THE IMPACT OF NEUROLOGICAL FATIGUE ON LINGUISTIC CHOICES
AFTER TBI

A Thesis
by
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Abstract

THE IMPACT OF NEUROLOGICAL FATIGUE ON LINGUISTIC CHOICES
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Traumatic brain injury (TBI) is one of the leading causes of death or long-term

disability in the United States. Individuals with these injuries must adapt to significant

changes in neurological functioning, and oftentimes attention, memory, and processing

difficulties mean that these individuals feel overwhelmed by the onslaught of information

provided by the outside world, leading to mental fatigue.

Mental fatigue, a common consequence of a TBI, may influence an individual's

ability to participate effectively in previous everyday work and social activities. Thus, it is

not surprising that many individuals with TBI report significant fatigue.

Research in the area of fatigue post injury has indicated that there is a relationship

between fatigue and physical, cognitive, emotional, and social factors. Individuals with

linguistic difficulties due to TBI related fatigue may experience difficulty with functional

language, and understanding these deficits is critical for speech-language pathologists, who

must understand the implications of fatigue on a client's ability to communicate effectively.

Systemic functional linguistics (SFL) is a theory of language use that focuses heavily on

linguistic choices as influenced by social context. This research used principles from SFL to investigate the language use of one individual after a moderate-severe TBI. The individual's interactions were analyzed to examine changes in her ability to successfully negotiate interactions that are secondary to the effects of fatigue. Overall findings indicated significant differences in the participant's use of modality and appraisal between non-fatigued and fatigued samples. Differences include increases in the participant's use of inclination and potential in modal auxiliaries, which demonstrate the participant's aspirational tone during non-fatigued language samples, as well as increases in negative appraisal during fatigued samples, demonstrating negative emotional involvement in these exchanges. These differences are discussed in light of assessment and self-reported survey results and implications for treatment are outlined.

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Finally, with all of my heart I thank my parents, Anne Kleinhesselink and John Swansinger, for being such a light in my life. Your overflowing love is what drives me, and your constant support is the reason I am standing here today.

Dedication

To Grandma, I love you most.

Table of Contents

List of Tables

List of Figures

Introduction

For individuals with traumatic brain injury (TBI), living with a combination of deficits with varying levels of severity can drastically impact their quality of life. One aspect of change is increasing levels of fatigue, which has been defined as "a state with reduced capacity for work following a period of mental or physical activity" (Ashman et al., 2008, p. 33). Fatigue can play an active role in an individual's ability to perform daily living activities, and it has been linked to lower cognitive performance in several studies (Belmont, Agar, & Azouvi, 2009). This study investigates the degree to which social language skills can be altered by fatigue in individuals after experiencing a TBI.

Literature Review

Traumatic Brain Injury

Traumatic brain injury (TBI) is one of the leading causes of death or long-term disability in the United States. According to the Centers for Disease Control and Prevention, all individuals are at risk for a TBI throughout their lifetime, especially in childhood or older adulthood. Researchers estimate that 10 million people are affected by TBI annually, with the global incidence of head injury at an estimated 106 individuals per 100,000, with twice as many males as females experiencing such an injury (Hyder, Wunderlich, Puvanachandra, Gururaj, & Kobusingye, 2007). Many of these cases are considered mild, with the National Centre of Health Statistics reporting that mild injuries, or mTBI, account for 85% of all TBI cases (Duff, Proctor, & Haley, 2002). Moderate cases occur in 12-14 individuals, with severe classification in 15-20 per 100,000 (Duff et al., 2002). Although medical advancements mean current survival rates are progressively higher, there are a variety of factors that influence an individual's ability to adapt to life after a TBI. Ylvisaker (2006)

1

states, "virtually any combination of strengths and deficits is possible after TBI, depending on the nature, severity, and location of the injury" (p. 246). These strengths and deficits may appear in the form of physical, cognitive, communicative and behavioral problems throughout recovery. Individuals with these injuries must adapt drastically to changes in neurological functioning that impact their cognitive skills. Cognitive deficits that manifest as attention, memory, executive functioning and processing difficulties mean that these individuals often feel overwhelmed by the onslaught of information provided by the outside world, leading to mental fatigue (Belmont, Agar, & Azouvi, 2009).

Mental Fatigue

Mental fatigue is observed in many individuals with a TBI, and it could be an important influence on an individual's ability to continue previous everyday work and social activities (Johansson & Ronnback, 2014). Living with fatigue can alter the outcomes of an individual's recovery, and it can exacerbate symptoms such as depression, weakness, or sleeplessness (Bushnik, Englander, & Wright, 2008). Recent studies have continuously worked to form a comprehensive definition of the phenomenon of mental fatigue, and researchers have hypothesized about how fatigue develops in individuals following a brain injury. Ashman et al. (2008, p. 34) predicted that fatigue may derive from "an imbalance between the amount of mental effort or activity required to perform a task and the internal resources that the person has available to perform it." Many studies cite the "coping hypothesis" of Van Zomeren et al. as a key cause of mental fatigue, indicating that fatigue serves as a compensatory coping mechanism for cognitive deficits and slower processing (as cited in Belmont, Agar, & Azouvi, 2009).

2

Characteristics of Fatigue

   Characteristics of fatigue vary greatly in both type and severity depending on the individual's specific injury and lifestyle. Fatigue is a common complaint among patients post-TBI, as shown in a study by Oullet and Morin (2006) where significant fatigue was reported in self-assessment by 68.5% of participants. With many individuals, returning to their pre-injury routines is a priority, and with enhanced understanding of changes in functioning after TBI, including fatigue, this may be an obtainable goal. Clinicians previously relied on patient history, interviews, and questionnaires to assess fatigue in their clients, with few adequate assessment tools to guide them (LaChapelle & Finlayson, 1998). Continued research in the area of assessment measures has resulted in improved instruments for measuring fatigue and related factors in individuals with TBI. The Mental Fatigue Scale (MFS), a self-reporting measure developed by Johansson and Ronnback (2014), is a checklist style scale that includes common symptoms reported after TBI and other insults and diseases to the brain or vascular system. The symptoms evaluated in this scale include mood swings, irritability, memory and sleep problems, and others. Other measures include the Multidimensional Assessment of Fatigue (MAF) and the Fatigue Severity Scale (FSS), which assesses the severity of fatigue in the areas of physical functioning, exercise, and socialization (Englander, Bushnik, Oggins, & Katznelson, 2010). Ever-improving measures help clinicians identify individuals with fatigue and give insight into its effects on their everyday lives. This information is indispensable to the planning of intervention and management techniques for these individuals.

Fatigue and Cognition

Research in the areas of fatigue post injury has indicated that fatigue has strong connections to many physical, cognitive, emotional, and social factors, as stated by Johansson and Ronnback (2014): "A typical feature of pathological mental fatigue after TBI or stroke is that the mental exhaustion becomes pronounced during sensory stimulation of when cognitive tasks are performed for extended periods without breaks" (p. 1). Individuals experiencing fatigue post-injury may also exhibit longer recovery time secondary to difficulties with restoring mental energy levels (Johansson & Ronnback, 2014). Cognition and its relation to fatigue has been studied in numerous contexts in the past decade, with researchers such as Van Zomeren and van den Burg linking fatigue to cognitive deficits, markedly in the area of attention (as cited in Belmont et al., 2009). Belmont et al. (2009) elaborated on this "coping hypothesis" assuming that the fatigue is the result of the coping strategies and efforts applied to deal with the cognitive difficulties experienced. Their results indicated that the participants' levels of fatigue correlated significantly with performance on attention tasks and with mental effort (Belmont et al., 2009). The correlations showed that "higher baseline fatigue was associated with higher mental effort and poorer attention performance" (p. 5, Belmont et al., 2009). Hence, they believe that because fatigue appears to increase with increased cognitive effort, it is possible that fatigue serves as a secondary coping mechanism to deal with the acquired difficulties.

Fatigue and Language

Nevertheless, whether a primary symptom of the physiological brain injury, or a secondary coping mechanism, the connection between mental fatigue and cognition goes beyond the individual's ability to perform cognitive tasks or maintain mental energy levels.

Language deficits are also commonly seen within this population. According to McDonald, Gowland, Fisher, Osborne-Crowley, and Honan (2014), individuals with TBI are observed to be "less appropriate, interesting, or rewarding and also more effortful to interact with than control speakers" (p. 1). Their studies indicated that participants were less capable of producing accurate details in conversations. Not only did these individuals exhibit communication difficulties, but results also demonstrated that executive functioning and Theory of Mind, both cognitive entities, impacted this deficit (McDonald et al., 2014). Byom and Turkstra (2012) found that individuals with TBI participated in conversations differently than controls, producing fewer thought and feeling related words, as well as using words inappropriately. These findings were based on research in the area of social cognition and its impact on conversation behaviors and social communication impairments (Byom & Turkstra, 2012). Individuals with TBI are also noted to exhibit a variety of pragmatic deficits, many of which have not been thoroughly examined (Bosco, Angeleri, Sacco & Bara, 2015). Bosco et al. (2015) explored the comprehension and verbal expression of individuals post-injury, in a variety of communicative interactions. Thirty participants were presented with videotapes depicting communicative exchanges and assessed on their ability to comprehend each task shown and respond accurately when adopting a communicative role. Results of their study found that participants demonstrated deficits in production of pragmatic phenomena including standard communicative acts, deceit, and irony (Bosco et al., 2015). The researchers expressed the need for an increased focus on studying individuals in a more natural setting, as well as continued research in assessing how communicative skills in different contexts may impact the daily lives of these individuals post-injury (Bosco et al., 2015). Current research is also calling for increasing studies of a qualitative nature to

provide more in-depth descriptions of cognitive-communicative deficiencies, in order to advance the assessment and treatment of communication disorders in this population. In 2015, Krug and Turkstra highlighted several checklists that they believe to be invaluable for measuring symptoms of mild TBI (mTBI). They also provided samples of standardized measures used to test cognitive and communication functions, explaining that two types of tests are often used by speech-language pathologists (SLPs): "(a) omnibus tests that give an overview of functions in a variety of cognitive domains, and (b) tests of specific cognitive and communication functions" (p. 21). While listing these valuable assessment resources, Krug and Turkstra (2015) also discuss an increased need for improved evidence-based practice guidelines in the area of assessment for clients with mTBI. These standardized and non-standardized measures of communicative functions post-injury are important in the accurate assessment of an individual's cognitive and linguistic skills and deficits after TBI. Including an assessment of fatigue may have a profound impact on the interventions used by SLPs while working with this population.

Implications for Speech-Language Pathologists

The impact fatigue has on an individual's language is often seen through the lens of social cognitive research, and many researchers do not point out a direct link between fatigue and communication. This is significant for speech-language pathologists, who must understand the implications of fatigue on a client's ability to communicate effectively. Hicks, Larkins, & Purdy (2011) express a need for further research in the fatigue management by SLPs in an effort to help their clients meet communicative and social goals. Research into the communicative skills and difficulties of individuals with fatigue after TBI will provide information about a topic area that has not yet been studied thoroughly and is of

vital importance to intervention in speech-language pathology. Struchen, Pappadis, Sander, Burrows, and Myszka (2011) stress that facilitating social communication post-injury is extremely important, and hence further research on fatigue and its impact on social communication is necessary. The increasing prevalence of TBI creates a critical need for an understanding of the role fatigue plays in the communicative abilities of these individuals, and an enhanced understanding may result in improved interventions for this population. The present study aims to provide a qualitative description of communicative skills in order to examine how they are impacted by mental fatigue. Hence, this research asks the following question: How does fatigue impact language skills after traumatic brain injury?

Methods

Participants

For this case study an English-speaking adult with a moderate-severe TBI as classified by loss of consciousness (between 30 minutes and 6 hours) and length of post traumatic amnesia (>24 hours) was recruited (Friedland & Hutcherson, 2013). Kate (pseudonym), KC in the excerpt transcripts, was a 53-year-old female from a middle-class socioeconomic background, and was two years post-injury at the time of this study, having been involved in a motor vehicle accident (MVA) in November 2012. Prior to her MVA, Kate was college educated (having previously received a bachelor's degree) and manager of a local business. After the injury Kate was high functioning but executive function difficulties interfered with her ability to secure and maintain a job, as well as her independence on higher-level cognitive tasks such as paying bills or filing taxes. She reported mental fatigue that commonly affected daily living activities, such as feeling

overwhelmed to the point of being unable to complete daily functions efficiently while remodeling her house, and was willing and able to participate in this research project. Written permission was obtained for involvement in this study. Additionally, 10 English-speaking healthy adults of similar age (ages 45-58), socioeconomic status, and educational background were selected as controls for this study. The Institutional Review Board (IRB) at Appalachian State University approved this study for the use of human subjects in research in October of 2015.

Recruitment

Kate was recruited from Appalachian State University's TBI therapy group, and controls were randomly selected from surrounding communities and graduate student families. Written consent was obtained before data collection and analysis began, and all participants were adequately informed both verbally and in writing that the study would focus on observing language concerns due to fatigue, and that while there may be societal benefit related to a greater understanding of fatigue, the research would be of no harm or benefit to any participant. The data collection occurred at a time during which Kate was also participating in group speech-language-pathology treatment for cognitive function. It was also emphasized to the participant and controls that they were not obliged to participate and were entitled to withdraw from the study at any time.

Design

This study utilized a qualitative, case study approach using the tools of systemic functional linguistics (SFL), an approach to linguistic analysis that views language as a strategic, meaning-making resource in which grammar serves a functional purpose for communication with others (Halliday and Matthiessen, 2014). Qualitative research has

greatly enhanced assessment and intervention techniques by speech-language pathologists, and it can contribute to a deeper understanding of communication. Qualitative research is defined as "a variety of analytic procedures designed to systematically collect and describe authentic, contextualized social phenomena with the goal of interpretive adequacy" (Damico & Simmons-Mackie, 2003, p. 132). Case studies are a frequently used approach to qualitative research (Damico & Simmons-Mackie, 2003). A case study may vary considerably in complexity, but it must portray a specific entity, whether person, topic, or agency (Stake, 1994). This research assumed the form of a case study, and the information learned may add insight into a specific area of interest in a single participant, namely communication abilities after experiencing mental fatigue. Information was collected based on many different facets of the case, including the nature, background, and setting.

Prior to sample collection, the Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI; Adamovich & Henderson, 1992) was administered to determine Kate's baseline measures of cognitive ability in various tasks based on five subtests: Perception and Discrimination, Orientation, Organization, Recall, and Reasoning. The SCATBI was chosen due to its ability to assess cognitive abilities without the benefit of functional application, as Kate has developed various strategies to compensate for functional tasks. To gain a quantitative baseline measure of her levels of fatigue, the Mental Fatigue Scale (MFS) was administered at the beginning of the study to determine the baseline levels of fatigue as perceived by Kate. The MFS was also administered to every control participant to gain a quantitative comparison of self-reported fatigue levels between healthy and brain-injured individuals. The MFS allowed for analysis of all participants' self-perception of fatigue over the past 30 days to gauge differences in how individuals see their own experiences and their

feelings surrounding these experiences of fatigue. This allowed for insight into possible

connections between Kate's communicative exchanges while fatigued and her reflective

thoughts on her levels of fatigue. The qualitative data, in the form of language samples, was

collected from Kate during everyday activities in order to create ample opportunities to

collect both fatigued and non-fatigued language samples. Two 30 minute segments were

chosen from these samples when the individual did not report fatigue, and another two 30

minute segments again after the individual reported significant fatigue. A sample was only

deemed to contain fatigued language after the participant verbalized fatigue either implicitly

('It's been a long day') in conjunction with nonverbal expressions of fatigue (slouching,

closing eyes, etc.), or explicitly ('I feel tired'). Thus, data collection involved one

administration of a fatigue self-assessment report to every participant, administration of the

SCATBI to the case study participant, and two one-hour recordings of interactions with Kate.

Data Analysis

This data was analyzed using the principles of systemic functional linguistics (SFL), a

theory of language use that focuses on linguistic choices as influenced by social context

(Eggins, 2004). Data analysis using a qualitative approach was interpreted with the aim of

uncovering functional information on the topic (Damico & Simmons-Mackie, 2003). Two

hours of video recorded data of social interactions were transcribed and analyzed to examine

language use and changes in the ability to successfully negotiate interactions that are

secondary to the effects of fatigue. Excerpts of these analyses were selected in half-hour

segments to highlight marked changes in communicative functioning following experiences

of fatigue. In total, two 30 minute segments of non-fatigued language and two 30 minute

segments of fatigued language were separately analyzed, equaling one hour in full of each

type of sample. For this study only the interpersonal metafunction was examined to gain an understanding of the effect fatigue has on interpersonal communication and social relationships.   In SFL the interpersonal metafunction includes the linguistic tools used to create "meanings about our role in relationships with other people and our attitudes to each other" (Eggins, 2004, p. 11). Interpersonal meaning is used to express attitudes and assume a role within a conversation (Eggins, 2004). Within the interpersonal metafunction, three categories will be investigated: speech function, modality, and appraisal.

Halliday refers to four different roles an individual can take in a conversation: giving information, receiving information, giving goods and services, or receiving goods and services (as cited in Eggins, 2004). These are described as the speech functions used to create dialogue between individuals (Eggins, 2004). Speech functions could include an individual making the offer "Would you like a cup of tea" to give goods or services, or demanding information with the question "Where are the car keys?"

The grammatical category of modality describes how an individual is able to express modalization and modulation (Eggins, 2004). Modalization outlines the meanings of probability, in which the speaker expresses the likelihood or probability of an event or being (e.g. "I might go to the store"), potential (e.g. "I could go to the store"), and usuality, in which the speaker expresses judgments about the frequency with which something takes place (e.g. "I always go to the store") (Eggins, 2004). The second subcategory of modality, modulation, explains the meanings of obligation and inclination. Obligation uses the grammatical structure of declaratives to imply that one must behave a certain way (e.g. "I need to go to the store"), while inclination answers the question "how willing am I to do something for you" (e.g. "I want to go to the store") (Eggins, 2004).

The third discourse semantic resource involved with interpersonal meaning is appraisal (Martin & White, 2005). Appraisal consists of three domains: graduation, engagement, and attitude (Martin & White, 2005). Graduation is the method by which an individual 'grades', or adjusts language to evaluate how weak or strong their feelings are toward a subject (e.g. "I *really* hate going to the store"). Engagement involves the way an individual uses language through the use of projection, modality, polarity, concession, and other comments to express involvement in the position held in the conversation (e.g. in response to an interlocutors account of the store "*Mhm, yeah,* a great store"). Lastly, Martin and White (2005) describe attitude as being "concerned with our feelings, including emotional reactions, judgments of behavior and evaluation of things" (p. 35). Attitude is further divided into three sections. The first, affect, explains how language is used to interpret emotional reactions (e.g. "He *loves* that store"). The next section, judgment, details how individuals judge behavior (e.g. "He *goes crazy* about that store"). Finally, appreciation looks into the resources one uses to see the value of different subjects (e.g. "That is a *good* store"). Overall, these aspects of appraisal are combined to explain how individuals use language to evaluate and adopt stances on topics in social communication (Martin & White, 2005).

Each of the described SFL tools were applied to the data in order to examine the differences in language use between non-fatigued and fatigued samples. These differences were discussed in light of the individual's reports on the Mental Fatigue Scale, the SCATBI scores, and also with the MFS reports of the control participants to gain insight into the fatigue experienced by the individual with TBI as compared to the control participants. Finally, the individual's mean length of utterance (MLU) was also calculated by running

transcripts through the SALT software program (Miller & Iglesias, 2010). This provided the researcher with an objective measure of how quantity of verbal language produced changes with fatigue in both the primary participant and the control subject (See Appendix D).

The current lack of qualitative insight into the communicative abilities of individuals with TBI indicated a need for a descriptive study that investigates the role fatigue plays in language deficits. The present study illustrates the characteristics of social communication that may be impacted most by fatigue, contributing valuable insight into appropriate intervention techniques for this population.

Results and Discussion

Scales of Cognitive Ability for Traumatic Brain Injury Results

Kate was assessed using the Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI; Adamovich & Henderson, 1992) at the Appalachian State University Communication Disorders Clinic. The normative sample of the SCATBI was developed using a sample of 322 subjects; head-injured subjects were used in norms construction, while non-injured subjects were used to estimate the difficulty of the subtests for healthy individuals and establish the SCATBI Severity Score. The results of the SCATBI assessment are shown below in Table 1.

Table 1: SCATBI Results

| *Subtest*	*Raw Score*	*Standard Score*	*Percentile Rank*
Perception/Discrimination	51	95	37
Orientation	20	119	90
Organization	28	115	89
Recall	35	101	53
Reasoning	40	110	75

Results of the SCATBI indicate that the participant experiences difficulties in the areas of perception, discrimination and recall, as evidenced by lower percentile ranks shown above. In the Perception and Discrimination subtest, the participant accurately responded to all visual stimuli presented. She demonstrated difficulty correctly responding to tasks providing auditory stimuli, especially in the presence of ambient noise. Her performance indicated that she is performing in the 37th percentile, as demonstrated by a standard score of 95. To assess orientation, the participant was asked various questions to determine her present orientation. She provided accurate responses to each question (e.g. "What day of the week is it? Tuesday."). Her performance indicated that she is performing in the 90th percentile, as demonstrated by a standard score of 119. The participant correctly responded to 7 of the 8 items presented during the Organization subtest. She was able to correctly group visual stimuli by category and determine the correct sequence of various events, with her performance indicating that she is performing in the 89th percentile, as demonstrated by a standard score of 115. To assess recall, the participant was asked to search pictures for a single image previously shown by the clinician. She was able to correctly identify signs and single objects, but she demonstrated difficulty finding objects in crowded drawings or on maps. Her standard score of 101 indicated that she is performing in the 53rd percentile. The participant demonstrated adequate problem solving abilities during tasks within the Reasoning subtest where she was required to explain a setting or provide a solution for various problems. She demonstrated difficulty providing logical conclusions to visual patterns. The participant's performance on this subtest indicated that she is performing in the 75th percentile, as demonstrated by a standard score of 110. The participant willingly underwent all tasks presented in the assessment; however, she reported detailed descriptions

of various everyday tasks that she experiences difficulty with, indicating cognitive difficulties in multiple areas. Although the participant demonstrated the ability to solve simple problems, the area of problem solving appeared to cause difficulty and frustration for her as she reported experiences of becoming 'overwhelmed' by information, which affects her memory and causes difficulties with organization or use of compensatory strategies. Additionally, the participant noted having trouble maintaining auditory attention in noisy environments, as well as experiencing word-finding difficulties. The results shown in Table 1 support her reports of difficulty when maintaining attention with ambient noise and her reports of memory difficulties. The difficulties identified by the SCATBI may lead to impairments in the participant's ability to perform complex tasks in various everyday settings.

Mental Fatigue Scale Results

The MFS (see Appendix A) was completed by participants to gain quantitative values of recent experiences of fatigue as reported by each individual while performing routine activities. Overall, 10 control participants completed the MFS. One control participant was eliminated due to an ongoing health issue that may have impacted the reliability of the scores. Hence, 9 participants' completed MFS surveys were compiled and compared to Kate's scores. The results shown in Figure 1 below highlight a stark contrast between Kate's results and the control participants' levels of reported fatigue in each prompted area. Additionally, Kate demonstrated difficulty completing the questionnaire itself, often expressing confusion or frustration with prompt questions.

Figure 1: MFS Results
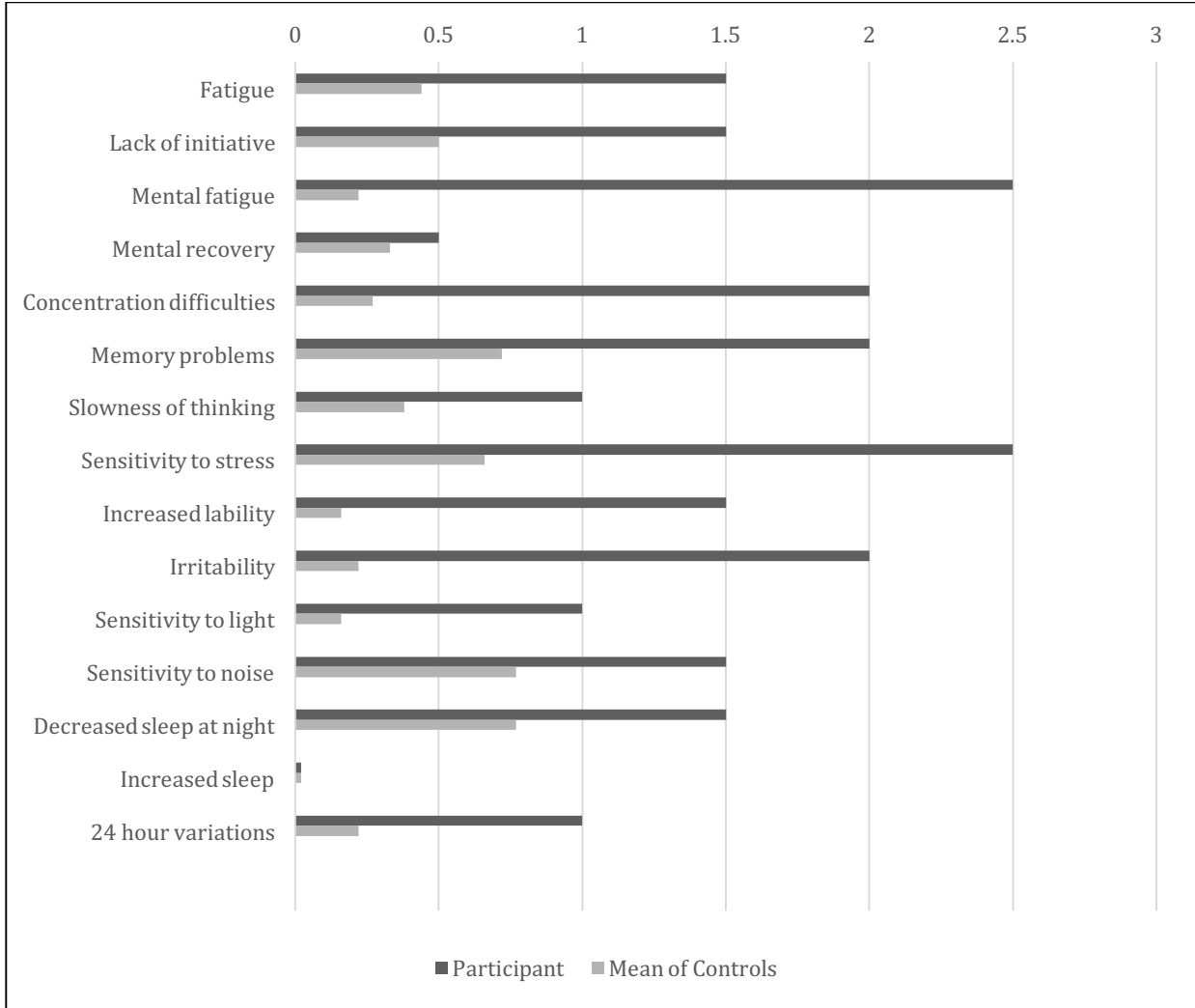
Results of each participant's MFS scores indicate that controls experienced much less fatigue overall when compared to Kate. These contrasts are particularly apparent in the third question regarding mental fatigue, where controls reported an average of 0.4 compared to the Kate's score of 2.5. Additionally, she exhibits a score that is 3.14 times greater than the mean of control participant scores (i.e. a score of 22 compared to the control average of 7). These heightened scores may be seen in light of the Kate's reports of various difficulties during everyday cognitive tasks, as shown above during administration of the SCATBI.

Language Analyses

The excerpts discussed in the following sections were chosen to highlight the differences in Kate's communicative functioning during periods of no fatigue as compared to when she explicitly or implicitly expresses experiencing fatigue (see Appendix C). Each excerpt corresponds to a separate, fully analyzed 30-minute language sample (see Appendix E). A key outlining the transcription and analysis conventions can be found in Appendix C.

Excerpt 1 (Non-Fatigued)

KC: well **Sarah**'s out of school again, **they** miss they miss so much school	GI
KC: **I** *would* really like **I** mean **I** know **I** *need* to do this but **I** *would* really *like* to get in there.	GI
LK: Uhhuh.	
KC: not today.	GI
LK: let's do this maybe we can get through a lot of this today and get and get in there for <a little bit yeah>	
KC: <or make a list anyway of what we're gonna do>	GI
KC: **I**'m *gonna* let them in : :05; :03	
KC: don't, **good boy, you** good boy, **I***'ll* give ya a chewy	GI, GG
KC: do it : :05 sit.	RG
LK: I see ya got a new addition.	
KC: **I** got that's, **I***'ve* had her.	GI
LK: you've had her.	
KC: but **my husband** ; :03 we **we** share custody {laugh} so to speak.	GI
KC: **he**'s the sweetest_smartest_**he**'s the smartest dog	GI
KC: and **I** said 'do you *wanna* take the beast; with you' and you know **he** was like 'oh no I*'ll let* you keep him'.	GI
LK: {laugh}	
KC: and **I** was like 'c'mon I *want* you to work with him' and **he**'s like ^	GI
LK: ok so this is your medical bill right.	
KC: now **that** is a huge thing going on.	GI
LK: okay.	
KC: and *maybe* **we***'ll* find it out because **I** have been going to the attorney's because **I** went to them and said 'um ok now' **I** said.	GI
KC: you know what I mean ; :03 **I** *keep* getting these letters.	GI
LK: Mhmm.	
KC: and **I** called the ho_hospital and **they** wanted me to do the whole thing again	GI
KC: **I**'m not *gonna* do that all that again, **I** mean ^	GI
LK: didn't they have you set up the last time?	
KC: yes and **she** said to do **it** all over again.	GI

This non-fatigued sample highlights Kate's notable use of positive appraisal, as shown in phrases such as "I would really like, good boy, and sweetest/smartest dog". Additionally, one of the two examples of negative appraisal ("beast") in the sample is used in context to tell a story in an ironic manner. This is important because although Kate uses negative appraisal in all samples, it is critical to consider the context of such language when determining the overall mood of the speaker's communicative exchanges. The phrases shown give her a significantly more positive tone than shown in fatigued examples. Kate exhibits two instances of disfluencies in her speech, one partial word repetition (i.e. "ho_hospital") and one phrase repetition (i.e. "he's the sweetest_smartest_he's the smartest dog"), each during periods where she was in the middle of a longer than average information giving story as compared to others in this example. She also demonstrates a wide variety of themes in this sample (i.e. "Sarah," "good boy," "my husband," etc.). Furthermore, Kate demonstrated good topic maintenance and transition abilities during this sample, as she was able to fluidly transition between various topics as her communication partner changed them.

Excerpt 2 (Fatigued)

KC: {exhales in a frustrated manner}	
KC: **I** mean **I** *don't want* to do this stuff.	GI
KC: **I** *can't* <u>think</u> through it.	GI
KC: **it** <u>seems</u> like **they**'*d* give you an assistant <or somebody>	GI
LK: <somebody would help you out>	
LK: right.	
KC: so now **I**'ve lost <u>all</u> that.	GI
LK: so do you need to keep any of this information?	
LK: do you need to try to talk to Cathy again?	
KC: **they** *don't* talk to her.	GI
LK: they don't talk to her?	
KC: that's why>	GI
LK: okay.	
KC: but **I** <u>don't know</u>.	GI
KC: I <u>just</u>>	
KC: it>	

18

LK: these charges, are on this.	
KC: okay.	RI
LK: so they're the same.	
LK: now; your payment plan was set up and X	
KC: XX cause **I** <u>don't know</u> who set up.	GI
LK: okay.	
KC: **I** *have to* have knowledge of this stuff to get sent that.	GI
LK: so that's why you're getting_getting all these letters from X	
LK: because they're separate^	
KC: but **I** *think* the **payment plan** was <u>only</u> on one>	GI
KC: <u>god.</u>	GI
KC: <u>only</u> on **one** and there's <u>so</u> **many** now.	GI
LK: yeah this is the account the payment plan was on.	
LK: so we rewrite what we've written in there.	
KC: okay.	RI

In this language sample Kate primarily demonstrates increased use of negative modality, including use of the words "don't" and "can't" as shown in this excerpt. The participant uses negative modal auxiliaries or clauses in 11 instances throughout this fatigued sample emphasizing a shift in attitude that occurs as she fatigues. Additionally, in this excerpt Kate uses the mental clause "I don't know" twice, and exhibits use of the words "I" and "they" as themes for a majority of her conversational turns. These mental clauses, when coupled with the high use of negative modality throughout the sample, indicate that she is using her feelings and perceptions to convey her thoughts and may be indicative of a heightened emotional state when fatigued, and introduces feelings of uncertainty into situations discussed. Kate also demonstrates significantly less variety in her use of thematic differences, commonly referring to "I" and "they" as themes in her utterances. Finally, when compared to the average MLU seen in other samples, Kate's utterances are much shorter (MLU of 4.11), demonstrating a lack of desire to elaborate on the topic discussed.

Excerpt 3 (Non-Fatigued)

KC: alright. Let's look in **there** because **what**'s missing *needs* to be_I mean **I** *need* to <u>know</u> how to put this stuff so ;02 that **it**'s ;03 like **I** *need* big folders that are about a year or so.	GI
SS: mhmm. Yeah about a year would be good so <XXX>	
LK: yes so then after that comma you can start talking about, um—	
SC: wait after where?	
LK: after right there where you put the thing {laughs} um so there you can add in stuff about_you can add in a whole new paragraph and make a list of things you think the NFL should have in the policy, basically they need to take action and that—	
KC: and a **list**, maybe, of what's in there ;02 would be good just written out so that **I** *can* look on the cabinet and say **that**'s in there.	GI
SS: mhmm.	
KC: okay I'm *gonna* hand you **this** goes with—	GG
SS: I'm going to write on here "fly shop" ;02 or "fly shop swatches"	
KC: ah, **this** is not fly shop	GI
SS: that one's house?	
KC: **this** is; no ;02 did **I** give you a—	GI, RI
SS: yeah, the house one's in the house	
KC: {looking through swatches}	
SC: is misconduct the same thing as <XXX>	
KC: misconduct—	
LK: <it could be like you're>	
KC: yeah **it** *could* be like **you** were being a <u>smartypants</u>	GI
KC: or a **kid**, misbehaving in class	GI
KC: **that's** ;04 there	GI
SS: okay	
KC: oh **this** goes with the house too sorry	GI, GG
KC: **this** goes with the shop	GI, GG

By participating in a communicative exchange with several others while simultaneously performing demanding mental tasks (i.e. organizing tax information), Kate demonstrates a noted increase in her ability to multi-task while not experiencing mental fatigue. In the initial part of this excerpt, she exhibits skill in working on tasks in the presence of distracting stimuli by continuing to organize materials while others in her immediate area discussed other subjects. Following this section, Kate then enters the outside conversation appropriately and effortlessly, as evidenced by her interjection "misconduct—"

and following statement "yeah it could be like you were being a smartypants". This indicates

that she was not just able to attend to her task while in the presence of background

conversation, but she was able to actively listen to the other speakers and formulate a

contributing statement while continuing to attend to her current task. Additionally, this

excerpt shows no use of "I" as the theme, with Kate always choosing other sentence

structures with varying words as themes to contribute to the conversation.

Excerpt 4 (Fatigued)

KC: {pulls out new folder with documents} ugh **this stuff** just goes <u>on and on and on</u>~	GI
KC: I guess **we** *should* go through all those things now ; :03 {sighs} <u>oh boy</u>.	GI
KC: are any of **these** okay this more of **those** {sets stack of paper aside, LK picks them up}	RI
LK: wow {laughs in reference to the size of the stack of papers}	GI
KC: <u>I know **I** know</u> {laughs}	
KC: **that**'s <u>a lot</u> of doctors.	GI
KC: alright maybe (w_) *should* **we** go through that?	RI
LK: through that we can I've no idea how to even begin with that {hands file to KC} but I^	
KC: **he** says separate 'em by the year and by the person.	GI
LK: okay	
KC: the dog **the dog** is right in the way.	GI
LK: okay let's move this filing box out of the way {picks up box and moves it out of camera shot}	
KC: {elbows LK} <u>Oops</u> <sorry>	GI
LK: <sorry>	
LK: this mileage folder what do you want to do with that? {hands folder to KC}	
KC: oh **this** is <u>trash</u> {hands paper to LK}	GI, GG
KC: **this** hmm {looks through folder} <u>I don't know</u> **I** gave them my other copy **I**'m *gonna* put that right here {sets file on chair beside her}	GI
LK: alright this is you this is you ^	
KC: what do **you** mean me? {takes glasses from the top of her head and puts them on}	RI
LK: I'm dividing them up by person first.	
KC: oh okay.	RI
LK: Kate.	
KC: alright and **I**'ll put it in there ^	GI
LK: Ralph.	

21

KC: wait ,where are **you** seein' the names?>	RI
LK: <Ralpht>	
LK: on the very top there {points to where she is reading names from paper and shows KC}	
KC: no **that** won't be where it i_oh well wait a minute ;03 oh wh_where are **you** seein' it?	GI, RI

Negative or neutral appraisal was increasingly evident in this excerpt when compared to others. The opening of this sample demonstrates this increase in Kate's use of appraisal to show frustration, with words and phrases including "on and on and on," "oh boy," "oops," and "trash". The use of negative appraisal in this language sample was higher than any other, indicating that Kate felt particularly discouraged during this communicative exchange. Additionally, frequent questioning is exhibited throughout this excerpt, as Kate appears to demonstrate greater difficulty in her ability to understand and follow the interaction taking place despite placing sole focus on only one task. This is notably different than Kate's apparent ability to actively contribute to a social discussion while focusing on other complex tasks while not fatigued (Excerpt 3).

Mean Length of Utterance

Overall, Kate demonstrated an average MLU of 5.75 in non-fatigued samples and 5.46 in fatigued samples (see Appendix D). While the difference between the MLU in non-fatigued and fatigued samples is not remarkable, it is worth noting that the total utterances and MLU in Sample 3 (non-fatigued) were considerably shorter than other samples due to the nature of the communicative exchange taking place. In this sample, Kate's abilities in multitasking were highlighted, and due to this she often interjected into conversations held by other conversational partners, often with short phrases to add points to the discussion quickly while still engaging in her planned tasks, or with significantly longer narratives to elaborate

on interjections before returning to tasks. This significantly alters the MLU of this sample, as it takes place in a much different communicative context than the other samples, which were based more on one-on-one exchanges.

"I" as Theme

Kate's use of themes varied greatly between samples, as shown below in Figure 2. Although Sample 1 showed a marked decrease in her use of "I" as the theme of a clause, this is not evident in the other non-fatigued language sample (Sample 3), which indicates higher levels of "I" as the theme of a clause than any other sample. Between the fatigued themes, Sample 2 demonstrates less use of themes than the other sample, with the Sample 1 showing the least use of any theme out of every language sample. These findings indicate that although Kate demonstrates a marked use of "I" as the theme of a clause in conversation, there is no notable difference in the use of themes between non-fatigued and fatigued language. According to Eggins (2004), "in face-to-face conversation, our point of departure for most of our messages is ourselves or those somehow connected with us" (p. 323). This supports the common use of "I" as the theme of many of Kate's utterances, as well as her inclusion of other "connected" themes including "they," "we," or "him" (her husband) throughout her communicative exchanges.

Figure 2: Use of "I" as Theme

Speech Function legend: ■ "I" as Theme ■ Other Themes
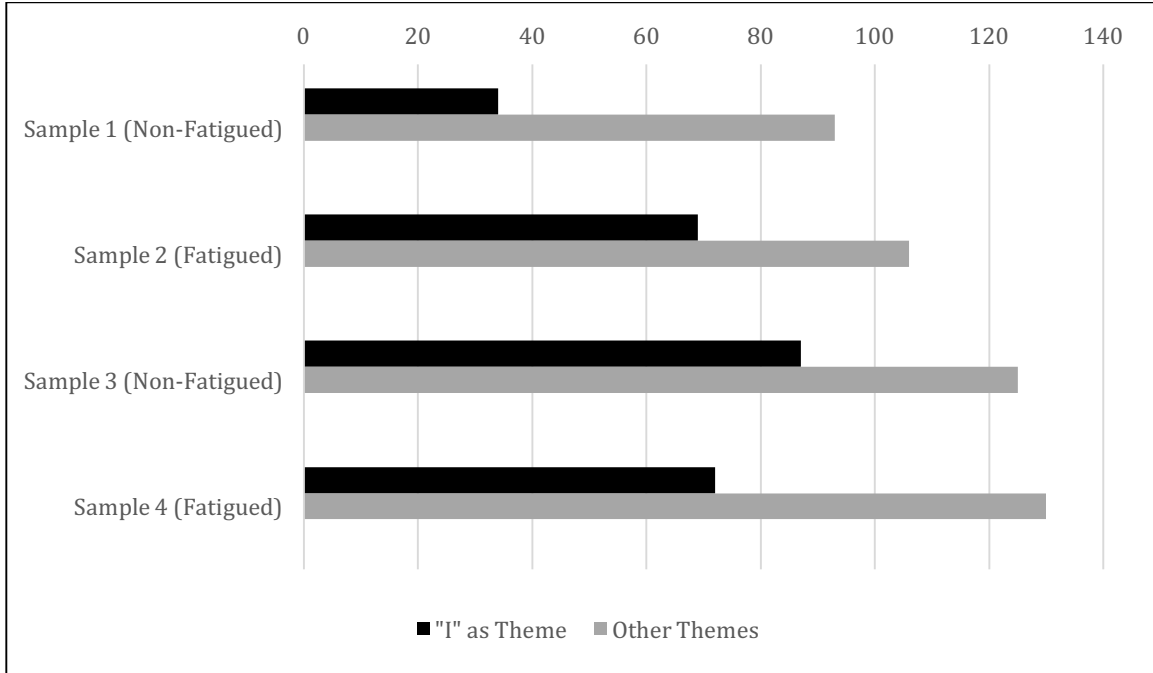
Speech Function

In both the non-fatigued and fatigued language samples, Kate demonstrated the speech function of giving information with more frequency than any other function, with the second most frequent function being receiving information, as shown in Table 2.

Table 2: Speech Functions in Non-Fatigued and Fatigued Samples

Speech Function	Non-Fatigued	Fatigued
Giving Information	64%	62%
Receiving Information	34%	35%
Giving Goods/Services	1%	2%
Receiving Goods/Services	1%	1%

These samples present a contrast from previous research indicating that individuals with brain injuries more commonly assume a receiving information role, likely due to clinicians

24

asking few questions as a method of controlling their interactions (Togher, Hand, & Code, 1996). This is largely due to the context of the communicative exchanges observed, which took place

in a setting in which Kate interacted with others mostly as a means of imparting information about her experiences or the current activity, or learning about strategies or current tasks from others. Additionally, the fatigued samples indicated no differences in the functions of giving and receiving goods and services, with Kate using one of these functions in 2% of clauses in non-fatigued samples and in 3% of fatigued samples. The samples indicate that many of these instances of giving or receiving goods and services involve misplacing the items necessary for completing tasks or expressing a need to move items to a different area to better organize tasks of increasing difficulty. These instances reflect back on the results of the SCATBI, especially in the Recall subtest, as well as her reports of experiencing cognitive difficulties on similar tasks to the ones found in the language samples. Overall, analysis of speech function indicates that Kate tends to assume a similar role in her contributions to conversations regardless of her level of fatigue.

Modality

Togher and Hand (1998) suggest that due to the sensitivity of modality analysis, it is a useful tool for the identification of interpersonal communication impairments, supporting detection of changes subsequent to fatigue in Kate's use of modal clauses. The most significant contrast between the non-fatigued and fatigued language samples is the noted increase in Kate's use of inclination in modal auxiliaries (i.e. "want" and "I'd really like") during periods in which she does not experience mental fatigue, as shown in Figures 3 and 4.

This is not surprising given that modality analysis is thought to be highly sensitive in the identification of interpersonal communication difficulties (Togher & Hand, 1998).

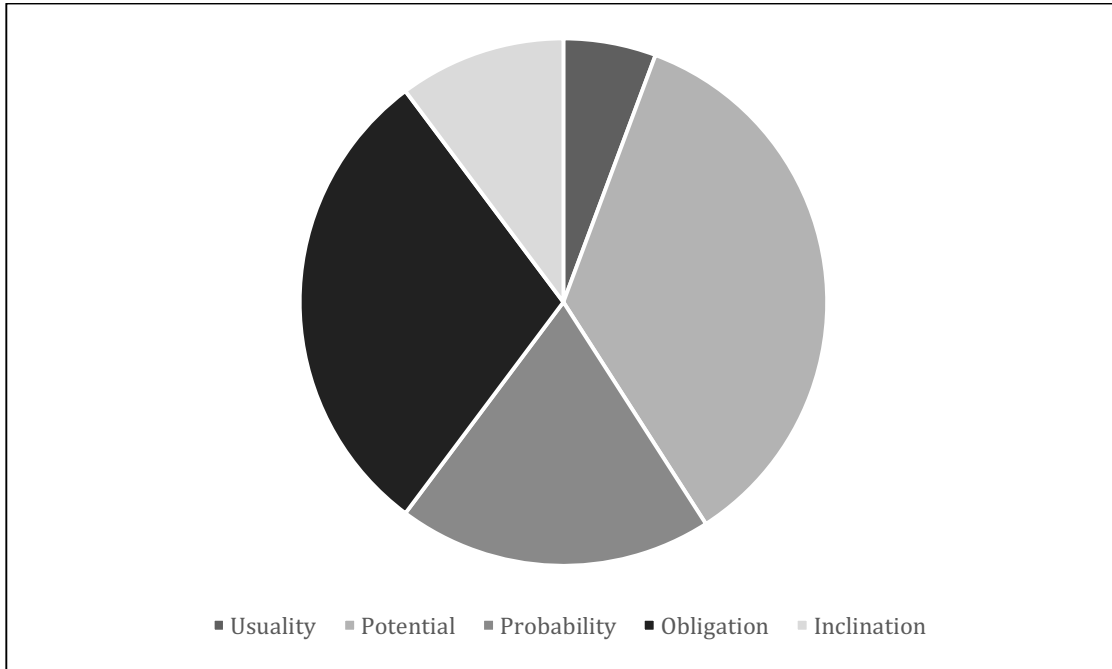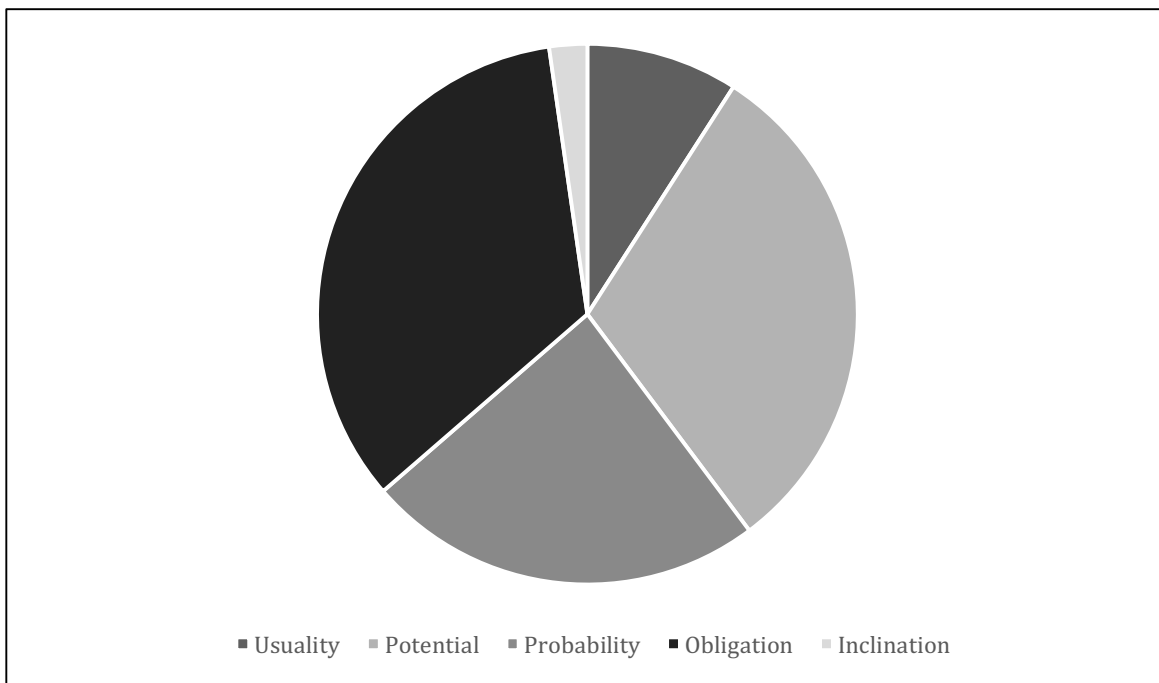**Figure 3: Types of Modality in Non-Fatigued Sample**

Usuality   Potential   Probability   Obligation   Inclination

Figure 4: Types of Modality in Fatigued Samples

Usuality   Potential   Probability   Obligation   Inclination

Inclination, one of the two facets of modulation (along with obligation), is "a way for speakers to express their judgments or attitudes about actions or events" in a range of degrees rather than just a standard "must do/must not do" or want to/don't want to" (p. 181, Eggins, 2004). The increase and varying degrees in which Kate uses inclination indicates that she exhibits a more aspirational attitude during non-fatigued communicative exchanges with others. Increased aspiration also corresponds to the elevated use of potential in non-fatigued samples, as she sees herself as more capable of achieving goals set for her by others or herself. This attitude increases the overall mood of Kate's communicative exchanges, indicating a more positive tone throughout her interactions with various conversational partners. This positive tone may have favorable implications for treatment, as aspiration can directly influence an individual's desire to set and work to achieve goals. This desire allows for clinicians and clients to work together to create goals that not only build the client's skills post-injury, but also work to restore abilities that are meaningful to the client (Ylvisaker, McPherson, Kayes, & Pellet, 2008). The inclusion of aspirational thought is further supported by Togher et al. (1996) through their identification of empowerment as a motivational construct and a method of strengthening a client's self-efficacy as they strive to accomplish treatment goals. Thus, these results may have implications for optimal rehabilitation intervention (i.e. during non-fatigued episodes).
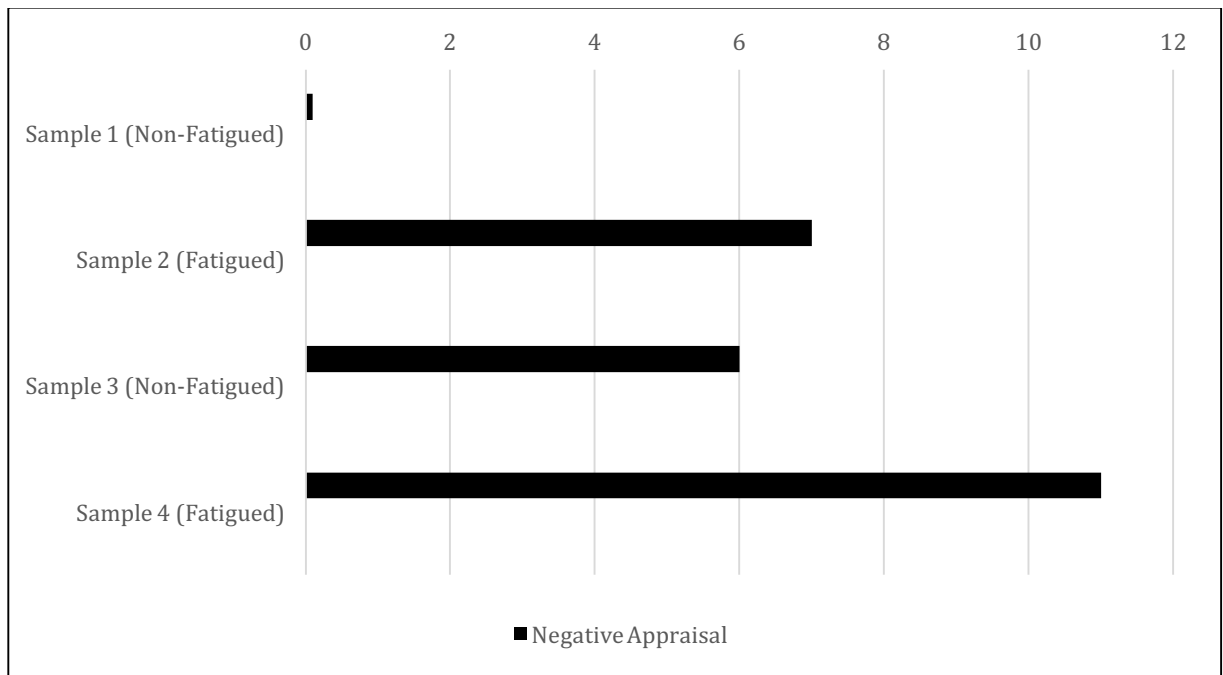
Appraisal

Significant variations were found in Kate's use of appraisal between the non-fatigued and fatigued samples, primarily in the quantity of negative appraisal exhibited when she experiences mental fatigue. As shown in Figure 5, Kate demonstrated increased use of negative appraisal (i.e. "god," "trash") during these instances when compared to non-fatigued

samples. This increased negative appraisal can be seen as a linguistic strength and a method of establishing identity in some individuals post-TBI (Keegan & McAdam, In Press). Keegan and McAdam (In Press) further elaborate that the use of negative language may be used by an individual post-injury as a means of emphasis and engage listeners by capturing attention and providing insight into their perspective. Hence, signs of negative appraisal in a client's language may be essential signals for SLPs to pinpoint topics that are engaging or emotional for a client and identify possible barriers caused by mental fatigue in heated discussion. The only non-fatigued sample that reaches near the same amount of negative language choices is Sample 3. Upon analysis of Kate's use of appraisal in this language sample, it becomes evident that much of the language used was in a narrative context while examining and expressing her opinion on controversial public events in the context of a social discussion. Examples of negative appraisal in this context included "this is sick" and "he ruined it". This use of appraisal, within the context of the discussion of a public event, differs greatly to Kate's appraisal of her situation and self, as seen throughout Sample 1. Thus, when comparing Sample 1 to Kate's fatigued language samples (Samples 2 and 4), both of which also demonstrate appraisal of personal topics, an evident difference is noted between her use of appraisal to comment on subjects that are relevant to her life while fatigued as compared to non-fatigued samples. Overall, Kate demonstrates less use of appraisal in non-fatigued samples than in fatigued samples. This shows that while she experiences fatigue, she also becomes more emotional, and includes greater amounts of appraisal (i.e. use of affect in utterances such as "oh my god") in communicative exchanges to express these emotions (Martin & White, 2005). This is not necessary in non-fatigued exchanges, as Kate demonstrates increased ability to engage in conversation without

exhibiting language choices that suggest a heightened emotional state. Byom and Turkstra

(2012) highlight that many individuals post-TBI already exhibit a heightened tendency to use

emotional terms in superficial conversations with others. During periods of mental fatigue,

these individuals may experience increased difficulty with maintaining social communication

with others by using inappropriate amounts of negative appraisal (see Figure 5). Due to the

already increased use of emotional language post-injury, the ability to manage negative

emotional language during interactions is imperative in many social situations, as it will

assist these individuals with maintenance of appropriate social interactions with varying

communication partners, especially those with whom the individual is not familiar with.

Figure 5: Use of Negative Appraisal

Conclusions

Analysis of three of the categories within the interpersonal metafunction of SFL

(speech function, modality and appraisal) between non-fatigued and fatigued language

highlights two points that exhibit potential clinical applicability for SLPs treating adults

following brain injury. First, the results suggest that the context in which a communicative

exchange takes place is vital to the examination of language, as the context of conversation

greatly influences the language choices exhibited. MLU analysis using SALT software

(Miller & Iglesias, 2010) highlights the importance of evaluating the context of each

interaction, as in multiple samples the situation in which Kate interacted with others

influenced the results. Additionally, use of negative appraisal was evident throughout all

language samples (e.g. "trash"/negative appreciation; "oh my god"/negative affect); however,

the non-fatigued samples contained significantly less use of negative auxiliaries, and many of

these were found within a narrative context (i.e. the participant expressing disgust at a current

event as it is discussed, using language including "awful"/negative judgment; "is that all he

got"/negative graduation). This highlights the importance of context in an individual's use of

appraisal, as Kate demonstrates use of appraisal both to evaluate or comment on public

events, as well as aspects of her own life or current situation, and the appraisal use in these

contexts have different functions (e.g. expressing negative opinion or expressing disillusion

with her own abilities). Hence, a deeper understanding of the context in which an individual

participates in communicative exchanges allows clinicians to more effectively navigate

situations in which their clients may demonstrate fatigue.

Second, this study demonstrates the applicability of SFL analysis as a useful clinical

tool for highlighting cognitive difficulties during various tasks, monitoring a client's

emotional state, and determining a client's ability to set achievable goals and maintain an

aspirational outlook in treatment. In all samples, Kate primarily assumed an information-

giving role. She also demonstrated similar use of speech function throughout all language

samples, regardless of her level of fatigue. Although the difference in the speech function of receiving information is not remarkable, the slight increases were noted to be due to cognitive difficulties that manifested as the increased need for Kate to find misplaced items or clarify information about items involved in current tasks. Additionally, major differences were evident in Kate's use of modality throughout all language samples, particularly in the increased use of inclination in non-fatigued samples. This, coupled with the increase in potential throughout non-fatigued samples, highlights Kate's more aspirational tone in her communicative exchanges when compared to the increased negative modality in fatigued exchanges. Benefits arise from adopting an aspirational stance following brain injury, especially during periods of rehabilitation. Ylvisaker et al. (2008) suggest that allowing clients to collaborate with clinicians to set goals for treatment (i.e. person-centered goal setting) allowed for a greater sense of accomplishment and satisfaction when these goals were achieved. This approach to treatment "allows [the participant] to consider other aspects of who [they] wanted to be" (p. 21, Ylvisaker et al., 2008). Finally, Kate's decrease in overall use of appraisal in her non-fatigued communicative interactions suggests that she is less prone to emotional exchanges while not experiencing signs of fatigue. This is in contrast to the increased use of appraisal to express emotions, often in negative forms, while fatigued. Through the use of SFL, clinicians may observe these linguistic markers in their own clients to pinpoint periods during which the client may need modifications in treatment due to experiences of mental fatigue.

Implications

It is critical for speech-language pathologists to be aware of the possibility that their clients may experience mental fatigue during therapy sessions, and by understanding the

linguistic markers of fatigue, they may be able to better tailor their treatment approaches to best work around these experiences of fatigue. As shown by the results of this study, emotional language is heightened as a client becomes more fatigued, and the use of negative language may also increase. Examination of this language using modality analysis may assist SLPs in identifying declines in interpersonal communication secondary to fatigue (Togher and Hand, 1998). Furthermore, as discussed by Keegan and McAdam (In Press), the use of negative language can be capitalized on in treatment, as it may highlight an individual's linguistic abilities that can be carried into other skills throughout intervention. These markers indicate that clients may be becoming agitated or discouraged, and they also may exhibit a decreased ability to maintain appropriate social interactions. When a client begins to demonstrate these linguistic markers, SLPs should be aware of increasing levels of mental fatigue and alter intervention approaches to better support these changes in mental status. By doing this, the clinician is able to provide the client with treatment that remains effective at targeting the client's goals without losing progress in the current session due to overwhelming fatigue. A possible method for combatting this mental fatigue is to allow for rest periods throughout treatment sessions, as suggested by Hicks et al. (2011) following incidences in which the client begins to demonstrate the linguistic markers discussed. These periods of rest allow for more effective treatment and support of the client's current cognitive abilities, as corroborated by Swain (2000): "While peripheral fatigue is managed with treatment such as rest, massage, and occupational therapy, the treatment of central fatigue needs a multidimensional approach including education, restructuring, and a balance between reasonable rest and activity" (p. 1). This multidimensional approach is vital to successful management of fatigue, and requires SLPs to be knowledgeable and watchful of their clients

throughout the duration of each treatment session. Clinicians must also be aware of their
client's non-fatigued demonstrations of positive linguistic markers as a sign of aspiration or
confidence in their potential. These markers may indicate that the client is willing to be an
active participant in their treatment and goal-setting, and clinicians should collaborate with
these clients using person-centered goal setting to enhance the client's engagement in therapy
tasks. By doing this, clinicians are able to support clients in building deeper feelings of
accomplishment by following the client's aspirational leanings since, as reported by
Ylvisaker et al. (2008), these clients are able to "experience for the first time since the injury
the satisfaction associated with achieving self-set goals" (p. 25).

Limitations

The nature of the communicative exchanges studied did not lead to many
opportunities to give or receive goods and services, therefore in all samples these functions
are limited and so not representative of the range of interactions an individual might
participate in. Thus, it may be beneficial in future studies to examine a wide variety of
interactions (e.g. shopping interactions, service interactions) as opposed to only instances of
conversational exchange. Additionally, a more in depth textual analysis identifying the
theme and rheme differences, may provide further information on the way material is
presented by participants when fatigued. Finally, although case-study, qualitative research is
invaluable for finding detailed, descriptive information about a topic, the use of a single case-
study participant makes it impossible to generalize the results of this research.

Future Directions

More research is needed to further explore how the varied and extensive tools of SFL
may provide insight into the differences in both fatigued and non-fatigued language

following TBI, both in typical populations as well as those with language disorders. Continued studies using transcript analysis software will also be able to examine differences between communicative exchanges of the same type (i.e. conversational, narrative, etc.). Analysis of these exchanges would require researchers to thoroughly examine each communication sample to determine the context of each exchange, whether the participant is one facet of a conversation with one person or several others, or if the participant is relaying information to others in a narrative structure. By determining the context and comparing these exchanges to others of the same type, researchers can more accurately determine differences between non-fatigued and fatigued language samples within the same setting.

Additionally, further analysis of the variety of themes exhibited throughout an individual's language choices will allow for a detailed comparison of the language choices used to describe the themes present in a topic while experiencing fatigue. Finally, the current study examines only one individual with a moderate-severe TBI who demonstrates a high level functioning. To generalize these results, further research must investigate the language choices of many individuals across different levels of severity to allow for comparison across a broad spectrum of impairment levels.

The prevalence of TBI in a variety of populations and continued medical advances improving the quality of life for individuals with brain injuries creates a critical need for understanding the role fatigue plays in the communicative abilities of these individuals. As speech-language pathologists, these findings and further research may influence treatment methods for this population. By applying functional methods such as those used in systemic functional linguistics for analyzing and detecting markers of fatigue in brain-injured individuals during communicative exchanges, speech-language pathologists will be better

prepared to provide intervention techniques that target the linguistic variables that are vital to maintaining positive interactions as they negotiate interactions that are secondary to the effects of neurological fatigue.

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Appendix A

Questions from the Mental Fatigue Scale (MFS), developed by Johansson and Ronnback and administered to participants at the beginning of the study.

1. **Fatigue**

   a. Have you felt fatigued during the past month? It does not matter if the fatigue is physical (muscular) or mental. If you recently experienced something unusual (for example an accident or short illness) you should try to disregard it when assessing your fatigue.

2. **Lack of initiative**

   a. Do you find it difficult to start things? Do you experience resistance or a lack of initiative when you have to start something, no matter whether it is a new task or part of your everyday activities?

3. **Mental fatigue**

   a. Does your brain become fatigued quickly when you have to think hard? Do you become mentally fatigued from things such as reading, watching TV or taking part in a conversation with several people? Do you have to take breaks or change to another activity?

4. **Mental recovery**

   a. How long do you need to recover after you have worked "until you drop" or are no longer able to concentrate on what you are doing?

5. **Concentration difficulties**

   a. Do you find it difficult to gather your thoughts and concentrate?

6. **Memory problems**

   a. Do you forget things more often than before, do you need to make notes or do you have to search for things at home or at work?

7. **Slowness of thinking**

   a. Do you feel slow or sluggish when you think about something? Do you feel that it takes an unusually long time to conclude a train of thought or solve a task that requires mental effort?

8. **Sensitivity to stress**

   a. Do you find it difficult to cope with stress that is, doing several things at the same time while under time pressure?

9. **Increased tendency to become emotional**

   a. Do you find that you cry more easily than previously? Do you often burst into tears when, for example, you watch a sad film or talk with your family members? If you recently experienced something unusual (for example an accident or short illness) you should try to disregard it in your assessment.

10. **Irritability or a "short fuse"**

    a. Are you unusually short-tempered or irritable about things that previously did not bother you?

11. **Sensitivity to light**

    a. Are you sensitive to strong light?

12. **Sensitivity to noise**

    a. Are you sensitive to noise?

13. **Decreased sleep at night**

a. Do you sleep badly at night? If you are sleeping more than before at night, please place a circle around the "0". If you are taking sleeping tablets and sleep normally, please place a circle around the "0".

14. Increased Sleep

a. Do you sleep longer and/or more deeply than before? If you are sleeping less than before, please place a circle around the "0". N.B. Please take account of time spent sleeping during the day.

15. 24-hour variations

a. Do you find that at certain times of the day or night the problems we asked about (for example tiredness, lack of concentration) are better or worse?

16. If you experience 24 hour variations:

a. When do you feel at your *best*?

b. When do you feel at your *worst*

Results from the Mental Fatigue Scale (MFS). Significant fatigue is indicated by a score above 10.5. KC (Kate) results located on far right in bold text.

Table 3: Participant Results

	MSH	JL	AJ	NB	LP	LW	AK	LA	DM	KC
1	0.5	0	1	0.5	1	0.5	0	0.5	0	**1.5**
2	0.5	0	0.5	1	1	0	1	0.5	0	**1.5**
3	0	0	0.5	0	1	0.5	0	0	0	**2.5**
4	0	0	1	1	0	0	1	0	0	**0.5**
5	0	0	1	0.5	1	0	0	0	0	**2**
6	0	0.5	1.5	1.5	1	0.5	1	0.5	0	**2**
7	0	0	1	0.5	1	0.5	0	0.5	0	**1**
8	0	0	2	2	0	0.5	1	0.5	0	**2.5**
9	0	0	1	0.5	0	0	0	0	0	**1.5**
10	0	0.5	0.5	1	0	0	0	0	0	**2**
11	0	0	0	1	0	0.5	0	0	0	**1**
12	0	0	2	1	1	1	1	0	1	**1.5**
13	0	1	1.5	0	1	1.5	1.5	0.5	0	**1.5**
14	0	0	0	0	0	0	0	0	0	**0**
15	0	0	0	0	1	0	0	0	1	**1**
TOTAL	1	2	13.5	10.5	9	5.5	6.5	3	2	**22**

Appendix C

Transcription conventions for language samples.

KC: Kate

LK: SLP

SS: Researcher

Unintelligible: XXX or (XXX)

Repetitions and Revisions: wo_word

Cut-off word: wor ^

Nonverbal Activity: {actions}

Timed Pause: ;03 etc.

Untimed Pause: .. or …

Overlapping Utterances: <words>

SFL analysis conventions for language samples.

Theme
Modality
<u>Appraisal</u>
Repetitions and Revisions
<u>Mental Verbs</u>
Speech Function (Reported to the right of each utterance)
      GI—Giving Information
      GG—Giving Goods and Services
      RI—Receiving Information
      RG—Receiving Goods and Services

Appendix D

SALT software analysis data.

Sample 1 (Non-Fatigued): 918 total words produced by Kate

STANDARD MEASURES		
	Client	**L**
TRANSCRIPT LENGTH		
Total Utterances	152	189
# Analysis Set (C&I Verbal Utts)	134	165
Total Completed Words	1052	1343
Elapsed Time (0:00)	0.00	0.00
SYNTAX/MORPHOLOGY		
# MLU in Words	6.85	6.79
# MLU in Morphemes	6.85	6.79
SEMANTICS		
# Number Different Words	285	343
# Number Total Words	918	1120
# Type Token Ratio	0.31	0.31
DISCOURSE		
% Responses to Questions	63%	85%
Mean Turn Length (words)	7.93	9.69
Utterances with Overlapping Speech	3	11
Interrupted Other Speaker	14	13
INTELLIGIBILITY		
% Intelligible Utterances	99%	95%
MAZES AND ABANDONED UTTERANCES		
# Utterances with Mazes	3	2
# Number of Mazes	7	3
# Number of Maze Words	7	3
# Maze Words as % of Total Words	1%	0%
Abandoned Utterances	4	1

Sample 2 (Fatigued): 711 total words produced by Kate

STANDARD MEASURES		
	Client	**L & M**
TRANSCRIPT LENGTH		
Total Utterances	211	247
# Analysis Set (C&I Verbal Utts)	173	211
Total Completed Words	915	1362
Elapsed Time (0:00)	0.00	0.00
SYNTAX/MORPHOLOGY		
# MLU in Words	4.11	5.46
# MLU in Morphemes	4.11	5.46
SEMANTICS		
# Number Different Words	253	349
# Number Total Words	711	1153
# Type Token Ratio	0.36	0.30
DISCOURSE		
% Responses to Questions	59%	68%
Mean Turn Length (words)	6.94	9.96
Utterances with Overlapping Speech	0	2
Interrupted Other Speaker	8	4
INTELLIGIBILITY		
% Intelligible Utterances	94%	96%
MAZES AND ABANDONED UTTERANCES		
# Utterances with Mazes	0	0
# Number of Mazes	0	0
# Number of Maze Words	0	0
# Maze Words as % of Total Words	0%	0%
Abandoned Utterances	21	17

Sample 3 (Non-Fatigued): 65 total words produced by Kate

STANDARD MEASURES		
	Client	**E&L&S**
TRANSCRIPT LENGTH		
Total Utterances	20	57
# Analysis Set (C&I Verbal Utts)	14	37
Total Completed Words	152	499
Elapsed Time (0:00)	0.00	0.00
SYNTAX/MORPHOLOGY		
# MLU in Words	4.64	7.38
# MLU in Morphemes	4.64	7.38
SEMANTICS		
# Number Different Words	45	155
# Number Total Words	65	273
# Type Token Ratio	0.69	0.57
DISCOURSE		
% Responses to Questions	23%	67%
Mean Turn Length (words)	8.10	17.73
Utterances with Overlapping Speech	2	4
Interrupted Other Speaker	3	5
INTELLIGIBILITY		
% Intelligible Utterances	93%	95%
MAZES AND ABANDONED UTTERANCES		
# Utterances with Mazes	0	0
# Number of Mazes	0	0
# Number of Maze Words	0	0
# Maze Words as % of Total Words	0%	0%
Abandoned Utterances	0	1

Sample 4 (Fatigued): 810 total words produced by Kate

STANDARD MEASURES		
	Client	**L**
TRANSCRIPT LENGTH		
Total Utterances	143	151
# Analysis Set (C&I Verbal Utts)	119	131
Total Completed Words	1051	1142
Elapsed Time (0:00)	0.00	0.00
SYNTAX/MORPHOLOGY		
# MLU in Words	6.81	7.17
# MLU in Morphemes	6.81	7.17
SEMANTICS		
# Number Different Words	271	301
# Number Total Words	810	939
# Type Token Ratio	0.33	0.32
DISCOURSE		
% Responses to Questions	58%	77%
Mean Turn Length (words)	10.32	9.22
Utterances with Overlapping Speech	4	9
Interrupted Other Speaker	7	9
INTELLIGIBILITY		
% Intelligible Utterances	90%	95%
MAZES AND ABANDONED UTTERANCES		
# Utterances with Mazes	2	1
# Number of Mazes	2	1
# Number of Maze Words	8	4
# Maze Words as % of Total Words	1%	0%
Abandoned Utterances	3	6

Appendix E

   To maintain the privacy of the participant and her conversational partners, full

transcripts are not included in this manuscript. Please contact the author with any questions

regarding SFL analysis of these samples or to view the analyzed transcripts used for this

study.

Vita

Shelby Nicole Swansinger was born in Cleveland, Ohio, to John Swansinger and Anne Kraft. She graduated from North High School in Eau Claire, Wisconsin, in 2010. In 2011, she graduated from the Defense Information School as a Broadcast Journalist in the Army National Guard before entering Utah State University in January 2012. In December 2014, she was awarded the Bachelor of Science degree in Communicative Disorders and Deaf Education. The following spring, she accepted a graduate assistantship in the College of Health Sciences at Appalachian State University and began study toward a Master of Science degree in Speech-Language Pathology. The M.S. was awarded in August 2016.