consistent with iOS guidelines.	2

5	Home	Menu list is not in the iOS style. it is too crowded, items are grouped, but not enough - the eye looks through the whole list and can not focus. Why do I need to see "about" and "feedback" when I want to work with the dictionary? When I use the ordinary dictionary (the book), I see credits only on the last page.	Fix the style and info layout.	3
Total: 5				
<b>[H5: Feed- back]</b>				
1	Home	Tapping on "send mail" does not always give feedback, only keyboard pops up and search keyword clears out. This happens after the first attempt to send the message.	The bug should be fixed.	4
Total: 1				
<b>[H6: Clearly marked exits]</b>				
1	Home	The back button does not always lead to the previous page.	Fix the bug.	4
Total: 1				

<b>[H7: Short-cuts]</b>				
1	Gesture	List of favorites is marked with the heart icon, but it should have familiar symbol, like a star.	Use star icon instead of the heart.	4
2	Gesture	Sharing icons take space from the gesture picture. It is not a standard approach, it is unfamiliar for the user on the iOS platform and brings excessive information load.	Convert all sharing icons into one short-cut, which will lead to opening shortcuts to popular applications, suitable for sharing.	3
Total: 2				
<b>[H8: Precise &amp; constructive error messages]</b>				
1	Home	Popup when search results are not found does not clearly state what to do, suggestion to browse through the gestures looks too small to notice, no apology that my search term was not found.	Add explanations and help the user understand what to do.	4

2	Home	Sending mail does not reliably work - sometimes it does not open the window with the feedback form.	Fix the bug.	4
Total: 2				
<b>[H9: Prevent errors]</b>				
1	Home	If i mistype the word in "search keyword" I will not be able to find the word and I will not be corrected.	Find a workaround or a clear way to show that there is no such word	4
Total: 1				
<b>[H10: Help and documentation]</b>				
1	Home	On first start only one help screen describes functionality of the application. There are no further comments on the system functionality.	Add help functionality on the first start - educate the user how to operate the program.	4
2	Home	It is unclear why "how to use gestunary" and FAQ are not united under stand menu item - more"?	Add standard menu for iPhone and a standard "more" option with FAQ and Help.	4

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3	List of gestures	No hint that the list should be scrolled to see more information.	Add some symbol to illustrate the list has more information to read.	3
4	Gesture	Not clear that I can scroll to see info after "related gesture" header. (which looks like a button)	Add a hint that there is information below the header.	3
Total: 4				

*Table A.3: List of Violations*

## Appendix B

### Body parts and actions

Body part	Variation	Action/position	Shape
Arms	left, right, both	raise, cross	
Armpit		tickle, hook, thumb under armpit	
Hand	both hands	up, down, rotate, wave, clasp, cross, front, back, horizontal,	ring, purse, v-sign, donkey, horn
Elbow		tap, flap	
Palm	fist	show, up, down, clench, beat, punch , raise, slap	
Finger	index, thumb, middlefinger, forefinger, little-finger	point, together, cross, hooked, interlock, shut, press, raise, spread , hook	
Forefinger		tap	
Forehead		knock, slap	
Brow		tap , touch	
Cheek		brush, cut, touched by finger, screw, support	
Chin		flick , point, tap	
Eye	eyelid	stare, rub, eyelid pull	
Ear		tear, hold, rub	

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Nose		hold	
Lips	teeth	point, seal, bite finger	
Hair		tear	
Chest		cross, hold, beat, tap fingers pointing down	
Belly		pat , cut , rub	
Knees		clasp, scratch	
Body:		bend, lean	

*Table B.1: Body parts and actions*

# Appendix C

## User-based testing of Gestunary for iOS

### **Goal of the user-based testing of Gestunary for iOS**

The goal of the user-based testing Gestunary for iOS is to find usability problems in general and to find ways for improvement.

### **Method**

Usability test, think aloud

### **Usability criteria**

- Qualitative: Usability test, think aloud
- Quantitative: Satisfaction - SUS

### **User groups**

- Users are preferably non-acquaintances.
- Number of test users? = 6 - 10 users + 1 pilot test user

Users are recruited among acquaintances.

### **Test overall setup**

Test length: 1 h

The test will be performed remotely and in person.

Tests will be performed one test at a time. One researcher/developer will be moderator and observer at the same time. I will make notes during the test.

### **Test protocol**

- Describe the purpose of the test in general terms

### **Topic introduction:**

The Gestunary mobile application is a dictionary for gestures and hand signs from around the world. It can help you orient in different situations when you travel

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and see an interesting gesture or want to express something using gesture. It can help you to avoid awkward situations educating you about forbidden or offensive gestures in the country of your destination. In one sentence, Gestunary will help you survive in another country.

- Researcher introduced himself, not telling that he is the author of the UI - Describe the product briefly (if it is still under development or just a prototype, tell that) - Tell the participants that they may quit at any time - Explain how to think aloud; give an example - Explain that you cannot provide help during the test (come back to the questions after the test tasks) - Remind the users that it's the system that is evaluated, not the user - Ask if the user has any questions, and then begin the test - Perform the test - perform SUS test, give users online link to fill in the form - Followup free-form conversation to learn more about user satisfaction, clear up any questions researchers got in notes, search for elements of delight during interaction with application

#### **Questionnaire after the test**

SUS after test , link to the online test

#### **Test tasks**

The main thing to test is how users will look up for gestures. The second thing to test is the overall usability and find UI improvement points for the search/browse functionality. Note the functions users would like to add. Time limit for tasks - 3 min

#### **Tasks:**

- find a few gestures for the topic of your interest.
- Read gesture details. what do you think about gesture description?
- Find recent gestures
  - how do you understand gesture titles?
  - how do you understand "similar sign seen in" section
- how would you like to share it?
- share this gesture with someone
- You are in a foreign country. You saw a gesture of a guy shaking his head. You want to understand what the guy means with this gesture. How can you look it up using Gestunary?
- browse by country
- browse by word
- explore survival basics for Japan

- 
- explore business 101 for Japan

### **Analysis of the test results**

- Notes analyzed and results documented

# Appendix D

## Android Gestunary Search/Browse UI test plan

### **Goal of the Android Gestunary UI evaluation**

The goal of the Android Gestunary UI evaluation is to find usability problems in general and to find ways for improvement.

Only search/browse functionality will be evaluated.

### **Method**

Usability test, think aloud

### **Usability criteria**

- Qualitative: Usability test, think aloud
- Quantitative: Satisfaction - SUS

### **User groups**

- Users are preferably non-acquaintances.
- Number of test users? = 6 - 10 users + 1 pilot test user

Users are recruited from english language teachers who travel a lot and teach english to other cultures.

### **Test overall setup**

Test length: 1 h

The test will be performed remotely.

Tests will be performed one test at a time. One researcher/developer will be moderator and observer at the same time. I will make notes during the test.

### **Test protocol**

- Describe the purpose of the test in general terms

### **Topic introduction:**

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The Gestunary mobile application is a dictionary for gestures and hand signs from around the world. It can help you orient in different situations when you travel and see an interesting gesture or want to express something using gesture. It can help you to avoid awkward situations educating you about forbidden or offensive gestures in the country of your destination. In one sentence, Gestunary will help you survive in another country.

- Researcher introduced himself, not telling that he is the author of the UI
- Describe the product briefly (if it is still under development or just a prototype, tell that)
- Tell the participants that they may quit at any time
- Explain how to think aloud; give an example
- Explain that you cannot provide help during the test (come back to the questions after the test tasks)
- Remind the users that it's the system that is evaluated, not the user
- Ask if the user has any questions, and then begin the test
- Perform the test
- perform SUS test, give users online link to fill in the form
- Followup free-form conversation to learn more about user satisfaction, clear up any questions researchers got in notes, search for elements of delight during interaction with application

### **Questionnaire after the test**

SUS after test , link to the online test

### **Test tasks**

The main thing to test is how users will look up for gestures. The second thing to test is the overall usability and find UI improvement points for the search/browse functionality. Note the functions users would like to add. Time limit for tasks - 3 min

Researcher should have prepared 4 self-made video gestures for the test.

### **Scenarios:**

1. You are in Italy. You saw a gesture (show 4 video illustrations of gesture). You want to understand what the person means with this gesture.

How can you look it up using Gestunary?

- Can you find this gesture using text filter?

- 
- Can you find this gesture using a visual filter?

- Can you find this gesture using search field?

2. You are at a dinner in Italy. You do not know the local language.

- You want to show the waiter that the food is too hot

- You want to say thank you to the waiter

- You want to tell the waiter - enough

3. You want to be prepared for the trip. You want to look up forbidden gestures in Italy.

- How can you do that?

4. You are on the plane and want to browse through gestures in Italy to get familiar.

- Can you browse all gestures in Italy?

- Can you browse all gestures in the Gestunary out of curiosity?

- Can you select Italy as the country and browse restaurant gestures?

### **Analysis of the test results**

- Notes analyzed and results documented

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**Table for notes taking:**

<b>Heuristic</b> Task name	Success?	emotion	t(min)	Other notes
<p>1. You are in Italy. You saw a gesture (show 4 video illustrations of gesture). You want to understand what the person mean with this gesture.</p> <ul style="list-style-type: none"><li>• How can you look it up using Gestunary?</li><li>• Can you find this gesture using text filter?</li><li>• Can you find this gesture using visual filter?</li><li>• Can you find this gesture using search field?</li></ul>				

<p>2. You are at a dinner in Italy. You do not know the local language.</p> <ul style="list-style-type: none"> <li>• You want to show the waiter that the food is too hot</li> <li>• You want to say thank you to the waiter</li> <li>• You want to tell the waiter - enough</li> </ul> <p>3. You want to be prepared for the trip. You want to look up forbidden gestures in the Italy.</p> <ul style="list-style-type: none"> <li>• How can you do that?</li> </ul>				
<p>4. You are on the plane and want to browse through gestures in Italy to get familiar.</p> <ul style="list-style-type: none"> <li>• Can you browse all gestures in Italy?</li> <li>• Can you browse all gestures in the Gestunary out of curiosity?</li> <li>• Can you select Italy as the country and browse restaurant gestures?</li> </ul>				

Table D.1: Number of Violations by Heuristic

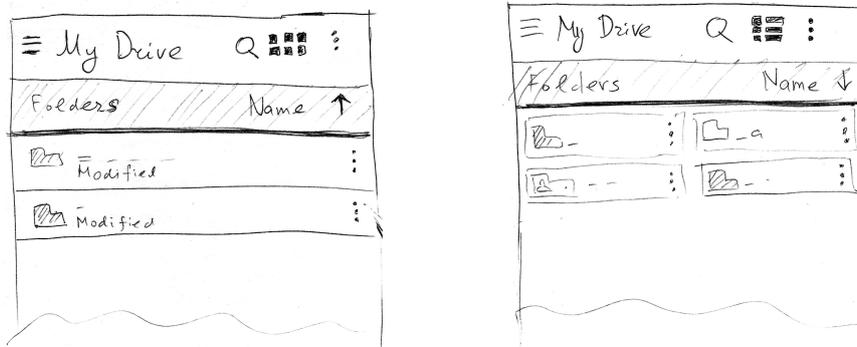
# Appendix E

## Android UI/UX patterns

### Google Drive application List view and Grid view and menus

Search results could be presented by UI elements, dedicated to displaying categories of data: by lists<sup>1</sup> or by grids<sup>2</sup>.

Example of List view and Grid view is presented in Figure E.1 below. Tap on the View Icon (arrangement of six squares) leads to view switch. ListView and GridView could be a good option for gesture list presentation.



a) List View example

b) Grid View example

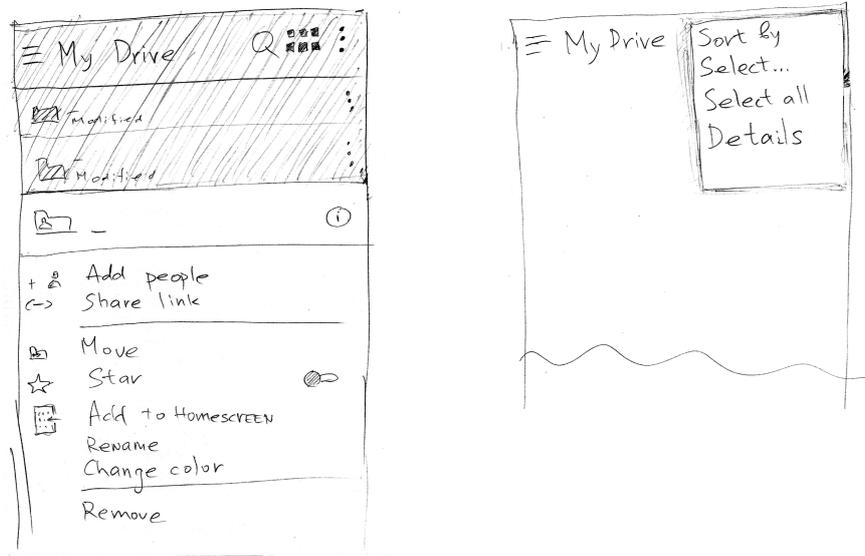
Figure E.1: List presentation.

### Menus

Menus should not be used as a primary method for navigation within the application. Menus present list items grouped in the category. Menus could be scrollable and static. In case the menu is presented as a modal dialog, the scrollable part of the menu is separated from the buttons by hairline. The standard icons for menu access are three lines in the left top corner of the Android UI or three dots to the right side of the UI element. In the figure E.2 I present an example of contextual menu. This menu is opened by the tap on the details icon (three dots arranged vertically). I will use similar menu in Gesturnary for Android.

<sup>1</sup><https://developer.android.com/guide/topics/ui/layout/listview.html>

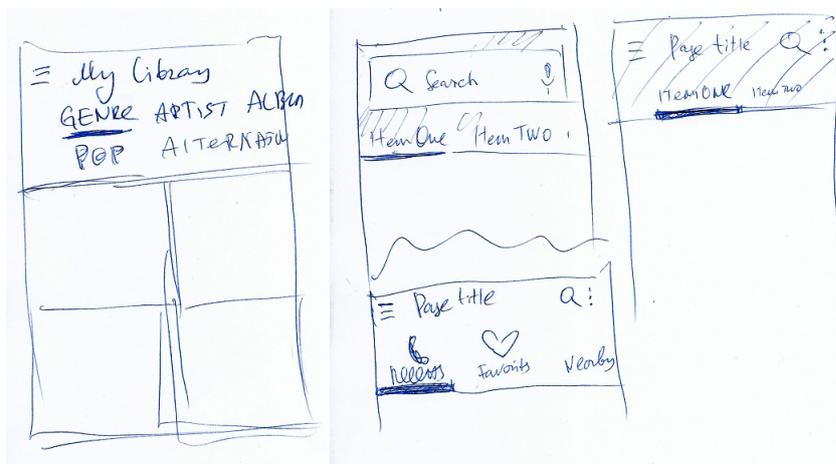
<sup>2</sup><https://developer.android.com/guide/topics/ui/layout/gridview.html>



**Figure E.2:** Examples of contextual menu.

## Tabs

Tabs provide a way to switch between views. Tabs on Android could be implemented as fixed at particular point of screen or could be made scrollable (Figure E.3). Tabs could be understood as an affordance in Norman's understanding of the term [47]. Fixed tabs could be applied if the user could benefit from consistent placement of the tabs in the same place, as it may help to develop muscle memory. Fixed tabs also used if there is a limited number of tabs. Scrollable tabs could be used in cases there are many tabs or the number of tabs is variable.



**Figure E.3:** Android Tab patterns.

## Error messages

On the picture below I present an example of error dialog on Android, from the

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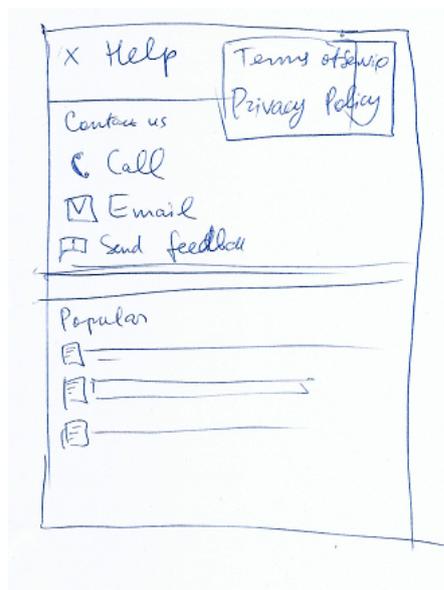
use case, when there is no wi-fi. Another option is to present Android toast<sup>3</sup>. The benefit of using toasts is the ease of implementation. The drawback is ability of the toast to overlay other applications, which could cause toast display at the unexpected moment.



**Figure E.4:** Android error dialog pattern.

### Help and Feedback

One of the examples of help screen is presented on the Figure E.5. It is a view which has an action bar with the title and a list of help links.



**Figure E.5:** Android help pattern.

### Progress indicators

Progress indicators could be presented by the rotating circle, for instance. They are used when the view is not fully loaded and it is necessary to show to the under

<sup>3</sup><https://developer.android.com/guide/topics/ui/notifiers/toasts.html>

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that the content is still loads up.

### **Bottom navigation**

Bottom navigation should be used if the UI has more than three buttons. In other choice it is recommended to use tabs. It is also recommended to limit the number of items to five. Bottom navigation has specific behavior. Swiping from left to right should not change views. Also, the bar could appear and hide dynamically during scrolling. I decided not to use bottom navigation and use tabs instead instead.

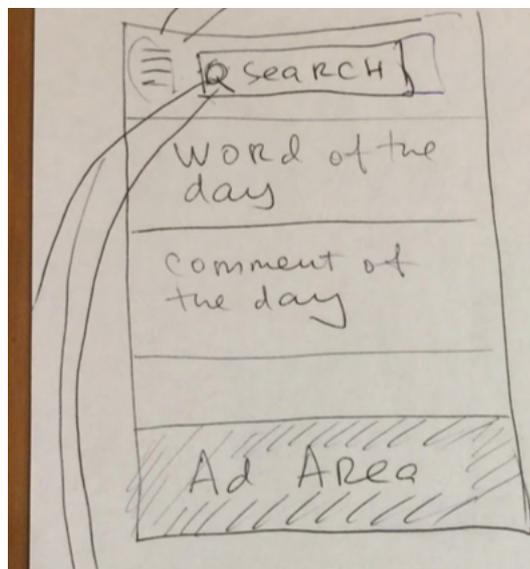
# Appendix F

## User feedback extras

Here I collected user feedback which is not directly related to search interface but could be useful for the future work on Gestunary application.

### Ads in free trial

The business goal of the application is to have paying version of the program in the future. Thus, I added a placeholder for the advertisement in low-fidelity prototypes (F.1). I placed it at the bottom of the view in the way of batter. I also suggested a choice of advertisements which cover the whole screen.



**Figure F.1:** Ads in free trial

One user said that he recommends not to waste space on screen for ads because there is empiric data that no one clicks on those banners. He recommends to use whole screen and show ads for payed version.

Two users prefer to buy use free versions. The other user confirmed that in his experience no one clicks on banners and it is better to use the whole screen

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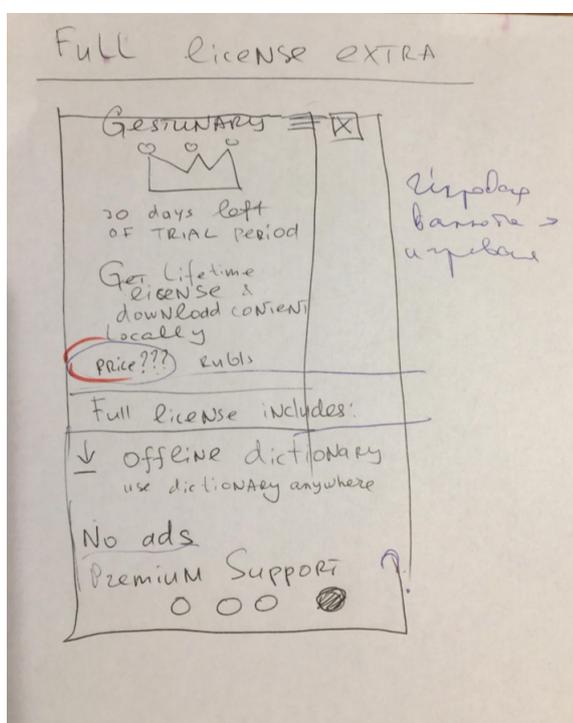
movies for advertisements. One of the options to use the program for free is to watch advertisement movies for additional tokens to be able to use the program.

### Quiz and gamification

All users were suggesting to add games to guess gestures. They considered it fun and nice addition to the application. One option included competing with other users.

### Trial vs. Full

The proposed functionality (F.2) is to let users install the application for free for 30 days, then ask them to pay money. Paying money will also remove ads and the user will be able to download the contents locally.



**Figure F.2:** Trial vs Full

One user said that it might be a good idea. Another solution could be to have some kind of tokens which the user can earn and then use tokens to extend the trial. Another user said "I will pay for the program only if it has outstanding design and functionality and I will really need it".