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Coding Discourse Using Distributed Communicative Principles

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Honors Thesis

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Introduction

Current Knowledge of Aphasia

Aphasia is a disorder that impairs one's ability to produce and understand language. Typically, aphasia is acquired after experiencing a stroke but potentially after other types of acquired brain injury, like trauma or tumor resection. For people with aphasia (PWA), this difficulty affects every aspect of their daily life, considering communication is arguably one of life's most important skills. It is the key way in which we express our thoughts and emotions and relate to those of others. This ability to facilitate successful interpersonal interactions has been proven to improve PWA's sense of self-worth as well as their confidence in their ability to speak (Wray & Clark, 2017). For these reasons, improving conversational discourse is a particular area of interest in aphasia rehabilitation research.

Communication Partner Therapy, or CPT, is a type of treatment that focuses on training a specific and familiar communication partner (i.e. spouse, family member, etc.) techniques to optimize conversational discourse for PWA (Simmons-Mackie, Raymer, Armstrong, Holland, & Cherney, 2010). Some of these techniques include a request for clarification, a sense of flow, a topic shift, or the use of a nonverbal modality, such as drawing a picture, to assist in the communication process (Carlsson, Hartelius, & Saldert, 2014). While the use of these techniques may vary from individual to individual, most PWA have noted that they experience more difficulties with their speech if their communication partner (CP) lacks an understanding of aphasia in general, and specifically, of these techniques (Johansson, Carlsson, & Sonnander 2012). However, these techniques are typically administered in a clinical setting, rather than in the home. It is important to take the home environment into consideration when discussing CPT because it is the setting in which these learned techniques are put to practical use. Likewise, the

home environment is typically the place where the PWA is most comfortable, and perhaps, most likely to be where they would have their best conversations. This is based on the knowledge that the type of physical environment in which a conversation takes place has a strong influence on communicative success (Johansson et al., 2012). For these reasons, we theorize that the truest demonstration of language potential will be when the PWA is at home. In this study, we will see whether certain types of communicative methods (distributed communication principles as described by Hengst and colleagues (2019), contribute to what we perceive as a rich communicative environment within the context of the home. This is a first step in understanding what constitutes a rich communicative environment. In the future when we have a good grasp of these principles, we aim to make recommendations to PWA and their families on how to create that environment in their own homes if needed. In this way, we will improve what is happening in the home in an effort to maximize recovery.

Familiar Communication Partners

Recent studies have shown that conversational discourse is strongest when PWA are in familiar settings and, even more specifically, when they are speaking to familiar CP's (i.e. spouse, housemate, partner) (Wray et al., 2017). One study, by Johansson and colleagues (2012), addressed the success of language at home by interviewing eleven PWA and gathering information on how they handle communication difficulties in everyday situations, such as with different conversation partners and in different communicative environments. This study demonstrated that a sense of familiarity decreased the PWA's feelings of stress, embarrassment, and inferiority, thus making it easier to produce more successful language. They felt lonely when their CP did not take the time to understand them and felt discouraged when they would lose

interest. The PWA also felt ignored when they were left out of the decision-making processes that take place in conversations (i.e. which roles, like speaker and listener, they could play in the conversation, what they could contribute, etc.). Most unfamiliar CP's assumed the role as the main contributor, forcing the PWA to assume a more passive role. Moreover, the majority of the PWA highlighted the importance of speaking with someone who understood their language difficulties because they would consciously increase opportunities for the PWA's success. By adapting their own speaking habits to accommodate the PWA, the PWA felt like they could actually contribute to a conversation, rather than be dominated by it. They could openly and voluntarily express their viewpoint, elaborating on their experiences and areas of expertise. By the same token, when the CP spoke with a familiar PWA, they had a better understanding of what the PWA was trying to say and could assist them in a more effective way by adapting to their individualized communicative needs (Johansson, Carlsson, & Sonnander 2012). Following this logic, our study will be analyzing conversations between PWA and their spouses because, according to findings by Johansson, discussed above, analyzing this type of communication is likely to give us the most accurate depiction of the PWA's ability to communicate.

Rating Language at Home

Further, the home environment is an important setting to assess the quality of spoken language because it is where people spend the majority of their time, making them the most comfortable. It is also where they are with their spouse, whom they feel the most comfortable with. The study mentioned previously also concluded that unfamiliar environments hinder the success of most conversations (Johansson, Carlsson, & Sonnander 2012). Most PWA avoided conversations in settings that were crowded, noisy, and unfamiliar. Interestingly, the weather

also influenced the success of conversations, as colder weather made the PWA more tense and shut down more easily. For these reasons, this study suggested that future studies observe these conversations in everyday settings, like the home (Johansson, Carlsson, & Sonnander 2012). The home is the ideal setting to observe conversations for PWA because they have full control over each of these factors.

Assessing Language in the Home

One effective tool for the assessment of language at home is the LENA (Language ENvrionment Analysis) recording device. This technology has been used historically to analyze language development in children who may be experiencing developmental delays (Wang & Clark, 2017). The recorder comes with a software that analyzes the recorded conversations in terms of total word count, number of conversational turns, and instances of background noise or periods of silence. While this software can count words and conversational turns, it cannot assess intonation or nonverbal elements of a conversation, like gestures, which are important in the assessment of successful communication in PWA.

Rich Communicative Environment

A communicative environment is the setting in which communication is taking place (Hengst, Duff, & Jones 2019). This setting is very important because many social, cultural, emotional, and physical factors may influence the quality of the communication that occurs within it. Optimal communication is likely to occur in a “rich" communicative environment. It has been proposed that a rich communicative environment is defined as complex, dynamic, and provides opportunities for the participants to willingly and voluntarily participate (openness) by

supporting activities that are meaningful to them (Hengst et al., 2019). Hengst and colleagues provide a contrast by describing a limited communicative environment as one that is very structured, rigid, and eliminates a participant's freedom to decide how and what they contribute (Hengst et al., 2019).

Studies conducted on rodents in cages have proven that enriched environments, saturated with toys and other mechanisms for stimulation, have led to greater neurological outcomes than in rodents that resided in empty cages on the basis of increasing the number of synapses in neurons (Greenough & Volkmar, 1973). Following this logic, we theorize that enriching environments for PWA could promote neuroplasticity and serve as a potential treatment. Therefore, an area of interest in aphasia research is assessing what comprises a rich communicative environment, so that families can create this type of an environment in their own homes. This would optimize rehabilitation of individuals with aphasia, considering the home is where the techniques they learn are put to practical use.

Aims

In this study, we aim to investigate what constitutes a rich communicative environment by transcribing and consequently assessing conversations taking place in the home. We recorded two-days' worth of conversations for a) two participants with aphasia (PWA) and their spouses and b) two non-brain injured (NBI) participants and their spouses as comparison. The conversations with the highest word count were combined until a cumulative hour of conversation was reached. These conversations were then transcribed and rated in terms of the distributed communication principles of salience, flexibility, multiplicity, positivity, success, and flow as described by Hengst et al. (2019) in order to answer the following research questions: Do

each of these principles, as described, adequately measure the various aspects of the communicative environment?

1. Do high (positive) marks in each of the respective categories indicate an enriched communicative environment? Or, might we consider the communicative environment to be enriched despite lower (negative or neutral) marks in each category?
2. Are some more meaningful than others (i.e. is salience a critical aspect, for example, but not multiplicity) and if so, which do we consider most indicative of an enriched communicative environment and which the least.

Methods

Participants

The participants included two participants with aphasia (PWA) and two non-brain injured (NBI) participants. PWA were recruited from the aphasia groups at the University of Connecticut while the NBI participants were recruited from the local community. It was a requirement that all participants live with only one other adult at home and no longer be employed, so that the majority of the time recorded would be spent at home with a familiar partner. Eligibility was also determined by the absence of any contraindications to communication production and perception, such as Parkinson's, Alzheimer's, or significant and uncorrected hearing loss. Each participant gave informed consent before enrolling. A description of each participant is listed below in Table 1.

Table 1: Participant Demographics

Participant	Gender	Age	Education (years)
PWA01	Male	73	16
PWA02	Male	57	16
NBI01	Female	50	14
NBI02	Female	54	16

Data Processing and Transcription

Data Collection

Each of the eligible participants were given two Language ENvironment Analysis (LENA) digital language processors (DLPs) recording devices, one charger, a set of operating instructions, a lanyard and mesh bag in order to wear the DLPs. Participants were trained to use the devices and asked to record a minimum of ten hours per day for two days yielding approximately 20 hours of recorded audio data per participant. Participants were instructed to turn the DLP on upon waking, to wear it throughout the day, and to turn it off before bed. It was advised that the participant not pause the DLP throughout the day so as to avoid difficulties when resuming the audio collection; however, they were told that this was acceptable if there was a conversation they did not feel comfortable recording.

Data Preparation

The recorded data was uploaded onto the lab's PC where Lena's ADEX Processing Software was installed. ADEX was used to locate 30-second intervals in which adult word count was highest across the two days. These 30-second segments were exported into an Excel

document where each of the segments occupied a different cell of the file. The beginning of the recording for each segment was marked by a timestamp. This timestamp was provided in the format of seconds passed since the onset of recording. By entering this timestamp into a software called Transcriber, the specific audio segment that corresponds to this timestamp was retrieved. A research assistant listened to these audio recordings and typed out a transcript of the conversations, verbatim. The transcription started at the given timestamp and ended once the conversation came to its natural end, with no further utterances for twenty seconds, or when the topic of the conversation switched. The transcriber marked the beginning and the end of each conversation by indicating the timestamps in which transcription began and ended. This process was repeated until the cumulative hour of conversation was transcribed.

Determining Where to Start Analysis

The conversational segments that made up this cumulative hour were copied from their cells in Excel and pasted into a separate Word document, each cell separated by a horizontal line across the page. Please note this line only separates each conversational segment and does not indicate where to start analysis, as that is defined by each *conversation topic*. Conversation topics were defined as the broad subject that the participant is speaking about (i.e. food, clothes, home project, work, vacations, etc.). This is not to be confused with the micro-topic changes that may fall under these broader categories (i.e. talking about ordering Chinese food versus Italian food, buying clothes for school versus buying them for a vacation, painting the closet doors versus cleaning up the paint, etc.). These micro-changes would not be considered separate conversations, while conversation topic shifts would be. For example, if the participant was initially talking about a home improvement project, but then started talking about what he/she

wanted for dinner, this would be considered to be two separate conversation topics and would be rated for each of the distributed communication principles separately. However, if the participant was discussing redoing the floors in their home, then redoing the wallpaper, and then about moving the microwave, these would all be considered to fall under the same conversation topic (home improvement) and would be rated together. There was a clear distinction between the topic of each conversation analyzed; a simple continuation of a conversation was different than an entire conversation topic change.

Conversation topics do not depend on the length, but rather, on the content. So, even if a participant is talking to him/herself for one conversational turn, it would still be analyzed separately. Likewise, if a participant was discussing a home project and then started a new conversation topic like, "What do you want for lunch?" and "Chinese food sounds good", it would still be analyzed separately even though it is only two turns.

Analysis of Communication

Distributed Communication Principles

Using the transcripts in the Word document, the first author assessed each conversation topic for instances of the distributed communication principles as defined by Hengst and et al. (2019): salience, flexibility, multiplicity, positivity, success, and flow. Each of these principles were expanded upon to assist with inter-rater reliability. We also included positive, neutral, and negative definitions for each principle. Our definitions are as follows:

Salience:

- Positive: A personally meaningful activity that the participant is intrinsically motivated to participate in. It is based on the *context* of the conversation and takes

into consideration what is both relevant and important to the individual participant (*Note*: this may vary for each participant based on their areas of expertise and life experiences). Salience is present in a conversation when the participant demonstrates intricate knowledge of a specific topic, as proven by their enthusiasm, length of speech, or references to specific names/facts regarding these specific topics.

    - Example topics: Talking about their kids or pets, talking about home improvement if they have a history of working in this industry, talking about specific sports/TV/video games.
    - Example statements/questions: "I miss Johnny and the grandkids so much. When are we having them over?", "Did you see the big game on Saturday?! I couldn't believe it! What a great game!"

- Neutral: The conversation is not necessarily meaningful to the participant but is also not forced upon them.
    - Example topics: Talking about the weather, ordering food, trying to accomplish a task (i.e. using their email, talking to a cashier, etc.).
    - Example statements/questions: "What's the weather like today? Seems pretty cloudy outside", "I'll take a chicken parm sub with fries," "You have to open up your email."
- Negative: The participant is put in a situation where they are forced to accomplish a specific task. They are not intrinsically motivated to participate. It is based on the *context* of the conversation and is neither important nor relevant to the interests of the individual participant.

    - Example topics: Closed-ended questions where the participant is probed to answer in a very specific way, as if being quizzed.
    - Example statements/questions: “What’s a word that starts with the letter A? B? C? Etc.”, “What do we call this object”, “What’s the cat’s name?”

Flexibility:

- Positive: The use of a nonverbal modality to *assist* communication (i.e. pointing to an item in a magazine/newspaper/menu/etc., drawing a picture, writing thoughts down, or using a gesture because the participant cannot verbalize their desired thoughts). This is more than just talking about a topic that is outside of their direct environment, but rather, the action of using a physical reference to replace verbal communication.
    - Example topic: After receiving a menu and talking to a waitress at a restaurant, the participant asks, “do you have this?”, while pointing to the menu because they cannot communicate their item of choice at that time.
    - Example topic: If the participant uses a pen and paper to write/draw the idea that they cannot verbally communicate at the time.
    - Example statements/questions: “Look at this picture, what is this thing called?”, “I want this” *pointing to an item in a magazine*
- No neutral category for this principle
- Negative: A nonverbal modality is not used to assist communication, as the idea can be communicated verbally.
    - Example topic: After receiving a menu and talking to a waitress at a restaurant, the participant requests chicken and French fries, without pointing to anything.

- Example topic: If the participant can communicate their ideas verbally without using a pen and paper.
- Example statements/questions: “Look at this picture, how cool is that new iPhone?!”, “I really want a new bike.”, “I think this wallpaper would look better in the living room rather than the bathroom.”

Multiplicity:

- Positive: There are one or more communication partners in addition to the spouse.
  - Example topic: The participant and the spouse are at a restaurant talking to the waitress.
  - Example topic: The participant and the spouse are on speaker phone speaking to a relative.
  - Example topic: The participant and the spouse are having family or friends over to their house.
- No neutral category for this principle
- Negative: The spouse is the only communication partner.
  - Example topic: The participant and the spouse are at home with no one else present.

Positivity:

- Positive: The participant enjoys the conversation and has a positive attitude towards it. This is based on the content of the conversation.
  - Example topic: Any conversation that is immersive, fun, familiar, humorous, or contains exclamations in the transcription such as “wow” and “yay”.

    - Example statements/questions: “Wow! You know, I’d love to go get pizza right now, that sounds like a great idea!”, “Yay! The weather outside is absolutely gorgeous today!”, “Oh I really like that actor! He’s always doing something hysterical *haha*!”

- Neutral: The participant is not markedly excited or upset by the content of the conversation.
    - Example topic: Any conversation that is routine, familiar, mundane.
    - Example statements/questions: “I guess we could get pizza for dinner tonight.”, “Is it nice outside today?”, “That actor did a great job in the movie we watched.”
- Negative: The participant is clearly annoyed, upset, or frustrated by what they are talking about. This is based on the content of the conversation.
    - Example topic: Any conversation that contains frustration, sadness, or annoyance as marked by words such as “ugh”, “aw” or curses.
    - Example statements/questions: “Damn it! I can’t remember what I was saying!”, “Aw! I can’t believe she got into a car accident. I’m so worried about her.”, “Ugh. I am just so frustrated!”

Success:

- Positive: The participant is able communicate his/or her message clearly. The spouse/communication partner can confirm an understanding with “mhm”, “yes”, follow up questions, etc.
    - Example statement/questions: PWA: “Could you get me a snack?” Spouse: “Do you want cracker jacks or regular popcorn?” PWA: “Regular popcorn is good” Spouse: “Sure. And do you want a drink?” PWA: “Oh, that would be great!”

- Neutral: The participant is partially able to communicate his/her idea clearly. The rater is unsure of what the participant is trying to say but the spouse seems to know and to understand them better. The spouse assists in communication by asking clarifying questions.
    - Example statement/question: PWA: “Could I have a s-s-snack?” Spouse: “Do you want cracker jacks or regular popcorn?” PWA: “R-real-red-rej” Spouse: “You mean regular?” PWA: “Yes” Spouse: “Ok, I’ll bring that in. And do you want a drink?” PWA: “Mmm-eh-mm-s-s-so-so-sod” Spouse: “Okay a soda it is!”
    - Example statement/question: PWA: “I’ll have the chicken par-park” Spouse: “Do you want the chicken parmesan or the chicken wrap?” PWA: “Parm and a s-s-sauce” Spouse: “Soup?” PWA: “Right”
- Negative: The participant is unable to communicate his/her message clearly. The spouse explicitly states their inability to understand by asking them to repeat themselves or rephrase. The spouse could also give a genetic answer (“mhm”, “ok”, etc.) and move on without addressing what the participant was trying to say.
    - Example statement/question: Spouse: “Do you want cracker jacks or regular popcorn?” PWA: “R-real-red-rej” Spouse: “What? Say that again, I don’t know what you mean” PWA: “R-r-ref-rel” Spouse: “A what?” PWA: “Regul-regular” Spouse: “Okay”
    - Example statement/question: PWA: “Well I mean you gon' say eh-- ten o'clock last night would go, you know? So I-don-- so I don't you know. You know what I'm saying-- you know what I'm saying? ... Saying.” *No response from spouse*

Flow:

- Positive: The conversation has a clear back and forth where each remark builds upon the other partner's last statement. The conversation focuses on one topic at a time with minimal interruption. This assesses the participants ability to assume different communicative roles and to transition between them.
    - Example statement/questions: Spouse: “What should we have for dinner tonight?” PWA: “Hmm, pizza?” Spouse: “Oh great idea, that would hit the spot.” PWA: “Do you think we should get mozzarella sticks too?” Spouse: “Oh yes! I wonder if they have the ones with the basil on top” PWA: “Those are the best!”
    - Example statement/questions: PWA: “What do you want to watch tonight?” Spouse: “Why don’t we try the Hallmark Channel? I love their Christmas specials” PWA: “Me too! My favorite one is Christmas in London. It reminds me of our trip there”
- Neutral: The conversation is not clearly positive but is not necessarily negative for flow. Despite some interruptions, most of the questions that are asked are eventually answered. The spouse seems to follow what the participant is saying but the rater is rather confused. Meaning, the spouse can carry on the conversation despite an imperfect flow.
    - Example statement/questions: Spouse: “What should we have for din--” PWA: “Hmm, p-p-piece?” Spouse: “--tonight? Oh yeah, pizza would hit the spot. What about mozzarella--” PWA: “With pepperoni” Spouse: “--sticks. Oh okay.”
    - Example statements/questions: Spouse: “These photos are--” PWA: “C-r-rar-r-” Spouse: “Duplicates or triplicates” PWA: “Oh-no-a lot” Spouse: “Right, about where you said you portioned them and it's--” PWA: “Right. Yeah.” Spouse: “A bunch of pictures in a row”

- Negative: The conversation does not have a clear back and forth. Each remark does not build upon the last. This could also be when the participant is talking to themselves and the spouse does not reply back, or one of the participants disregards the other participants comment completely and changes topics.
    - Example statement/questions: Spouse: "What should we have for dinner tonight?" PWA: "Umm oh the pizza restaurant that's what--" Spouse: "Mm I don't want--" PWA: "We could--" Spouse: "My leg hurts"
    - Example statement/question: PWA: "Well if we want this-- then we have to--we just gotta" Spouse: "Nice weather outside today, huh?" PWA: "Oh."

Qualitative Analysis

Each of the principles (salience, flexibility, multiplicity, positivity, success, and flow) were considered for each conversation topic. Each conversation topic was then re-read and comments were put on the side of the document rating each principle as either positive, negative, or neutral, as described above. An example of a conversation topic is weather. If the PWA asked what the weather was like outside, and his/her spouse replied "It's been pretty chilly this morning but it's supposed to get warmer as the day goes on," and they replied stating they would wear a light jacket to the grocery store, the comments would read that this conversation topic was considered to be neutral for positivity because neither the participant nor the spouse was particularly excited. In the same way, it would be neutral for salience because weather is not intrinsically motivating for this participant. It would also be negative for multiplicity, as there are no other communication partners present, and negative for flexibility since they do not use a nonverbal modality to progress the conversation. Success and flow would also be positive.

Data Analysis

After this analysis, the total number of conversational turns was counted. Every instance of salience, flexibility, multiplicity, positivity, success, and flow was also tallied and the total number of instances for each principle was calculated (See Table 2 in the Results section). Totals were converted into a percentage by dividing the total number of instances into the total number of conversation topics analyzed and multiplied by 100. For example, if there were a total of 67 conversation topics analyzed, with 40 instances being positive for salience, 15 where it was neutral, and 12 where it was negative, that would indicate that 59.7% of the time salience was positive, 22.3% of the time it was neutral, and 17.9% of the time it was negative. This allowed for comparison between participants despite any differences in the number of conversation topics. Additionally, the total number of conversational turns were counted by the rater and put in the table as well.

Reliability

Intra- and inter-reliability were performed to ensure replicability of this coding system. Inter-reliability was performed for 50% of the transcripts and intra-reliability was performed for 25% of the transcripts. The first rater created the system and coded each principle within every conversation topic as either positive, neutral, or negative. The second rater was provided a written list of instructions which she was instructed to follow while rating. Reliability was determined by comparing the two transcripts and marking any instances where there were inconsistencies between ratings. All disagreements were resolved by discussion and the written instructions were revised accordingly. Reliability was calculated by dividing the total number of

agreements by the sum of agreements and disagreements. In this case, that would be six times the total number of conversation topics analyzed, since there are six total principles being measured.

Initially, there was 80.2% inter-rater reliability, so we added more examples to the definitions of each distributed communication principle to make them more clear. The raters continued to refine these principles until reliability between them was 97.5%. These revised definitions were then given to a third rater, who analyzed the transcripts solely based on these written instructions. Reliability with the third rater was 95.61% demonstrating that coding rules were clear and replicable, even to a naive rater.

Once all of the transcripts were analyzed, the original rater re-rated 25% of the uncoded transcripts to establish intra-reliability. This was reported as 95.5%.

Results

Distributed communication principles (salience, flexibility, multiplicity, positivity, success, and flow) were analyzed for each of the four participants. For each participant, one cumulative hour of conversation was analyzed. This hour is comprised of the longest, most substantive conversations across two days of recording. The first author rated each conversation to determine whether each principle was an example of a positive, negative, or neutral communication principle (see Table 2). These numbers were converted to a percent out of the total number of conversation topics analyzed to allow for comparison between participants. For three out of the four participants, salience was mostly neutral, but for PWA02 it was mostly negative. Flexibility and multiplicity were mostly negative for all participants. Positivity was mostly neutral for all participants. Success and flow were mostly positive for NBI and mostly neutral for PWA. Both PWA had a higher number of conversational turns than both NBI.

Table 2

Percentage of instances of distributed communication properties

Salience	NBI01	NBI02	PWA01	PWA02
Positive	31.3%	25.0%	31.7%	4.4%
Neutral	68.8%	75.0%	68.3%	26.7%
Negative	0.0%	0.0%	0.0%	68.9%
Flexibility	NBI01	NBI02	PWA01	PWA02
Positive	0.0%	0.0%	1.7%	2.2%
Negative	100.0%	100.0%	98.3%	97.8%
Multiplicity	NBI01	NBI02	PWA01	PWA02
Positive	40.6%	0.0%	5.0%	0.0%
Negative	59.4%	100.0%	95.0%	100%
Positivity	NBI01	NBI02	PWA01	PWA02
Positive	15.6%	4.7%	16.7%	2.2%
Neutral	75.0%	87.5%	81.6%	91.1%
Negative	9.4%	7.8%	1.7%	6.7%
Success	NBI01	NBI02	PWA01	PWA02
Positive	100.0%	98.4%	35.0%	2.0%
Neutral	0.0%	0.0%	50.0%	75.6%
Negative	0.0%	1.6%	15.0%	4.4%
Flow	NBI01	NBI02	PWA01	PWA02
Positive	93.8%	78.1%	25.0%	11.1%
Neutral	0.0%	0.0%	53.3%	84.5%
Negative	6.3%	21.9%	21.7%	4.4%
Topics Analyzed	NBI01	NBI02	PWA01	PWA02
	32	64	60	45
Conversational Turns	NBI01	NBI02	PWA01	PWA02
	564	401	732	842

Note: The percentages were calculated by dividing the number of instances for each distributed communication property by the total number of conversation topics analyzed. Total numbers of conversational turns and conversation topics are also reported for each participant.

Trends Across Distributed Communication Principles

Salience

NBI01, NBI02, and PWA01 displayed mostly neutral instances of salience (personally meaningful content). The instances of neutral salience for these participants ranged from 68.3% to 75.0%. However, the conversations for PWA02 differed considerably. 68.9% of PWA02's instances of salient topics were negative. Interestingly, PWA01 had the highest number of salient topics that were positive.

Flexibility and Multiplicity

For both PWA and NBI, the majority of the conversations analyzed were negative for flexibility (nonverbal modality to assist communication) and multiplicity (more than one communication partner) (see Table 2). Percents ranged from 95% to 100% in both of these categories, with the exception of NBI01. 59.4% of NBI01's topics were negative for multiplicity.

Positivity

Between both PWA and NBI, the majority of the conversations analyzed were neutral for positivity (enjoyment, positive attitude) (see Table 2), with scores ranging from 75.0% to 91.1% in this category. PWA01 had the most amount of positive interactions at 16.7% and the least amount of negative ones at 1.7% and. NBI01 had the highest number of negative instances at 9.4%. PWA02 had the lowest number of positive instances at 2.2%.

Success and Flow

Overall, both PWA mostly had neutral instances for success (ability to communicate message clearly) and flow (clear back and forth, each remark builds on the last) (see Table 2). The instances that were neutral for success ranged from 50% to 75.6%, and the instances that were neutral for flow ranged from 53.3% to 84.5%. PWA02 had the highest amount of neutral successes at 75.6% and PWA01 had the highest amount of negative successes at 15%. The conversations between the NBI differed considerably. These participants never had instances of neutral success and flow (see Table 2), and mostly had positive instances of these principles. This makes sense given the absence of a communication disorder. The positive success of NBI ranged from 98.4% to 100%. The positive flow for NBI ranged from 78.1% to 93.8%.

Conversation Topics and Turns

The number of conversational turns differed greatly between PWA and NBI. The number of conversational turns for NBI ranged from 401 to 564, while PWA ranged from 732 to 842.

Discussion

This study provided a unique perspective on communication in the home environment for people with aphasia and their spouses. To achieve this, we recorded the conversations of two PWA and two NBI for two days in their homes. After uploading and processing these recordings, we identified the conversations that had the highest word count and created a cumulative hour-long transcript. This transcript was analyzed in terms of the distributed communication principles: salience, flexibility, multiplicity, positivity, success, and flow in accordance with the work done by Hengst and colleagues (2019). We investigated each of these principles to determine which ones, if any, contributed to an enriched communicative environment. As

previously mentioned, a rich communicative environment has been defined as one that *provides opportunities for openness, or, for elaboration on topics that are meaningful to the participant and for the participant to adopt multiple communicative roles* (i.e. speaker and listener) *(Hengst et al., 2019).* In contrast, a *limited* communicative environment is defined as one that is very rigid and would reduce the number of opportunities for the participant to be open.

Research Question 1: Do high (positive) marks in each of the respective categories indicate an enriched communicative environment? Or, might we consider the communicative environment to be enriched despite lower (negative or neutral) marks in each category?

High (positive) marks in each category did not necessarily indicate a rich communicative environment in this study, and low (negative or neutral) marks did not necessarily indicate a limited environment. In fact, raters judged PWA01 as having the qualities of a rich environment as defined by Hengst et al. (2019) despite low (neutral) rankings for salience, positivity, success, and flow. This is due to the fact that he was provided with many opportunities for openness, allowing him to elaborate on topics that were significant to him, such as football and home improvement projects. Here, he was able to build on his areas of expertise, causing some of his longest and most successful conversations to center around these topics. In this way, he was not limited to one rigid pattern of participation; instead, he adopted multiple communicative roles, switching frequently between storyteller and listener. His spouse played a critical part in the success of these roles, because whenever he was misunderstood, she would usually ask him questions to clarify his meaning. For these reasons, the raters judged this environment as enriched despite lower (neutral) marks in most categories.

In contrast, PWA02 was part of what appeared to be a very limited environment and had mostly low (negative or neutral) marks in each category. For the entire hour of conversation that was analyzed, PWA02 was quizzed by his spouse. She asked him closed-ended questions, such as “what is the cat’s name?” and “where do I work?”, and did not move onto the next question until he got the right answer. This created an environment where success had one rigid definition, limiting his opportunities to achieve it and causing him to be very frustrated, leading to very low rankings for positivity. Additionally, this environment confined him to one communicative role, eliminating his voluntariness, or, his opportunity to make choices about how and when he would participate (Hengst et al., 2019). This also prevented him from being able to elaborate on his areas of expertise, causing him to score very low in the category for salience. In this case, raters perceived low marks for salience, success, and positivity as suggestive of a limited communicative environment. Clearly, the relationship between the level of each ranking and enrichment is dependent upon the context of each individual.

In terms of the number of conversational turns, a high ranking in this category did not necessarily indicate a rich communicative environment. This was surprising, considering the work done by Romeo (2018) that demonstrated that turn-taking was the most important indicator in determining enrichment in conversations between children and adults. A high number of conversational turns indicated more opportunities for the child to practice their language and to receive useful feedback from their adult communication partner (Romeo, 2018). In terms of our study, both of the PWAs had higher numbers of conversational turns than the two NBIs. Yet, PWA01 seemed to be a part of an enriched environment while PWA02 seemed to be a part of a more limited one. For PWA01, the frequent conversational turns offered him the ability to adopt many different roles in communication. However, for PWA02, the frequent conversational turns

were a reflection of his short and simple answers to very narrow, closed-ended questions. For that reason, the number of conversational turns was not necessarily indicative of their quality, which is, again, subjective to the context of the individual.

Research Question 2: Are some more meaningful than others (i.e., is salience a critical aspect to a rich communicative environment, for example, but not multiplicity) and if so, which do we consider most indicative of an enriched communicative environment and which the least.

This study has shown that some distributed communication principles are more meaningful than others. Salience appeared to be the most important in ensuring that the other distributed principles were accessed. High levels of salience indicated the experiential quality of the conversation was optimized since the topic of the conversation was personally meaningful to the participant. This encouraged them to make voluntary choices about how and when they participated and offered them the chance to adopt more than one communicative role. As such, more opportunities to achieve success, flow, and positivity were created. For example, when PWA01 talked about football and home improvement projects he was more successful and more positive. He also had more flow in his conversations, as his spouse was more engaged in the conversation and made a stronger effort to understand him, asking follow-up questions when necessary.

In contrast, PWA02 did not get to discuss topics that were relevant to his life experiences, which impeded his ability to adopt multiple communicative roles. This, combined with his environment being centered around right versus wrong answers, limited his ability to achieve success. Consequently, he had higher instances of frustration and did not get to use the principles of multiplicity and flow very often. Overall, PWA01 out-performed PWA02 in terms of

multiplicity, positivity, success, and flow. It is possible that this is due in some part to the reduced saliency of his conversations.

Success was another principle that ensured the other distributed communication principles were accessed. For both of the PWA, success was predominantly dependent upon the spouse's ability to understand what the PWA was trying to say, which was marked as neutral for this category. As such, the communication partner played a vital role in structuring the communicative environment and influenced the PWA's ability to access the principles of salience, flexibility, flow, multiplicity, and positivity. So, while we found that success does not automatically indicate enrichment, it is still an important principle to consider since it has a strong influence on all other principles. Similarly, positivity typically meant that the other distributed communication principles were accessed. PWA02 only had one instance of positivity, which was when he answered a question correctly and was proud of himself for achieving success on his own. Likewise, for PWA01, positivity typically indicated high marks of success, salience, flow, and occasionally, multiplicity and flexibility. Lastly, instances of flow demonstrated that each participant had a clear understanding of which communicative role they played and could effectively switch between them. This was typically related to success, and improved when the conversation was more salient, positive, and involved more participants.

In terms of the principles that were less indicative of a rich environment, neither of the NBIs used flexibility and each of the PWAs used it less than 2% of the time. Multiplicity also had very limited use among the participants. Although these principles were not used often, they did appear to be effective when they were used. The few instances of multiplicity and flexibility we assessed in PWA01 demonstrated increased instances of success and flow. This could be due to the fact that he was speaking with a waitress and had to answer short, closed-ended questions

about what food he wanted to order and could readily select it off of a menu, but we would need to explore this principle further in the future to gather more data. Table 3 is a summarization of the above information.

Table 3

Assessment of Distributed Communication Principles

Distributed Communication Principle	**How principle is thought to contribute to an enriched environment**	**Rater's Assessment** (I, U, ND)
Salience	Topics that are important to the speaker will give them the chance to demonstrate their intricate knowledge on the topic	I
Multiplicity	Talking to more partners challenges PWA to communicate effectively	ND
Flexibility	The use of multimodal resources suggests a more complex environment	ND
Positivity	Joy and immersion suggest enrichment	I
Success	If the participate can communicate his or her message clearly to the communicative partner	I
Flow	Clear back and forth indicates a high level of concentration on each topic and the ability to effectively switch communicative roles	I

Note: Rater- first author; I-important; U-unimportant; ND- not enough data to make a determination

Limitations of the coding system

This study offers new insight on what comprises a rich communicative environment but is limited in how the hour-long conversations for each participant were collected. The longest conversations across the two days of recordings were combined until sixty minutes of cumulative material was created for each participant. This could have contributed to the varying levels of

complexity for each participant. For example, PWA02 was quizzed by his spouse for the entire hour of conversation, which seemed to indicate that he lived in a limited communication environment. For someone so severe, these quizzing sessions may truly have been where he had the longest conversations, but shorter conversations may have proven to be more natural and salient. Going forward, we may attempt to analyze an hour of the conversations with the most conversational turns, rather than those with the highest word count. This would also eliminate the issue that some of the conversations that were suggested by LENA were only one to three conversational turns total. This short length made it difficult to analyze each of the distributed communication principles. For example, if a participant was speaking to him or herself, to his or her pets, or to the communication partner without receiving a response, the conversation was considered negative for flow due to the short length of the conversation. This limitation would be eliminated if there were a minimum number of conversational turns needed for the conversation to be considered.

Future Research

This study enlightened our perspective on the distributed communication principles proposed by Hengst and colleagues (2019) and the extent to which they contribute to a rich communicative environment. To improve this study, we could add a variable that would analyze the quality of each conversational turn, in addition to counting their quantity. By assessing the different communicative roles a participant adopts (i.e. storyteller vs. listener, asker vs. answerer), we can make stronger predictions about what type of communicative environment the participants are a part of (rich or limited). Based on the data in the present study, we predict that PWA02 would be an example of someone with a low score in this category because his spouse

dominated their conversations. She created a quiz-like environment, where she asked closed-ended questions and limited her partner's ability to be the storyteller or to ask questions of his own. Since she confined him to one communicative role (listener) throughout the entire conversation, he would get a very low score in this category. However, a participant like PWA01 would have a high score in this category because he frequently transitioned between the roles of storyteller and listener. He commonly elaborated on his areas of expertise and was asked follow-up questions by his wife when necessary. A high score in this category would indicate a healthy balance of communicative roles between PWA and their communication partners which would contribute to a rich communicative environment.

Moreover, in accordance with the discourse work done by Coelho (1998), we could add a variable to measure how well topics are managed, as a more specific way to measure flow (Coelho, 1998). Effective communication can be measured by how well an individual introduces new topics, changes topics without abrupt disturbances, and adds new/relevant information to an existing topic (Mentis, 1994). Therefore, we would want to create a rating scale that would judge the adequacy of responses in future studies. Using the data collected in the present study, we expect that this new measure would demonstrate that PWA01 and the NBIs come from rich communicative environments, while PWA02 comes from a more limited one. This is due to the fact that PWA02 never introduced new conversation topics nor did he provide new information to any existing topics, while the rest of the participants did. So, by assessing topic management, we could measure how much the PWA contributes to the conversation.

Additionally, we would aim to increase instances of multiplicity and flexibility in future studies. In terms of multiplicity, we noticed that people who live with just one other person are less likely to have instances of talking with more than one person. So, we would recommend that

all of the participants try to increase their number of interactions (i.e. inviting people over, calling someone on the phone, going out, etc.) to improve instances of multiplicity. Similarly, to improve instances of flexibility, the PWA should be provided with materials, such as white boards for writing down ideas or drawing pictures or a communication book to locate pictures of common items. In making these improvements we will have a better understanding of how flexibility and multiplicity influence communication in the home environment.

Clinical Implications

In this study, we demonstrated the critical importance of salience, success, flow, and positivity as indicators of environmental enrichment for PWA in the home environment. This suggests that education on how to implement these principles in the home environment should be an important topic of aphasia rehabilitation research. It was clear from reviewing these transcripts that salience is a key feature driving effective communication and that multiplicity and flexibility are areas that require emphasis as they may not happen without effort. If communication partners find ways to bring up topics they know to be of importance to the PWA, and provide them with materials, such as a white board or communication book, for example, then their environment could potentially become richer establishing the potential for better, more complete rehabilitation. This can be beneficial for the PWA, their communication partner, and even, people with communicative disorders other than aphasia.

Conclusions

This study was designed as a way to codify some of the distributed communication principles that have been proposed as constituting a rich communicative environment (Hengst et

al., 2019). Salience was found to be the most important principle in determining this, as it increased the participant's number of opportunities to switch communicative roles, to change the patterns of participation, and to elaborate on a topic that is significant to them (Hengst et al., 2019). Conversational turns were also proven to be influential but would be even more useful if we assessed their quality rather than their quantity by assessing what communication roles the participants adopt and how well they manage conversation topics. Listening to the transcripts, it became clear that while these may be qualities we strive for within a clinic setting and while these may be parameters important for better rehabilitation; they do not all necessarily constitute "communicative richness" at home. If we consider the empty rat cage compared to the enriched cage which inspired this line of thinking, we can see that the difference is perhaps simply stimulation. Other animals, toys, mazes, and exercise equipment provide the rat with choices and interaction. It's possible that an enriched communicative environment may be as simple as the number of quality interactions, which could be measured by assessing which communicative roles the participant adopts. A quality interaction may be as straightforward as being a human interaction (as opposed to computer, podcasts, television, or radio).

Moving forward, we would want to repeat this study, with the inclusion of the variable to assess the quality of each conversational turn, the variable to assess topic management, and suggestions on how to improve multiplicity and flexibility. Our goal is to determine how these variables are used with a larger sample. Eventually, this will allow SLPs to provide extensive education on how to incorporate all variables more in the home environment. In this way, we can improve current CPT techniques by focusing on these principles more closely as a way to improve outcomes for PWA, NBI, and their spouses.

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