

**Critical Review:**  
**The Reliability of Internet-Based Assessment of Persons with Motor Speech Disorders**  
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This critical review examines the reliability of the use of telecommunication assessment of individuals with motor speech disorders when compared to traditional face-to-face assessment. Study designs include: counter-balanced repeated measures and double-crossover repeated measures within-group studies. Current research supports the use of Internet-based assessment to effectively and reliably assess adults with motor speech disorders; however, future research should include detailed methodologies for replication and include English speaking participants from North America and Europe in order to generalize clinical results to a wider range of English speaking communities.

### *Introduction*

According to Duffy (2005), more than 60% of adults who have had strokes suffer from a motor speech disorder (MSD) following neurological damage resulting in impairments of motor planning, programming, neuromuscular control and speech execution (p.6). In addition to stroke, MSDs including apraxia and dysarthria may be associated with traumatic brain injury and progressive neurological disorders such as Parkinson's disease, multiple sclerosis and amyotrophic lateral sclerosis. Also present in children, these speech disorders reduce speech intelligibility, which may significantly influence the individual's ability to communicate in academic, social and vocational environments, affecting quality of life. The concomitant physical disabilities that frequently occur with neurogenic communication disorders in addition to the number of people living with disability increasing with an aging population make access to much-needed rehabilitation services challenging (Hill, Theodoros, Russell and Ward, 2009; Theodoros, Hill, Russell, Ward & Wootton, 2008).

The use of Internet-based assessment of motor speech disorders through video-conferencing as an alternative method to traditional face-to-face assessment may alleviate the current challenges of accessing services (Hill et al., 2009; Tsanas, Little, McSharry & Ramig, 2006). In addition, telerehabilitation may allow clinicians to more efficiently and effectively meet their growing caseload by decreasing the financial demands and travel time needed to access clients – ultimately improving patient care (Hill et al., 2009; Duffy, Werven & Arnold, 1997; Theodoros, Russell, Hill, Cahill and Clark, 2003; Tsanas et al., 2006).

### *Objectives*

The primary aim of this paper is to critically evaluate the existing literature regarding the reliability of Internet-based videoconferencing assessment for

persons with motor speech disorders. The secondary objective is to present an evidence-based recommendation about the use of videoconferencing by speech-language pathologists as a means to assess individuals with motor speech disorders from remote locations.

### *Methods*

#### Search Strategy

Computerized data bases, including PubMed, Scopus, and the University of Western journal database were searched using the following strategy: ((Motor speech disorder) OR (apraxia) OR (dysarthria) OR (Parkinson's Disease)) AND ((telecommunications) or (Internet) or (remote)) AND (assessment).

#### Selection Criteria

Studies selected for inclusion in this critical review were required to investigate the reliability of tele-communicative or Internet-based assessment of motor speech disorders when compared to traditional face-to-face assessment. No limits were set on the demographics of research participants, outcome measures or severity of motor speech disorders assessed.

#### Data Collection

The five studies collected employed within-group repeated measures designs using randomization of participants to face-to-face or video-based assessment environments.

### *Results*

Hill, Theodoros, Russell and Ward (2009) examined the use of remote apraxia assessment by comparing the subtest scores of the Apraxia Battery of Apraxia-2 (ABA-2) using the Wilcoxon rank statistic and analysis of the degree of agreement. Participants were simultaneously assessed by one clinician face-to-

face and another clinician from a remote location. Moderate to very good agreement was established using the weighted Kappa analysis (0.66-.097) with no significant differences found between the two environments ( $p=0.06-0.68$ ). Inter- and intra-rater reliability could not be statistically validated because of the small sample size, however, the means and standard deviations between ABA-2 subtest scores and severity levels suggested that inter- and intra-rater reliability was adequate, therefore, replication of the study with a larger sample study would provide better reliability. Hill et al. (2006) also gathered qualitative information by employing a questionnaire to participants following the video-conferencing assessment to determine participant satisfaction with the non-traditional form of assessment. Five out of six of the participants assessed through telecommunication reported high satisfaction and confidence in the results of the session.

Hill, Theodoros, Russell, Cahill, Ward and Clark (2006) were concerned with the feasibility and reliability of assessing dysarthria in adults with neurological impairment with motor speech impairments. In their counter-balanced repeated measures design, adults with dysarthria were assessed by the Frenchay Dysarthria Assessment (FDA), Assessment of Intelligibility of Dysarthric Speech (ASSIDS), a perceptual analysis of a speech sample, and an overall severity rating of dysarthria in both environments with a 2-3 day window between assessments. Percentage level of agreement measured the consistency in perceptual rating of speech dimensions across both environments in order to determine if a clinically significant difference existed. Overall, the video conferencing assessment exceeded the minimum 80% level of agreement across the four subtests when compared to face-to-face assessment results, indicating that results of video-conferencing tele-communicative assessment of dysarthria are comparable to face-to-face assessment.

Theodoros et al. (2003) explored the validity of telecommunicative assessment of dysarthric speech in adults following acquired brain injury. An overall 7-point rating of intelligibility was used in conjunction with the FDA and the ASSIDS to gather information about the participant's motor speech function, percentage of word and sentence intelligibility, words per minute and communication efficiency. Similar to the aforementioned article, participants were assessed in both the face-to-face and online-videoconferencing environments separated by a 1-day interval. The levels of agreement across the three tests and between the two environments were analyzed. Ninety-percent agreement was found between the two assessment environments for the overall severity of dysarthria rating in addition to the 70-100% level of agreement for the FDA. A significant Wilcoxon P-value was not found when the

ASSIDS was used to determine if there was a difference between the face-to-face and online assessments in terms of percentage of sentence intelligibility, words/minute and communication efficiency, suggesting that Internet-based video assessment may be a valid method for assessing dysarthria in adults with acquired brain injury.

Palsbo (2007) investigated whether videoconferencing biased measurement of assessment of functional communication of speech in adults post-stroke in a randomized, double-crossover repeated measure design. The Boston Diagnostic Aphasia Examination (BDAE) as well as 3/11 single-item constructs from the National Outcomes Measurement System (NOMS) were used to assess functional abilities (including motor speech). A Speech Language Pathologist (SLP) via video-conferencing equipment and traditional face-to-face assessment recorded the scores of the two tests simultaneously. Statistical results of the 95% limits of agreement fell within critical criterion for remote administration of the BDAE, suggesting the assessment of a patient's functional communication through video-conferencing is equivalent to face-to-face assessment.

Within-groups repeated measures design was used by Waite, Cahill, Theodoros, Busuttin and Russell (2006) to determine if childhood speech disorders could be assessed using Internet-based telehealth systems. The Single Word Articulation Test (SWAT), a connected speech sample, and an oral-motor assessment were used by clinicians in remote and traditional settings. Again, simultaneous assessment of the participants by both clinicians took place. Proportional agreements were used to evaluate reliability between the two clinicians across the three tasks. A 92% level of agreement was found between the two clinicians for consonants in all word positions for the SWAT, with intra- and inter-rater agreement at 94 and 87% respectively. Speech intelligibility based on the connected speech sample was rated as 100% in agreement between the two clinicians, with 100% intra-rater and 83% inter-rater agreement. Motor task agreement from the oral-motor assessment reached 91% overall agreement with intra-rater reliability of 90% and inter-rater reliability of 76%, which suggests that childhood speech disorders of a variety of severities may be assessed with reliability through Internet-based telehealth systems.

### *Discussion*

The studies mentioned above seem to suggest that assessment of adults with motor speech disorders by way of video-conference telecommunication is equivalent to face-to-face assessment, however, many factors within the study's subject selection, methodology and statistical analysis must be critically

evaluated to determine the clinical implications of the results.

### Subject Selection

The most notable issue within subject selection between the previously mentioned articles is the small sample size ranging from 11-26 participants, which were recruited through convenience samples from surrounding hospitals. Convenience sampling only accesses those in the populations who have had access to services by the surrounding hospitals, thus, they may not be reflective of the general population who have motor speech disorders. Participant exclusion-criteria, stated clearly in each study, may have resulted in the decreased number of eligible participants because of the exclusion factors of coexisting disorders or significant visual and/or hearing impairments. Because only participants who could comprehend informed consent were included in the study, remote assessment may be limited to higher-functioning participants only.

### Methodology

Participant randomization to assessment lead by a clinician in either face-to-face or remote-assessment environments was employed across all repeated measures designs. The studies that chose to use repeated assessment (Hill et al. 2006; Theodoros et al. 2003) as compared to simultaneous assessment (Hill et al. 2009; Palsbo 2007; Waite 2006) are at a higher risk for decreased validity and reliability due to participant fatigue or variability, and test-retest effects. Four out of five studies randomized clinicians to either the face-to-face or remote assessment environments; however, attempts to eliminate clinician-bias towards or against the use of video-conferencing were not accounted for. Positively, all test administrators were blind to participants' pre-determined severity levels and other administrators' results preventing experimental bias.

Most of the measurement tools selected are internationally recognized for their validity and reliability of use in motor speech assessment. The tools employed were appropriate in relation to each hypothesis. Unfortunately, the methodology of the application of the questionnaire used by Hill et al. (2009) in addition to the details of the oral-motor assessment used by Waite et al. (2006) are not defined for the reader, thus, the methodology cannot be replicated nor the results analyzed accurately.

### Statistical Analysis

In addition to Pearson's  $r$  and Spearman's  $\rho$  correlation coefficients, the Wilcoxon Rank Statistic, Percentage Levels of Agreement and Kappa statistical tests were judged to be typical and appropriate statistical procedures for assessing the reliability of the outcome

measures within and between assessment environments. One out of five studies relied on descriptive data to analyze inter-rater and intra-rater reliability due to the small sample size (Hill et al., 2009), which decreases the objectivity and strength of the reliability results in that study.

### *Conclusions and Clinical Implications*

The present review provides support for the use of Internet-based videoconferencing as a reliable alternative to traditional face-to-face assessment of motor disorders. Unfortunately, most of this telecommunication research has taken place in Australia (four out of five studies). Continued research in the reliability and effectiveness of remote assessment must be conducted in other English speaking countries (i.e. USA and Canada) in order to generalize the clinical use of video-conferencing to assess apraxia, dysarthria or other motor speech disorders in English speaking children and adults. Studies must be replicated with a greater number of participants and continue to use psychometrically sound, standardized tests of measurements as a basis of comparing results of assessments between remote and face-to-face environments in order to account for validity and reliability within each environment before comparing reliability between the two environments. The use of standardized procedures such as the ABA-2, ASSIDS, and FDA in Internet-based assessment will allow for increased power of clinical conclusions and allow adequate replications of study methodologies.

Advances in technology in addition to the increased acceptance of telecommunications as an effective mode of assessment in the field of medicine will continue to build upon the findings of these early studies. Specifically, the use of Web cameras with the ability to zoom and focus from a remote location will increase the reliability of areas of assessment that are at highest risk for decreased reliability (i.e. palatal movement during oral-motor examinations).

The need for speech-language pathologists in both urban and rural communities will continue to grow as the population continues to age, the amount of individuals with disabilities continues to increase, and the financial and prioritization limits of clinician caseloads are stretched. Therefore, it is the recommendation of this author that Internet-based video-conferencing be considered as an augmentative mode of assessment of motor speech disorders so that speech services may be more accessible to individuals in urban and remote communities; thus, decreasing physical, financial and time-based challenges while ultimately providing better client care.

### References

- Duffy J.R., Werven G.W., Aronson, A.E. (1997). Telemedicine and the diagnosis of speech and language disorders. *Mayo Clinic Proceedings*, 72(12), 1116-1122.
- Duffy, J. R. (2005). *Motor speech disorders: Substrates, differential diagnosis, and management* (2nd ed.). St. Louis, Mo.: Elsevier Mosby.
- Hill, A. J., Theodoros, D., Russell, T., & Ward, E. (2008). Using telerehabilitation to assess apraxia of speech in adults. *International Journal of Language & Communication Disorders / Royal College of Speech & Language Therapists*, 44(5), 731-747.
- Hill, A. J., Theodoros, D. G., Russell, T. G., Cahill, L. M., Ward, E. C., & Clark, K. M. (2006). An Internet-based telerehabilitation system for the assessment of motor speech disorders: A pilot study. *American Journal of Speech-Language Pathology / American Speech-Language-Hearing Association*, 15(1), 45-56.
- Palsbo, S. E. (2007). Equivalence of functional communication assessment in speech pathology using videoconferencing. *Journal of Telemedicine and Telecare*, 13(1), 40-43.
- Theodoros, D., Hill, A., Russell, T., Ward, E., & Wootton, R. (2008). Assessing acquired language disorders in adults via the Internet. *Telemedicine Journal and e-Health: The Official Journal of the American Telemedicine Association*, 14(6), 552-559.
- Theodoros, D., Russell, T. G., Hill, A., Cahill, L., & Clark, K. (2003). Assessment of motor speech disorders online: A pilot study. *Journal of Telemedicine and Telecare*, 9 Suppl. 2, S66-8.
- Tsanas, A., Little, M. A., McSharry, M. E., & Ramig, L. O. *Accurate telemonitoring of Parkinson's disease progression by non-invasive speech tests*. Unpublished manuscript.
- Waite, M. C. (2006). A pilot study of online assessment of childhood speech disorders. *Journal of Telemedicine and Telecare*, 12, 92-94.