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Technical Report

Conducting a Virtual Study With Special Considerations for Working With Persons With Aphasia

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Purpose: The use of technology (e.g., telehealth) in clinical settings has rapidly increased, and its use in research settings continues to grow. The aim of this report is to present one potential solution to a clinical issue that of virtual and remote assessment for the purposes of spoken language research in persons with aphasia (PWA). To do so, we report detailed methods for conducting a multitimepoint (test–retest) virtual paradigm, assessing lifestyle, physiological, cognitive, and linguistic factors in persons with and without aphasia.
Method: Procedures for virtual assessment are detailed in a sample of adults with no brain damage (N = 24) and PWA (N = 25) on a test–retest paradigm (data collection approximately 10 ± 3 days apart). This report provides practical information about pre-assessment (e.g., recruitment, scheduling), assessment (e.g., aphasia-friendly consent presentation, investigator fidelity), and postassessment (e.g., data storage, quality check) procedures for human behavior research using a virtual platform.
Results: Preliminary study data are provided, indicating high retention rates, high rates of data acquisition, and feasibility. Common technological troubles and solutions are discussed, and solutions are offered. The results suggest that our pre-assessment, assessment, and postassessment procedures contributed to the success of our study.
Conclusions: We provide a practical methodology for conducting a multitimepoint study, with considerations for PWA, adding to the body of research on telehealth in clinical populations. Future studies should continue to evaluate telemethodology, which may be core for diversifying studies, improving study retention, and enrolling larger sample sizes.
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Involving persons with aphasia (PWA) in basic and clinical research is crucial for developing and improving assessment and treatment. Employing technology, such as in teleassessment or teletherapy (collectively, "telehealth") is particularly inviting given restrictions on in-person assessment (i.e., external factors [COVID-19] or internal factors [reduced mobility]). Additionally, telehealth can be beneficial for increasing sample size, thus improving design power, and for diversifying samples (Koonin et al., 2020). Not only has telehealth increased the availability of resources to certain populations, but it has also allowed for continuity of care clinically and in research (e.g., longitudinal designs).

Telehealth has considerable advantages for use in populations with acquired and progressive language impairments (Weidner & Lowman, 2020). One of the biggest draws to teletherapy, in particular, is that dosage can be improved using virtual methodologies (Henry et al., 2019). Furthermore, telehealth practices ensure that assessment and therapy can reach populations of persons with more rare conditions, such as persons with primary progressive aphasia, because sessions can be attended from any geographical location, do not require physical transportation, and can be scheduled more freely. Indeed, recent research has suggested that teletherapy in primary progressive aphasia is feasible and effective (Dial et al., 2019; Meyer et al., 2016).

Use of technology for neuropsychological assessment is increasingly common. A recent methodological report suggested that the Western Aphasia Battery–Revised (Kertesz, 2007), a core outcome for the measurement of language impairment in aphasia (Wallace et al., 2018), could be successfully adapted for telehealth purposes (Dekhtyar et al., 2020). Other neuropsychological tests have also been validated for use in telehealth assessment (Brearly et al., 2017; Brennan et al., 2004).

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While the advantages are clear, teletherapy and teleassessment may not be appropriate in all cases. Clinical judgment is important, as each patient should be evaluated on a case-by-case basis as to whether teletherapy or teleassessment fits their needs and abilities. For example, some patients are not able to engage and/or participate effectively virtually, for reasons such as cognitive impairment (e.g., inattention), language disorder (e.g., impaired auditory comprehension inhibiting full participation), concomitant speech or voice disorder (e.g., unintelligible; voice that cannot be picked up by microphone), or noncognitive reasons (e.g., issues with technology [Internet, hardware]). Therefore, while many studies provide evidence for telehealth effectiveness, a commitment to the most appropriate method for the individual remains of highest importance.

The trend of evidence suggests that, overall, virtual assessment and treatment is feasible and effective for populations with acquired and progressive language impairments. However, current literature does not offer detailed guidance or, indeed, "lessons learned" for researchers wanting to deploy telehealth methods for their own studies. In this technological report, we will outline our methodology for deploying a multitimepoint, assessment-based study using a virtual platform, whose primary goal is to examine spoken discourse stability in persons with and without aphasia. Assessing cognitive–linguistic variables virtually comes with considerable obstacles (e.g., data quality, cognitive demands, technological proficiency), and we will discuss our own approaches to overcoming each of these obstacles. We believe that increasingly more virtual research will take place in the area of aphasia and related language disorders, and as such, we provide comprehensive procedural details on all aspects of our multitimepoint study. We also include preliminary data demonstrating feasibility of these methods. The overarching goal of this technical report is to offer easy-to-deploy and successful methods for speech, language, and hearing sciences researchers and clinicians, for use in their own telehealth work.

Methodology and Design

Brief Overview of Study

This report details methodology and design for a test–retest design study (IRB No. 1904590484 at Indiana University), evaluating the stability of language variables (specifically, microlinguistic elements extracted from spoken discourse) in a sample of persons with and without aphasia. Our inclusion parameters for adults with no brain damage (NB) were native English speakers, 45–80 years of age with at least 10 years of education, and without a history of brain injury, neurological, or developmental language disorder. Inclusion parameters for PWA were native English speakers, 18 years and older, with a diagnosis of aphasia as a result of an acquired brain injury that was at least 6 months prior to entrance into the study, and without any other neurological disorder or neurodegenerative disease. Given an earlier power analysis based on pilot data from AphasiaBank (MacWhinney et al., 2011), the goal was to recruit $N = 22$ into each group (PWA, NB).

We believe that our study's methodology is informative for telehealth, because we employed multiple sessions (test and retest), engaged multiple investigators and study personnel, recruited and assessed different participant groups, used different technological platforms for data acquisition and preservation, and acquired a large variety of data (i.e., demographic, mood, lifestyle, cognitive–linguistic). As such, we will elaborate on the three critical portions of our study, in hopes that they are useful to other studies of similar designs: (a) *prestudy* recruitment, screening, and scheduling; (b) *main study* virtual data collection and special considerations for PWA; and (c) *poststudy* data curation and quality assurance of data collection.

Prestudy

Procedures, before the study began, are detailed here, including the recruitment, screening, and scheduling of participants and training of investigators. We elaborate on measures that we felt contributed to participant retention and investigator fidelity.

Recruitment, Screening, and Scheduling

Subject recruitment was conducted predominantly virtually with one exception of in-person recruitment prior to the onset of the COVID-19 pandemic in the United States. Recruitment flyers were shared with directors of stroke support groups via e-mail, posted on social media, posted on the lab's website, and previous subjects, who had showed interest in participating in future studies, were contacted via phone and e-mail (see Supplemental Material S4). Potentially eligible participants were given a prescreen survey link to complete, which was hosted on the HIPAA-compliant REDCap (Harris et al., 2019, 2009). Participants could choose to complete the survey on their own or with a trusted other. When they completed this survey, a nonidentifiable, unique ID was generated, from which all further materials generated in the study were titled.

Multiple efforts were made during the scheduling process to enhance the retention of participants. Participants who appeared eligible were contacted by the research coordinator (author A. H.) via the preferred method of contact (as indicated in the REDCap form). Upon the first contact with the research coordinator, the participant's time zone was confirmed to schedule a suitable time for both participant and investigator to meet. As this experiment required participation in two sessions, the scheduling of both sessions happened simultaneously. Participants received a confirmation e-mail immediately after scheduling was determined and subsequent reminder e-mails 1 day before each session. Confirmation and reminder e-mails contained the time and date of both sessions, in the appropriate time zones, and the virtual assessment meeting link (e.g., Zoom). E-mails were sent to the participant, the investigator, the project manager (author A. D.), the primary investigator (author B. C. S.), and the NEURAL Research Lab's private e-mail.

For this experiment, we employed Zoom Health as our HIPAA-compliant videoconferencing software, but the

details in this report should offer guidance for any virtual platform. In the confirmation and first reminder e-mail, instructions for downloading the videoconference application and necessary items to have for the session (e.g., reliable Internet, headphones) were listed. For PWA, the list also included relevant items to have before the session that were specific to the assessments used (e.g., a medication list for intake and/or physical objects for an object naming task). Attached to the e-mails were the study's Informed Consent sheet and the Ideal Environment Checklist (described in the next section, Training of Study Personnel and Ensuring Experiment Fidelity).

Training of Study Personnel and Ensuring Experiment Fidelity

Prior to data collection, the project manager trained two graduate students (i.e., investigators) in data collection procedures. Each investigator attended an interactive training with the primary investigator, project manager, and research coordinator in which they were introduced to the Study Procedure sheet (see Supplemental Material S1), the Ideal Environment Checklist (see Table 1; for an aphasia-friendly version, see Supplemental Material S5), and a tutorial on the videoconferencing application and its necessary tools. A "Virtual Tips and Tricks" guide, which consisted of step-by-step instructions, troubleshooting tips, and visual aids, was given to investigators (this is available upon request to author B. C. S.). In this initial training session, the investigators practiced using the application's tools. Following the group training session, each investigator was required to individually complete *at least one* mock assessment with the project manager to practice administering all assessments (described in Main Study section). Investigators were required to practice all cognitive–linguistic assessments *at least 3* times before conducting assessments with participants.

Experimental fidelity and consistency were maintained by pairing an investigator and participant for both sessions of the study (i.e., Investigator A ran both the Test and the Retest portions of the study for Participant X). Periodically, the project manager would observe data collection sessions during the study, to confirm continued fidelity and provide any necessary feedback to the investigator afterward.

Two core components of the study's success were the use of both the Ideal Environment Checklist and Study Procedure sheet. The Ideal Environment Checklist proved to be an integral part in creating a successful virtual interaction, as each session began with the investigator and participant going through the checklist together. Using this checklist was key for maintaining testing environment consistency and experimental fidelity. For PWA, the Ideal Environment Checklist document was adapted to be more aphasia friendly (i.e., shortened phrases, use of visual aids). Anecdotal feedback from participants confirmed that this document was helpful for participants to have for the study and for other virtual interactions.

The Study Procedure sheet contained detailed steps for each session (i.e., opening the virtual meeting, administering all assessments, saving the data). This sheet was integral to the study's success as it ensured inclusion and proper order of test administrations.

To maximize clarity and importance of certain items, the Study Procedure sheet was written in plain font, using italicized, bolded, and underlined font to differentiate important information. Outlined text boxes were used to differentiate technical instructions from the rest of the procedures. Italics were used to give "if scenarios," such as, "*If the participant does not provide a full utterance…,*" which were then followed by plainly written script instructions. Bolded font and the highlight function were utilized to ensure that the investigators did not miss crucial prompts or instructions. Examples of text that were bolded or

Table 1. Recommended ideal environment checklist.

Recommended ideal environment checklist	
Internet connection	□ Ethernet connection (preferred) or reliable Wi-Fi ○ If possible, confirm the reliability of your Internet by determining bandwidth and speed
Hardware	□ Screen sharing device (i.e., computer, iPad) with an adequate display resolution (roughly 9 in. of screen) is required □ Built-in or external webcam/camera device □ Functioning audio system is required (i.e., microphone, speaker) ○ Headphones for investigator and participant are recommended □ Recommended that device can stand on its own (i.e., not required to be handheld)
Environment and experiment setup	□ Image (i.e., camera placement) of participant and investigator should include head and shoulders in the center of the screen ○ If necessary, the camera angle should be adjusted to include participant gesticulation □ Lighting should be adequate for clear visibility (i.e., facial features, object manipulation) □ To prevent potential distractions from the experimental environment: ○ Close household windows to reduce background noise ○ Notify other people that you are in a session ○ Remove pets from the room (if possible) ○ Turn phone and other devices to silent or off ○ Close door(s) to room (if possible) ○ Close all unnecessary programs and windows on computer

highlighted include "Remember: Speak Slowly" on the procedures for the group with aphasia and "Use your cursor to show the participant how to move the mouse." Increased font size was used to provide reminders, such as, "After you have completed data collection, proceed to post-data collection procedures immediately." Importantly, the Study Procedure sheet included a checklist for the investigator to ensure that all tasks were administered and administered in a consistent order.

Main Study

Procedures during the multitimepoint main experiment (i.e., test day, retest day) are detailed here, divided into sections concerning methods that took place prior to the session, and during data collection, with a section on special considerations for working with PWA.

Prior to Session

Prior to each session, the Study Procedure sheet instructed all investigators to gather all required material needed to administer the assessments, any relevant background information on the participant from REDCap (i.e., name, geographic location, age), and the date and time of the participant's retest session. Investigators were instructed to open the virtual meeting link 15 min before the scheduled meeting time. During this time, the investigator checked the meeting's audio and visual quality. Promptly after the participant's arrival, the investigator confirmed that the participant had adequate audio and visual quality, followed by going through the Ideal Environment Checklist together. Before continuing to the assessment administration, the investigator confirmed that the session was being recording properly.

Data Collection

The investigator first collected verbal informed consent. For the aphasia group, a slideshow presentation with aphasia-friendly formatting and graphics was provided to augment comprehension (see Supplemental Material S3).

The participant then completed an intake form using REDCap, obtaining demographic and lifestyle information. To efficiently complete the intake form, the participant was given control of the investigator's cursor and keyboard through the virtual testing interface (in our case, Zoom). This allowed the participant to quickly fill out the intake form themselves. To ensure that the participant did not navigate away from the appropriate page, a simple move of the cursor on the part of the investigator halted the participant's control of the mouse and keyboard. This ensured that the participant could not obtain access to any other material on the investigator's shared screen.

The participant then filled out a "check-in form" via REDCap. This form was collected at the beginning ("check-in") and end ("check-out") of each session, and acquired information about important variables (e.g., sleep, exercise, fatigue, pain, hunger, caffeine, mood) at that moment, and occurring in the past week. In the NB population, the remote control (as described in relation to the intake form, above) was used to fill out the check-in form. Depending on the skill and comfort level of the participant, three methods of completing the check-in forms were available to the PWA group: (a) The participant could fill out the form using remote control; (b) the investigator could verbally ask the questions and type in the participant's answers; or (c) a trusted other (e.g., partner) joined the meeting and filled out the form using remote control. The PWA's check-in forms included more visual aids (see Supplemental Material S2 for an example of a check-in form used for PWA).

The participant then completed a set of cognitive and language assessments. It is not our intention in this technical report to discuss specific cognitive and language assessments. Instead, we endeavor to provide information about how to adapt them. We interfaced with publishers of the assessments, using pre-adapted material (that the publisher provided) or obtaining legal permission to use our own adapted material. Specifically, we collected data using a brief aphasia battery (Kertesz, 2007), two versions of a test of confrontation naming (Walker & Schwartz, 2012), the complete AphasiaBank discourse protocol (MacWhinney et al., 2011), subtests evaluating sustained visual and auditory attention (Robertson et al., 1994), a brief cognitive screener (adults with no brain damage [NBD] group only; Nasreddine et al., 2005), and an assessment of apraxia in adults (Dabul, 2000). The only assessment that was scored live was a cognitive screener in the NB group, whereby scoring below a cutoff score was an exclusionary measure. Due to the exclusionary nature of this assessment, the intake form process and check-in form process were completed after this cognitive screener.

After instructions for cognitive–linguistic assessments were given, the investigator muted their microphone. Muting the microphone eliminated background noise and reduced distraction. Furthermore, it prevented interruptions from the investigator (e.g., inadvertent commenting during a task). The investigator informed the participant that they would mute themselves after they had given the task instructions, so that the participant knew to expect only visual feedback from the investigator while they completed each task.

Most of the main study involved screen sharing—that is, sharing the investigator's screen with the participant. To eliminate potential distractions or premature introduction to stimuli during visual stimulus tasks, a presentation program was used (we used PowerPoint), with each stimulus having its own slide. The investigator was required, while screen sharing with the participant, to have the slideshow in presentation mode (i.e., full screen) to prevent exposure to upcoming stimuli. During tasks that used a PDF, the investigator was required to have the page fully magnified when screen sharing began. During tasks that employed audio, PowerPoint was used. During neuropsychological testing, PowerPoint's auto-advance feature was used to advance slides after any required time limits, to prevent user error (e.g., the investigator not advancing them after the allotted time).

For the purposes of recording, the participant's window (i.e., the box where their video was located) was enlarged to

the largest degree possible without completely obscuring the stimulus. When possible, investigators delivered verbal prompts with the screen set to "speaker view," meaning only the speaker was maximally visible. Throughout the session, the participant's window was selected to be the focus of the recording (i.e., use of the "pin" function) to guarantee the video captured all relevant visual material. This allowed the researchers to best see gestures, facial expressions, and other visual cues when analyzing the data later. Upon completion of the test session, the investigator confirmed the participant's retest session, providing additional assurance of subject retention.

Special Considerations for Working With PWA

We believe that the tools and techniques used in this study (i.e., Ideal Environment Checklist and Study Procedure sheet) are easily adjusted to accommodate working with various populations. This section details the specific changes we made to the tools and techniques, to employ optimal virtual data collection when working with PWA.

During recruitment, the research coordinator designed and distributed aphasia-friendly flyers, which included limited text, large font, and visual aids. The research coordinator communicated with PWA via phone or e-mail, depending on the participant's preference. All e-mail communication was aphasia friendly, employing short, basic sentences and the use of contrast, such as bolding important dates and times.

The Ideal Environment Checklist was revised to an aphasia-friendly version, comprising more visual information. When possible and applicable, a trusted other was asked to be present at the beginning of each session, aiding in experiment setup and ensuring an ideal environment. Occasionally, the trusted other would provide contextual information during the intake and check-in form administration (e.g., a participant with aphasia points to a visual aid on the check-in form, and the trusted other verbalizes the choice).

When preparing to work with PWA, the investigator referenced a "Tips for Working with People with Aphasia Virtually" guide, which consisted of a list of tips, techniques, and encouragement (see Table 2). The purposes of this guide were to aid in communication and reduce communication barriers.

Table 2. Tips for virtual interactions with persons with aphasia.

Instructions to investigators for interactions with persons with aphasia virtually
1. Speak slowly but naturally.
2. Confirm that your rate of speech is understandable to your participant.
3. Utilize augmented, aphasia-friendly communication.
a. Study-specific example: informed consent augmentative presentation
4. Give your participant ample time to understand what you have said/what they have read.
5. Pay attention to your participant's level of fatigue and take breaks if/when necessary.
6. Give encouraging feedback.
7. Try to avoid feedback about accuracy or performance.
8. Be prepared to adapt materials and instructions if need be, such as simplification and restatement.
9. As we are engaging in tasks that are difficult, be engaged and empathetic to emotion elicited from these tasks. Take time to engage after task (as a "debrief") when necessary.
10. Approach each session with grace: Telehealth is most likely new for your participant, and you are both learning together.

Poststudy

Below, the steps taken after the main experiment session ended are described.

Data Curation

The research coordinator or project manager created a Box Health folder (a HIPAA-compliant, cloud-based storage system), titled by the participant's unique identifying ID, which housed all materials collected during the study. To ensure data quality and curation, investigators followed a set of postdata collection procedures. A reminder to complete these steps was included on the final page of the Study Procedure sheet in a large red box to indicate its importance. The postprocedures started at the completion of each session, which began with the automatic downloading of the recorded session. Immediately upon completion of downloading, the video file was uploaded to its appropriate Box Health folder.

Investigators then updated the participant's information in REDCap. Specific to this study, REDCap was used to confirm the completion of assessments and to confirm the order of assessment administration. If any paper forms for testing were used, investigators would scan those forms into the appropriate REDCap data collection area and to the participant's Box Health folder. We summarize pre-, main, and poststudy core components in Table 3.

Quality Check

Once the video recording was uploaded to the participant's folder, the research coordinator or project manager conducted a brief quality check to confirm an adequate audio and visual recording. Following this quality check, REDCap was checked for completion. Examples of data quality checks included the research team relistening to the collected video to ensure adequate audio quality, checking that the video had completely uploaded to the Cloud server, uploading any documents or screenshots to REDCap, and checking that all REDCap data entry points for the day were completed (e.g., at test day [first session], intake form, check-in form, check-out form are collected live, and should therefore be marked as complete in REDCap).

Subject Payment

At study completion, electronic gift cards (eGift Card) were sent via e-mail from the research coordinator. All relevant information needed to access the eGift Card was compiled into a spreadsheet and attached to the e-mail.

Table 3. Tips and tricks for a multitimepoint virtual study.

Study part	Procedure
Prestudy	*Study materials preparedness*
	▫ Create a Study Procedure sheet to ensure proper data collection
	▫ Create an Ideal Environment Checklist to ensure a reliable data collection environment
	▫ Other useful documents (i.e., considerations for working with a selected population, tricks for technology)
	▫ Acquiring necessary assessments
	Recruitment and prescreening
	▫ Recruit subjects. Successful ways we virtually recruited:
	○ Flyers posted on social media platforms and the lab's website
	○ E-mails to directors of rehabilitation and support groups
	○ Identification of possible participants from our lab's database
	▫ Conduct prescreening via virtual survey
	Scheduling
	▫ Schedule all meetings upon determining subject's eligibility (i.e., multiple sessions scheduled at one time)
	▫ Send a confirmation e-mail with dates, times, and appropriate videoconference link
	○ Attach the Ideal Environment Checklist, the information sheet, and other helpful documents to confirmation e-mail
	▫ Send a reminder e-mail (or leave a voicemail) the day before each session
	Investigator preparedness
	▫ Investigators conduct at least one practice session with a member of the primary research team, in addition to one training session
	○ Additionally, investigators have a minimum of three practice assessment administrations on their own prior to data collection
Main study	*Investigator fidelity*
	▫ Have the Study Procedure sheet in hard copy during all sessions
	▫ Ensure fidelity by having senior study personnel (e.g., research coordinator, project manager) sit in randomly on sessions
	Assessment procedures
	▫ Confirm ideal environment, recording function, and audio/video quality at the beginning of each session
	▫ Administer all assessments according to the Study Procedure sheet
	Troubleshooting
	▫ Be familiar with technical options in case troubleshooting becomes necessary
	▫ Create a "tips and tricks" documents for quick troubleshooting
	▫ Designate a senior study personnel to assist in troubleshooting, if necessary
Poststudy	*Data curation and quality check*
	▫ Immediately upload data to your secure storage location
	▫ Update database
	▫ Perform a quality check for the recording of the session
	▫ Send subject payment and thank you e-mail

For record-keeping, this spreadsheet was uploaded to the participant's Box Health folder.

Results

The data to test the success of the above methods are reported herein.

Study Participation

Seventy-five people registered interest in the study within 3 months of recruiting, which we believe highlights the interest in and feasibility of this virtual study. Seventy people were invited to participate (after completing our prescreen form), with 56 people completing the entire study by the time of this report. Fourteen people did not respond to scheduling invites sent via e-mail (NB, $N = 9$; PWA, $N = 5$), and five did not attend their first scheduled session (NB, $N = 2$; PWA, $N = 3$). Two NB group members were excluded based on a cognitive screener conducted at the beginning of the first session.

We completed testing on $N = 24$ in the NB group. NB participants ranged in age from 45 to 77 years old ($M = 58 \pm 8.72$ years, 18 females). We completed testing on $N = 25$ in the PWA group, who ranged in age from 40 to 79 years old ($M = 63.6 \pm 10.3$ years, seven females). See Table 4 for detailed demographic information. Eighteen states and four time zones were represented. Anecdotally, approximately one third of participants reported that they were familiar using our video conferencing platform prior to the study.

Subject Retention

Despite operating on four different time zones, with varying levels of technological familiarity, and during a highly unusual climate (e.g., COVID-19), virtual testing in this study maintained a retention rate of 100% (i.e., all participants participating in the first session also completed the second session). While identifying reasons for high retention was not our primary objective in this study, we can speculate as to what contributed significantly. Some measures that we employed that we felt enhanced retention included communicating with subjects by their preferred method of communication (i.e., phone, e-mail), confirming the subject's time zone during first contact, providing testing

Table 4. Demographic and study data.

Demographic information	Subject groups	
	NBD (N = 24)	PWA (N = 25)
Male/female	6/18	18/7
Age range (years)	45–77	40–79
Education range (years)	12–22	12–25
Race	24 White	23 White 1 Black or African American 1 More than one race
Ethnicity: Hispanic/non-Hispanic	1/23	0/25
Interest in study	42	33
Invited to participate	37	33
Nonresponsive to invite	9	5
Scheduled for study	28	28
Withdrawals before or no-shows at test session	2	3
Excluded	2	N/A
Represented states/time zones	8/3	12/4
Average total study time (hours)	2.19	3.28

Note. NBD = adults with no brain damage; PWA = persons with aphasia; N/A = not applicable.

session times in the subject's time zone, scheduling both sessions simultaneously, and consistent reminder e-mails days prior to scheduled session. As it was not uncommon for subjects to reschedule their session(s), reminder e-mails ensured clear communication and organization across both parties.

Session Length

For the NB group, the testing session duration ranged from 1.25 to 2 hr (M = 1.51 ± 0.2 hr) and the retesting session duration ranged from 0.5 to 1 hr (M = 0.68 ± 0.17 hr). When combining test and retest sessions for the NB group, the total time committed to the project ranged from 1.75 to 3 hr (M = 2.19 ± 0.31 hr). For the PWA group, the testing session ranged from 1 to 3 hr (M = 1.95 ± 0.47 hr) and the retesting session ranged from 0.75 to 2 hr (M = 1.32 ± 0.32 hr). When combining test and retest sessions for the PWA group, the total time committed to the project ranged from 2.25 to 4.5 hr (M = 3.28 ± 0.61 hr).

Data Completeness and Preliminary Results

We report a sample of our check-in data. Here, we provide two metrics collected during check-in and check-out: current stress level and current mood level. Each was acquired using visual slider bars, with higher scores indicating higher stress and lower mood (see Table 2). At test, both groups had significantly different stress scores at check-out than at check-in, at test (NBD, p = .005; PWA, p = .03 [not significant after multiple comparisons]) and at retest (NBD, p = .001; PWA, p = .01; using Bonferroni correction, significance value of p < .0125). For the NBD group, this reflected a reduction in stress at check-out for each session, whereas for the PWA group, this reflected an increase of stress at check-out for each session (see Table 2). Stress levels were, on average, below 50 (out of 100) for both groups at both check-in and check-out, at both test and retest sessions. Interestingly, at both test (p < .001) and retest (p = .001), the PWA group endorsed lower current stress levels than the NBD group at check-in. This was not the case for check-out (test, p = .78; retest, p = .995). We did not find any significant differences in mood between groups (PWA, NBD) or between time points (check-in/check-out) for sessions (test, retest; all p values > .37; see Table 5).

While we had high retention of participants, there were some cases where not all procedures could be carried out. This is a limitation that we acknowledge, and we detail these in Table 6. Out of 196 check-in form acquisitions (check-in before session, check-out after session, at both test and retest), N = 2 (1%) were not acquired, and both of these were for the check-out form during test and retest, for two participants in the PWA group. Both were due to technological issues.

For the cognitive and linguistic assessments, we had an acquisition success rate per assessment of 95.83%–100% for the NBD group, across both test and retest sessions. The median completion rate of assessments at test was 100%. We were missing data for three total assessments, and all of these occurred at test, and happened in two participants. In one case, the attention assessment we collected, which had two parts, was not performed correctly and we did not catch it live, thus excluding those assessments later. In another case, one story from the AphasiaBank protocol (Important Event) was not collected due to a technology issue. All assessments were completed at retest in the NBD group.

At test, the PWA group had a relatively high completion rate for assessments, ranging from 84% (N = 21 completers) in an attention subtest to 100% (N = 25 completers) across several subtests. The median completion rate of assessments at test was 96% for the PWA group. At retest, we likewise had a relatively high completion rate for assessments, ranging from 92% to 100%, with a median of 96% completion.

Troubleshooting

Of 66 completed sessions (collapsing test and retest sessions), there was one case of Internet malfunction and five cases of technological malfunction. In the single case of Internet malfunction, a participant's weak Internet connection led to the rescheduling of said participant. Two technological malfunctions were composed of an overload of computer bandwidth, resulting in the loss of video feed. This loss of video feed occurred after intake form but prior to cognitive–linguistic assessments. In both cases, the investigator restarted the meeting and data collection resumed. In two other cases, there was a problem with participant audio. In both cases, the investigator voluntarily ended and restarted the meeting and data collection resumed. In a final case, the meeting ended abruptly and, when restarted, did not automatically record, causing a loss of data.

Broadly, another area of troubleshooting that occurred was cursor malfunction during participant screen control.

Table 5. Data from the check-in forms collected before and after each session (test, retest).

Session	Subject group	Current stress level (higher score = more stressed, max 100)		Current mood (higher score = lower mood, max 100)	
		Check-in *M* (*SD*)	Check-out *M* (*SD*)	Check-in *M* (*SD*)	Check-out *M* (*SD*)
Test	PWA	16.96 (15.79)	28.13 (25.53)	21.00 (18.83)	21.29 (19.97)
	NBD	38.21 (22.23)	26.21 (20.82)	19.04 (16.80)	17.33 (17.03)
Retest	PWA	16.24 (15.81)	27.67 (22.69)	19.52 (15.80)	18.96 (17.10)
	NBD	36.88 (22.26)	27.63 (20.79)	22.13 (21.05)	19.54 (16.56)

Note. PWA = persons with aphasia; NBD = adults with no brain damage.

When this occurred, participants were encouraged to answer verbally or to use pen and paper. When pen and paper were used, the final "drawing" was held up to the camera by the participant, and the investigator took a screengrab of the drawing. At some points, PWA pointed at their screen and, because the investigator cannot see what the participant is pointing it, would ask for verbal clarification (e.g., "Are you pointing at the X?").

Discussion and Conclusions

Here, we provide a technical report of a multitime-point (test–retest) study designed to measure the reliability of spoken language in persons with and without aphasia, and the influence of other factors (i.e., attention, lifestyle, physiological) on this reliability. There were several critical components of the study, which we have here organized in prestudy, main study, and poststudy procedures. We provide what we believe are components for a successful study, comprising such things as a study procedure sheet, ideal environment checklist, and tips/tricks for conducting a virtual study with PWA. We also provide specific examples for troubleshooting, in hopes that these are useful for pre-empting related issues in future studies.

We acknowledge limitations to this study design. While this study was intended for spoken language assessment, we did not provide participants with standard headphones or microphones, meaning that we relied upon their choice of audio and their own device's microphone quality. Because of this, there was some general fuzziness of the audio because of microphones embedded in the participant's device (which we could not control). Furthermore, some participants had to sit further back from their computer (e.g., vision, wheelchair use), which reduced the volume of the recorded audio. For these reasons, a study using the methods we have described here may not be ideal for evaluating certain outcomes, such as speech-related outcomes. Providing standard equipment to participants would be a feasible means of combating this

Table 6. Data completeness.

Assessments	PWA (*N* = 25)		NBD (*N* = 24)	
	Test	Retest	Test	Retest
Check-in Before	100% (25)	100% (25)	100% (24)	100% (24)
Montreal Cognitive Assessment	Not collected	Not collected	100% (24)	Not collected
Western Aphasia Battery–Bedside	100% (25)	Not collected	Not collected	Not collected
Apraxia Battery for Adults–Second Edition	Not collected	100% (25)	Not collected	Not collected
Test of Everyday Attention, Subtest 3	96% (24)	Not collected	95.83% (23)	Not collected
Test of Everyday Attention, Subtest 4	84% (21)	Not collected	95.83% (23)	Not collected
Philadelphia Naming Test, Short Form A	92% (23)	Not collected	100% (24)	Not collected
Philadelphia Naming Test, Short Form B	Not collected	92% (23)	Not collected	100% (24)
AphasiaBank Discourse Protocol				
Stroke Story	96% (24)	96% (24)	100% (24)	100% (24)
Important Event	100% (25)	96% (24)	95.83% (23)	100% (24)
Cat Rescue	100% (25)	96% (24)	100% (24)	100% (24)
Refused Umbrella	96% (24)	96% (24)	100% (24)	100% (24)
Broken Window	96% (24)	96% (24)	100% (24)	100% (24)
Cinderella	96% (24)	92% (23)	100% (24)	100% (24)
Sandwich	96% (24)	92% (23)	100% (24)	100% (24)
Check-in After	96% (24)	96% (24)	100% (24)	100% (24)
Median completion rate	96%	96%	100%	100%
Mean (*SD*) completion rate	96% (4%)	96% (3%)	99% (2%)	100%

Note. Shows percentage of completers for each task with number of completers in parentheses. Note that several assessments were only collected for a single subject group and some at a single time point. PWA = persons with aphasia; NBD = adults with no brain damage control group.

limitation, but also introduces considerably more cost. We also completed a hearing and vision screening by self-report, but future studies may investigate some of the now readily available hearing screenings available online. Preliminary results suggest that the methods we used correlated with high retention and culminated in recruiting a relatively diverse (geographic location, sex) sample. However, we did not achieve our recruitment goal regarding race and ethnic diversity, having a comparatively homogeneous sample in relation to these variables. We acknowledge this flaw and are currently evaluating ways to improve sample diversity.

Another consideration is that some publishers have their own virtual administration guides and platforms. While these should interface well with video sharing platforms for the purposes of research, regulations should be adhered to regarding specific assessments.

In conclusion, this technical report highlights our experience in hopes to provide clear direction for creation and implementation of a virtual, assessment-based study or program with multiple time points, which suggests feasibility for use in populations with a communication disorder.

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References

Brearly, T. W., Shura, R. D., Martindale, S. L., Lazowski, R. A., Luxton, D. D., Shenal, B. V., & Rowland, J. A. (2017). Neuropsychological test administration by videoconference: A systematic review and meta-analysis. *Neuropsychology Review, 27*(2), 174–186. https://doi.org/10.1007/s11065-017-9349-1

Brennan, D. M., Georgeadis, A. C., Baron, C. R., & Barker, L. M. (2004). The effect of videoconference-based telerehabilitation on story retelling performance by brain-injured subjects and its implications for remote speech-language therapy. *Telemedicine and E-Health, 10*(2), 147–154. https://doi.org/10.1089/tmj.2004.10.147

Dabul, B. (2000). *Apraxia Battery for Adults–Second Edition*. Pro-Ed.

Dekhtyar, M., Braun, E. J., Billot, A., Foo, L., & Kiran, S. (2020). Videoconference administration of the Western Aphasia Battery–Revised: Feasibility and validity. *American Journal of Speech-Language Pathology, 29*(2), 673–687. https://doi.org/10.1044/2019_AJSLP-19-00023

Dial, H. R., Hinshelwood, H. A., Grasso, S. M., Hubbard, H. I., Gorno-Tempini, M. L., & Henry, M. L. (2019). Investigating the utility of teletherapy in individuals with primary progressive aphasia. *Clinical Interventions in Aging, 14,* 453–471. https://doi.org/10.2147/CIA.S178878

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., & Duda, S. N. (2019). The REDCap consortium: Building an international community of software platform partners. *Journal of Biomedical Informatics, 95,* 103208. https://doi.org/10.1016/j.jbi.2019.103208

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics, 42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Henry, M. L., Hubbard, H. I., Grasso, S. M., Dial, H. R., Beeson, P. M., Miller, B. L., & Gorno-Tempini, M. L. (2019). Treatment for word retrieval in semantic and logopenic variants of primary progressive aphasia: Immediate and long-term outcomes. *Journal of Speech, Language, and Hearing Research, 62*(8), 2723–2749. https://doi.org/10.1044/2018_JSLHR-L-18-0144

Kertesz, A. (2007). *Western Aphasia Battery–Revised*. The Psychological Corporation.

Koonin, L. M., Hoots, B., Tsang, C. A., Leroy, Z., Farris, K., Jolly, B. T., Antall, P., McCabe, B., Zelis, C. B. R., Tong, I., & Harris, A. M. (2020). Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic—United States, January–March 2020. *Morbidity and Mortality Weekly Report (MMWR), 69*(43), 1595–1599. https://doi.org/10.15585/mmwr.mm6943a3

MacWhinney, B., Forbes, M., & Holland, A. (2011). AphasiaBank: Methods for studying discourse. *Aphasiology, 25*(11), 1286–1307. https://doi.org/10.1080/02687038.2011.589893

Meyer, A. M., Getz, H. R., Brennan, D. M., Hu, T. M., & Friedman, R. B. (2016). Telerehabilitation of anomia in primary progressive aphasia. *Aphasiology, 30*(4), 483–507. https://doi.org/10.1080/02687038.2015.1081142

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53*(4), 695–699. https://doi.org/10.1111/j.1532-5415.2005.53221.x

Robertson, I., Nimmo-Smith, I., Ward, T., & Ridgeway, V. (1994). *Test of Everyday Attention*. Pearson.

Walker, G. M., & Schwartz, M. F. (2012). Short-form Philadelphia Naming Test: Rationale and empirical evaluation. *American Journal of Speech-Language Pathology, 21*(2), 140–153. https://doi.org/10.1044/1058-0360(2012/11-0089)

Wallace, S. J., Worrall, L., Rose, T., Le Dorze, G., Breitenstein, C., Hilari, K., Babbitt, E., Bose, A., Brady, M., Cherney, L. R., Copland, D., Cruice, M., Enderby, P., Hersh, D., Howe, T., Kelly, H., Kiran, S., Laska, A.-C., Marshall, J., . . . Webster, J. (2018). A core outcome set for aphasia treatment research: The ROMA consensus statement. *International Journal of Stroke, 14*(2), 180–185. https://doi.org/10.1177/1747493018806200

Weidner, K., & Lowman, J. (2020). Telepractice for adult speech-language pathology services: A systematic review. *Perspectives of the ASHA Special Interest Groups, 5*(1), 326–338. https://doi.org/10.1044/2019_PERSP-19-00146