Telehealth administration of narrative and procedural discourse: A United Kingdom and United States comparison of traumatic brain injury and matched controls

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What is already known on this subject: Although little research has explored the feasibility of administering discourse assessments for individuals with TBI via telehealth, some studies have found that discourse interventions can be feasibly administered via telehealth. It is also well established that individuals with TBI struggle with the suprastructural and macrolinguistic elements of discourse production. Both procedural and narrative discourse tasks have been found to differentiate individuals with TBI from healthy controls.

What this study adds: Few studies have investigated the feasibility of, and procedures for, administering discourse tasks via telehealth. Additionally, the inclusion of multiple types of discourse tasks to parse cognitive-communication abilities is lacking in the current literature. Findings from this study support that narrative and procedural discourse can be feasibly sampled via telehealth and that international collaboration for research on this topic can facilitate such studies. Individuals with TBI performed more poorly on three measures of narrative discourse. No differences between groups were identified for the procedural task.

Clinical Implications of this study: Telehealth assessment for discourse provides flexibility for both the individual with TBI and the speech-language therapist and does not compromise the quality of data collected. The administration of discourse tasks and collection of data was not

time consuming and was well accepted by the study participants. International research collaboration not only expands potential participation in research but increases the opportunity to recruit and study more diverse groups.

Background: Impaired discourse production is commonly reported for individuals with traumatic brain injury (TBI). Discourse deficits can negatively impact community integration, return to employment, and quality of life. COVID-19 restrictions have reduced in-person assessment services for people with communication impairments. Advances in telehealth may help speech and language therapists (SLTs) to assess monologic discourse more systematically and improve access to services for patients who may find it difficult to attend in-person.

Aims: To examine the feasibility of telehealth administration of narrative and procedural discourse tasks with individuals with TBI and matched controls.

Methods and Procedures: A total of 20 individuals with TBI and 20 healthy controls, aged 18-55, were directly recruited from the UK and indirectly recruited from the US. For participants with TBI, time post-injury was at least 3 months with no diagnosis of aphasia. Control participants were matched for sex and as closely as possible for age. Feasibility of measures was based upon time taken to administer both discourse tasks, the report of any technological problems, and participant feedback. Discourse samples were transcribed verbatim and analysed using story grammar analysis (for narrative discourse) and identification of propositions (for procedural discourse). Inter-rater reliability was calculated using percent

agreement for 50% of the data. Non-parametric analyses were used to analyse the performance of the two groups.

Outcomes and Results: Narrative and procedural discourse samples were collected via telehealth in approximately 10 minutes with no reported technical difficulties or complaints from any participants. For narrative discourse performance, there were significant differences for the TBI and control groups for measures of complete episodes ($p<0.001$) and missing episodes ($p=0.005$). No significant group differences were noted for any of the procedural discourse measures.

Conclusions and Implications: Results support the feasibility of collecting discourse samples via telehealth. Although the participants' discourse performance distinguished the TBI and control groups on the narrative task, no differences between the groups were noted for the procedural task. The narrative discourse task may have been more difficult than the procedural task, or video cue support reduced the cognitive load of the procedural task. This finding suggests the use of more complex procedural tasks without video cue support may be needed.

Introduction

Traumatic brain injury (TBI) can negatively impact many day-to-day functions for individuals, such as the ability to participate in discourse (Coelho, 2007; Galleto et al., 2013; Marini et al., 2011; Stubbs et al., 2018). Impaired discourse is associated with poorer psychosocial adjustment in the first-year post-injury (Elbourn et al., 2019). Discourse, or language beyond the sentence (Kemmerer, 2014), is complex and reliant on higher-order cognitive functions. A successful discourse exchange is reliant on the ability to organize multiple pieces of information, plan the best order to communicate the overall meaning or message, monitor the language being shared, and make repairs as needed in response to environmental shifts or social feedback. Discourse-level deficits experienced by individuals with TBI are unlike those that result from aphasia. Instead of difficulties at the word, phrase, or sentence level, the problems seem to be more pragmatic and affect the overall ability to organize, plan, monitor, or repair the message in a way that communicates coherent meaning to the listener (Duff et al., 2012; Marini et al., 2017). There are several genres of discourse representing predictable and reoccurring patterns of social function that have been identified to better categorize types of discourse. These genres include: narrative (sharing of a story), procedural (instructions to perform an action), expository (expression of opinion), and conversation (a discussion that frequently includes a variety of topics) (Cherney, 1998; Lé, Mozeiko, & Coelho, 2011; Togher et al., 2012). Two of these genre's commonly assessed are narrative and procedural discourse (Snow & Douglas, 2000). Both procedural and narrative discourses require intact abilities of planning and organizational skills, as well as monitoring and maintenance of topic. For example, in story narratives a person must recall the details of an event, the characters and the locations

which needs to be concisely organized when retold. Similarly, procedural discourse requires that individuals be able to recall steps toward a goal and be able to chronologically communicate those steps to a listener (McDonald, 1993).

Discourse deficits secondary to TBI, and without the presence of aphasia, are characterized as cognitive communication disorders. Narrative discourse may be compromised at the micro- and macro-linguistic (i.e. suprastructural level). Micro-linguistic analysis is focused on semantic and syntactic measures that examine multiple aspects of the sentence including word choice/use, length of the utterance, grammar, and repetition (Coelho, 2007; Lé et al., 2011). Macro-linguistic measures focus on the coherence of the story. This includes local coherence (across sentence meaning), global coherence (the overall gist of the story), and suprastructural measures such as story grammar which examine the organization of the story (Coelho, 2007; Lé, et al., 2011). Individuals with TBI may demonstrate difficulties at all levels of discourse analysis (Peach & Hanna, 2001). However, several studies have documented particular difficulty with suprastructural measure of story grammar (Cannizzaro & Coelho, 2002 & 2013; Coelho et al., 2013; Marini et al., 2011). Similarly, procedural discourse productions from the same population have been described as "confusing and disorganized" (McDonald, 1993, p. 43) and lacking necessary detail and order (McDonald, 1995; Snow, Douglas, & Ponsford, 1997; Stubbs et al., 2018).

Discourse is not often formally assessed by speech and language therapists (SLT) particularly in acute care compared to community settings as found in a survey study by Frith et al. (2014). While Frith et al. (2014), did not specify what was meant by discourse, issues with time to transcribe and analyze samples, and training to complete analyses reliably are often

barriers to routine discourse assessment in clinical practice (Coelho, 2007; Steel & Togher, 2019). Greater knowledge of discourse assessment with more feasible methods for analysis need to be considered for clinical practice (Steel & Togher, 2019). Monologic samples including narrative and procedural discourse are more efficient with respect to transcription and analysis compared to conversational discourse (Snow & Douglas, 2000). However, this is often dependent on the level of analysis performed (Coelho, 2007). During 2020, the COVID-19 pandemic shifted rehabilitation services online and telehealth delivery became routine for many people seeking speech and language services (Fernandez et al., 2020; Tohidast et al., 2020). While the premise of telehealth services was not new, it was still not a widely used method of interaction for SLTs and their clients (Aggarwal et al., 2020; Fong et al., 2020) and was not necessarily fully trusted as a reliable method of rehabilitation by clients (Kraljević, Matić, & Dokoza, 2020; Lam et al., 2021). While some regulatory and insurance barriers were eliminated to make telehealth services more accessible, some barriers remained throughout the pandemic such as access to technology and in-home assistance and training needed to operate technology (Campbell & Goldstein, 2021). There is still limited research supporting the feasibility and reliability of standardized assessments administered via telehealth (Campbell & Goldstein, 2021). Despite these barriers, a recent systematic review of 31 studies published between 2014 and 2019 found supporting evidence that telehealth was an appropriate delivery method for adults receiving speech and language services (Weidner et al., 2020).

There are many potential advantages to clinical care being delivered via telehealth. Telehealth interventions provide a more convenient modality of care for individuals who may struggle to attend in-person sessions (Turkstra et al., 2012) or may have economic or physical

barriers to attending in-person (Girard, 2007). Telehealth meetings between clinicians and clients may help to reduce feelings of loneliness and, as a result, may be a more convenient and flexible delivery of treatment for many individuals (Ricker et al., 2002; Turkstra et al., 2012). A study by Mashima and Doarn (2008) identified significant increases (up to 11% from 2006 to 2016) in healthcare occupations which was projected to impact the availability of SLTs for individuals depending on their geographical area. Telehealth removes this barrier, allowing individuals to meet with clinicians regardless of location.

Despite the promising convenience of telehealth, very little is known regarding the effectiveness and feasibility of telehealth services for individuals with TBI. A recent communication training intervention delivered by SLTs via telehealth for individuals with traumatic brain injury was found to be acceptable (Rietdijk et al., 2020). In a similar study, no significant differences were identified between telehealth and in-person administration of communication therapy for individuals with TBI and their carers (Rietdijk et al., 2022). A study by Turkstra et al. (2012) identified no significant differences in language production comparing in-person and telehealth assessment of conversation, narrative, descriptive and procedural discourse ability in a group of 20 adults with moderate-to-severe TBI. A second study that explored telehealth assessment of conversational discourse largely found no significant differences between in-person and telehealth assessment for 19 adults with TBI (Rietdijk et al., 2018). To date, few research studies have focused on equivalence between in-person and telehealth delivery for monologic and conversational discourse. No studies have explored the differences between people with TBI and matched controls via telehealth only. Most research of assessment practices via telehealth post-injury is focused on cognitive abilities (Brearly et al.,

2017; Chapman et al., 2021). While research on the assessment of narrative and procedural discourse has been well-established (Coelho et al., 2005; Steel, Elbourn, & Togher, 2021; Steel & Togher, 2019; Turkstra et al., 2005), little is known about the feasibility or reliability of assessing discourse via telehealth. The present study was a novel collaboration between two research teams, one in the US and one in the UK. To our knowledge, there are no published studies examining the discourse abilities of individuals with moderate-to-severe TBI across continents. There were two primary aims outlined for this investigation. The first aim was to examine the feasibility of telehealth administration of narrative and procedural discourse tasks to individuals with TBI and matched controls. The second aim was to compare discourse performance of individuals with TBI and those without brain injury (NBI). It was hypothesized that telehealth administration of discourse tasks would be feasible, with few technical issues or complaints from participants and that there would be differences observed between the TBI and NBI groups.

Methods

A cohort study was used to explore the discourse performance of individuals with TBI with matched controls from two countries, the UK and US. Ethical approval for the study in the UK was granted by the School of Health Sciences Research Ethics Committee (ETH 1920-0010) at City, University of London and through the University of Connecticut IRB (H17-087) in the US.

Participants

Study participants were recruited in both the US and UK. In the US, participants were indirectly recruited online, using social media and word-of-mouth referrals. Participants in the UK were directly recruited through local brain injury support and rehabilitation groups, and through personal contacts of the investigators. A total of 20 TBI and 20 NBI participants were recruited, divided evenly between the Acquired Brain Injury Lab at the University of Connecticut and the research group at City University London. Inclusion criteria for healthy controls were as follows: must be a native speaker of English; must be between the age of 18-55 (The upper limit was set to reduce the impact of impairments often associated with normal ageing (Verhaegen & Salthouse, 1997)); and capacity to consent to participate in the study. Inclusion criteria for individuals with TBI were same as for the control group with some additions: sustained a diagnosis of mild to severe TBI; as determined by the period of post-traumatic amnesia (PTA), Glasgow Coma Scale score at the time of injury, or clinical presentation (i.e., the extent of cognitive and physical impairments); time post-onset of at least three months; no presence of aphasia (as defined by a score >93 on the Western Aphasia Battery (WAB; Kertesz, 2006); and no diagnosis of motor speech disorder as diagnosed by an SLT. A summary of participant demographics can be found in Table 1. In the US, severity of TBI was confirmed by medical documentation provided by each participant. In the UK, participants provided either medical documentation or a report from their health professional. Because most participants had sustained severe TBI's, the researchers worked closely with caregivers to coordinate participation and technology required, however, all individuals participated without the aid of a caregiver for study tasks.

Table 1: Participant Demographics

Group	Gender	Age (years)*	Time-Post TBI Onset (years)*	TBI Severity
TBI				
USA	Female: 4 Male: 6	M: 39.1 SD: 10.45 Range: 27-55	M: 7.9 SD: 4.86 Range: 1-18	Moderate: 4 Severe: 6
UK	Female: 4 Male: 6	M: 37.5 SD: 6 Range: 26-47	M: 12.8 SD: 6.58 Range: 8-29	Severe: 10
NBI				
USA	Female: 5 Male: 5	M: 35.3 SD: 12.14 Range: 20-53		
UK	Female: 4 Male: 6	M: 35.7 SD: 8.21 Range: 22-48		

Procedure

Consent. Participants were provided a copy of the information sheet and consent form in advance of their first appointment. Consent was secured via an authorized email signature and a verbal confirmation before the start of the study. The consent form was also verbally reviewed at the start of the study.

Participation. In the UK, there is a legal requirement for each participant to demonstrate mental capacity to participate and make decisions about their own inclusion in a research study. Capacity for participants in the UK was assessed by a qualified SLT (NB). As this process

can take additional time, individuals with TBI in the UK were assessed across two sessions rather than one as to reduce assessment burden, while the NBI individuals completed their participation in one session. Participants in the US had to meet inclusion criteria, provide consent to participate without the aid of a caretaker, and provide medical documentation for their head injury (for the TBI group) before their scheduled meeting. Consent was reviewed again, verbally, at the start of each session just in case participants had any questions prior to the study. All participants in the US were run in one session. Participation for this study was entirely online. Participants used a video conferencing link through Zoom (Version 4.6.9., 2020) to communicate with the researcher. This allowed for the researcher to share their screen where needed with participants and video and/or audio record as appropriate. Participants utilized a personal home computer, laptop, or tablet to video conference with the researcher. Some participants gained access to the interaction with the researcher with help from a caretaker; however, no participants required any additional support to complete study tasks.

Measures

Cognition: The *Repeatable Battery for the Assessment of Neuropsychological Status* (RBANS) is a neuropsychological screening battery originally developed as a screening for dementia but is commonly used to screen cognitive functioning for a range of neurological conditions including traumatic brain injury (Galusha-Glasscock, 2016; McKay et. al., 2007;; Turkstra et al., 2012). The battery consists of 12 subtests that combine to form a Total score and Index scores across five categories of performance: Immediate Memory, Visuospatial-

Constructional, Language, Attention, and Delayed Memory. The Index scores are calculated from age-based standard scores (M= 100, SD= 15) (Shura et. al., 2018). The RBANS takes about 30-45 minutes to administer and has been shown to be a valid, reliable assessment suited for telehealth administration (Galusha-Glasscock et. al., 2016). Index scores were then combined into a Total Sum of Index scores. This Index correlates with an overall Total Score for each participant.

Narrative discourse: The narrative task was a story retelling task in which participants were shown a wordless picture story, *Old McDonald had an Apartment House* (Barrett & Barrett, 1998), via a self-paced 16-frame PDF. The story depicts Old McDonald and his wife's attempts to grow vegetables and establish a farm inside an urban apartment home. The chaos that ensues results in trouble with the tenants and the owner of the apartment home. This story was selected due to previous work by Mozeiko et al. (2011) and Lê et al. (2011) showing discriminative results between retellings from individuals with brain injury and healthy controls. Participants were provided a PDF copy of the story at the beginning of the study and instructed to open the document to view during this portion of the study. Participants were informed that they could take as long as they wished viewing the story (going back and forth between the pages as required), and that they must exit out of the PDF when they were finished and ready to tell the story to the researcher. Participant story retellings were prompted by the researcher with the statement: "Can you tell me the story you just viewed in as much detail as possible?" Story retellings were video and audio recorded through the record feature on Zoom for later analysis.

Narrative discourse was transcribed verbatim and analyzed for story grammar elements and accuracy. For story grammar, samples were divided into T-Units, which are independent clauses with any attached or embedded dependent clauses (Hunt, 1964; Lé et. al., 2011). Story grammar was then examined by analyzing episode structure in each story retelling. The story, *Old McDonald had an Apartment House*, (Barrett & Barrett, 1998) can be divided into a total of 6 episodes, which describe the sequences of events that form the story. Episodes can be broken down into three components: an initialing event (IE), an action (A), and a direct consequence (DC) (Liles et. al., 1995; Merritt & Liles, 1987). The initiating event introduces a goal or problem that needs to be solved; the action is the protagonist's attempt to accomplish the goal; and the direct consequence is the result of that action. Each story retelling was broken down into each episodic sequence of an IE, A, and DC. If a sequence included all three elements, it was coded as "complete"; if it was missing one of these elements, it was coded as "incomplete". Those that were lacking two or more components, were not coded as an episode and were noted as "no episode structure" (NES). Complete episodes were awarded one-point, incomplete episodes were awarded half a point, and NES episodes no points. See Appendix A for a full episode list for the narrative task.

For accuracy, the details recounted beyond episode structure were analyzed. All inaccurate details recorded were first identified. To classify these inaccuracies further, two categories of error were identified: false details (FD) and flourishes (FL). An element was coded as a false detail if it did not appear in the story. Details were coded as flourishes if they were exaggerated or embellished details but rooted in something salient in the story. Total inaccuracies and

individual totals for flourishes and false details were recorded. Examples of inaccurate details are shown in Appendix B.

Procedural discourse: The "Dice Game" is a procedural discourse task developed by McDonald (1993). The game is played between two players and consists of a multicolored, striped board with a start and finish on opposite ends. In this game, each player gets a game piece (a car) and rolls a single die that has colors that match the lines on the game board. Each player then is to move their game piece to the color they roll unless they rolled black. If they rolled black, they lose a turn. The first one to the finish line wins. For this task, participants watched a soundless video of the game being played by two players and were to deduce the rules based on observing the players playing the game. They were provided with the following instructions before watching the video, "You will now be shown a video of a game being played. I'd like for you to see if you can figure out the rules to the game and explain them to me so that I may play the game with you if I wished." After viewing the video, participants were instructed "*Now tell me how to play this game so that we could play it together if we wanted to*." Participant explanations were video and audio recorded through the record feature on Zoom for later analysis.

Procedural discourse tasks were transcribed verbatim and organized into propositions, according to McDonald (1993). Propositions are the steps or details that describe the important aspects of the game (McDonald, 1995). Irrelevant remarks were excluded from proposition analysis. Propositions are then organized into one of six categories: orientation, cars, board, die, procedure, and extra details. To accurately code each proposition, a questionnaire checklist was used to identify and calculate the total number of essential propositions (McDonald,1993).

Essential propositions were those details fundamental to the game; those details which described the core features of the game. Summary data included: total number of propositions, number of extra details, number of repeated details, and number of essential propositions.

Reliability of analyses

All transcriptions and coding of discourse samples were checked independently by two raters in each of the US and UK research group. Story grammar, accuracy analysis, and proposition analysis on each transcript (both UK and US) was initially performed by two researchers, one from each location (UK and US). All samples (US and UK combined) were then checked blindly by three raters not aware of the group assignment or the country the data was from. The blind raters were undergraduate students trained at the onset of the study by the PI of the UCONN lab. All raters made notes of potential errors. These notes were discussed and reviewed between the PI and student reviewer. Changes regarding analysis decisions were made by the PI only. Final review of all transcripts was done in a group meeting between the US and UK research team and disagreements were reached through consensus agreement. Inter-rater reliability was calculated using percent agreement for 50% of all discourse samples. Inter-rater reliability was 88% for story grammar elements; 95% for story accuracy; and 97% for proposition analysis in the procedural discourse task. Intra-rater reliability was also performed for 20% of transcripts using percent agreement. Story grammar intra-rater reliability was 98%; accuracy was 97%, and proposition analysis for the procedural discourse task was 100%.

Statistical Analysis

Aim #1: Feasibility was explored in three ways: total time for discourse to be collected, unsolicited participant feedback, and technical difficulties experienced during the telehealth meeting. Total time was collected via audio and video recordings for both the narrative and procedural discourse tasks. The time was marked when the researcher began explaining the task to the participant and ended when the participant stopped speaking. Participant feedback was not probed specifically by the researcher but was recorded as it occurred during task administration. Technical difficulties were defined as a failure of the weblink or software for recording and disruption in the internet connection during the study.

Aim #2: To investigate possible group differences in monologic discourse tasks between the TBI and NBI groups. Participants were divided into NBI and TBI, combining the participants from the UK and US into their respective grouping. Due to the small sample size and variability in the data a Mann Whitney U test was used via SPSS (version 26) to compare group performance across tasks. For cognitive functioning, group performance between both groups (TBI vs NBI) was compared on the RBANS total composite score and five index scores. For the discourse tasks, group performance was assessed in the areas of story grammar (number of complete episodes, incomplete episodes, missing episodes, and a total episode score) and accuracy (number of flourishes, false details, and total number of inaccurate details) of the narrative story retelling task. Similarly, group comparisons for the procedural task were performed with the total propositions, extra details, repeated propositions, and essential propositions.

Results

To address the first aim, feasibility was assessed based on three measures: time to administer the discourse tasks, unsolicited participant feedback, and technical difficulties. Discussion and comparison of field notes between the two research groups (US and UK) revealed no reported complaints. No technical difficulties were noted in regards to the weblink, video conferencing software, or devices used to participate; however, there were some difficulties noted by the US research team in the collection of part of the RBANS assessment. For the physical drawing portion of the visuospatial/constructional task, some participants struggled to hold their drawings still enough to be captured via the screen shot feature. This led to multiple attempts to capture a clear enough image for analysis. Additionally, some participants required caregiver aid to access supporting materials or links. Completion time for discourse task was under ten minutes with production time (participant speaking time) ranging from 0.39- 4:47 minutes in the TBI group for the narrative task and 0.20- 2:34 minutes for the procedural task. Ranges for the NBI group were 0.44-4:43 minutes for the narrative task and 0.52-4:17 minutes for the procedural task. Average production time across all participants when combining the discourse tasks was 1:45 minutes.

To address the second aim, the TBI and NBI groups from each location were compared across tasks (see Table 2 for group results).

Cognitive functioning: There were significant differences between the TBI and NBI groups in the areas of Immediate Memory (U= 301.50, p= .01), Language (U= 320.50, $p < .001$), Attention (U= 316.50, $p < .001$), and the total score (U= 315.50, $p < .001$). Delayed Memory was identified as trending towards significance (U= 273.50, p= .05). In each of these cognitive processes, the TBI group performed significantly poorer relative to the NBI group.

Table 2: RBANS Assessment TBI and NBI Groups (UK and US)

Assessment	**TBI**		**NBI**		***Z***	***U***	***p***
	M	**SD**	**M**	**SD**			
RBANS							
Immediate Memory	80.80	17.19	94.60	10.81	-2.75	301.50	.01
Visuospatial/ Constructional	85.55	16.58	98.25	12.13	-1.82	267.00	.07
Language	79.60	20.53	101.50	13.92	-3.26	320.50	< .001
Delayed Memory	83.70	22.35	98.60	18.11	-1.99	273.50	.05
Attention	94.05	16.33	107.75	9.30	-3.16	316.50	< .001
Total Score	80.40	20.72	97.55	11.33	-3.13	315.50	< .001

Narrative Task: Group comparisons revealed significant group differences in three of the seven narrative categories (see Table 3). Individuals with TBI produced significantly fewer complete episodes (*U*= 67.50, *p* < *.001*) and more NES (*U*= 98, *p* = .01). Accuracy analysis revealed significant differences in the production of false details (*U*= 122, *p* = .04) and the total number of inaccuracies was approaching significance *(U*= 129, *p*= .05). No significant differences were identified for flourishes.

Procedural Task: Group comparisons revealed no significant differences between groups on any of the four categories of the procedural discourse task (see Table 3 for group performance).

Table 3: Group Performance on Narrative and Procedural Tasks (UK and US)

Assessment	**TBI**		**NBI**		***Z***	***U***	***p***
	M	**SD**	**M**	**SD**			
Narrative Discourse Task							
Complete Episodes	1.15	1.12	1.80	1.06	-3.75	67.50	<.001

Incomplete Episodes	1.95	1.40	2.35	1.18	-1.79	135.5	.08
No Episode Structure (NES)	2.80	1.70	2.00	1.08	-2.85	98	.01
Total Score	3.28	2.35	4.55	2.08	-3.48	72	.06
Flourishes	.80	.97	.85	1.13	-.12	196	.93
False Details	1.73	1.57	1.15	1.13	-2.17	122	.04
Total Inaccuracies	2.53	1.91	2.00	1.83	-1.95	129	.05
Procedural Discourse Task							
Total Propositions	14.20	5.85	17.20	9.47	-.75	172.5	.46
Repeated Propositions	2.25	2.15	2.65	3.82	-.54	180.5	.60
Extra Details	2.20	2.33	1.25	1.65	-1.27	155	.23
Essential Propositions	5.70	1.69	6.70	1.03	-1.94	130	.06

Discussion

This study was a novel approach to an international collaboration and was successful in the systematic administration of a study protocol via telehealth during the COVID-19 pandemic. The fact that few technical problems were recorded by either research group, given the range of modalities used by participants (i.e. mobile phones, tablets, laptop, and desktop computers) was surprising and encouraging. The reported difficulty collecting a still screen shot of the visuospatial/constructional drawing task of the RBANS can be addressed in future studies by having a caregiver hold the image to the screen, providing a means to mail the image to the research team, or having the participant scan the item (if available). Additionally, the modalities that participants chose to use for participation was of interest because specific instructions to

use a computer or laptop were not provided before participation. The researchers allowed participants to utilize whatever electronic tools they had available. No differences or barriers in the ability to participate fully related to the electronic device used to connect with the researcher were observed. Additional investigation is needed to establish if more portable SMART devices such as a cell phone or tablet are viable, dependable methods to connect to a telehealth appointment.

Participant feedback was overwhelmingly positive with no reported complaints. In fact, several participants were enthusiastic at the convenience the telehealth design offered them for participation. The time required to administer the discourse tasks was relatively short (<10 minutes each) and yielded valuable insight and were comparable for all participant groups. Overall, no barriers to the successful administration of the discourse tasks were identified, thus supporting the initial hypothesis for aim one, that telehealth administration of discourse tasks would be feasible. Such findings are consistent with other studies that have reported feasibility for conducting assessments via telehealth (Turkstra et al., 2012; Rietdijk et al., 2018).While it was not a specific aim of this study, differences between the TBI and NBI groups on the RBANS cognitive assessment were expected and group performance results were consistent with these expectations. Performance on the RBANS assessment in the present study are in line with similar studies that have administered this assessment via telehealth (Galusha-Glasscock et. al., 2016; Turkstra et al., 2012) and add to the literature regarding telehealth administration of the RBANS for individuals with brain injury.

It was hypothesized for the second aim that differences between the TBI and NBI groups would be identified on the discourse tasks, with the TBI group performing poorer on measures

of narrative and procedural recall. The narrative discourse task yielded story retellings that contained fewer complete episodes and more NES in the TBI group. Overall, the production of episode structure by the TBI group was significantly less complex than that of the NBI group as evident in their poor story grammar. This decreased organization and planning yielded stories that were missing key details, were less cohesive, and incomplete. The deficits in story structure impacted the cohesion and global coherence of the narrative. As large sections of essential details and entire plot lines were missing from the story retellings of the TBI group, local cohesion was disrupted. This failure to produce cohesive narratives had a negative impact on the global coherence of the story for individuals with TBI. As a result, the listener may not arrive at or make sense of the ending. In other words, the goal-state cannot be achieved without producing detailed narratives that are locally cohesive and globally coherent. These findings are consistent with other, in-person discourse studies which revealed the narratives of individuals with brain injury to be disordered, incomplete, and lacking meaning (Anaraki et al., 2015; Cannizarro & Coelho, 2002; Coelho et al., 2013; Marini et al., 2011; Snow et al., 1999).

The significant production of false details in the narratives of the TBI group was of interest. This finding suggests that their stories were either poorly planned or insufficiently repaired. It is possible that false details were inserted when a participant failed to recall the correct detail. In the present study, individuals with TBI did perform significantly worse on immediate memory, language, and attention tasks; however, whether this performance influenced their narratives is difficult to determine with small sample sizes. Other studies have identified that “disordered cognition” (Anaraki et al., 2015; p. 278) may be a central cause of disordered, less coherent stories (Marini et al., 2011). Overall, these findings are in line with the

hypothesis that individuals with moderate to severe TBI would produce significantly poorer narrative compared to individuals without brain injury. This finding is consistent with other research that shows individuals with TBI produce stories that are less complex, incomplete and confusing (Cannizzaro & Coelho, 2002 & 2013; Coelho et al., 2013).

No significant differences were identified between groups in the procedural discourse task, which was a surprising finding as significant differences were hypothesized. A possible explanation for this finding was how the dice game task was administered. The dice game was originally intended to be played in person (McDonald, 1993; McDonald & Pearcei, 1995); however, to move this task online, a video of the game being played was created. Instead of asking participants to play the game and infer the rules in this manner, participants were placed in a "third party" position by watching the game being played by others. It is unclear whether this shift in the modality of the task influenced the salience or cognitive load for participants; thus making it easier to disseminate the rules to the game and produce more complete propositions. It is also possible that there was a visual scaffold via the video that made it easier to infer the steps to the task. As procedural discourse is known to differentiate TBI from non-injured peers (McDonald & Pearcei, 1995; Snow et al., 1997; Stubbs et. al.; 2018), consideration of more complex procedural discourse tasks that can be delivered via telehealth without the visual scaffold may be needed. A narrative review by Steel and Togher (2019) identified the need for a better understanding regarding the types and preferences of visual aids designed and utilized in technologies for individuals with brain injury. To date, the literature is unclear as to whether static or moving images aid or hinder discourse production for this population (Steel & Togher, 2019).

As shown in the findings of this preliminary study, abilities between types of discourse, may differ. While these results must be interpreted with caution due to the small size of our participant group and focus on monologic discourse only, they do shed light on potential differences in the level of difficulty between the two discourse tasks, with story recall requiring an increased level of creativity and cognitive demand than procedural discourse. Taken together, the differences between performance on the narrative task and the procedural task highlight the importance of including more than one discourse task, whether assessing monologic discourse abilities in-person or via telehealth. According to McDonald and Wiseman-Hakes (2017), one of the barriers to improved outcomes for individuals with cognitive-communicative disorders is the gap between the analysis of deficits experienced in this population and the consolidation of these findings into practical tools and actions for clinicians. The ability to produce fluent discourse, whether monologic or conversational, is essential to almost every element of social, professional, and personal communication daily. The impacts of the array of cognitive-communicative deficits that individuals with TBI experience has been well documented as affecting quality of life, relationships, employment, and community activity and integration (Pagulayan et al., 2006; Stocchetti & Zanier, 2016). To better understand communication difficulties that these individuals experience, a more comprehensive picture of monologic and conversational discourse is needed.

Limitations

Some limitations include most notably the small sample sizes from both countries and so the data should be interpreted cautiously. This study intended to compare individuals with

TBI with non-injured peers. As such, no equivalence testing was completed to compare cognitive and discourse data collected via telehealth with in-person and should be considered in the future. It is also important to note the differences taken between the countries in the recruitment of participants for this study. It is possible that a more cohesive approach to recruitment may have yielded a more varied group of participants. Another limitation was the adaption of the dice game task to a telehealth environment (from in-person to a video viewed online). The change in how the task was administered may have impacted group performance. As previously mentioned, there was some difficulty in getting a clear screen shot of the visuospatial/constructional drawing portion of the RBANS. This challenge can now be anticipated in future telehealth studies utilizing the RBANS assessment. Lastly, it is important to note that, for some of our more severe participants with TBI, additional instruction was required to successfully access supporting materials and links required to participate. While this did not hinder participation, it may prevent some individuals from participation if caregiver or in-home support is not readily available. Specific attention to the ease of access and the simplicity of tasks needs to be a continued focus in further telehealth designed research.

Conclusion

The findings of this study reflect a novel approach to the assessment of discourse from individuals with TBI and NBI controls. A systematic protocol and regular communication between the research teams made the administration of this study and the synthesis of findings relatively straightforward. The results support the feasibility of telehealth administration of discourse tasks and the collection of clinically relevant discourse data from such administration.

It also highlights the benefits of international collaboration in expanding the assessment and administration of treatment protocols to a more diverse pool of participants, which is of the highest importance to ensure that interventions and approaches to intervention are as inclusive as possible. Further analysis and understanding of these potential differences is of interest in that it may impact the responsiveness of individuals to standardized assessments and/or interventions.

Declaration of Interest:

The authors declare that there is no conflict of interest.

Appendix A: Episode Structure and Coding for *Old McDonald had an Apartment House*

(Barrett & Barrett, 1969; Mozeiko & Lê, 2007)

Episode 1: Old McDonald is superintendent of an apartment house
IE: Old McDonald/farmer and wife leave farm life for urban/apartment living A: Old McDoanld gets job/works as superintendent of the apartment building DC: Old McDonald is happy after a day of work/greeted by dog

Episode 2: Growing a plant indoors
IE: Wife disappointed/puzzled/sad about wilting plant
A: Old McDonald chops down bushes in front of window DC: Plant grows/produces small tomatoes

Episode 3: Vegetable garden outdoors
IE: Old McDonald moves/grows tomato plant outdoors
A: Old McDonald plants more vegetables in front of apartment DC: Tomato plant flourishes/neighbors are displeased

Episode 4: Vegetable garden indoors
IE: Old McDonald wants a bigger garden/neighbors are unhappy with outdoor garden A: Old McDonald plants vegetables/brings animals indoors
DC: Plants/animals take over the house/creates chaos

Episode 5: Building owner/landlord evicts the McDonalds
IE: Building is overrun with plants/animals and tenants move out
A: Owner/landlord sees the mess and gets mad/yells at/evicts Old McDonald DC: McDonald loses job as superintendent and/or they pack/move out of building

Episode 6: Starting a fruit & vegetable business
IE: Owner is stuck with vegetables/has second thoughts about evicting couple
A: Owner realizes business opportunity/builds the McDonalds a vegetable stand
DC: The vegetable stand is a success/building owner and McDonald's share the business

Appendix B: Accuracy Analysis

In the Old McDonald story, the reader sees Old McDonald clearing the land outside his apartment, so his tomato plant can get some sunshine. If the participant said, “He cleared the trees and bushes away,” it was marked correct. If they said, “He planted the tomato plant under a tree,” it was marked as inaccurate.

An example of each would be:

1. False Details: *“He was trying to grow stuff outside, but it wasn’t taking well.”*
2. Flourishes: *“So, in order to please his wife and make his wife happy, he went out cut down all the trees.”*

References

Anaraki, Z. G., Marini, A., Yadegari, F., Bakhtiari, B. M., Fakharian, E., Rahgozar, M., & Rassouli, M. (2014). Narrative discourse impairments in persian-speaking persons with traumatic brain injury: A pilot study. *Folia Phoniatrica et Logopaedica*, *66*(6), 273-279.

Aggarwal, K., Patel, R., & Ravi, R. (2020). Uptake of telepractice among speech-language therapists following COVID-19 pandemic in India. *Speech, Language, and Hearing*, 1–7.

Barrett, J., & Barrett, R. (1969). *Old Mac Donald had an apartment house*. Atheneum.

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.

Campbell, & Goldstein, H. (2022). Evolution of telehealth technology, evaluations, and therapy: Effects of the COVID-19 pandemic on pediatric speech-language pathology services. *American Journal of Speech-Language Pathology*, *31*(1), 271–286.

Cannizzaro, M. S., & Coelho, C. A. (2002). Treatment of story grammar following traumatic brain injury: A pilot study. *Brain Injury*, *16*(12), 1065-1073.

Cannizzaro, M. S., & Coelho, C. A. (2013). Analysis of narrative discourse structure as an ecologically relevant measure of executive function in adults. *Journal of Psycholinguistic Research*, *42*(6), 527-549.

Chapman, S. B., Fratantoni, J. M., Robertson, I. H., D'Esposito, M., Ling, G. S., Zientz, J., ... & Spence, J. S. (2021). A Novel BrainHealth Index Prototype Improved by Telehealth-Delivered Training During COVID-19. *Frontiers in Public Health*, *9*, 1-22.

Cherney, L. R., & Halper, A. S. (1998). Communication problems following stroke. *Topics in Geriatric Rehabilitation*, *14*(2), 18-27.

Coelho, C. A. (2007). Management of discourse deficits following traumatic brain injury: Progress, caveats, and needs. In *Seminars in Speech and Language*, *28*(2), 122-135.

Coelho, C. A., Grela, B., Corso, M., Gamble, A., & Feinn, R. (2005). Microlinguistic deficits in the narrative discourse of adults with traumatic brain injury. *Brain Injury*, *19*(13), 1139-1145.

Coelho, C., Lê, K., Mozeiko, J., Hamilton, M., Tyler, E., Krueger, F., & Grafman, J. (2013). Characterizing discourse deficits following penetrating head injury: A preliminary model. *American Journal of Speech-Language Pathology, 22*(2). S438–S448.

Duff, M. C., Mutlu, B., Byom, L., & Turkstra, L. S. (2012). Beyond utterances: Distributed cognition as a framework for studying discourse in adults with acquired brain injury. *Seminars in Speech and Language, 33*(1), 44-54.

Elbourn, E., Kenny, B., Power, E., Honan, C., McDonald, S., Tate, R., ... & Togher, L. (2019). Discourse recovery after severe traumatic brain injury: Exploring the first year. *Brain Injury*, *33*(2), 143-159.

Fernandes, F. D. M., Lopes-Herrera, S. A., Perissinoto, J., Molini-Avejonas, D. R., Higuera Amato, C. A. D. L., Tamanaha, A. C., & Goulart, B. N. G. D. (2020). Use of telehealth by undergraduate students in Speech Therapy: Possibilities and perspectives during COVID-19 pandemic. *CoDAS, 32*(4), 1-3.

Fong, R., Tsai, C. F., & Yiu, O. Y. (2020). The implementation of telepractice in speech language pathology in Hong Kong during the COVID-19 pandemic. *Telemedicine and e-Health, 27*, 30–38.

Frith, M., Togher, L., Ferguson, A., Levick, W., & Docking, K. (2014). Assessment practices of speech-language pathologists for cognitive communication disorders following traumatic brain injury in adults: An international survey. *Brain Injury*, *28*(13-14), 1657-1666.

Galetto, V., Andreetta, S., Zettin, M., & Marini, A. (2013). Patterns of impairment of narrative language in mild traumatic brain injury. *Journal of Neurolinguistics*, *26*(6), 649-661.

Galusha-Glasscock, J. M., Horton, D. K., Weiner, M. F., & Cullum, C. M. (2016). Video teleconference administration of the repeatable battery for the assessment of neuropsychological status. *Archives of Clinical Neuropsychology*, *31*(1), 8-11.

Girard, P. (2007). Military and VA telemedicine systems for patients with traumatic brain injury. *Journal of Rehabilitation Research & Development*, *44*(7), 1017-1026.

Hunt, K. W. (1964). *Differences in Grammatical Structures Written at Three Grade Levels,*. Florida State University.

Kemmerer, D. (2014). *Cognitive Neuroscience of Language*. Psychology Press.

Kertesz, A. (2006). Western aphasia battery-revised (WAB-R). *Austin, TX: Pro-Ed*.

Kraljević, J. K., Matić, A., & Dokoza, K. P. (2020). Telepractice as a reaction to the COVID-19 crisis: Insights from Croatian SLP settings. *International Journal of Telerehabilitation*, *12*(2), 93-104.

Lam, J. H. Y., Lee, S. M. K., & Tong, X. (2021). Parents' and students' perceptions of telepractice services for speech-language therapy during the COVID-19 pandemic: Survey study. *Journal of Medical Internet Research Pediatrics and Parenting, 4*(1), e25675.

Lê, K., Mozeiko, J., & Coelho, C. (2011). Discourse analyses: Characterizing cognitive-communication disorders following TBI. *The ASHA Leader*, *16*(2), 18-21.

Liles, B. Z., Duffy, R. J., Merritt, D. D., & Purcell, S. L. (1995). Measurement of narrative discourse ability in children with language disorders. *Journal of Speech, Language, and Hearing Research*, *38*(2), 415-425.

Marini, A., Galetto, V., Zampieri, E., Vorano, L., Zettin, M., & Carlomagno, S. (2011). Narrative language in traumatic brain injury. *Neuropsychologia*, *49*(10), 2904-2910.

Marini, A., Zettin, M., Bencich, E., Bosco, F. M., & Galetto, V. (2017). Severity effects on discourse production after TBI. *Journal of Neurolinguistics*, *44*, 91-106.

Mashima, P. A., & Doarn, C. R. (2008). Overview of telehealth activities in speech-language pathology. *Telemedicine and e-Health*, *14*(10), 1101-1117.

McDonald, S. (1993). Pragmatic language skills after closed head injury: Ability to meet the informational needs of the listener. *Brain and Language*, *44*(1), 28-46.

McDonald, S., & Pearcei, S. (1995). The 'dice'game: A new test of pragmatic language skills after closed-head injury. *Brain Injury*, *9*(3), 255-271.

McDonald, S., & Wiseman-Hakes, C. (2010). Knowledge translation in ABI rehabilitation: A model for consolidating and applying the evidence for cognitive-communication interventions. *Brain Injury*, *24*(3), 486-508.

McKay, C., Casey, J. E., Wertheimer, J., & Fichtenberg, N. L. (2007). Reliability and validity of the RBANS in a traumatic brain injured sample. *Archives of Clinical Neuropsychology*, *22*(1), 91-98.

Merritt, D. D., & Liles, B. Z. (1987). Story grammar ability in children with and without language disorder: Story generation, story retelling, and story comprehension. *Journal of Speech, Language, and Hearing Research*, *30*(4), 539-552.

Mozeiko, J. & Lê, K. (2007). Story retelling scoring procedure. Unpublished.

Mozeiko, J., Le, K., Coelho, C., Krueger, F., & Grafman, J. (2011). The relationship of story grammar and executive function following TBI. *Aphasiology*, *25*(6-7), 826-835.

Pagulayan, K. F., Temkin, N. R., Machamer, J., & Dikmen, S. S. (2006). A longitudinal study of health-related quality of life after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, *87*(5), 611-618.

Peach, R.K., & Hanna, L.E. (2021). Sentence-level processing predicts narrative coherence following traumatic brain injury: Evidence in support of a resource model of discourse processing. *Language, Cognition, and Neuroscience, 36*(6), 694-710.

Ricker, J. H., Rosenthal, M., Garay, E., DeLuca, J., Germain, A., Abraham-Fuchs, K., & Schmidt, K. U. (2002). Telerehabilitation needs: a survey of persons with acquired brain injury. *The Journal of Head Trauma Rehabilitation*, *17*(3), 242-250.

Rietdijk, R., Power, E., Attard, M., & Togher, L. (2020). Acceptability of telehealth-delivered rehabilitation: Experiences and perspectives of people with traumatic brain injury and their carers. *Journal of Telemedicine and Telecare, 28*(2), 122-134.

Rietdijk, R., Power, E., Attard, M., Heard, R., & Togher, L. (2020). Improved conversation outcomes after social communication skills training for people with traumatic brain injury and their communication partners: a clinical trial investigating in-person and telehealth delivery. *Journal of Speech, Language, and Hearing Research*, *63*(2), 615-632.

Rietdijk, R., Power, E., Attard, M., Heard, R., & Togher, L. (2020). A clinical trial investigating telehealth and in-person social communication skills training for people with traumatic brain injury: Participant-reported communication outcomes. *The Journal of Head Trauma Rehabilitation*, *35*(4), 241-253.

Rietdijk, R., Power, E., Brunner, M., & Togher, L. (2018). The reliability of evaluating conversations between people with traumatic brain injury and their communication partners via videoconferencing. *Neuropsychological Rehabilitation*. 1-18.

Snow, P. C., & Douglas, J. M. (2000). Subject review: Conceptual and methodological challenges in discourse assessment with TBI speakers: Towards an understanding. *Brain Injury*, *14*(5), 397-415.

Snow, P., Douglas, J., & Ponsford, J. (1997). Procedural discourse following traumatic brain injury. *Aphasiology*, *11*(10), 947-967.

Steel, J., Elbourn, E., & Togher, L. (2021). Narrative discourse intervention after traumatic brain injury: A systematic review of the literature. *Topics in Language Disorders*, *41*(1), 47-72.

Steel, J., & Togher, L. (2019). Social communication assessment after traumatic brain injury: A narrative review of innovations in pragmatic and discourse assessment methods. *Brain Injury*, *33*(1), 48-61.

Stocchetti, N., & Zanier, E. R. (2016). Chronic impact of traumatic brain injury on outcome and quality of life: a narrative review. *Critical Care*, *20*(1), 1-10.

Stubbs, E., Togher, L., Kenny, B., Fromm, D., Forbes, M., MacWhinney, B., & Power, E. (2018). Procedural discourse performance in adults with severe traumatic brain injury at 3 and 6 months post injury. *Brain Injury*, *32*(2), 167-181.

Togher, L., Power, E., Rietdijk, R., McDonald, S., & Tate, R. (2012). An exploration of participant experience of a communication training program for people with traumatic brain injury and their communication partners. *Disability and Rehabilitation*, *34*(18), 1562-1574.

Tohidast, S. A., Mansuri, B., Bagheri, R., & Azimi, H. (2020). Provision of speech-language pathology services for the treatment of speech and language disorders in children during the COVID-19 pandemic: Problems, concerns, and solutions. *International Journal of Pediatric Otorhinolaryngology*, *138*, 110262-4.

Turkstra, L. S., Coelho, C., & Ylvisaker, M. (2005). The use of standardized tests for individuals with cognitive-communication disorders. *Seminars in Speech and Language*, *26*(4), 215-222.

Turkstra, L. S., Quinn-Padron, M., Johnson, J. E., Workinger, M. S., & Antoniotti, N. (2012). In-person versus telehealth assessment of discourse ability in adults with traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *27*(6), 424-432.

Verhaeghen, P., & Salthouse, T. A. (1997). Meta-analyses of age–cognition relations in adulthood: Estimates of linear and nonlinear age effects and structural models. *Psychological Bulletin*, *122*(3), 231.

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.

Zoom Video Communications, Inc. (2020). *ZOOM cloud meetings* (Version 4.6.9) [Mobile app].