

Article

Overcoming the Language Barrier in Hearing-Speech Rehabilitation Using Multilingual Conversational Applications

Rötz, W., Eichler, T., Kim R., Sudhoff, H. and Todt I.*

Medical Faculty OWL, University of Bielefeld, Campus Mitte, Department of Otorhinolaryngology, Head and Neck Surgery, Teutoburgerstr.50, 33604 Bielefeld, Germany

* Correspondence: author: Mail: todt@gmx.net; Phone:+49 521 581 3313

Abstract: Background: In order to achieve the best possible hearing and understanding with a cochlear implant (CI), regular hearing speech therapy treatment is necessary after implantation. This treatment should also be accessible to the growing proportion of hearing-impaired people with a migration background. This requires an alternative to therapy in the therapist's native language. The aim of this study was to evaluate six multilingual conversation applications with regard to their usefulness for therapy. Material and Methods: The six most commonly used applications were reviewed in terms of accuracy of content and grammatical translation, as well as pronunciation for English, Spanish, Arabic, Turkish, and Russian by native speakers. The number of available languages, availability, cost, and additional features were also analyzed. The accuracy of the content and grammatical translation as well as the pronunciation were statistically evaluated, and the differences were highlighted. The results of the different applications were compared with the performance of a native speaker. Results: All applications tested differed significantly from the native speaker level, with Google Translator showing the closest approximation to the native speaker level. All apps offer translations for multiple languages and, with exceptions, are available in both app stores. Furthermore, all apps have additional therapist-facilitating features. Conclusion: Multilingual conversation apps can make speech therapy in a foreign language much easier when used with patients. An adaptation of the software to the specific requirements of a hearing speech therapy is necessary to achieve a linguistic level that corresponds to the native language of the therapist and to enable an easy use in the therapy.

Keywords: speech therapy; translation; digital application; language; cochlea implant

1. Introduction

A total of 21.9 million people with a migration background live in Germany. (Federal Statistical Office 2021). Depending on the duration of residence and the degree of integration, knowledge of the German language varies. The more limited the command of the German language, the more problems arise in the medical context in the communication between practitioner and patient.

A common solution to overcome this barrier is the involvement of interpreters or interpreting relatives. However, the quality of translated information and instructions is variable. By having a non-specialist translate, the practitioner relinquishes control over the content and choice of words as well as the expression. However, depending on the purpose of the conversation, a translation that is appropriate to the meaning or wording can be crucial for establishing a basic understanding of the content as well as a stable relationship of trust with the patient [1].

Especially in speech and language therapy with cochlear implant (CI) users, treatment cannot be meaningful if the translation is incorrect. This results in the need for a

therapeutically controlled translation option that not only enables a word-for-word translation, but also includes consideration of grammatical and content-related information as far as possible.

1.1. Speech therapy requirements

The goal of post-implantation speech-language therapy is to provide the patient with the best benefit through optimal adaptation of the speech processor. The basis for this is an appropriate auditory speech therapy [2,3].

Linguistic utterances of different levels of complexity serve as therapy material. Complexity refers to different utterance lengths and different levels of content [2]. An increase in complexity occurs once the patient demonstrates the best possible understanding without or with little assistance from the therapist [4].

In order to be able to accomplish these tasks within a foreign language, therapists need supporting aids for the execution of the exercises. A possible solution for this can be multilingual conversation applications. The application takes over the role of the interpreter, and optimally translates the content and grammar correctly. The therapist can then not only translate the therapy material, but also let it speak and draw well-founded conclusions about necessary adjustments to the speech processor. Due to increasing digitalization, integrating such apps into therapy is a contemporary and readily available option.

1.2. Goal

Speech therapy-unspecific apps have not yet been evaluated in terms of their suitability for therapy in a foreign language and their usefulness has not been verified. This makes it difficult to select a suitable app [5]. This study aims to identify an app that is suitable for use in therapy for different languages and that enables optimal processor adjustment in the first step of therapy.

2. Material and methods

A selection of the three most frequently used multilingual conversational apps from the Apple App Store and the Google Play Store (access date: 15.04.2021) was made (Table 1). The selection was based on the frequency of downloads.

Table 1. Overview of the multilingual conversational applications studied.

Google Play Store	
iTranslate Translator 14.0	iTranslate Translator and Dictionary 5.6.3
Microsoft Translator 21.3.1.0	Microsoft Translator Version 4.0.4961.792afab1
Google Translator 6.17.0	Google Translator 6.17.1.04.359877260
-	Q Multi Language Translator (NyxCore) 1.4.6
Sprachübersetzer Translation (Talkao) 3.0.3	Talkao Translate – Translator Voice & Dictionary 314.0
Reverso Context Translator 9.9.7	Reverso dictionary, Translator 9.9.7

In the evaluation, seven categories were considered and all available options in the respective full versions were evaluated (Table 2).

Table 2. Evaluated categories.

Categories
Accuracy of content translation
Accuracy of grammatical translation
Quality of Pronunciation
Availability in app stores

Costs for using the full version
Number of selectable languages
Additional functions

The accuracy of the content and grammatical translation and the quality of the pronunciation were evaluated for the languages English, Spanish, Arabic, Turkish and Russian by native speakers using a questionnaire. The evaluation was done by either indicating "correct" (100%) or "not correct" (0%). Any discrepancy within an item resulted in a "not correct" rating for the entire item. For this purpose, hearing therapy exercise items of different complexity levels were translated. Five items each of the categories: words, phrases and sentences (Table 3).

Table 3. Examined test items of different complexity levels in the categories of words, phrases and sentences.

Words	Phrases	Sentences
Elephant	Wait a minute	The fish swims in the water.
Farm	Good morning	The car is driving on the road.
Post office (specifically: post office branch)	Go shopping	This is a topic that is often discussed.
Structure	Be on the spot	The fishing rod runs to the bottle.
On the side	Request silence	The monkey is distracted by the flying trees.

Subsequently, an app-specific analysis was performed across all items in all languages. This results in a total number of items considered of 225 items per app. The collected data was statistically analyzed (ANOVA, Matlab, R2002a).

Furthermore, the categories of availability, costs, number of languages and additional functions were evaluated on the basis of the manufacturer's specifications with regard to their utility in the therapy process.

3. Results

There was a significant result for the three categories evaluated (content $p < 0.001$, grammar $p < 0.001$, pronunciation $p = 0.002$). For a more detailed analysis, pairwise comparisons were made to highlight the difference between native language level and the level of each app. All significant results are shown in bold. (Table 4)

Table 4. Results of pairwise comparisons between native speaker and app.

Categories	Comparison	App	p
Accuracy of the content translation	Native speaker	iTranslate translator	$3,93 \cdot 10^{-8}$
		Microsoft translator	$7,82 \cdot 10^{-6}$
		Google translator	$2,26 \cdot 10^{-6}$
		Q Multi Language Translator (NyxCore)	$1,34 \cdot 10^{-11}$
		Talkao translator	$5,77 \cdot 10^{-6}$
		Reverso translator	$1,32 \cdot 10^{-17}$
Accuracy of the grammatical translation	Native speaker	iTranslate translator	0
		Microsoft translator	0,94
		Google translator	0,94

		Q Multi Language Translator (NyxCore)	0,70
		Talkao translator	0
		Reverso translator	5,88*10⁻⁴
		iTranslate translator	0,25
		Microsoft translator	0,008
		Google translator	0,69
Accuracy of pronun- ciation	Native speaker	Q Multi Language Translator (NyxCore)	0,97
		Talkao translator	0,07
		Reverso translator	0,008
		iTranslate translator	3,43*10⁻⁴
		Microsoft translator	2,53*10⁻⁵
		Google translator	0,003
Total	Native speaker	Q Multi Language Translator (NyxCore)	3,43*10⁻⁴
		Talkao translator	4,94*10⁻⁴
		Reverso translator	6,66*10⁻¹²

The Reverso translator is the only app that differs significantly from the native speaker in all three categories. Microsoft Translator is the only app to show significant differences to the native speaker in two categories, content translation and accuracy of pronunciation. The other four apps only differ significantly from the native speaker in the category accuracy of content translation.

In the overall evaluation of the three categories, all apps differ significantly from the native speaker, with Google Translator showing the closest overall approximation to the native speaker. Fig 1 shows the distributions graphically, based on percentages for clarity.

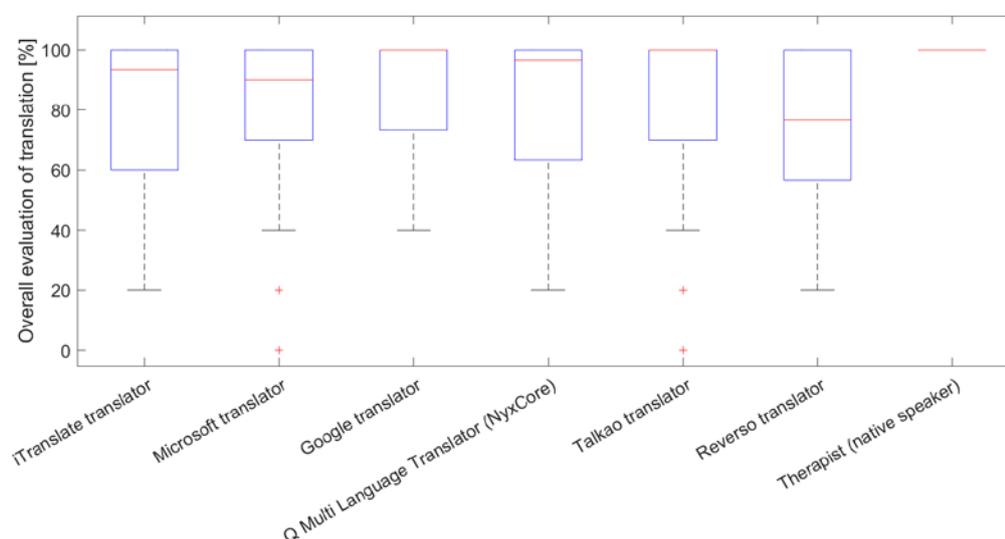


Figure 1. Illustration of the distributions of the overall rating of the applications for the categories of content and grammatical accuracy and pronunciation.

Except for Q Multi Language Translator (NyxCore), all apps are available in the Apple App Store, as well as the Google Play Store. Microsoft translator, Google Translator and the Q Multi Language Translator (NyxCore) can be used free of charge. Four apps have a selection of more than 100 different languages. Only Microsoft translator has a slightly smaller number of 91 languages. The Reverso translator has a much smaller selection of thirteen languages.

In the additional features, all apps offer the possibility to save a history and the option to select alternative translations. With the exception of Talkao Translator, the speech rate can also be changed in all apps. iTranslate and Microsoft Translator also offer a choice between a male and female voice, while Q Multi Language Translator (NyxCore) also has several male and female speakers. The Q Multi Language Translator (NyxCore) is the only app that offers the possibility to change the pitch of the voice. The more comprehensive, cost-effective, and easily accessible the app, the more flexibly it can be integrated into therapy. (Table 5)

Table 5. Evaluation of the availability in the app stores, cost, number of available languages, and additional functions.

App	Availability in the app stores	Costs	Number of languages	Additional functions
iTranslate translator	Apple and Google	Google: 4,99€/month and 39,99€/year Apple: 59,99€/year	Google and Apple: 100	<ul style="list-style-type: none"> History storage Change in speaking rate Choice between male and female voice Selection of alternative translations

Microsoft translator	Apple and Google	Free of charge	Google and Apple: 91	<ul style="list-style-type: none"> • History storage • Change in speaking rate • Choice between male and female voice • Selection of alternative translations
Google translator	Apple und Google	Free of charge	Google and Apple: 109	<ul style="list-style-type: none"> • History storage • Change in speaking rate • Selection of alternative translations
Q Multi Language Translator (NyxCore)	Google	Free of charge	109	<ul style="list-style-type: none"> • History storage • Change in speaking rate • Pitch change • Selection of different speakers with different dialects • Selection of alternative translations
Talkao translator	Apple and Google	Google: 49,99€/year Apple: 4,99€/Monat und 49,99€/Jahr	Google and Apple: 129	<ul style="list-style-type: none"> • History storage • Selection of alternative translations
Reverso translator	Apple and Google	Google: 3,99€/Monat und 19,99€/Jahr Apple: 3,99€/Monat und 29,99€/Jahr	Google and Apple: 13	<ul style="list-style-type: none"> • History storage • Change in speaking rate • Selection of alternative translations

4. Discussion

Considering the linguistic diversity in Germany and the known limited availability and cost intensity of interpreters, alternative possibilities for communication in hearing speech rehabilitation with CI are necessary. Multilingual conversational applications are one option and in their current form can already significantly simplify basic concerns of hearing speech therapy. Overall, the requirements for multilingual conversation apps in this context are high, as are the demands on the therapists, who ultimately have to be able to understand the patients' feedback and responses and also evaluate them in a foreign language.

On the part of the app, various criteria had to be met, which were initially defined. The quality of the translation in different languages is of fundamental importance in therapeutic use, which is why both the content and grammatical consistency as well as the pronunciation were checked by native speakers and compared with the linguistic abilities of a native speaker. However, since a therapeutic treatment consists of more than the simple translation of individual items, further characteristics of the app were considered and examined with regard to the most suitable possible use in therapy. In the first phase of rehabilitation, exercises at the word, phrase, and sentence level are sufficient to draw conclusions about further necessary adaptation steps [6]. Therefore, the item selection was initially limited to these levels.

Optimally, an application that can be used for several languages should be available in the therapeutic setting. Therefore, the individual apps were analyzed in terms of their suitability for different languages.

In terms of pure translation and pronunciation performance, all apps differ significantly from the linguistic abilities of a native speaker. Even though Google Translator shows the closest approximation to the native speaker level, this prerequisite is not sufficient to draw reliable conclusions from individual exercises for language processor adaptation. Since the language barrier does not allow for any control on the part of the therapist, the translation and pronunciation in particular should be reliable. The evaluation of the other categories shows the possibility of a partial compensation of this deficit. Above all, the selection of alternative translations can remedy deficiencies in the accuracy of the translation of the content. However, the selection option and the other functions examined are not practicable in the therapy process in all apps, so that disruptions occur, for example due to long pauses. Only the selection of alternative items in Google Translator and the iTranslate translator as well as the adjustment of the speaking rate in Microsoft Translator are spontaneously available for each input.

In the study, the main focus was on the suitability of the app, yet the user must also be able to integrate the app meaningfully into the therapy. This task requires a high degree of concentration on the part of the therapist, since it is necessary to register in which frequency ranges problems in understanding arise. The missing display of the phonetic transcription within the app makes this analysis more difficult. An additional problem results from the difference of the phonetic systems of the different languages.

In order to be able to use multilingual conversation applications with an improved therapy benefit, the extension of the translation by the phonetic transcription is meaningful. The use of assistance should also be made possible, and the utility of the application should be improved. For example, a selection of feedback through Applications or the possibility to repeat a specific word in a sentence would be conceivable.

Furthermore, the complexity of the utterance, such as the length of a word, has therapeutic value [4]. Since the words in a foreign language do not necessarily have the same number of syllables as in the therapy language, the therapist loses control over the therapy material at this point.

Not included were utterances of higher complexity, which would be necessary in order to use a wider range of exercise materials and also to be able to have counseling and

therapy conversations directly with the patient and give exercise instructions or instructions for adjusting the required exercise volume.

Another challenge was the German language skills of the native speakers who evaluated the translations. The level of language proficiency was such that conversations in German were possible, but not at a native level for all. In addition, none of the individuals had prior knowledge of linguistics. This may have led to inaccuracies in the evaluation. Likewise, some reported that certain words or phrases did not translate well directly.

In order to compensate for the possible limitations in therapeutic action and any inaccuracies in the evaluation of the translation, designing foreign-language therapy material would be helpful.

However, the more reliably apps function for translating complex content, the broader the spectrum of possible applications. The active involvement of the patient becomes easier and the contact to the patient more direct, more personal and has an influence on the motivation for therapy and thus on the success of the therapy.

5. Conclusion

In an overall comparison, Google Translator currently offers the best possibilities for use in therapy. The biggest limitation, the partially inaccurate translation of content, can be partially compensated for by the alternative translation suggestions integrated in the app. The app is free of charge and thus quickly available in the daily practice or clinic routine.

For further adaptations of the apps, the optimization of the fitting and the habituation to hearing and understanding with the CI should be in the foreground. Achieving this would motivate further practice and allow for the quickest possible benefit for the CI user. Ultimately, however, the goal should be the closest possible approximation to a therapy carried out by a native speaker.

References:

1. Merse, S., Translation processes in doctor-patient communication. In: Anton Gillessen, Solmaz Golsabahi-Broclawski, André Biakowski, and Artur Broclawski (eds.): *Intercultural Communication in Medicine*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2020, 61-71.
2. Diller, G. (Re)habilitation after treatment with a cochlear implant. *HNO* 2009, 57 (7), 649-656. DOI: 10.1007/s00106-009-1922-3.
3. Illg, A. Rehabilitation in children and adults: An overview. *HNO* 2017, 65 (7), 552-560. doi: 10.1007/s00106-016-0311-y.
4. Heinemann, S. The path to new hearing. Aspects of counseling and therapy for adult cochlear implant users. *Spectrum Patholinguistics* 2014 (7), 13-39.
5. Jonas, K., Jaecks, P., Niebuhr-Siebert, S., Wahl, M., Leinweber, J., Bilda, K., et al. (): *Spectrum patholinguistics volume 14*, 2021. focus topic: click by click: Steps in digital speech therapy.
6. Rötz, W., Bertram, B., *Cochlear implant in adults. Care and rehabilitation in speech and language therapy*. Heidelberg: Springer. 2022.