Tallinn University

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Evaluation of Software Applications for Improving Speech and Language Development

Master Thesis

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Tallinn 2013

The Author's Declaration

I hereby declare that, apart from work whose authors are clearly acknowledged, this

Document is the result of my own and original work. This thesis has not and is not being submitted for any other comparable academic award.

PhD David Lamas and MSc Helen Saareoja have supervised the thesis.

May 6th 2013

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Abstract

The Master thesis by Argo Ilves Evaluation of Software Applications for Improving Speech and Language Development focuses on the devices and software applications, which are suitable for using as a substitute for speech generating professional AAC devices. During the research process speech therapists are involved for their relevant and experienced input about the needs of patients and other interest groups surrounding patients with speech and language development disabilities. Author points out main aspects for choosing and evaluating such devices and describes criteria to use as key values for evaluation process. Benchmarking tool proposed by the author can be applied as an aid for choosing the suitable appliance for speech and language development process.

Foreword

I would like to thank everyone who contributed to the completion of this thesis. Thank you, official and unofficial supervisors, friends, who read the work several times and added their remarks and suggestions and colleagues, who accepted my absence for a couple of weeks; my supervisor, who encouraged me to fail and learn from it as a normal part of every process.

Also I am very grateful that my family supported me during this tense time. The paper is dedicated to my daughter Liisa-Marie, who is the main reason and inspiration for writing the current thesis and my master studies in general.

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Introduction

The main research goal of the current thesis is to evaluate software applications created for improving speech and language development in order to use them as AAC[1] devices. According to the information gathered from interviews before the research process, there is a recognized need for such programs and many other special devices, but in many countries, due the limited finances in welfare system, have people with speech and language development needs have limited resources for obtaining such technologies. Through different Apps for mobile and tablet platforms this gap between possibilities and needs can be reduced. The research problem is stated accordingly to find replacement solutions as tablet computers and suitable Apps for relatively expensive special devices.

The main research questions of the thesis are:

1. *What are the main key points for evaluating or choosing an AAC App?*
2. *Is it possible to design evaluation tool accordingly?*
3. *How relevant are the results gathered from evaluation tool considering the real use of the software?*

To answer these research questions the following research strategies will be used:

1. *Interviews with therapists to get an overview of the situation in the local area.*
2. *Questionnaire among speech therapists and literature overview for choosing the key points for the evaluation tool.*
3. *Design in the benchmarking[2] tool.*
4. *Testing Apps with the evaluation tool.*
5. *Interviews for getting feedback for testing.*

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1 (2009). Augmentative and Alternative Communication (AAC). Retrieved April 5, 2013, from http://www.asha.org/public/speech/disorders/AAC/.

2 (2004). Benchmarking - Wikipedia, the free encyclopedia. Retrieved April 5, 2013, from http://en.wikipedia.org/wiki/Benchmarking

6. *Redesigning of the tool.*
7. *Additional testing for usability and accessibility*

The development of the technology during the past centuries has been enormous. For example the phone, which was invented already more than 130 years ago, has still kept it is initial function by allowing us to contact people over long distances. Now there are even more possibilities as first intelligent smartphones can be used for much more: record, take pictures and also send them to other devices if necessary. There is even Siri[3], who is almost an artificial intellect, when connected to Internet.

Despite of the high-tech possibilities available today, the overall technical level has not reached the point where everybody needing the help of the technology would be able to benefit from it in every possible way, i.e. people with special needs would need many special features to start using all functions that smartphones offer. This gap may be called as a "special divide", which is even more difficult to overcome, than the digital divide overall. The main reason for the gap is the overall insignificant need for such technology. As the support by speech is needed by only a small fraction of whole population, the interest groups do not have enough influence to affect the overall technological process towards direction of reducing this gap.

In the other hand, such gap is quite understandable as the main target group for e.g. tablet computers is average people without any special needs. Still, fortunately, there are already many different devices available, which people with special communication needs can use; even users themselves have a possibility to design e.g. different Apps for smartphone platforms. The problem is that the development process for creating a good AAC app is more complex than that of a simple tutorial based app. The biggest advantage would be the reachability of cheapest android tablets that are available for about 100 euros. The disadvantage is the inability to create such App independently without proper knowledge of the design principles and

3 (2012). Siri lets users to use voice to send messages, schedule meetings, place phone calls, and more. Apple - iOS 6. Retrieved April 5, 2013, from http://www.apple.com/ios/siri/.

development technologies, which are especially important in relation to the AAC target users, who constitute a more complex and problematic testing group to use in process.

The question lies on decision - what is the best possible way to proceed and what to take into account when developing AAC technology. The telephone as we know it today was also invented though the process of development, as Alexander Graham Bell who worked with deaf people started to design a speech amplifier. Taking that into account, there is always a possibility that an App designer working with AAC technology invents something new, which also becomes widespread.

The current situation is that AAC technologies are widespread in big countries, where development is much easier as bigger population also creates bigger possibilities of financing. In small countries, the target group who need AAC devices is very small making such development much more difficult or even impossible. The overtake of devices developed in other countries (e.g. in English) is sometimes complex because of the language problem. Some of the devices are easily translatable, but many of them are not usable at all in other countries except by the native speakers of the language used for creating the device.

As all patients need a personal approach, benchmarking offers the possibility to determine if the current App is best suitable for the current patient. On the other hand it gives a major input for App designers for planning software development in the field of AAC. In addition to the Benchmarking tool, a list of evaluated criteria will be created with an explanation added of how they affect the usability and/or accessibility of the device.

The expected result of the current research will be a theoretical overview of a problem of different important characteristics of AAC devices. The needs for Apps used as a replacement devices on tablet computers will be presented accordingly. A framework will be created to evaluate different Apps available on market. The framework itself will offer relevant information for further development such devices.

1. Literature Review and Interviews with Speech Therapists

The overview of literature is based on two basic categories to cover the research areas in terms of the current thesis. First, terms of Augmentative and Alternative Communication must be explained to clarify the topic of AAC devices, which can be both, aided and unaided. In addition, to create a benchmarking tool, the basic knowledge of software evaluation and benchmarking theory must be covered.

1.1. AAC Term Explained.

AAC itself is a term to describe a situation, where people are using different methods to express themselves either temporarily or permanently. In both situations there are several ways to do it. According to American Speech-Hearing-Language And Association, the term is widened starting from 2005. The idea is to cover all the related research areas and educational practices in the field. Basically the AAC refers to a need for communication and inability to perform it without additional support or devices (Samuel, 2009). Important note from the authors was to ensure with a term, that everybody who need any kind of augmentative comprehension and expression aid would be described as target group for AAC devices without describing the exact intellectual or multiple disabilities.

The authors also explained that AAC is mainly divided into two spare areas and in one case it is called an unaided AAC, as communicating works with patients body only, and aided AAC, where any kind of equipment's are used. These equipment's can vary from very simple ones like simple drawing board or blocks wit signs etc. to a more complex ones as at the other end of the list is the more technical equipment, which can synthesize words or replay the recorded words by support person or therapists. The need for aided AAC is mainly present in situations, where patients' condition limits his/her ability to use body as AAC.

Based on the described difference between aided and unaided AAC, it can be concluded that AAC technical devices are definitely aided systems created to support

speech and language or to develop it. Using such devices is not limited, as the latest researches have confirmed that the usage of devices has a proven impact to the speed of speech and language development. Still each device patient's chronological age, degree of disability, and specific environmental needs, which may play, must take important role in in language and communication development into account (Romski & Sevcik 1997).

Current thesis focuses more on devices, which can be used as aided devices for AAC and especially suitable for using by children with speech and language development difficulties. Such technologies are in most cases ready to use out of box devices with different capabilities. By designing such devices, it has to be kept in mind, that users of such devices cannot often verbally express themselves and in many cases they may also have some other disabilities and thus need full time support to use the device.

Romski & Sevcik (1997) claim that children who can benefit from AAC are heterogeneous group, who span medical etiologies, can walk or use wheelchairs, and are usually identified based on communication profiles. Medical etiologies can include, but are not limited to, Down syndrome, autism, pervasive developmental disorder, dual sensory impairments, cerebral palsy, seizure disorder, and, often, an etiology that is unknown. Depending on the children's chronological age and disability severity, communication profiles may range from unintelligible speech to a very limited number of words (e.g., less than ten), or no speech at all.

1.2. Speech and Language Development with AAC Devices

Today's Approach acknowledges that even without any real progress in speech and language development, all fields of mental development can be supported by AAC strategies. Despite of the referred positive results of Applied AAC strategies, the real procedure must be planned carefully before the therapy begins, to ensure that all needs for mental support will be covered by AAC strategies. The selection of appropriate interventions has to be determined individually by professionals and family members (Weitz, Dexter & Moore 1995). Authors also argue that multiple Approaches of AAC can be used simultaneously to give the child a high level of cultural and communicational abilities, i.e. the patient must be very carefully examined before deciding which device or App to use.

The important part of AAC strategies is not just to support language development, it is more about the actual ability of a person to contact others and to make oneself understood. In other words, AAC can be used as a separate method to enhance speech and language development, as well as a method of augmentative communication. AAC, as part of a multimodal communication system, may be a short-term strategy until speech reaches an acceptable level of intelligibility, or it may be a long-term strategy to build and maintain effective communication (Weitz, Dexter & Moore 1995). To conclude, it makes patients more social and self-confident and encourages them to use communication skills as much as possible.

As mentioned above, the whole process of speech and language development therapy with AAC devices must be carefully planned to suit the needs of patients and to take into account the patients diagnosis which are related to communication development. If the therapy includes any aided devices, the devices must be thoroughly tested before usage to avoid extra stress or usability issues, which may occur if patient has several complaints.

Research by McNaughton, Rackensperger, Benedek-Wood, Krezman, Williams & Light (2008) highlights the main aspects of choosing the suitable device or software for speech and language development therapy with AAC methods. Two basic ideas are

parents and child's part in the whole process. While conducting the research, authors discovered that main questions or concerns related to using or choosing AAC device were:

1. *Device selection*
2. *Knowledge for using device*
3. *Overriding barriers to learn using AAC*
4. *Teaching / learning with device as whole process*
5. *Support by society.*

Many parents who participated in research, claimed that before they did not have any information about the devices, or how they could impact speech development and how to use or choose one. Another major issue discussed by family members was the knowledge and skills needed from a child to successfully use the AAC technology. Four sub-themes were identified in this category: operational competence, linguistic competence, social competence, and strategic competence (McNaughton, Rackensperger, Benedek-Wood, Krezman, Williams & Light 2008).

To conclude the last referred research, the AAC device utilization must be an intensive process including family, teachers, therapists and and other members of society who might play an important role in patients language development. Clearly, most patients will find their way out sooner or later, but according to Mcnamara, Lankveld, Van, Vervaeke & Gutknecht (2010) building early language therapies may decrease the likelihood that children will develop reading difficulties later in the elementary school years. To sum up, it is important that all stakeholders concerned with young patients or children with speech and language development difficulties turn their efforts to improving different speech and language related skills in the preschool years – particularly to those who demonstrate language problems in early years.

It is important to encourage parents and patients to consider different AAC devices, and also the promoting should be planned and directed not so much towards the patient, but more towards the therapist and the patient's social circle. Such decisions may have a huge impact and must be taken seriously. One possibility to raise

awareness about possible speech and language supportive AAC devices is also a tool for evaluation and it would give an opportunity for a designer or a therapist to evaluate different Apps available and choose the most suitable one for the patient at hand.

In addition to focusing on problems with the usage of AAC devices according to referred researches among English speaking patients and needs of their support group, current thesis also discusses the so called “small language” problem. It refers to the amount of people speaking the language or people living in the country - e.g. there is a huge divide in the number of people speaking English and for example Estonian. In such cases the development process is more expensive and adaptability of devices or software developed for other languages might have even more setbacks than described by McNaughton, Rackensperger, Benedek-Wood, Krezman, Williams & Light (2008). For Estonia and other similarly small countries, the easiest solution would be to learn from others, translate software and start using it. Still, the special needs of a patient might create complicated situation, where users find that choosing the right one to use or redesign is not so easy.

2. Benchmarking Tool for Evaluating an AAC Device.

Benchmarking in general stands for an evaluation matrix for comparing things generated for similar or for exactly the same purpose. As a part of the current thesis and overall by testing, benchmarking must be used with care to avoid situations where the focus point has not been researched much and may mislead the results. Therefore the importance of benchmark suitability is difficult to overestimate, as the main purpose for devices under evaluation is to support speech and language development. To avoid any mistakes, supervisors, therapists and members of patient support group must be involved, as patients themselves might not give the best input for creating such evaluation tool. The involvement of experts with everyday experience working with patients is especially important if the focus is on children or patients with mental disability. At this point, feedback from support group is more adequate.

Benchmarking as a tool for evaluation gives an opportunity or so called benchmark for comparing similar devices with each other by given scale and metrics. In addition it works as a trustworthy model for real-life situations and needs - this is the point, where science meets society (Sim, 2003). This step enables an everyday user to be a part of science and research, which may have a positive impact to related persons and obviously to users. Still, the input for matrix must be created by scientific research, e.g. in our case the basic information about AAC must be taken into account to keep the results as much evidence based as possible.

2.1. Interviews with Therapists

To get a good input for benchmarking tool, the opinion of a speech therapists or any other member of patient's social circle or if possible from both, is needed. As in current research process it was not possible to involve patients or their close ones, a small questionnaire was created to gather input information for benchmarking tool. Answers to the questions were first expected to give an overview of the experience in the field of therapists and furthermore about their experience with technical devices. In cases, where therapist does not have much experience with AAC technical devices,

therapists' experience in the field must also be taken into account. Real experience with patients suitable for current research is also considered an important factor, as patient's behaviour and reactions might play an important role in AAC choosing process.

The experience of a speech therapist gives an important input also for usability evaluation of AAC device. According to Berkun (2003), such knowledge is needed for creating a capturing point of the current level of ease of use of AAC device or App, which can later be used as a reference point for measuring AAC against in the future. It means that the same device is either used for the same patient whose language and speech are improved or by different patient whose needs are similar, but due to some extra problems has different needs for usability. Such reference point does not answer the question of how usable is enough, but makes this current Benchmarking tool more effective in situations where it is needed. If Benchmarking tool is properly compiled, it allows us to use it in various cases and evaluate the ease of usage for the future.

Furthermore, the therapist plays an important role when using the device as one of the members of the patient support group and is responsible for the correct treatment and development of the patient. In addition to the experience, it is also important to know if therapist has any experience with AAC technology. Using this information we cannot exclude anybody, but we still might have an idea of the actual therapists practices, i.e. if the therapist is aware of possible cases when a patient might benefit from the usage of AAC.

As the thesis mostly concentrates on children's speech and language development, it is important to connect the idea of benchmarking with design and usability design for children. Design in this context is first of all seen as interaction and usability and later graphical side of AAC purpose - App as a piece of software for easier communication. Basic design principles can be taken into account only as much as the therapist can be in the role of a tester by playing the role of a child. Other option would be to use children for testing who are capable of participating in the process and are also able to give adequate feedback. The advantage of children joining as design partners is that

they will provide more valuable input into the design process that is likely to result in technologies that better address their needs, interests, and abilities (Hourcade, 2007).

Appendix 1 includes a questionnaire, which consists of basic questions for matrix in order to select evaluation points for benchmarking tool. The questionnaire was designed for semi-structured interviews with speech therapists all over Estonia, where respondents first had to give an overview of their experience and their understanding and views on devices on using AAC technology. For creating the questionnaire, a literature review, research on characteristics of out of box devices and interviews with therapists were used to point out the important evaluation points for AAC devices.

2.2. Interview Outcomes

All respondents had over 5 years of experience in their field and most of them even over ten years. In next open question they were asked about the usage of different AAC technical devices as a part of the therapy process. Respondents were asked to shortly describe why or when would they use such a device and also situations where they would avoid them. As expected, the main point from therapists who work with people was that patient should be able to use it. Most therapists claimed that using such technical devices always has a positive effect, if such device is available for the current patient and if support from family is granted.

Main reason pointed out by most of the interviewed therapists for avoiding AAC technology was patient's limited motor and mental abilities. In other hand, they noted that such technology is either too expensive or too complicated for the user and mostly not available in Estonia, as the prices for out of box devices are not acceptable by aid technology funding system for people with such impairments.

With minimal introduction to the research topic, therapists were asked about their ideas of possible devices for using AAC personal technology. As an example, devices as smartphone, desktop computer, tablet, laptop computer, etc. were introduced. As expected, therapists were not very sure in choosing a very concrete device, as devices for everyday use have limited usability for people with multiple disabilities and this

may result as having an opposite effect on a patient. With remarks to patient's motor and mental abilities, many therapists pointed out tablet computers, as a device having a screen which is "big enough" for such purpose.

Tablets which have screens bigger than the ones of a phone and which are comfortable to carry have an advantage over other devices. Tablets and other devices designed for everyday use can be used for AAC without any additional expenses as in most cases they are obtained before usage as AAC device. Also, tablets are more easily reachable and easier to sell on after-market. The ability to use the Tablet as AAC device without special App (Application) was also pointed out as an advantage. According to the therapists, there are not any good Apps available in Estonia, which leads to preferring out of box devices as communicators, which, as therapist's stress, have quite low quality and usability.

As follows, all respondents were asked to evaluate the importance of each aspect given about technical device for using as AAC technology. First of all, as already mentioned, the tablet computer has higher value as AAC device, but it is worthless without the proper App. Today, two main platforms used by different tablet computers are iOS (by Apple Inc.) and Android (by Google). As prices for hardware vary quite a lot, it is important to know, if the chosen App works with a current tablet.

Most respondents found it important that App is developed as a multi-platform program (Importance of multi platform availability of the App).

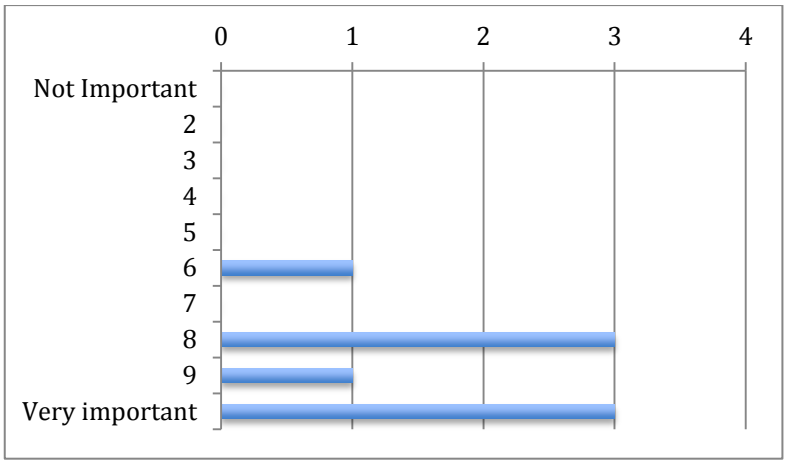

Figure 1 Importance of multi platform availability of the App

It means that the Application is downloadable from iOS App STORE and/or Google Play (Sample links for downloading Apps from iOS App Store or Google Paly.).

Figure 2 Sample links for downloading Apps from iOS App Store or Google Paly.

As current thesis focuses children, then the language of the App is one of the most important properties when choosing or evaluating them for using as AAC technology. All respondents found it very important to have App either translated into the language spoken by the patient or that it would have a multilingual option.

As out of box devices are often too expensive and out of reach for patients with speech problems, one of the important concerns became the price. It means that the App or at least some limited edition of full-featured software should be available for free. The author's opinion is that AAC devices and Apps are like any other tools for people with special needs - they should be obtainable for a reasonable price. All respondents found the price for AAC device or App to be an important characteristic (App is available for free or with a very small price).

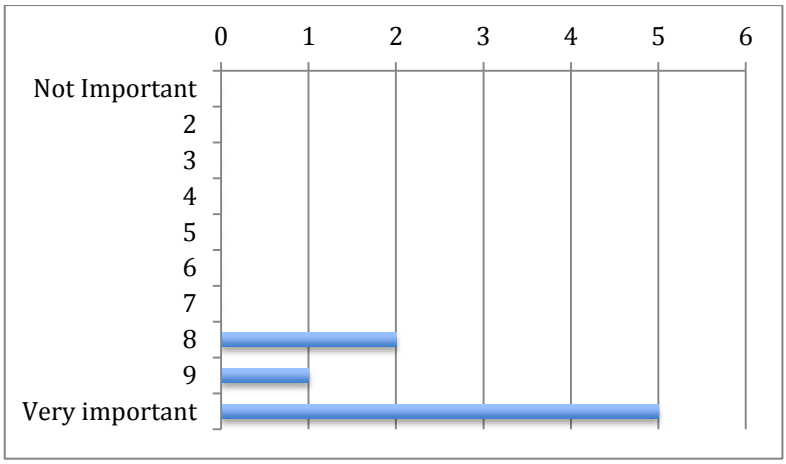

Figure 3 App is available for free or with a very small price

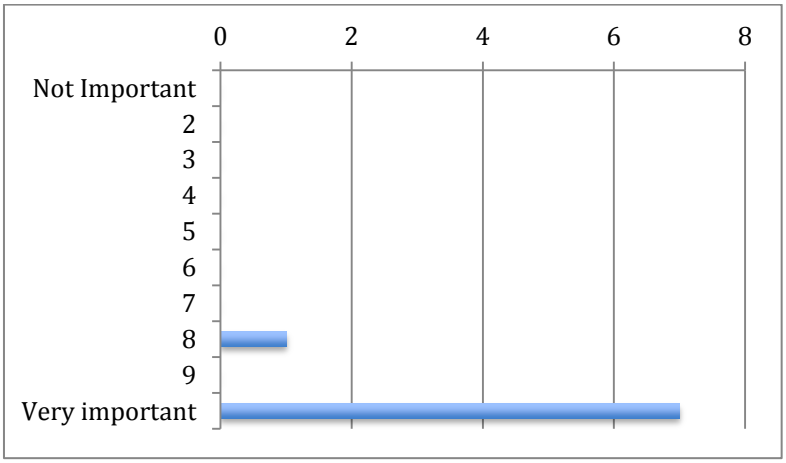

Figure 4 App is easy to use for both, patient and therapist

Using tablet computer or other similar device as AAC technical device is a little different from using specially designed devices, as out of box ready to use devices has some vocabulary or images preinstalled. According to respondents, the importance of such preparation is also important when using AAC App's (App is). Ready to use environment gives patients the ability to start using the device without complicated preparation process.

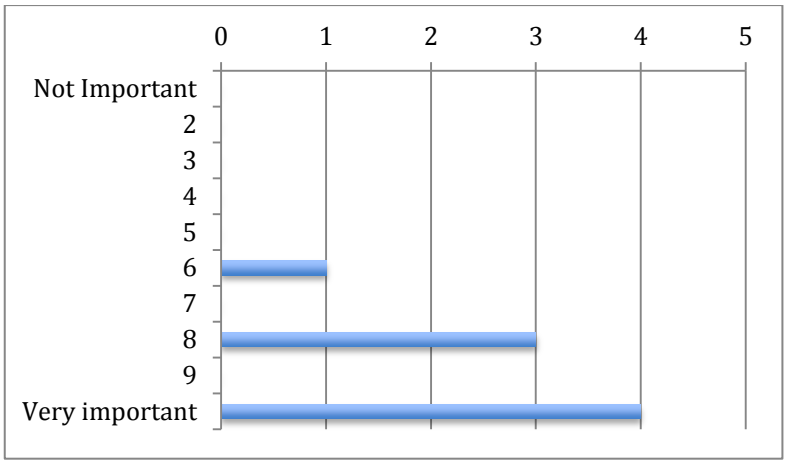

Figure 5 App is pre-configured

In addition to the ability to use the preconfigured device or App, it must have some extra options for improving the process of development according to the patient's development, e.g. downloadable content by topics or possibility to add one' s own content, which is especially important for patients with diagnosis of autism (Shelly & Golubock, 2007), who need the environment and routines which may not be consistent with the family's former lifestyle. Respondents found the ability to edit and add one's own content to be a very important characteristic of the App (**Tõrge! Ei leia viiteallikat.**).

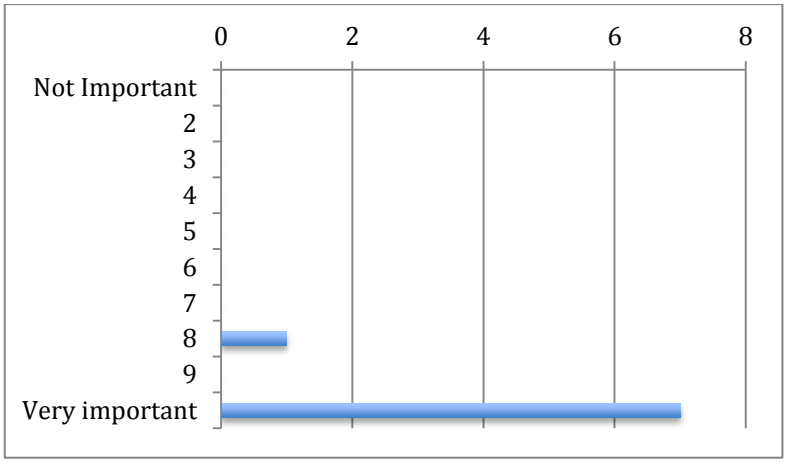

Figure 6 Materials in APP are editable

The following question rated different aspects of choosing AAC App, focusing on software's ability to evaluate patient's development and compare it with correct speech. This, and also the option to use devices as speech synthesizers were not considered as important as the previous questions (

Figure 7 App evaluates patient development).

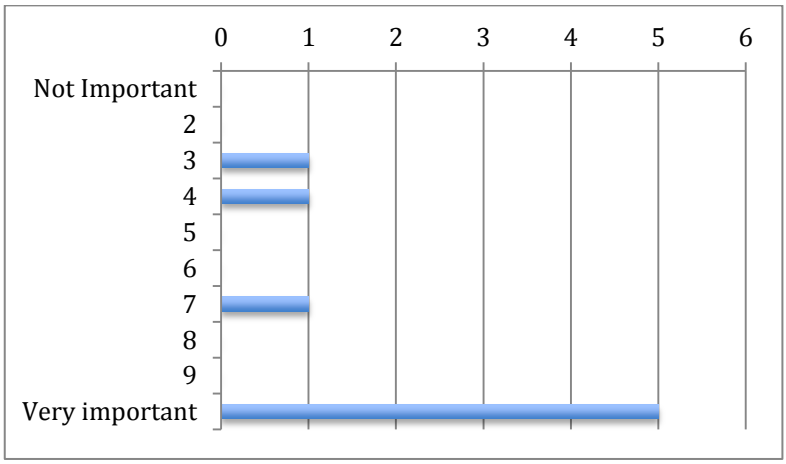

Figure 7 App evaluates patient development

As a problem it was pointed out, that App might not be able to evaluate patients with deep speech problem. Instead it would be good to have multiple levels instead of assessment of the functionality. The last question for choose/evaluation matrix was about App's user-created content. Each therapist might face the situation, where once created content for one patient would also be usable for another. The importance of this question was not as high as responses to previous questions, but still most of the respondents found it very important to be able to reuse the content (Ability to use or share content created for App).

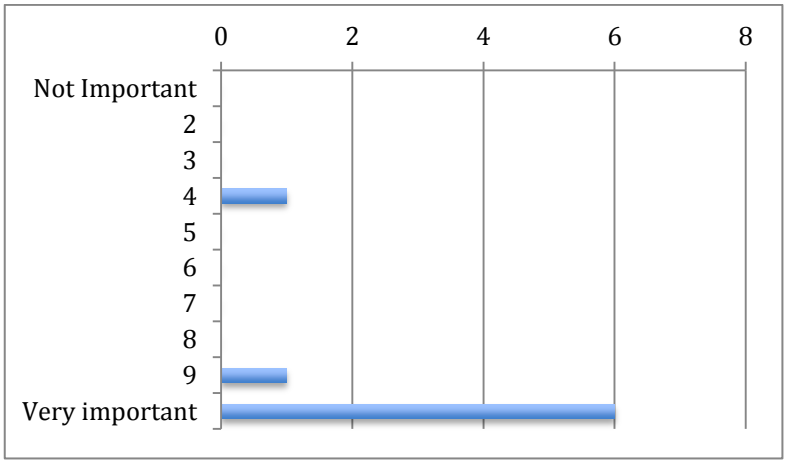

Figure 8 Ability to use or share content created for App

To sum up the therapists' opinions, they were asked about their subjective view about the graphical and usability design of the presumed App and also add comments about

the questionnaire and using App's for different platforms as AAC devices for children with speech problem. As an average, the approach when designing for children or people with special needs is, that the layout should be easy to grasp, the colors used should avoid problems with visibility for people who have multiple complaints or needs, etc.

Colors and images should be used not more than a few per page, but on the other hand, therapists pointed out, that layout should be either adaptive or adoptable, e.g. in a way most computer games use difficulty levels. The same approach would make it tremendously easier to use Apps in therapy. As the idea is to develop and replace patient's speech, it is normal, that every patient or support group has different needs and expectations from the device and that all patients are also on a very different level, both mentally and physically. It means that if one patient is able to grasp a screen with 10 items and also manipulate with them mentally and/or physically or with special remote devices, than the other either may not be mentally able to handle such amount of information at once or the range of physical movement of a patient may be limited.

Graphical design of Apps was not as important for therapists as clear, simple and unambiguous design with usability and accessibility kept in mind. They agreed, that an universal solution in such cases does not exist and that is why they added a possibility to adjust the interface as much as possible. In addition to answering the given questions, respondents were asked to freely comment on the topic or on devices for using as AAC devices. Most respondents focused on the characteristics and functionalities of the device. Some of the respondents also pointed out the nuances for development process and about the process of planning the product's specifications.

List of expected characteristics indicated by respondents.

1. *Adjustable colors of screen background, words etc. Important by visual or multiple impairments.*

2. *Forgiving interface which means a design with either adjustable layout or icons / buttons with a size that would be easy to handle.*
3. *Interaction model should be the same through all of the App's interfaces - e.g. a button with an image of a house always takes back to the beginning of App.*
4. *Nice and large/adjustable images or elements through different interfaces of the App.*
5. *Possibility to attach remote devices for controlling the App - large external switches, eye trackers, etc.*
6. *Simplicity - everyday basic communication is enough to keep it simple.*
7. *Adjustable content according to the patient's language, age, mental and physical ability, cultural origin, etc.*
8. *Repository of different downloadable additional materials and personal materials.*

2.3. Using Benchmarking Tool for Evaluation Process

According to the previous chapters with an analysis of therapist's responses, it became evident that such devices or Apps are needed and it would be beneficial to use them as AAC devices on tablet computers. Tablet with installed AAC App is one of the options to support patient's ability to develop speech and language or replace speech completely. Therapists and patient support group must consider various aspects when choosing App for their tablet or in an opposite was - choosing tablet to install the most suitable App.

As speech therapists are mostly not qualified enough in computer science or software development narrowly to create an App suitable for each case, it is reasonable to choose the most suitable from available Apps for the current patient and his/her support group. Therapists can create list themselves or someone from patient support group or even by some third party enthusiast. It is important to have the same starting point for each App to get as relevant evaluation as possible.

3. Benchmarking Matrix

According to the respondents and literature overview, the generated list of questions can be used as initial key problems in the field. In addition to point of evaluation, these should also be taken account in the process of real development in future. Each question or so-called key problem can be used for choosing a basis for decision-making for usage of current AAC App in process of speech-language therapy by current patient.

3.1. Evaluation Values

As a next step, it should be decided how valuable each key problem is for overall rating of each App. Value of each problem-characteristic must be somehow measured. As most of the respondents found all questioned sides of AAC App's very important for decision-making, it is reasonable to treat all of them equally. It means that if the App fully meets the need that was pointed to in the question, it will get one (1) point, and zero (0) if the feature is not present at all.

The first question was about the platform that is needed for using AAC App. According to the research (IDC, 2012), mobile market is fast developing and so is Windows Phone and Windows 8 share. Today, the two biggest platforms used for mobiles are Android and iOS and these two were used as a basis for choosing and finding Apps. As it was discovered during the evaluation of the Apps, one of them was available for Windows 8, too, then this will be the maximum score for the characteristic. E.g. App with Android, iOS and Windows 8 versions will get 1 point and only one platform gets 0.33 points.

Next evaluation point is related to the previous one. The price for the APP is important, as the price for tablets varies widely. This point for evaluation in the current thesis is limited, as only free Apps can be used for testing with benchmarking tool. In this point all App's will get one (1) point, as they are all available for free in full or limited edition. Many have only limited edition for free, but that will be more thoroughly studied

during the real testing process. Having an limited edition will give points between zero and one according to the features available.

As in language-speech development we should start by choosing the suitable AAC device for the therapy process patient's native language, then App's in other languages and without the ability to translate, edit or add one' s own content will get zero (0) points and all others will get one (1) point when evaluating the App against this point.

Such devices must be easy to use. There are numerous reasons for that. Patients with different diagnosis, who need AAC aided devices, often do not have adequate possibilities to express themselves and let others know about their problems of usability. Apps with proper design and easy to use interface and logical interaction pattern, which stays unchanged during different interactions with the device, gets one (1) point. If a situation appears during testing where the tester is confused about the usability, the App gets points between zero and one. In the current thesis the testing process is performed by author who is experienced in usability testing and the author tries to understand the App's logic and use it as a patient or a support person or a therapist would. Here the following principle is applied: if the author has any trouble with using it, the patient or therapist would have the same problem. During testing, subjective comments will be added to each App. Usability tests will be performed by speech therapist and support persons in the final part of the current thesis.

Preinstalled material gives the user a possibility to start using the App immediately and then, when needed, to edit or add materials according to the patient's needs. Preinstalled material for fulfilling basic needs, gives one (1) point and an App without any materials gets points between zero and one.

According to the special needs of the audience who needs such types of Apps, when evaluating, the ability to edit existing materials or add new content, which is most needed or accurate by the current patient, is a very important feature. Apps with the possibility to fully add and edit content will get one (1) point. If only editing is allowed or somehow adding or editing is limited, App will get between zero and one points.

Next feature chosen for evaluation is the App's ability to assess the patient's progress. This feature has an important role if the App is used as a tool for therapy and patient should learn how to properly say some words. The App's ability to synthesize the speech and either accept the patient's effort or to discard it by repeating the correct word and asking to do so from the patient as well, can be used. At this point, the usage of such a feature according to the patient's mental abilities and willingness to cooperate must be carefully considered. As we talk about devices for replacing speech, we do not need to add such features, as probably the patient is not able to speak at all. Due to the reason, that such a feature could not be found on Apps available for free, therapists who supervised testing, recommended to leave this key point out, as a feature with a too specific approach.

In the author's opinion, the last evaluation point is most important for therapists who need to use the same kind of device and App frequently with different patients. App's ability to share or reuse content at different tablets gives an extra value to the point, where patient can use their own tablet computer and therapist can share a precreated content with them.

4. Hands on Evaluation of Chosen Apps

Eight Apps were picked quite randomly for testing within Apps found after discussion with supervising speech therapists. The main aspect considered when choosing each app was the need to get at least a limited version for free. Also, the App should be suitable for speech development and the design should look as much as possible user (child) friendly. Below is the list of chosen Apps with links to developer's sites or Google Play App store:

1. *Alexicom AAC - http://www.alexicomaac.com*
2. *TapToTalk - http://www.taptotalk.com*
3. *JABtalk - http://www.jabstone.com*
4. *AAC speech - https://play.google.com/store/apps/details?id=com.epfl.android.aac_speech*
5. *GoTalk Now - http://www.attainmentcompany.com*
6. *FCS Lite - http://education.conovercompany.com/mobile/apps/fcs/*
7. *Spell-A-Word Lite http://www.appannie.com/app/ios/spell-a-word-lite/*
8. *Aeir Talk - http://aeirtalk.com*

4.1. Initial Evaluation Process

To evaluate each App a table was created, where first column contains App's name and next ones would contain one criteria's for evaluation (Appendix 2).

During the first testing process all apps were installed to the devices with two platforms mentioned in the current thesis. As most Apps found were available for iOs or Android, these two platforms were used for testing. As iOs device Apple iPad 2 (iOs version 6.1.3) was used and for Android Apps Asus Transformer Pad TF300T (Android 4.1.1 Jelly Bean). The installation process is not relevant in terms of the current research and it is not described in detail. Just as a remark, the installation was as easy as installing every other App to tablet and no extra knowledge were needed. The author, who has experience in usability testing, performed first testing. For each App,

the test performer tried to open and start using App as fast as possible. E.g. to say or to train how to say, “I need something”. As all apps are not ready to use in Estonian, it was only possible to do it in English. As for the current thesis a foreign language is a huge limitation, then by testing the user tried to change the sound of each button and also written part of each option. Testing done by the author was supervised by speech therapist, who slightly commented on each App afterwards.

The first App to be tested was Alexicom AAC. At first the App empty, but instantly the user is asked to download demo materials from Internet. Downloaded materials are editable by user - sound, images and text. At first the using of the App took a little time, but it was easy to comprehend and learn. With text and images, the user was able to edit the downloaded material's text and choose new images from image library of the tablet. Only the audio part was limited, as the user was not able to upload one's own sound files on Android. However, the user was able to add one's own materials and share them online. Supervising therapist liked the amount of materials for initial use after installation.

TapToTalk was the tester's favorite, as it possessed much better interface than the previous ones. It appeared more children friendly with its bigger graphical images and interface was easier to manipulate. The previous version also had to possibility to adjust image sizes, but images themselves were not as nice - probably the practical value had been kept in mind. Unfortunately the content available and even free additional “album”, which was open for download after registration, was not editable. So, in current position TapToTalk is not suitable in this context. The paid version still has all the needed functionalities - adding / editing content, sharing etc.

Without pre-installed and ready to use downloadable materials JabTalk is a good choice if the user is looking for an App, where user could create all of the materials. The App is available only for Android platform and it does not have an option to add external devices for controlling device unlike two previous Apps, except universal ones for controlling any App. App allows to share or reuse content over network, but has an option to back up the created materials and restore from it. Supervising therapist was

discontented with App's design, as the colors that were used seemed to make it difficult to distinguish between different elements, especially by patients with visual impairments. The ability to change colors was not discovered.

Next App is almost at the same level as the previous one. It has some ready to use materials, but they are not editable. The App uses Google speech synthesize libraries. The App is also available for Android platform. Usability is similar to Alexicom AAC and TapToTalk, but design is not so friendly.

GoTalk Now has some content available for free, but adding one's own materials is limited. Paid options are with good abilities to share content and make it possible to use other users libraries.

Like JabTalk on Android is FCS Lite a good option to start work on iPad. As an advantage there is already some added content which user can delete and in addition to add one's own content, as recorded sound etc. App has quite good usability and interface is designed with good artistic sense.

Two last Apps under testing had quite a similar construction. The app has ready to use materials in free version, which can be used to practice some words. Limited version did not have a comfortable usability and gave a clue about software performance but as for demo versions, they were not usable for therapy at this point. In conclusion to initial testing, tester would recommend free and easy to use Apps FCS lite for iPad and JabTalk or Alexicom AAC for Android. Last App is also available as Windows 8 App, but as a disadvantage the ability to record one's own voice is limited on android, however, available on iOS.

Such testing by the author only is not relevant in terms of real ease of use by patient or therapist, but with comments from supervising therapist and other therapists, who answered to the initial questionnaire, a good overview and starting point for those not familiar with AAC Apps is given as well as an overview of different characteristics and options of each App chosen for research. Initial evaluation matrix with test results can be found in Appendix one.

5. Usability and Accessibility

In previous chapters and by initial evaluation, it was pointed out that the usability as criteria is important for choosing an appropriate App for using as an AAC device. Different Apps require different approaches, but in most cases and especially by patients with multiple or profound disabilities, Apps are used by multiple users. In current evaluation research patients are not involved into the sample of testers for this is a complicated procedure and could be a disturbing or an inconvenient experience for them. Therapists or parents conducted all evaluation or testing procedures. In other words, they are used for testing all interfaces - patient, parent, therapist, etc. In addition to testing the usability it is good to know the accessibility of such devices for patients. Again, this is especially important; it patient has various health problems in addition to deficient speech and language development.

5.1. Usability

According to the initial testing's, most Apps had a reasonable usability for the tester and problems occurred only when testing the limited editions of the Apps. To imitate patients, all Apps were tested against the usability of users who have only speech and language development problems. The goal was to reach the first words and to "say it out" as soon as possible. Of course there is always some time needed to assimilate the patient with a device, but the rule of thumb is that it should be a task simple enough for everyone.

In addition to the logic of usability design, the limitations of graphic interface were not so unambiguous as one would expect from such devices e.g. images for categories have been created taking into consideration the culture as well, which makes the same category almost impossible to use in a different region without any editing done to the content.

Next step in usability testing was to include therapists and test the Apps with highest results from initial testing's against usability in backend user interface which is the

main tool for patient support group to adequately edit or add content by each patient. The testing result gives an evaluation point, which can be measured as one important key point in evaluation process. The basic criteria were not to end with dead end in usability testing process. The results and procedure of testing and discussion on results is described in detail in chapter 6.1.

5.2. Accessibility

As mentioned by therapists, all users should be able to access the device or App despite their mental or physical disabilities they might have in addition to the speech and language development problems. To test it, additional tests were performed to test each App in addition to the usability also and against basic visual accessibility needs.

All tests were performed without patients and to test the accessibility, the Apps configuration was checked to detect if changing the visual interface of frontend is possible or not. In addition, Apps configuration was explored for functionalities as connecting to different external devices. Finally, for accessibility testing, a color blindness test was performed with screenshots of Apps with Color Oracle[4].

[4] http://colororacle.org/index.html

6. Additional testing with therapist and final discussions

To test the usability for therapists or parents, who will need to use AAC Apps in their everyday work as an optional tool for speech and language development, they were asked to prepare content according to the topics. The goal was to test the usability of the App by preparing content in one and the same topic in three different Apps - two on iPad and two on Android devices. The main goal was to do the task without facing so called dead ends.

6.1. Testing for Usability with Therapists

For testing with therapists, they were asked to prepare materials they will later need, and to add them to an AAC device - images and texts for one category and one new item in the same category. During testing they were closely observed for any different possible setbacks in each App. Time and notes were taken during the testing of each App with the results more closely described in the next paragraph.

The task for testing was to create a category of words, to name it, add pictures and sound if needed and possible and add one word to the same category with image, text and sound if possible. Images, if needed or wanted by the tester, were added to the image galleries of the tablets used. The same task was performed twice on both devices. Apps for testing were:

1. *iPad - FCSLite*
2. *iPad - Alexicom AAC*
3. *Asus - JabTalk*
4. *Asus - Alexicom AAC*

During the testing procedure, the author was an observer and noted down all the actions and handled timing for recording task procedure as closely as possible. When the tester reached a dead end, the time was stopped and observer helped the tester back on track. All data of performed tests results are shown in Table 1. Tests were

performed in same order in all cases, e.g. AAC on Android, JabTalk on Android, FCS on iPad and AAC on iPad. Detailed results of usability tests can be found in Appendix 5.

All testers were either parents of or closely related to patients with speech and language development need or therapists who work with such patients. As seen in the table of testing results (Appendix 5), the test was performed in total 40 times on different devices and Apps. There were 10 different testers of whom 4 were therapists and 6 form other testing groups. The average time to complete the task was 200,4 seconds. The highest result was achieved by tester, who is a therapist with previous experience on Android, who performed task with JabTalk on Android within 151 seconds and with 1 error (not included second attempt with AAC on other device). Overall, the least time was spent on a task with iPad 164 seconds with FCS Lite and With Android as mentioned, 151 seconds with JabTalk.

Due to the small amount of testers it is difficult to highlight the best App according to the current results, but in general there was a significant relation between the user's previous experience and the device used in the test. Also, better results obviously occurred with AAC on the second test on different platform, as the basic design was already familiar to the tester. This situation's purpose was to get a more general view of the App with highest rank in initial testing. It gave an overview of the Apps characteristics on different devices. This revealed that all functionalities of the Apps are not presented in Android version, which caused many errors during testing, as many testers were looking for the ability to record voice, but on Android such feature was not presented.

Afterwards therapists were asked to describe their emotions about the Apps used and to evaluate them as optional devices and Apps to use for everyday work. They described which and why they would use and recommend the current device and App and why not. Before testing was proposed criteria was to fail or not. If the tester reached dead end and was not able to recover from it by her, the test was paused and returned previous correct position for retry. Errors were discussed with testers and mostly they argued that the usability was "not logical". Most of the fatal errors were

revealed in situations where the tester was not familiar with current device. They added that if using the App as an AAC device would be an advantage all persons related to patients therapy were acquired basics in the usage of the chosen device.

6.2. Accessibility According to the Therapists

After testing for usability, therapist were asked about their experience with patients potential needs or problems with accessibility, e.g. how many patients with speech and language development problems have any additional issues, either mental or physical disorders which may affect the proper usage of the AAC device.

Therapists pointed out, that having an ability to connect external devices for controlling AAC App by the patient adds an extra value as it enlarges the accessibility of the device or an App for different patient groups with more complex diagnosis. Such external devices for expanding the accessibility are for example different switches, eye trackers, etc.

6.3. Accessibility Testing

To test the accessibility of AAC devices or Apps, adequate testing subjects are potential patients, but it must be kept in mind not to make the procedure inconvenient for the patient.

There are many standards to test the accessibility for and also multiple tools (http://www.rnib.org.uk, 2009), which basically cover all same testing points with either stricter or in a less strict way. The widespread development of different accessibility points has become more important when website design has become an everyday practice. Without proper accessibility compliance websites become inaccessible and that is not acceptable by government or public services websites. Operating systems have added such built-in support options as adjustment screen visual appearance, keyboard or mouse access, sound etc., for about decade now (De Lioncourt, 2011).

To test four AAC Apps for accessibility all potential issues were categorized according to human senses - sight, hear and touch. In addition, the target group and additional diagnosis of potential patients including all other possible accessibility factors were kept in mind during the whole process. Tests should give an input for decision about current matrix relevance and if needed the information to improve.

The visual part of the App should be clear and adjustable. The decision of who should be able to adjust the visibility is also difficult as depending on patient's abilities; he/she might be able to do it by himself/herself, too. There is an option to leave all of the adjustments for therapists assuming that at least for the first times the device is used under the observation of a therapist or any other super user of the App. The size of the elements must be editable on all devices. Elements must be designed with colors to meet all the needs of patients with visual impairments, e.g. different types of color blindness.

All Apps had some way in settings to edit the size of elements visible on screen. For testing against color blindness, Color oracle (Figure 8). As seen on the Figure, all Apps are somehow readable, but in the authors and therapist opinion, the AAC Alexicom App and FCS Lite had the best results as both had a lighter background, which makes the information more easily readable.

To conclude the accessibility tests all Apps passed the tests and had no major issues with visual ability. After current testing JABTalk as an App for patient with color blindness would not be recommended by therapists. In testing against physical accessibility all Apps were checked for ability to connect to external controllers, which may include switches, pointers, eye trackers etc. All tested Apps had options for adding such controllers either based on App settings or in a level of device configuration.

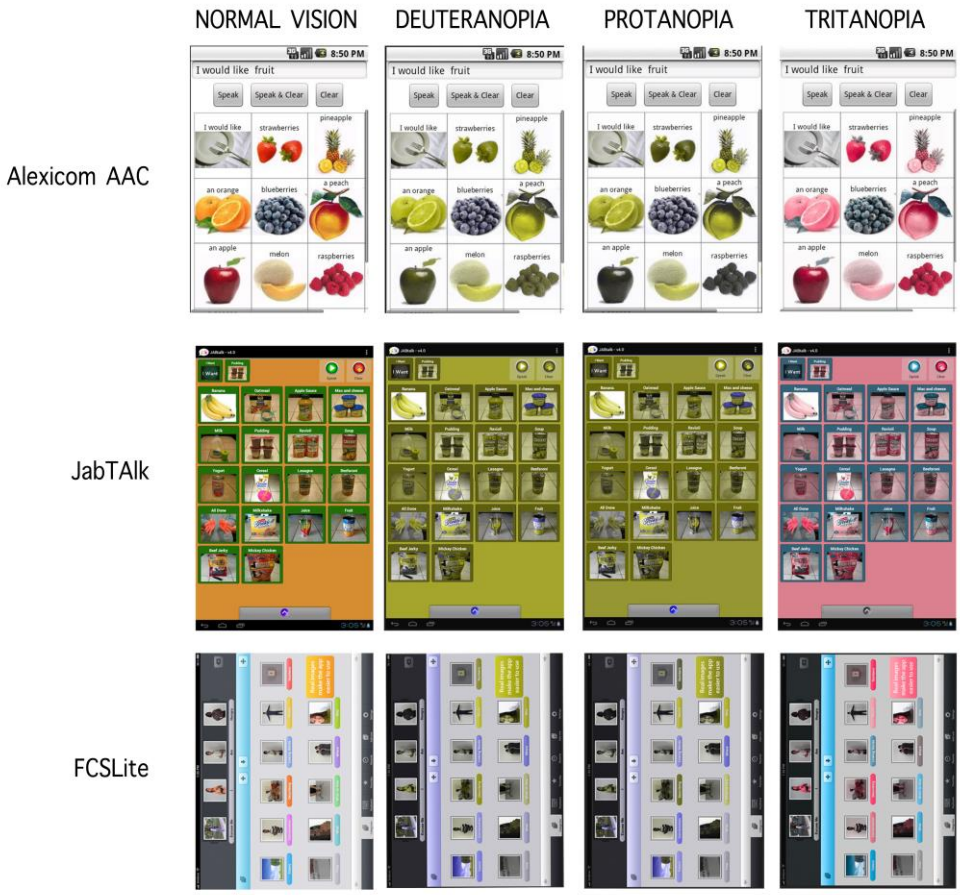

Figure 9 Accessibility testing against different types of color blindness.

Hearing is also very closely related to speech and language development and in current cases, the AAC device, as an App must be checked for technical specifications on each device. Devices used for testing had the ability to adjust volume and if needed, to connect to external speakers, amplifiers, etc. The only thing that is questionable might be the patient's ability to adjust the volume himself/herself. This option was not separately evaluated as device options and configurations are not relevant in terms of the current research.

Touching the device, or more specifically the screen of the device, has also two approaches in the context of the current thesis and accessibility. The screen as a part of the device cannot be evaluated separately. Our testing revealed that the screen of the iOS device works better and each touch is registered more correctly and quickly

than on the Device with Android operating system. The other problem related to touching the device was noted on iOS device, where home button was a potential threat for accidental exit, i.e. home button should be somehow hidden on the device. Furthermore, the accessibility on devices is important in cases where patient's physical ability is somehow limited. Here different external devices can be used, which are not included in App and are also needed with out of Box AAC devices. The ability to control the App with such devices like Bluetooth buttons; Eye Trackers, etc. are a bonus on each device and App.

These results lead to the decision that there is a need for improving the initial matrix for evaluation. Additional characteristics had to be added to get more detailed results from Benchmarking tool. Following the decision, the new key points for adding to the matrix were:

1. *Ability to connect to external devices*
2. *Visual appearance is adaptable*

As a feature that is otherwise important in the development process, the Apps ability to evaluate patient’s progress was removed from the matrix.

Conclusion

The main research goal of the current thesis was to evaluate software applications created for improving speech and language development in order to use them as AAC devices. To assess different characteristics of such Apps, a Benchmarking tool was created for further research and evaluation of the software created for using on desktop and tablet computers as AAC devices. Experts in field and other people with experience with patients who need AAC devices tested these characteristics. As a main result of the thesis, the evaluation tool for AAC Apps was proposed as one solution for main research problem to overdue limitation of high prices of ready to use AAC devices.

The main research questions of the thesis were answered through research strategies and all expected results were achieved, which means that the tool created be used for evaluating Apps under question but involving of experts is recommended due to limited knowledge of patient and parents of speech therapy. Benchmarking tool includes important key-points for evaluation selected in the research process. The relevance of the result was given a positive evaluation by the therapists. The overview of the process is visualized in a diagram in Appendix 6.

Tablets are good alternatives for ready to use AAC devices. Being quite widespread they are very popular devices with Android, iOS or Windows 8 operating systems. Also Tablet computers are multifunctional and can be used by several family members. If such a device is already purchased, it can also be used as a supportive device for children and/or also for elderly people as an AAC device for speech and language development.

Furthermore, Benchmarking tool that was created can be used as an evaluation matrix with relevant evaluation points to choose an App for the available device. The Matrix can be used for sequencing different Apps according to the gathered points for each evaluation point and also for eliminating Apps, which are not suitable for the current

patient. An evaluation matrix is included with a proper guide to find or compare different applications.

In addition, the thesis explored the designing principles, which have to be taken into account when designing hardware and software for an AAC. During different research procedures, the author discovered that an evaluation process of such Apps is more complex than it first seemed as there are too many unknown variables. E.g. each patient has a different social background, they can be younger or older, and they may be able to use the device by themselves or not due to different physical or mental disabilities. In addition, personal qualities and habits of each patient must be considered as well.

All the Apps were chosen considering the following criteria: free of charge (at least lite or limited version), App is developed at least for one chosen platforms or even better, for multiple platforms. Basic questionnaire was created for testing based on the interviews with two speech therapists. According to the respondent's average ratings, all points for evaluation were important when evaluating an AAC App. As all questions initially asked gathered over 8 points and more in most cases, it refers to the relevancy of the question.

The final tool with comments and instructions can be found in Appendix three. The tool is improved in meaning to get as much input while evaluating, e.g. usability ratings and accessibility concerns mentioned in the initial table as bonus features (external devices and color blindness assessing point). An overview of how to use the tool and how to interpret the results of the evaluation is also added.

While writing the thesis, it was discovered, that it is possible to create a speech synthesizer (EKI, 2013) in Estonian as well, but according to the therapist, it is not acceptable as an only option to generate speech, as in the development process some patients may need the speech with maximum quality, slower speed, etc. Based on the aforementioned, the feature was excluded from the evaluation process.

Further research should concentrate in detail on finding the key questions of AAC Apps and use them as input for creating an adaptive App suitable for more devices and with ability to reuse the content. The benchmarking tool can be used as a basis for describing the requirements for developing an AAC App. In addition to current research information, the subsequent researches should also involve patients and their close ones for testing the out of box devices against tablet computers with Apps.

The thesis includes a benchmarking tool, which is designed for evaluation purposes as one of the options to use the different products of the new media. The positive effect of using such product is even more important; as the result gives an average user the ability to assess Apps created by professionals and to select the most appropriate solution for each situation. Indeed, the final decision should be discussed with professional therapist, but the tool gives for an average user the power to create new knowledge and if needed, share it.

Kokkuvõte

Käesoleva magistritöö eesmärgiks on anda hinnang tarkvarale, mis on loodud kasutamiseks alternatiiv ja augmentatiivkommunikatsiooni (augmenatatiiv - häälikuline kõne) vahendina (AAK). Sellised seadmed valmisseadmetena on suhteliselt kallid ja paljudes olukordades ei saa patsient või tema lähedased sellist seadet endale finantsilistel põhjustel lubada. Sanuti on eesmärgiks luua hindamismudel sarnaste tarkvaraliste lahenduste hindamiseks.

Alternatiivina valmisseadmele on võimalik kasutada tarkvara, mis mõnele arvutile installeerituna on kasutatav samadel eesmärkidel, kuid võrreldes tavapärase kõne süntesaatori põhimõttel toimiva vahendiga on tarkvaraliste lahenduste puhul paljud võimalused piiratud. Magistritöö uurib tahvelarvutite ja neile koostatud tarkvaliste rakenduste kasutamist kõne arengut toetava või kõnet asendava seadmena. Tahvelarvutitena on töös kasutusel iPad 2 ja ASUS Transformer TF300T.

Magistritööl on kaks juhendajat, et katta töö pealkirjast ja uurimise valdkondadest tulenevate kahe teadmiste põimumise. Töö läbiviimiseks koostati logopeedidega koostöös esialgne küsimustik AAK seadmetele esitatavate oodatavate nõuete kohta. Küsimustiku vastuste põhjal selgusid võtmeküsimused, mis peaks olema ühel AAK seadmel, et vastata minimaalsetele logopeedide või patsientide nõuetele.

Koos logopeedidega valiti välja kõige sobilikumad seadmed ja rakendused, mis vastaks kõigile algses küsimustikus viidatud nõuetele ja annaks võimaluse võtta need sobiva seadme olemasolul kasutusele igapäevase suhtlusvahendina. Esialgne hindamine viidi läbi autori poolt koos logpeediga, kes kommenteeris tulemust ja võimalusi, mida iga seade sisaldas. Testimise põhjal sai 8 valitud rakenduse kohta pingerea koostada. 4 paremat tulemust saanud rakendust testiti lisaks logopeedidest ja lapsevanematest testijate poolt, kes pidid testi käigus kasutama tarkvara sõnaderühma ning selle sisse ühe uue sõna lisama.

Testi käigus jälgis autor testijaid ning koostas iga testi kohta märkmed ning arvestas testi läbimiseks kulunud aega. Lisainfona andsid testijad infot oma varasema kogemus

kohta tahvelarvutite kasutamise osas ning pakkusid välja rakendusi, mis neile enim meeldivad ning mille nad sooviksid kasutusele võtta.

Täiendavalt testiti valitud rakendusi ka ligipääsetavus osas, mis piirdus küll peamiselt nägemisega seonduvate probleemide välistamiseks seadmete kasutamisel, kuid lisaks said läbi arutatud ka kuulmise nign motoorikaga seotud probleemid. Testi tulemusena selgus, et osad parima tulemuse saanud testobjektid ei olnud värvipimeduse testis väga hea tulemusega, sest taustavärv takistas objektide eristamist.

Kokkuvõtvalt selgus magistritöö käigus, et olemasolevat tahvelarvutit on võimalik kasutusele võtta kõnet toetava seadmena, kui sellele valida sobiv tarkvara. Tarkvara valikuks koostatud hindamismaatriks toetab valikut ning kitsendab piirates seda iga patsiendi jaoks vajalike kriteeriumite hindamise ja valikuga.

Edasise uurimise jaoks tuleks läbi viia teste suurema hulga huvigruppide ja ka patsientidega, mis nõuab suuremat ressurssi ja spetsialistide kaasamist, mis võimaldaks täpsemalt välja selgitada antud hindamismaatriksi vastavuse reaalsele patsientide vajadusele ning kasutamisele igapäevases õppe ja arendustegevuses. Töös kogutud infot on võimalik kasutada kui algmaterjali uue tarkvara arendamisel. Töö käigus selgus, et Eesti Keele Instituudis on 15 aasta arenduse tulemusena loodud piisavalt tarkvara kõnesüntesaatorire näol, mis võimaldaks selle rakenduse loomist ka eesti keeles. See annaks rohkem võimalusi loodavat rakendust mitmekülgselt kasutada kas sisseloetud kõnet esitades või kõnesüntesaatori abil lausete koostamist, mis võimaldaks rakendust kasutada patsiendi poolt koostatud teksti väljaütlemiseks.

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Appendixes

Appendix 1 Questionnaire

Kõnet toetavad või asendavad tehnilised vahendid.

Hea terapeut!

Küsimustik
on koostatud eesmärgiga koguda alginfot kõnet toetavate või asendavate tehniliste vahendite vajalike omaduste kohta. Saadud andmete põhjal saab koostada maatriksi, mis võimaldab tehnilisi vahendeid hinnata.
Vastamine võtab aega umbes 10 - 15 minutit.

Uuritakse erinevate
nutitelefonide ja tahvelarvutite jaoks loodud programme (APP-e ing. keelsest sõnast application), mis peaks võimaldama kõne arendamist või asendamist.

Kui kaua olete tegelenud kõneprobleemidega patsientidega? *
palun märkige aastate arv

Kui on valida mitme meetodi puhul, siis millises olukorras kaaluksite tehnilist abivahendit. Mis on peamine põhjus tehniliste vahendite kõrvalejätmisel? *

Millised võiks olla Teie nägemusel kõnet toetavad või asendavad tehnilised seadmed? *
Näiteks: arvuti, telefon, tahvelarvuti, sülearvuti jne.

Andke hinnang 10-punktilisel skaalal järgnevate omaduste olulisusele. *
APP on siin kontektstis programm, mida saab kasutada telefonis, tahvelarvutis jne.

	ei ole oluline	2	3	4	5	6	7	8	9	väga oluline
APP on saadaval mitmele platvotmile (PC, Mac, Android, iOS)	○	○	○	○	○	○	○	○	○	○
APP on saadaval patsiendi keeles või võimaldab info soovitud keeles	○	○	○	○	○	○	○	○	○	○
APP on tasuta või väga soodsa hinnaga ning ostmine on lihtne	○	○	○	○	○	○	○	○	○	○
APP-i kasutamine on lihtne nii	○	○	○	○	○	○	○	○	○	○

juhendajale kui ka patsiendile										
APP sisaldab valmispaketti (nimisõnad, tegusõnad jne.)	○	○	○	○	○	○	○	○	○	○
APP-i sisu on muudetav tekstid, helid, pildid jne. ja / või võimaldab luua personaalset sisu	○	○	○	○	○	○	○	○	○	○
Lisaks kõne asendamisele suudab APP hinnata patisendi kõnet ning võrrelda seda etteantud korrektse kõnega	○	○	○	○	○	○	○	○	○	○
APP-is loodud sisu on taaskasutatav - terapeut saab oma materjale jagada mitmele patsiendile	○	○	○	○	○	○	○	○	○	○

Milline peaks olema APP-i graafiline kujundus? *
kirjeldage võimalikult lihtsate omadussõnadega (ilus, suur, loetav, hele, tume jne.)

Kas kujundus ja/või kasutaja tegevuste muster peaks olema loodud lähtudes mingitest spetsiifilistest erivajadustest? *
Näiteks jäsemete liikuvuse/liikumatuse probleemid vmt.

Lisakommentaarid.
Võite vabas vormis lisada oma mõtteid kõne toetava või asendava tehnilise vahendi kasutamisega seotud asjaolude kohta, mida küsimustega ei puudutatud.

Kui olete nõus osalema uurimuse järgmistes etappides, siis palun jätke oma e-posti aadress.

Appendix 2 Initial evaluation matrix

	Alexicom AAC	TapToTalk	JABtalk	AAC	GoTalk now	FCS Lite	Spell-A-Word Lite	Aeir Talk
Platform	0,66	1	0,33	0,33	0,33	0,33	0,33	0,33
Price	0,5	0,5	1	1	0,5	1	0,5	1
Languages	1	1	1	1	0,5	1	0	0
Usability	1	1	1	0,5	1	1	0	0,5
Ready to use preinstalled materials	1	1	0	1	1	1	1	1
Edit and add content	1	0	1	0	0,5	1	0	0
Share or reuse own content	0,5	0	0,5	0	0,5	0	0	0

Appendix 3 Improved evaluation matrix as BMT

Evaluation point					Instructions
Platform	☐ iOS	☐ Android	☐ Windows	____ ☆	1 point if all platforms are presented
Price	☐ Free	☐ Limited	☐ Paid	____ ☆	0 if only paid version availible - 1 for free version
Languages	☐ One	☐ Multi	☐ Translatable	____ ☆	0 points for one language - 1 for unlimited
Materials	☐ Available	☐ Downloadable	☐ No	____ ☆	0 for no materials - 1 for basic set
Editable content	☐ Available	☐ Limited	☐ No	____ ☆	0 for non ediatable - 1 for all functionalities
Sharing	☐ Available	☐ Limited	☐ No	____ ☆	0 for none - 1 for fully shareable content
Usability	☐ Available	☐ Limited	☐ No	____ ☆	0 for getting into dead end using basic functionalities - 1 for non-error usage
External control	☐ Available	☐ Limited	☐ No	____ ☆	0 without option for externals control - 1 if external contol is enabled
Adaptable appearance	☐ Available	☐ Limited	☐ No	____ ☆	0 for fully fixed appearnce - 1 for fully customizable interface

Name of App	Points	
Sample App	6.4	★★★★★½☆☆☆☆

Evaluation tool can be used for two main purposes. Firstly for creating a list of Apps available in order to rank them and add additional comments, if needed.

As all results will be preserved and updated by users continuously, the tool can be used also for choosing App most suitable for each situation.

In order to evaluate App is needed at least one of devices to evaluate current App. Some of information needed can be gathered from developers site, but some of it should be tested by using App.

According gathered points, gets each App some amount of points, which will be represented visually as stars. Such evaluation makes it easier for quick choosing process if such App is needed.

Appendix 4 Usability testing results

	Tested Application: FcsLite - 1, Alexicom - 2, JabTalk - 3	Testing platform: 1 = iOS, 2 = Android	Points in initial matrix	Time to task in seconds	Errors	Test performed by: 1 = therapist, 2 = other	Experience with tablets: none - 0, ios - 1, Android - 2
1	2	2	5,66	192	3	1	2
2	3	2	4,83	155	0	1	2
3	1	1	5,33	245	2	1	2
4	2	1	5,66	77	0	1	2
5	2	2	5,66	170	3	2	1
6	3	2	4,83	248	3	2	1
7	1	1	5,33	215	3	2	1
8	2	1	5,66	120	0	2	1
9	2	2	5,66	285	5	1	0
10	3	2	4,83	326	3	1	0

11	1	1	5,33	458	6	1	0
12	2	1	5,66	123	2	1	0
13	2	2	5,66	137	2	1	2
14	3	2	4,83	151	1	1	2
15	1	1	5,33	235	2	1	2
16	2	1	5,66	106	0	1	2
17	2	2	5,66	189	4	2	1
18	3	2	4,83	176	1	2	1
19	1	1	5,33	289	2	2	1
20	2	1	5,66	115	0	2	1
21	2	2	5,66	264	3	1	1
22	3	2	4,83	185	2	1	1
23	1	1	5,33	164	1	1	1
24	2	1	5,66	143	0	1	1
25	2	2	5,66	301	2	2	1

26	3	2	4,83	246	1	2	1
27	1	1	5,33	185	0	2	1
28	2	1	5,66	168	0	2	1
29	2	2	5,66	275	2	2	0
30	3	2	4,83	206	2	2	0
31	1	1	5,33	249	1	2	0
32	2	1	5,66	84	0	2	0
33	2	2	5,66	267	1	2	2
34	3	2	4,83	185	2	2	2
35	1	1	5,33	212	3	2	2
36	2	1	5,66	95	1	2	2
37	2	2	5,66	341	4	2	1
38	3	2	4,83	178	2	2	1
39	1	1	5,33	168	1	2	1
40	2	1	5,66	89	0	2	1

Appendix 5 Diagram of design process