# Social Interaction and Child Learning and Language: The Effects of Multimedia Technology.

by

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Abstract

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Social Interaction and Child Language and Learning: The Effects of Multimedia Technology

Thesis directed by Dr. Pui Fong Kan

Introduction: In recent years, clinicians from several fields (including Speech-Language Pathology) have used multimedia technologies to provide specialized services to clients. The purpose of this master's thesis is to explore the effects of using videoconferencing to collect language samples from young children using the story retelling task (SRT). In an SRT, children are told a story and are asked to retell the story to a naïve listener. The research questions ask whether face-to-face (FTF) and videoconferencing (VC) administrations of the SRT result in different language samples (Question 1), learning of novel words (Question 2), or task administration (Question 3).

Methods: Using a within-subjects design, six children, ages 3;0 – 5;11, were given the SRT in both FTF and VC conditions. For Question 1 (Q1), three language measures were taken from the resulting language transcripts. For Question 2 (Q2), children were tested on novel/target and control words before and after the SRT in both conditions to test for word learning. For Question 3 (Q3), FTF and VC administrations of the SRT were measured for length of time, total number of words spoken by the child, and total number of prompts given by the examiner.

Results: In response to Q1, the statistical analyses did not reveal significant differences between FTF and VC conditions. The children were shown to learn significantly more novel/target words than control words. However, no significant differences were revealed between the two conditions in the amount of words learned (Q2). Finally, there were no significant differences between FTF and VC conditions in any of the task administration variables (Q3).

Conclusions: In all three questions, there were no differences discovered between FTF and VC administrations of the SRT. However, children learned new words across both learning conditions. As a result, this study provides evidence that the two conditions are comparable when administering the SRT to typically developing young children. Despite these preliminary findings, more research is needed to verify whether similar results would be found with young children with communication challenges.

*Keywords:* telepractice, videoconferencing, preschool children, story retelling task, word learning

# Dedication

I lovingly dedicate this thesis to my family members—my wife, Chelsey, my son, Wesley, and my mom and dad, Donna Rae and Bill. Without your persistent love, support, and encouragement to persevere, this work would not have been possible.

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## Introduction

From television and computers to videogames and the Internet, advances in technology have made these multimedia mechanisms commonplace in our lives today. As a result, multimedia technology seems to have entered almost every aspect of our lives. From facilitating long-distance meetings to playing video games with a friend in another country, these mechanisms facilitate new possibilities for interaction in our world.

In recent years, many clinicians have even been using these multimedia technologies to offer specialized services (Theodoros, 2008; Waite, Theodoros, Russell, & Cahill, 2010). The American Speech-Language-Hearing Association (ASHA) commonly refers to this method as *telepractice*. Consequently, there has been a surge in research on the impact of multimedia technology on communication, learning, clinical practice, and many other areas. The purpose of this study is to further elucidate the relationship between social interaction, child language, and multimedia technology. In particular, I will examine the effect of videoconferencing on young children's language and learning skills when retelling stories. Further, I will examine the practical effects of videoconferencing on the administration of the story retell task. In what follows, I will review the current literature on multimedia technology and its use in clinical practice, especially in the realm of speech-language pathology. More specifically, I will critique the specific findings considering the impact of multimedia technology on young children (from birth to six years-old). Furthermore, I will discuss some incomplete areas in our knowledge base. After exploring these introductory issues, I will describe in detail the methods and results from the current study on the effects of multimedia technology on child learning. In conclusion, I will discuss the implications of these results for our general knowledge base and also for our specific use of multimedia technology in speech-language pathology.

**Background**

The use of multimedia technology in speech-language services is an important and relevant issue in research for several reasons. First, several health professions such as speech-language pathology, psychiatry, dentistry, and nursing are currently using telepractice (ASHA, 2005a; Stanberry, 2000). Consequently, validating these practices through research has been a major way to verify that the quality of services is being maintained (ASHA, 2005a; Antonacci, Bloch, Saeed, Yildirim, & Talley, 2008; Brown, Brannon, & Romanow, 2010).

Second, limitations in funding and increasing workload demands are continually challenging speech language pathologists (SLPs). As a result, they are forced to search for creative ways to reduce the cost and time investment for services. Telepractice has been a frequently proposed answer to these issues in delivery of speech language services (Juenger, 2009; Mashima & Doarn, 2008; Rose et al., 2000; Waite et al., 2010).

Another issue related to the increased workload demands is acute shortages in the amount of SLPs. Vacancies in SLP positions increased from 25% in 2002 to 40% in 2005; further, the total number of SLP positions in the United States is expected to grow 11% from 2006 to 2016 (Mashima & Doarn, 2008). Additionally, there is currently a widespread shortage of specialized services for specific populations such as people who stutter, the Deaf and Hard of Hearing population, and people with extremely limited mobility (Mashima & Doarn, 2008; McCarthy, Munoz, & White, 2010; Theodoros, 2008; Wilson, Onslow, & Lincoln, 2004). Given these increasing shortages, fewer SLP's are managing the same number of caseloads in given areas. Consequently, they are forced to take on larger caseloads and/or to limit the types or amounts of services to many clients. Telepractice has been proposed as a way to enable the SLP's to more efficiently handle their caseloads (Brown et al., 2010; Grogan-Johnson et al., 2011; Polovoy, 2008).

Many potential clients who need services live in remote or rural areas. Far too often, these clients are unable to access services because of a lack of specialized or generalized SLPs in their surrounding area (Wilson et al., 2004). Telepractice has been proposed as a possible answer to this limited access to speech-language services (Mashima & Doarn, 2008; McCarthy et al., 2010; Polovoy, 2008; Theodoros, 2008; Wilson et al., 2004). Single parents and families with two working parents in urban areas also face barriers to service such as financial concerns, insufficient health insurance, childcare conflicts, problems with scheduling, and lack of transportation to service providers. Yet again, telepractice has been proposed as a means of addressing these common barriers to SLP services (Ciccia, Whitford, Krumm, & McNeal, 2011; Theodoros, 2008). In short, all of these factors have increasingly brought telepractice into the crosshairs of researchers around the world. Although telepractice has been proposed as a solution to these many challenges facing SLPs, we still do not have adequate evidence that telepractice services are equivalent to face-to-face services in the majority of clinical contexts, especially considering the provision of direct services to young children.

## Telepractice Defined

### ASHA's Definition

According to ASHA, "Telepractice is the application of telecommunication technology to deliver professional services at a distance" (ASHA, 2005a, p. 1). An important requirement from ASHA for using telepractice in speech-language pathology is that the quality of services provided through telepractice must be comparable to ones that are provided face-to-face (ASHA, 2005b). Although telepractice is generally associated with videoconferencing (VC), it can take on several modes, and it can be carried out with several different communication technologies (ASHA, 2005a; Theodoros, 2008).

**Modes.** First, telepractice can be used in an asynchronous mode. Asynchronous telepractice does not require direct communication between the clinician and the client (ASHA, 2005a; Schols, 2009). In this mode, samples are taken at a convenient off-site location. The sample collector could take x-rays, videos (e.g., clinical observation or instrumental assessment), audio recordings, or other artifacts of relevant information from the client. Some examples of these other artifacts are: written documents (e.g., medical records), test protocols, client data (e.g., test protocol results and treatment performance), and still pictures (ASHA, 2005b). Once this data is collected, it can later be sent to the clinician through a variety of carriers—the Internet, telephone modems, or even fax machines (ASHA, 2005a).

The second mode – synchronous mode – seems to be more commonly associated with telepractice. In this mode, the clinician and the client interact directly through video or audio telecommunication technologies such as the telephone or VC. One example of the synchronous mode is a videoflouroscopy guided online by a clinician via VC.

The final mode of telepractice is self-monitoring. In this mode, the client collects data himself (e.g., from questionnaires filled out or from monitoring software/devices) and gives it to the clinician (ASHA, 2005b). No on-site facilitator is required for this mode (ASHA, 2005b).

An important consideration is that these three modes of telepractice are not mutually exclusive. In fact, they can be combined to get real-time interaction while also obtaining better quality recordings of the interaction. An example of this scenario is when a clinician elicits a language sample through a story-retelling task, and he also has a high quality video recording made of the interaction to transcribe at a separate time. This example is an integration of both the synchronous and asynchronous modes of telepractice.

**Technology.** There are several considerations concerning the technology required for telepractice. These include the hardware or devices used, software or programs used, and Internet connections with adequate bandwidth for transmitting large amounts of digital data in real-time. Examples of types of devices are: videophones, closed circuit TV, Internet-based software with Webcams, personal computing devices, image capture devices, dedicated VC systems, and interfacing instrumentation (such as video laryngoscopy) for telepractice use (ASHA, 2005b). An example of software that could be used for VC is Adobe *ConnectPro (URL:*http://www.adobe.com/ products/acrobatconnectpro/*)*. Additionally, it is not sufficient to simply *have* the necessary technology; SLPs who wish to make use of telepractice must also have knowledge and understanding of the technology (ASHA, 2005b). For example, they must be knowledgeable enough to assess whether their personal computing devices are adequate to use for telepractice (ASHA, 2005b). In addition, SLPs must also know about ensuring privacy and security when using telepractice. They must have a general understanding of the Internet and networking, connecting to a remote site, and trouble-shooting problems when they arise (ASHA, 2005b). One such example of knowledge needed to implement telepractice involves a popular VC platform—Skype. Namely, although the audio-video signals transmitted by Skype's online software is encrypted and not stored on Skype's system, text that is sent on the Skype chat screen is stored on the Skype servers. As a result, SLPs should know that while the VC mode is secure, the text chat functions are not compliant with the Health Insurance Portability and Accountability Act (HIPAA). Thus, this function should not be used to transmit private information. Telepractice introduces additional elements into assessment or treatment sessions that the speech-language pathologist will have to learn to work with seamlessly in such a way that these elements are not a distraction that interferes with the quality of the interaction (ASHA, 2005b).

## The Use of Telepractice to Deliver Services

### The History of Telemedicine

It may be tempting to assume that only the technology of the last decade could enable the delivery of medical services to patients. However, it could be said that the advent of telepractice was in the early 1900s. In 1910, doctors used analogue telephone networks to transmit electrocardiograms and electrocephalograms (Stanberry, 2000). By 1920, they were providing medical advice to people out at sea through Morse code and voice radio (Stanberry, 2000). The precursors to VC are the two-way closed circuit television systems of the 1960s, which were used to transmit both images and consultations between service providers and patients (Stanberry, 2000). Telemedicine continues to be a major player in today's world. It is used in serving rural populations and developing countries as well as in any given clinic to transmit medical files, information, or images and to allow communication between providers (Stanberry, 2000).

### Early Uses of Telepractice in Speech-Language Pathology

The earliest documented use of what would later evolve into telepractice as it is known today was in the mid-1970s (ASHA, 2005a). In hopes of finding a solution to serving patients in remote locations, the Birmingham VA Hospital received a grant to explore "tele-communicology" (ASHA, 2005a, p. 4). Services were provided over the telephone with filmstrips, workbooks, and audiotapes to supplement the telephone communication (ASHA, 2005a). The Mayo Clinic began offering speech and language assessments through three of their U.S. facilities in 1987 (ASHA, 2005a).

**Current Uses of Telepractice in Speech-Language Pathology**

The technology available and the modes outlined by ASHA allow telepractice to be used in a number of locations including hospitals, health care facilities, speech-language pathology clinics, clients' homes, and schools (ASHA, 2005a). According to a survey from 2002, the majority of speech and language services being delivered through telepractice are done in the school setting (ASHA, 2005a). To date, SLPs have used telepractice for the screening, assessment, and treatment of adults and children in a variety of areas such as swallowing disorders, voice disorders, stuttering, neurological impairments, and speech, language, and hearing impairments (American Speech-Language-Hearing Association, 2005a; Ciccia et al., 2011; Lancaster, Krumm, Ribera, & Klich, 2008; Theodoros, 2008). SLPs are also providing services for military service members via telepractice (ASHA, 2005a). Some examples of such services are as follows: connecting patients remotely with providers; identifying concussions and mild traumatic brain injuries using electronic cognitive assessment systems; sharing information between clinical teams for collaboration purposes; managing medication; and training providers through interactive video programs and web-based courses (Doarn, 2009 as cited in Mashima, 2010). In summary, these uses of newer technology have increased the demand for telepractice today and have raised questions for researchers about the delivery of service through telepractice. Namely, is telepractice a feasible way to provide services and save time and money? Further, is telepractice an effective service delivery model? Most importantly, is telepractice a valid method for SLPs to interact with young child clients and provide speech and language services?

**Research Regarding Use of Telepractice for Speech-Language Pathology**

In an effort to answer some of these important questions, research on telepractice has been increasingly surging. Researchers have examined the feasibility, efficacy, and effectiveness of using telepractice in a variety of settings; they have used it to screen, assess, and treat several adult and child populations. In the following paragraphs, I will discuss the results from studies looking at these uses of telepractice, and I will conclude by discussing the importance of future research.

**Assessment in Adults**

As mentioned above, the Mayo Clinic was one of the first major venues that offered speech language assessments via telepractice. In this preliminary investigation from 1987-1994, three Mayo Clinic practices in Minnesota, Arizona, and Florida used VC to give speech and language consultation assessments to 150 patients ranging in age from 20-90 years-old (Duffy, Werven, & Aronson, 1997). The goal of these consultations was to provide clients with diagnoses and recommendations for clinical management of speech, language, and voice disorders. Through retrospective analysis, Duffy and colleagues (1997) found that only six out of all 150 assessments lacked sufficient information for a diagnosis and required a face-to-face (FTF) session. Although this early study provided some evidence that these assessments were effective, the study did not discuss any other control or comparison groups. As a result, the authors offered little support for determining whether the VC sessions were "comparable" to face-to-face conditions.

In an attempt to provide such a comparison, Wertz and colleagues (1992) provided both VC and FTF assessments to seventy-two clients from a sample of patients from the Mayo Clinic telemedicine consultations. They found differences in one of two standardized assessments between VC and FTF conditions. Although scores on the Western Aphasia Battery (WAB) were not different, the overall scores of the Porch Index of Communicative Ability (PICA) did reveal a significant difference between the FTF and VC administrations. Despite this difference, the authors found high levels of agreement for overall diagnostic conclusions between the FTF and VC conditions. In other words, although the two conditions resulted in some significantly different scores, the clinicians interpretations of the standardized assessments resulted in essentially the same overall diagnoses (Wertz et al., 1992).

Since these earlier studies, similar results have been found concerning the use of VC for the assessment of swallowing, speech, and language in adults. Pearlman and Witthawaskul (2002) used telephone communication and high speed internet file transfers to successfully direct swallowing assessments from offsite locations. In this study, however, no control or comparison groups were discussed. Hill and colleagues (2006) explored the effectiveness of delivering standard motor speech assessments through VC. They found good levels of agreement between FTF and VC conditions on severity ratings of conversational speech, speech sample analysis, the Assessment of Intelligibility of Dysarthric Speech, and on all but four subtests of the Frenchay Dysarthria Assessment. Finally, Georgeadis and colleagues (2004) performed the story retell task on mild to moderately impaired clients with stroke or traumatic brain injury (TBI). They found no significant differences between retold stories in FTF and VC conditions.

**Treatment in Adults**

Although much of the early telepractice research looked mainly at assessment, an increasing number of investigations have been conducted on the use of VC for implementing therapy for a wide variety of adult disorders. Clinicians at the department of Veteran Affairs in Kentucky reported gains in treatment and cost savings using videophones to treat patients with anomia (Mashima & Doarn, 2008). Clinicians of aphasic patients in Sweden reported positive outcomes and high levels of patient satisfaction with an asynchronous application of telepractice (Mashima & Doarn, 2008). After intensive FTF treatment, clinicians in Alberta, Canada used VC to continue fluency treatment with clients living in remote areas. They reported that patients met treatment goals and had high levels of satisfaction (Mashima & Doarn, 2008). Several investigations have implemented the Lee Silverman Voice Treatment (LSVT) and other voice treatments with internet videoconferencing (Hill et al., 2006; Howell, Tripoliti, & Pring, 2009; Theodoros, 2008). Overall, they have found significant gains in treatment outcomes that were comparable to FTF treatments (Hill et al., 2006; Howell et al., 2009; Theodoros, 2008). Howell and colleagues (2009) concluded that although telepractice may not be a good option for all candidates, "Some patients can benefit from treatment across the Internet and that technical problems associated with it (for both client and clinician) can be overcome." To date, no standards for candidacy recommendations for adults or for children have been assembled.

**Assessment/Screening in Children**

In an effort to determine whether children could be good candidates, several studies have examined the use of telepractice to conduct speech and language assessments and screenings. Waite and colleagues (2010) reported on three studies from 1987 to 2006 looking at the use of telepractice to assess the speech and language of children. One study examined telephone assessments, while two other studies looked at the use of VC. Over the three studies, clinicians gave standardized and informal assessments through telepractice looking at speech, language, and oral motor functioning. During the assessments, both FTF and offsite clinicians simultaneously rated assessment performance. Overall, the studies found high levels of agreement between the offsite and FTF clinicians' simultaneous assessment ratings. None of the studies included a control group of evaluations given FTF. Waite and colleagues (2010) administered the Clinical Evaluation of Language Fundamentals – Fourth Edition (CELF-4) to twenty-five children ages 5-9 years old in both FTF-led and VC-led conditions. Additionally, they simultaneously assessed children in both conditions with offsite and FTF clinicians. Accordingly, they found no significant differences between the FTF and VC conditions and concluded that these two CELF-4 testing environments were not significantly different (Waite et al., 2010).

In 2012, Waite and colleagues assessed twenty children's intelligibility and oral structures and functioning FTF and via VC. As in their previous study, they gave the assessments in two conditions—FTF-led and VC-led. Again, both offsite and FTF clinicians gave simultaneous ratings of the assessment performance of the ten oral structure/function tasks. They also made recordings of spontaneous speech samples. FTF clinicians made audio recordings with standard recording equipment, while offsite clinicians made recordings using the VC system. After the evaluation sessions, both clinicians rated their recordings for intelligibility. The authors found high levels of agreement between FTF and offsite ratings of speech intelligibility and of six out of ten oral motor tasks (Waite, Theodoros, Russell, & Cahill, 2012). They found fair or poor agreement between ratings of four oral motor tasks.

Two studies looked at the use of VC to implement speech-language and hearing screenings to children. Lancaster and colleagues (2008) gave hearing screenings to 32 third grade children in both FTF and VC conditions. They gave separate administrations of otoscopy, pure tone audiometry, and tympanometry. The authors reported full agreement in otoscopy and tympanometry, and only five students were rated differently in pure tone testing. More specifically, four students were referred by the offsite clinician and not by the FTF clinician, whereas one student was referred by the FTF clinician and not by the offsite clinician.

Consequently, the VC screenings resulted in high sensitivity and low specificity. In other words, the offsite clinicians did refer children with hearing impairments for full evaluations, but they also referred more children without hearing impairments for full evaluations. As a result, more children would have received full evaluations when screened through VC than when screened FTF. Lancaster and colleagues (2008) noted that the low number of participants could exaggerate these sensitivity and specificity scores.

In 2011, Ciccia and colleagues used Skype to deliver speech, language, and hearing screenings at two primary care clinics in Cleveland, Ohio. They offered screenings during scheduled doctor visits of 411 young children up to six years old living in heavily populated urban areas (Ciccia et al., 2011). To screen hearing, they administered tympanometry to all children, Distortion Product Otoacoustic Emissions (DPOAE) for children up to three years old, and behavioral audiometry for children ages 3-6. To screen speech and language, they used the Receptive-Expressive Emergent Language Test – Third Edition (REEL-3) for children up to three years old, and they used the Screening Kit of Language and Development (SKOLD) for children 2.5-6 years old. Importantly, only hearing procedures were administered to the children in both FTF and VC conditions. The authors reported high levels of family satisfaction for the screenings, and out of the children that failed screenings, 72% of the parents scheduled appointments for comprehensive evaluations. Ciccia and colleagues (2011) also reported good reliability for both hearing and speech-language screenings; however, they used small samples of their participants to calculate this reliability (n=10 for the speech-language screenings).

Two studies reported on asynchronous modes of telepractice. Waite et al. (2010) reported on a 1999 study by Haaf and colleagues where the authors administered a PC version of the Peabody Picture Vocabulary Test – Revised (PPVT-R). They randomly assigned 72 children ages 4-8 to standard administration or to one of two methods of PC administration. The PC methods required no direct clinician supervision, classifying these methods as asynchronous. One PC method used trackball selection, while the other used visual scanning with push button activation. The authors found no significant differences between the scores from the three different administration methods. They concluded that PC administration of the PPVT-R was equivalent to standard administration (Haaf et al., 1999 as cited in Waite et al., 2012).

Rousseau, Onslow, and Packman (2008) examined recordings of 36 young children who stutter. Their research question was whether examination of audio-only and/or audio-visual recordings is sufficient to assess stuttering behaviors. The participants, ages 3-6, were participating in a telepractice version of the Lindecomb Program. In this study, clinicians evaluated audio-only and audio-video samples of previously recorded parent-child interactions at the families' homes. Overall, they found that clinicians judged the percentage of syllables stuttered to be significantly lower in the audio-only condition. They concluded that the audio-video samples may give clarity to more ambiguous stuttering/stuttering-like behaviors, and as a result, audio-video samples should be considered best practice when analyzing recorded samples of parent-child interaction (Rousseau et al., 2008).

**Treatment in Children**

Most studies on the use of telepractice in the treatment of speech and language disorders in children involve little or no direct interaction between the SLP and the children during VC sessions. In England, Rose and colleagues (2000) used a high quality VC system with children in school settings. During these sessions, SLPs consulted with educational support assistants to aid them in providing interventions to their clients. Compared to the traditional FTF sessions, VC saved an average of 29 minutes per child per month (Rose et al., 2000). Additionally, they reported good satisfaction ratings from both clinicians and parents concerning the use of VC.

In 2001, McCullough and colleagues examined the use of VC in the treatment of four preschool children with special needs. In the target intervention, the parents of participants were trained to enhance the communication skills of their children. They used VC as a means of improving communication between SLPs and parents. The VC sessions were adjunct to weekly home visits. Parents reported that the program did improve their knowledge and comfort in working with their children and that their children's communication skills had improved (McCullough, 2001). No comparison groups or objective data on language development were reported.

Two studies based in Australia examined the use of telepractice in an adaptation of the Lindcome Program. Traditionally, this intervention program is a parent-administered behavioral treatment for young children who stutter. In the first stage of the program, parents are trained how to respond to their children's fluent and stuttered speech. After demonstrating competence with the strategies, parents use them daily in everyday conversations with their children. With sufficient progress, families visit the clinic less frequently, progressing through the second and third stages of the program. In 2004, Wilson and colleagues used telepractice to implement the stuttering program with five children who stutter (and their parents). All students received the treatment via telepractice, and no comparison groups were reported. In the adapted version of the Lindcome Program, the parents receive initial training through a sequence of videos. All visits to the clinic were replaced with *telephone* consultations. Further, SLPs monitor parents' use of strategies and the stuttering behaviors of the children with recordings made of the children in their home environment. In order to improve access to the clinicians, the authors made a consultation hotline available to all participants. The authors reported that the percentage of syllables stuttered decreased for all children such that each child reached completion of the first stage of treatment (Wilson et al., 2004). They also reported that more consultations were needed than expected by the program, suggesting that the method was a less efficient version of the treatment. In 2008, Lewis and colleagues implemented a Phase II open plan, parallel group, randomized controlled trial using the same adaptations as in Wilson et al.'s 2004 study. In other words, the participants were randomly allocated to a treatment or no treatment group, which both participants and investigators were not blinded to (Lewis, Packman, Onslow, Simpson, & Jones, 2008). They enrolled 22 preschool children ages 3-4.5 into the study (Lewis et al., 2008). Based on pre-/post- speech samples, the authors reported a significant reduction of percentage of syllables stuttered in comparing the treatment and no treatment conditions. Similar to previous findings, Lewis and colleagues (2008) reported that the telepractice adaptation required three times more phone consultations than FTF consultations of the standard Lindcome Program. Despite this time discrepancy, the authors contend that the telepractice adaptation is a means of providing stuttering intervention to children living in remote areas of Austrailia.

McCarthy and colleagues (2010) examined the cost-effectiveness of a VC intervention for children living in remote areas of Australia and who are deaf or hard-of-hearing. From 2002 to 2010, the Royal Institute for Deaf and Blind Children (RIDBC) in Australia provided intervention services to over 170 families through telepractice. Throughout the intervention, SLPs use weekly VC sessions to observe the families and teach strategies to facilitate learning and interaction for the children. According to the authors, "Participants have reported that teleintervention has provided an effective method of delivering a personal, immediate, and specialized service." Service providers reported that parents seemed to learn strategies more quickly and cancelled fewer sessions with VC intervention (McCarthy et al., 2010).

Grogan-Johnson and colleagues (2011) conducted a rare examination of using VC *to interact with child clients* while providing intervention services. In this pilot study, the authors enrolled thirteen school-age children (ages 6-11) with identified speech sound disorders. Seven children received services via VC, and six children received traditional FTF intervention. The authors reported that both groups had significant improvements in performance on the Goldman-Fristoe Test of Articulation-2 (GFTA-2). Furthermore, there were no significant differences between the groups' performance on the GFTA-2 before or after treatment. Interestingly, the authors also reported that more students mastered Individualized Education Plan (IEP) goals in the VC group (Grogan-Johnson et al., 2011).

In general, this research base suggests that telepractice has the potential to provide at least some services that are comparably equivalent to the same services provided FTF. Thus, it seems reasonable to conclude that telepractice also has the potential for addressing some challenges facing SLPs such as increasing workload demands and shortages in SLPs (discussed above). However, the current research base alone is still insufficient to justify the use of telepractice in many clinical contexts.

**The Importance of and Need for Telepractice Research**

Research on speech-language telepractice services for young children is important for three main reasons. First, the United States government (via the No Child Left Behind Act (NCLB) of 2001 in conjunction with the Individuals with Disabilities Education Act (IDEA) of 2004) and ASHA have both mandated the use of evidence-based practice with young children (ASHA, 2005c). Clinicians who use an evidence-based approach to their services often employ the PICO model (Johnson, 2006). The PICO model applied to telepractice would be: clinicians consider the research regarding the patient population (young children), the intervention (telepractice assessments/treatments), a comparison (with face-to-face assessments/treatments), and the outcome (Johnson, 2006). As noted above, ASHA specifically mandates that telepractice services be comparable to the same treatments given face-to-face (ASHA, 2005a). As a natural result, research on the efficacy of telepractice with young children is imperative to making evidence-based clinical decisions about the use of telepractice.

Second, research in telepractice is important for the establishment of more reimbursement legislation. Medicare does not yet cover telepractice services in speech-language pathology (Romanow & Brannon, 2010). Since third party payers tend to follow Medicare's precedent regarding unestablished procedures, telepractice services are not covered by insurance at the national level (ASHA, 2005a). According to an ASHA survey, more than two-thirds of the reported use of telepractice services was not reimbursed (2005a). As a result, much of the funding for telepractice services has originated in grants from the Department of Education and/or other agencies (ASHA, 2005a; Brown et al., 2010). Despite a lack of nation-wide support, several states have passed legislation requiring insurance to cover services via telepractice that are also covered in face-to-face intervention situations (Deppe, 2009). Thus, more validating research is an important step toward promoting favorable legislation in the remaining states and at the national level as well.

Finally, more research on using telepractice with young children is needed because the current research is lacking in two main ways—quantity and quality.

**Research on Telepractice is Lacking in Quantity.** The current research-base (as outlined above) gives support to the use of telepractice with only a limited sample of the population of young children (from birth to six) in limited intervention contexts. Only six out of the twenty-six studies reviewed above specifically looked at the use of telepractice with the population of young children (Ciccia et al., 2011; Lewis et al., 2008; McCarthy et al., 2010; McCullough, 2001; Rousseau et al., 2008; Wilson et al., 2004). Of these six studies, only two looked at the use of telepractice to deliver services involving direct interaction with children via VC (Ciccia et al., 2011; McCarthy et al., 2010). The other four studies examined the use of telepractice to provide *consultation and training services* to parents of children who stutter, are deaf or hard-of-hearing, or have special needs. As a result, the evidence of using VC to provide interactional intervention services to children is virtually nonexistent. Although they provided anecdotal reports of satisfaction from parents and clinicians, McCarthy and colleagues (2010) did not provide any data on child outcomes or on comparisons with traditional treatment methods. Ciccia and colleagues (2011) also failed to provide comparison groups for their speech and language screenings. And although they reported good reliability for VC screenings, they used less than 3% of their pool of participants to calculate these ratings. As a result, the strongest current research-base supports little more than the use of telepractice to deliver consultation and training services to the parents of young children.

**Research on Telepractice is Lacking in Quality.** None of the twenty-six studies examined above are considered Level Ia evidence as defined by ASHA (well-designed meta-analysis of more than one randomized controlled trial; N.d.). Only one of those twenty-six studies achieved Level Ib status (well-designed randomized controlled trial; Lewis et al., 2008). As noted above, Lewis and colleagues' (2008) Level Ib examination of the Lindcome Program narrowly supports the use of telepractice for parent consultations and training. The vast majority of studies on the use of telepractice are Level IIa – III evidence at best. Furthermore, even the better-designed studies have some considerable methodological problems. Waite and colleagues (2010) use of VC to implement the CELF-4 is one such instance. Although the authors included a control group for FTF comparison (Level IIa), they did not control for the participants' language abilities before the experiment. Additionally, the authors did not employ random assignment. As a result, the authors cannot have expectations on how the participants should have performed on the CELF-4, nor can they assume that the participants from the VC and FTF groups are part of the same population. Even though the authors found no differences between the conditions, it is possible that one condition in the experiment helped a weaker group of participants score higher than they would have, making their scores statistically equivalent with the scores of the other group. In this way, the results of the study do not necessarily support the use of telepractice.

Several studies used methods that raise other methodological concerns. Namely, four studies used the standard scores to compare the administration of standardized assessments through telepractice and through the standardized procedures (Ciccia et al., 2011; Grogan-Johnson et al., 2011; Waite et al., 2010). However, because the VC conditions were not part of the standardization processes of the assessments, their standard scores are not necessarily valid. Thus, these comparisons of telepractice and FTF administrations of standardized tests could be invalid as well. Another disadvantage of using standardized assessments is that the telepractice versions of the assessments were custom designs that are not commercially available. Consequently, their findings have little functional application in the practice of SLPs today.

After this brief analysis of the research on the use of telepractice with young children in speech and language services, at least one important question still remains—Is telepractice a valid method for SLPs to *interact with* young clients and provide speech and language services?

## Child Learning through Multimedia Technology

In an attempt to answer this question, a short overview on more general research concerning child learning and multimedia technology will prove helpful. Much research has been done on the relationship between child language and television viewing. The general consensus has been that television viewing is associated with negative outcomes in aggressive behaviors, nutrition, academic performance, and language scores (Education, 2001; Zimmerman et al., 2009). The current author conducted a previous observational study on television viewing with a group of young children ages 3-5 (Manzanares, 2010). Consistent with previous research, the first main effect showed that children who watched less than 9.5 hours of television per week had significantly higher language scores than children who watched more than 9.5 hours per week as measured by the MacArthur Bates Communicative Development Inventory (MBCDI) (Manzanares, 2010).

In 2003, Kuhl and colleagues conducted two studies on infants' abilities to perceive the phonemes of all languages (categorical perception). In monolingual environments, categorical perception typically declines in infants for non-native sounds as they learn the phonetic inventory of their native language. In their first study, Kuhl and colleagues found that exposure to Mandarin reversed the decline of categorical perception for infants from English speaking homes (Kuhl, Tsao, & Liu, 2003). In other words, with FTF exposure to Mandarin, the infants retained the ability to discriminate sounds of English and Mandarin. In their second study, they exposed children to audio-video and audio recordings of movies in Mandarin. The authors found that this multimedia exposure to Mandarin did not have an effect on the decline of categorical perception. The authors concluded that joint attention with the speaker and social interaction were the main components that impacted the phonetic learning in infants (Kuhl et al., 2003).

Despite this overwhelming consensus, the research-base is not entirely one-sided concerning television viewing and child language. Controlling for external variables such as parent education, family size, and child gender, Rice and colleagues (1990) found that viewing Sesame Street at age three is predictive of higher vocabulary scores at age five. Interestingly, the authors note that, “The dialogue on ‘Sesame Street’ closely resembles that of a mother talking to her child, with simple sentences, much talk about the here and now, repeated emphasis on key terms, and an avoidance of abstract terminology,” (Rice, Huston, et al., 1990, p. 422). They found that viewing adult- or child-directed programing without these characteristics did not predict improvements in vocabulary scores (Rice, Huston, et al., 1990). Thus, it seems that the nature of the programming seemed to have an effect on the language learning outcomes.

The second main effect in Manzanares’s observational study (2010) looked at the nature of the television-viewing environment itself. Namely, the author looked at the interactional patterns of parents and children during television viewing. Based on this sample of participants, two interactional patterns emerged—no change in interactions with others while viewing and a decrease in interactions with others while viewing. Accordingly, the children who experienced no change in parent-child communication scored higher than the children whose communication decreased during television viewing. The author concluded that types of television viewing that are associated with more parent-child communication are involved in producing better language outcomes (Manzanares, 2010). As a result, social interaction is a main component in multimedia technology and child language learning.

Based on this television research, VC seems to have the potential to provide a beneficial language-learning environment, which could possibly be used for interacting with young clients and providing speech and language services. Although VC is a multimedia technology, the main activity focuses on active participation in social interaction—one of the important variables in child language learning.

Several general studies on VC provide evidence that young children can learn through VC and similar multimedia. Deloache and Korac (2003) claim that, “Older infants’ ability to learn from video has been very well established by research using imitation tasks.” In such studies, infants as young as 14-15 months have learned to imitate specific object-directed actions (DeLoache & Korac, 2003). Through two experiments, Troseth and colleagues (2006) presented instructions on finding toys in rooms to toddlers in three conditions—FTF, VC with adult-child interaction, and noninteractional prerecorded videos. They found that young children (23-25 months-old) were able to learn instructions and retrieve toys at above chance levels in only the FTF and VC with interaction conditions. Moreover, they found that the children’s performance in these two conditions were statistically equivalent (Troseth et al., 2006). The authors argued that, “Near their second birthday, toddlers clearly mark people on video as being different from real people, and glean less information from people on video,” (Troseth et al., 2006, p. 796). Despite this “video deficit,” they concluded that the social interaction occurring over VC alters how the children perceive and interpret verbal information occurring through this medium.

Krcmar and colleagues (2007) tested the abilities of 48 toddlers (15-24 months-old) to learn novel words attributed to unfamiliar objects in a limited number of exposures—an ability also known as fast mapping. They presented the toddlers with the items and a non-word label in five different conditions—a stimulus item without label (control condition), FTF with joint attention on the object, FTF with divided attention, a prerecorded video with an adult introducing stimuli, and an adaptation of the show, Teletubbies, with a non-personal presentation of the stimuli. Although it was distinct from VC, the prerecorded video condition mirrored the VC environment. Namely, the adult was looking directly at the camera during the recording and talking to the camera in a conversational manner. The authors found that children were capable of fast mapping and that they were able to learn words best in the "FTF with joint attention" and "prerecorded video of an adult" conditions and had more difficulties learning the words in the other two conditions.

These results are consistent with other research on fast mapping in preschool children with language impairment (Alt, Plante, & Creusere, 2004; Rice, Buhr, & Nemeth, 1990; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, Bode, & Pae, 1994). Rice and colleagues (1990) looked at the fast mapping abilities of preschoolers with specific language impairment (SLI) and two groups of peers that were matched for chronological age and for mean length of utterance. In only one video condition, they presented similar stimuli as Krcmar et al. (2007). Although the children with SLI performed the worst, the authors found that typically developing children *and* children with SLI were able to fast map novel words (Rice et al., 1990). Further, the authors reported that fast mapping was stronger for nouns and adjectives than for verbs and affective state words for all children.

This research-base not only provides evidence that young children can learn through VC but also that they can learn at least some components of language (vocabulary) through multimedia technology that mirrors VC conditions (Krcmar et al., 2007). Therefore, the research base partially answers our previous question about the validity of using telepractice to interact with and provide services to young children. Namely, the evidence seems to suggest (as outlined above) that it is plausible to use VC to implement some direct services to children. As a result, researchers can narrow the broader question—what types of language tasks can be facilitated through VC with outcomes that are comparable to FTF interactions?

**Research on Story-Retelling**

Story retelling has been widely used to elicit spontaneous connected speech from children and adults for research and clinical purposes (Gazella & Stockman, 2003; Hayward, Gillam, & Lien, 2007; Wong, Au, & Stokes, 2004). Story samples have provided information about children's productive language skills at all levels of performance, including syntax, semantics, and pragmatics (Gazella & Stockman, 2003; Gillam & Carlile, 1997; Wong et al., 2004).

A story-retelling task (SRT) typically involves two phases: (1) the presentation of the story (a learning phase) and (2) the elicitation of the story (a testing phase). Gazella and colleagues (2003) compared children's performances on the task in audio-only and audio-video conditions. They found that children performed equally well in both conditions, making this task a versatile tool. Furthermore, the story retell task does not involve standardized procedures and standard scores; the stories and procedures used can be adjusted to meet the unique needs of various clinical and research environments. As discussed above, a major weakness of prior telepractice research revolves around the comparison of standard scores between FTF and VC conditions. The story retell task avoids such validity concerns; information can be gathered from VC conditions and validly compared to FTF administrations of the task. Thus, the story retell task is an ideal procedure in the context of the current investigation.

## The Current Study and Research Questions

In an attempt to add to our knowledge base, the current study examined the effects of multimedia technology on child language learning in a story-retelling task. I read age appropriate narratives to 3 to 5 year-old children from wordless picture storybooks in VC and FTF conditions. Thus, the independent variable for all research questions is the condition in which the original story was presented (FTF or VC). After hearing the stories, I asked the children to tell the story to a naïve listener—the story-retell task.

**Questions**

My primary research question (Q1) was “Are there differences in children’s story-retelling performances between two learning conditions: (1) FTF and (2) VC?” I analyzed the preservation of the original story script and the overall content of the language sample elicited from both conditions. As a result, the dependent variables for Q1 are the objective measurements of language samples derived from the task such as mean length of utterance (MLU), total number of different words, and percentage of content words from the original script.

My secondary research question (Q2) was “Are there differences between FTF and VC conditions in the number of novel words children are able to learn/fast map while participating in the story retell procedure?” Much like previous studies on fast mapping, dependent variables for this question are the number of words that children are able to incidentally learn through limited exposure in the SRT.

My final question (Q3) was “Are there differences in task administration between the two conditions?” In other words, are the FTF and VC administrations of the SRT comparable? To compare the conditions, I analyzed three components related to the administration of the SRT—time, language sample size, and quantity of prompting. As a result, three sub-questions can be derived from the original question. First (Q3a), “Are there differences between the two conditions in the total time that children took to retell the stories?” The dependent variable for Q3a is the total time of the SRT language sample. Second (Q3b), “Are there differences in the total number of words children produce in the two conditions?” Consequently, the dependent variable for Q3b is the total number of words per language sample. Finally (Q3c), “Are there differences between the two conditions in the amount of prompting needed to elicit language samples?" The dependent variable for Q3c is the total number of prompts examiners used in the SRT. Answers to these questions can help fill in some of the gaps in our theoretical knowledge base concerning the use of multimedia technology in language assessments such as the SRT.

**Hypotheses**

From the research reviewed above, only one study compared language samples elicited in FTF and VC conditions. Namely, Georgeadis and colleagues (2004) examined the percentage of information units produced by adults in both conditions. Accordingly, they found no significant differences in the *content* of language samples of mild to moderately impaired adults with stroke or TBI. In the current study, I am looking at the *form* of young children's language and the *content* that they learn from the story retell task. Consequently, Georgeadis and colleagues' results (2004) provide little information concerning Q1. However, multimedia research has produced consistent findings that VC has enabled interactions that are comparable to FTF interactions (Krcmar et al., 2007; Troseth et al., 2006). As a result, my hypothesis for Q1 is that there will be no differences between conditions in the story-telling performances of young children (H1).

Concerning Q2, research on the fast mapping of young children has provided consistent evidence that children can learn words through VC and other similar conditions (Krcmar et al., 2007; Rice, Buhr, et al., 1990). As mentioned above, mild to moderately impaired adults were able to learn similar amounts of story content from FTF and VC (Georgeadis et al., 2004). These findings seem to suggest that there will be no differences between the *content* that children will learn from stories in either condition. Therefore, my hypothesis to Q2 is that there will be no differences in the amount of words learned between the FTF and VC conditions (H2).

Of all the studies on telepractice and VC reviewed above, none have reported quantitative comparisons of story retelling elicitation in FTF and VC environments. This research-base suggests that VC does facilitate many types of usable remote interactions. However, common experiences with VC provide evidence that many variables can have a negative effect on VC interactions such as interruptions in VC connection, inconsistent Internet signals, low quality audio and video stimuli, and limited screen size. All of these variables could affect the efficiency of administering the SRT. As a result, my hypothesis to Q3 is that there will be significant differences in the task administration between the two conditions. More specifically, I hypothesize that VC will take more time (Q3a) and prompting (Q3c) to elicit the retellings and that children will produce smaller samples (Q3b) in the VC condition (H3).

# Methods

## Research Design

As mentioned above, each child in the study was tested in the story-retelling task in FTF and VC conditions—a within-subjects design. The order of the two conditions was counterbalanced. I chose a within-subjects design for the current study for two main reasons. First, this design helps control for the individual variability between children in the target population. The language abilities of children from 3 to 5 years old are widely variable. Further, age is not always an accurate predictor of the language capabilities of a particular child within this range. As a result, the language samples taken in a *between-subjects* design need to be validated by a comprehensive language measure. Without this additional analysis, between-subjects studies are at risk for an unexplained external variable. More specifically, the differences between the experimental conditions in the children's performance could be explained by the children's varying language levels rather than by the condition that they were tested in. By using the within-subjects design, each child contributes a sample in both conditions at their level of language development. As a result, the within-subjects design proved to be a way to control for the individual variability of language level in the target population without using a lengthy and comprehensive language assessment.

The second reason I chose the within-subjects design is that it seems to approach the experimental conditions more clinically. This design asks whether the children in the study do better in one condition rather than another. Likewise, clinicians must constantly ask which conditions will lead to greater success for their treatments or assessments. In these ways, the within-subjects design seemed to be most compatible with this study.

**Participants**

I recruited 6 typically developing children, ages 3;0 – 5;11. Four participants were boys and two were girls (see Table 1 for participant characteristics). The children were monolingual English-speaking, without diagnosis or report of language disorder, hearing loss, or emotional or behavioral disorders as reported by parents in a parent survey (Appendix A). Accordingly, all children were from middle class families as indicated by parent education level. Namely, all parents of participants had achieved at least a four-year bachelor's degree. In addition, Expressive and Receptive One-Word Picture Vocabulary Tests (EOWPVT, ROWPVT) were used to measure the children's expressive and receptive vocabulary skills. Although the children do represent a wide range of ages and vocabulary levels, this variability did not affect the results of the study. As noted above, each child contributed a language sample in both conditions. Thus, the age and vocabulary variability is equally represented in both conditions.

**Table 1: Participant Characteristics**

| Subject | Sex | Age (mos.) | EOWPVT (Raw Score) | ROWPVT (Raw Score) | Daycare/ School | TV Viewing (Hrs. Per Wk.) | VC Familiarity | Assignment Group |
|---|---|---|---|---|---|---|---|---|
| 1 | M | 41 | 28 | 43 | None | 16 | Never Seen | A |
| 2 | M | 42 | 48 | 53 | Preschool | 14 | Uses Frequently | B |
| 3 | F | 48 | 56 | 65 | Daycare | 25 | Uses Frequently | C |
| 4 | F | 51 | 31 | 48 | None | 12 | Seen Before | D |
| 5 | M | 36 | 39 | 64 | None | 12 | Used Once | A |
| 6 | M | 71 | 82 | 86 | Kindergarten | 9 | Uses Frequently | B |

**The Story Retelling Task**

**Materials.** The protocols for the story-retell sessions contained two wordless storybooks by Mercer Mayer—*A Boy, a Dog and a Frog* (story 1) and *Frog Where Are You?* (story 2). To accommodate for VC, portable document format (PDF) copies of the story were made to display on the VC website (discussed below). Narrative story scripts were written for each wordless storybook. Each story contained not more than 30 different illustrations with approximately one sentence per illustration. Four unique words were embedded in each script for the presentation (e.g. "hornet" was chosen to replace "bee," and "antelope" was chosen to replace "deer."). A total of eight words were included for the evaluation of word learning. To help identify the occurrence of word learning, a four-choice vocabulary evaluation protocol was developed from the eight target words (from both Mercer Mayer story scripts) and eight unrelated control words (sixteen total words). This protocol was given before and after the story retelling task to determine whether the children learned the words through the testing procedures (see details below).

**Presentation Conditions.** Each participant was tested in the story-retelling task in two story presentation conditions: (1) FTF condition (2) VC condition. For the VC condition, the examiner presented the electronic version of the story on one laptop computer through Adobe *ConnectPro (URL:http://www.adobe.com/ products/acrobatconnectpro/)* in a separate room in the Speech, Language, and Hearing Sciences building at the University of Colorado at Boulder. Meanwhile, each participant, with the supervision of another examiner, looked at each page on the laptop in another room in the same building. The *ConnectPro* website enabled video-conferencing and facilitated the presentation of the PDF slideshows of the wordless storybooks (Adobe, 2009).

**Story Elicitation.** For both conditions, test administrators read the narrative scripts corresponding with the storybooks to the children before another naïve listener elicited retellings of the story. These scripts mostly contain descriptive sentences about the story (Appendices B and C).

**Unfamiliar Word Measure.** I used a word identification task before and after the SRT to assess whether the children learned the unfamiliar words from the story retelling task. This word identification task was a four-choice picture identification task. More specifically, the examiner showed the child a stimulus card with four objects and asked the child to identify one object on the stimulus card. There were a total of sixteen stimulus cards presented. As mentioned above, eight of the target words for this task were unique words occurring in the narrative scripts, and eight of the target words were control words not appearing in the narrative scripts (See Appendix D for a sample stimulus page).

**Dependent Measures.** For answering Q1, all language samples were transcribed and analyzed using Systematic Analysis of Language Transcripts (SALT) software methods. This question asked whether VC and FTF administrations of the SRT would result in differing representations of young children's language (via language samples). In the analysis of the baseline stories and story-retelling samples, I acquired three objective measures of the language used. First, I measured the total number of different words used—a measure of lexical diversity. Second, I measured the MLU of each child's language samples, an indicator of syntactic ability. Third, I counted the number of total content words (from the original scripts) in the samples and calculated the percentage of content words to compare VC and FTF conditions. The script for *A Boy, a Dog and a Frog* had 70 total content words, and the script for *Frog Where Are You?* had 63 total content words (See Table 2 for the lists of words). Since the baseline storytelling condition had no original script (see further description below), no baseline comparisons were used in this measure.

**Table 2: Content Word Lists**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A Boy, a Dog, and a Frog** | boy | dog | frog | took | pail | catcher | find | looked | tree |
| **(Story 1)** | scratched | ear | hill | saw | pond | ran | down | look | happy |
| | stumbled | over | branch | slickers | pail | flew | air | fell | high |
| | air | smiled | because | on | head | reached | catch | jumped | away |
| | saw | log | said | head | raised | tried | caught | instead | got |
| | shout | goodbye | sad | see | leaved | ragged | walked | all | way |
| | home | alone | decided | follow | tracks | find | house | floor | taking |
| | bath | finally | too | jumped | high | landed | surrounded | | |
| **Frog Where Are You?** | where | boy | dog | found | frog | put | jar | night | when |
| **(Story 2)** | slept | jumped | out | ran | away | morning | woke | up | see |
| | searched | looked | broke | out | window | find | silly | fell | everywhere |
| | mad | outside | hive | hole | found | angry | gopher | fall | looked |
| | tree | hornets | chased | raptor | huge | piece | granite | antelope | carried |
| | cliff | threw | pond | splash | heard | something | quiet | log | two |
| | whole | family | frogs | took | baby | home | waved | bye | with |

For answering Q2, I recorded responses from the children during the unfamiliar words measure before and after administration of the SRT. Q2 asked whether there are differences in the amount of words children learn during FTF and VC story retellings. Items that were missed before the task but identified after the task were considered potentially "learned" items. To test whether learning did occur, I compared the pre/post amounts of words "learned" between control and target words. Further, I compared the total number of both control and target words that children answered correctly on the pre-/post-tests. Two outcomes in these tests were needed to confirm that learning of *target words* had occurred. First, significantly more target words must be "learned" than control words. Second, the target words must show a significant increase in total number correct from pre- to post-testing, while the control words must show either no significant difference or a significant decrease in total number correct from pre to post testing.

Since the control words do not appear in the SRT, they should not be "learned" through testing, and participants should not score higher on post-test control words. If both outcomes are met, it is highly probable that the variance in the two outcomes is due to "learning" of the target words and not due to mere chance from guessing unknown words.

The SALT transcripts and video samples were further analyzed to collect data to answer Q3a – Q3c. Q3a asked whether there were differences in the amount of time that story retellings take between the conditions. As a result, the dependent variable to answer this question was the total time of the retellings. More specifically, the time was marked first when the examiner first prompted the child to retell the story and second when the child finished the last utterance of her/his retelling. By comparing these times in each condition, I tested whether potential difficulties with VC interactions (such as delayed video signals or equipment/connection malfunctions) would make retellings take a significantly longer period of time than the natural FTF interactions. Q3b asked whether there were differences in the total number of words that children use in the two conditions. In other words, does one condition encourage children to talk more than the other condition? As a result, the dependent variable for this question was the total number of words spoken in each condition. Q3c asked whether the retellings from one condition resulted in more prompting than retellings in the other. To generate the dependent measure, all clinicians' utterances during the retellings were scored as either prompts or non-prompts. Prompts were identified as imperative or interrogative utterances that told or asked children to produce language. Examples of prompts were, "Tell me about this page," or "What is going on here?" Non-prompts were defined as declarative or exclamatory utterances that did not specifically ask the children for a response. Examples of non-prompts were, "I see," or "Wow!" Immediate repetitions of child utterances—glossing—were also counted as non-prompts.

**Task Administration.** Each session required three trained examiners to fill the three roles in the story retell task. There was one storyteller, one naïve listener, and one story supervisor. Each experimenter played a specific role in the story retell task (described below). All lab assistants in the experiment were required to participate in a training and at least one lab workshop before working with participants.

**Group Assignment**

This study required that each participant be tested once in both presentation conditions. As a result, three types of ordering effects could pose threats to the validity of the results. First, the order of the presentation of the two storybooks could have affected the results of the study—the story-order effect. In other words, children could have given better samples with one book over another, and this could have potentially skewed the samples given in a particular condition if not controlled. Second, the order of the presentation of the conditions could also have affected the results of the study—the condition-order effect. In this instance, the children could have potentially done better when presented a given *condition* first. This could have also skewed the data if not controlled. Finally, the order of the story and condition presentation could have also have affected the results of the study—the story-condition-order effect. More specifically, the participants could perform better when presented first with a certain story along with a certain condition. As a result, participants were assigned their story-condition order using a counterbalanced technique. Since there were two stories (1 and 2 below) and two test conditions (V for videoconference and F for face-to-face) in this within-subjects design, there were four possible story-condition sequences. These possibilities were as follows:

A. 1F → 2V
B. 2F → 1V
C. 1V → 2F
D. 2V → 1F

As noted above, all subjects were assigned based on a counterbalancing method. More specifically the participants were divided into four sequence groups (A-D) based on the chronological order in which they scheduled their first session (see Table 3 for a story-condition order flowchart). Because there were only six participants, four participants were in the A and B story-condition order groups and only two participants were in the C and D groups. As a result, the story-condition order groups did not have enough participants per group to test for differences between each possible story-condition order. Further, four participants started with the FTF condition, whereas only two participants started with the VC condition. As a result, the uneven numbers in these two condition-orders prevented testing for differences. However, three participants started with story 1, and three participants started with story 2. As a result, two groups emerged within the story-order factor—those that had story 1 first and those that had story 2 first. These two groups made up the only between-subjects factor that could be used in the within-subjects analyses. Thus, although I was able to test for a story-order effect, I was unable to test for either a story-condition-order effect or for a condition-order effect.

**Table 3: Story-Condition Order Flowchart**

**Session 1**

| Condition Possibilities | Story Possibilities: A Boy, a Dog, and a Frog. | Story Possibilities: Frog Where Are You? |
|---|---|---|
| Face-to-Face | A | B |
| Videoconference | C | D |

→

**Session 2**

| Condition Possibilities | Story Possibilities: A Boy, a Dog, and a Frog. | Story Possibilities: Frog Where Are You? |
|---|---|---|
| Face-to-Face | D | C |
| Videoconference | B | A |

**General Procedures**

Each participant was tested in two sessions over a period of no more than two weeks.

**Session 1.** Before session 1 began, each subject's parent filled out a physical copy of the parent survey.

First, each session started with an initial playtime session for each child. The experimenters led the child in play activities with age appropriate toys for ten minutes. This activity allowed the experimenters to meet and establish a rapport with the child. The playtime sessions were held in a specific room used only for playtime administration. The children were under direct supervision of a Child Language and Learning Lab member at all times during each of these sessions.

Second, in each session, the initial playtime was followed by a baseline storytelling task. In this task, the child was asked to tell a story from a wordless picture book from the same line of storybooks by Mercer Mayer in the SRT. The examiner gave the child two choices of such wordless storybooks to use for their storytelling. This task provided a baseline measure of the child's storytelling abilities.

Third, the baseline storytelling task was followed by a SRT. Each subject was assigned one of the four story-condition sequences (discussed above). The story-condition sequence assigned to each subject determined which condition they were given in session 1 and in session 2. The SRT was divided into four phases: a pre-story vocabulary evaluation phase (PreVEP), the storytelling phase, the story retelling phase, and a post-story vocabulary evaluation phase (PostVEP).

***PreVEP.*** During this phase, the experimenters showed each child a set of stimulus cards with four pictures on each card. There were a total of sixteen stimulus cards for the PreVEP. For each stimulus card, the experimenter asked the child to point to one of sixteen vocabulary words. Eight of the sixteen vocabulary words were unique vocabulary words from *both* of the Mercer Mayer story scripts. The other eight words were control items unrelated to the stories. This phase endured for no longer than five minutes, and it occurred only in Session 1 for all participants.

***Storytelling Phase.*** During this first phase, the storyteller simply showed the subject the sequence of story illustrations while reciting the script that corresponded to each page. In the FTF condition, the storyteller told the story to the subject using the physical copy of the book. In the VC condition, the storyteller told the story to the subject through the computer screen using the digital copy of the book. This phase endured no longer than ten minutes.

***Transition time.*** There was a transition time between the phases to allow for the storyteller to exit and for another examiner to enter. This transition took no more than five minutes.

***Story Retelling Phase.*** In this phase, the subject was introduced to another examiner who served as a naïve listener (through the same condition as the story was told). The listeners were trained to facilitate the story retelling using a narrow script of phrases that minimized the examiner's influence on the participants' language samples. The subject then retold the story to the naïve listener using either the book in the FTF condition or the PDF in the VC condition. The entirety of the story retelling task was video-recorded to allow for language samples to be transcribed.

***PostVEP.*** During this final phase of the story retell task, the experimenters presented the set of stimulus cards corresponding to the four unique words from the story script in the retelling phase. Including four unrelated control items for each story, there were a total of eight stimulus cards for the PostVEP. For each stimulus card, the experimenter asked the child to point to one of these eight vocabulary words. This phase endured for no longer than three minutes, occurring in both Session 1 and 2 for the corresponding story script. As a result, the story retelling task endured for no more than 33 minutes (including the five minute transition time).

After the story-retell task, the subjects were taken back to the playroom for a water break and another playtime session. The last task for each session was either the Receptive One-Word Picture Vocabulary Test (ROWPVT) or the Expressive One-Word Picture Vocabulary Test (EOWPVT). This task was administered in no more than fifteen minutes. Finally, the subjects were taken back to the playroom once more to participate in playtime for up to ten minutes or until their parent arrived to pick them up.

**Session 2.** Mirroring session 1, this session started with an initial playtime. Second, playtime was followed by another baseline storytelling task. Third, the storytelling task was followed by a story-retell—the other condition and story. Next, the subject was taken back to the playroom for a water break and another ten-minute playtime session. Finally, depending on the test given in session 1, each child was given the ROWPVT or the EOWPVT. After this final task, the subject was taken back to the playroom once more to participate in playtime for up to ten minutes or until their parent arrived to pick them up.

**Analysis**

A repeated measures analysis of variance (*rm*ANOVA) was the main test used to compare the two conditions and to test for session and story effects. Because of the between-subjects variable of story-order, a related measures T-test was insufficient to analyze the data. One test also included a baseline covariate and required a repeated measures analysis of covariance (*rm*ANCOVA). More specifically, performances of MLU should not vary as a function of the type of task (i.e. storytelling versus story retelling). As a result, baseline measures from FTF storytelling samples were used as covariates in a *rm*ANCOVA. This use of baseline measures of MLU helped control for potential variability in the MLU of the young children across performances. For other dependent measures such as total different words, the storytelling and the story retelling may result in differing values because of differences in the tasks. Namely, the retelling could result in more words and more different words simply because the retelling includes an a priori model of the story. Because of this potential inconsistency, baseline storytelling measures were not used as covariates to the other retelling measures as with MLU. Instead, the measures were analyzed with *rm*ANOVA (as noted above). In all tests, story-order was used as a between subjects variable to test for story-order effects.

## Results

**Question 1: "Are there differences in children's story-retelling performances between two learning conditions: (1) FTF and (2) VC?"**

Table 4 summarizes participants' performance across the two learning conditions.

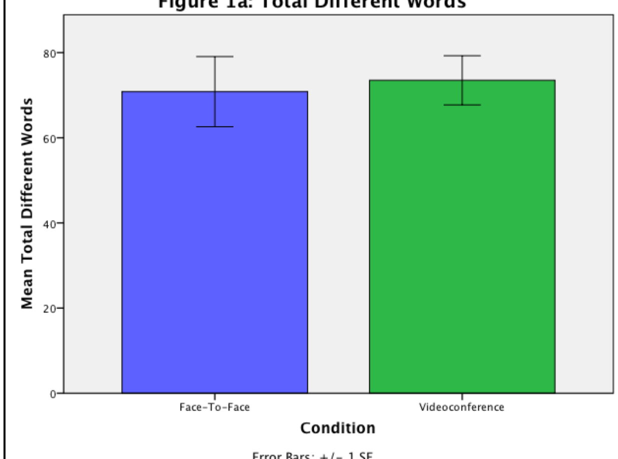
**Table 4: Question 1 Performance Summary**

| Dependent Variable | FTF | VC |
|---|---|---|
| Number of Different Words | 70.8 (20.1) | 73.5 (14.1) |
| Mean Length of Utterances | 5.86 (1.30) | 6.17 (1.26) |
| Percentage of Content Words | 30.9 (13.8) | 32.2 (5.9) |

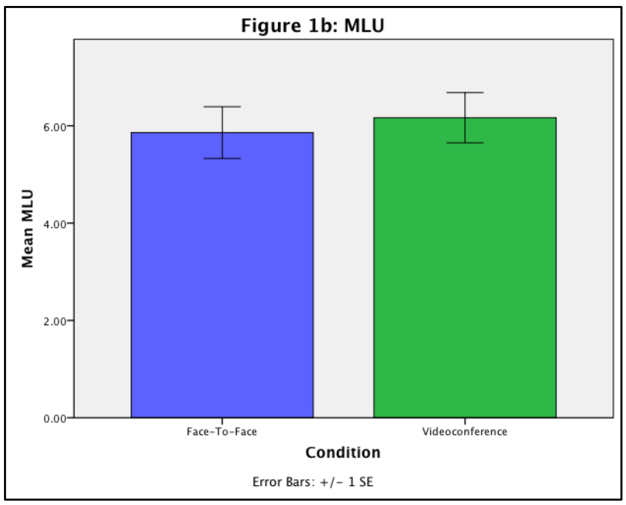
Note. The values indicate the sample means and standard deviations across the two conditions. E.g. M(SD).

The first dependent variable for Q1 was a measure of lexical diversity—number of different words. The higher the value of different words, the more lexical diversity the children have demonstrated. Storytelling covariates were not used on this test because storytelling and story *re*telling tasks could potentially result in different amounts of *total* words. Namely, the retelling could result in more words (and more *different* words) simply because the retelling includes an a priori model of the story. Consequently, a *rm*ANOVA was performed on the independent variable—condition. Further, there were no differences found between VC and FTF conditions in number of different words, $F$ (1, 4) = 0.041, $p$ = .849, $\eta^2$ = 0.018 (See Figure 1a). Additionally, no significant story-order interactions were found in any of the three tests as measured by the story-order between-subjects factor (discussed above). In other words, there was not an observed story-order effect on the number of total different words in the children's retellings.

Figure 1a: Total Different Words



The second dependent variable used to compare FTF and VC language performances was a measure of syntactic ability—MLU. As mentioned above, storytelling covariates were used in this performance measure because MLU should not be affected by the amount of content the child produces. Instead, MLU reflects the syntactical skills of the child. Accordingly, *rm*ANCOVA found no significant differences between the FTF and VC conditions in MLU, $F(1, 2) = 0.239$, $p = .673$, $\eta^2 = 0.108$ (See Figure 1b). Additionally, there were no observed story-order effects as demonstrated by an interaction between condition and story-order.




The final dependent variable comparing FTF and VC language performances was the percent of content words used from the original script. Because the a priori model of the story affects this measure, it also had the potential to demonstrate "learning" through the SRT. Namely, learning of the story script could have been demonstrated by increases in the percentage of content words in the children's story *re*tellings when compared to storytellings without the a priori model. However, scripts were not developed for the wordless storybooks used for the storytellings. Further, the children were given two choices of books to give their baseline stories (as noted above). As a result, their use of the two storytelling books was not equally distributed, prohibiting a comparison with retellings. Consequently, I was unable to test whether learning of *story scripts* occurred through the SRT. Accordingly, percentage of content words was solely used as a language measure. Analysis of the data revealed no significant differences in percentage of content words between FTF and VC conditions, $F$ (1, 4) = 0.083, $p$ = .788, $\eta^2$ = 0.020. In other words, children were not shown to use different percentages of content words via VC or FTF methods (See Figure 1c). As with number of different words and MLU, there was not an observed story-order effect. See Table 5 for a summary of Q1's results.

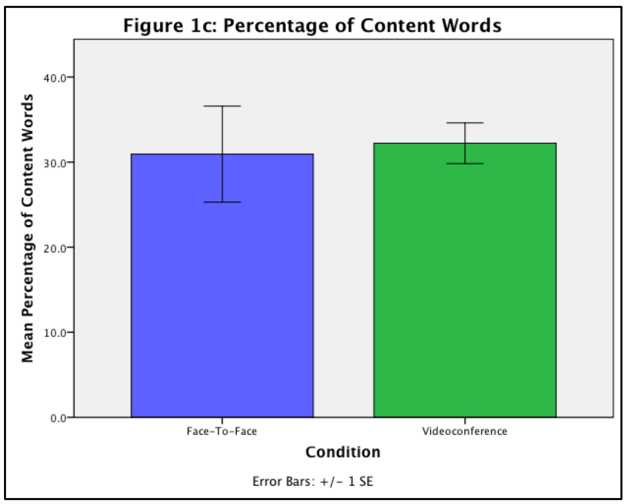



**Table 5: Question 1 *rm*ANOVA/*rm*ANCOVA Table**

| Dependent Measure | *df* (between treatments) | *df* (error) | F | $\eta^2$ | p | Observed Power |
|---|---|---|---|---|---|---|
| *Total Different Words* | 1 | 4 | 0.074 | 0.018 | .800 | 5.5% |
| *MLU (rmANCOVA)* | 1 | 2 | 0.239 | 0.108 | .673 | 6.1% |
| *% Content Words* | 1 | 4 | 0.083 | 0.020 | .788 | 5.6% |

*Note:*
* Indicates near significant value (p ≤ .100)
**Indicates significant value (p < .05)

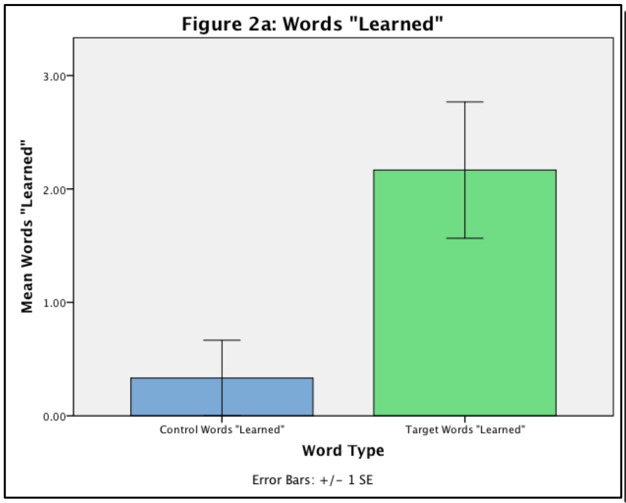
**Question 2: "Are there differences between FTF and VC conditions in the number of novel words children are able to learn/fast map while participating in the story retell procedure?"**

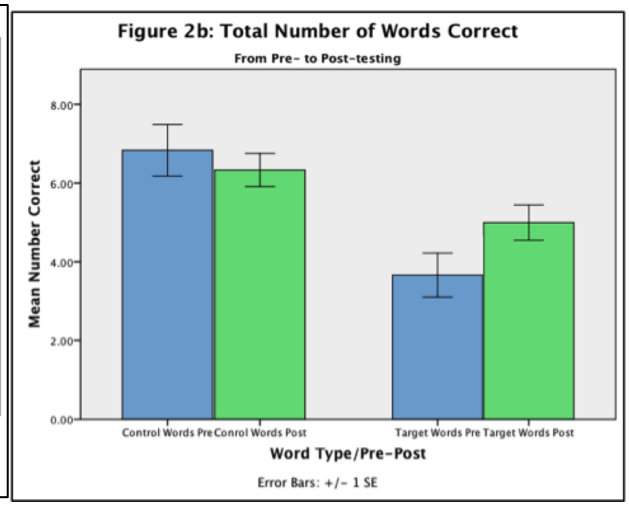
Table 6 summarizes participants' word learning performance across the two learning conditions.

| Table 6: Question 2 Performance Summary | | |
|---|---|---|
| **Word Type** | **FTF** | **VC** |
| Target Words | 1.17 (1.6) | 1.00 (0.63) |
| Control Words | 0.00 (0.00) | 0.33 (0.81) |

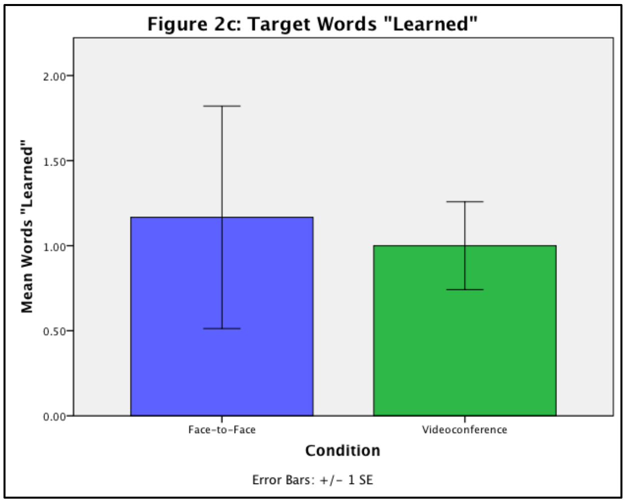
Note. The values indicate the sample means and standard deviations across the two conditions. E.g. M(SD).

Before testing for differences in learning between FTF and VC conditions, the occurrence of learning must first be demonstrated. As mentioned above, two outcomes were needed to demonstrate learning. First, the amount of target words "learned" must be significantly greater than the amount of control words "learned." Analysis of words "learned" confirmed this first outcome. There were significantly more target words "learned" than control words, $F$ (1, 4) = 30.25, $p$ = .005, $\eta^2$ = 0.883. Accordingly, 88% of the variance in the data was explained by differences between the control and target words learned (See Figure 2a). The second outcome was two-fold. Namely, the total number of target words correct must increase from pre- to post-testing, *and* the total number of control words correct must stay the same or decrease from pre- to post-testing. Analysis of the data confirmed both components of this second outcome measure of learning (See Figure 2b). The total number of target words correct was significantly greater in the post-test, $F$ (1, 4) = 32.000, $p$ = .005, $\eta^2$ = 0.889. According to this effect size, 89% of the variance in the data was explained by differences between the pre- and post-tests. Additionally, the number of control words was not significantly different from pre- to post-testing, $F$ (1, 4) = 0.643, $p$ = .468, $\eta^2$ = 0.138. Therefore, consistent with prior research, children were able to learn target words from the SRT.




Based on this demonstration that learning of target words did occur, I tested the two conditions for differences in target words learned. The *rm*ANOVA did not reveal significant differences in the amount of words learned between conditions, $F$ (1, 5) = 0.044, $p$ = .842, $\eta^2$ = 0.009. In other words, the children did not learn significantly different amounts of words from FTF or VC administrations of the SRT (See Figure 2c). Only one of these tests revealed a significant interaction with story-order. Namely, the target words correct (pre- to post-test) had an observed story-order effect, $F$ (1, 4) = 18.00, $p$ = .013, $\eta^2$ = 0.818. More specifically, the “Story 2 → Story 1” group performed significantly better on the pre-test than the “Story 1 → Story 2” group (See Figure 2d). There were no other observed story-order effects for word learning. See Table 7 for a summary of Q2’s results.



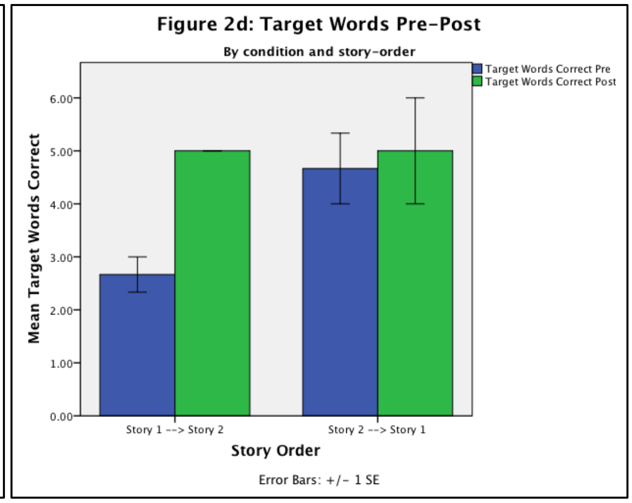



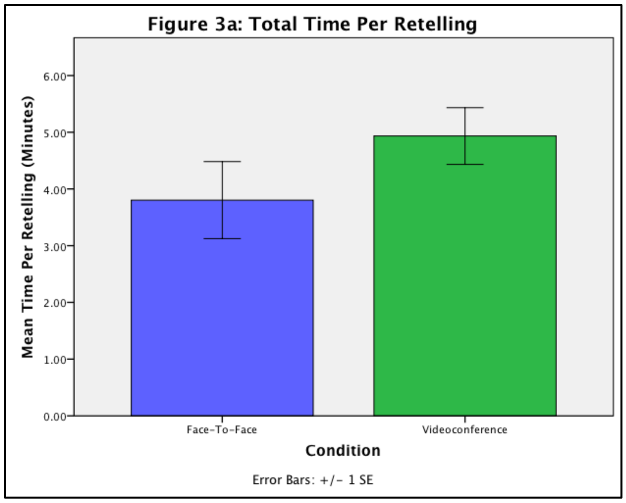

**Table 7: Question 2 *rm*ANOVA Table**

| Dependent Measure | Comparison | *df* (between treatments) | *df* (error) | F | $\eta^2$ | p | Observed Power |
|---|---|---|---|---|---|---|---|
| *# Words "Learned"* | Target/Control | 1 | 4 | 30.25 | 0.883 | *.005*** | 97.9% |
| *# Controls Correct* | Pre/Post | 1 | 4 | 0.643 | 0.138 | .468 | 9.6% |
| *# Targets Correct* | Pre/Post | 1 | 4 | 32.00 | 0.889 | *.005*** | 98.4% |
| *# Targets Learned* | FTF/VC | 1 | 4 | 0.063 | 0.015 | .815 | 5.4% |

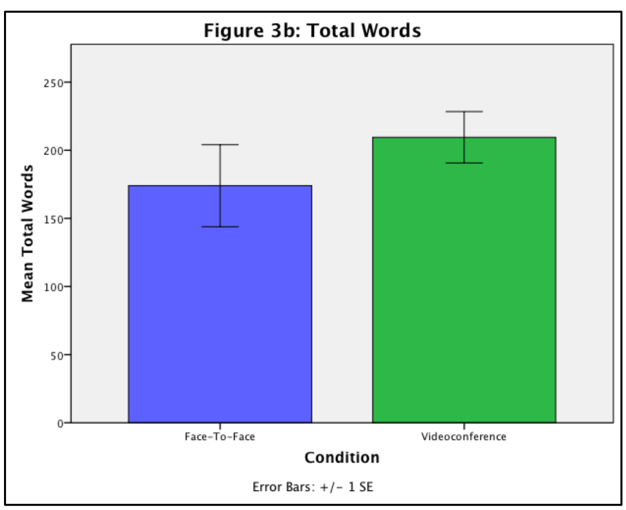
*Note:*
* Indicates near significant value ($p \leq .100$)
**Indicates significant value ($p < .05$)

**Question 3: "Are there differences in task administration between the two conditions?"**

**Q3a.** As mentioned above, three dependent variables were examined to answer this final question—total retelling *time* (Q3a), total *number of words* (Q3b), and total number of retelling *prompts* (Q3c). Q3a asked whether one condition took longer to administer than another condition. Accordingly, *rm*ANOVA did not find significant differences between the duration of FTF and VC retellings. Furthermore, no significant story-order interactions were found.




**Q3b.** This question considered the possibility that children would talk more (say more words) in a given condition when retelling a story. Children talking more in one condition over another could suggest that children are more comfortable in that condition or that they are more engaged in the task. As a result, significant differences in this dependent measure could raise questions about the validity of using VC (if it results in fewer total words), or differences could support the use of VC (if it results in more total words). The *rm*ANOVA revealed that FTF and VC retellings did not result in significantly different amounts of total words, $F$ (1, 4) = 0.733, $p$ = .440, $\eta^2 = 0.155$ (See Figure 3b). No significant story-order interactions were observed.



**Q3c.** The final question asked whether there were differences between FTF and VC SRTs in the prompts used to elicit stories. More prompts in a condition could suggest that the condition does not engage children as much as the other condition. The *rm*ANOVA did not reveal significant differences in the number of prompts given in FTF and VC conditions, $F$ (1, 4) = 0.733, $p$ = .157, $\eta^2$ = 0.431 (See Figure 3c). As with all other variables in all questions, no significant story-order effects were observed. See Table 8 for a summary of Q1's results.

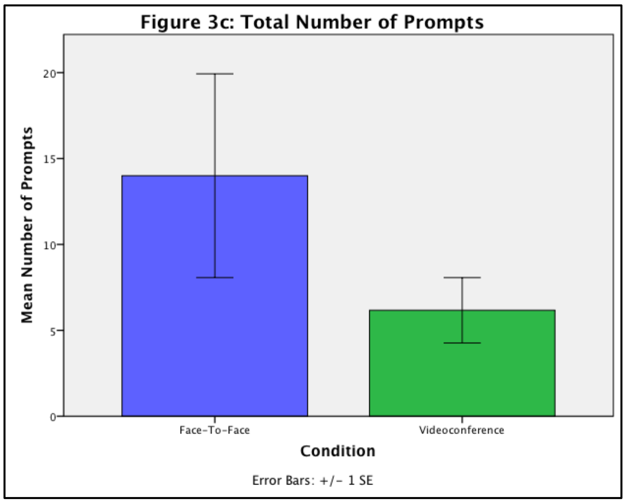



**Table 8: Question 3 *rm*ANOVA Table**

| Dependent Measure | *df* (between treatments) | *df* (error) | F | $\eta^2$ | p | Observed Power |
|---|---|---|---|---|---|---|
| *Total Retelling Time* | 1 | 4 | 1.541 | 0.278 | .282 | 16.2% |
| *# Total Words* | 1 | 4 | 0.733 | 0.155 | .440 | 10.3% |
| *# Total Prompts* | 1 | 4 | 3.026 | 0.431 | .157 | 26.9% |

*Note:*
* Indicates near significant value (p ≤ .100)
**Indicates significant value (p < .05)

## Confounding Variables

The current study could be affected by at least two different confounding variables—session (1 or 2) and story (1 or 2). As a result, the dependent measures could be analyzed with respect to each confounding variable—by session and story. Analyzing the variables by *session* asks whether the dependent variables vary based on the session number. In other words, analyzing by session asks whether the children performed better in one session over another. More specifically, children could possibly perform better in the second session due to increased comfort with the procedures. Testing by *story* asks whether the children performed better with one story over another. Although the stories have similar characters and themes, the stories could possibly elicit different language samples (Q1), learned words (Q2), or task administration variables (Q3). These potential differences between the sessions and stories could affect the results of testing by condition. For example, if children perform better in the second session, results from condition comparisons could be skewed. Namely, more children (four) had VC in the second session, whereas only two children had FTF in the second session. As a result, differences between VC and FTF could be a reflection of the session-effects and not a reflection of differences between VC and FTF administrations of the SRT. To examine these potential confounding variables and to answer my target questions, I analyzed each dependent variable (except MLU) by session and story using *rm*ANOVA. For MLU, *rm*ANCOVA was performed with both baseline storytelling samples serving as covariates (as noted above). Furthermore, all analyses included the between-subjects factor of story-order to test for story-order effects. Accordingly, analyses confirmed that no significant confounding variables were observed (see results summary in Table 9). In other words, neither the session nor the story had a significant effect on any of the dependent measures of the study.

**Table 9: Confounding Variable *rm*ANOVA/*rm*ANCOVA Table**

| Dependent Measure | Confounding Variable | *df* (between treatments) | *df* (error) | F | $\eta^2$ | p | Observed Power |
|---|---|---|---|---|---|---|---|
| *Total Different Words* | Session | 1 | 4 | 5.652 | 0.586 | .076* | 44.2% |
| | Story | 1 | 4 | 0.041 | 0.010 | .849 | 5.3% |
| *MLU (rmANCOVA)* | Session | 1 | 2 | 1.692 | 0.459 | .323 | 12.5% |
| | Story | 1 | 2 | 1.078 | 0.350 | .408 | 9.9% |
| *% Content Words* | Session | 1 | 4 | 6.894 | 0.621 | .058* | 51.4% |
| | Story | 1 | 4 | 1.058 | 0.200 | .362 | 12.6% |
| *# Targets Learned* | Session | 1 | 4 | 0.450 | 0.101 | .539 | 8.2% |
| | Story | 1 | 4 | 3.063 | 0.434 | .155 | 27.1% |
| *Total Retelling Time* | Session | 1 | 4 | 1.298 | 0.245 | .318 | 14.4% |
| | Story | 1 | 4 | 0.027 | 0.007 | .877 | 5.2% |
| *# Total Words* | Session | 1 | 4 | 3.810 | 0.488 | .123 | 32.3% |
| | Story | 1 | 4 | 0.178 | 0.043 | .695 | 6.3% |
| *# Total Prompts* | Session | 1 | 4 | 1.447 | 0.266 | .295 | 15.5% |
| | Story | 1 | 4 | 0.067 | 0.017 | .808 | 5.5% |

*Note:*
* Indicates near significant value ($p \leq .100$)
**Indicates significant value ($p < .05$)

## Discussion

The purpose of the current study is to examine the effects of VC on children's language and learning skills when retelling stories and the effects of VC on the administration of the SRT. Q1 focused on children's language skills. As noted above, there were no differences in the total different words, MLU, or percentage of content words between FTF and VC conditions. Thus, these results are consistent with my first hypothesis. Namely, there were no differences between conditions in the story-telling performances of young children. Further, these findings are consistent with previous telepractice and multimedia technology research on both children and adults (Georgeadis et al., 2004; Krcmar et al., 2007; Troseth et al., 2006). Consequently, the answer to Q1 seemingly adds to the evidence base supporting the use of VC in providing speech and language services. VC did not significantly affect the language performance of the typically developing children in this study.

Q2 focused on children's word learning through the SRT. As discussed above, the results demonstrated that the children in this study did learn words through minimal exposure. These findings are consistent with previous research on multimedia technology. Namely, children can learn through television and VC (Krcmar et al., 2007; Rice, Buhr, et al., 1990). Additionally, the current results did not reveal that children learned significantly different amounts of words between FTF and VC conditions. Thus, these findings are consistent with my hypothesis that there would be no differences in word learning between conditions. Furthermore, the answer to Q2 also seems to be consistent with the current evidence base supporting the use of telepractice by SLPs (discussed above). VC did not significantly affect the amount of words learned by the typically developing children in this study.

Q3 examined the effect of VC on the administration of the SRT. The results did not reveal significant differences between conditions in the time, the amount of talking, or the amount of prompting used in the SRT. Consistent with common VC experiences, there were technical disruptions throughout the sessions related to the VC software and Internet connection. However, these disruptions did not significantly affect any of the task administration measures. Contrary to my predictions, these findings suggest that there were not significant differences in task administration between conditions. Consequently, the answer to Q3 seems to support the use of VC in the administration of the SRT to young typically developing children.

**General Conclusions and Concerns**

As noted above, this study did not find significant differences between FTF and VC conditions in any of the language (Q1), word learning (Q2), or task administration (Q3) measures. One conclusion that could be drawn from these findings is that there are no differences between language samples taken from VC and FTF administrations of the SRT. However, a major concern when interpreting the results of this study is the small size of the sample (n = 6). One consequence of a small number of participants is reduced statistical power. More specifically, small numbers reduce the likelihood of correctly identifying significant differences between conditions or between the confounding variables of session and story. In the current study, seventeen out of the twenty-two tests that failed to find significant differences had less than a 20% chance of correctly identifying differences (refer to Tables 5, 7, 8, and 9). In other words, although the results did not find significant differences, the reduced power indicates that there was a low probability of detecting differences even if they did exist for most of the analyses.

Five of the twenty-two tests had greater than 20% chance of correctly identifying significant effects. From these five results, two were near significant ($p \leq .100$), and the other three had *p*-values less than .160 (refer to Tables 8 and 9). These results were the closest to finding significant condition, story, or order effects in the current study. Considering the reduced chance of correctly identifying significant effects, it is possible that larger numbers could have revealed significant differences for these five results. Given this possibility, a closer examination of these five results will prove beneficial in further elucidating the conclusions of the current study.

As mentioned above, at least two confounding variables could also have an impact on the data—session and story. Only one of these five results examined story effects. As seen in Table 9, the story test of the number of target words learned had a 27.1% chance of correctly identifying significant differences, $F(1, 4) = 3.063$, $p = .155$, $\eta^2 = 0.434$. However, because both stories had equal representation in both conditions (n = 3), differences between stories should also be evenly distributed in both conditions. Thus, even if one story were better than another story, the advantage should affect the conditions equally. As a result, it seems that even if larger numbers identified a significant difference between the stories, the condition results would not be affected.

Three out of these five results examined session effects—total different words, percentage of content words, and total words. Although none of the tests revealed significant differences, total different words and percentage of content words revealed *near* significant differences between sessions (refer to Table 9 for specific statistical measures). Namely, session 1 had higher—albeit not significantly higher—means than session 2 of total different words and of percentage of content words. Importantly, the FTF condition occurred four times in session 1, whereas the VC condition occurred only two times in session 1 (as mentioned above). Consequently, session 1 was over-represented in the FTF condition. Accordingly, if session 1 did give an advantage in total different words and percent content words, then the FTF condition's values would be inflated. Upon examining the conditions in both cases, the VC means are already slightly higher—though not significantly—than the FTF means. The third session result also implicated a possible session 1 advantage. Again, a true session 1 advantage would imply that the FTF condition's values are inflated. And similar to total different words and percent content words, the VC mean of total words is once again already higher—though not significantly—than the FTF mean of total words. Consequently, even if greater numbers revealed these session 1 advantages, the VC results would not likely be negatively affected.

Only one out of these five results examined the target condition effects—number of prompts. Accordingly, this test revealed a higher—though not significantly—mean of FTF prompts than VC prompts (refer to Table 8 and Figure 3c). Although such a difference could have many causes, one explanation is that children needed less prompting in the VC condition and that they were more independently engaged in the task in this condition. Whatever the cause, one of the main goals of eliciting samples from the SRT is to have less prompting by examiners. As a result, even if greater numbers revealed a significant difference between prompts in FTF and VC conditions, the VC condition would not likely be negatively affected. On the contrary, given the goal of less prompts, the results would rather support the use of VC with the SRT.

A closer examination of the story-order interaction reveals another concern that is related to small sample size. As noted above, the only significant story-order effect was found with respect to the measure of target words correct from pre- to post-test. Namely, the "Story 2 → Story 1" group performed significantly better on the pre-test than the "Story 1 → Story 2" group (refer to Figure 2d). Importantly, the total number of participants was divided in half to create these story-order groups. Since there were only six total participants, the story-order groups had only three participants per group (as mentioned above). Upon looking closer at the data, the "Story 2 → Story 1" group had the oldest participant, Subject 6, who incidentally scored at least two more correct on his pre-test than each of the other participants. Accordingly, another concern with such a small number of participants is that outliers such as Subject 6 can significantly affect the means, standard error, and confidence intervals of the study. This robust outlier effect also makes finding significant differences more unlikely.

Despite the small sample size and the related increases in confidence intervals and standard error, some measures of the current study *were* shown to be significantly different. As noted above, the number of target words learned were significantly greater than the number of control words learned. Additionally, the total number of target words correct demonstrated a significant increase from pre- to post-testing. Both of these results were expected considering previous research on child learning and multimedia technology. Given the small sample size, these results are quite robust. Thus, despite the small number of participants, this study was able to detect child learning through the SRT.

Based on this more in-depth examination of the results, a more clarified conclusion can feasibly be drawn. To answer all three questions, there are no *robust* differences between VC and FTF administrations of the SRT in language (Q1), word learning (Q2), or task administration (Q3) measures. As a result, a reasonable headline is that VC is comparable to FTF conditions when collecting language samples from typically developing young children via the SRT.

**Strengths and Contributions of the Study**

Based on the established need for research on the use of telepractice in speech-language pathology, the current study has several strengths and contributions to the current research base. First, this study provides a rare examination of the use of VC to administer interactional, speech and language tasks with young children. To my knowledge, no studies to date have compared VC and FTF administrations of such tasks. Most studies on the use of VC to provide interactional services looked at adult populations. On the contrary, most studies on young children looked at the use of VC to provide consultation services by interacting with caretakers and other professionals. As mentioned above, none of the studies involving interactional services included the population of young children.

Second, the methods of the study improved upon some observed weaknesses in previous studies. As noted above, most studies on the use of interactional services through VC compared the standard scores of children. Because validly interpreting standard scores relies upon the use of standardized procedures, the validity of comparisons between FTF and VC administrations are threatened. The current study used measures that do not rely on standardized materials and administration.

Third, the design of the study improved upon some observed weaknesses in previous studies. As mentioned above, most studies on child assessments used a between-subjects design and did not include a priori language measures of the children. Consequently, the FTF and VC groups could have had significantly different levels of language skills. As a result, finding no differences in the performance on assessments could be due to the interaction of a condition advantage and differing language levels (as discussed above). The current study controlled for this potential threat by using a within-subjects design. More specifically, each participant made a contribution to both conditions.

Finally, the current study used a task and materials that are readily available to SLPs. As mentioned above, studies on the use of VC to administer standardized assessments required extensive development of stimulus materials that publishers have not released general permissions to use. The SRT used in the current study involved standard desktop and laptop computers and software and materials that are readily available to the general public. As a result, clinicians could take the methods from this study and use them in their practice today.

**Considerations for Practice**

Before recommending the use of VC to administer the SRT in clinical practice, several considerations should be noted. First, the personnel involved in the current study were all graduate and undergraduate students. None of the examiners were certified SLPs. Furthermore, all of the participants were typically developing children whose parents reported no speech, language, or hearing concerns. Consequently, it is possible that the results may not apply to clinical situations with certified SLPs and clients with suspected or identified speech-language challenges. Accordingly, in their study on child learning from multimedia content, Krcmar and colleagues (2007) found that children with high vocabularies learned words better in both FTF and multimedia conditions than children with low vocabularies. Schols and colleagues (2009) discussed a study on second language learning from multimedia programs. More specifically, the authors noted that students with high spatial and verbal abilities performed better than those with low spatial and verbal abilities. Thus, at least some evidence suggests that the results of the current study may not apply equally to children with lower vocabulary scores or to children with lower verbal and spatial abilities.

**Final Comments and Questions**

Based on these considerations, it is clear that more research is needed on the use of VC to implement interactional services to young children. Although this study has provided some evidence to suggest that the application of telepractice is potentially feasible, it has also left some questions unanswered. Namely, is telepractice a comparable method of providing interactional services to young children *with speech and language concerns/challenges*? Further, what are the effects of lower verbal and spatial abilities and other developmental challenges on young children's performance on interactional tasks administered via telepractice? Finally, what are the best indicators for determining young children's candidacy for telepractice?

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Appendix A

**Speech-Language Research Study**

**Questionnaire for 3 – 5 year-olds**

**Brian Manzananres**

**Speech, Language, and Hearing Sciences**

**University of Colorado, Boulder**

Feel free to email comments/questions to: brian.manzanares@colorado.edu

A. Parent/Family Background Questions

1. How many siblings does your child have: older______; younger_______.

2. Education level of the child's father (circle one):

    a. Some High School
    b. High School Graduate
    c. Some College
    d. 2-year Associate's Degree
    e. 4-year Bachelor's Degree
    f. Some Post Graduate
    g. Graduate Degree

3. Education level of the child's mother (circle one):

    a. Some High School
    b. High School Graduate
    c. Some College
    d. 2-year Associate's Degree
    e. 4-year Bachelor's Degree
    f. Some Post Graduate
    g. Graduate Degree

B. Child Questions

1. Age: _____yrs. ______mos.; Sex: M / F

2. Does your child attend a daycare program, preschool, or kindergarten?

   Yes / No.

   If so, which program type? _______________.

   How many hours per week? _____.

Continued on the next page:

3. On average, how many hours per *week*-day does your child watch television: ________hrs.

4. On average, how many hours per *weekend*-day does your child watch television: ________hrs.

5. While watching television, verbal communication between me and my child (circle one):
    a. Decreases Significantly
    b. Decreases
    c. Does not Change
    d. Increases
    e. Increases Significantly

6. To your knowledge, how familiar is your child with the wordless "frog books" created by Mercer Mayer and originally printed in the 1970's?
    a. My child has seen them multiple times.
    b. My child has seen them one time.
    c. To my knowledge, my child has never seen them.

7. How familiar is your child with videoconferencing technologies such as Skype, iChat, Adobe Connect, or other videoconferencing technologies?
    a. My child uses this technology frequently.
    b. My child has used this technology a few times.
    c. My child has used this technology once.
    d. My child has seen this technology before.
    e. To my knowledge, my child has never seen or used this technology before.

Continued on the next page:

8. Has your child received speech-language therapy or intervention? (circle one): Yes / No

9. Do you have concerns with your child's speech-language development? (circle one): Yes / No

10. Has your child been diagnosed with hearing loss?
(circle one): Yes / No

11. Has your child been diagnosed with an emotional or behavioral disorder?
(circle one): Yes / No

# Appendix B

**<u>A boy, a dog and a frog</u>**

1. Cover Page
2. Title Page
3. The boy and his dog took a ***pail*** and a ***catcher*** to find a frog.
4. The boy looked in the tree and the dog scratched his ear.
5. When the boy was on the hill, he saw a frog in the pond.
6. The boy and dog ran down the hill to the pond. The frog did not look happy.
7. The boy stumbled over a branch because of his heavy ***slickers***.
8. They fell into the pond, and the frog wasn't happy about it.
9. The frog smiled at the boy because the *pail* was on his head.
10. As the boy reached to catch the frog, he jumped away from the boy.
11. They saw the frog on the log.
12. The boy said, "You go that way, and I'll go the other way."
13. The boy and the dog surrounded the frog on the log.
14. The boy raised his *catcher* as the dog tried to catch the frog.
15. The boy caught the dog instead of the frog!
16. The frog got away as the boy tried to free his dog.
17. The boy and the dog shout "goodbye" to the frog.
18. The frog was sad to see the boy and the dog leave.
19. The boy dragged his *catcher* as he walked all the way home.
20. The frog was sad to be all alone.
21. So he decided to follow the ***tracks*** to find the boy and the dog.
22. He followed the *tracks* into a house, and saw the boy's *catcher* on the floor.
23. The boy and the dog were taking a bath.
24. The frog was happy to finally find the boy and his dog.
25. The boy and his dog were happy to see the frog too, and his *slickers* were on the floor.
26. The frog jumped high into the air…
27. And landed right on the dog's head.

# Appendix C

***<u>Frog, Where Are You?</u>***

1. Book Cover
2. Title Page
3. The boy and his dog found a frog. They put the frog in a jar.
4. At night, when the boy and his dog slept, the frog jumped out of the jar, and ran away.
5. In the morning, when the boy and his dog woke up, they did not see the frog!
6. The boy and his dog searched everywhere for their frog.
7. They looked out the window to find the frog, but the frog was not there.
8. The silly dog fell out of the window and broke the jar!
9. The boy was mad at him.
10. They looked outside to find the frog, but the frog was not there.
11. The dog looked in a hive while the boy looked in a hole.
12. The boy did not find the frog, but he found an angry ***gopher*** instead!
13. And the dog made the hive fall, while the boy looked in a tree.
14. The ***hornets*** chased the dog,
15. And the ***raptor*** chased the boy.
16. They looked on a huge rock.
17. But found an ***antelope*** instead.
18. The *antelope* carried the boy to the cliff
19. And threw the boy and the dog into the pond!
20. The deer watched the boy and the frog splash in the pond.
21. The boy and his dog heard something in the pond.
22. The boy told the dog "Sh, be quiet"
23. They looked over the log to see if they could find the frog.
24. They found two frogs!
25. They found a whole family of frogs!
26. The boy and his dog took a baby frog home with them, and waved "Bye" to the family of frogs.

Appendix D

**“Point to *hornet*”**

Number 3