An Assessment of Mobile Applications Targeting Speech Sound Disorders and Accent Modification

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Abstract

Speech language pathologists have increased the use of mobile applications for treating speech sound disorders. Therefore, it is important to know the quality of mobile apps, as many cost money. Previous research has assessed the quality of mobile health applications but was not specific to speech sound disorders and the research put into them. The current study was developed to assess the quality of mobile health applications of speech sound disorders and accent modification and focused on correlation between quality and price. We collected data by searching for relevant keywords on the Apple App Store and cataloged the results. The apps were assessed on multiple quality indicators including functionality, aesthetics, information, subjective quality, and SLP-specific metrics. The metrics created a profile of the apps and correlations between quality app features and cost were examined.

Our findings indicate it is unclear if there is a correlation between price and quality, but price does have some influence over quality. More expensive apps seem to cite research more often and provide treatment for more sounds. Additionally, the apps targeting speech sound disorders seemed to be of a higher quality because they were more likely to have an SLP on the development team or cite research, than apps targeting accent modification or both. Ultimately, an SLP should use mobile applications that are evidence-based and most relevant to their client's needs.

Introduction

As the world has become more technologically advanced, there are more and more advantages to using technology to learn, grow, and educate patients on their disorders. Speech-language pathology is one field that has grown and adapted over time and has begun to use technology to benefit patients in need of speech therapy. Telehealth is one example of the use of technology to benefit patients, because it allows for long distance care, education about the patient's disorder, support, and reminders. Mobile applications have also become more popular with speech language pathologists, because they can be used independently by clients/patients to practice skills.

In 2020, the COVID-19 pandemic struck full force and coerced many health fields, including speech language pathology, to use technology to provide services to clients remotely to ensure adequate social distancing. As hospitals, clinics, and schools were shut down across the United States, there were limited ways for health professionals to interact safely with patients. For speech language pathologists, this was especially difficult because treating speech errors must occur face to face, whether it be in person or through telehealth treatment. The safety precautions to avoid the virus also included wearing masks, which can be detrimental to providing an accurate diagnosis of communication disorders—particularly in the case of speech sound disorders. Given these barriers to treatment for speech, the alternate route of mobile applications for treating/practicing treatment methods became much more popular. The use of mobile apps allowed speech language pathologists to continue treating their patients and allowed patients to continue to practice their treatment methods outside of their speech appointments.

Speech sound disorders can occur when individuals leave sounds out, add sounds, change a sound, or substitute one sound for another. It is, "an umbrella term referring to any difficulty or combination of difficulties with perception, motor production, or phonological representation of speech sounds and speech segments—including phonotactic rules governing permissible speech sound sequences in a language," (ASHA, n.d.). Treatment includes clients learning when sounds are correct or incorrect, and learning the correct way to make sounds. It also includes clients practicing how to make the correct sounds in words and sentences. Speech language pathologists purchase these apps to treat their patients in therapy sessions, and they are used for outside practice when patients are sent home with a list of goals, homework, or exercises to practice. Overall, it is important to know the quality of the app, as many of them cost money and clients deserve to have a quality product that will help treat their speech disorder.

In reviewing the current literature at the start of this study, there was only one peer-reviewed study that widely and systematically assessed the quality of speech-language pathology apps. In 2016, Furlong and colleagues from La Trobe University, Healthscope Northpark Private Hospital, and the Centre for Sport and Exercise Medicine Research in Bundoora, Australia, wrote a protocol for using evidence to assess the quality of mobile apps for speech sound disorders. The protocol utilized the Mobile Application Rating Scale (MARS) presented by Stoyanov and colleagues in 2015, which is a general, 5-point scale for measuring the engagement, functionality, aesthetics, information, and subjective quality of apps. The app quality criteria were then clustered into 23 subcategories. A few of the subcategories included entertainment, interest, ease of use, layout, quality of information, and subjective qualities, like

"Would you recommend this app?" (Stoyanov 2015). The scale has no section for assessing treatment methodologies, inclusion of research, or any other SLP-specific metrics.

In 2018, Furlong and colleagues presented outcomes following their 2016 protocol to assess apps targeting speech sound disorders in children aged 12 and under. Based on the Mobile Application Rating Scale, most of the apps assessed were rated as average and none were rated as excellent. They did acknowledge that the rating scale may not necessarily correlate with outcomes or therapeutic benefit and suggested that a tool considering intervention theory and methods is needed. Furlong and associates opened the door for more speech language pathology mobile app research by using the MARS to assess speech sound disorder apps and pointing out how the scale could be improved for these apps. We attempted to complement their analysis and tailor it more to treatment for speech sound disorders by including metrics that target intervention theory and methods.

We had two research goals. First, we set out to determine what types of treatment features were available in apps for the treatment of speech sound disorders and accent modification. We considered which sounds were targeted, what treatment methods were utilized, what stimuli were provided, and whether research evidence was cited. We decided to focus on apps for speech sound disorders and accent modification because speech sound disorders are common in children and accent modification apps are focused on accurate production of speech sounds. Speech sound disorders and accents can also lead to, "social and academic difficulties with persisting consequences into adolescence and adulthood," (Furlong 2018). It is important to treat speech sound disorders early and successfully but accessing speech therapy can be difficult. However, technology and mobile health can improve access.

Second, we wanted to look for possible relationships between the app quality/treatment features and price. Our hypothesis was that when the app quality and number of treatment features go up, so does price.

Methods

In this research study, mobile applications for children with speech sound disorders and individuals seeking accent modification were assessed for quality.

An undergraduate research assistant searched for relevant applications in the Apple Application Store. The assistant searched the Application Store for apps using the terms "speech, phonology, phonological, articulation, artic, talk, pronunciation, speak, say, chat, speech therapy, speech pathology, accent modification/accent mod, accent training, accent reduction training, accent reduction, and speech disorder". The terms "speech, phonology, phonological, articulation/artic, talk, pronunciation, speak, say chat, speech therapy, and speech pathology" were previously used in a study for assessing quality of mobile health applications for speech sound disorders detailed by Furlong and colleagues (2016). The current study was altered to include applications targeting both speech sound disorders for children and accent modification because technology and mobile access to speech therapy is important to treating a speech sound disorder early. This search yielded 2,907 titles.

Screenshots were captured and collected for every search term's result to ensure all applications were captured with minimal repetition. Salazar and colleague's publication (2018) concerning quality of mobile health applications for the management of pain discussed the changeability of the application market and that application results may appear in varying order

or present different sets of apps. Taking screenshots of the results provided a snapshot of the applications in the Application Store when the process began (mid-December 2020). Once screenshots were compiled, the undergraduate assistant transcribed all application titles in a Microsoft Excel document, sorted by search term.

To narrow the review pool, irrelevant applications were highlighted and removed. Applications with clearly irrelevant titles were removed first. An application was considered irrelevant by title, for example if there was no correlation between the title and speech pathology or speech sound disorders or accent modification, like the title of an app, “Text to Speech!”. From this title we were able to determine that the app was used to bring speech production from the words that were entered into the text box, it was not used for speech therapy. That app was considered irrelevant based on the title. This metric removed 63 percent of the original pool. All “accent mod” titles were deemed irrelevant, and 99.6 percent of “chat” titles were removed because they were not specifically relevant to speech therapy. Then, applications were removed by two undergraduate assistants based on the applications’ screenshots or the picture icon of the app. If the icon showed that the app was for a different language, for example, the app was removed from the list. After the second wave of removal, 100 percent of “say” and “speech impediment” titles and 99.1 percent of “talk” titles were deemed irrelevant based on descriptions. The remaining titles that we considered relevant and wanted to analyze focused on alphabet learning, apraxia, English sounds and visualization, rhyming, phonics, minimal pairs, syllables, and vowels to ensure all applications relevant to speech sound disorders and accent modification were included.

The list of relevant applications was then entered into a Microsoft Excel spreadsheet to prepare for analysis. After all applications were listed, Excel's conditional formatting was used to remove duplicate titles. Conditional formatting changes the appearance of cells based on the conditions the owner of the spreadsheet specifies. We used conditional formatting to notice if any app titles were repeated. This step allowed us to notice repeated titles we may not have caught with the naked eye. Additionally, 29 apps were removed from the App Store at some point during our research. Irrelevant titles, duplicates, and those that disappeared from the App Store were removed from our sample. After this initial sorting and [removal of apps that were taken off the market over the course of our research], we were left with 159 relevant titles.

Thirty-five metrics were chosen to assess the efficacy of the relevant apps based on what we considered as helpful to determine the quality of an app. Several metrics were adapted from the MARS and previous similar studies (Stoyanov et al., 2015; Stoyanov et al., 2016; Furlong et al., 2016; Furlong et al., 2018; Handel, 2011; Morera et al., 2016; Salazar et al., 2018). Previous reviews of mobile health applications focused less on consumer data and security, so several metrics were adapted from Morera and colleagues' "Security Recommendations for Mobile Health Apps" (2016). Consumer data is needed, because customers are the people using the apps. A list of all metrics is below. Many metrics simply identify each application as having a feature (with a binary yes/no rating), while other metrics are more complex. Protocols for assessing complex metrics are described in Table 1. These metrics helped us create a profile of current apps and draw correlations between app quality features and price.

Table 1

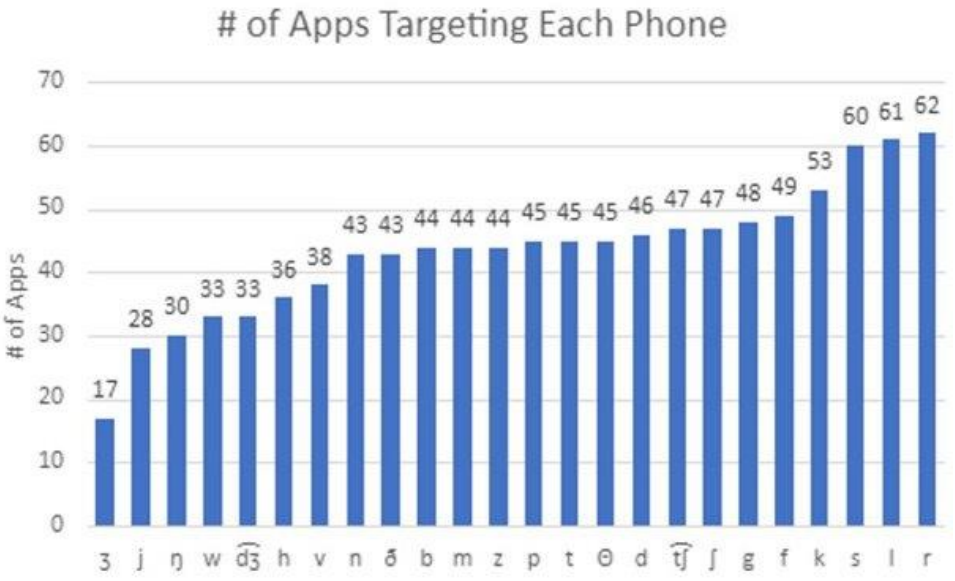
Coded Metrics

Metric Code	Description
Updates	# of updates so far.
UpdtFreq	Avg time between updates.
Year	Year released.
Rating	App Store rating.
NumRates	# of audience ratings.
Price	Cost of basic/cost of premium.
Devel	Name of developer.
PrivPol	Has a privacy policy.
Age	Age targeted.
Disorder	Disorder(s)/condition(s) targeted.
Treatment	Treatment(s) utilized.
Vids	Use of video in treatment.
Pics	Use of photos in treatment.
DevelSLP	Developed by or with an SLP.
Research	Research cited in app or description.
%Phones	Percent of total 24 English consonants available to practice.

Results

The aim for this study was to determine what types of treatment features were available in apps for the treatment of speech sound disorders and accent modification, and to look for possible relationships between app quality/treatment features and price. First, we measured the number of applications that target each phone.

Figure 1



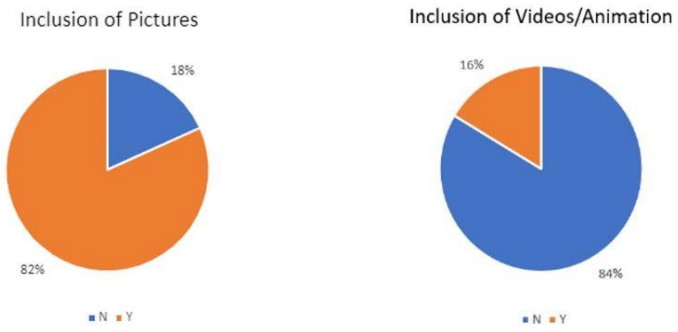
In Figure 1, when we analyzed our data with sounds compared to the number of apps that target each sound, we used the international phonetic alphabet (IPA) to look at the data. There are 26 letters in the English alphabet, but there are 44 phonemes or individual sounds used by speakers. When we focus on speech sound disorders and accent modification, we want to focus on phonemes to see more in depth of what is being targeted.

The “r” sound was found to be targeted the most often, in 62 apps, while the /ʒ/ sound is targeted in only 17. Each sound was targeted in 44-45 different apps. Additionally, most of the frequently targeted sounds seem to be late acquired, which is expected, because late-acquired

sounds are the most frequently in error. “Within the United States, the consonants /ɹ/ and /s/ are commonly reported as ‘residual errors’ and ‘common clinical distortions’ for children with persistent SSDs, (e.g., Karlsson et al., 2002; Shriberg et al., 1997b),” (Crowe). However, there are a few late-acquired sounds like /ʒ/ and /ŋ/, which are targeted in fewer apps than the median of 44.5. This could be due to the fact that these sounds are less frequently in use.

Next, we’ll look at the inclusion of pictures and videos in these apps. We wanted to identify whether pictures and videos were used in the apps because these can help the individual visualize what they are supposed to do with their oral structures. They can also help create conversation and are a way to get the individual to start talking and share communication.

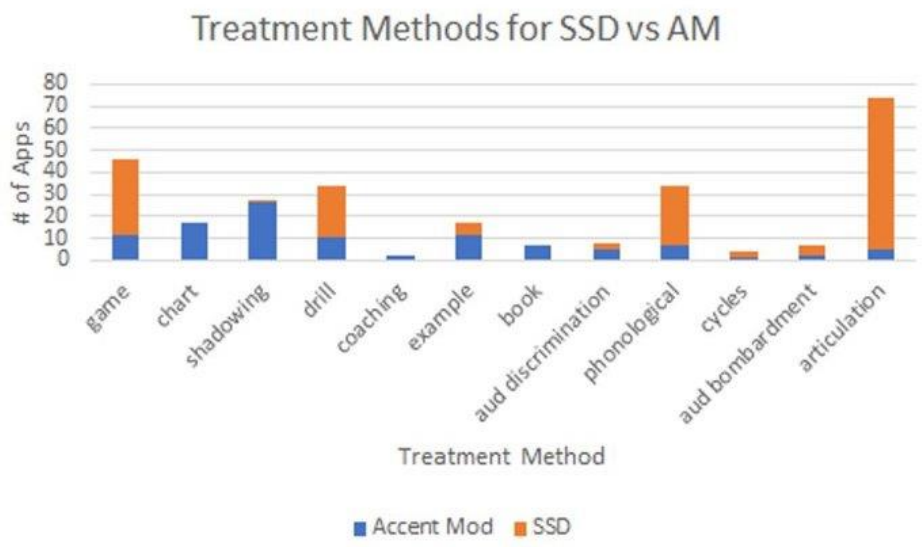
Figure 2



In Figure 2, the apps that include pictures (left panel) or videos (right panel) are colored orange. Those that do not are colored blue. Based on our findings, the majority of the apps we analyzed included pictures when treating speech sound disorders or accent modification. Videos were much less common. Fewer than 1 in 5 of the apps we considered use videos or animations to stimulate improvement.

Next, we analyzed treatment methods used for intervention of speech sound disorders and accent modification in our sample.

Figure 3

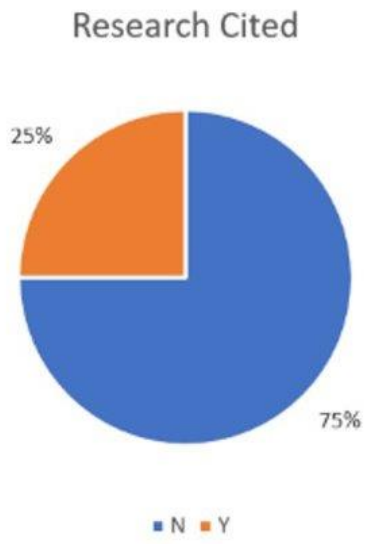


Now, looking at Figure 3, the frequency of treatment methods used in apps for speech sound disorders is marked orange. The blue areas mark the frequency of treatment methods in apps for accent modification. When we looked at apps that target speech sound disorders (orange in the figure), we first classified them based on whether the intervention took a phonological approach, meaning the intervention focused on targeting a group of sounds with similar errors or an articulation approach, meaning the intervention focused on the formation of clear sounds. Then, we gave the apps tags to help describe what kind of treatment they provide. Apps targeting speech sound disorders more frequently used the articulation approach and most descriptions explained that a lot of the apps used games or drilling to practice speech sounds. For apps targeting accent modification, shadowing was most common, which is when clients repeat a

word or phrase after hearing it. Many apps also provided a chart of words or letters with audio clips in which each sound was spoken aloud for the user to hear.

Another quality metric we looked at was if research was cited or a part of the development of the app. We wanted to look at research in the mobile applications, because licensed SLPs are bound by ASHA's Code of Ethics to provide evidence-based treatment. If we saw there was a licensed SLP on the development team, it told us that there was a good chance that evidence-based intervention was used for treatment in the app.

Figure 4

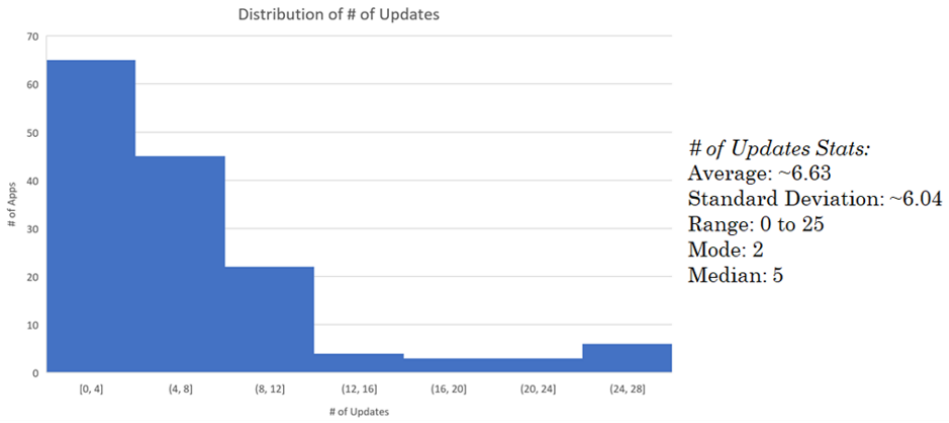


In order to determine whether apps cited research, our team read app descriptions and checked screen captures on the App Store to see whether research was mentioned or if a SLP was on the development team. Licensed SLPs are bound by ASHA's Code of Ethics to provide evidence-based treatment, so if we see there was a licensed SLP on the development team, it suggests that research was likely considered, and clinical judgment was used. According to

Figure 4, we found that only a quarter of the apps we assessed cited research or had an SLP on the development team. This indicates that the bulk of speech sound disorder and accent modification intervention apps on the market may not provide evidence-based treatments.

In total, we analyzed 93 speech sound disorder apps, 55 accent modification apps, and 12 apps that targeted both. While we were not able to get a clear answer of whether every single app cited research, our data suggested that apps targeting speech sound disorders are more likely than apps targeting accent modification or a combination of the two to cite research or have an SLP of the development team.

Figure 5



Additionally, we examined the number of times that apps were updated. The idea was that if the mobile applications were kept updated, it was likely that they would have current, relevant, and evidence-based treatment. If the apps had current intervention styles, it was likely that they were of a higher quality.

This histogram in Figure 5 gives a visual of how many updates are common in apps for the treatment of speech sound disorders and accent modification. The number of updates may indicate how much revision and improvement is happening in these apps.

As you can see in the histogram, many of these apps have between 0 and 4 updates. Very few apps have 16 to 24 updates. On average, apps for the treatment of speech sound disorders and accent modification have 6 to 7 updates. 11 of the 159 apps in our sample had no updates, meaning no changes or improvements were made to the apps. This means at least 93 percent of the apps we analyzed had at least one update at the time of analysis. However, there were no patterns relating to the number of updates that were found and no statistical relation between number of updates and either price or app rating.

Figure 6

Overall, we wanted to see some features related to price. Two categories stood out to us specifically, the number of phones or speech sounds targeted compared to price and if there was research cited, how that related to price.

As you can see, in Figure 6, price increases as you move along to the right on the x-axis and the number of sounds targeted in an app increases upward on the y-axis. The R-value is 0.31, which means that there is a moderate, positive correlation between price and the number of sounds targeted. For background, the mode for the number of sounds targeted in speech sound disorder apps was 1. The most sounds any of these apps targeted was 25. The median number of sounds targeted was 8.

Using this data and the app price data, we plotted every speech sound disorder app to see how price corresponds to the number of sounds targeted and inserted a line of best fit. The data we gathered suggests that higher prices correlate with more phones being targeted. This further supports the hypothesis that higher prices correlate with better quality.

Figure 7

The other feature we wanted to focus on was if there was research cited, and how that related to the price of the app. According to Figure 7, the most expensive app was $59.99, and the median price was $1.99. We sorted the apps into categories, paid versus free, to see whether the apps were different in their citation of research. The orange sections represent the number of apps that cited research and blue sections represent those that did not. The left column shows the distribution of free apps and the column on the right shows the distribution for paid apps. This appears to show that paid apps are more likely than free apps to cite research. This, again, follows our hypothesis that higher prices would correspond with higher quality treatment.

Discussion

When focusing on our first research goal of determining what types of treatment features were available in apps for the treatment of speech sound disorders and accent modification, we started by looking at the number of applications that target each phone. Each sound was targeted

in 44-45 different mobile applications. Most of the repeated, targeted sounds seemed to be acquired late, which was expected, because late-acquired sounds seem to cause the client to have the most errors. This is helpful for mobile applications targeting speech sound disorders and accent modification, because it allows the client to have more practice on the sounds that, on average, are more difficult to acquire.

When looking at the inclusion of pictures and videos in these apps, the majority of the apps included pictures, videos were much less common. More pictures are an advantage over more videos, because to treat speech sound disorders and accent modification, the client must practice speaking out loud. Pictures can help create a conversation or stimulate a discussion, whereas videos must be watched and then talked about. When an app uses pictures instead of videos, it gives the client more time to practice speech verbally.

As for the frequency of treatment methods used, apps that targeted speech sound disorders were more likely to use an articulation approach, and games or drills to practice specific speech sounds. Games are helpful to keep the client invested and enjoying the treatment, while still allowing the client to practice specific sounds many times. For apps targeting accent modification, shadowing was used many times, which is when clients repeat a word or phrase after hearing it. This repetition is healthy, because again, it allows the client to practice specific sounds many times after hearing how they are supposed to be spoken in the correct accent.

When looking at research cited, we analyzed 93 speech sound disorder apps, 55 accent modification apps, and 12 apps that targeted both. Our data relayed the information that only a quarter of the apps we assessed cited research or had an SLP on the development team, which

indicated that most of the mobile applications on the market focus on speech sound disorders and accent modification intervention, might not provide evidence-based treatment. This is helpful for speech language pathologists to be aware of. An app does not have to cite research to be beneficial to a client, but it is good for an SLP to be aware that not all apps are required to provide evidence-based interventions.

The last metric we examined on its own was the number of times that apps were updated. It was our hypothesis that if the apps were updated, it would be likely for them to have current evidence-based interventions. If they had evidence-based treatment, it was likely that the apps were of a higher quality. However, there were no patterns relating to the number of updates that were found and no statistical relation between number of updates and either price or app rating.

When focusing on our second research goal and looking for possible relationships between the app quality/treatment features and price, we started by looking at price and the corresponding number of sounds targeted. There was a moderate, positive correlation between the number of sounds targeted and price. When more phones were being targeted, there was a correlation to a higher price, and supports the hypothesis that higher prices correlate with better quality. However, it should be noted that higher prices do not guarantee good app quality and that some more affordable apps may be of good quality and provide treatment for all a client's relevant speech sounds. Relevant meaning, the client may not need all 25 sounds that may be offered in an app, they may only need one.

We also focused on the correlation between research and the price of mobile applications for the other part of our second research goal. Paid apps were more likely than free apps to cite

research, which, again, follows our hypothesis that higher prices would correspond with higher quality treatment. Nevertheless, it is concerning that less than 13 percent of free apps cite research, even though they are more available to a wide audience of clients.

Overall, there is a lack of research cited in these apps and it is unclear if there is a true correlation between price and overall quality. We did not have enough apps with research, which qualified them as a quality app, so we cannot draw a statistically solid correlation between the two factors. However, price does seem to play some role in quality. If the quality goes up, the price of the app tends to go up as well. SLPs should not determine quality solely by app price, but more expensive apps do seem to cite research more often and provide treatment for more sounds. It is up to the SLP to determine which apps are the most evidence-based and most relevant to their clients, but it is our hope that our research helps narrow down which apps have the best quality and have the best treatment interventions.

Along with Furlong and colleagues, we found that most of the apps targeting speech sound disorders and accent modification that were assessed were average, and none were exceptional. How the apps were rated might not correlate with outcomes or benefits, but we hope that more apps for intervention of speech sound disorders and accent modification will be developed with an SLP on the development team. An SLP on the development team will help to ensure that more mobile applications use evidence-based practice. Our hope is that this would lead to more quality apps that target speech sound disorders and accent modification to be placed on the market.

Conclusion

In conclusion, there is a wide variety of app features. Some apps are expensive, and some are not. Some apps target more sounds than others and some are more visually appealing. While cited research may point to apps providing better evidence-based treatment, other factors are up to taste.

There is a wide variety of app quality and quality is subjective. Some SLPS may prefer videos, others may find them distracting. SLPs that see many clients struggling with a small list of sounds may prefer more affordable apps that target fewer sounds over expensive apps that include everything. An app may not need to target all 24 English consonants to do its job.

Conclusively, speech language pathologists should use a holistic approach and clinical judgment when deciding which apps are best. Research and evidence are important, but understanding what app fits their client best is just as important. All features are relevant to app selection, but there is no "one perfect app" that will fit for every client and SLP. It is the hope that this information allows SLP's to make more informed choices when suggesting and using mobile apps in intervention.

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