Broca's vs. Wernicke's Aphasia: A Comparison of Enacted Communication Methods in Discourse Tasks

by

Alexis Danielle Mansour

A thesis submitted in partial fulfillment
of the requirements for the Master of Arts
degree in Speech Pathology and Audiology in the
Graduate College of
The University of Iowa

May 2022

Thesis Committee: Jean K. Gordon, Thesis Supervisor
Karen Bryant
Kristi Hendrickson
Si On Yoon

To Jeremy

ACKNOWLEDGMENTS

Thank you to my mentor, Dr. Gordon, for all your guidance and assistance during this project. Thank you to my committee members, Dr. Bryant, Dr. Hendrickson, and Dr. Yoon, for your helpful insights and suggestions. Thank you to Emma, Abby, and Kila for collaborating with me to develop the coding protocols and for all your help in coding the data. Thank you to my husband, Jeremy, for your endless support throughout this process.

ABSTRACT

Enactment refers to when an individual acts out a scene or event, through linguistic, paralinguistic, and/or nonlinguistic means, within discourse. Enactment may be either compensatory or facilitative for individuals with aphasia, as it often involves nonlinguistic and paralinguistic methods of communication that are still readily accessible to this population. The influence of nonfluent vs. fluent aphasia type (e.g., Broca's vs. Wernicke's aphasia) on the use of enactment has not been well investigated overall, and certain types of enactment have received limited attention within research. The specific aims of this project were to: 1) compare the types and frequencies of enactment methods used by individuals with Broca's aphasia and Wernicke's aphasia, 2) determine whether the type of discourse task influenced the use of each method in these two populations, and 3) compare the use of these methods to the severity of verbal deficits in both Broca's aphasia and Wernicke's aphasia. Three broad categories of enactment, including direct reported speech (e.g., "She said 'How are you?'"), sound effects (e.g., "boom"), and gesture (e.g., turning the hand as if unlocking something), were examined within three discourse tasks (picture description, story retell, and procedural narrative) for 20 individuals with Broca's aphasia and 20 individuals with Wernicke's aphasia who were matched in aphasia severity. Participants with Broca's aphasia produced a greater degree of enactment overall. Task was also found to influence enactment use, suggesting that some means of enactment may be more readily applicable to specific contexts. Furthermore, relationships between enactment and the severity of verbal deficits were revealed, indicating that use of enactment may potentially facilitate and/or compensate for verbal production abilities in individuals with aphasia. These findings are relevant to the field of speech-language pathology, as clinicians can encourage clients with aphasia to implement enactment in order to improve the effectiveness of their communication.

PUBLIC ABSTRACT

This thesis explores the use of enactment, when a person acts out a scene or event in conversation, in individuals with aphasia. Aphasia, a language disorder that most commonly results from stroke, can be classified as nonfluent or fluent based upon how continuously spoken language is produced. Broca's aphasia and Wernicke's aphasia are the most representative types of nonfluent and fluent aphasia, respectively. Enactment can help people with aphasia communicate, as it often involves nonverbal methods of communication that individuals with this disorder can readily produce. Three broad categories of enactment, including direct reported speech (e.g., "She said 'How are you?'"), sound effects (e.g., "boom"), and gesture (e.g., turning the hand as if unlocking something), were analyzed and compared within three conversational tasks for 20 individuals with Broca's aphasia and 20 individuals with Wernicke's aphasia. The two groups' use of these methods was also compared between the three tasks to determine if task type affected enactment use. Additionally, the relationship between enactment use and the severity of spoken language impairments was investigated. Participants with Broca's aphasia produced more enactment overall, and task was found to influence the types of enactment used. Furthermore, relationships between enactment and the severity of spoken language impairments were revealed, indicating that use of enactment may facilitate and/or compensate for spoken language production abilities. These findings are relevant to the field of speech-language pathology, as clinicians can encourage clients with aphasia to implement enactment in order to improve the effectiveness of their communication.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Aphasia, an acquired communication disorder that most commonly results from brain damage secondary to stroke, impacts an individual's ability to both produce and comprehend language (American Speech-Language-Hearing Association, n.d.). This disorder affects over 2.5 million people in North America, with approximately 180,000 new cases occurring per year in the United States alone (National Aphasia Association [NAA], n.d.-b; Simmons-Mackie, 2018). This condition limits a person's ability to express their thoughts, wants, and needs to family members, friends, medical professionals, and other individuals encountered within the community (NAA, n.d.-a). Lam and Wodchis (2010) investigated the effects of 60 diseases and 15 conditions, including aphasia, on over 66,000 long-term care residents in Ontario, Canada and found that aphasia had the greatest negative impact on health-related quality of life. As communication is vital to socializing and participating in many aspects of daily living, it is not surprising that aphasia can have substantial adverse effects on an individual's quality of life.

Aphasia is frequently classified into two broad categories based upon the dimension of fluency: nonfluent and fluent aphasia. The verbal output associated with nonfluent aphasia may be characterized by impaired articulation and prosody, grammatical deficits, and more sparse, effortful speech production overall. Individuals with fluent aphasia, in comparison, produce language continuously with relatively little disruption. However, while their verbal output often features a more typical rate and length, it is frequently error-filled. Several types of aphasia are traditionally classified as nonfluent, including Broca's aphasia, global aphasia, and transcortical motor aphasia, while fluent aphasias traditionally include Wernicke's aphasia, transcortical sensory aphasia, conduction aphasia, and anomic aphasia (Goodglass & Kaplan, 1983). Broca's aphasia and Wernicke's aphasia are perhaps the most well-known and prototypical types of nonfluent and fluent aphasia, respectively, likely due in part to their long-documented history in the field of aphasiology (Broca, 1861a, 1861b, 1861c; Wernicke, 1874) and the contrasting nature of the language deficits associated with each.

Broca's aphasia is typically associated with left hemisphere damage to the inferior frontal gyrus, particularly the lower portion of the premotor cortex known as Broca's area (Brookshire, 2015; NAA, n.d.-c). This aphasia syndrome usually results in atypically short utterances that consist of only a few content words, especially nouns. Additionally, articulation issues are common, and words are often produced with long pauses in between, which may further contribute to the perception of nonfluency. Since individuals with Broca's aphasia frequently omit grammatical function words (e.g., articles and prepositions) and inflectional morphology (e.g., the past tense *-ed* and plural *-s* suffixes in English), their speech is sometimes referred to as "agrammatic" (Bastiaanse & Thompson, 2012; Brookshire, 2015). Although Broca's aphasia is associated with impairments in language production, individuals with this aphasia type often have relatively preserved comprehension and are usually aware of their deficits (Brookshire, 2015).

Left hemisphere lesions to the temporal lobe, particularly to the posterior superior portion of this area (i.e., Wernicke's area), often result in Wernicke's aphasia (Brookshire, 2015; NAA, n.d.-d). In contrast to Broca's aphasia, Wernicke's aphasia is associated with speech production that is continuous and apparently effortless. In fact, people with Wernicke's aphasia may be excessively verbose, a trait which is sometimes described as "hyper-fluent" (Clough & Gordon, 2020). In addition, individuals with this aphasia type usually produce seemingly complete utterances with a typical range of intonation patterns. Despite the ease with which they produce verbal output, individuals with Wernicke's aphasia frequently produce word errors, including verbal paraphasias (i.e., word substitutions) and neologisms (i.e., nonwords) (Brookshire, 2015). Furthermore, individuals with Wernicke's aphasia may erroneously add or substitute inflectional morphemes (e.g., "He*'s* went to pick*s* the /dɪkɪz/." [Butterworth, 1994]), substitute function words for one another (e.g., "I'm fed up *to* it." [(Butterworth, 1994]), misuse content words as the wrong part of speech (e.g., "disasterized" [Klor, 1984]), and produce disordered syntactic constructions (e.g., "Isn't look very dear, is it?" [Butterworth, 1994]). Such deficit patterns have been referred to as "paragrammatism" (Butterworth, 1994). Wernicke's aphasia also commonly results in significantly impaired language comprehension, especially for those with more severe aphasia, and individuals with this aphasia type may also have poor recognition of their impairments, thus making little effort to repair their errors (Brookshire, 2015).

While the verbal language production of individuals with aphasia has perhaps been the most researched aspect of communication for this population, nonverbal communicative methods (e.g., drawing, gesture, communication boards) have also received considerable attention within the field of aphasiology. In aphasia research and treatment, the term "multimodal" is often used to describe nonverbal communication modalities that may either compensate for or facilitate verbal language abilities (Pierce et al., 2019).

Enactment is one discourse phenomenon that often involves multimodal communication. This term refers to when an individual acts out a scene or event, through linguistic, paralinguistic, and/or nonlinguistic means, that they wish to convey to their discourse partner. Examples of linguistic forms of enactment include direct reported speech (e.g., "She said, 'How are you?'") and onomatopoeias (e.g., "boom"), while examples of nonlinguistic forms include vocal imitation (e.g., using the speech mechanism to mimic the sound of a creaking door) and gesture (e.g., turning the hand as if unlocking something) (Groenewold & Armstrong, 2018;

Groenewold & Armstrong, 2019; Wilkinson et al., 2010). An example of paralinguistic enactment involves altering prosodic characteristics (e.g., pitch, intonation) in an instance of direct reported speech to represent the voice of an individual being quoted (Groenewold & Armstrong, 2019). Prior research has shown that, compared to neurotypical individuals, the use of various enactment methods is retained (Hengst et al., 2005; Ulatowska & Olness, 2003; Ulatowska et al., 2011; Wilkinson et al., 2010) or even increased (Berko Gleason et al., 1980; Groenewold & Armstrong, 2019; Groenewold et al., 2013) in individuals with aphasia. Enactment may serve as either a compensatory or facilitative strategy for individuals with aphasia, as it often involves nonlinguistic (e.g., gesture) and paralinguistic (e.g., prosody) methods of communication that are still readily accessible to this population (Groenewold & Armstrong, 2018; Groenewold & Armstrong, 2019).

The goal of this project was to compare and contrast the use of these various enactment methods in individuals with Broca's aphasia and Wernicke's aphasia, as this could reveal whether nonfluent vs. fluent aphasia type affects the use of enactment for communication purposes. As previously discussed, compared to people with Wernicke's aphasia, those with Broca's aphasia tend to produce more sparse and effortful verbal output, while also typically possessing better language comprehension and awareness of their verbal deficits. For these reasons, it seemed plausible that individuals with Broca's aphasia might implement means of enactment more frequently to compensate for and/or facilitate their verbal language production, thus increasing the effectiveness of their communication.

Each of the afore-mentioned enacted communication methods, including direct reported speech and accompanying prosodic changes, onomatopoeia and vocal imitation, as well as gesture, are discussed in more detail below.

Direct Reported Speech and Accompanying Prosodic Changes

Reported speech refers to when people either paraphrase or quote another individual or themselves within a narrative context (Hengst et al., 2005). Reported speech falls into two primary categories: direct and indirect. Direct reported speech involves citing the actual words of the speaker (e.g., “Joe said, ‘Yes, I will come.’” [Hengst et al., 2005]), whereas indirect reported speech paraphrases the speaker (e.g., “Joe said that he would come.” [Hengst et al., 2005]). While indirect reported speech involves describing the general content of a previous statement, direct reported speech entails re-enacting the specific utterance being cited (Hengst et al., 2005); direct reported speech thus belongs to the category of enactment. Both types of reported speech typically use framing clauses that precede the reported utterance, as in the prior examples (e.g., “Joe said...”). However, reported speech can also be framed through other contextually relevant means, such as by using gestural cues or by altering prosodic characteristics (e.g., pitch, intonation) to represent the voice of the reported speaker (Groenewold & Armstrong, 2019; Hengst et al., 2005). Reported speech frequently occurs in everyday communication and has been well studied in the field of sociolinguistics; despite this, relatively little research has been conducted to determine if and how individuals with aphasia utilize reported speech within discourse (Hengst et al., 2005; Ulatowska et al., 2011).

Berko Gleason et al. (1980) compared the verbal language production of five participants with Broca’s aphasia, five participants with Wernicke’s aphasia, and five neurotypical controls in picture description tasks. Individuals with Broca’s aphasia were found to produce more instances of direct reported speech, with a mean of 1.7 instances, compared to both the Wernicke’s aphasia group, who produced a mean of 0.17 instances, and the neurotypical group, who produced a mean of 0.33 instances. In order to identify reported speech in the utterances of individuals with aphasia, Hengst et al. (2005) analyzed conversations between four individuals with fluent aphasia and three individuals with nonfluent aphasia and their routine communication partners (e.g., spouses or caregivers) during everyday activities. The aphasia group averaged 21 episodes of reported speech overall, and the communication partner group averaged 36 episodes. While most individuals with aphasia produced fewer instances of reported speech overall compared to their neurotypical conversation partners, all seven participants with aphasia produced at least one instance. Furthermore, direct reported speech constituted the majority of reported speech episodes in all participants, with prosodic changes being frequently used to mark occurrences of direct reported speech. The effect of nonfluent vs. fluent aphasia type on reported speech use was not analyzed in this study. Ultimately, Hengst et al. (2005) concluded that individuals with aphasia are able to use reported speech in conversation to express complex communicative functions and achieve successful communication overall. Additionally, regarding the use of prosody to signify direct reported speech, Groenewold and Armstrong (2019) found that six individuals with aphasia of unspecified type implemented prosodic changes to enact a reported speaker in approximately 78% of direct reported speech instances, while neurotypical individuals altered the prosodic features of their speech in only around 55% of such instances. Ulatowska et al. (2011) also conducted research in this domain, examining the use of reported speech in 33 individuals with aphasia (aphasia type was not specified) during a narrative task. They found that the participants utilized direct reported speech more frequently than reported speech, concluding that the use of reported speech supported participants' narrative-telling abilities and pragmatic skills.

Sound Effects: Onomatopoeia and Vocal Imitation

While most words have an arbitrary relationship between the form of the word and its meaning, some involve a more direct relationship between these two factors. For example, the combination of speech sounds that comprise the word "cat" have no meaningful relation to the actual animal. In comparison, the speech sound sequence in the word "meow" literally represents the word's definition, the noise a cat produces, and thus has a meaningful, or iconic, relationship between the form of the word and its meaning (Meteyard et al., 2015). Iconic words, such as "meow," that acoustically resemble the sound to which they refer are termed onomatopoeias. The use of onomatopoeia in aphasia has received very little attention within research. A study by Meteyard et al. (2015) examined the performances of 13 individuals with different types of nonfluent and fluent aphasia in production and recognition tasks featuring both iconic and non-iconic words. The authors ultimately concluded that the iconic words conferred a greater word processing advantage overall for the participants, perhaps due to the more transparent connections between word meaning and form in the brain. No statistically significant differences in performance were found based upon aphasia type.

Vocal imitation, such as vocally mimicking the sound of shattering glass, involves using the speech mechanism to generate sounds, just as in oral language production. Vocal imitations are thus similar to onomatopoeias in that they can be used to depict a sound effect. However, while onomatopoeias are a form of language, vocal imitations are not, as there is not a conventionalized symbolic relationship between meaning and form as with words. Instead, vocal imitations are idiosyncratically produced in the moment. Neurotypical individuals can both effectively produce vocal imitations to convey environmental sounds (e.g., the sound of a car passing by [Lemaitre et al., 2016]) and can accurately understand and interpret the imitations produced by others (Lemaitre et al., 2016; Lemaitre & Rocchesso, 2014). However, this phenomenon has not been well studied overall, and, to our knowledge, no research has been conducted to specifically examine the use of vocal imitation by individuals with aphasia.

Gesture

Gesture, a form of nonverbal communication, refers to movement of parts of the body, such as the hands or head, to convey information. Gesture can often play an important role in communication, and humans utilize gesture when communicating across cultures and languages (Kita, 2009). According to Clough and Duff (2020), gestures can be broadly categorized as either representative, meaning that they convey meaningful semantic content, or as nonrepresentative, meaning that they do not. Representative gestures include deictic, iconic, and metaphoric gesture types, while beat gestures comprise nonrepresentative gestures. According to McNeill (1992), deictic gestures involve pointing to either a physical object within the environment (i.e., a concrete deictic gesture) or to an imagined referent in empty space (i.e., an abstract deictic gesture). Gestures that depict a concrete semantic concept are referred to as iconic gestures; gestures of this type can be further subdivided into iconic observer viewpoint (OVPT) gestures and iconic character viewpoint (CVPT) gestures. OVPT gestures depict a concrete action, event, or object as though the speaker is observing the entity from a third-person perspective (e.g., moving the index and middle fingers to represent the action of running), while CVPT gestures depict a concrete action, event, or object from a first-person perspective, as if the speaker were the entity itself (e.g., swinging the arms back and forth as if running). Metaphoric gestures are like iconic gestures in that they depict imagery; however, metaphoric gestures use a physical form to convey an abstract concept (e.g., motioning to the space behind the body to represent the past) rather than a concrete one. These gesture types are all idiosyncratic, as they are spontaneously generated by the speaker in the moment; however, another category of gesture, emblems, are more conventionalized, using a standardized form to portray a culturally specific meaning (e.g., giving a thumbs-up to indicate approval). Emblems are thus also representative in that they communicate meaning. Beat gestures, on the other hand, do not convey semantic meaning, but rather are body movements that are often synchronously produced with the rhythm of speech (McNeill, 1992).

While the use of gesture by individuals with aphasia has received limited study compared to neurotypical individuals (Clough & Duff, 2020), a variety of research on gesture use in individuals with aphasia has been conducted. Notably, differences in gesture production between individuals with nonfluent vs. fluent aphasia have been observed. Kong et al. (2017) found that, compared to those with fluent aphasia, people with nonfluent aphasia produced gestures at a significantly higher rate during discourse tasks. Furthermore, in a study by Sekine et al. (2013), participants with Broca's aphasia were found to generate gestures at double the rate of those with Wernicke's aphasia during a story retell task.

Distinctions in the functional use of gestures by individuals with different types of aphasia have also been recounted in the literature. Behrmann and Penn (1984) observed that individuals with nonfluent aphasia predominantly gestured to replace verbal language (i.e., for compensatory means), while those with fluent aphasia typically gestured to facilitate rather than substitute their verbal output. Sekine and Rose (2013) analyzed gesture use in 98 participants with fluent (Wernicke's, transcortical sensory, conduction, anomic) and nonfluent (Broca's, transcortical motor, global) types of aphasia as well as 64 neurotypical individuals. Overall, individuals with aphasia gestured significantly more than neurotypical controls, and aphasia type influenced gesture use. More specifically, the majority of participants with Broca's aphasia produced CVPT gestures, while most participants with Wernicke's aphasia used OVPT and metaphoric gestures. The authors concluded that individuals with Broca's aphasia tended to gesturally communicate through concrete images and detailed depictions of character actions, while those with Wernicke's aphasia typically portrayed events in a vague and/or abstract fashion via gesture.

Differences in gesture use based upon task type have also been borne out by prior research. Stark and Cofoid (2022) found that task type significantly influenced use of iconic gestures in a study featuring 75 participants with nonfluent or fluent aphasia. Participants produced significantly more gestures during a procedural discourse task that involved explaining how to make a peanut butter and jelly sandwich than during an expository discourse task that involved describing a picture. Differences between participants with fluent vs. nonfluent aphasia types were not analyzed.

A relationship between fluency and gesture use in aphasia was found by Sekine and Rose (2013), as well as by Stark and Cofoid (2022). In both studies, there was a negative relationship between gesture use and fluency; in other words, individuals who scored higher on fluency metrics tended to gesture less, while those who were deemed less fluent tended to gesture more. In both studies, all participants with aphasia were analyzed as one group, so potential differences in gesture production based upon aphasia type were not explored.

Present Study

While prior studies have demonstrated that individuals with aphasia use various types of enactment when communicating, there has been limited attention given to certain phenomena, such as use of sound effects (i.e., onomatopoeia and vocal imitation). Furthermore, the influence of aphasia type and fluency on the use of different enactment methods has not been well investigated overall. For example, to our knowledge, there has been either little or no research analyzing the use of sound effects and direct reported speech in relation to verbal production fluency. Furthermore, there have been few studies examining a wider range of enactment methods, with most studies focusing on just one type (e.g., gesture). Thus, in order to more broadly examine how individuals with nonfluent vs. fluent aphasia use enactment to communicate, discourse task productions were analyzed and compared for 20 individuals with Broca's aphasia and 20 individuals with Wernicke's aphasia who were matched in aphasia severity. Additionally, the two groups' use of these methods were compared between three different discourse task categories (picture description, story retell, and procedural narrative) to determine whether and how task type affected enactment use. Identifying and quantifying the use of these enacted communication methods, as well as the types of discourse to which they may be well-suited, will hopefully help to elucidate how people with Broca's aphasia in particular may overcome their often disfluent verbal output to successfully communicate with others. Ideally, this research will help clinicians to strategically capitalize on such accessible areas of communication within treatment in order to improve the overall communicative effectiveness and/or verbal production fluency of individuals with aphasia.

The specific research aims of this project were to: 1) compare the types and frequencies of enacted communication methods used by individuals with Broca's aphasia and Wernicke's aphasia, 2) determine whether the type of discourse task influenced the use of each method in these two populations, and 3) compare the use of these methods to the severity of verbal deficits in both Broca's aphasia and Wernicke's aphasia. Because individuals with Broca's aphasia typically have more awareness of their language deficits, it was hypothesized that this group would produce at least some of these enactment methods to a greater degree than those with

Wernicke's aphasia, as enactment can provide more readily accessible means of communication and can thus help to compensate for disfluencies in verbal production. For example, based on prior research, it was hypothesized that individuals with Broca's aphasia would utilize more CVPT gestures to clearly depict reported events, while those with Wernicke's aphasia would produce more OVPT and metaphoric gestures. For similar reasons, it was postulated that individuals with more severe verbal language impairments would implement enactment methods more frequently to improve their communicative effectiveness during discourse. We also theorized that certain types of enactment would be used more frequently within specific discourse tasks, hypothesizing that direct reported speech and accompanying prosodic changes would be used most in picture description tasks and/or the story retell task, as both included many characters that could be enacted. Regarding gesture use, it was expected that the story retell task and/or the procedural narrative task would feature the highest use of iconic CVPT and/or OVPT gestures, as both tasks involved many concrete actions, characters, and objects that could be depicted. Similarly, it seemed plausible that participants would use metaphoric gestures the most in the story retell task, as the narrative featured many abstract concepts that could be gesturally conveyed.

METHODS

Participants

Participants were chosen from AphasiaBank, an online password-protected database of protocol-based interactions between clinicians and individuals with aphasia (MacWhinney et al., 2011). A total of forty participants (20 with Broca's aphasia and 20 with Wernicke's aphasia) were selected from a pool of over 300 within the AphasiaBank database for inclusion in this study.

Twenty participants who were diagnosed with Wernicke's aphasia (the WA group) based on both their Western Aphasia Battery-Revised (WAB-R, Kertesz, 2006) classification, as well as based upon clinician judgment, were first selected. Twenty participants with Broca's aphasia (the BA group) were then matched to those with Wernicke's aphasia via one-to-one matching on the WAB-R Aphasia Quotient (AQ); participants with Wernicke's aphasia were each paired with a participant with Broca's aphasia whose score fell within three points of their own score. The WAB-R AQ score is a weighted composite of 10 WAB-R subtests and is considered a measure of overall aphasia severity (i.e., language impairment) (Kertesz, 2006). WAB-R AQ scores of participants were thus used as the primary basis for matching to control for aphasia severity for individuals with different aphasia types. In order to control as much as possible for differences in demographic variables between the two groups, the age, sex, and years of education of participants were also considered during the matching process.

The BA and WA groups did not differ significantly in WAB-R AQ ($p = .99$), years of education ($p = .35$), or sex, with 12 males and eight females in each group. However, the mean age of participants in the WA group (70.9 years of age) was higher than the mean age of participants in the BA group (64.7 years of age), with this age disparity approaching statistical significance ($p = .067$). Former research has demonstrated an association between older age and Wernicke's aphasia and younger age and Broca's aphasia (Ellis & Urban, 2016; Eslinger & Damasio, 1981), so the age disparity in the present study is not unprecedented.

In addition to the WAB-R AQ, other stroke variables included in this study were aphasia time post-onset (TPO) and WAB-R fluency scale scores. The WAB-R fluency scale is a rating scale that allows clinicians to qualitatively judge the fluency, grammatical competence, and degree of paraphasias in the verbal productions of individuals with aphasia. Scores range from 0 ("no words or short, meaningless utterances") to 10 ("sentences of normal length and complexity without definite slowing, halting, or paraphasias"), with scores of 0 to 4 being classified as nonfluent and scores of 5 to 10 being classified as fluent (Kertesz, 2006). The demographic variables and stroke variables of the 40 participants, divided into the BA group and the WA group, are displayed below in Tables 1 and 2.

Table 1. Demographic and Stroke Variables of Participants with Broca's Aphasia

Broca's Aphasia	**Age (years)**	**Sex**	**Years of Education**	**TPO**	**WAB-R AQ**	**WAB-R Fluency Scale**
Scale03a	52.8	M	12.0	2.7	28.1	2
Kansas16a	63.5	M	12.0	3.3	32.4	2
Kurland22a	80.0	M	8.0	0.7	35.7	1
Tap06a	72.8	M	20.0	4.3	38.2	2
Tap13a	49.3	F	16.0	4.7	44.4	4
Elman06a	76.9	F	16.0	1.9	45.5	4
Whiteside03a	76.5	F	12.0	4.0	47.2	2
Whiteside04a	65.4	M	12.0	22.7	50.0	4
UNH09a	65.9	M	13.0	4.1	50.8	2
Scale01a	78.3	M	18.0	25.8	52.5	4
Whiteside16a	46.8	F	12.0	NA	53.4	4
Adler13a	52.4	M	18.0	5.0	55.8	4
Tap17a	65.5	F	12.0	2.3	59.5	4
ACWT01a	69.9	F	18.0	11.8	63.9	2
Scale26a	58.8	M	16.0	11.3	64.8	4
Elman03a	55.2	M	20.0	11.0	66.2	4
Scale36a	55.2	M	15.0	3.2	66.3	4
Kurland19a	70.5	F	12.0	8.8	67.2	4
Williamson11a	64.8	F	16.0	5.3	68.0	4
Kurland02b	72.8	M	23.0	10.1	74.7	5
Mean	**64.7**	**(M: 60%)**	**15.1**	**7.5**	**53.2**	**3.3**
SD	**10.2**	**(F: 40%)**	**3.7**	**6.8**	**13.2**	**1.1**

Table 2. Demographic and Stroke Variables of Participants with Wernicke's Aphasia

Wernicke's Aphasia	Age (years)	Sex	Years of Education	TPO	WAB-R AQ	WAB-R Fluency Scale
Adler06a	70.6	M	12.0	4.9	30.2	7
Tucson03a	46.8	F	19.0	1.3	34.5	7
Williamson23	60.8	M	16.0	2.7	36.8	8
Kurland16a	70.0	M	12.0	0.3	37.1	7
Tucson15a	74.1	M	16.0	1.3	43.1	7
Kurland18a	74.3	M	16.0	4.7	44.0	6
Adler23a	81.3	M	NA	7.0	46.8	8
ACWT11a	61.7	M	16.0	2.2	49.9	6
Whiteside10a	68.3	M	16.0	3.0	52.0	8
Garrett01a	76.7	F	17.0	2.8	52.4	7
Kansas23a	75.6	F	12.0	0.8	54.7	8
Kurland01a	57.8	M	16.0	6.0	55.7	8
Williamson06	88.2	F	20.0	9.0	60.1	8
Scale38a	70.8	M	16.0	7.6	63.8	6
BU10a	75.8	M	18.0	4.3	65.1	6
Elman14a	76.3	F	17.0	4.7	65.7	8
Scale11a	90.7	F	12.0	1.1	65.9	7
Williamson16a	63.5	F	16.0	4.9	66.4	8
Kansas14a	77.4	F	17.0	0.7	67.4	8
Elman12a	57.4	M	20.0	3.5	74.4	8
Mean	**70.9**	**(M: 60%)**	**16.0**	**3.6**	**53.3**	**7.3**
SD	**10.6**	**(F: 40%)**	**2.5**	**2.5**	**12.8**	**0.8**

Discourse Samples

For this study, we analyzed the 40 participants' spontaneous speech samples in five different discourse tasks. These tasks are each described in detail below.

Participants produced discourse samples in three picture description tasks, titled Broken Window, Refused Umbrella, and Cat Rescue. For each picture description task, participants were shown a series of pictures or a single picture that featured black and white line drawings. Participants were asked to tell a story about the images with a beginning, a middle, and an end. For the Broken Window task, participants were shown a four-paneled picture that depicts the following sequence of events: a boy kicks a soccer ball, the soccer ball crashes through the window of a house, a startled man inside the house observes the soccer ball crash through the window and into a lamp, the man then looks out through the broken window. The Refused Umbrella task includes a six-paneled image that portrays the following sequence of events: a boy refuses an umbrella from a woman, leaves his home, gets caught in the rain, returns home soaking wet to the woman, and then ventures outside into the rain again with the umbrella. In the Cat Rescue task, a single picture depicts a cat stuck in a tree with a little girl reaching up toward the cat from the ground. A tricycle is next to her. A man is also stuck in the tree with a fallen ladder and a barking dog below him on the ground. Two firemen walk toward the tree carrying a ladder, with a firetruck in the background. A bird is also perched on a tree branch.

For the story retell task, known as the Cinderella Story task, participants were given a picture book featuring the story of Cinderella and were instructed to look through the book. Afterward, the book was taken away, and the participants were asked to retell the story in their own words. If they were unable to do so, they were allowed to view the picture book as they told the story; only one of the 40 participants included in this study (from the WA group) did so.

During the procedural narrative task, known as the Sandwich task, participants were instructed to explain how to make a peanut butter and jelly sandwich. If a participant experienced difficulty in verbally responding to this request, they were allowed to look at a picture with labelled photographs of peanut butter, bread, and jelly. The picture was used for 17 of the 40 participants (nine with Broca's aphasia and eight with Wernicke's aphasia) included in this study.

These five tasks were sorted into three discourse task categories for the purposes of the present study. The three picture description tasks were grouped together in one category, labeled Picture Description, as each of these tasks involved describing images. The second discourse task category, story retell, included the Cinderella Story task. Lastly, the procedural narrative task included the Sandwich task.

Coding

Transcripts for all the samples were available in AphasiaBank, segmented by utterance and coded for word-level and utterance-level errors, with some instances of enactment already identified with AphasiaBank codes in the transcripts. After the speech sample transcripts for each of the previously described discourse tasks were retrieved from the AphasiaBank database, they were converted into Microsoft Excel files, with each individual utterance on its own line. These transcripts were then revised to include only statements that were relevant to the specific discourse task. Thus, comments on the task itself (e.g., "I can't say it," "That's all") or responses to the clinician that did not contain any new information (e.g., "Okay," "I think so") were excluded from the Excel transcripts. Coding and analyses were then performed on these pared-down transcript files.

Core Utterances

The main message or proposition, known as the "core utterance," was then identified for each individual utterance in order to prevent extraneous material from contributing to the utterance length. Thus, repetitions of words and phrases that were not meaningful to the task, word and phrase errors that were subsequently repaired, and non-meaningful utterance-initial conjunctions (e.g., "and," "so," "but") were removed. AphasiaBank codes (e.g., the code [*n:uk] to mark neologisms with an unknown lexical target) were also excluded from the core utterances.

Direct Reported Speech and Accompanying Prosodic Changes

Most occurrences of direct reported speech were already coded in the AphasiaBank transcripts; however, sometimes identified instances of direct reported speech had not been marked as such in the data. In these cases, the utterances deemed to be direct reported speech were coded as such in the final transcripts. Additionally, the author of this thesis watched and listened to the video files for each transcript and coded whether participants changed the prosodic features of their speech to enact a character's voice when directly quoting them.

Sound Effects: Onomatopoeia, Vocal Imitation, and Singing

Some occurrences of onomatopoeia and vocal imitation, as well as singing, were already coded in the AphasiaBank transcripts. Additional instances of these phenomena that had not been previously marked in the transcripts were also identified and coded. Onomatopoeias (e.g., "boom", "ruff-ruff"), vocal imitations (e.g., mimicking the sound of a siren), and singing (e.g., vocally producing the melody of the Wedding March) that were relevant to the discourse task were all coded.

Gesture

As with direct reported speech and sound effects, some gestures were already coded within the AphasiaBank transcripts; however, a significant number of gestures were not. Thus, during the initial coding process, the author watched the video files of the discourse tasks for each of the participants and coded gestures that were determined to be meaningful and task relevant. Later, these gesture codes were reviewed and categorized. Previously identified gestures that were determined to be non-meaningful (i.e., beat gestures) were excluded in this step of coding, and meaningful gestures that had not been initially identified were coded. Gestures were classified into one of eight categories: concrete deictic, abstract deictic, iconic character viewpoint (CVPT), iconic observer viewpoint (OVPT), metaphoric, emblem, letter, and number. After identifying them, concrete deictic gestures were excluded in the analyses, as they were not a measure of interest; participants mostly pointed to images during the Picture Description task category. Different gesture types were sometimes carried out through the perspective of a character (e.g., giving a thumbs-up, an emblem, while enacting the fairy godmother in the Cinderella Story task). In such cases, the gesture was coded first as an iconic character viewpoint (CVPT) gesture and was also assigned a code to mark it as the other gesture type (e.g., an emblem).

The gesture classification system used in this study was modified from a protocol devised by Sekine and Rose (2013), with substantial influence from McNeill's classification system (1992). Detailed descriptions of the gesture categories are provided in Table 3.

Table 3. Gesture Types

Gesture Type	Definition	Reference
Concrete Deictic	Indicates an existing referent (e.g., a book) within the physical environment. Pointing is most often produced with an extended index finger, though can also be accomplished through other means, such as movement of the head or extension of a limb. *Example: pointing to a book in the vicinity of the speaker*	McNeill (1992)
Abstract Deictic	Involves pointing to an empty region in space and attributing referential value to it. *Example: pointing to an empty space and saying "shoe"*	McNeill (1992)
Iconic Character Viewpoint (CVPT)	Depicts a concrete action, event, or object as though the speaker is the entity itself (i.e., from a first-person perspective). *Example: swinging the arms back and forth as if running*	McNeill (1992)
Iconic Observer Viewpoint (OVPT)	Depicts a concrete action, event, or object as though the speaker is observing the entity from a third-person perspective. *Example: using the index and middle fingers to create a running motion*	McNeill (1992)
Metaphoric	Is pictorial like iconic gestures, but rather than a concrete concept, presents an image of an abstract concept (e.g., knowledge, time, language itself, the genre of the narrative). *Example: motioning to the space behind the body to represent the past*	McNeill (1992)
Emblem	Form and meaning that are established by the conventions of specific communities and that can usually be understood without speech. *Example: a thumbs-up to indicate approval*	Kendon (1980)
Letter	Movements associated with tracing letters in the air or on a surface with the fingers or hand. *Example: tracing the word "tree" on the surface of a table*	Cicone et al. (1979)
Number	Uses the speaker's fingers to count and/or display numbers. *Example: holding up three fingers to represent a quantity of three*	Cicone et al. (1979)

Reliability Analyses

A team of one graduate student (the author) and two undergraduate students completed coding for the core utterances, including identification of direct reported speech and sound effects. Each person coded the participants' transcript files on an individual basis and then met to compare results and resolve any coding discrepancies via consensus. The thesis advisor for this project then reviewed this coding for all participant transcripts to further ensure accuracy.

For the gesture classification coding, a trained undergraduate student was provided with 10 participants' transcript files that were randomly selected from the total pool of 40. These files contained the gesture codes identified by the author but not the classification codes (they were marked simply as #ges) so that the undergraduate coder could identify gesture type independently. The undergraduate also added and categorized any gestures that had not previously been coded and that she thought should be included; similarly, she also identified previously coded gestures that she thought should be omitted (e.g., a gesture that had been coded as a metaphoric gesture but that she identified as a beat gesture). Interrater agreement was first calculated by identifying the total number of agreements per utterance and then the total number of agreements by gesture code. The two raters agreed on the coding of 86% of the utterances and 80% of the individual gesture codes. The raters met to discuss any disagreements in coding. These discrepancies were resolved through consensus, and the 10 final transcript files containing the agreed-upon gesture codes, along with the other 30 files coded solely by the author, were used for the final analyses.

Statistical Analyses

The average numbers of words, utterances, and words per utterance produced in each of the three discourse task categories, as well as across task categories, were calculated for both the BA group and the WA group. These measures were analyzed in order to compare the degree of verbal productions between the groups both within and across task categories.

For analysis purposes, the codes for onomatopoeia, vocal imitation, and singing were collapsed into one category termed "sound effects," as the distinction between these three categories was sometimes blurred. For example, a participant may say "la-la-la," an onomatopoeia that represents singing, while vocally producing a melody. Furthermore, it was sometimes difficult to distinguish whether a sound effect was a vocal imitation or an onomatopoeia. A participant might obviously generate speech intended to represent the sound a dog makes; however, whether the production fit the conventionalized onomatopoeia "ruff-ruff" was difficult to decide at times, in part due to potential paraphasic and/or apraxic errors in speech production. As onomatopoeia, vocal imitation, and singing all served the same discourse function across tasks, to enact sounds within the reported environment, it was logical to group them into one category for the purposes of this study. Additionally, the letter and number gesture types were combined into one category, letter/number, for analysis purposes due to their similarity in depicting conventionalized symbols. Thus, there were nine individual categories of enactment included in the final analyses: direct reported speech, prosodic changes, sound effects, abstract deictic gestures, CVPT gestures, OVPT gestures, metaphoric gestures, emblem gestures, and letter/number gestures.

A main comparison of interest was use of overall enactment between the two groups; thus, the nine categories of enactment were combined and collectively analyzed across tasks to determine whether participants in the BA group vs. the WA group differed in their broad implementation of enactment within discourse. Additionally, in order to examine enactment use based upon modality, the nine enactment methods were organized into two larger categories depending upon whether they were performed via speech or gesture. The speech enactment category included direct reported speech, prosodic changes, and sound effects, and the gesture enactment category included the abstract deictic, CVPT, OVPT, metaphoric, emblem, and letter/number gesture types. When calculating the mean number of speech enactments and the mean number of overall enactments, as well as when calculating the mean number of speech enactments produced per utterance and the mean number of overall enactments produced per utterance, the prosodic changes measure was omitted. This was done to avoid duplicate results, as the prosodic changes method always co-occurred with direct reported speech when it was used within discourse.

One of the aims of this study was to compare the types and frequencies of different enactment methods used by individuals with Broca's aphasia and Wernicke's aphasia. Thus, in order to determine whether the BA group and WA group differed in their use of the nine enactment methods, the mean number of instances of each enactment method per utterance (e.g., the average number of OVPT gestures produced per utterance) was calculated for the participants within each of the three discourse task categories, as well as across task categories. The use of enactment in relation to utterance was meaningful for the purposes of this study, as it demonstrated the degree to which verbal productions involved means of enactment.

Two-way ANOVAs were conducted for the mean number of words, mean number of utterances, and mean number of words per utterance, as well as for each of the nine main outcome measures (i.e., the mean number of each enactment method produced per utterance). Each ANOVA included two factors: task category (three levels: Picture Description, Cinderella Story, and Sandwich task) and group (two levels: BA group and WA group). One of this project’s aims was to determine whether the type of discourse task influenced the use of enactment methods in these two populations, so these analyses were performed to detect potential interaction effects between group and task category for each measure, as well as to calculate potential main effects of group and task. In addition, t-tests were conducted to identify significant contrasts in case of a main effect of task (e.g., whether direct reported speech was used more in the Cinderella Story task vs. the Picture Description task category) or to identify a significant interaction between task category and group.

In order to detect potential relationships among variables, Pearson's correlations were calculated between the outcome measures (the mean number of words, mean number of utterances, mean number of words per utterance, and mean number of instances per utterance for each of the nine enactment methods) and the demographic (age and years of education) and stroke (TPO, WAB-R AQ, and WAB-R fluency scale score) variables. Another main aim of this project was to compare the use of enactment methods to the severity of verbal deficits. To explore this association specifically, correlations were calculated between participants' average number of enactment methods used per utterance and their WAB-R AQ scores, as this measure represents overall aphasia severity, including impairments in expressive language production. The WAB-R fluency scale was also used as a severity measure since it measures fluency, grammaticality, and word-level accuracy, which are all salient aspects of verbal production abilities. In addition to the outcome measure correlations, intercorrelations between the demographic and stroke variables were also calculated to uncover potential interactions and detect potential confounds.

RESULTS

Mean Numbers of Words, Utterances, and Words per Utterance

In each of the three discourse task categories, individuals in the WA group produced a higher mean number of words, mean number of utterances, and mean number of words per utterance compared to those in the BA group; these differences were all found to be statistically significant. These outcomes are not unexpected given the disparity in verbal production fluency that exists between these two aphasia types, as previously discussed. The results for these measures are displayed in Table 4 and are discussed in more detail below.

In each discourse task, the greatest disparity between the groups was in the number of words produced, as individuals in the WA group produced at least three times as many words on average compared to those in the BA group. Furthermore, in each task, participants in the WA group produced utterances that contained at least twice as many words compared to the utterances produced by the BA group. Though the mean number of utterances varied the least between the groups when compared to the other two measures, the WA group still produced around one and a half times more utterances than the BA group in all three task categories.

Table 4. Mean Number of Words, Mean Number of Utterances, and Mean Words Per Utterance for the BA Group and the WA Group in Each Task and Across Tasks

	Task	Mean Number of Words	Mean Number of Utterances	Mean Words per Utterance
BA Group	Picture Description	68.3	22.9	2.9
WA Group	Picture Description	235.0	36.3	6.3
BA Group	Cinderella Story	69.2	18.8	3.5
WA Group	Cinderella Story	221.0	33.6	7.1
BA Group	Sandwich	15.1	5.8	2.4
WA Group	Sandwich	48.9	9.3	5.3
BA Group	Total	152.5	47.4	3.1
WA Group	Total	504.8	79.2	6.4

ANOVAs revealed an interaction effect between task and group for the mean number of words, as well as main effects of group and/or task for the mean number of words, mean number of utterances, and mean number of words per utterance. These results are shown in Table 5 and are described below.

Two-way ANOVAs revealed a significant interaction effect between task and group ($p < .001$) for the mean number of words produced across task categories, indicating that the difference in the quantity of words used between the two groups was influenced by task category. Specifically, group differences were greater in the Picture Description and Cinderella Story tasks because vastly more words were produced overall in these tasks. There were also main effects of both group ($p < .001$) and task ($p < .001$) for this measure. As previously discussed, individuals in the WA group produced more words than those in the BA group (an average of 504.8 vs. 152.5 words, respectively) across task categories ($p < .001$). T-tests revealed that the task effect arose because of significant differences in the number of words between the Sandwich task and the Picture Description task ($p < .001$) and between the Sandwich task and the Cinderella Story task ($p < .001$).

Two-way ANOVAs did not reveal a statistically significant interaction effect between task and group for the mean number of utterances produced across task categories; however, there were main effects of both task ($p < .001$) and group ($p < .001$) for this measure. Across tasks, participants in the WA group produced a higher mean number of utterances (79.2) compared to the BA group (47.4) ($p < .001$). The task effect was accounted for by significant differences between the Sandwich task and the Picture Description task ($p < .001$) and between the Sandwich task and the Cinderella Story task ($p < .001$).

The average number of words per utterance did not show an interaction effect, though a main effect of group ($p < .001$) was detected, with participants in the WA group producing a mean of 6.4 words per utterance across tasks compared to a mean of 3.1 words per utterance in the BA group. A task effect was also found ($p < .001$), which was accounted for by significant differences between the Cinderella Story task and the Sandwich task.

Table 5. ANOVA Results for Mean Number of Utterances, Mean Number of Words, and Mean Words Per Utterance

Measure	Effect	Degrees of Freedom	Sum of Squares	Mean Square	F-Statistic	P-Value
Means Words	**Task**	2	361937	180969	25.92	<.001
	Group	1	413718	413718	59.26	<.001
	Task x Group Interaction	2	106161	53081	7.60	<.001
	Residuals	114	795860	6981		
Utterances	**Task**	2	11268	5634	32.38	<.001
	Group	1	3360	3360	19.31	<.001
	Task x Group Interaction	2	752	376	2.16	.120
	Residuals	114	19838	174		
Mean Words Per Utterance	**Task**	2	42.3	21.2	8.34	<.001
	Group	1	328.3	328.3	129.31	<.001
	Task x Group Interaction	2	2.9	1.5	0.58	.564
	Residuals	114	289.4	2.5		

Speech Enactments, Gesture Enactments, and Overall Enactments

Participants in the BA group and those in the WA group were similar in the average number of overall enactments, which included all nine individual enactment methods, produced across task categories, with a mean of 56.6 vs. 59.7 enactments, respectively. Across task categories, individuals in the BA group and WA group also produced similar numbers of speech enactments (direct reported speech, prosodic changes, and sound effects), with a mean of 15.8 vs. 12.6 speech enactments, respectively. Additionally, across task categories, the BA group and the WA group also produced similar numbers of gesture enactments (abstract deictic, CVPT, OVPT, metaphoric, emblem, and letter/number gesture types), with a mean of 40.8 vs. 47.1 gesture enactments, respectively. None of these differences reached statistical significance.

However, the difference in the mean number of overall enactments produced per utterance approached statistical significance (p = .067), with the BA group producing an average of 0.991 enactments per utterance and the WA group producing an average of 0.740 enactments per utterance. Additionally, individuals in the BA group used a mean of 0.259 speech enactments per utterance, while those in the WA group produced a mean of 0.142 per utterance; this disparity in use also approached statistical significance (p = .062). The difference in average gesture enactments per utterance between the BA group and WA group (a mean of 0.732 instances per utterance vs. 0.598 instances per utterance, respectively) did not approach statistical significance. These results are displayed below in Table 6.

Table 6. Mean Numbers of Speech Enactments, Gesture Enactments, and Overall Enactments

	Total Speech Enactments	**Total Gesture Enactments**	**Total Overall Enactments**	**Speech Enactments per Utterance**	**Gesture Enactments Per Utterance**	**Overall Enactments Per Utterance**
BA Group	15.8	40.8	56.6	0.259	0.732	0.991
WA Group	12.6	47.1	59.7	0.142	0.598	0.740
T-tests	.582	.553	.834	.062	.158	.067

Individual Enactment Methods

In the two-way ANOVAs, no statistically significant interactions between group and task category were found for any of the nine individual enactment methods (i.e., the average number of each method produced per utterance), indicating that the differences in the use of these measures between the two groups were not influenced by task category. However, main effects of group and/or task were found for the different enactment methods. The ANOVA results for each of these measures are described in detail below and are displayed in Tables 7–9. Figures 1 and 2 illustrate the group differences across tasks for each speech enactment method and each gesture enactment method. Figures 3–8 illustrate the group differences within each task category (Picture Description, Cinderella Story, and Sandwich task) for each speech enactment method and each gesture enactment method.

Speech Enactments: Direct Reported Speech, Prosodic Changes, and Sound Effects

Various main effects were found for the speech enactment measures. There was a main effect of task ($p < .001$), but not group, for the direct reported speech measure, though the group effect did approach statistical significance ($p = .090$). T-tests revealed a significant difference across groups in direct reported speech use between the Sandwich task and the Picture Description task ($p < .001$) as well as between the Sandwich task and the Cinderella Story task ($p < .001$). These results are not surprising; there were no instances of direct reported speech in the Sandwich task since there were no human characters to enact, unlike the Picture Description task and Cinderella Story task, which both included several human characters that could be enacted through direct quotation.

For the prosodic changes measure, main effects of both group ($p = .025$) and task ($p < .001$) were found. Individuals in the BA group used an average of 0.144 instances of prosodic changes per utterance compared to 0.077 instances per utterance in the WA group. As with direct reported speech, which prosodic changes always accompanied when they were used within discourse, significant differences between the Sandwich task and the Picture Description task ($p<.001$) as well as between the Sandwich task and the Cinderella Story task ($p = .001$) were revealed via t-tests for this measure. Again, the differences between the Sandwich task and the other two tasks are not unexpected; no instances of prosodic changes were used in the Sandwich task since there were no characters to enact.

A main effect of group ($p = .018$), but not task, was revealed for the sound effects measure. Individuals in the BA group produced a higher average of sound effects per utterance across tasks compared to the WA group: an average of 0.086 sound effects per utterance vs. 0.027 per utterance, respectively.

Gesture Enactments: Abstract Deictic, CVPT, OVPT, Metaphoric, Emblem, and Letter/Number Gesture Types

Differing main effects were also found for the various gesture types. There were main effects of task, but not group, for the abstract deictic ($p < .001$), OVPT ($p < .001$), metaphoric ($p < .001$), and letter/number ($p = .009$) gesture types. For the abstract deictic category, the task effect was due to statistically significant differences in use between all three task categories (Picture Description vs. Cinderella Story: $p < .001$, Picture Description vs. Sandwich task: $p = .007$, Cinderella Story vs. Sandwich task: $p = .010$). Analyses of the OVPT category revealed significant differences between the Picture Description and Cinderella Story tasks ($p < .001$) and between the Picture Description and Sandwich tasks ($p = .020$). For the metaphoric gesture type, the task effect arose due to significant differences between the Cinderella Story task and the Picture Description task ($p < .001$) as well as the Cinderella Story task and the Sandwich task ($p = .001$). The letter/number gesture category showed a significant difference in use only between the Picture Description task and the Cinderella Story task ($p = .005$).

For the CVPT gesture type, there were main effects of both group ($p = .014$) and task ($p < .001$). Participants in the BA group produced a mean of 0.339 instances of CVPT gestures per utterance compared to a mean of 0.174 instances per utterance in the WA group. The task effect for this measure was accounted for by statistically significant differences between the Sandwich task and the Picture Description task ($p < .001$) and between the Sandwich task and the Cinderella Story task ($p = .002$).

There were also main effects of both group ($p = .035$) and task ($p = .001$) for use of emblem gestures. Individuals in the BA group used an average of 0.039 emblem gestures per utterance across tasks, while the WA group used an average of 0.012 instances per utterance. The task effect arose because of statistically significant differences in emblem use between the Sandwich task and the Picture Description task ($p = .001$) and between the Sandwich task and the Cinderella Story task ($p = .007$). It should also be noted that the task by group interaction for emblem gestures approached statistical significance ($p = .051$). This nearly significant interaction effect resulted because there were group differences in the Picture Description task but not in the Cinderella Story task. Neither group used any emblem gestures in the Sandwich task.

Table 7. ANOVAs for Direct Reported Speech, Prosodic Changes, and Sound Effects

Measure	Effect	Degrees of Freedom	Sum of Squares	Mean Square	F-Statistic	P-Value
Direct Reported Speech						
	Task	2	0.638	0.319	14.50	<.001
	Group	1	0.064	0.064	2.93	.090
	Task x Group Interaction	2	0.032	0.016	0.73	.482
	Residuals	114	2.507	0.022		
Prosodic Changes						
	Task	2	0.376	0.188	11.53	<.001
	Group	1	0.084	0.084	5.17	.025
	Task x Group Interaction	2	0.043	0.021	1.31	.273
	Residuals	114	1.86	0.016		
Sound Effects						
	Task	2	0.005	0.003	0.20	.820
	Group	1	0.079	0.079	5.78	.018
	Task x Group Interaction	2	0.021	0.011	0.77	.466
	Residuals	114	1.559	0.014		

Table 8. ANOVAs for Abstract Deictic, CVPT, and OVPT Gesture Types

Measure	Effect	Degrees of Freedom	Sum of Squares	Mean Square	F-Statistic	P-Value
Abstract Deictic						
	Task	2	0.892	0.446	14.89	<.001
	Group	1	0	0	0	.958
	Task x Group Interaction	2	0	0	0	.997
	Residuals	114	3.415	0.03		
CVPT						
	Task	2	1.919	0.96	11.19	<.001
	Group	1	0.54	0.54	6.30	.014
	Task x Group Interaction	2	0.16	0.08	0.94	.395
	Residuals	114	9.778	0.086		
OVPT						
	Task	2	0.809	0.405	7.83	<.001
	Group	1	0.015	0.015	0.29	.589
	Task x Group Interaction	2	0.03	0.015	0.29	.751
	Residuals	114	5.896	0.052		

Table 9. ANOVAs for Metaphoric, Emblem, and Letter/Number Gesture Types

Measure	Effect	Degrees of Freedom	Sum of Squares	Mean Square	F-Statistic	P-Value
Metaphoric						
	Task	2	0.17	0.085	10.73	<.001
	Group	1	0	0	0.01	.935
	Task x Group Interaction	2	0.007	0.004	0.46	.631
	Residuals	114	0.902	0.008		
Emblem						
	Task	2	0.024	0.012	7.15	.001
	Group	1	0.008	0.008	4.57	.035
	Task x Group Interaction	2	0.01	0.005	3.06	.051
	Residuals	114	0.188	0.002		
Letter/Number						
	Task	2	0.039	0.019	4.91	.009
	Group	1	0.004	0.004	1.10	.297
	Task x Group Interaction	2	0.008	0.004	0.98	.380
	Residuals	114	0.449	0.004		

Figure 1. Across-task Group Differences for Each Speech Enactment Measure

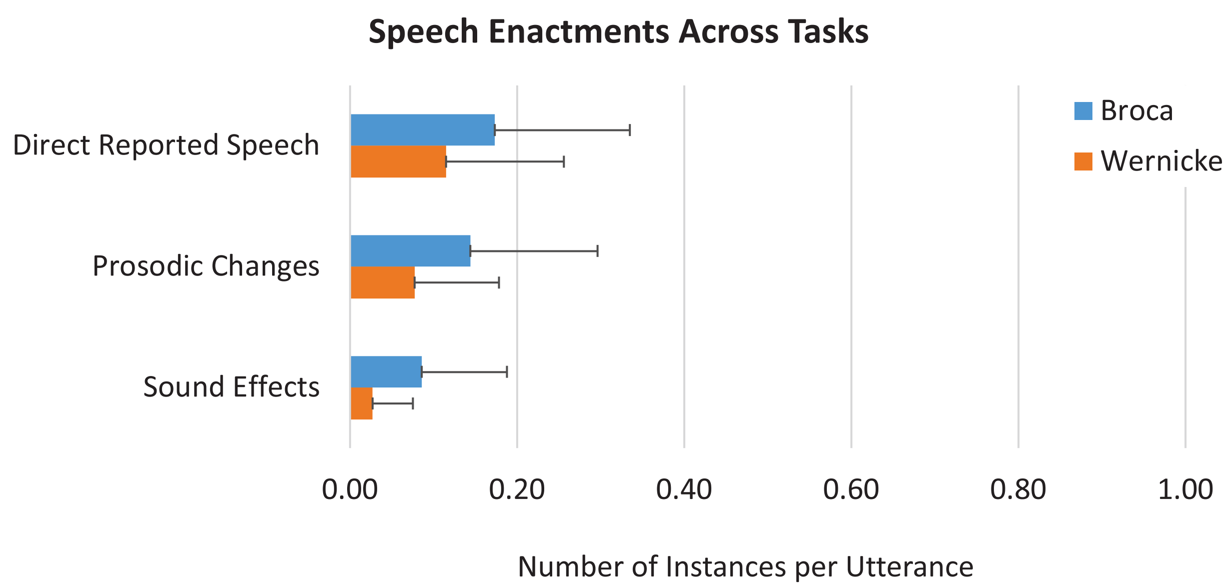


Figure 2. Across-task Group Differences for Each Gesture Enactment Measure

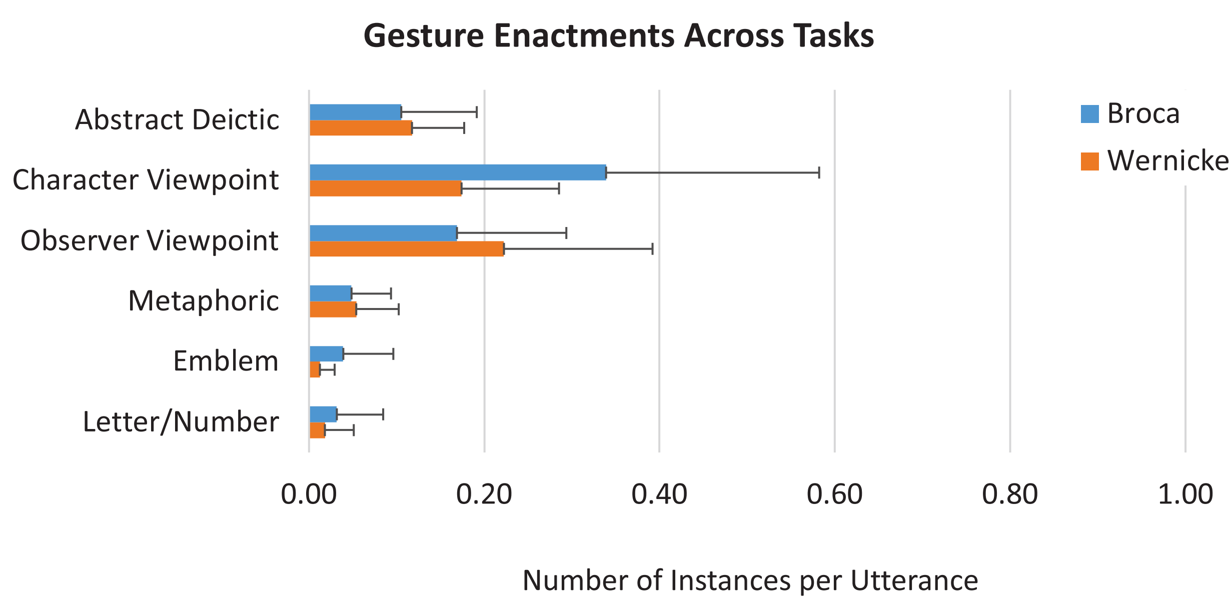


Figure 3. Group Differences in Each Speech Enactment Measure in the Picture Description Task

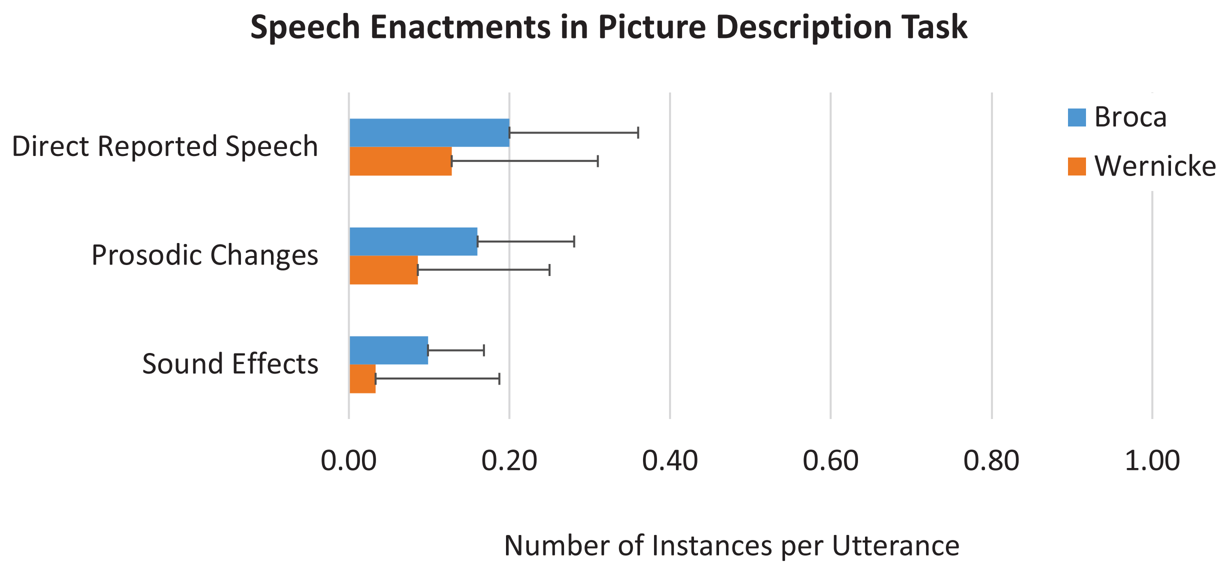


Figure 4. Group Differences in Each Speech Enactment Measure in the Cinderella Story Task

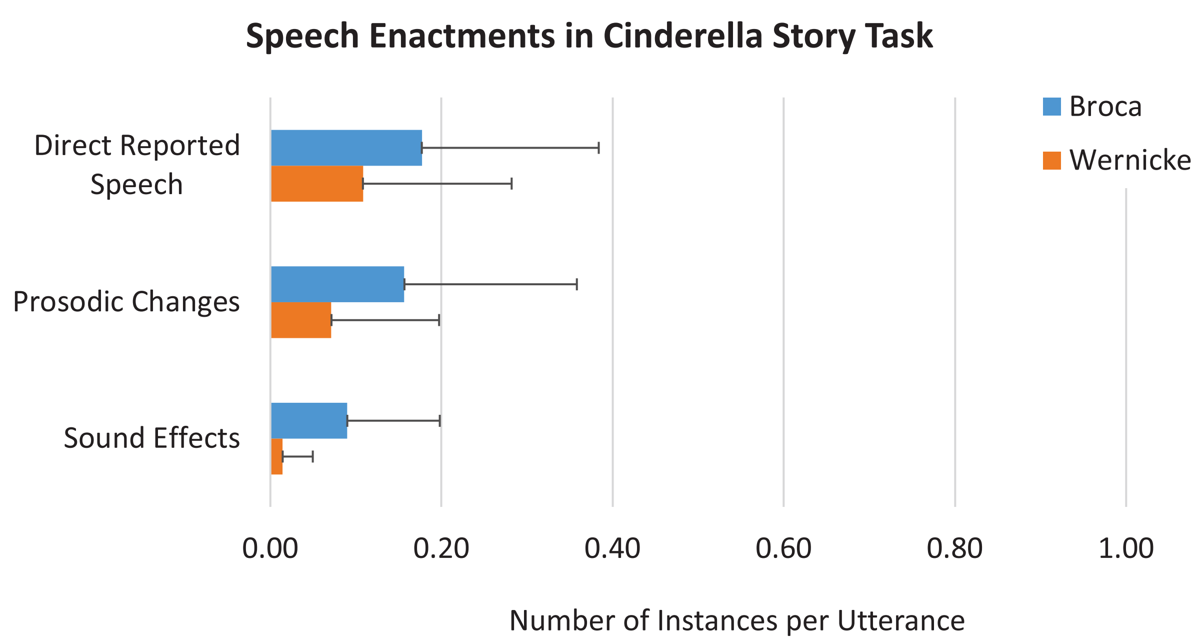


Figure 5. Group Differences in Each Speech Enactment Measure in the Sandwich Task

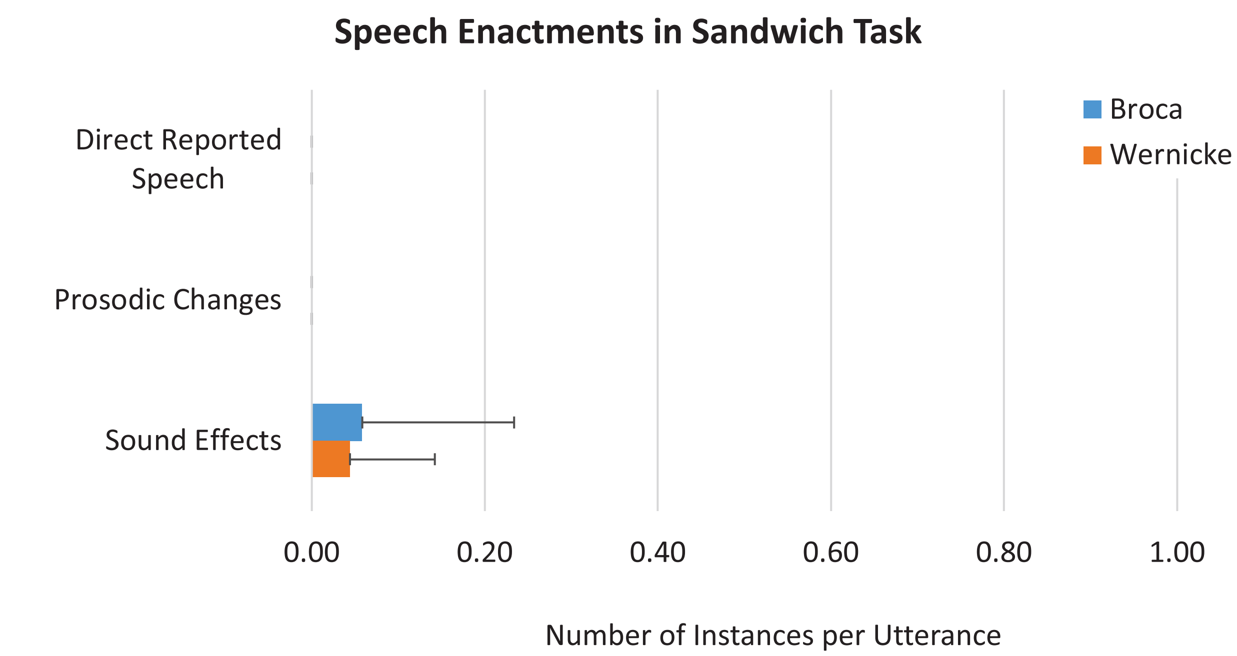


Figure 6. Group Differences in Each Gesture Enactment Measure in the Picture Description Task

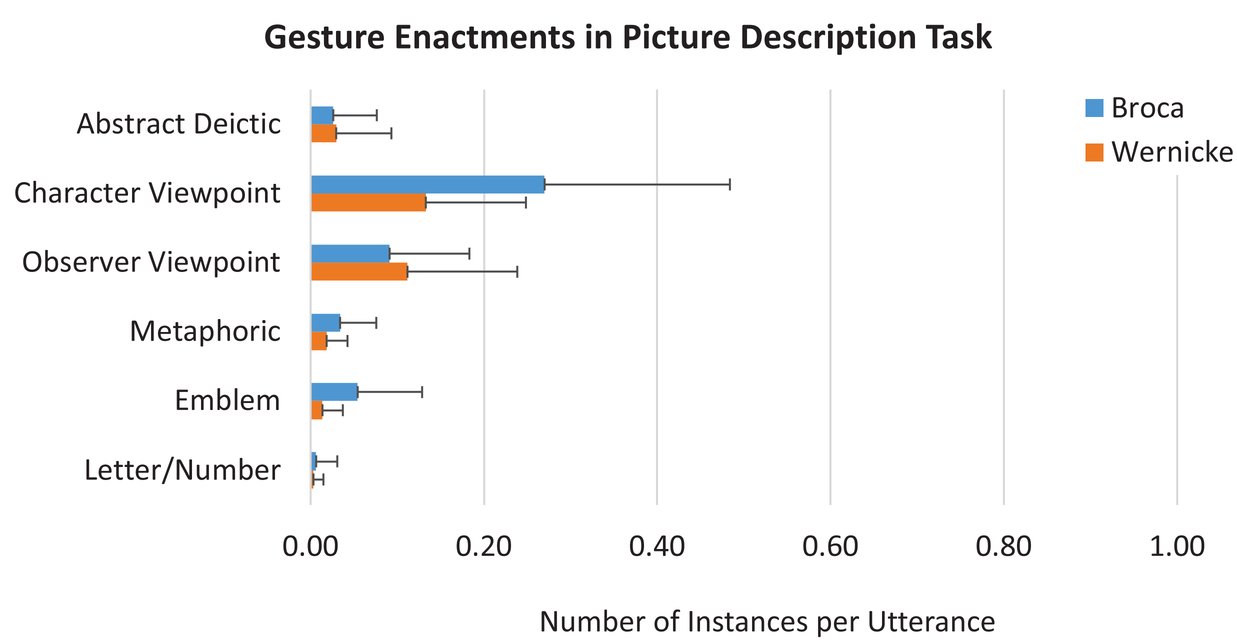


Figure 7. Group Differences in Each Gesture Enactment Measure in the Cinderella Story Task

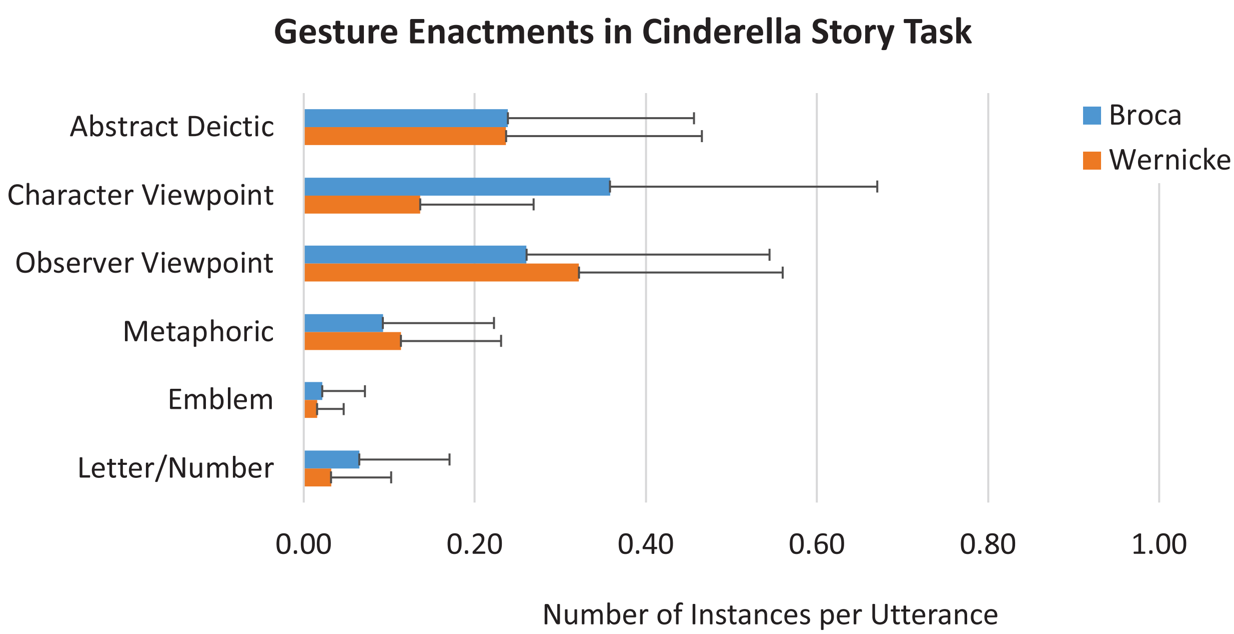
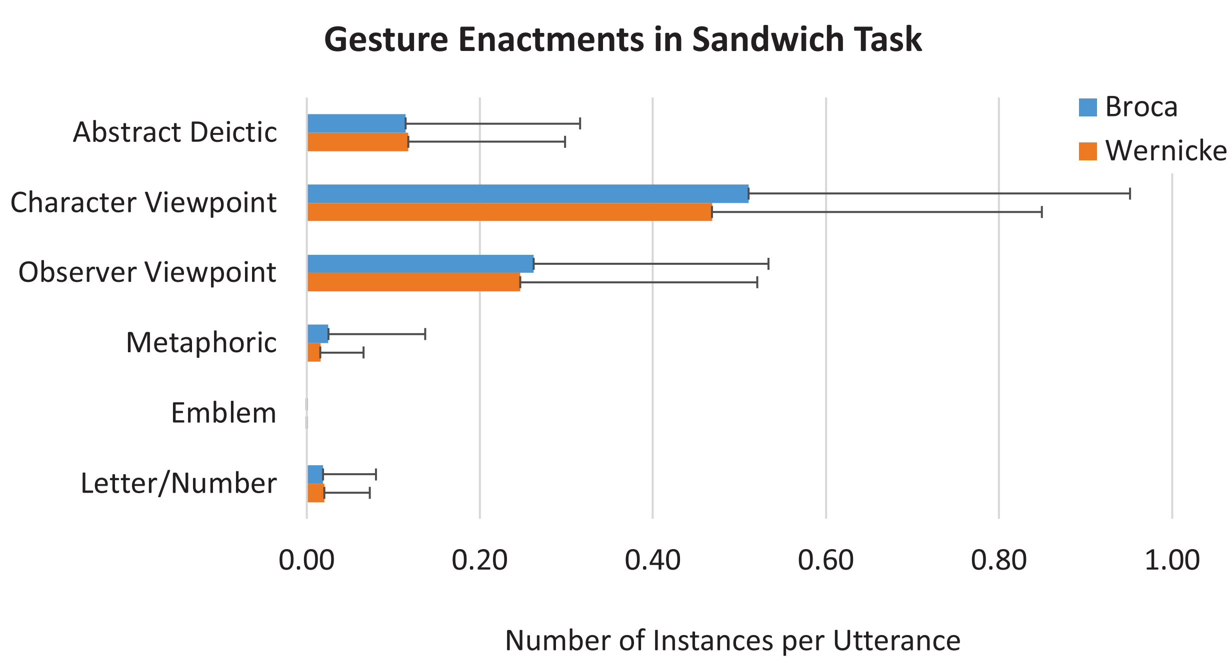


Figure 8. Group Differences in Each Gesture Enactment Measure in the Sandwich Task



Correlations

The correlations between the outcome measures and the demographic and stroke variables are displayed in Tables 10–15, and the intercorrelations between the demographic and stroke variables are displayed in Tables 16–18. Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text. The results of these correlations are discussed in detail below.

There was not a significant correlation between aphasia TPO and the mean number of overall enactments per utterance for the entire group of 40 participants, though there was a significant positive correlation of weak strength ($r = .365$, $p = .021$) between TPO and the mean number of CVPT gestures per utterance across groups, indicating that, as more time passes, people with aphasia may learn to use this iconic gesture type more frequently within discourse to perhaps compensate for and/or facilitate their verbal language production. In the WA group, a significant negative correlation of moderate strength ($r = -.491$, $p = .001$) between TPO and the average number of abstract deictic gestures per utterance was revealed, which suggests that individuals with Wernicke's aphasia may rely less on this gesture type in discourse as their language abilities recover with time.

There were no significant correlations involving WAB-R AQ when all 40 participants were analyzed collectively, though significant correlations involving this variable were found when the BA group and WA group were analyzed separately. Moderate positive correlations between WAB-R AQ and the average number of words ($r = .557$, $p = .011$) and between WAB-R AQ and the average number of words per utterance ($r = .580$, $p = .007$) were revealed for the BA group. This is not surprising; as Broca's aphasia is a nonfluent type of aphasia, it is expected that individuals with more severe Broca's aphasia, and thus lower WAB-R AQ scores, would produce less verbal language, while those with milder cases, and thus higher WAB-R AQ scores, would produce more verbal language. Furthermore, in the BA group, there was also a strong positive correlation between WAB-R AQ and WAB-R fluency scale scores (r = .678, p = .001). As the WAB-R fluency scale score contributes to the WAB-R AQ score in the Western Aphasia Battery-Revised (WAB-R), it is expected that these variables would demonstrate a positive correlation with one another (Kertesz, 2006).

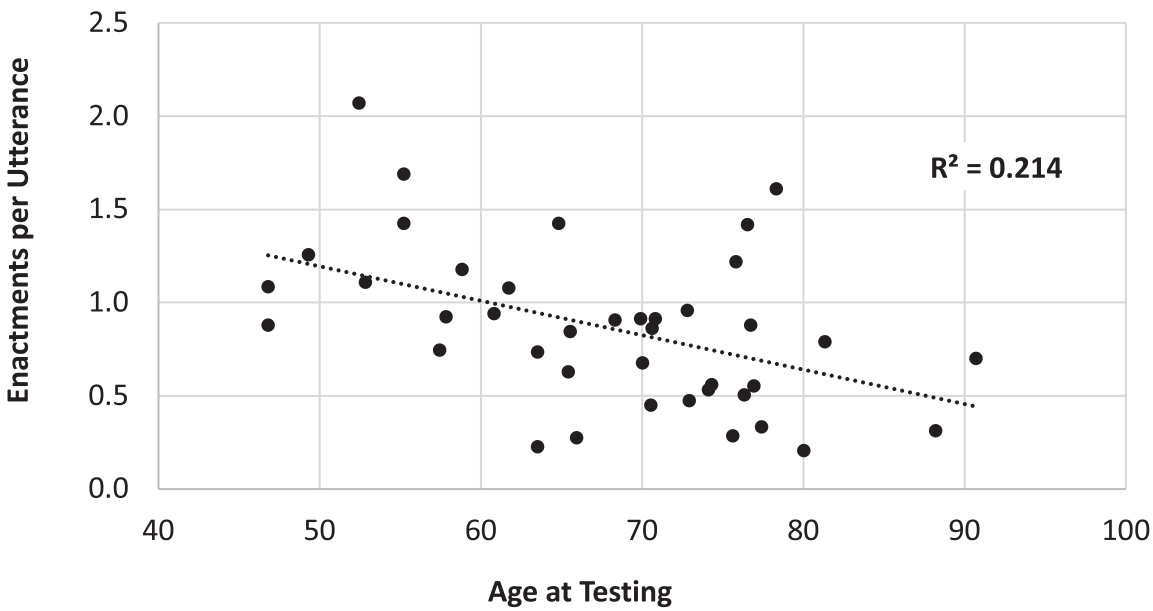
Correlations between years of education and other variables were also found. Across all 40 participants, education showed a weak positive association with the average number of words (r = .331, p = .037) and a moderate positive association with the average number of utterances (r = .410, p = .009). In the BA group, significant positive relationships of moderate strength were found between education and the average number of words (r = .513, p = .021) and between education and the average number of words per utterance (r = .463, p = .040). Additionally, education level showed a moderate positive correlation with WAB-R AQ (r = .417, p = .007) for all 40 participants; a significant positive correlation of moderate strength between education and WAB-R AQ (r = .475, p = .034) in the BA group primarily drove this. In the BA group, education was also positively associated to a moderate degree with the WAB-R fluency scale (r = .449, p = .047).

The relationship between age and enactment was particularly noteworthy. Across groups, a moderate negative correlation between age and the average number of overall enactments per utterance was found (r = −.462, p = .003); a weak negative association between age and the average number of speech enactments per utterance (r = −.374, p = .017) as well as a moderate negative association between age and the average number of gesture enactments per utterance (r = −.418, p = .007) across all 40 participants contributed to this correlation. Moderate negative correlations across groups between age and the mean number of direct reported speech instances per utterance ($r = -.410$, $p = .009$), between age and the mean number of prosodic changes per utterance ($r = -.403$, $p = .010$), and between age and the mean number of CVPT gestures per utterance ($r = -.543$, $p < .001$) contributed most to the negative associations between age and mean speech enactments per utterance, between age and mean gesture enactments per utterance, and between age and mean overall enactments per utterance across all 40 participants. Furthermore, the moderate to strong negative relationships in the BA group between age and the average number of direct reported speech instances per utterance ($r = -.635$, $p = -.003$), between age and the average number of prosodic changes per utterance ($r = -.588$, $p = .006$), and between age and the average number of CVPT gestures per utterance ($r = -.611$, $p = -.004$) primarily drove the across-group correlations between age and the mean number of direct reported speech instances per utterance, between age and the mean number of prosodic changes per utterance, and between age and the mean number of CVPT gestures per utterance.

The moderate correlations between age and the average number of overall enactments per utterance were negative in both the BA group ($r = -.434$) and the WA group ($r = -.452$); this relationship approached statistical significance ($p = .057$) in the BA group and reached significance in the WA group ($p = .045$). Though the relationship between age and the mean number of overall enactments per utterance did not reach statistical significance in the BA group, the moderate correlation between age and the mean number of speech enactments per utterance did ($r = -.495$, $p = .026$). In the WA group, the negative correlation between age and the average number of overall enactments per utterance mainly resulted from the moderate negative relationship between age and the average number of metaphoric gestures per utterance (r =

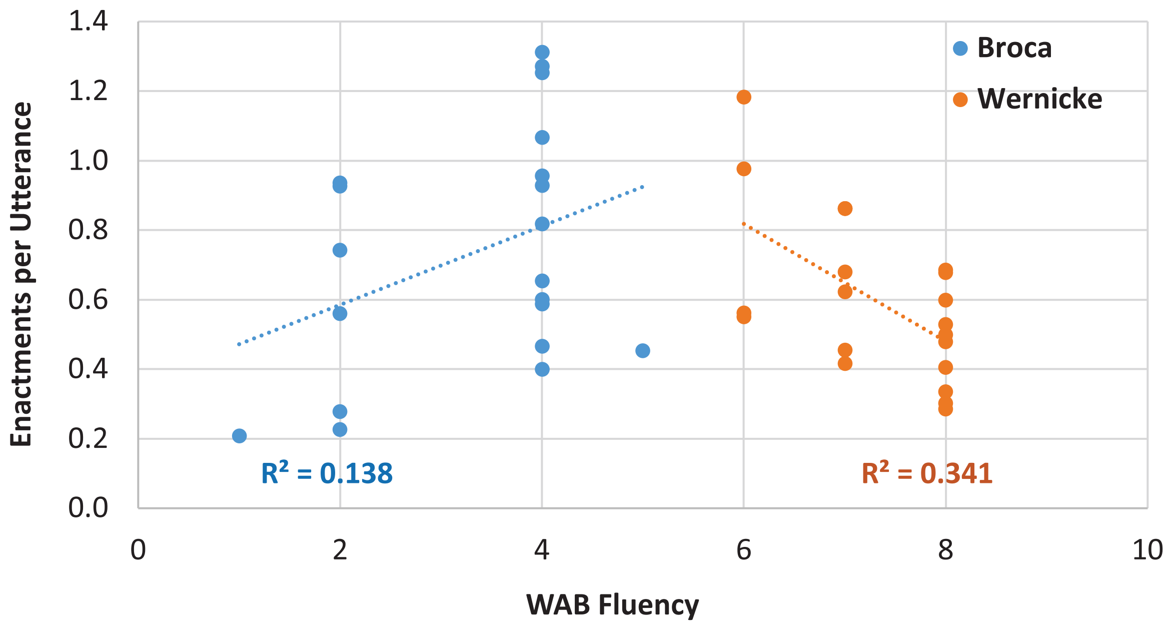
−.483, p = .031). The relationship between age and the mean number of overall enactments per utterance across all 40 participants is displayed in Figure 9.

Figure 9. Correlation Between the Age at Testing and the Average Number of Overall Enactments per Utterance for All 40 Participants



Across groups, there was a weak negative association between the mean WAB-R fluency scale scores and the mean number of overall enactments per utterance (r = −.209), though this correlation was not statistically significant. There were, however, significant negative correlations of weak strength between the WAB-R fluency scale scores and the average number of sound effects per utterance (r = −.352, p = .026) and between the WAB-R fluency scale scores and the average number of emblem gestures per utterance (r = −.325, p = .041) across all 40 participants. Notably, there were opposite correlational relationships between the WAB-R fluency scale scores and the average number of overall enactments per utterance in the BA group and the WA group. A weak positive correlation between the WAB-R fluency scale and the average number of overall enactments per utterance was revealed for the BA group ($r = .344$), though this correlation did not reach statistical significance; however, a significant positive relationship of moderate strength ($r = .489$, $p = .001$) between the WAB-R fluency scale and the average number of CVPT gestures per utterance was found for this group. In contrast to the BA group, a significant negative relationship of moderate strength ($r = -.448$, $p = .048$) between the WAB-R fluency scale and the mean number of overall enactments per utterance was revealed for the WA group. This correlation was primarily accounted for by the moderate negative association ($r = -.584$, $p = .007$) between the WAB-R fluency scale scores and the average number of total gesture enactments per utterance in the WA group, which in turn was driven by the moderate negative relationships between the WAB-R fluency scale and the average number of abstract deictic gestures per utterance ($r = -.491$, $p = .028$) and between the WAB-R fluency scale and the average number of letter/number gestures per utterance ($r = -.517$, $p = .020$). The correlations between WAB-R fluency scale score and the mean number of overall enactments per utterance for both the BA group and the WA group are displayed in Figure 10 below.

Figure 10. Correlations Between WAB-R Fluency Scale Scores and the Average Number of Overall Enactments per Utterance for the BA Group and the WA Group



Across all 40 participants, the WAB-R fluency scale also showed strong positive correlations with the average number of words (r = .731, p < .001) and the average number of words per utterance (r = .841, p < .001) as well as a moderate correlation with the average number of utterances (r = .566, p < .001). These results were primarily driven by the strong positive association between the WAB-R fluency scale and the average number of words (r = .661, p = .002) and by the moderate positive associations between the WAB-R fluency scale and the mean number of utterances (r = .588, p = .006) and between the WAB-R fluency scale and the mean number of words per utterance (r = .561, p = .010) in the BA group. These results are also not surprising, as longer and/or more frequent verbal productions are often associated with more fluent speech.

Table 10. Correlations Between Demographic/Stroke Variables and Individual Outcome Measures for All 40 Participants

	No. of Words	No. of Utterances	No. of Words per Utterance	Direct Reported Speech	Prosodic Changes	Sound Effects	Abstract Deictic	CVPT	OVPT	Meta-phoric	Emblem	Letter/ Number
Age (Years)	.043	−.067	.169	−.410	−.403	−.139	−.008	−.543	.109	−.309	−.277	−.062
Years of Education	.331	.410	.236	.190	.193	.083	.128	.156	.146	.181	−.130	−.017
TPO	−.199	−.083	−.255	.131	.137	.068	.197	.365	−.155	.072	.095	.073
WAB-R AQ	.196	.287	.092	.195	.246	−.190	.239	.112	−.162	.310	−.119	.164
WAB-R Fluency Scale	.731	.566	.841	−.044	−.109	−.352	.030	−.243	.068	.154	−.325	−.206

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 11. Correlations Between Demographic/Stroke Variables and Combined Outcome Measures for All 40 Participants

	Total Speech Enactments	Total Gesture Enactments	Total Overall Enactments
Age (Years)	−.374	−.418	−.462
Years of Education	.182	.219	.233
TPO	.130	.254	.235
WAB-R AQ	.069	.109	.108
WAB-R Fluency Scale	−.183	−.180	−.209

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 12. Correlations Between Demographic/Stroke Variables and Individual Outcome Measures for the BA Group

	No. of Words	No. of Utterances	No. of Words per Utterance	Direct Reported Speech	Prosodic Changes	Sound Effects	Abstract Deictic	CVPT	OVPT	Meta-phoric	Emblem	Letter/ Number
Age (Years)	−.197	−.417	.228	−.635	−.588	−.045	.121	−.611	.298	−.181	−.374	.142
Years of Education	.513	.425	.463	.296	.296	.215	.322	.271	.290	.055	−.109	−.044
TPO	.251	.158	.305	.013	−.023	−.093	.436	.251	−.089	.135	−.041	.011
WAB-R AQ	.557	.425	.580	.329	.366	−.218	.514	.270	−.186	.417	−.182	.168
WAB-R Fluency Scale	.661	.588	.561	.421	.382	−.132	.080	.489	−.086	.389	−.095	.011

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 13. Correlations Between Demographic/Stroke Variables and Combined Outcome Measures for the BA Group

	Total Speech Enactments	Total Gesture Enactments	Total Overall Enactments
Age (Years)	−.495	−.357	−.434
Years of Education	.322	.360	.365
TPO	−.036	.265	.157
WAB-R AQ	.143	.302	.255
WAB-R Fluency Scale	.252	.371	.344

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 14. Correlations Between Demographic/Stroke Variables and Individual Outcome Measures for the WA Group

	No. of Words	**No. of Utterances**	**No. of Words per Utterance**	**Direct Reported Speech**	**Prosodic Changes**	**Sound Effects**	**Abstract Deictic**	**CVPT**	**OVPT**	**Meta-phoric**	**Emblem**	**Letter/ Number**
Age (Years)	−.256	−.128	−.365	−.096	−.042	−.040	−.252	−.335	−.109	−.483	.213	−.261
Years of Education	.318	.406	−.074	.119	.137	−.058	−.392	.154	−.066	.364	.015	.126
TPO	−.049	.055	−.336	.299	.396	.073	−.491	.306	−.200	.062	.158	.008
WAB-R AQ	.192	.258	−.161	.046	.096	−.202	−.162	−.183	−.153	.210	.007	.175
WAB-R Fluency Scale	.362	.210	.364	.136	.102	.049	−.491	−.181	−.399	.045	−.217	−.517

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 15. Correlations Between Demographic/Stroke Variables and Combined Outcome Measures for the WA Group

	Total Speech Enactments	**Total Gesture Enactments**	**Total Overall Enactments**
Age (Years)	−.095	−.427	−.452
Years of Education	.089	.029	.080
TPO	.280	−.100	.088
WAB-R AQ	−.020	−.172	−.170
WAB-R Fluency Scale	.133	−.584	−.448

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 16. Intercorrelations Between Demographic and Stroke Variables for All 40 Participants

	Age (Years)	**Years of Education**	**TPO**	**WAB-R AQ**	**WAB-R Fluency Scale**
Age (Years)	1.000	−.058	.034	.107	.195
Years of Education		1.000	.229	.417	.284
TPO			1.000	.231	−.212
WAB-R AQ				1.000	.207
WAB-R Fluency					1.000

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 17. Intercorrelations Between Demographic and Stroke Variables for the BA Group

	Age (Years)	**Years of Education**	**TPO**	**WAB-R AQ**	**WAB-R Fluency Scale**
Age (Years)	1.000	−.007	.157	−.056	−.295
Years of Education		1.000	.293	.475	.449
TPO			1.000	.297	.377
WAB-R AQ				1.000	.678
WAB-R Fluency					1.000

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

Table 18. Intercorrelations Between Demographic and Stroke Variables for the WA Group

	Age (Years)	**Years of Education**	**TPO**	**WAB-R AQ**	**WAB-R Fluency Scale**
Age (Years)	1.000	−.257	.178	.276	−.009
Years of Education		1.000	.388	.351	.111
TPO			1.000	.205	.045
WAB-R AQ				1.000	.192
WAB-R Fluency					1.000

Statistically significant positive correlations are depicted with green text, and statistically significant negative correlations are depicted with red text.

DISCUSSION

The primary motivation for this study was to investigate whether the use of enacted communication methods varied between individuals with Broca's aphasia and Wernicke's aphasia based upon disparities in fluency as well as potential differences in awareness of verbal deficits. Additionally, we were interested in exploring whether the use of enactment methods was influenced by discourse task type for both groups. The third broad purpose of this research was to examine whether there was a relationship between aphasia severity, as measured by WAB-R AQ and WAB-R fluency scale scores, and use of enactment methods in the two groups.

Overall, this study found evidence that individuals with Broca's aphasia and Wernicke's aphasia vary in their overall use of enactment and in the types of enactment they tend to use. Furthermore, the frequency of use for different enactment methods varied according to the type of discourse task, indicating that certain means of enactment may be more readily applicable to specific contexts. Finally, the results demonstrated opposite relationships between the overall use of enactment and the severity of verbal deficits, as measured by the WAB-R fluency scale, for the BA group and the WA group.

Group and Task Analyses

As hypothesized, individuals in the BA group collectively produced more enactments per utterance on average compared to those in the WA group. This difference approached statistical significance, indicating a possible effect of group. It is feasible that a statistically significant result may have been found with a higher powered study (i.e., more participants in both groups). Notably, the overall difference in the use of enactments per utterance between the two groups was primarily driven by speech enactments vs. gesture enactments.

Furthermore, for over half of the enactment methods, including prosodic changes, sound effects, as well as CVPT, emblem, and letter/number gesture types, participants in the BA group produced a significantly greater number per utterance on average compared to those in the WA group. It should also be noted that the group effect for direct reported speech approached statistical significance, with the BA group producing more instances per utterance on average; thus, a significant difference between the two groups for this measure may have been found with more statistical power. This study's results for the production of CVPT gestures are thus partially consistent with the initial hypothesis that individuals in the BA group would produce more CVPT gestures, though those in the WA group did not produce significantly more OVPT or metaphoric gestures, as originally predicted. Furthermore, this outcome supports Sekine and Rose's (2013) finding that individuals with Broca's aphasia tend to produce CVPT gestures.

In addition to the group differences for prosodic changes as well as CVPT, emblem, and letter/number gestures, some enactment methods were found to be influenced by discourse task type. ANOVAs revealed a main effect of task for the following measures: direct reported speech, prosodic changes, and all gesture type categories.

As previously discussed, there were no human characters to enact in the Sandwich task, so the task effects that arose for both direct reported speech and prosodic changes, which were due to the absence of both measures in the Sandwich task, are not surprising. Furthermore, these results are consistent with the original prediction that direct reported speech and prosodic changes would be most utilized within the Picture Description task and/or Cinderella Story task due to the variety of characters that could be enacted in both. The group difference for the prosodic changes measure, which resulted from individuals in the BA group utilizing prosodic changes significantly more than those in the WA group across tasks, suggests that this enactment method may be particularly useful for people with Broca's aphasia and other nonfluent aphasia types. Introducing direct reported speech with a framing clause (e.g., "Cinderella said…") may be difficult for people with nonfluent aphasia, particularly those with agrammatism. Thus, instead of marking direct reported speech in this more grammatically complex way, such individuals can instead indicate when they are directly quoting someone by altering the prosodic features of their speech. This is consistent with the findings of Hengst et al. (2005) and Groenewold and Armstrong (2019), which showed that people with aphasia frequently mark direct reported speech with prosodic shifts; our results expand upon this by providing insight into how aphasia type and fluency influence the use of this enactment method.

The task effect for abstract deictic gestures resulted from statistically significant differences in use between all three task categories. The Cinderella Story featured the highest production of this gesture type, followed by the Sandwich task, and then the Picture Description task. This is not surprising; 39 of 40 participants did not have the picture book to point to during the Cinderella Story task, unlike the Picture Description tasks, which always included images, and the Sandwich task, in which nearly half of the participants were provided with an image featuring the necessary ingredients. These results thus suggest that individuals with aphasia are more likely to produce abstract deictic gestures, in which they point to an empty space and assign referential value to it, when they do not have any relevant pictures or objects to which they can point for communicative purposes. Pointing to different vacant spaces may help people with aphasia to communicate that they are referring to distinct entities, especially in narratives that feature a variety of characters and objects, such as in the Cinderella Story. This may be especially useful when individuals with aphasia experience word retrieval difficulties and thus refer to several distinct entities with the same vague term, such as "thing."

A task effect was also found for CVPT gestures, which was accounted for by statistically significant differences between the Sandwich task and the Picture Description task as well as between the Sandwich task and the Cinderella Story task, with this gesture type being produced most in the Sandwich task. These results are also not surprising, as this gesture type, which involves portraying an action or entity from a first-person view, is well-suited for depicting how to make a peanut butter and jelly sandwich (e.g., motioning as if spreading peanut butter on bread). This aligns with the initial hypothesis that either the Sandwich task or the Cinderella Story would be most conducive to using CVPT gestures. Furthermore, this result is consistent with Stark and Cofoid's (2022) finding that more iconic gesture types were used during a procedural narrative task (the Sandwich task) than during a picture description task (the Broken Window task). CVPT gestures may thus be particularly useful for individuals with aphasia when they want to communicate about different actions, as this method can allow them to act out events in a clear and understandable way. Furthermore, since this gesture type also showed a main effect of group, with participants in the BA group producing CVPT gestures in more utterances, it may be particularly useful for individuals with nonfluent types of aphasia, such as Broca's aphasia, as it may help them to compensate for and/or facilitate verbal production abilities.

The task effect for OVPT gestures arose due to significant differences between the Picture Description task and the Cinderella Story task and between the Picture Description task and the Sandwich task. This gesture type was produced significantly more in the Cinderella Story and Sandwich tasks, thus fitting with the initial hypothesis that OVPT gestures would be used more frequently in these two tasks compared to the Picture Description task. These results also further support Stark and Cofoid's (2022) research, which showed that iconic gesture types were more commonly produced in the Sandwich task, a procedural narrative task, compared to the Broken Window task, a picture description task. All participants were provided with images during the Picture Description task, unlike in the Cinderella Story and Sandwich tasks. Furthermore, both the Cinderella Story and Sandwich tasks featured a variety of actions, characters, and objects. This suggests that people with aphasia may benefit from utilizing OVPT gestures when relaying information about a variety of entities that cannot be observed or pointed to in the physical environment or in images.

Use of metaphoric gestures also showed a task effect, with significant differences in use between the Cinderella Story task and the Picture Description task as well as between the Cinderella Story task and the Sandwich task. These results support the initial hypothesis that metaphoric gestures would be used most in the Cinderella Story task, as the narrative includes a considerable number of abstract concepts, such as time (e.g., *after* the ball) and character traits (the stepmother was *mean*). This gesture type may thus be practically applied when individuals with aphasia want to portray such abstract concepts, especially when telling stories.

There was also a main effect of task for emblem gesture use. There were significant differences in the use of this gesture type between the Sandwich task and the Picture Description task and between the Sandwich task and the Cinderella Story task. Emblem gestures were not used at all in the Sandwich task, so it is not surprising that the main effect of task was driven by differences between the Sandwich task and the other two tasks. In the discourse tasks, emblem gesture types were often produced to express judgment of a situation (e.g., giving a thumbs-down to indicate dissatisfaction that Cinderella cannot go to the ball) or to convey meaning from the perspective of a character (e.g., waving goodbye while enacting the boy in the Refused Umbrella Picture Description task). There was little contextual information to comment on in the

Sandwich task and no characters to enact, so it makes sense that participants did not use emblem gestures in this task. These findings thus suggest that emblem gestures may be of particular use to people with aphasia when expressing their own viewpoint on a matter or when expressing another person's viewpoint. There was also a group effect for this measure, with participants in the BA group producing more emblems than participants in the WA group. Emblem gestures may be especially beneficial for individuals with Broca's aphasia and other types of nonfluent aphasia, as they convey a contextualized cultural meaning that can be communicated and understood sans accompanying speech.

Additionally, a task effect was found for the letter/number gesture type category, which was accounted for by differences in use between the Picture Description task and the Cinderella Story task. This gesture type may have been produced more per utterance in the Cinderella Story since the typical protocol did not include pictures; thus, participants were unable to point to an image to refer to an entity. Gesturally representing the number of objects could potentially help people with aphasia demonstrate how many referents are in the reported event (e.g., two evil stepsisters in the Cinderella Story), while tracing out the spelling of the intended lexical target may help to facilitate word retrieval, especially when the referent cannot be pointed to and thus needs to be named. There was also a main effect of group that arose due to the BA group producing more letter and number gestures per utterance on average. This suggests that individuals with Broca's aphasia, as well as other nonfluent aphasia types, may particularly benefit from using gesture to represent the number of referents when experiencing verbal production difficulties. Additionally, gesturally writing out letters and words may help people with nonfluent types of aphasia to retrieve an intended lexical target during instances of anomia (i.e., word finding difficulty).

Correlations

Across the 40 participants, correlations between years of education and the average number of words, average number of utterances, and WAB-R AQ scores were found. These results are consistent with prior research that has demonstrated a connection between higher levels of education and better aphasia recovery outcomes (El Hachioui et al., 2012; González-Fernández et al., 2011). This link is perhaps due to the increased cognitive reserve (i.e., the brain's ability to functionally compensate after neural damage) conferred by education (González-Fernández et al., 2011).

An unexpected correlation between participant age and the overall use of enactment was also found in this study. Compared to younger participants, individuals of more advanced age tended to produce fewer enactments per utterance on average. Prior studies have shown that elderly individuals show more limited gesture use, with less production of representational gestures specifically compared to younger individuals (Cohen & Borsoi, 1996; Feyereisen & Havard, 1999), perhaps due to age-related decline in visual-spatial cognitive abilities (Özer & Göksun, 2020). Gesture enactments were frequently produced by participants in this study, so age-related differences in gestural ability may have contributed to the negative association between age and overall enactment that was found.

This study also revealed correlations between the overall use of enactment and the severity of verbal deficits as measured by the WAB-R fluency scale. Most notably, different correlational relationships between WAB-R fluency scale scores and the mean number of overall enactments per utterance were revealed for the BA group and WA group. Though the association did not reach statistical significance, there was a positive correlation between WAB-R fluency scale scores and the average use of overall enactment per utterance for the BA group, while a statistically significant negative correlation between overall enactment and the WAB-R fluency scale was revealed for the WA group. The two groups thus demonstrated inverse patterns for this relationship, as participants in the BA group with higher WAB-R fluency scale scores tended to produce more enactments per utterance on average, while participants in the WA group with higher WAB-R fluency scale scores tended to produce fewer on average. It was initially hypothesized that individuals with more severe verbal deficits would produce more enactments overall to compensate for language impairments and improve communicative effectiveness. The results for the WA group are thus consistent with this prediction, as individuals in this group tended to produce fewer enactments as WAB-R fluency scale score increased, suggesting less need to utilize enactment for compensatory or facilitative purposes. However, the correlational outcomes for the BA group were opposite to what was hypothesized, since individuals with higher WAB-R fluency scale scores tended to produce more enactments per utterance than those with lower WAB-R fluency scale scores. These results were thus unexpected for several reasons, as not only were the outcomes of the BA group contrary to what was hypothesized, but the two groups also demonstrated opposite patterns to one another.

The correlation between overall enactments per utterance and the WAB-R fluency scale score was primarily driven by gesture for both the BA group and the WA group. Stark and Cofoid (2022) identified a strong negative relationship between rate of iconic gesture use and WAB-R fluency scale scores in participants with aphasia. Similarly, Sekine and Rose (2013) also found a small to medium negative correlation between gesture frequency and WAB-R Spontaneous Speech scores (a WAB-R score that is partially derived from the fluency scale score) for participants with aphasia. Their results are thus consistent with this study’s findings for the WA group but conflict with the findings for the BA group. However, in both studies

(Sekine & Rose, 2013; Stark & Cofoid, 2022), there were more than double the number of participants with fluent aphasia types than nonfluent types. Furthermore, in both studies, rather than being analyzed separately in a fluent aphasia group and a nonfluent aphasia group, all participants were collectively analyzed as one group. It is thus possible that, had participants been evaluated in two separate groups according to the dimension of nonfluent vs. fluent aphasia type, a similar contrasting pattern in the relationship between gesture and fluency would have been discovered.

According to the lexical retrieval hypothesis, gesture production directly facilitates the process of word retrieval (Krauss, 1998; Krauss & Hadar, 2001). More specifically, it has been proposed that iconic gesture types in particular can aid lexical retrieval via the rich imagery that they depict. In this study, participants in the BA group produced more iconic CVPT gestures per utterance on average than the WA group, and there was a significant positive correlation between the average number of CVPT gestures per utterance and the WAB-R fluency scale score for the BA group. It is thus possible that in the BA group, a higher degree of enactment, which included more production of iconic CVPT gestures, may have facilitated word retrieval through the detailed imagistic information that these gestures activate, thus contributing to greater fluency overall. Individuals in the WA group produced more OVPT gestures and abstract deictic gestures than any other gesture types. As previously discussed, abstract deictic gestures involve pointing to an empty space and attributing referential value to it; this gesture type thus does not convey detailed imagery. Furthermore, in this study, it was commonly observed that some OVPT gestures produced by individuals with Wernicke's aphasia were unclear in form (e.g., vaguely motioning with the hand to portray an object's shape) and thus often depicted less salient and recognizable imagery compared to many CVPT gestures (e.g., pretending to hold a ball and throw it). Therefore, even though participants in the WA group with lower WAB-R fluency scale scores tended to produce more enactment overall, including gesture, production of these gestures may not have effectively facilitated lexical retrieval due to their ambiguous nature. These results suggest that individuals with Broca's aphasia may be more able to produce gestures, particularly of the CVPT type, that support their verbal production abilities compared to those with Wernicke's aphasia. Speech-language pathologists could thus explicitly instruct patients with Wernicke's aphasia to produce more CVPT gestures, as these gesticulations may help them to activate the semantic content for a lexical target and thus improve their verbal communication, while also increasing the clarity of their intended message.

Overall Implications

An interesting possibility emerges when the results of this study are broadly considered. Based upon this study's findings, individuals with Broca's aphasia tend to use enactment more to convey information within discourse compared to those with Wernicke's aphasia, especially methods that allow them to more literally act out a reported event, including prosodic changes, sound effects, and CVPT gestures. For example, by altering the prosodic characteristics of their speech, individuals can directly represent the voice of someone in a reported scene, while use of onomatopoeia and vocal imitation can allow someone to convey environmental sounds within the reported scene. Furthermore, CVPT gestures provide a means of physically depicting the actions of an entity within the reported event. The results of this study also suggest that, within discourse, younger individuals with Broca's aphasia tend to use enactment more frequently to convey information compared to those who are older. Similarly, people with Broca's aphasia who possess more fluent verbal production abilities tend to implement a greater degree of enactment when communicating within discourse compared to those who are less fluent. When collectively considered, these results suggest that individuals with Broca's aphasia who have more cognitive capacity (i.e., those who are younger and who have less severe aphasia impairments) may be better able to adapt in discourse when encountering verbal production difficulties by more explicitly acting events out, thus increasing the effectiveness of their communication.

In contrast, the results of this study suggest that people with Wernicke's aphasia use less enactment overall when communicating within discourse compared to those with Broca's aphasia. Furthermore, individuals with Wernicke's aphasia who are more verbally fluent tend to use less enactment to communicate within discourse. This suggests that people with Wernicke's aphasia who have more fluent verbal production may not feel the need to rely on means of enactment when communicating, as they are fluent enough that they can consistently produce verbal output freely and with relative ease. It is also possible that fluency is negatively associated with enactment use in those with Wernicke's aphasia due to their limited recognition of their own verbal production deficits; as previously discussed, individuals with this aphasia type often have more impaired language comprehension, which is tied to poor awareness of their verbal production errors. On the WAB-R fluency scale, a score of 7, which falls into the upper end of the fluent range, is associated with excessive verbal output that is fluently produced but that is filled with paraphasic jargon; this rating is described as characteristic of severe Wernicke's aphasia (Kertesz, 2006). This example thus demonstrates the potential connection between higher fluency and poorer awareness of deficits in individuals with Wernicke's aphasia.

Limitations

This study had several limitations. First, there was a relatively small sample size, with only 20 participants in each group; this limited statistical power and thus limited the ability to detect significant effects in the two groups. Furthermore, the data included lots of individual variation in the use of enactment methods. In future analyses, this data will be analyzed with a mixed effects model to account for this variability. Additionally, outliers in the data will be identified and potentially removed in future work.

Interrater agreement for the gesture coding was relatively high for the 10 files coded by both raters. However, categorizing gestures is a fairly subjective task, especially when the co-occurring speech cannot always be relied upon to aid in interpreting the meaning of the movements. It was sometimes difficult to identify gesture types for participants with more severe verbal deficits, particularly when their verbal language consisted primarily of paraphasic jargon, which was the case with some participants in the WA group. Ideally, to increase accuracy, all 40 files would have been independently coded by two raters who then resolved all discrepancies through consensus.

Furthermore, gesture production may have been limited due to all participants being seated at a table. This condition has been shown to limit gesture use because it provides a surface upon which a person can rest their hands (Jacobs & Garnham, 2007). In future studies examining gesture, it would be ideal for all participants to be seated with nothing in front of them, as they may be more inclined to gesture in this condition.

Additionally, it would have been beneficial to include a greater range of aphasia severity, as measured by the WAB-R AQ, among participants. All 40 individuals included in this study scored within the moderate or severe range on the WAB-R AQ. A correlation between severity of verbal deficits, as measured by WAB-R AQ, and enactment use may have been found if participants with WAB-R AQ scores ranging from mild to very severe had been analyzed.

Conclusion

This study provided additional insights into the use of enactment in individuals with nonfluent vs. fluent aphasia. Participants with Broca's aphasia were found to produce a greater degree of enactment overall compared to those with Wernicke's aphasia, as predicted. Task category and task stimuli (e.g., the presence or absence of pictures) were also found to influence the types of enactment used, indicating that certain means of enactment may be more readily applicable within different contexts. Furthermore, relationships between enactment use and the severity of verbal deficits, as measured by WAB-R fluency scale scores, were revealed, indicating that use of enactment can potentially facilitate and/or compensate for verbal production abilities in individuals with aphasia.

These findings have clinical relevance to the field of speech-language pathology, as clinicians can encourage clients with aphasia to implement various methods of enactment in different situations to support verbal language production and increase the overall effectiveness of communication within discourse.

REFERENCES

American Speech-Language-Hearing Association. (n.d.). *Aphasia*. https://www.asha.org/practice-portal/clinical-topics/aphasia/

Bastiaanse, R., & Thompson, C. K. (2012). *Perspectives on agrammatism*. Amsterdam University Press.

Behrmann, M., & Penn, C. (1984). Non-verbal communication of aphasic patients. *International Journal of Language & Communication Disorders, 19*(2), 155–168. doi: 10.3109/136828284 09007186

Berko Gleason, J., Goodglass, H., Obler, L., Green, E., Hyde, M. R., & Weintraub, S. (1980). Narrative strategies of aphasic and normal-speaking subjects. *Journal of Speech, Language, and Hearing Research*, *23*(2), 370–382. https://doi.org/10.1044/jshr.2302.370

Broca, P. (1861a). Nouvelle observation d'aphémie produite par une lésion de la troisième circonvolution frontale. Bulletins de La Société D'anatomie (Paris), 2e Serie, 6, 398–407.

Broca, P. (1861b). Perte de la Parole, ramollissement chronique et destruction partielle du lobe antérieur gauche du cerveau. Bulletin de la Société Anthropologique, 2, 235-23

Broca P. (1861c). Remarques sur le siège de la faculté du langage articulé, suivies d'une observation d'aphémie (perte de la parole). Bulletins de la Société Anatomique de Paris 6:330–57.

Brookshire, R. H. (2015). *Introduction to neurogenic communication disorders* (8th ed.). Mosby.

Butterworth, B. (1994). Disorders of sentence production. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 346*(1315), 55-61.

Cicone, M., Wapner, W., Foldi, N., Zurif, E., & Gardner, H. (1979). The relation between gesture and language in aphasic communication. *Brain and Language*, *8*(3), 324–349. https://doi.org/10.1016/0093-934x(79)90060-9

Clough, S., & Duff, M. C. (2020). The role of gesture in communication and cognition: Implications for understanding and treating neurogenic communication disorders. *Frontiers in Human Neuroscience, 14*. https://doi.org/10.3389/fnhum.2020.00323

Clough, S., & Gordon, J. K. (2020). Fluent or nonfluent? Part A. Underlying contributors to categorical classifications of fluency in aphasia. *Aphasiology*, *34*(5), 515–539. https://doi.org/10.1080/02687038.2020.1727709

Cohen R. L., & Borsoi D. (1996). The role of gestures in description-communication: a cross-sectional study of aging. *Journal of Nonverbal Behavior, 20*, 45–63.

El Hachioui, H., Lingsma, H. F., van de Sandt-Koenderman, M. W. M. E., Dippel, D. W. J., Koudstaal, P. J., & Visch-Brink, E. G. (2012). Long-term prognosis of aphasia after stroke. *Journal of Neurology, Neurosurgery & Psychiatry*, *84*(3), 310–315. https://doi.org/10.1136/jnnp-2012-302596

Ellis, C., & Urban, S. (2016). Age and aphasia: a review of presence, type, recovery and clinical outcomes. *Topics in Stroke Rehabilitation, 23*(6), 430-439.

Eslinger, P. J., & Damasio, A. R. (1981). Age and type of aphasia in patients with stroke. *Journal of Neurology, Neurosurgery & Psychiatry*, *44*(5), 377–381. https://doi.org/10.1136/jnnp.44.5.377

Feyereisen P., & Havard I. (1999). Mental imagery and production of hand gestures while speaking in younger and older adults. *Journal of Nonverbal Behavior, 23*, 153–171.

González-Fernández, M., Davis, C., Molitoris, J. J., Newhart, M., Leigh, R., & Hillis, A. E. (2011). Formal education, socioeconomic status, and the severity of aphasia after stroke. *Archives of Physical Medicine and Rehabilitation*, *92*(11), 1809–1813. https://doi.org/10.1016/j.apmr.2011.05.026

Goodglass, H., & Kaplan, E. (1983). *The assessment of aphasia and related disorders.* Lea & Febiger.

Groenewold, R., & Armstrong, E. (2018). The effects of enactment on communicative competence in aphasic casual conversation: A functional linguistic perspective. *International Journal of Language & Communication Disorders*, *53*(4), 836–851. https://doi.org/10.1111/1460-6984.12392

Groenewold, R., & Armstrong, E. (2019). A multimodal analysis of enactment in everyday interaction in people with aphasia. *Aphasiology*, *33*(12), 1441–1461. https://doi.org/10.1080/02687038.2019.1644814

Groenewold, R., Bastiaanse, R., & Huiskes, M. (2013). Direct speech constructions in aphasic Dutch narratives. *Aphasiology*, *27*(5), 546–567. https://doi.org/10.1080/02687038.2012.742484

Hengst, J. A., Frame, S. R., Neuman-Stritzel, T., & Gannaway, R. (2005). Using others' words. *Journal of Speech, Language, and Hearing Research, 48*(1), 137–156. https://doi.org/10.1044/1092-4388(2005/011)

Jacobs, N., & Garnham, A. (2007). The role of conversational hand gestures in a narrative task. *Journal of Memory and Language*, *56*(2), 291–303. https://doi.org/10.1016/j.jml.2006.07.011

Kendon, A. (1980). Gesticulation and speech: Two aspects of the process of utterance. In A. Kendon (Ed.), *The relationship of verbal and nonverbal communication* (pp. 207–227). De Gruyter. https://doi.org/10.1515/9783110813098.207

Kertesz, A. (2006). *Western Aphasia Battery-Revised*. Pearson.

Kita, S. (2009). Cross-cultural variation of speech-accompanying gesture: A review. *Language and Cognitive Processes, 24*(2), 145–167. https://doi.org/10.1080/01690960802586188

Klor, B. M. (1984). *Speech and language profiles of aphasic adults*. C.C. Publications.

Kong, A. P. H., Law, S. P., & Chak, G. W. C. (2017). A comparison of coverbal gesture use in oral discourse among speakers with fluent and nonfluent aphasia. *Journal of Speech, Language, and Hearing Research, 60*(7), 2031–2046. https://doi.org/10.1044/2017_jslhr-l-16-0093

Krauss, R. M. (1998). Why do we gesture when we speak? *Current Directions in Psychological Science, 7*(2), 54. https://doi.org/10. 1111/1467-8721.ep13175642

Krauss, R. M., & Hadar, U. (2001). The role of speech-related arm/hand gestures in word retrieval. In R. Campbell & L. Messing (Eds.), *Gesture, speech, and sign* (pp. 93–116). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198524519.003. 0006

Lam, J. M. C., & Wodchis, W. P. (2010). The relationship of 60 disease diagnoses and 15 conditions to preference-based health-related quality of life in Ontario hospital-based long-term care residents. *Medical Care*, *48*(4), 380–387. https://doi.org/10.1097/mlr.0b013e3181ca2647

Lemaitre, G., Houix, O., Voisin, F., Misdariis, N., & Susini, P. (2016). Vocal imitations of non-vocal sounds. *PLOS ONE*, *11*(12), e0168167. https://doi.org/10.1371/journal.pone.0168167

Lemaitre, G., & Rocchesso, D. (2014). On the effectiveness of vocal imitations and verbal descriptions of sounds. *The Journal of the Acoustical Society of America*, *135*(2), 862–873. https://doi.org/10.1121/1.4861245

McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. University of Chicago Press.

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

Meteyard, L., Stoppard, E., Snudden, D., Cappa, S. F., & Vigliocco, G. (2015). When semantics aids phonology: A processing advantage for iconic word forms in aphasia. *Neuropsychologia, 76*, 264–275. https://doi.org/10.1016/j.neuropsychologia.2015.01.042

National Aphasia Association. (n.d.-a). *Aphasia fact sheet*. https://www.aphasia.org/aphasia-resources/aphasia-factsheet/

National Aphasia Association. (n.d.-b). *Aphasia FAQs*. https://www.aphasia.org/aphasia-faqs/

National Aphasia Association. (n.d.-c). *Broca's (expressive) aphasia*. https://www.aphasia.org/aphasia-resources/brocas-aphasia/?gclid=CjwKCAiAs92MBhAXEiwAXTi25-K2MPN3HAehyPiHkAH7EYsDZy0HLujbPlNpBnSQ9DPXka2-CnHrdxoCZxkQAvD_BwE

National Aphasia Association. (n.d.-d). *Wernicke's (receptive) aphasia*. https://www.aphasia.org/aphasia-resources/wernickes-aphasia/

Özer, D., & Göksun, T. (2020). Gesture use and processing: A review on individual differences in cognitive resources. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.573555

Pierce, J. E., O'Halloran, R., Togher, L., & Rose, M. L. (2019). What is meant by "multimodal therapy" for aphasia? *American Journal of Speech-Language Pathology*, *28*(2), 706–716. https://doi.org/10.1044/2018_ajslp-18-0157

Sekine, K., & Rose, M. L. (2013). The relationship of aphasia type and gesture production in people with aphasia. *American Journal of Speech-Language Pathology*, *22*(4), 662–672. https://doi.org/10.1044/1058-0360(2013/12-0030)

Sekine, K., Rose, M. L., Foster, A. M., Attard, M. C., & Lanyon, L. E. (2013). Gesture production patterns in aphasic discourse: In-depth description and preliminary predictions. *Aphasiology, 27*(9), 1031–1049. https://doi.org/10.1080/02687038.2013.803017

Simmons-Mackie, N., (2018). *Aphasia in North America*: *A comprehensive report on incidence, causes and impact*. Aphasia Access: Moorestown, NJ.

Stark, B. C., & Cofoid, C. (2022). Task-specific iconic gesturing during spoken discourse in aphasia. *American Journal of Speech-Language Pathology*, *31*(1), 30–47. https://doi.org/10.1044/2021_ajslp-20-00271

Ulatowska, H. K., & Olness, G. S. (2003). On the nature of direct speech in narrative of African Americans with aphasia. *Brain and Language*, *87*(1), 69–70. https://doi.org/10.1016/s0093-934x(03)00202-5

Ulatowska, H. K., Reyes, B. A., Santos, T. O., & Worle, C. (2011). Stroke narratives in aphasia: The role of reported speech. *Aphasiology, 25*(1), 93–105. https://doi.org/10.1080/02687031003714418

Wernicke, C. (1874). Der aphasische Symptomencomplex: eine psychologische Studie auf anatomischer Basis. Breslau (Wroclaw), Poland: Max Cohn & Weigert.

Wilkinson, R., Beeke, S., & Maxim, J. (2010). Formulating actions and events with limited linguistic resources: enactment and iconicity in agrammatic aphasic talk. *Research on Language & Social Interaction*, *43*(1), 57–84. https://doi.org/10.1080/08351810903471506