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Making Sense of Right Hemisphere Discourse Using RHDBank

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Abstract

Purpose: Right hemisphere brain damage (RHD) commonly causes pragmatic language disorders that are apparent in discourse production. Specific characteristics and approaches to assessment, diagnosis, and treatment of these disorders are not well-defined. RHDBank, a shared database of multimedia interactions for the study of communication using discourse, was created to address these gaps. The database, materials, and related analysis programs are free resources to clinicians, researchers, educators, and students.

Method: A standard discourse protocol was developed to elicit multiple types of discourse: free speech, conversation, picture description, storytelling, procedural discourse, and question-asking. Testing included measures of cognition, unilateral neglect, and communicative participation. Language samples were video-recorded and transcribed in CHAT format. Currently, the database includes 24 adults with RHD and 24 controls.

Results: Illustrative analyses show how RHDBank can facilitate research using micro- and macrolinguistic discourse analysis techniques both within this population and across populations. Educational resources, such as the Grand Rounds tutorial, were developed using case studies from the database.

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This course focuses on one product/service of RHDBank. The authors, Dr. Jamila Minga and Dr. Melissa Johnson co-developed the RHDBank, and Dr. Margaret Blake was a consultant on the development of the RHDBank which is a database that was developed for the systematic exploration of cognitive-communication disorders after right hemisphere discourse (RHD). The RHDBank provides free resources to clinicians, researchers, educators, and students. Dr. Davida Fromm worked on the AphasiaBank project and oversees the other adult clinical language banks that have been developed as part of the TalkBank system for the study of communication skills in dementia, right hemisphere disorder, and traumatic brain injury. Dr. Brian MacWhinney developed a series of 13 TalkBank open access online databases (which includes the RHDBank) for the study of language learning, multilingualism, and language disorders. Dr. Johnson and Dr. Blake were co-creators of RightHemisphere.org, a website designed to provide education and resources about RHD which is mentioned in the article. Dr. Blake is the Publications Editor for the International Cognitive-Communication Disorders conference which is also mentioned in the article. Dr. Blake has presented nationally and internationally on evidence-based practice for disorders associated with RHD. Additional author disclosures can be found at <http://links.lww.com/TLD/A73>.

Conclusions: RHDBank is a shared database of resources that can facilitate educational and research efforts to address the gaps in knowledge about RHD communication and improve the clinical management of individuals with RHD.

Keywords

automated discourse analysis; discourse production; right hemisphere brain damage; shared database; stroke

RIGHT HEMISPHERE BRAIN DAMAGE (RHD) can affect communication in a variety of ways (Blake, 2018; Tompkins, 2016). Language production may be less efficient, more tangential, overpersonalized, or disorganized; language comprehension may be impaired, particularly in situations where there are multiple or ambiguous meanings (e.g., figurative language) or when inferences are required; and impaired social and contextual nuances such as altered eye contact, respect for personal space, and turn-taking may impact daily communicative interactions. In addition, cognitive impairments affecting attention, executive function (EF), awareness, or memory can impact the efficiency and effectiveness of communication. Collectively, these areas of deficit constitute a cognitive communication disorder (CCD) that impacts quality of life and social integration (Hewetson & Cornwell, 2020; Hewetson et al., 2017).

Theory development in regard to RHD discourse production deficits is still in its infancy. The cognitive pragmatic theory (Bara, 2010), which holds that cognitive processes are shared for linguistic (microlinguistic and macrolinguistic) and extralinguistic aspects of communication, has been applied to assessment approaches to pragmatic language use (Parola et al., 2016). Aligning with this theory, cognitive constructs of theory of mind, attention, and executive functioning are proposed to account for at least some RHD communicative changes (Cummings, 2019; Martin & McDonald, 2003; Sherratt & Penn, 1990), but there are only a few studies that have systematically evaluated the relationships (Bartels-Tobin & Hinckley, 2005; Rogalski et al., 2010). Specificity is needed concerning the relationship between cognition and language production (Sherratt & Penn, 1990). In the absence of a theoretical structure, the current understanding of discourse revolves around descriptions of linguistic and extralinguistic aspects of production that are more or less likely to be affected after RHD. For example, both microlinguistic (e.g., syntax, morphology, and lexical semantics) and macrolinguistic (e.g., global coherence [GC], productivity, content, and appropriateness) aspects of language can be affected, but these deficits may vary with respect to prominence (e.g., see Blake, 2018, and Minga, 2016, for a review; Balaban et al., 2016; Blake, 2003; Sherratt & Byran, 2012) both within and across individuals and no consistent patterns of occurrence have been reported. Extralinguistic features (e.g., gestures, body language, and eye contact) are also commonly affected after RHD (see review in Blake, 2018; Parola et al., 2016), but the limited scientific inquiry of these aspects in relation to discourse prevents any more specificity in describing the deficits.

Multiple factors contribute to the gaps in knowledge about RHD discourse, the primary ones involving methodological weaknesses and limited exposure to the population by clinicians and researchers in training. The overarching goal of this project was to take advantage of

the TalkBank system (<https://talkbank.org/>) to create a clinical language bank dedicated to discourse in RHD. TalkBank is the world's largest open-access repository of data on spoken language, containing shared databases of multimedia interactions for the study of child language, aphasia, traumatic brain injury (TBI), fluency, and more. We address three main contributors to the knowledge gaps to emphasize the importance of collecting a rich database of RHD discourse in a systematic fashion.

CONTRIBUTORS TO KNOWLEDGE GAPS

Research Methodology

Existing research about RHD discourse production deficits is quite limited in quantity and somewhat difficult to synthesize into a coherent set of evidence-based recommendations to support differential diagnosis and clinical decision-making. As of 2019, there were approximately 25 research studies of discourse production (see Blake, 2018, for a review). Across these studies, at least 35 different aspects of production were measured (e.g., productivity, coherence, cohesion, content, structure, appropriateness, and pragmatics) using a variety of tasks including storytelling, picture description, procedural discourse, and conversation. Most failed to find consistent deficits across genres (e.g., Brady et al., 2003, 2005; Mackenzie et al., 1997, 1999). Compiling the results across studies, the only consistent findings are that coherence and cohesion are typically spared (Brady et al., 2005; Sherratt & Bryan, 2012; but see Marini et al., 2005), use of emotional words is reduced compared with control groups (Blake, 2003), and extralinguistic cues associated with pragmatics (e.g., eye contact, turn-taking) can be impacted (Mackenzie et al., 1997, 1999; Parola et al., 2016). Inconsistent results have been reported for all other variables.

Several aspects of study design limit the conclusions that can be drawn about RHD discourse production from any one study or the small group of studies that exist. First, comparing results across studies is difficult due to limited information about the participants. Many studies fail to provide adequate descriptions of the participants (e.g., scores for a variety of cognitive and communication tasks), so it is not possible to get a clear picture of the participants' actual profiles (e.g., Brady et al., 2003, 2005, 2006; Chantraine et al., 1998; Cherney et al., 1997; Parola et al., 2016). Second, only a handful of studies have analyzed the relationships between discourse production and other cognitive or communication abilities to provide information about how deficits may co-occur and/or influence each other (Bartels-Tobin & Hinckley, 2005; Sherratt & Bryan, 2012; Tompkins et al., 1992). Third, studies of micro- or macrolinguistic variables rarely include correlations between such variables to explore patterns of deficits. The cluster analysis of linguistic, paralinguistic, and extralinguistic abilities conducted by Parola et al. (2016) is a welcome exception. Finally, many studies report only group results and do not consider individual differences (Brady et al., 2003, 2005, 2006; Mackenzie et al., 1997, 1999; Tompkins et al., 1992). When individual differences are examined, researchers almost universally find that there are subgroups that are not impaired on the variable(s) of interest as well as different levels of severity or patterns of performance in the remaining participants (e.g., Blake & Lesniewicz, 2005; Chantraine et al., 1998; Kennedy, 2000). This information is critical for developing a deeper understanding of RHD communication disorders, theories of RHD, and, in turn,

assessments and treatments. Given these methodological limitations, it is not surprising that language production after RHD is not well understood and to date has failed to yield coherent patterns of deficits or subtypes.

Research Personnel

A relatively small number of professionals are actively involved in investigating CCDs, and even fewer focusing on discourse production in RHD. Although it is difficult to pinpoint all of the factors that contribute to this, one is likely the historic view of the right hemisphere as “silent” or nondominant for language production. In addition, there are anecdotal reports that it is difficult to find and retain RHD participants. This could be because anosognosia (reduced awareness of deficits) makes individuals with RHD less likely to self-identify and volunteer for research or persist through multiple visits to complete research studies. It could also be because the communication deficits can be subtle and therefore difficult for survivors or their families to determine exactly what is “not right” and what to do about it. Finally, given the small number of researchers in the area, there are few mentors to stoke interest and excitement in students who would help expand the research and knowledge base. Researchers who do not specialize in RHD may be hesitant to mentor a student in this area, especially if the population of interest may be difficult to recruit and/or retain.

Education and Resources

A broader issue in RHD is that education and resources are lacking compared with other neurogenic communication disorders such as aphasia, dysarthria, and even apraxia of speech. There are many graduate textbooks focusing on aphasia. Most of these have chapters related to CCDs but rarely more than one chapter for RHD. Typically, the number of chapters on aphasia exceeds the combined number of chapters about CCDs for etiologies such as RHD, TBI, and dementia. Some textbooks focus on CCDs, but the options are limited. Over the past 25 years, there have been only three books that focus exclusively on RHD (Blake, 2018; Myers, 1999; Tompkins, 1995).

Continuing education after graduate school is also limited. A survey of presentations at the American Speech-Language-Hearing Association (ASHA) convention over a 5-year period (2014–2018) indicated that, on average, there were more than 200 presentations per year on aphasia, more than twice as many as all CCD etiologies combined (TBI ~50, dementia ~40, RHD <10; Ramsey & Blake, 2020). The first research conference specifically focused on CCDs, the International Cognitive Communication Disorders Conference, was inaugurated in 2017. Other resources for clinicians, patients, and families are similarly limited. The first website specifically focused on RHD (www.RightHemisphere.org) was launched in 2019. Perhaps, limited educational emphasis has contributed to reduced public knowledge of RHD and resulting impairments as well (Ivanszky et al., 2016).

RATIONALE FOR RHDBANK DEVELOPMENT

Given the constellation of complex communication deficits that occur after RHD, a systematic exploration of discourse production is essential for developing a greater understanding of communication impairments and contributing cognitive processes (Barnes

& Armstrong, 2010). RHDBank (<https://rhd.talkbank.org>) was initiated in 2015 as a critical resource to increase our understanding of language production in RHD. It was specifically modeled after two other adult language banks that were created several years earlier: AphasiaBank (MacWhinney et al., 2011) and TBIBank (Elbourn et al., 2019). However, the project was customized to meet the unique needs of the population and to address some of the issues in the existing literature. The goal was to develop a shared platform to advance knowledge concerning discourse production after RHD and impact the development of population-specific assessment and treatment protocols.

METHODS

Participants

Although participant recruitment is ongoing, Table 1 provides a summary of the current database, which includes participants who sustained a stroke to the right hemisphere ($N=24$) and neurologically healthy controls ($N=24$). Language samples in the current database were from two sites (North Carolina Central University and Nazareth College), representing two different regions of the country. Each institution's institutional review board approved consent forms, which all participants signed before beginning the project. Demographic data (51 items) were collected from all participants and entered into a master spreadsheet using a de-identified participant ID containing the corpus name, participant number, and a letter to indicate the order of the visit (e.g., minga09a). The demographic fields covered basic general demographics (e.g., sex, race, age, education, handedness), as well as stroke-related information (e.g., etiology, locus, time post-onset), language background, general medical history, and more. Inclusion criteria for both groups were as follows: English speakers,¹ at least 6 months post-onset of single right hemisphere stroke, no other neurological condition, vision and hearing adequate for testing, high school diploma or equivalent, no history of alcohol or drug abuse, and no history of learning disability.

The RHDBank protocol

Most of the materials and resources described are available from links at the RHDBank webpage. However, in accordance with TalkBank policies, all participant data (e.g., demographics, test results, language transcripts, media files) are password protected.²

RHDBank test battery—Participants completed a battery of tests that assess cognitive-linguistic functioning, handedness, and visuospatial neglect. During development, a primary consideration for the RHDBank protocol was feasibility for clinicians and researchers to administer all aspects of the protocol. That is, the protocol was designed with tools that would be relatively easy for speech–language pathologists (SLPs) to access and administer in a reasonable time frame. All tests were administered to RHD participants, but only the first two items listed below were administered to control participants. Administration of the full test battery takes approximately 45 min. The Cognitive Linguistic Quick Test (CLQT;

¹Tasks completed by speakers of languages other than English are available in the noncorpora section of RHDBank.

²Researchers and clinicians working with those with RHD who are interested in joining RHDBank should send an email to Brian MacWhinney (macw@cmu.edu) with contact information and affiliation. Students interested in using the data should ask their faculty advisors to join as members.

Helm-Estabrooks, 2017) is the only part of the testing protocol that is not available from links at the RHDBank webpage. The following five tests are included in the protocol.

Cognitive Linguistic Quick Test: Cognitive deficits co-occur with communication deficits, but the specific role of cognition in discourse production is not fully understood (Bartels-Tobin & Hinckley, 2005; Rogalski et al., 2010). The CLQT has been used to evaluate cognitive capabilities in a host of neurogenically compromised populations including those with RHD (Bartels-Tobin & Hinckley, 2005), Parkinson's disease (Parashos et al., 2009), aphasia (Helm-Estabrooks, 2002), and TBI (Blyth et al., 2012). It is also a measure that is most likely accessible to practicing SLPs (Ramsey & Blake, 2020). Inclusion of the CLQT provides an avenue for disorder-based performance comparisons, and it allows researchers to examine the link between cognitive domains (i.e., attention, memory, executive functioning, visuospatial skills, and language) and the different discourse tasks included in the database. Table 2 has a summary of CLQT domain scores by group and a column showing the ranges for normal scores in each domain. For the current complement of participants, the RHD group means are below the normal range on the Attention, Executive Function, and Visuospatial domains, and in the low end of the normal range on the Memory and Language domains; the control group scored in the normal range throughout.

Edinburgh Handedness Inventory (Oldfield, 1971): Lateralization of language function is associated with handedness (Knecht et al., 2000). This 20-item inventory determines handedness using hand, foot, and visual preferences for 10 functional tasks. This information allows researchers to consider lateralization of processes related to communication. RHDBank participants' scores indicate that the majority of participants are right-handed, with the exception of two RHD participants (one left-handed, one ambidextrous) and three control participants (all left-handed).

General Short Form of the Communicative Participation Item Bank (Baylor et al., 2013): Communication deficits after RHD can result in negative social outcomes that disrupt social relationships and the ability to maintain vocational or avocational pursuits (Tompkins, 2012; Yorkston et al., 2008). This 10-item questionnaire was included to measure their perceived level of impairment in actual communication situations. Each item is scored as "not at all" (3 points), "a little" (2 points), "quite a bit" (1 point), or "very much" (0 points), for a maximum possible score of 30, which would indicate that the individual believes their condition does not interfere at all with situations such as *talking with people they know, asking questions in a conversation, or giving someone DETAILED information* on an average day. The mean score for RHD participants in the current database is 22.6 ($SD = 5.9$), which is slightly (about half a standard deviation) above the mean reported by Baylor et al. (2013) for a large population representing four diagnoses (i.e., multiple sclerosis, Parkinson's disease, amyotrophic lateral sclerosis, and head and neck cancer). Although not currently done, it may be useful to have a family member also complete the Communicative Participation Item Bank (CPIB) to indirectly examine awareness of deficits, given that some adults with RHD may have reduced insight about their communication abilities.

Apples Test (Bickerton et al., 2011): Visuospatial neglect occurs in 13%–81% of adults with RHD (Barrett et al., 2006; Lee et al., 2009). Neglect can affect viewer-centered (i.e., egocentric) and object-centered (i.e., allocentric) spatial orientations. Persistence of neglect can cause significant disability and loss of independence (Cherney et al., 2001). The Apples Test is a cancellation task that was designed to detect the presence of viewer-centered and object-centered neglect.

Participants are presented with a page of irregularly spaced line drawings of apples, some with small gaps on either the right side or the left side. They are asked to cross off all of the whole apples (i.e., those without a gap). Participants with viewer-centered neglect would be expected to miss more apples on the left side of the page than on the right. Of the 23 RHDBank participants who completed this task, the mean number of apples correctly canceled was 43 ($SD = 12$) out of a possible 50. Five RHD participants (21.7%) scored below the cutoff score of 42 (below the 5th percentile of the normative sample), demonstrating evidence of viewer-centered neglect. Participants with object-centered neglect would be expected to inaccurately select as “whole” those apples with a gap on the left side due to left-side inattention to each apple. Thus, object-centered neglect can be detected by examining the number of apples with a gap on the left side that were incorrectly identified as whole. Seven RHD participants (30.4%) scored 1 or higher on this measure, suggesting the presence of object-centered neglect. Three participants (13.0%) demonstrated evidence of both viewer-centered and object-centered neglect.

The Apples Test was included in the RHDBank protocol to allow researchers to examine the occurrence of visuospatial neglect (egocentric and allocentric) after RHD and potential relationships to discourse characteristics. One study by Marini et al. (2005) found differences in discourse measures on tasks that were not dependent on a visual stimulus (i.e., storytelling not based on a picture book) compared with those that did incorporate a visual stimulus (i.e., telling stories based on cartoon pictures). To date, we are not aware of any such analysis of the RHDBank samples, although this is potential ground for future investigation.

Indented Paragraph Test (Caplan, 1987): Visuospatial neglect may result in impaired reading, or neglect dyslexia (ND). Use of the Indented Paragraph Test (IPT), a reading passage with irregular left-hand margins, suggested improved detection of mild or subtle ND (Caplan, 1987), but this finding has not been replicated (Towle & Lincoln, 1991). This test was included as an opportunity for researchers to examine ND and possible correlations with other available measures.

On the IPT, mild ND is indicated by missing one to nine words; moderate-severe ND is suspected when 10 or more words are omitted. Of the 22 RHDBank participants who read this passage, an average of 2.8 words ($SD = 5.2$) were omitted. Nine participants (40.9%) demonstrated mild ND; two participants (9.1%) showed moderate-severe ND.

RHDBank discourse protocol—An essential element of the existing adult language banks mentioned earlier is the establishment of a standard discourse protocol for use with all participants. For RHDBank, the discourse protocol consists of elicitation tasks spanning four

different discourse genres: descriptive, narrative, procedural, and conversational. Research in adult language production has always emphasized the importance of examining a variety of discourse genres to comprehensively measure different aspects of discourse and tap into the different cognitive and linguistic demands inherent in each type (Bryant et al., 2017; Capilouto et al., 2005; Coelho et al., 1991; Fergadiotis & Wright, 2011; Pritchard et al., 2017; Saffran et al., 1989; Shadden et al., 1991; Ulatowska et al., 1990). Some of the tasks selected for the RHDBank protocol have been used in the AphasiaBank discourse protocol and other AphasiaBank corpora because they elicit the types of discourse that people use on a daily basis and they have been used throughout the years to study different aspects of discourse in normal aging, aphasia, and other acquired adult language disorders. They have a long and proven history of success in eliciting language samples that can be used to study a variety of aspects of language with tools such as correct information units (Nicholas & Brookshire, 1993), main concept (MC) analysis (Capilouto et al., 2005; Dalton & Richardson, 2019; Richardson & Dalton, 2020), and core lexicon (Dalton et al., 2020), as well as basic lexical and morphosyntactic analyses.

The specific tasks in the RHDBank discourse protocol were selected on the basis of several considerations. First, we wanted to sample a variety of discourse genres that would be functionally relevant in personal, professional, and social contexts. The narratives, procedures, descriptions, and the particular type of conversation task included in the protocol (i.e., a first encounter with a stranger) were chosen for their potential to highlight the pragmatic and social discourse aspects of language that commonly affect individuals with RHD (Ferré et al., 2012). Second, we wanted to overlap with selected discourse tasks from AphasiaBank, TBIBank, and DementiaBank (all of which include the free speech samples, the Cat Rescue picture [Nicholas & Brookshire, 1993], Cinderella story retelling, and sandwich procedural discourse; the Cookie Theft picture [Goodglass et al., 2001] is only included in AphasiaBank and DementiaBank). By using tools that are consistent with other TalkBank corpora, comparisons can be drawn across populations to help improve understanding of right hemispheric influences on communication. Furthermore, because of the paucity of research and clinical resources available about RHD, clinicians sometimes delve into the aphasia or TBI literature, assessment tools, and treatment techniques when working with people with RHD despite the obvious differences in mechanisms of injury and neurological and communicative characteristics. RHDBank can help bridge this gap, allowing clinicians and researchers to differentiate among these populations, drive theory development, and spur development of assessment and treatment approaches that meet the specific needs of people with RHD. Third, we wanted to be able to compare this new corpus of data with discourse data reported in the existing literature on RHD that has included several of these tasks, specifically the Cinderella story and Cookie Theft picture (Bartels-Tobin & Hinckley, 2005; Brady et al., 2006; Marini, 2012; Nicholas & Brookshire, 1995; Sherratt & Penn, 1990). Finally, it was also important to make the set of tasks manageable for the participants in terms of time and effort. Administration of the discourse protocol takes about 35–50 min. All relevant materials for administering the discourse protocol are available from links at the RHDBank webpage.

The RHDBank Discourse Protocol includes the following tasks:

1. *Free speech.* The protocol begins by asking participants about their communication capabilities, how their communication is perceived by others, and what they remember about their stroke and recovery. Control participants are asked to respond to questions about their experience with a person who demonstrated communication difficulties and about a personal illness.
2. *Conversational discourse.* Participants are asked to have a first-encounter conversation (Kennedy et al., 1994). During this 5-min conversation, participants are introduced to a person they have never met before and asked to “get to know” the other person. The other person is typically a graduate student in speech–language pathology. Specific instructions are given to both the student and the participant, emphasizing the goal of the task.
 - Instructions to student: *This is not an interview. This is an opportunity for the two of you to get to know each other. Just converse as you would with anyone you are meeting for the first time. But please—this is very important—be sure to allow time for your partner to initiate topics, even if this ends up creating some long pauses.*
 - Instructions to participant: *I’d like you to meet one of my students. (If investigator is a student clinician, say: I’d like you to meet another student here.) I don’t think you’ve met her/him before. This is a chance for you to get to know each other. This is not an interview, so s/he doesn’t have a list of questions to ask you. See what you can get to know about her/him.*
3. *Descriptive discourse.* The Cookie Theft picture (Goodglass et al., 2001) is presented with the usual prompt of *Tell me everything you see going on in the picture.* Although the Cookie Theft picture has been updated since the development of RHDBank (Berube et al., 2019), data described in this article elicit language using the original image. Future studies may incorporate both images.
4. *Narrative discourse.* Two story narratives are used to elicit this type of discourse. First, the Cat Rescue picture (Nicholas & Brookshire, 1993) is presented with the prompt to look at everything that’s happening and then tell a story with a beginning, a middle, and an end. Participants are then asked to look through a paperback book of Cinderella (Grimes, 2005), with the text covered, to remind them of the story. After reviewing the book, they are asked to tell the Cinderella story in their own words. Participants are permitted 5 min to complete the Cinderella storytelling. This time limit was instituted because of the tendency for individuals with RHD to sometimes be verbose and tangential, not getting to the point or bringing the story to a close. (The 5-min time frame was based on data from the larger AphasiaBank database, showing that control participants and participants with aphasia did the same task in an average of 3.2 and 3.6 min, respectively, with no time constraints).

5. *Procedural discourse.* Participants are asked to describe the process of making a peanut butter and jelly sandwich.
6. *Question-asking.* Participants are asked to look at five pictured objects individually and generate three questions that would help them determine the purpose of the object. Each object's purpose was undeterminable by physical appearance and rated as unfamiliar looking by a group of controls (see Minga et al., 2020). Responses to questions are not provided, and participants are informed of this in the task prompt: "Ask me at least three questions that would help you figure out the purpose of the object. I won't actually answer your questions, but I'm interested in hearing at least three questions you would ask to find out what the object is for. Here is the first object." If at least three questions are not produced, the investigator asks the following question: "What are three questions you could ask to figure out what this object is for?" The task prompt is repeated with each pictured object.

A script was developed to maintain consistency in protocol administration across investigators. The script includes second-level prompts that may be used if a participant does not respond to the initial prompt in a specified period of time, typically 10 s. Investigators are encouraged to use nonverbal encouragers (e.g., good eye contact, facial expressions, head nods), keeping verbal encouragers to a minimum and trying not to talk at the same time as the participant. This makes the transcription process much more efficient and accurate while still making the interaction as socially engaging and appropriate as possible.

Approximate times (in minutes) are given to estimate how long each task should take, but only two of the tasks (First Encounter and Cinderella Story) have time constraints. For the First Encounter task, the investigator simply ends it after 5 min by coming back into the room and thanking the volunteer. For the Cinderella task, the investigator uses this first prompt after 5 min: "Sorry to interrupt, but please try to finish up with the rest of the details of the story so we can get to the other things we still have to do." One minute later, the investigator gives this second prompt: "Okay, just tell me how the story ends, we have to move on." These prompts have only been necessary for two of the participants currently in the database.

The discourse portion is video-recorded using established guidelines that help maintain high audio and video quality. Video recording guidelines are posted at the AphasiaBank website, with specific instructions for equipment use and configuration and methods for file creation for video output.

Transcription and coding: The basic process of transcription and coding for RHD samples is the same as that described in an article published in this journal describing the methods for studying discourse in AphasiaBank (MacWhinney et al., 2011). Briefly, discourse samples are orthographically transcribed in CHAT format, which then allows for a large number of automated analyses of linguistic and discourse structures using the CLAN program (MacWhinney, 2000). The CLAN program is free to download from the TalkBank website, where one can also access resources such as manuals and tutorial screencasts for transcription and analysis training.

For RHDBank, transcriptions are completed by trained speech–language pathology students or research assistants and then reviewed by at least two other experienced transcribers, one of whom is always a certified, licensed SLP. Utterances are segmented on the basis of a hierarchy of indicators: syntactic, intonational, pauses, and semantic (Berndt et al., 2000). CHAT transcription format includes symbols for marking behaviors such as repetitions, revisions, fillers, sound fragments, and pauses. Transcripts can be coded further for word-level or utterance-level errors using a detailed error coding system that is available in the CHAT manual at the TalkBank website or a customized set of codes to meet the needs of a particular project (e.g., cohesion, main events). Word-level error categories include phonemic, semantic, and neologistic types. Utterance-level codes can identify larger issues such as grammaticality, circumlocution, jargon, and empty speech. Examples of some utterances from RHD participants' CHAT transcripts are given as follows, showing several of these codes:

1. Sound fragment and repetition*PAR: and the &+g father's trying to get the [/] the cat.
2. Short pause and related semantic error*PAR: and so the prince invited her in (.) and sat down and slipped the slipper on him [: her] [* s:r].
3. Revision and filler*PAR: Cinderella was [/] &-um had two mean sisters.

After the sample is transcribed and coded, the CLAN command for morphological tagging, MOR, is used to automatically create two new lines under each speaker tier in the transcript. The first line, %mor, provides the lexical and morphological tags for each word from the speaker tier (ignoring repetitions and revisions); the second line, %gra, shows pairwise grammatical relations between words. These results, which are generated in few seconds, can be used to examine syntactic patterns and support automatic computation of morphosyntactic profiles for analyses such as the Northwestern Narrative Language Analysis (Thompson et al., 1995) and the Quantitative Production Analysis (Berndt et al., 2000). Examples of how this information can be applied to discourse studies in RHD are addressed later. Here is how the first sentence discussed earlier appears after running the MOR command: *PAR: and the father's trying to get the [/] the cat. %mor: coord|and det:art|the n|father~aux|be&3S part|try-PRESP inf|to v|get det:art|the n|cat. %gra: 1|5|LINK 2|3|DET 3|5|SUBJ 4|5|AUX 5|0|ROOT 6|7|INF 7|5|COMP 8|9|DET 9|7|OBJ 10|5|PUNCT

RESULTS

The primary goal of this project was to create a shared database for the study of discourse in RHD using a standard discourse protocol in a well-defined population. In the few years since its development, 90 clinicians and researchers have requested membership in RHDBank so that they can access its password-protected resources. As with the other TalkBank databases, interested members can use these resources to advance their understanding and to educate students and new clinicians. Specifically, members may elect to test the adherence of data to different linguistic theories, compare and contrast RHD with other acquired adult language impairments, explore patterns or subgroups based on type and severity of symptoms, and distinguish adults with RHD from controls for targeting and measuring treatment. We

highlight a number of ways in which the materials have been used to learn more about RHD discourse.

Illustrative analyses

The CLAN program can be used to conduct a variety of analyses on micro- and macrolinguistic aspects of discourse from transcripts in the RHDBank database. Some examples of the application of these and other analysis tools are provided later, but they only scratch the surface of the potential uses of the database (see “Future directions” section). In most of the examples, a different CLAN command is used to analyze the language samples. Figure 1 shows the CLAN commands window where the user types the command (or uses the *Progs* button for the drop-down menu) to create the command (for more details, see MacWhinney et al., 2011).

FREQ—This CLAN program can be used for frequency analyses. A simple application would be to compare the top 10 nouns used in an RHD participant’s Cinderella story and compare them with those of the control group. By running this command *c* on the minga08a CHAT file, we find that the top 12 nouns used, in order of frequency, were as follows: Cinderella, ball, prince, shoe, godmother, chance, gown, opportunity, part, slipper, stagecoach, and stepsister.

A previous article on automated analysis of the Cinderella story reported on the top 12 nouns produced by a group of controls in the AphasiaBank database as follows: Cinderella, ball, prince, slipper, mother/stepmother, dress, daughter/stepdaughter, fairy, godmother, sister/stepsister, home, and girl (MacWhinney et al., 2010). Interestingly, only half of the lexical items in the sample from minga08a overlapped with this list, although the total number of words was in line with the control participants. The RHD participant did not use the same words that most people use during this task, and her word selection was generally nonspecific. For example, here are some utterances from her story: *PAR: she didn’t think she was up to standard to be able to participate in something like that. <regarding the invitation to the ball>*PAR: and &-um so she was conscientious about the evening getting by. <regarding Cinderella’s curfew>*PAR: and that led to the happily ever after of you_know back to the kingdom. <regarding Cinderella and the prince getting married> This information may be clinically useful for improving communication clarity, relevance, and focus for this individual with RHD who reported difficulty returning to work. Core lexicon analysis would be another way to evaluate the typicality of lexical items used by an individual with RHD compared with a normative sample (Dalton et al., 2020).

EVAL—This program, which has been described in several other publications, offers a way to get a composite summary of 32 discourse measures that can be used to make comparisons for a given individual or a group of individuals (Forbes et al., 2012; Fromm et al., 2020). The measures include total utterances, total words, total unique words, mean length of utterance (MLU), type–token ratio, words per minute, verbs per utterance, noun–verb ratio, % word errors, propositional idea density, number or percentage of various parts of speech (e.g., nouns, verbs, adjectives, adverbs, prepositions), and morphological features (e.g., plurals, third person singular, present progressives, past participles). To illustrate, we

ran this program to compare the Cinderella story told by minga27a, a 37-year-old woman, with the Cinderella stories told by AphasiaBank control participants using this command: `eval +t*par+d"control"+ g"Cinderella" minga27a.cind.cex`. Figure 2 shows a section of the spreadsheet output. The asterisks in columns C, D, and J indicate that minga27a was 1 *SD* above the control group on total utterances, MLU, and words per minute. This type of information could be useful in working with this woman on communication efficiency. The EVAL command could then be used to compare her own samples over time, or before and after treatment.

Global coherence analysis—People with RHD can have difficulty maintaining a topic (Myers, 1993), but there are few clinical measures to guide SLPs in their assessment and treatment planning in this regard. In fact, differentiating between typical and atypical discourse may not always be straightforward, and this distinction may be even more difficult in elderly groups (Mackenzie et al., 1999). In a study where SLPs subjectively rated discourse, many were unable to reliably differentiate between healthy adults and people with RHD (Blake, 2006), demonstrating the need for reliable, clinically applicable discourse measures from which diagnostic and descriptive inferences can be drawn.

Coherence is an aspect of discourse that reflects the speaker's ability to organize the narrative and maintain a unified theme (Glosser & Deser, 1990). More specifically, GC refers to the degree to which each utterance relates to the overarching topic and reflects the speaker's ability to maintain the topic (Glosser & Deser, 1990; Wright & Capilouto, 2012). Using the RHDBank database, GC was examined for the Cinderella storytelling and the peanut butter and jelly procedural tasks to compare the performance of adults with RHD versus people with aphasia and healthy controls (Cator et al., 2017; Johnson et al., 2019). Samples were scored using the 4-Point Global Coherence Rating Scale (GCRS; Wright et al., 2013), which has been shown to be a valid and reliable measure of GC in adults with and without aphasia.

The storytelling samples included all RHDBank participants (those with RHD and controls) who were available at that time (Cator et al., 2017). For the procedural discourse sample, all RHDBank participants were matched for age and education with participants from AphasiaBank and controls (from RHDBank or AphasiaBank) (Johnson et al., 2019). Participant characteristics are shown in Table 3.

Global coherence scores were added to the RHDBank transcripts using a designation of [+g#] at the end of each utterance, where the number indicated the score (1–4) according to the GCRS definitions (see Table 4 with example utterances; this coding scheme is also available at <http://aphasia.talkbank.org/discourse>). Establishing interrater reliability was challenging and required the GCRS scoring schema to be refined during multiple rounds of coding. This was partly due to the inherently subjective nature of some portions of the scale and partly due to the need to develop conventions to address some common coding challenges. For example, when scoring, the rater must decide whether a given utterance was essential to the narrative and whether it was related to the main topic. For our purposes, utterances that repeated essential but relevant information were scored as G3 because, upon repetition, they were no longer essential but still remained related to the main topic (e.g., “and they all

loved Cinderella,” [+ g4]; “everybody loved Cinderella,” [+ g3]). Conversely, if an utterance rated as essential to the story was later described in a more complete or accurate manner, it was coded as G4 (e.g., “but it was hard for her” [+ g3]; “the ... sisters made fun of her” [+ g4]). These conventions ultimately resulted in achieving an interrater reliability of 82.7% and 85.3% for the Cinderella storytelling and procedural discourse tasks, respectively.

Using the CLAN command *freq +s"<+ *>"+t*par+d2+re *.cha*, a spreadsheet with frequency counts was generated for each of the GC scores by group and percentages of total utterances with each score were calculated for each group (see Table 5). Group differences in GC between adults with RHD and controls for Cinderella storytelling approached significance ($p = .059$; Cator et al., 2017). For procedural discourse, there were significant differences ($p < .001$) in GC ratings between adults with RHD, people with aphasia, and controls (Johnson et al., 2019). In addition, the aphasia and RHD groups had significantly more G1 and G2 scores and significantly fewer G4 scores than the control participants, demonstrating that the neurogenically compromised groups produced fewer on-topic utterances. Interestingly, differences between participants with RHD and those with aphasia were not statistically significant. However, the qualitative differences between these two groups were notable and clearly evident, as discussed further later.

Main concept analysis—Main concept analysis measures how well a speaker states the essential, or most important, elements of a narrative and is considered to be a measure of informativeness at both macro- and microlinguistic levels (Dalton & Richardson, 2019). Nicholas and Brookshire (1995) analyzed Cookie Theft picture descriptions from participants without brain injury and identified seven MCs that were mentioned by at least 70% of their sample. This measure has been used to differentiate between controls and individuals with aphasia and between individuals with fluent and nonfluent aphasia (Kong et al., 2016). Similarly, Dalton and Richardson (2019) analyzed the Cinderella storytelling and the peanut butter and jelly procedural discourse tasks from AphasiaBank controls. Concepts that were mentioned by at least 33% of their sample were identified as MCs. This resulted in 34 MCs for the Cinderella task and 10 MCs for the procedural task (these data are available at: <https://aphasia.talkbank.org/discourse>).

The accuracy and completeness of each MC were evaluated for the Cinderella story (Cator et al., 2017) and the peanut butter and jelly procedural discourse samples (Johnson et al., 2019) using Nicholas and Brookshire’s (1995) MC process and Dalton and Richardson’s (2019) MC list. For each transcript, each concept was coded as “accurate and complete” (AC), “accurate/incomplete” (AI), “inaccurate/complete” (IC), “inaccurate/incomplete” (II), or “absent” (AB). A total MC score was then calculated using the formula: $MC = (3 \times AC) + (2 \times AI) + (2 \times XIC) + (1 \times II) + (0 \times AB)$ (Dalton & Richardson, 2019, p. 297). The maximum possible score for the storytelling task was 102; the maximum score for the procedural task was 30. Results of the MC analyses for these two tasks are shown in Table 6.

For the storytelling task, the mean score for the RHD group was lower than that of the controls, but the difference was not statistically significant. Given the relatively small sample sizes and the wide range of MC scores, further investigation with a larger sample size is warranted. For the procedural discourse comparison, the mean score of the control group

was significantly higher than the other two groups (aphasia and control) whose scores did not significantly differ from each other. Thus, both the aphasia group and the RHD group were less accurate and complete than controls in describing how to make a peanut butter and jelly sandwich but, presumably, for very different reasons.

Word retrieval can be a challenge for people with aphasia on this task, as was evident when the language samples were analyzed further. Participants with aphasia produced significantly fewer total words, nouns, and verbs than did the controls or the people with RHD. There was no significant difference between participants with RHD and controls on these measures. Rather, for those with RHD, the challenge involved staying on topic and inhibiting nonessential details. In fact, for one participant, 41.9% of his 41 utterances on the procedural task focused on his favorite type of peanut butter and where he purchased it, at the expense of describing the entire process. Another participant discussed an adaptive device he used to compensate for his left hemiparesis when making a sandwich. In some cases, these tangential comments distracted the participant from ever completing the discourse task. Indeed, one participant began discussing the benefits of eating elder-berries and never finished describing how he would make a sandwich. However, for others, such comments represented temporary detours, as they did eventually return to the topic of making a sandwich. It is also important to note that some participants with RHD produced concise, accurate narratives with few off-topic remarks, illustrating the known heterogeneity of communication capabilities in this population. In addition, some controls included a number of off-topic remarks. For instance, one control participant described his wife's peanut butter and jelly sandwich preferences in some detail. Further study and clear definitions of criteria for differentiating disordered from typical discourse are needed to distinguish and reliably diagnose the irregular discourse produced by some participants with RHD. These are examples of the type of research that RHDBank language samples can support moving forward.

Question-asking—Questions play an important pragmatic role in communication. They serve to elicit information as well as initiate and maintain conversation. They are also relatively easy to identify, which makes it clinically feasible to measure frequency and type of questions with a high level of reliability. On the RHDBank question production task (Unfamiliar Objects Task), participants with RHD used questions differently than those used by controls based on question type (Minga et al., 2020). Specifically, polar questions (questions that elicit a choice between two responses, e.g., yes/no) were used less frequently than content questions in this structured task. These results suggest that incomplete or insufficient integration of information from multiple sources may modulate the type of question asked. In terms of frequency of question use, Kennedy et al. (1994) observed that adults with RHD asked fewer questions during a “get-to-know-you” conversation than did controls. A forthcoming study examining question-asking during the First Encounter task (Minga et al., 2020) replicates and expands upon Kennedy et al. to further explore both the type and frequency of questions used to meet the task purpose.

Correlations across measures—It is likely that the most effective means of evaluating discourse requires a combination of measurements (Lê et al., 2011). For instance, when

rating GC, tangential comments receive low scores and therefore result in a higher proportion of G1, G2, and G3 scores. However, for the same sample, the MC score could still be high, as there is no decrement to the score if extra comments are added, as long as a sufficient number of MCs are mentioned accurately. Cator et al. (2017) found a significant correlation between RHD participants' MCs and on-topic utterances for the Cinderella story but not for the procedural discourse task. It may be that participants with disordered discourse who become derailed during the Cinderella storytelling have a more difficult time returning to the main thread of the story than they did in the procedural discourse task. These findings illustrate the utility of having access to multiple discourse genres to analyze a variety of discourse outcome measures.

In addition to allowing comparisons across discourse measures, the RHDBank protocol provides data for examining relationships between cognitive and communication tasks. As described in the Cummings (2019) discourse model, the role of theory of mind, visuospatial deficits, and EF impairments should be considered when examining the discourse production of individuals with RHD. Aspects of EF, including planning, organization, and the ability to inhibit irrelevant information, may affect a range of discourse measures. Cator et al. (2017) used the EF domain score from the CLQT to examine the potential effects of EF impairment on the ability to produce coherent, efficient, on-topic narratives. Results indicated large, significant correlations between CLQT-EF scores and both GC ($r = .78$ for percent utterances rated G4, $r = .82$ for percent utterances rated G3 or G4) and MC scores ($r = .77$), suggesting a relationship between EF and these types of macrolinguistic aspects of discourse production.

Teaching resources

Speech–language therapy graduate student clinicians may have minimal exposure to deficits associated with RHD compared with other groups with neurogenic communication disorders (Tompkins, 2016), and instructors often struggle to find good examples of RHD to use in classes. The growing collection of cases in RHDBank allowed for the development of two educational resources, Grand Rounds and Classroom Activities, designed to enhance knowledge about discourse in RHD.

Grand Rounds—RHDBank Grand Rounds is an educational platform that explains and illustrates the communication behaviors typically seen in individuals with RHD. First, there is a brief overview of these communication behaviors and some non-language-based deficits that may also be observed during discourse production. Then, three individuals from the RHDBank database are presented, each with a short case history, video samples from different discourse tasks in the protocol, and questions for discussion. The discussion questions that follow each video presentation focus on specific behaviors from the video. Some example questions are as follows:

What pragmatic deficits do you see in Miranda during this clip?

Did Phil's prosody sound impaired to you?

What aspects of Phil's story do you think were unusual?

Based on the excerpts from these two discourse tasks, would you have a basis for recommending speech–language therapy for Phil?

Most of the discussion questions have possible answers provided; however, “In your opinion” and “Case reflection” questions are posed for each case to stimulate further thought and independent evaluation of the salient discourse behaviors. The RHDBank Grand Rounds ends with research highlights on cognitive communication topics relevant to RHD discourse, such as memory, anosognosia, unilateral neglect, aprosodia, attention, and treatment. The highlights include brief summaries as well as links to key articles.

Classroom Activities—Classroom assignments specifically designed to explore a variety of RHD topics can be downloaded from RHDBank. Some assignments focus on clinical observation, assessment, treatment, and analyses of communication after RHD. Others focus on comparisons of discourse behaviors in RHD and aphasia, prompting students to compare the nature of the deficits, compensatory behaviors, word-level errors, pragmatic skills, topic maintenance, prosody, and other relevant features. Finally, several assignments focus on the application of discourse analysis techniques, such as computing correct information units (Nicholas & Brookshire, 1993), coding for GC and MC analysis, and using CLAN’s EVAL program to compare RHD discourse with that of a control participant. Each assignment is designed to provide empirical learning opportunities to foster a deeper understanding of discourse impairments after RHD. Instructors are encouraged to develop their own classroom activities and contribute them to this resource as well.

Additional resources

Nonprotocol corpora—The RHDBank website also includes contributions of language samples that do not make use of the full discourse protocol described earlier. For example, the Hopkins corpus has Cookie Theft picture descriptions from 42 RHD participants seen acutely and then at various time intervals thereafter. The PerLA corpus has 11 Spanish-speaking participants with RHD completing the Cookie Theft picture description, conversing, and telling a story. The Minga corpus includes an additional 29 participants with RHD and 21 neurologically healthy controls who completed the Unfamiliar Object Task of the RHDBank Discourse Protocol. Each set of language samples offers a different lens through which communication impairments after RHD can be observed and examined further.

Presentations and posters—Links to conference posters and presentations that have made use of RHDBank data are available at rhd.talkbank.org. In addition to providing people the opportunity to see information that they may have missed, these materials provide students with ideas for their own research projects using the database.

DISCUSSION AND CONCLUSION

Cognitive communication disorders after RHD are common and have long-term consequences for patients and their families (Hewetson & Cornwell, 2020; Hewetson et al., 2017), but specific communication deficits may not be assessed formally by SLPs (Ramsey & Blake, 2020). Strategic and structured inquiry of language production is warranted to aid

in increasing the understanding of CCDs after RHD. RHDBank is the first shared corpus of multimedia language samples designed to help meet the clinical, research, and educational needs in the field and to fill some of the gaps in our current knowledge.

Although we know that communication after RHD is impaired, we do not yet know the specific components of syntax, grammar, vocabulary, and discourse that contribute to the perception of tangential, egocentric, inefficient, and/or inappropriate discourse (Blake, 2006), nor have we begun to systematically measure extralinguistic aspects of communication (e.g., eye contact, facial expression, gestures) that may contribute to communication disorders in this population (Mackenzie & Brady, 2008; Mackenzie et al., 1997, 1999; Parola et al., 2016). Stronger research methods and a larger cohort of researchers exploring language production after RHD are needed to expand our understanding and move the field forward. RHDBank allows for the examination of language production characteristics across a variety of discourse genres using a consistent approach with a well-defined population. Researchers and students can collect data using the protocol or use existing RHDBank data to test theories and hypotheses as well as discover valid and reliable metrics for evaluation and treatment. Contributions of data from various institutions, clinics, and stroke centers can significantly increase the size, geographic, and cultural-linguistic representation of the shared database, while maintaining a high level of methodological consistency and transparency. The transcripts, in CHAT format, can be analyzed automatically using the many language analysis programs available in CLAN and results can be compared with other TalkBank databases (e.g., TBIBank, AphasiaBank). In addition, coding can be added to the transcripts to investigate any other relevant questions that are beyond the scope of automated morphosyntactic analysis (e.g., GC, question types). The availability of a variety of test scores reported in the database allows for a comprehensive picture of the participants and examination of the relationships between language and associated impairments.

In our examples, we analyzed language transcripts to show that in some areas adults with RHD perform differently than do controls and adults with aphasia. Global coherence findings suggest specific features of language production that contribute to difficulty with topic maintenance. Interestingly, MCs distinguished the RHD group from controls on the procedural discourse task but not storytelling. A host of factors may contribute to this difference including cognitive-linguistic impairments, genre complexity, response length, lexical content, and, of course, measurement choice. Specificity concerning aspects of language production that can be quantified is essential to understanding characteristics of discourse production and diagnostic processes. For example, combining MC analysis with targeted CLAN commands (e.g., EVAL, FREQ) may allow us to determine the specific lexical features that contribute to MC differences.

Beyond our examples, others have demonstrated the utility of using the procedural discourse task of RHDBank to gain insight into patterns of performance. For example, Cummings (2019) qualitatively examined seven RHDBank participants' procedural discourse samples and found a range of performance from essentially normal discourse to underinformative, overinformative, and tangential. Results showed that the majority of the RHD participants' descriptions were underinformative in terms of the steps in the process but overinformative

about tangential or even irrelevant content. The most consistent finding was that four participants (57.1%) exhibited egocentrism, contributing to overinformative, extended digressions.

Comparisons of language production characteristics across a variety of genres can illuminate communicative challenges that are task specific and that may aid in generating new hypotheses. For example, the finding that individuals with RHD used fewer polar questions than controls during a structured task led to the development of a conceptual framework about the cognitive-linguistic factors that could contribute to the observed behaviors (Minga et al., 2020). A subsequent study examining question-asking during conversation will test the hypothesized framework and add to our understanding of language use in this population. In this way, RHDBank has been used to test novel measures that may aid in distinguishing communication performance. Knowledge gained through such inquiry may serve as the foundation for new theories of pragmatic aspects of language production specific to RHD, which, in turn, can be the basis for the development of assessment and treatments that specifically target question types.

The teaching resources can help address the gaps in educational opportunities and clinical exposure at the undergraduate and graduate levels. Grand Rounds is a comprehensive educational tool that permits knowledge acquisition beyond what is available in existing textbooks. Enhancing educational opportunities can translate to improved familial, caregiver, and general public knowledge of the RHD communication deficit profile. Research productivity can be facilitated by the fact that there is no need to recruit or retain research participants, but rather students and researchers can use the data already collected to explore a variety of questions about discourse production or other aspects of communication. The increased research output, clinical exposure, and general knowledge can have a cascading effect on the quality of professional services available to individuals with RHD and, subsequently, on their quality of life poststroke.

Limitations

RHDBank is the first repository for communicative interactions of people with RHD. Although the tasks were selected on the basis of decades of work in language production and the current understanding of CCDs related to RHD, this area of the field is still in its infancy, particularly in terms of explanatory theories and models. There are tasks and assessments that might be useful that are not currently in the protocol but could be added. For example, since the development of RHDBank, more data have been published suggesting that aprosodia may be more prevalent than originally thought (e.g., Sheppard et al., 2020) and more prevalent than visuospatial neglect (Dara et al., 2014), indicating that a measure of prosody might be valuable. Similarly, theory of mind deficits have been reported in up to 70% of samples of acute (Schnur & Blake, 2020) and chronic stroke (Balaban et al., 2016), suggesting that this, too, would be a valuable addition to RHDBank. The Grand Rounds were developed on the basis of the state of the knowledge within the field. Some characteristics of the discourse productions (e.g., verbose, tangential) are not well defined, but this is again due to the paucity of measures available and the traditional reliance on clinical judgment. As more research is conducted and a greater understanding develops,

the RHDBank protocol can be modified and the Grand Rounds can be updated with more clinical examples and clearer behavioral definitions. The RHDBank resource, like the other TalkBank resources, is meant to expand and grow over time to address new and relevant educational, clinical, and research topics.

Future directions

RHDBank has the potential to foster foundational knowledge and interest that can propel the development of population-specific hypotheses, measures, and treatments to better serve adults with RHD, while educating future clinicians. To date, the number of explorations is small and limited to a few micro- and macrolinguistic variables. The knowledge to be gained through the use of RHDBank is limited only by the questions researchers ask. For example: What aspects of discourse production vary with cognitive abilities? How frequently does emotional aprosodia occur and how does it vary during structured and unstructured discourse in individuals with chronic RHD? To what extent does gesture production vary across discourse production genres? Do people with RHD produce figurative language or humor with the same frequency as adults without brain damage? In what ways do people with RHD participate in conversation (e.g., measured by the adapted Kagan Scales; Togher et al., 2010)?

As the database continues to grow, we hope that this resource will encourage a new generation of clinicians and researchers to thoughtfully consider what is essential to learn about communication after RHD. Such considerations are important to establishing sound theoretical underpinnings for communication impairments after RHD, which may, in turn, influence the development of procedures for the diagnosis and treatment of RHD CCD and positively impact the lives of patients and families.

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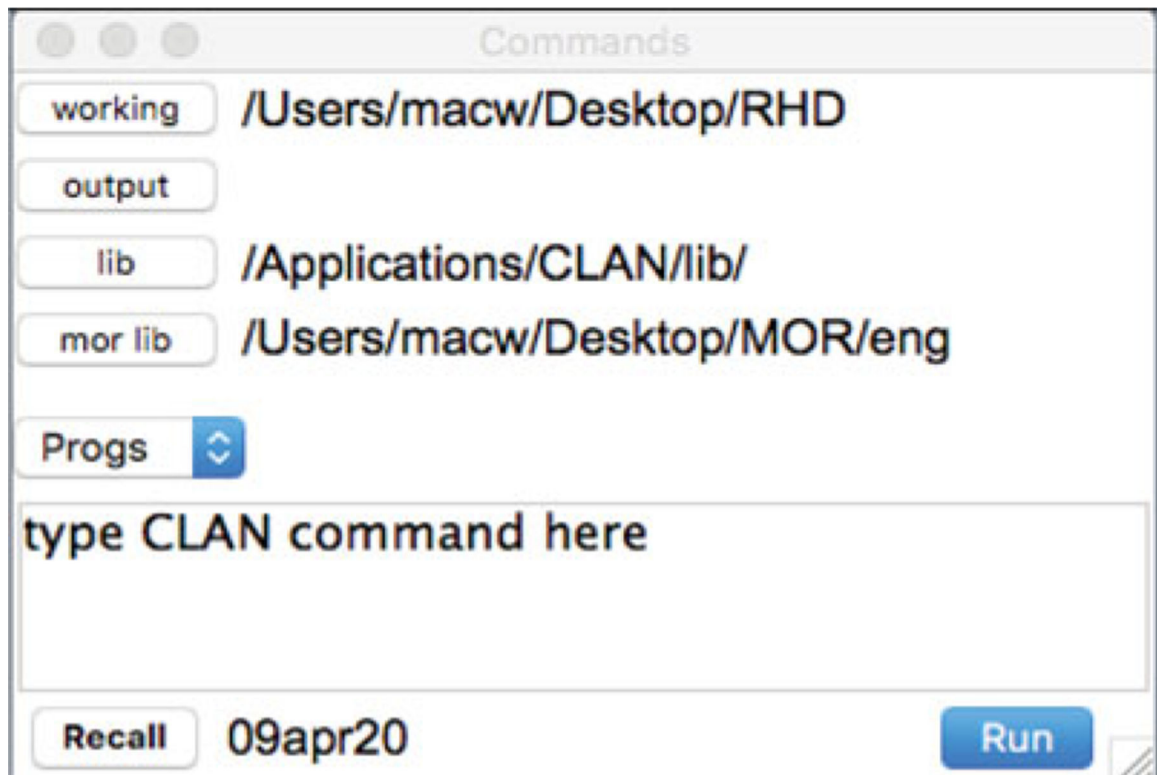


Figure 1.
CLAN commands window. RHD = right hemisphere brain damage.

	A	B	C	D	E	F	G	H	I	J
1	File_DB	Duration_(sec)	Total_Utts	MLU_Utts	MLU_Words	MLU_Morphemes	FREQ_types	FREQ_tokens	FREQ_TTR	Words_Min
2	minga27a.cind.cex	218	85	85	7.694	9.341	195	690	0.283	189.908
3	+/-SD	00:00:00.181	1.213	1.218	-0.984	-0.823	0.806	0.875	-0.991	1.777
4			*	*						*
5	Mean Database	00:03:17	46.073	45.98	9.888	11.476	147.861	450.408	0.374	136.751
6	Min Database	00:00:13	5	5	5.359	5.8	23	29	0.179	54.316
7	Max Database	00:11:28	248	247	19.95	22.955	340	1717	0.793	204.566
8	SD Database	00:01:52.659	32.098	32.024	2.23	2.593	58.499	273.845	0.092	29.922
9										
10										
11	+/- SD * = 1 SD, ** = 2 SD									
12	Database Gems:Cinderella									
13	Database keywords:control									
14	#_files_in_database:245									

Figure 2.
Example of CLAN spreadsheet output.

Table 1.

RHDBank demographic information

Age	Education Mean (Range), years	Time Post	Sex		Ethnicity Race		
			Female	Male	AA	WH	OTH
RHD 57 (31–82)	17.7 (12–30)	4.5 (0.2–13)	11	13	8	18	1
Control 47.4 (20–71)	16.2 (11–21)		18	6	7	17	

Note. AA = African American/Black; OTH = neither WH or AA; RHD = right hemisphere brain damage; WH = European American/White.

Table 2.

Mean scores of CLQT domains and communication participation by group

	Mean (SD)		WNL
	RHD (n = 24)	Controls (n = 24)	
Attention	163.3 (45.3)	197 (24.0)	180–215
Memory	159.4 (22.4)	168.1 (15.3)	155–185
Executive function	23.8 (7.3)	32.0 (4.1)	24–40
Language	31.1 (3.7)	33.4 (2.2)	29–37
Visuospatial	75.3 (18.8)	95.7 (7.5)	82–105

Note. CLQT = Cognitive Linguistic Quick Test; RHD = right hemisphere brain damage; WNL = within normal limit.

Table 3.

Participant characteristics for storytelling and procedural discourse samples

	RHD			Aphasia			Control		
	Storytelling	Procedural		Storytelling	Procedural		Storytelling	Procedural	
<i>N</i>	13	18			16		5	13	
Age, range (mean)	31.1–81.7 (61.6)	31.1–80.7 (57.0)			30.3–79.9 (55.8)		44.1–64.2 (53.5)	31.2–81.1 (55.4)	
Sex	4 F, 9 M	7 F, 11 M			7 F, 11 M		4 F, 1 M	6 F, 9 M	
Education range (mean)	13–24 (18.1)	13–30 (18.7)			12–20 (16.3)*		14–21 (17.0)	14–22 (16.4)*	
CLQT-EF domain (mean)	8–35 (23.9)								

Note. CLQT = Cognitive Linguistic Quick Test; EF = executive function; F = female; M = male; RHD = right hemisphere brain damage.

* $p < .05$.

Table 4.

Definitions and examples of global coherence codes

GC Code	Definition	Example From Storytelling Samples	Example From Procedural Samples
G1	Entirely unrelated to the stimulus or contained tangential information	"I had pretty much the same life to the point where I call my older sister my elderly ugly sister"	"So, I could go shopping at Whole Foods"
G2	Remotely related to the stimulus and may include egocentric or tangential information	"I'd call him a colonel in the army"	"Since I'm one-handed I like to slice diagonal pieces"
G3	Related to the stimulus but not essential	"I'm thinking the birds help"	"Put it on a paper towel on the counter"
G4	Contained main details and were overtly related to the stimulus	"She turned a pumpkin into a coach and some rats into a horse"	"Get two slices of bread and ajar of jelly and a jar of peanut butter"

Note. GC = global coherence. The GC codes and definitions are from "Evaluating Measures of Global Coherence Ability in Stories in Adults," by H. H. Wright, G. J. Capilouto, and A. Koutsoufas, 2013, *International Journal of Language & Communication Disorders*, 48(3), pp. 249-256 (<https://doi.org/10.1111/1460-6984.12000>). The storytelling and procedural discourse examples are from the RHDBank).

Table 5.

Percentage of global coherence scores for storytelling and procedural discourse

Task	RHD				Aphasia				Control			
	%G1	%G2	%G3	%G4	%G1	%G2	%G3	%G4	%G1	%G2	%G3	%G4
Storytelling	11.91	4.73	22.31	61.06					6.02	3.70	20.83	69.44
Procedural	9.74	25.64	22.56	42.05	7.89	28.68	22.79	44.12	1.16	16.86	22.67	59.30

Note. RHD = right hemisphere brain damage.

Table 6.

Main concept analysis of storytelling and procedural discourse

Task	RHD (<i>n</i> = 18)		Aphasia (<i>n</i> = 16)		Control (<i>n</i> = 13)	
	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)
Storytelling	10–80	43.4 (21.0)			39–82	54.8 (19.2)
Procedural	5–24	13.67* (6.4)	4–20	10.44** (4.8)	9–25	19.77 (4.7)

Note. RHD = right hemisphere brain damage.

* $p < .05$.

** $p < .001$ compared with the control group; comparison between the RHD and aphasia groups, $p = .213$ (NS). ANOVA: $F(2, 44) = 10.92$, $p = .001$.