# Provision of Speech-Language Pathology Telepractice Services Using Apple iPads

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## Abstract

*This exploratory study evaluated the effectiveness of Apple (Cupertino, CA) iPad® (second generation) to deliver telepractice speech and/or language services. Five children and their parents/guardians, as well as four adult participants, received services for communication disorders in a university clinic setting over two academic semesters. The children met some of their speech goals and all of their language goals. All adult clients met some of their communication goals. Personal opinions about telepractice did not change statistically before and after therapy. The major problem identified during the study was skipping and/or freezing of images on the iPads during interactions with FaceTime® (Apple). Further studies are needed to investigate the feasibility of using Apple iPads in telepractice.*

**Key words:** *telehealth, pediatrics, rehabilitation, education*

## Introduction

The American Speech-Language-Hearing Association (ASHA) defines telepractice as "the application of telecommunications technology to deliver professional services at a distance by linking clinician to client, or clinician to clinician for assessment, intervention, and/or consultation."[1] Although other synonymous terms are frequently found in the literature such as telehealth, telecommunication, and telerehabilitation, for the purpose of this speech–language pathology study, the term telepractice will be used. The provision of telepractice services in the United States requires that speech–language pathologists (SLPs) continue to adhere to the ASHA Code of Ethics, ASHA Scope of Practice, state and federal laws (e.g., licensure, the Health Insurance Portability and Accountability Act (HIPAA),[2] etc.), and ASHA policy documents on professional practice.[1,3]

### BENEFITS OF TELEPRACTICE

Individuals across the generations, and especially students, use electronic devices for communication, games/entertainment, education, and social media.[4] In an era of rapid technological change, new electronic devices that provide interactive, synchronous (real-time audio and video), communication between the SLP and client can be effective in the evaluation and intervention of speech and/or language disorders.[4–6] This is especially true for clients who live in "remote, rural, and underserved" communities.[3] A comparison of various approaches in the provision of speech–language services found several benefits to using telepractice.[7] Telepractice provides improved access to care for individuals that travel long distances for services and who have mobility limitations (e.g., walking and getting out of the home).[7] Other benefits include a reduction in cost of care due to decreased travel time, consultations with SLP specialists at a distance, access of services from bilingual SLPs, increased motivation for therapy, and an improvement in outcomes.[1,3,5–8]

### PROBLEMS ASSOCIATED WITH TELEPRACTICE

Clients who receive speech and/or language services may have unique needs and limitations (e.g., physical, sensory, and cognitive) that should be evaluated to see if they are appropriate candidates for participation in telepractice. Some of these limitations such as cognitive deficits (e.g., sustained attention, working memory, problem solving, and reasoning) may negatively affect being able to remember instructions on how to use telepractice devices and to decide what to do if the technology is not working properly. Other clinically related limitations include possible modifications of assessment and therapy procedures and materials, client orientation and training for telepractice, private and adequate environments for telepractice sessions, accessibility of Internet services, and the use of the telepractice equipment in a culturally sensitive manner.[1,3,5,7]

Prior research indicated the importance of using proper connectivity mediums, bandwidth, and equipment for the desired clinical outcomes.[9] Problems with bandwidth, network congestion, poor audio and/or visual quality, disconnections, audio static and echo, and delayed audio and/or visual images during videoconferencing are commonly reported in the literature.[10–14]

### TELEPRACTICE STUDIES WITH CHILDREN WITH COMMUNICATION DISORDERS

Telepractice therapy has been implemented with children and adults with various types of communication disorders.[4,8,15] For children, telepractice is widely used in school settings for speech and/or language disorders.[8] Suggestions have been made for the successful implementation of telepractice services delivered to children in educational settings.[8] These recommendations include ensuring client privacy and confidentiality, marketing the benefits of telepractice to other school professionals and parents, determining equipment need, obtaining personnel assistance, selecting appropriate materials,

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choosing the best setting to conduct telepractice, and analyzing outcomes.[8] Caution should be taken when performing standardized assessments with children via telepractice because of the limited evidence-based research available.[14,16,17]

## TELEPRACTICE STUDIES WITH ADULTS WITH COMMUNICATION DISORDERS

In adults with traumatic brain injury the use of telepractice for the assessment of discourse ability was investigated.[18] Twenty adults with chronic, moderate to severe traumatic brain injury were evaluated using the two conditions of in-person and telepractice assessments. A stationary, designated telepractice computer and laptop were used in this study. Participants were randomly selected to complete testing using one condition (e.g., in person) and then were re-assessed using the second condition (e.g., telepractice). The Repeatable Battery for the Assessment of Neuropsychological Status was administered in-person and via telepractice with each participant using alternate Repeatable Battery for the Assessment of Neuropsychological Status forms.[18] Additionally, the discourse measure of extemporaneous conversation with the clinician, narrative discourse/story-telling, descriptive discourse/picture description, and procedural discourse using the Mediated Discourse Elicitation protocol and protocol from the AphasiaBank were video-recorded and transcribed for analyses.[18] The authors reported that there were no statistically significant differences between both evaluation conditions. The in-person and telepractice assessments obtained similar results for language productivity, variety, fluency, and clinician behavior. Participant feedback was mixed in regards to which condition was preferred for assessment. The researchers concluded that there are "many potential benefits to make telepractice worth pursuing."[18]

Another telepractice study focusing on the assessment of adults with neurogenic disorders was completed.[13] The study included 32 participants with aphasia due to stroke or traumatic brain injury. The researchers compared the validity and reliability of in-person versus Internet videoconferencing assessment using the Boston Diagnostic Aphasia Examination-3 short form and the Boston Naming Test (2nd edition).[13] Participants were simultaneously assessed by two SLPs for comparison of test results. A satisfaction questionnaire was also completed by the 15 participants who were assessed using videoconferencing. Results found no statistically significant differences between in-person and videoconferencing test scores, with good to very good inter- and intrarater reliability for the telepractice assessments. Participants receiving the videoconferencing assessment indicated high overall satisfaction.

Various adult case studies that incorporated videoconferencing telerehabilitation in a university clinic setting have been described.[19] Telerehabilitation was administered via either Google (Gmail) or ooVoo using PC laptops or Apple (Cupertino, CA) MacBook® laptops. One of the case studies received both in-person and videoconferencing for accent modification. Final data revealed that the client's productions at the word level were similar to results expected for in-person therapy, but the client's performance for sentence level productions was lower than expected. However, the authors stated that the sentence-level productions were "not outside of the range observed for in-person therapy."[19] In the second case study, constraint-induced language therapy for aphasia was provided to seven clients with mild to moderate aphasia via videoconferencing. The authors reported that results for telepractice therapy were similar to those obtained with in-person therapy. The third case study described a client with global aphasia who received in-person trial therapy before receiving communication therapy via Skype on laptop computers. Initial baseline measures of performance were at or below chance, and final data increased to 80% or higher.

## TELEPRACTICE STUDIES WITH STUTTERING

A systematic evidence-based review for stuttering was completed.[20] The authors found no studies that were conducted via telehealth for stuttering assessment. In terms of therapy, adolescents and adult clients who received "telehealth speech restructuring treatment" by telephone and home-based Internet programs required "fewer hours of additional in-person clinic time."[20] In contrast, telehealth services with young children required more in-person clinic time. The authors explained that the difference was possibly due to the training needs of the parent/caregiver of the younger children. The parents/caregivers required more direct education, demonstration, and feedback for their participation in stuttering intervention.[20] Although "videoconferencing or home-based Internet webcam intervention" appears to be readily available, the authors cautioned that "it is probably unrealistic to expect every client who stutters would be managed effectively using these types of intervention."[20] The authors also stated the need for additional telepractice research with school-aged children and adolescents who stutter, especially because this generation has grown up with electronic technology. They concluded that "there is no doubt about the potential contribution of telehealth to assessment and treatment of stuttering"[20]; however, there is a need for more research with this communication disorder.

## TELEPRACTICE STUDIES WITH VOICE AND DYSPHAGIA

An overview of telepractice studies conducted for voice and swallowing disorders was completed.[21] The use of telepractice for the evaluation of dysarthria and voice disorders in adults has been shown to be effective.[11,22] Due to the "frequency and intensity of follow-up" needed for voice therapy, the use of telepractice is a viable means for delivering intervention.[21] One study investigated in-person versus videoteleconference provision of voice therapy.[23] A stationary, dedicated computer and a laptop were used in the same facility to provide the telepractice services. Pre- and posttreatment voice samples from 47 participants were acquired, and acoustic analyses were completed. Participant satisfaction ratings were also obtained. The authors found no statistically significant differences on pre- and posttreatment measures of vocal quality (as rated by two SLPs), jitter scores, and shimmer scores. Mean satisfaction scores for therapy did not differ between in-person and videoteleconference delivery. Thus, the authors concluded that voice therapy provided via video telepractice was as effective as treatment given in-person. This also seems to be the case

for the use of telepractice to deliver the Lee Silverman Voice Treatment (LSVT) for adults with Parkinson's disease.

In another telerehabilitation study, 34 adult participants with Parkinson's disease and mild to moderate hypokinetic dysarthria were assessedpleted.[10] The study was conducted in a university setting using a stationary, personal computer-based videoconferencing system that was located in separate rooms. Participants were randomly assigned to LSVT sessions delivered either in-person or through videoconferencing. Results suggested that LSVT provided through telerehabilitation was as effective as in-person therapy in the areas of sound pressure level parameters, duration of phonation, and maximum fundamental frequency range. Telerehabilitation was also found to improve perceptual voice parameters (e.g., breathiness, roughness, loudness [level and variability], pitch variability) and word and sentence intelligibility. Participant satisfaction using telerehabilitation indicated that they were "very happy or comfortable" receiving LSVT online.[10]

Other researchers investigated the use of an assistive technology system known as the LSVT Companion that supports the LSVT LOUD program for patients with Parkinson's disease.[24] Sixteen adult participants with Parkinson's disease received in-person and LSVT Companion treatment. LSVT Companion is an "interactive, customized, personal, digital assistant-based software program that the participants can use at home for self-training" on home computers combined with in-person therapy.[24] Each participant received nine in-person voice therapy sessions and then independently used the LSVT Companion program at home for 7 weeks of therapy. Descriptions of the types of computers used by the participants for LSVT Companion were not provided. The authors indicated that the participants made significant gains in vocal sound pressure level measures, voice quality, and articulation when results were compared between pre- and post-LSVT and between pre-LSVT and follow-up at 6 months. Participants were able to use the LSVT Companion without difficulty and found the program "very helpful."[24] Significant others rated vocal changes as "favorable" following the program of in-person LSVT and the use of LSVT Companion.[24] The authors concluded that the LSVT Companion program is effective when combined with in-person LSVT services.

Telepractice has also been used for the evaluation of adults with dysphagia. A clinical assessment telerehabilitation study was conducted to evaluate the swallowing abilities of 10 simulated patients (role-played by two SLPs with >5 years of experience) in a university setting.[12] Two stand-alone portable notebook computers with Internet-based, custom videoconferencing software were used. The evaluation of dysphagia was conducted face-to-face with one SLP and through telerehabilitation with another SLP in separate rooms. The Clinical Swallowing Examination protocol was used but required modification with videoconferencing. Results indicated that the SLPs had 100% exact and clinical agreement for the patients' general orientation, alertness, and posture. The SLPs had high mean overall exact agreement and 100% overall clinical agreement for oromotor and laryngeal function examinations. Diet decisions for food textures and liquid made by the SLPs had high percentage of exact and 100% clinical agreement. Finally, the percentage exact agreement for referral for instrumental assessment between the SLPs was 100%.

The use of an Internet-based system (i.e., Teledynamic Evaluation Software System) was evaluated to assess oropharyngeal swallowing abilities.[25] Two stationary computers dedicated to receive telefluoroscopic information were used. The Teledynamic Evaluation Software System provided remote, interactive, and real-time evaluations between two university swallowing facilities. Participants included 32 adult patients with a diagnosis of stroke or head/neck cancer. Two SLPs at one facility and one SLP doctoral candidate at another site served as clinical evaluators. All participants completed one traditional fluoroscopic study and one telefluoroscopic study. Analyses of the swallowing assessments revealed good agreement between in-house and off-site clinicians in the subjective diagnosis of severity of swallowing difficulty and on Penetration-Aspiration scale ratings. Moderate to high agreement was found for treatment recommendations.

In summary, the studies described in the literature provide evidence that support the use of telepractice for the delivery of speech and/or language services to children and adults. In the studies reviewed, the authors suggested that more investigation into the use of telepractice with communication disorders is necessary. There is a recognized need for more evidence-based telepractice studies in the areas of selection of client candidacy, assessment protocols and intervention procedures, clinical efficacy and effectiveness, and satisfaction of clients, clinicians, and caregivers.[1,3,9,26]

Many of the studies presented in the literature have conducted telepractice services with stationary computers using Internet-based systems for synchronous videoconferencing in hospital and university settings. Laptop computers have also been incorporated in some of the studies.[12,18,19,23] Currently, "low cost devices can now be used to provide less expensive quality treatment."[4] New synchronous communication equipment and programs (e.g., iPad® [Apple], tablet, and smartphone) are becoming more affordable and accessible to the public. These devices often perform the same functions as stationary and laptop computers. However, these devices allow the client to be "mobile recipients" of telepractice services, which allows therapy to be delivered in functional, everyday situations, both in and outside of the home.[27] More research is needed to determine if these mobile devices can deliver speech and/or language intervention as well as stationary and laptop computers.[27]

The Northern Arizona University (NAU) Speech and Hearing Clinic provides services to rural areas surrounding Flagstaff, AZ. Approximately 20% of the clients who receive services in this facility travel a considerable distance from neighboring locations.[28] Because of the need to relieve the burden of cost and travel of these clients and based on the recommendations and suggestions of prior studies in telepractice, the following research questions were addressed for this exploratory study using iPad devices for telepractice services:

1. Was the use of Apple iPads to deliver telepractice speech and/or language therapy effective for pediatric and adult clients in a university clinic setting?

2. What technological and clinical problems were associated with the use of Apple iPad devices for the delivery of telepractice speech and/or language services in a university clinic setting?
3. How satisfied were clients, parents/caregivers, graduate student clinicians, and supervisors using iPad-delivered telepractice for speech and/or language services in a university clinic setting?

Based on a review of prior telepractice evidence-based research, no studies were found that evaluated the use of the iPad with FaceTime® (Apple) for service delivery. Therefore, it is unknown if the iPad device will be effective for delivering telepractice services. It is also unknown if there will be technical and clinical problems associated with its use and if clients, parents/guardians, student graduate clinicians, and supervisors will be satisfied with the therapy administered using this device.

## Materials and Methods

### PARTICIPANTS

In total, six second-year graduate student clinicians (one male and five females) with a mean age of 23 years (range, 23–25 years) provided speech and/or language services over two academic semesters to participants in this study. For the pediatric population, five children (four boys and one girl), 4.5–9.8 years old (mean, 7.1 years), and their parent and/or guardian participated in the study. Additionally, three male adults with aphasia (two with conduction aphasia and one with Broca's aphasia), 39–57 years old (mean, 51 years), and one female adult with traumatic brain injury, 32 years old, participated in the study. Of the children, four were identified as white, and one was Asian. Of the adults, three were identified as white, and one was Hispanic. All of the participants had received in-person therapy the semester prior to beginning the telepractice study. All therapy services were administered at the NAU Speech and Hearing Clinic. The children received therapy for speech and/or language disorders. For the adult participants, two received language therapy, one received speech and language therapy, and one received cognitive-communication therapy (*Table 1*). The two researchers who are licensed, ASHA-certified SLPs served as the clinical supervisors during this study. Both researchers have >20 years of experience supervising graduate student clinicians.

**Table 1. Demographic Information of Participants**

| PARTICIPANT | GENDER | AGE (YEARS) | ETHNICITY | COMMUNICATION DISORDER |
|---|---|---|---|---|
| Child 1 | Male | 4.5 | White | Childhood apraxia of speech/cognitive delay |
| Child 2 | Male | 6.5 | White | Childhood apraxia of speech |
| Child 3 | Male | 6.10 | White | Childhood apraxia of speech |
| Child 4 | M | 8.6 | Asian | Cleft lip and palate |
| Child 5 | Female | 9.8 | White | Developmental articulation disorder |
| Adult 1 | Female | 32 | White | Traumatic brain injury/cognitive communication |
| Adult 2 | Male | 39 | White | Broca's aphasia/speech and language |
| Adult 3 | Male | 56 | Hispanic | Conduction aphasia/language |
| Adult 4 | Male | 57 | White | Conduction aphasia/language |

### PROCEDURES

Prior to beginning the telepractice study, consent forms were completed by the participants, parents/guardians, and graduate student clinicians. Pre- and posttherapy telepractice questionnaires were developed for the participants and parents/guardians. The participant and parent/guardian questionnaires contained one multiple-choice question about types of electronic items currently used, three open-ended questions about likes, dislikes, and difficulties with electronic interactive devices, and six questions that required a response on a 5-point Likert scale about ease of using electronic devices, satisfaction with electronic devices, satisfaction with telepractice services, cost of services, and cost of devices (see Appendices A and B). Posttherapy telepractice questionnaires were developed for the graduate clinicians and clinical supervisors. The graduate student clinician and clinical supervisor questionnaires contained six open-ended questions about improvements made in therapy, difficulties using the device (describing problems of participants, parents/guardians, and student clinicians), positive experiences, changes/modifications needed for therapy, and subjective opinion of the device's effectiveness in therapy. The final question was for additional comments (see Appendices C and D).

For this telepractice study, the Apple iPad was selected because of its quality of audio and visual display, capability of performing functions similar to laptop computers, ability for real-time recording, ease in the use of the device, accessibility, affordability, and easy WiFi Protected Access II (WPA-2 using 128-bit Advanced Encryption Standard to protect data) settings for HIPAA compliance. Initially, WiFi-compatible 16GB Apple iPads with retina display (third generation) and FaceTime were selected for this study. However, because of bandwidth interference from competing devices, WiFi-compatible 16GB Apple iPads (second generation) with FaceTime were used instead. The second-generation devices had less interference with audio and videoconferencing abilities for service delivery. For this telepractice study, a secure, encrypted, password-protected, wireless network was developed by NAU information technology specialists. This network was used for all transmission of videoconferencing information during the study. A wireless local area network using the 802.11b WiFi industry standard at a frequency of 2.4 GHz was used in the clinic.

Therapy was conducted in a controlled environment consisting of separate clinic rooms at the NAU Speech

**Fig. 1.** A graduate student clinician provides telepractice using the iPad device in the Northern Arizona University Speech and Hearing Clinic to a child participant and her parent and/or guardian located in a separate therapy room. The supervisor observes the session behind the two-way mirror.

and Hearing Clinic. The supervisors were in observation rooms and watched the graduate students, participants, and parent/guardian who were in separate clinic rooms (*Figs. 1* and *2*).

Materials used in therapy varied for children and adult participants. Children and their parent/guardian were provided various games and toys. Adult participants were provided paper and pens to assist with word finding, sequencing, and problem solving. Student clinicians used data collection sheets and pens during telepractice services. Written and verbal feedback was given to the student clinicians by the supervisors.

**Fig. 2.** Telepractice conducted via iPad in a separate therapy room. The child participant interacts with the graduate student clinician and the parent and/or guardian. The parent and/or guardian of the participant serves as an assistant in therapy. This ensures that videoconferencing connections are made, optimal views of the participant and clinician are obtained, and turn-taking during activities and changes in activities are completed during the treatment session.

## STUDY DESIGN

After obtaining institutional review board approval, potential participants were identified from a list of prospective NAU Speech and Hearing Clinic clients. The clients and parents/guardians who were identified were then contacted by telephone to determine their interest in participating in the research study. Participation in this study was strictly voluntary. During the initial preparation phase of this study, to ensure compliance with HIPAA[2] for clients and the Family Educational Rights and Privacy Act[29] for graduate student clinicians, the researchers contacted NAU information technology specialists to develop a secure, clinic-designated, password-protected, wireless network for the videoconferencing.

Clinical assignments of graduate student clinicians are completed 3 months prior to each academic semester. Following the assignments, the clinicians were contacted to determine if they were interested in participating in this research project. Participation was strictly voluntary. Written consent to participate in the study was obtained from the graduate student clinicians. All the clinicians were asked to complete a telepractice questionnaire regarding therapy at the end of the semester.

Client participants who agreed to be in the research study signed written consent forms and were charged a lower fee for services during the semester. Participants and parents/guardians were asked to complete the telepractice questionnaire prior to therapy and then again at the end of the semester. During the first session, the participants and parents/guardians received training on how to use the iPad device and the program FaceTime. During the training, questions were answered, and problems were discussed. Children, as well as their parents/guardians, and the adults all demonstrated proficiency in the ability to access FaceTime on the iPad device.

All participants received individual telepractice therapy for this study. All of the child participants received a total of 15 weeks of therapy per academic semester. The sessions were provided one time a week for 30–45 min using the iPads with parent/guardian assistance in a clinic therapy room. The adult participants also received 15 weeks of therapy per semester. Each session occurred one time a week for 1 h using the iPads in a clinic therapy room. A graduate student clinician was in a different clinic room and provided therapy using the same generation of iPad device. The student clinician was close enough to assist the client if technological problems occurred. The clinical supervisors were in adjoining observation rooms that allowed them to observe both the graduate student clinician and participants. The supervisors completed their telepractice questionnaires at the end of each semester of clinic.

## DATA ANALYSES

Therapy intervention and clinical interactions were typical of traditional in-person speech and language treatment. For each client

participant, therapy goals were established based on analyses of previous semester performance and/or most recent assessment results. Therefore, the goals for each participant were specifically tailored to the individual's communication needs. A short-term goal was met when the adult or child participant performed the targeted skill over three consecutive therapy sessions at the established criterion. The graduate student clinicians with feedback from the clinical supervisors determined when the short-term goal was met. The percentages of goals obtained by each of the clients are presented to establish efficacy of the use of iPads for therapy.

Both qualitative and quantitative analyses were conducted in this study. Questionnaire responses and personal interviews conducted with the clients and parents of child participants, graduate student clinicians, and supervisors about telepractice using the iPads were used in qualitative analyses. Common themes in the responses provided by clients and parent/caregiver on pre- and post-telepractice questionnaires, and posttherapy questionnaire responses from graduate student clinicians and supervisors are presented to describe technological and clinical problems associated with the use of the Apple iPads for telepractice services. Paired two-tailed *t* tests for Likert scale responses related to questions about opinions about telepractice services were completed to determine if changes occurred pre- and posttherapy. Finally, responses to the open-ended questions about satisfaction of using Apple iPads in therapy from participants and parents/caregivers, as well as posttherapy questionnaires from graduate student clinicians, and clinical supervisors were collected and analyzed for common themes.

## Results

### RESEARCH QUESTION 1: WAS THE USE OF APPLE IPADS TO DELIVER TELEPRACTICE SPEECH AND/OR LANGUAGE THERAPY EFFECTIVE FOR PEDIATRIC AND ADULT CLIENTS IN A UNIVERSITY CLINIC SETTING?

Child participants 2 and 3 with childhood apraxia of speech and no cognitive delays worked on sound production at the multisyllable and conversation level and on organization of short narratives. Both of these clients achieved 100% of their speech and language goals. Child participant 1 with childhood apraxia of speech and cognitive delays achieved one (33%) of his speech goals at the syllable/word level and all (100%) of his expressive grammar/syntax goals. Child participant 5 achieved half (50%) of her speech production goals at the word and sentence levels. Child participant 4 with cleft lip and palate achieved all (100%) of his speech production goals at the sentence and cued conversation levels.

Adult participants 3 and 4 with conduction aphasia were working on compensatory strategies for anomia, organization of narratives, and auditory comprehension skills. Adult participant 1 achieved most (80%) of his language goals, and adult participant 2 achieved some (60%) of his language goals. Adult participant 2 with Broca's aphasia was working on apraxia of speech, compensatory strategies for anomia, auditory comprehension, and production of verbs. He achieved his speech goal but only some (60%) of his language goals.

**Table 2. Number of Speech–Language Pathology Goals Achieved with iPad-Delivered Telepractice**

| PARTICIPANT | SPEECH GOALS | LANGUAGE GOALS | COGNITIVE-COMMUNICATION GOALS |
|---|---|---|---|
| Child 1 | 1/3 (33%) | 2/2 (100%) | – |
| Child 2 | 1/1 (100%) | 2/2 (100%) | – |
| Child 3 | 3/3 (100%) | 1/1 (100%) | – |
| Child 4 | 22 (100%) | – | – |
| Child 5 | 1/2 (50%) | – | – |
| Adult 1 | – | 4/5 (80%) | – |
| Adult 2 | – | 3/5 (60%) | – |
| Adult 3 | 1/1 (100%) | 3/5 (60%) | – |
| Adult 4 | – | – | 3/4 (75%) |

Adult participant 1 with traumatic brain injury was working on compensatory strategies to improve working memory, organization skills, and forming solutions to everyday problems. She achieved most (75%) of her cognitive-communication goals.

For each participant, the number of goals achieved and the type of goal targeted are presented in *Table 2*.

### RESEARCH QUESTION 2: WHAT TECHNOLOGICAL AND CLINICAL PROBLEMS WERE ASSOCIATED WITH THE USE OF APPLE IPAD DEVICES FOR THE DELIVERY OF TELEPRACTICE SPEECH AND/OR LANGUAGE SERVICES IN A UNIVERSITY CLINIC SETTING?

All of the parents of child participants in this study reported that their child used computers/laptops and electronic tablets on a regular basis. Three (60%) of the parents of child participants indicated that their child used cell phones/smartphones on a regular basis. Two (40%) of the adult participants reported using computers on a regular basis, one (25%) reported use of an electronic tablet, and all four reported regular use of cell phones/smartphones. Therefore, more child participants had prior experience with the use of electronic tablets, whereas for most of the adult participants use of these devices was a novel experience.

Three out of five parents/guardians (60%) of child participants and two out of four (50%) of adult participants indicated that the biggest problem during the use of Apple iPads for therapy was skipping and/or freezing (audio and visual image) of the real-time videoconferencing interaction. This occurred for several seconds and required the speaker to repeat information for clarification. Similarly, three out of six (50%) of the graduate student clinicians and both clinical supervisors (100%) also identified the skipping and/or freezing of the real-time transmission as problematic using this device for telepractice. Another problem noted by two out of six (33%) of the

graduate student clinicians was the occurrence of overlap between speakers. When this occurred, one of the speakers had to stop and become a listener in the interaction.

For clinical concerns, four out of five parents/guardians (80%) of child participants worried about the lack of an actual clinician in the room. They stated that it reduced in-person social interactions and child motivation for performance. Four out of six (67%) graduate student clinicians stated that they had to preplan more for therapy delivered via telepractice than for in-person services. Some examples of preplanning provided by the clinicians included making multiple copies of homework assignments to review with the family, ensuring that multiple games were available for the children and their parent/guardian, and learning how work without tactile cues for children and adult participants. The clinical supervisors reported no clinical concerns using the Apple iPad.

### RESEARCH QUESTION 3: HOW SATISFIED WERE PARTICIPANTS, PARENTS/CAREGIVERS, GRADUATE STUDENT CLINICIANS, AND SUPERVISORS USING APPLE IPAD DELIVERED TELEPRACTICE FOR SPEECH AND/OR LANGUAGE SERVICES IN A UNIVERSITY CLINIC SETTING?

Six of the responses on the telepractice questionnaire required a selection on a 5-point Likert scale. These questions asked the participants and parents/guardians about the ease of using electronic devices, satisfaction with electronic devices, satisfaction with telepractice services, cost of services, and cost of devices. Results from a paired two-tailed *t* test for these responses pre- and post-telepractice therapy using the iPads did not reveal statistical significance ($p > 0.05$). An interesting change in Likert scores from parents/guardians of child participants occurred in responses to question 9, "The cost of SLP services should be the same whether it is provided in-person or with electronic interactive devices." Before telepractice therapy, three parents/guardians responded with "neither agree/disagree," but after telepractice therapy, two changed their responses to "strongly agree." The responses moved in a positive direction even though there were technical difficulties of videoconferencing transmission of images. For the adult participants, Likert scale scores remained relatively stable pre- and post-telepractice.

When we reviewed themes in responses from open-ended questions, most parents/guardians commented about "ease of use" and "a fun" new activity for clinical service provision. Two out of five (40%) parents/guardians were concerned about their child's reduced attention during therapy sessions. Three of the four adult participants enjoyed using the Apple iPads in therapy. Participant 4, who mainly focused on cognitive-communication goals, preferred having an actual clinician in the room with her. Selected comments from the adult participants included, "This is cool," "I like this," and "Fun to learn something new."

The graduate student clinicians and the clinic supervisors indicated that if the technological problems were resolved, they were satisfied overall with the use of Apple iPads in telepractice. The graduate student clinicians stated that it was helpful to view family members assisting in therapy. This allowed the clinicians to provide suggestions to the parents/guardians for more effective carryover of skills.

## Discussion

The findings from this telepractice study using Apple iPad (second-generation) devices indicate that participants met the majority of their therapy goals. Previous research studies have found similar results with the use of stationary and laptop computers to deliver speech–language pathology telepractice services.[4,8,10,15,19,20,23] It is interesting that the child and adult participants with cognitive difficulties were not as successful in achieving their goals. This was possibly because of their decreased concentration and difficulty with sustained attention using the iPads. All of the prior telepractice studies have recommended that further research be conducted for informal and standardized assessments and therapy procedures. The researchers of the current study concur that additional studies using Apple iPads are needed to ensure that this is a reliable and effective method for service delivery.

Six questions that required responses on a 5-point Likert scale on the telepractice questionnaire focused on ease of using electronic devices, satisfaction with electronic devices, satisfaction with telepractice services, cost of services, and cost of devices. Based on statistical analyses of these responses, there was not a significant change of opinions regarding telepractice services following the study. This may have been due to the technological problems encountered during therapy or the amount of prior experience using technological devices for some of the participants. During the synchronous videoconferencing, skipping and/or freezing of images occurred for several seconds throughout sessions. This was evident at various times during the session even though the Apple iPad (second generation) device was used. It is uncertain if opinions about telepractice would have changed significantly if these problems did not occur during the study. Many of the participants did not have a strong opinion about services provided via telepractice (i.e., responded with neither agree/disagree). The participants who enjoyed using electronic technology before therapy continued to enjoy using it following therapy.

Graduate student clinicians who participated in the study learned to become better problem solvers when delivering speech and/or language therapy via telepractice. Additionally, they had to improve their skills for preplanning session activities and to ensure that all handout materials for homework or education were prepared ahead of time.

The clinical supervisors were in agreement that the Apple iPads were adequate for the delivery of speech and/or language services. At the time of this study, both supervisors could view the graduate student clinicians, participants, and parents/guardians through observation windows. However, a future study is intended to investigate the use of iPads with child and adult clients and parents/guardians in their home environment. This would prohibit the supervisors from viewing the graduate student clinician, participants, and parents/guardians at the same time. Therefore, other real-time interactive computer-based programs will have to be considered so that

supervision can be completed without distraction to graduate student clinicians or the clients.

Because this study was exploratory in nature, several limitations were evident. First, there were technological problems of the images on FaceTime skipping and/or freezing for up to 5 s during interactions. Some therapy sessions had no problems with skipping and/or freezing of images; however, therapy sessions that were conducted concurrently while academic classes were being taught in the same building had up to five instances of skipping and/or freezing of images per session. When this occurred, the graduate student clinician requested repetition from the client or repeated what was spoken. These findings are similar to prior studies in the telepractice literature.[10–14]

The NAU information technology specialists stated that there were two problems associated with the skipping and/or freezing on the Apple iPads: (1) they identified that other devices from classrooms were competing at the same frequency, and (2) the number of users of the same frequency at the same time added more congestion for transmission of images. Following the study, the NAU information technology specialists upgraded the WiFi system by adding a second frequency of 5 GHz with the 802.11N standard (which supports both 2.4 GHz and 5 GHz frequencies). This upgrade supports up to 300 megabits/s of raw speed in air transmission. These accommodations should lessen future skipping and/or freezing of images during videoconferencing. Although the upgrades in frequencies should improve videoconferencing capabilities at the NAU Speech and Hearing Clinic, this does not guarantee that the same quality of videoconferencing will be seen outside of the clinic environment. Therefore, depending on the network services used by the clients and/or family members of clients for telepractice, there is the possibility that technical problems could be worse than those found in the present study.

Second, although the iPad is portable, another limitation is that the camera is built into the device. Therefore, the student clinicians instructed the clients and parents/guardians to move the device as needed. At times, the entire device was moved to obtain a clear view of oral structures and speech productions for therapies such as those related to childhood apraxia of speech and articulation. Also, the iPad was moved farther away from the client for language-based therapies to obtain a wider view of the activities and items used. Additionally, during the production of written responses, the client was instructed to hold the paper with the response closer to the iPad for display to the clinician. Although movement of the iPad devices was required during therapy, the built-in camera provided satisfactory visual display for data collection and clinical interactions.

Third, because of the heterogeneity of the participants' communication disorders, replication of this study would be difficult. Because speech and/or language goals are formed based on the functional needs and abilities of each client, different goals may be selected for clients with the same diagnosis. However, this limitation would exist in any telepractice study where there is not a specific set of procedures used for therapy. Finally, there was a small sample size of child and adult participants. Although the sample size was limited, the results from the current study demonstrated that the clients made gains for the majority of the goals targeted in therapy sessions delivered via Apple iPad (second generation) devices.

## Conclusions

This is an exciting time for the advances seen in interactive technology. The literature in telepractice for speech–language pathology services is growing. However, as rapid technological advances are being made, there is a constant challenge for researchers to evaluate the effectiveness of these devices for evaluation and therapy purposes. Therefore, the use of stationary computers may, in the not so near future, become outdated. As smaller, portable, synchronous devices become readily available and more affordable to the general population, additional telepractice studies incorporating these devices (e.g., tablets, smartphones, etc.) are needed.

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(*Appendix follows* →)

## Appendix A

PARENT/GUARDIAN TELEPRACTICE RESEARCH QUESTIONNAIRE

Age (years) of child_____
Gender of child_____
Ethnicity _____
Years in speech–language therapy _____
Type of communication disorder _____

1. My child uses the following interactive devices on a regular basis (please circle all that apply):
   Computers/laptops
   Electronic tablets (e.g., iPad)
   Cell phone/Bluetooth/smartphone
2. What do you (the parent/guardian) like about electronic interactive devices?
3. What do you (the parent/guardian) **dislike** about electronic interactive devices?
4. What specific difficulties have you or your child had with electronic interactive devices?

**Please circle your responses to the following statements:**

5. My child finds it easy to use new electronic interactive devices (e.g., smartphone, computer, tablets).

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

6. My child enjoys using electronic devices (e.g., smartphone, computer, tablets).

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

7. For speech–language services, it is important for the clinician to be in the therapy room with my child.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

8. The same quality of speech–language therapy can be provided using electronic interactive devices.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

9. The cost of speech–language services should be the same whether it is provided in person or with electronic interactive devices.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

10. The cost of an electronic interactive device ($300-$600) will determine if I buy it.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

## Appendix B

ADULT CLIENT TELEPRACTICE RESEARCH QUESTIONNAIRE

Age (years)_____
Gender_____
Ethnicity _____
Years in speech–language therapy _____
Type of communication disorder _____
Type of employment _____

1. I use the following interactive devices on a regular basis (please circle all that apply):
   Computers/laptops
   Electronic tablets (e.g., iPad)
   Cell phone/Bluetooth/smartphone
2. What do you like about electronic interactive devices?
3. What do you **dislike** about electronic interactive devices?
4. What specific difficulties have you had with electronic interactive devices?

**Please circle your responses for the following statements:**

5. I find it easy to use new electronic devices (e.g., smartphone, computer, tablets).

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

6. I enjoy using electronic devices (e.g., smartphone, computer, tablets).

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

7. For speech–language services, it is important for the clinician to be in the therapy room with me.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

8. The same quality of speech–language therapy can be provided using electronic interactive devices.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

9. The cost of speech–language services should be the same whether it is provided in person or with electronic interactive devices.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

10. The cost of an electronic interactive device (e.g., $300–600) will determine if I buy it.

1_____2_____3_____4_____5
Strongly Disagree Disagree Neither Agree/Disagree Agree Strongly Agree

## Appendix C

GRADUATE STUDENT TELEPRACTICE QUESTIONNAIRE

Age (years) _____
Gender_____
Ethnicity _____
Number of semesters in clinic _____
Type(s) of speech–language disorder(s) treated this semester _____

1. Based on your clinical data, what areas in communication show improvement using the iPad?
2. What types of difficulty did your client and/or parent/guardian have using the iPad? (e.g., motor problems to push apps, turning device on/off, etc.)
3. What problems did you encounter when providing therapy using the iPad?
4. What **positive** experiences did you have when providing therapy using the iPad?
5. What changes/modifications did you have to make in therapy when using the iPad?
6. In your opinion, was the iPad an effective device for providing speech–language services? Explain.
7. Additional comments/concerns?

## Appendix D

CLINICAL SUPERVISOR TELEPRACTICE QUESTIONNAIRE

Number of years supervising students _____
Type of communication disorders supervised this semester _____

1. Of the clients that received services using the iPad, what types of communication disorders showed improvement?
2. What types of difficulty did your clients have using the iPad? (e.g., motor problems to push apps, turning device on/off, etc.)
3. What problems did you encounter when providing supervision using the iPad?
4. What were some **strengths** when providing supervision using the iPad?
5. What changes/modifications did you have to make in supervision and therapy when using the iPad?
6. In your opinion, was the iPad an effective device for providing speech–language services? Explain.
7. Additional comments/concerns?