

IN5480 - final report

Group 6



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Vibeke Johnson
Mari Cathrine Karlsen
Solveig Engevold Gaustad
Sigrid Linn

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About us

Our group consists of the following students: Vibeke Johnson, Mari Cathrine Karlsen, Solveig Engevold Gaustad and Sigrid Linn. We are all master students at UiO in the program Informatics: Design, use, and interaction. We have different educational backgrounds, where one completed the bachelor's degree at Hioa in Oslo, two at Kristiania University College, and one at the Norwegian University of Science in Gjøvik.

- Vibeke Johnson (vibej@uio.no)
- Mari Cathrine Karlsen (marick@uio.no)
- Solveig Engevold Gaustad (solveeg@uio.no)
- Sigrid Linn (sigrilin@uio.no)

Area of interest

We are interested in the area surrounding universal interaction between humans and chatbots. How do people with dyslexia interact with chatbots? How they communicate, in what way they communicate, feedback and usability. Universal Design, HCI, and Human-AI interaction will be emphasized in this study.

«A chatbot provides textual means of communication, and may be more challenging for people with dyslexia, who will often avoid reading long texts and/or experience difficulties in understanding it. They often misspell words when they write text. Difficulties with decoding words and understanding text occurs in all forms of dyslexia»

(Shaywitz & Shaywitz quoted by Lilleby, Marstein, and Verne 2021)

We find dyslexia as a subject interesting because of the lack of literature regarding this theme. The curiosity prevailed when we read the article "I'm not stupid" by Gerd Berget & Siri Fagernes, 2018. How people with dyslexia feel stupid and misunderstood in certain settings because they receive materials that are formatted and changed so it is supposed to be easier for them to read. As quoted in the text by (Berget & Fagernes, 2018) "*The need to not feel different may be closely related to low self-esteem, which is reported to be a key issue in people with dyslexia, both adults and children, and especially among females*".

Many with dyslexia feel like they are being treated like children when they receive materials that are adapted in format and therefore associated with primary school books. It is important to focus on the findings from articles and have in mind the object of universal design. *“How to make the design suitable for everyone, thus removing the need for especially adapted solutions for particular user groups, such as dyslexics”* (Berget & Fagernes, 2018). We have to keep in mind accessibility and how to make the content in the chatbot easy but also similar to other chatbots so that the users “don’t feel stupid”, a chatbot that will work for everyone.

Background

People with dyslexia often have additional symptoms such as reduced working memory, low concentration, reduced motor skills, and difficulties with sequencing (Sandnes 2011, p. 192 quoted by Lilleby, Marstein, and Verne 2021). This paper written by Lilleby, Marstein, and Verne shows us different examples of how people with dyslexia struggle to communicate with a chatbot. For instance, users who experience trouble with spelling errors. On one hand, you have the human factors that cause difficulties like communication and understanding. On the other hand, you have AI technology that does not act like a human being. Chatbots can have problems with understanding spelling errors etc.

“Dyslexia is actually about information processing. Dyslexic people may have difficulty processing and remembering information they see and hear, which can affect learning and the acquisition of literacy skills.” (Lilleby, Marstein and Verne 2021). People with dyslexia often seek personal help or a phone call service instead of talking to chatbots. Especially when the chatbot's answer is too long, like an explanation or instruction. On that note, we need to make sure that the communication between the user and the chatbot is optimized and easy to use.

We have to understand the issues and how we, as designers can increase the structure and elements of a chatbot.

In this project, we will use WCAG 2.1’s guidelines to focus on universal design (*Web Content Accessibility Guidelines (WCAG) 2.1*, no date).

Research question

How do language and pronunciation work together with chatbots to make sure universal design is in place? If a user with dyslexia chooses to use a chatbot, is it possible for this individual to feel understood and perform the task needed?

Methods

The feedback given from our fellow students made a wish for more clarity and precision in the method part of our document. In module two we changed and worked with this part and felt more comfortable with the selection of methods. The feedback from the midterm was very helpful as well, and this made us look at the whole document in a new way. The wish was to present the research question so it would not be indistinguishable from what we were trying to answer in our project. We worked further on the paper to simplify the question and answer this based on questionnaires, articles, and research.

As we mentioned at the beginning of the project, we were uncertain how the corona situation would prevent the project from physical contact with users. So, based on this uncertainty we decided to make the project digital and perhaps try to conduct initial interviews and test the usability at the end of the project. We will evaluate our methods during the project timeline.

In addition to this, we will use research articles and other relevant curricula to support our writing.

Method - Questionnaire

In this assignment, we have used a questionnaire as a method. After some discussion, we figured out that the best questionnaire to use is the one made by the University of Oslo (*Chatbot og dysleksi – Vis - Nettskjema*, no date). This web form takes into account the prospect that many of our users need to have the questions read out loud for them with TTS (TextToSpeech).

The reason for using a questionnaire as a method can provide more information about the chosen technology from future users. Similar to other methods, questionnaires have their limits. One imperfection is the use of a broad collection of data, instead of deep dive into one specific topic you want to explore. (uio.no, 2021)

As a start for the project, we have to identify the problem the users have. Understand and portray how it is like for a person with dyslexia to use a Chabot.

By using a questionnaire, we will have the possibility to collect data from several people in a relatively short time. The method of using questionnaires will allow us to obtain concrete and useful information, first and foremost if you have spent some time developing the questionnaire. We used closed questions to have the prospect decide which response format you want back. Therefore, it becomes easier to extract concrete information from those who are asked in the survey. Since the only personal information collected from the questionnaire is age, we have decided that it is not necessary to apply for the storage of personal data. We have made it clear to the participants that the data collected will only be used in our report.

We have sent the questionnaire by mail to the association Dyslexia Norway, and also shared the questionnaire on social media. The implementation of the survey will be most efficient if we collect answers from numerous users.

Method - Literature

To further increase our knowledge about dyslexia and chatbots, we have chosen to use literature as a method for collecting insight. By reading several articles on the subject, we have been able to get to know the subject and previous research on it.

These are the main articles we decided to focus on:

Article	Writers	URL
They often avoid text. Chatbot for young adults with dyslexia (Lilleby <i>et al.</i> , 2021)	Anton Lilleby, Steffen Marstein, and Guri Verne	https://www.researchgate.net/profile/Guri_Verne/publication/349038405_They_often_avoid_text_Chatbot_for_young_adults_with_dyslexia/links/601bfff1a6fdcc37a8000689/They-often-avoid-text-Chatbot-for-young-adults-with-dyslexia
Accessible conversational user interfaces: considerations for design	Kate Lister, Tim Coughlan, Francisco Iniesto, Nick Freear, and Peter Devine.	https://dl-acm-org.ezproxy.uio.no/doi/abs/10.1145/3371300.3383343

(Lister <i>et al.</i> , 2020)		
Android based educational Chatbot for visually impaired people (Kumar <i>et al.</i> , 2016)	M Naveen Kumar; P C Linga Chandar; A Venkatesh Prasad; K Sumangali	https://ieeexplore.ieee.org/abstract/document/7919664?casa_token=bOrBA5d7-yYAAA:69juCdTL3OAo3cx8ShT4613zvn6sz9ml0RiFuX-NE3BRJa9aLF4k_HQyFwyeqyX0GLE3p078LEw

We will also be working with Web Content Accessibility Guidelines (*Web Content Accessibility Guidelines (WCAG) 2.1*, no date) to make sure our project is universally accessible. These will be valuable tools and guidelines for us in our work to make an accessible chatbot for everyone.

Findings

During our questionnaire, we focused on getting knowledge around different experiences around dyslectic people and their use of chatbots. We tried to use open questions, and let the participant elaborate on their own experiences and thoughts around chatbots at the end of the questionnaire. For us, it was important to ask simple questions to understand their feelings around their use of chatbots, what types of similar functionalities they apply to their daily use. We have based our findings on 19 responses from participants in our survey.

Questionnaire

To get insight on users with dyslexia and chatbots, we choose to ask these research questions:

Questions:
Do you use chatbots?
If no, why not?
If you can choose between chatbot and personal help (phone or chat), what do you choose?

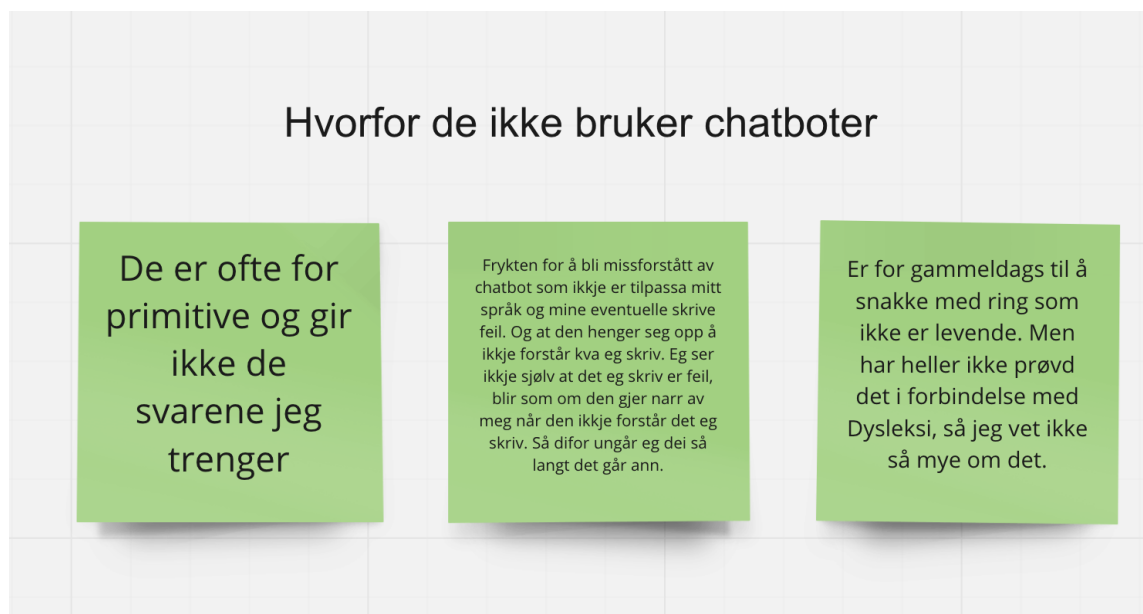
How do you feel about being transferred from a chatbot to a real person?

Are you using a text-to-speech feature?

How would you like the content of the chatbot to be?

If there were no restrictions, what would you like a chatbot to contain to make it easier to understand?

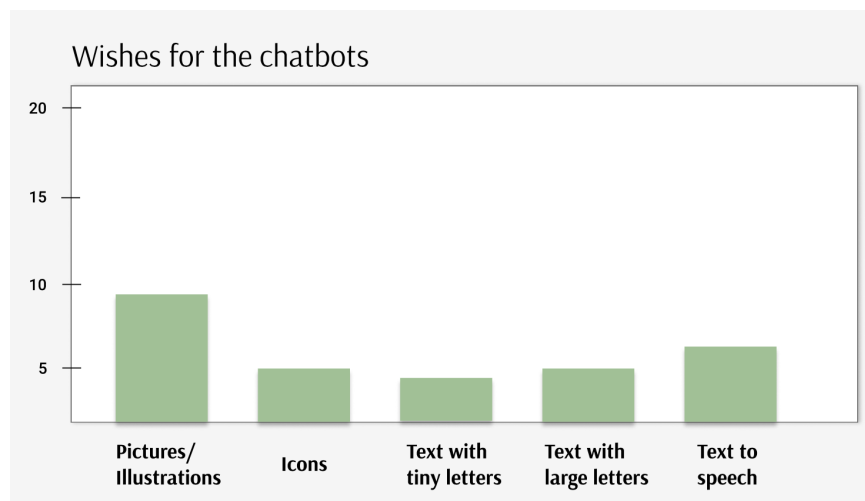
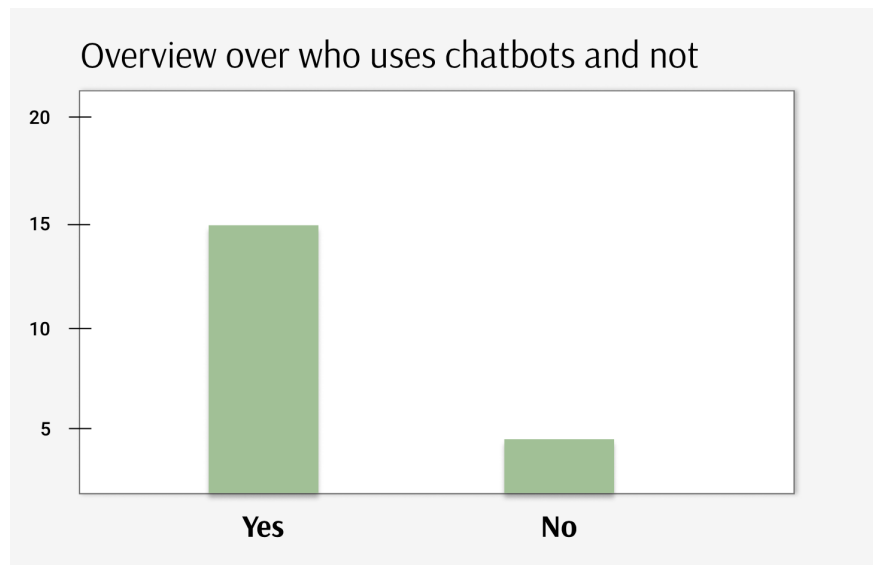
Dyslexia affects a large percentage of the population. People with dyslexia frequently report having poor self-esteem, which is often the outcome of unpleasant experiences in school or at work. We analyze the views of dyslexics towards their experience using chatbots in their daily life, intending to determine how to improve such solutions (Berget & Fagernes, 2018). One answer has been to design materials specifically aimed towards dyslexic users in the context of generating products that are well-suited for users with reading difficulties. However, we have researched the views towards adaptability among dyslexic users and their experience with chatbots with these questions.



The main aspects of why they choose not to use chatbots are mainly that they don't give them the response they are seeking. They fear being misunderstood, along with the frustration of

making tiny mistakes in their spelling which results in the chatbot not being able to give a proper response.

Based on the feedback and the experience regarding why they choose not to use chatbots, the survey still shows that **15 out of 19** have tried it or use it often. Only **4** users answered “no” and said they haven’t tried it or used it.

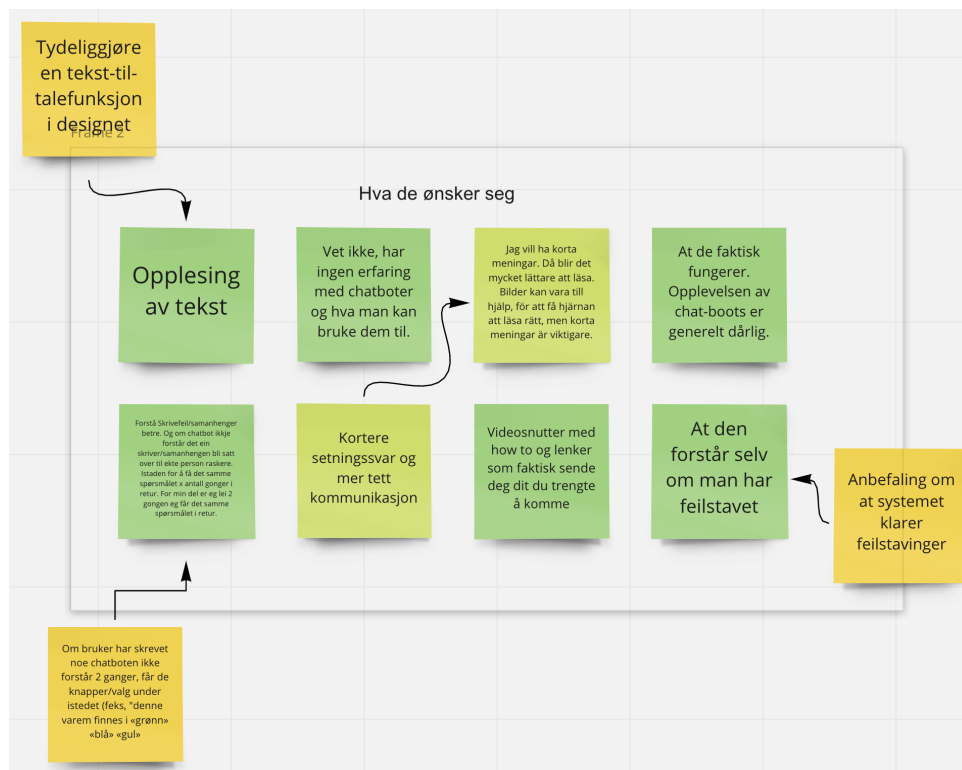


What the user group wishes to experience in the future, is to have the text read out loud with shorter text and answers. The questionnaire shows that **9 out of 19** wish to see more illustrations or use pictures to gain

better communication and understanding. In general, they don’t feel any efficient use with the chatbots. They express a wish that they were able to communicate and that the chatbot would understand their typos and be more comprehensible.

Rello and Baeza-Yates (2013), say that the way a text is presented is extremely crucial for dyslexics. For example, Rella and Baeza-Yates found that sans-serif, monospaces, and roman font styles increased screen reading ability. Proportional fonts, serifs, and italics, on the other hand, had a detrimental impact on the reading performance. Larger typefaces may help dyslexic people read faster, according to O’Brien, Mansfield, and Legge (O’brian et al., 2005). This conclusion was in line with the findings of Rello, Pielot, Marcos, and Carlini (Rello and Baeza-Yates, 2013), who found that font size has a substantial influence on the

understanding and readability of a screen text and recommended adopting an 18-point font to fulfill this.



WCAG 2.1

To make a chatbot user-friendly for someone with dyslexia, it will be essential to follow the guidelines from WCAG 2.1 (*Web Content Accessibility Guidelines (WCAG) 2.1*, no date). In our work we have analyzed the success criterion in WCAG 2.1, to find the ones we find appropriate for our research question. A lot of the criteria are more global and meant for the whole website or app that the chatbot is used in.

As a baseline the readability and visibility of the text on the page is important, this can be obtained by meeting success criteria 1.4.3 (contrast ratio on text and images of text) and 1.4.12 (Text spacing)(*Web Content Accessibility Guidelines (WCAG) 2.1*, no date). Some fonts work better for those with dyslexia and special fonts are designed especially (Rello and Baeza-Yates, 2013). All these variables can give a reader better conditions for understanding the text presented to them.

To meet success criteria 3.1.3 (Unusual Words) and 3.1.4 (Abbreviations) it would be helpful to give the chatbot a mechanism that helps the user learn what a word means if they don't understand it or do not know the abbreviation. It would also be important to use a

language that the reader can understand and make sure the text does not require a higher level of reading ability (Success Criterion 3.1.5 Reading Level).

Guideline 3.3 of WCAG 2.1 concerns input assistance, this is a part where we believe that a lot of users can be helped with misspelled words and such. Success criteria 3.3.1 (Error Identification) and 3.3.3 (Error Suggestion) can help the user understand what kind of errors have occurred and get help with suggestions for words they have misspelled.

The last of the WCAG guidelines we would like to add is 4, «Content must be robust enough that it can be interpreted by a wide variety of user agents, including assistive technologies». This would include a screen reader (TTS - Text to speak) for the users who want to apply this as a tool for a better understanding of the text provided.

Guidelines for Human-AI Interaction by Amershi et. al.

Amershi et. al (2019) has put together a set of 18 guidelines for making human and AI interaction better. These are not only for chatbots but all AI-based products. We have selected the guidelines we find relevant for the interaction between people with dyslexia and chatbots.

G1	Make clear what the system can do. Help the user understand what the AI system is capable of doing.	By making clear what the system can do, it will be easier for the user to know what to expect from the chatbot. If the user believes that the system is capable of something more than it is, the user probably will be frustrated and feel that the chatbot isn't working on the same page as them.
G2	Make clear how well the system can do what it can do. Help the user understand how often the AI system may make mistakes	A chatbot will not be all-knowing and there will be misunderstandings. If the chatbot communicates in a good way what it can, and cannot do, the user will not be set with unrealistic expectations and feel ignorant for not knowing.
G5	Match relevant social norms. Ensure the experience is delivered in a	Depending on the setting, the chatbot needs to match social norms. If the chatbot is made to be a helper for websites doing official work, like «NAV» or

	way that users would expect, given their social and cultural context.	«skatteetaten», the chatbot will be expected to use a more formal language than if it's implemented on a website with a less formal image. The language must be simple and easy to understand for the user in both scenarios since the use of complicated language can make a user with dyslexia give up and choose to not use the chatbot service.
G12	Remember recent interactions. Maintain short-term memory and allow the user to make efficient references to that memory.	By giving the chatbot a possibility to remember what the user has said before, or what selections they have made earlier, it might be better for the user to navigate the solution. By remembering the user's actions, the user will have a lesser mental load.
G13	Learn from user behavior. Personalize the user's experience by learning from their actions over time.	By learning from the users' behavior, the chatbot can for example learn what words the user usually gets wrong when trying to write something, or if a user always chooses to have their answers read out loud to them, the chatbot could use this as default after a given amount of times.
G16	Convey the consequences of user actions. Immediately update or convey how user actions will impact future behaviors of the AI system.	By giving the user knowledge about what happens if an action is done, the user can perform unwanted tasks that are smaller.
G18	Notify users about changes. Inform the user when the AI system adds or updates its capabilities.	If the user knows the system, it's important to let them know when bigger changes to the system are made. If a user with dyslexia is accustomed to using a system, we believe that they do a lot of the work on autopilot, and larger changes would make the user re-learn the system again.

Self-learning chatbot

“Automation of a chatbot communication such that it communicates on behalf of humans considering preferences is what has been demonstrated as a proposed system. By self-learning, the system is adaptive and takes into consideration every preference of the user and learns more and more about the user over time.” Thosani, Sinkar, Vaghasiya, Shankarmani (2020).

This definition emphasizes that an AI system is developed to adapt and learn from the users' input. The system needs to learn and adapt over time, to build an understanding of different contexts, and how to give the right answer to the user depending on the conversation.

Self-learning systems or self-learning chatbots in our context are important because they will increase a conversation's flow. A system with self-learning abilities will help, not only people with dyslexia but every user of a system. After a while, the chatbot can communicate, understand and answer the user in a better way based on the input performed by the user. Based on research and literature, we will implement the technology of self-learning chatbots in our solution proposal.

Recommendations for an enhanced and polished chatbot

After working with our insight and methods, we have developed a set of recommendations for what a chatbot with a focus on user-friendliness for dyslexics should include. While working with a chatbot it's also ideal to include the pattern matching techniques by Kumar et al., (2016):

- A. Symbolic Reduction:
Simplify pattern, will be used when the user asks a complex grammatical question.*
- B. Divide and Conquer:
Reuse the template for different queries to complete the response.*
- C. Synonyms Resolution:
To give the same output for different query with similar synonyms.*
- D. Keyword Detection:
Return the output for the specific keyword which was presented in the query.*

With the help of WCAG 2.1, pattern matching techniques by Kumar et al., (2016), and Human-AI Interaction by Amershi et. al. (2019), our first draft of recommendations is presented below:

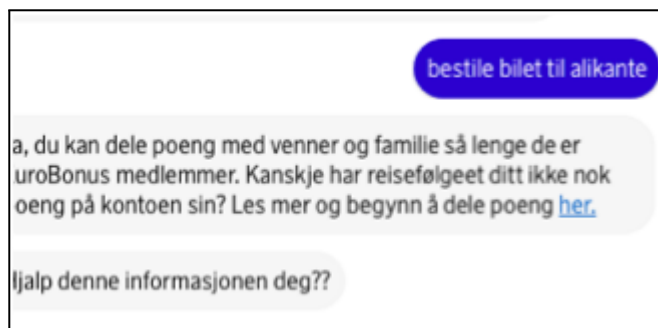
- Readable text
 - It's important to make the text itself easy to read, with a font that is more readable for people with dyslexia (Berget & Fagernes, 2018).
 - As quoted in the article (Berget & Fagernes, 2018), «Rello, Pielot, Marcos and Carlini, reported that font size has a significant impact on the understandability and readability of a screen text, suggesting using 18-point font»,
- Understandable text
 - If the text provided to the user can be user-tested it can be more effective for the reader to perceive.
- Full-screen button.
 - This would make it easier for the user to focus on the task at hand, and it would also be an idea to make the size of the text adjustable inside the window, for users that want larger or smaller text.
- Self-learning chatbot
 - When the chatbot learns from the user input and understands the users' preferences, the chatbot will adapt to each user. For example, if a user chooses to use the text to speech several times the system could make it so that text to speech is always on.
- Text to speech
 - For a user with dyslexia, it would be easier to have the text read out loud rather than reading it themselves (Kumar et al., (2016)).
 - As noted above, an AI-based text to speech function would make it so that the user doesn't have to make repetitive choices.
- Give the user a possibility to use their voice to ask questions.
 - This can make the chatbot experience easier, as it eliminates the possibility of spelling mistakes.
 - «If speech and audio are used, the capability to understand the user's voice with accuracy is clearly essential to accessibility». (Lister et al., 2020)

- A mechanism that helps the user learn what a word means
 - If the user comes across a word they don't understand, the chatbot could read it out loud to them, and explain what the word means.
- Auto-Correction
 - Find errors in text and correct them
 - Input – NLP(Natural language Processing) techniques. (Kumar et al., (2016))
 - If the user has spelling errors, the system should be able to pick up on common errors and ask «do you mean:?»
- Let the user know what the chatbot can do
 - If the user is presented with the abilities the chatbot has, before beginning their task, the possibility of misunderstandings is lower. This complies with guideline number one from the article by Amershi et. al (2019).
- Buttons instead of text input as an alternative
 - To make the burden of writing lighter for some users, it would be ideal to offer buttons with a few choices. If the user has written something the system cannot decipher, the chatbot could offer a set of buttons to press with topics the system thinks could be right for the user, with a «do you mean any of these» questions.
- FAQ - frequently asked questions
 - A system like a chatbot is destined to have a lot of repeating questions. With a self-learning chatbot and some filters, it would be a good idea to have a faq, to make the burden of writing and searching after answers lighter.

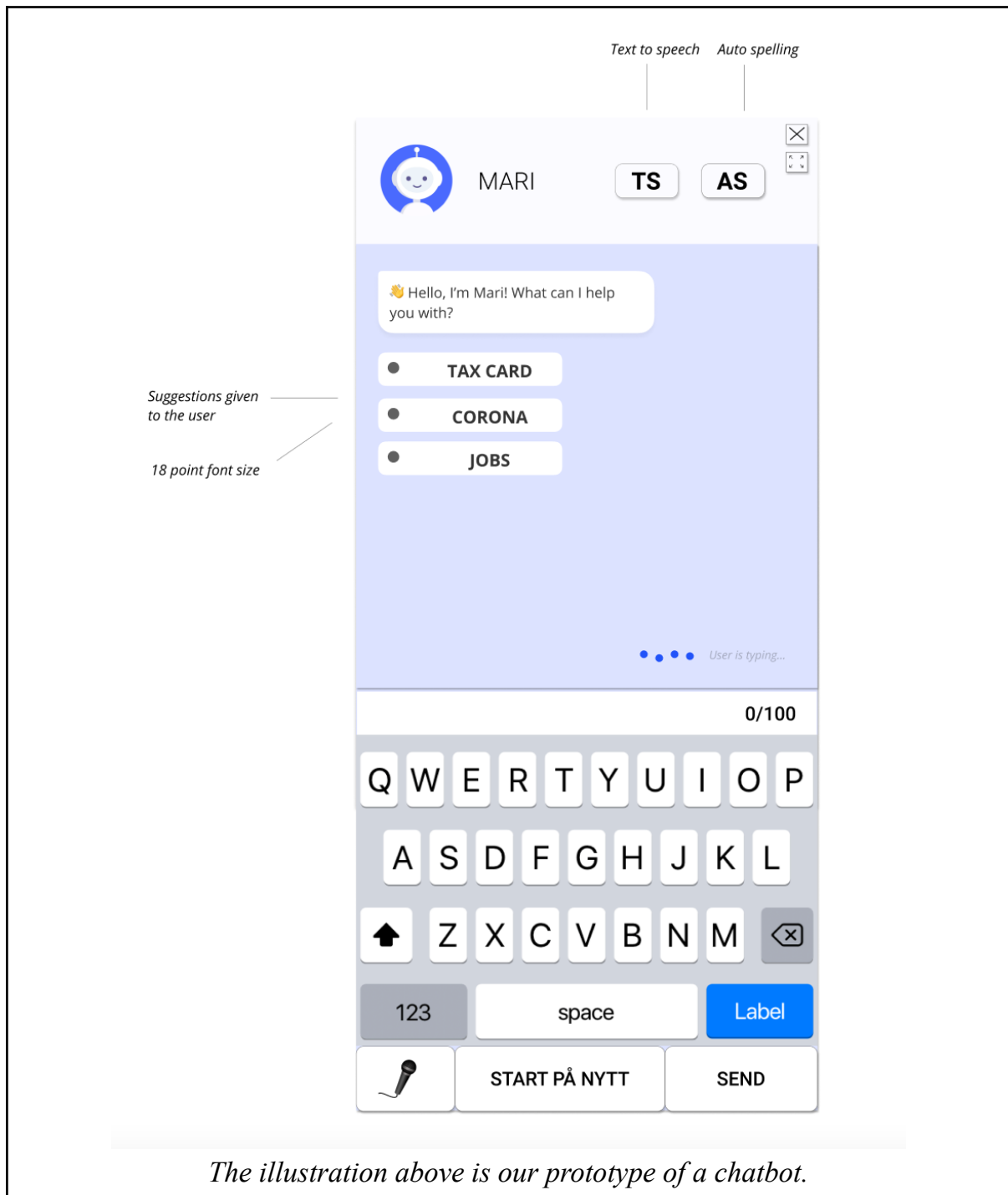
Sketch

After looking into multiple chatbots for NAV, travel agencies, phone companies, doctor's offices, and more we have concluded that many of them need improvement in Universal Design. The travel agencies have a lot of text and it is hard to read and figure out what

to write. They are missing several important elements in their chatbot to make them user-friendly, for example, full screen, auto-correction, or Text to Speak. They do



articulate that the chatbot “TURI ” is a self-learning chatbot, but after several different inputs we received the same answer every time. It did not learn from our previous input or mistakes. We tried different approaches in the questions and found out that they do not understand misspelling or have a function that helps you with the spelling. Like ordering a plane ticket to Alicante with SAS airline. The chatbot does not recognize the misspelling and proposes euro bonus points instead of a plane ticket.



Based on our experiences of the chatbots we have tested, and together with the answers and feedback from our survey, we have made our chatbot with the improvements we believe are necessary and important. At the top bar we added buttons for “Text to speech” and “Auto spelling”. This feature will allow them to have the text read out loud, as well as give suggestions along with as they type. They will receive buttons with suggestions to what they need help with on the screen, and as they continue to write, it will be updated with relevant suggestions for the user. These buttons are 18 font size to improve the understanding and readability of the screen text. The bottom left shows a microphone that allows the user to speak what they want to communicate to the chat.

Discussion

At the beginning of this project, we knew we wanted to make a chatbot that people wanted to use, and we soon landed on wanting to focus on those with dyslexia. To make a chatbot for people with dyslexia you need to understand what the users with dyslexia think are confusing. We chose to collect our insight from a questionnaire and the available literature that we could find.

After reading the report from Funka Nu (2019) about universal design, we came up with the idea to make a checklist not just focusing on universal design but concerning dyslexia. *“People with reading- or writing disabilities would find it confusing when the typography and several messages are arriving at the same time”* (Funka nu, 2019). In addition to this report by Funka Nu (2019), we found it necessary to implement a text-to-speech function. With AI technology the text-to-speech function can learn from itself. For instance, if the user is repeating the speech button two times, the AI will play it over again for the third time automatically.

Instead of just doing some research in the field of chatbots and dyslexia, we found it more useful to make a checklist. The checklists were based on several research articles, the questionnaire, and WCAGs guidelines. A lot of the research around universal design is done with the focus on blindness or visual impairment. The fact is that there are more people with dyslexia than visual impairment, both in Norway and worldwide. The essence of the checklist is that it will benefit every user of a chatbot and still be adaptive for people with dyslexia. By using this checklist the chatbot will increase the user experience and minimize miscommunication.

We contacted Gerd Berget, Associate Professor at OsloMet, after recommendations by Jo Herstad, and got a lot of sources of information for our thematics. But since our project has a deadline and the articles we got recommended were sent to us very near the deadline, we sadly did not have the time and resources to investigate these further. The thematics of our project is something that could be worked more deeply over time and is a very important issue for a lot of people in everyday life.

We would like to make it clear that either the recommendations or the sketches we have made in this project are in no way user-tested, but this would have been a priority if the project had gone on longer than a semester. If the project had a longer duration, we would make a hi-fi prototype of a chatbot using our recommendations. This way we would be able to do usability testing to validate our hypotheses and design choices.

Our main takeback from this project is that a chatbot designed for users with dyslexia can also benefit normal users. Making a particular chatbot that has a «dyslexia-mode» might feel discriminating and possibly give the users a feeling of being different and dumb. If we decide to make the functions that help dyslexics use a chatbot universal it can benefit numerous people. For example, if you were in a place where you cannot type your questions it would be nice to have the possibility to record your questions vocally to the chatbot and receive the answers in the same way.

Finally, this project has been very educational and inspirational. We have had the opportunity to study further the blueprint of a chatbot from users and research, to fully understand the challenges people with and without disabilities have using a chatbot. This has opened our eyes to the possibilities a chatbot and an AI system can achieve when functioning together.

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