4-9-2015

Tell Us Your Story: Investigating the Predictive Ability of Trauma Narrative Linguistic Features

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TELL US YOUR STORY: INVESTIGATING THE PREDICTIVE ABILITY OF TRAUMA NARRATIVE LINGUISTIC FEATURES

by

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A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

Major: Psychology

The University of Memphis

May 2015

Abstract

Luno, Jeremy Adam. M.S. The University of Memphis. May 2015. Tell Us Your Story: Investigating the Predictive Ability of Trauma Narrative Linguistic Features. Major Professor: J. Gayle Beck, PhD

Linguistic features can predict several aspects of human behavior. Little is known, however, whether syntactic, semantic, and structural language features can also predict psychological disorders such as posttraumatic stress disorder. The current study investigated whether the linguistic properties in trauma narratives written by survivors of a Motor Vehicle Accident (MVA), change as function of the intensity of posttraumatic stress disorder (PTSD) symptoms. A short form diagnostic tool known as the Posttraumatic Stress Disorder Checklist (PCL) was used to determine the severity of participant PTSD symptomatology. Scores were then compared to linguistic variables from seven different computational algorithms. In an experiment participants were asked to write a neutral narrative or a narrative that described their traumatic event. Results from this study suggest that the relative intensity of PTSD symptomatology affects syntactic, semantic, and structural aspects of the narrative.

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Language patterns can be good predictors of relations in the world. For instance, language statistics can predict the modality of a word (Louwerse & Connell, 2011), the iconic relationship of words (Louwerse, 2008), social networks (Hutchinson, Datla, & Louwerse, 2012), and even geographical locations of cities (Louwerse & Benesh, 2012; Louwerse & Zwaan, 2009). Language patterns have also shown to be predictors of aspects of human behavior. For instance, linguistic features predict fraudulent events (Louwerse, Lin, Drescher, & Semin, 2010), an individual's personality type (Gill, Nowson, & Oberlander, 2009), whether an individual is lying (Hancock, Curry, Goorha, & Woodworth, 2004), and even the extent to which people visit their doctor's office (Campbell & Pennebaker, 2003). The intent of this study is to determine whether patterns in language use can also predict psychological symptoms, specifically symptoms of posttraumatic stress disorder (PTSD).

PTSD is a disorder diagnosed in persons who have "experienced, witnessed, or been confronted with events that involve potential death, serious injury, or a threat to the physical integrity of oneself or others" (APA, 2000, p. 467). PTSD patients will persistently re-experience the event (while simultaneously avoiding thoughts) and/or environmental reminders of the event, with those symptoms lasting for longer than one month. Specific symptoms include re-experiencing the traumatic event, avoiding thoughts of the event, suffering mental/emotional numbing, and experiencing physical hyper-arousal. These symptoms are further delineated to include flashbacks, nightmares, sleep difficulties, and irritability (APA, 2000).

PTSD was first observed and studied in the military community, but has since been studied in the civilian community as well (Kunst, Bogaerts, & Winkel, 2011; Resnick, Kilpatrick, Dansky, Saunders, & Best, 1993; Shercliffe & Colotla, 2009). Although combat exposure is one potential mode of PTSD induction, there are many others, such as rape-related trauma and motor vehicle accident (MVA) trauma, which both carry the hallmarks of events that can lead to PTSD. Even though there is no guarantee that an individual experiencing trauma will eventually develop PTSD, studies have addressed what factors can predict the development of this condition (Ehlers, Mayou, & Bryant, 1998). Percentage estimates of the prevalence of MVA survivors who develop PTSD vary widely. Recent studies have narrowed the range of prevalence estimates and suggest that 25% to 33% of victims will experience PTSD 30 days post-MVA (Beck & Coffey, 2007; Bryant, Harvey, Guthrie, & Moulds, 2000; Harvey & Bryant, 1999; Ursano et al., 1999). Despite the variance in percentage estimates, it is agreed that MVAs are significant events that often lead to the development of PTSD (Blanchard, Hickling, Taylor, Loos, & Gerardi, 1994; Ehlers, Mayou, & Bryant, 1998; Malt, 1988; Norris, 1992). For an overview of possible predictors for one type of trauma (i.e., survivors of an MVA), see Heron-Delaney, Kenardy, Charlton, and Matsuoka (2013).

The prevalence of PTSD has increased in recent years. Studies indicate that 20% of women and 9% of men will develop PTSD, while 7.8% of those diagnosed will live with the disorder indefinitely (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). The increase in prevalence is due not only to an awareness of the disorder in the clinical psychology community, but also to the development of diagnostic tools such as the PTSD

Checklist (PCL; Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). The PCL is a 17-item self-report measure that monitors trauma symptomatology much like the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1990), a 30-item semistructured interview considered the "gold standard" in the assessment of PTSD. Despite the CAPS being the longstanding method to assess PTSD symptoms, current research validates that the PCL correlates highly with the CAPS measure as well as with its diagnostic efficiency (Blanchard et al., 1996). One study demonstrated the reliability of the PCL even within highly specific civilian populations (e.g., college students, MVA survivors; Elhai, Gray, Docherty, Kashdan, & Kose, 2007). Indeed, these direct questions administered in the CAPS and PCL have proven to be a valid way of determining PTSD (Blanchard et al., 1996). However, they leave open the question whether there are alternative, perhaps less-direct measures that can similarly reveal PTSD symptoms identified by the CAPS and PCL.

Despite these effective methods for identifying PTSD, prognosis is often indeterminable. One main issue confounding recovery from the disorder is that sufferers have difficulty mentally integrating the event into their current cognitive schemas, as the event seems disconnected from other events in the sufferer's life narrative (Dalgleish, 2004). Dual representation theory suggests that the traumatic experience is mentally represented by two constructs, situationally accessible memories (SAMs) and verbally accessible memories (VAMs). Only VAMs can be deliberately retrieved; SAMs are activated by situation-dependent reminders of the event, which are often avoided by those suffering from PTSD (Brewin, Dalgleish, & Joseph, 1996). Despite the readily accessible nature of VAMs, the tendency for avoidance might explain why PTSD sufferers will still

report confusion of the details, as well as difficulty in forming coherent accounts of the traumatic event (Ehlers, Ehring, & Kleim, 2012).

Further complicating recovery is that sufferers of PTSD will often suppress thoughts related to the trauma. The ironic nature of thought suppression suggests that doing so will only heighten the intrusion of the traumatic event (Wegner, Schneider, Carter, & White, 1987). Shipherd and Beck (1999, 2005) used trauma language to demonstrate an intrusive-thought rebound of trauma-related thoughts following their deliberate suppression. In one stage of their experiment, participants were asked to write freely while suppressing trauma-related thoughts. Following the suppression task, participants were then allowed to write without restriction. Trauma-related thoughts appeared in the latter task with a greater frequency than during the suppression task, as well as relative to the baseline frequency of these thoughts. From these findings, as well as those from Ehlers et al. (2012), relevant questions arise. Can the language use of an individual who experiences PTSD symptoms reveal cognitive confusion and/or lack of clarity in their ability to recall the details of the traumatic event? Can their language reflect the tendency for avoidance or suppression of the event?

The hypothesis that language can predict behavior has been tested before. Gill et al. (2009) were able to demonstrate that personality traits can be measured by the lexical content of electronic messages. By analyzing the linguistic features of blogs and comparing these data with personality measures relative to their blog authors, Gill et al. quantified personality dimensions based on discrete linguistic features, such as verb tense, pronoun usage, and even discrete categories of language (i.e., positive and negative emotion words). More specifically, Gill et al. found that bloggers scoring high on the

neuroticism dimension used first-person singular pronouns and negative emotion words more than individuals with lower neuroticism scores. Bloggers with high neuroticism scores used fewer positive emotion words or words referring to time. Four other personality dimensions were considered (i.e., extraversion, openness, conscientiousness, and agreeableness), each dimension yielding a specific pattern in the bloggers' language.

Language patterns have been observed in deceptive and truthful communication, as well. Hancock et al. (2004) conducted a study in which participant dyads were used, one participant assigned as a sender of an electronic message and the other as receiver. In these dyadic conversations, senders communicated both deceptive and truthful statements to the participant acting as receiver. Using linguistic category analyses similar to the Gill et al. (2009) study, Hancock et al. found not only differences in the language used within both types of discussion, but also differences between participant roles. For example, during truthful communications, both senders and receivers used the same amount of words. However, during the deceitful communications, senders were found to use more words than did the receivers. During deceitful communication, both roles were found to have used more sense-related words (e.g., *see*, *touch*, *listen*), but senders were found to use more third-person pronouns than did the receivers.

Language has also been shown to reveal more global aspects of speech and discourse. Hayati and Maniati (2010) demonstrated that beggars follow a specific narrative structure in telling their personal anecdotes to passers-by. Borrowing from Labov's model of personal narrative (Labov & Waletzky, 1967), Hayati and Maniati suggest that a beggar's anecdotes follow a structure involving six narrative sections (i.e., abstract, orientation, complicating action, evaluation, resolution, and coda). But where

the Gill et al. (2009) and Hancock et al. (2004) studies involved discrete language units, the Hayati and Maniati study considered the broad-stroke features of narrative. Bearing in mind the utility and uniqueness of personal narrative, coupled with the ability of linguistic patterns to demonstrate mental processes and behaviors, one can again ask if there are patterns in the language of trauma survivors, as well.

Language use of trauma survivors has been previously studied. However, many analyses used in these studies consider the global qualities of trauma language (e.g., Mansfield, McLean, & Lilgendahl, 2010; Smyth, Stone, Hurewitz, & Kaell, 1999; Tausczik & Pennebaker, 2010; Tuval-Mashiach et al., 2004) as opposed to its more specific units (e.g., words). For example, Mansfield et al. describe the foci of their analysis of trauma narratives with the terms *complexity*, *personal growth*, and *resolution*. Similarly, Tuval-Mashiach et al. utilized the terms *coherence*, *self-evaluation*, and *meaning* to describe the foci of their analysis. These are notable and reasonable concepts to isolate within a trauma-related text, but again their measure was identified in a text as the result of interrater agreements. To be specific, in both the Mansfield et al. and Tuval-Mashiach et al. studies, two raters coded the narratives on predetermined dimensions defined by the experimenters. Interrater reliability was high (above .80 in both studies), but only after discrepancies were discussed and consensus was reached among the research team. Despite theoretical grounding of constructs and a high interrater reliability, the coding itself is prone to subjectivity. In many of these studies there is also a lack of control groups and control conditions, as well as a dearth of clinical samples (Römisch, Leban, Habermas, & Döll-Hentschker, 2014).

Many narrative studies are handled in this fashion, whether the narratives are trauma related or otherwise. However, there are more explicit methods of narrative analysis available, methods that consider word-level frequency as opposed to the isolation of contextual thoughts. In defense of computational methods of narrative analysis, Tausczik and Pennebaker (2010) highlighted two reasons to consider computational methods when analyzing trauma narratives. From their studies, it was found that, despite extensive training, raters do not agree in their ratings of most dimensions, especially when the rating involves a wide range of "deeply personal stories." The collecting of ratings by multiple judges for multiple documents is slow and expensive. Computational methods alleviate some of these issues, most certainly the issues related to time and quantity, but also the issue of subjectivity in regard to the coding of personal narratives. As well, computational methods capture details that might be overlooked or unconsidered in line-by-line coding of narratives.

The study outlined has two aims. First, in our analyses of trauma narratives, we wanted to isolate word-level constructs similar to constructs of the aforementioned studies, as well as test categories of language previously unconsidered, yet theoretically grounded. Second, this study aimed to use these linguistic measures not only to investigate textual differences between trauma and neutral texts, but also to explore the relationship of language use and trauma symptom severity as measured by the PCL. The linguistic models used in the current study were chosen with these intentions in mind.

Linguistic Model Dimensions

Few studies have utilized computational linguistic measures in the analysis of trauma narratives, but for those that have, the model most often used is Linguistic Inquiry

and Word Count (LIWC). Considering the longstanding use of LIWC in studies of trauma narratives, the majority of the categories used in this study come from this model. However, despite the lack of direct use of the other models used in this study, their inclusion is still warranted as they are relevant categories that reflect constructs previously used in narrative studies. Despite the reasonable sample size collected for this study, there is still danger of Type I error if too many categories are considered. With a large enough collection of word categories (i.e., too many dependent variables) some will reach statistical significance, but might offer no theoretically supported explanation for the data. To heed this caution, only categories previously reported in trauma narrative studies are used. The remaining categories' inclusion is supported by narrative and trauma study literature.

The models used are classified within the overarching *syntactic*, *semantic*, and *structural* dimensions, but are further delineated into subclasses that consider the specific utilities of each chosen model. Considering the bag-of-words computational approach to this study, most part-of-speech constructs are used (e.g., nouns, verbs, adjectives, determiners). However, these constructs often appear together in the same model category. For example, the LIWC category *death* includes nouns, verbs, and adjectives. The classifications used here serve to illustrate the various dimensions these models cover. Although there is overlap in part-of-speech components in the various categories, each of the categories used in this study aligns with one of the broad-stroke linguistic distinctions, syntactic, semantic, and structural. The word categories chosen from these models are further explained in the Predictions section that follows.

The first of the subdivisions featured is labeled as *syntactic*. The models included in this dimension analyze the features of text related to syntax. Two models are featured within this subdivision, *general linguistic features* (Biber, 1988) and *interclausal connectives* (Louwerse, 2002). Biber built a model using 67 linguistic categories, primarily syntactic, demonstrating their function(s) in the analyses of dialogue, literature and its subgenres, personal and professional correspondence, written public media, and public speeches. Factor analysis correctly classified genres based on six dimensions: four dichotomous dimensions and the other two explicit. Dimensions from this model are *Involved versus Informational Production*, *Narrative versus Non-Narrative Concerns*, *Explicit versus Situation-Dependent Reference*, *Overt Expression of Persuasion*, *Abstract versus Non-Abstract Information*, and *On-line Informational Elaboration*. Only seven categories from the Biber model were used here, all of which are component measures in the *Involved versus Informational Production* genre dimension.

The other model in this subdivision considers the syntactic utility of interclausal connectives. Louwerse (2002) built a taxonomy of interclausal relationships that can be used to demonstrate cohesion and coherence within a text. As with Biber's features, the connectives considered by Louwerse offer a more specific aspect of syntactic functions, namely words that function as connectors between otherwise disparate clauses. This model includes three groups, *additive*, *temporal*, and *causal*, the latter being the category used in this study. The causal category is further delineated into the groups *positive* and *negative*. These categories were included to investigate the fragmented nature of trauma recall and the direction of the clauses within the narratives (e.g., cause precedes effect or effect precedes cause).

The next subdivision is labeled as *structural*. The aspects of discourse captured in this dimension are labeled as *punctuation*, *word count*, and *type-token ratio*. Punctuation considers the frequency of periods, commas, quotes, and other nonalphanumeric characters. Word count is a simple count of the total number of words within a text. Type-token ratio (TTR) is the ratio between the number of words in the text, *tokens*, and the total unique occurrences of words in the text, *types*. For example, a text might have 100 words, giving that text a total of 100 tokens. However, some of these words might repeat. Every unique word is considered a type. The ratio is computed by dividing the total types by the total tokens then multiplying that number by 100. The resulting percentage can be used to better understand the lexical variety within a text. This ratio has been used in a host of research settings ranging from, though not limited to, studies of textual complexity, cognitive states, and education-level dimensions (Sherblom & Sherblom, 1987). The insight offered by the TTR into lexical density warrants its inclusion here, as textual density might indicate a trauma survivor's ability to convey meaning in written text.

The last of the subdivisions within our collected models is labeled as *semantic*. The measures included here are considered *bag of words* models. The bag of words notation implies that the categories within the specific model are built from a collection of words. In this regard, the measures featured under the semantic subdivision are concerned with the meaning of the words, and the categories within the models themselves are organized based on the semantic similarity of the words within each category. The semantic measures used here come from Pennebaker, Chung, Ireland, Gonzales, and Booth's (2007) Linguistic Inquiry and Word Count (LIWC). Categories in

this model are primarily semantic in nature, although there are a few syntactic measures in the model as well. The categories featured in LIWC, just as in the general linguistic features and interclausal connectives models, are measured by computationally extracting these features in written narratives. LIWC is made up of 84 word categories, such as *health*, where all the words in the category are in some way related to the concept (i.e., fever, cough, sneeze). Only 9 categories from the LIWC model were used in this study.

The current study used these linguistic categories to analyze written narratives produced by participants who experienced an MVA. The intent was to complement previous studies that examined trauma narrative language, but to include computational linguistic measures yet to be utilized in this type of investigation. The strength in using these models stems from the large spectrum of linguistic dimensions they offer. In total, the models featured here contain 157 semantic and/or syntactic word category dimensions. From the available categories within these models, only 21 were used in this study.

Similar to the studies featured here, the current study employed tasks involving written trauma narratives. Participants in this study were asked to write specifically about an MVA they experienced, and they were also asked to write about a trauma-neutral activity (see Methods section for task details). In addition to the linguistic features obtained in both the MVA writing and the neutral writing, participants completed the PCL to assess PTSD symptoms. The PCL scores obtained in our sample served as the independent variable with which the associated linguistic features were compared. Due to PCL scores falling on a continuum, it is possible that the usage of certain linguistic

categories will increase and/or decrease as a function of these scores, regardless of the type of text a trauma survivor might write.

Predictions

Syntactic categories were utilized in predictions concerning the thought structures of the trauma survivors, as represented in their recall of the traumatic event. Confusion, coherence, and clarity are terms used to describe the difficult nature of remembering the details of the traumatic event, as well as the difficulty in mentally integrating the event. Categories from the Biber model include all the ones related to the dimensions most relevant in his genre classification scheme *Involved versus Informational Production*. The texts procured in this study were expected to align with the personal letter, interview, and spontaneous speech genres from the corpus used in Biber's (1988) study. These text types are more involved than other texts within the genre classification, such as professional letters and press reportage. Many of Biber's measures from this genre classification require co-occurrence measures. As this study is only concerned with word-level constructs, only those measures not requiring co-occurrence analysis were included. The word-level linguistic category frequencies that predict these genres are as follows: *BE* as the main verb, determiners, emphatics, prepositions, the pronoun *It*, private verbs (i.e., verbs expressing private attitudes, thoughts, and emotions), and the seem/appear category (i.e., verbs of perception). Due to the dimensions that correspond to the Involved versus Informational Production classification, prepositions share a negative relationship with the other categories used here. For example, a more informative text (e.g., instruction manual) will have a higher incidence of prepositions and lower use of emphatics than a personal letter, which would yield more emphatics and fewer

prepositions. Therefore, excluding prepositions, it was hypothesized that a greater frequency of these categories would appear in trauma texts compared to neutral texts. The notion here is that the trauma narratives will demonstrate greater involvement than the events described in the neutral texts. Prepositions were expected to be lower in the trauma texts rather than the neutral texts. As well, excluding prepositions, it was hypothesized that these categories would demonstrate an increase in frequency related to participant PCL scores.

The remaining syntactic measures, both positive and negative causal connectives, come from the connectives model. Connectives are a crucial aspect of discourse demonstrating cohesion within a text, specifically cohesion between clauses (Graesser, McNamara, Louwerse, & Cai, 2004; Louwerse, 2002). Römisch et al. (2014) found an increase in clauses indicating narrative fragmentation in trauma recall. Frequencies of connectives in the texts collected here were expected to demonstrate this pattern. Due to the fragmented nature of trauma recall, as well as the understanding that the MVA was a cause to any subsequent effect in the narrative, an increase in clausal connectives was expected for trauma texts relative to neutral texts. Positive and negative causal connectives were both considered in order to identify the direction between clauses. Positive connectives indicate a forward progression between thoughts, whereas negative connectives would indicate a divergence of thoughts (i.e., hesitation, doubt, second-guessing). For trauma texts, an increase in negative connectives was predicted, whereas an increase in positive connectives was expected for the neutral texts. A positive relationship between PCL scores and the negative connectives was expected, whereas a negative relationship was expected for positive connectives.

The structural measures included here are closely related to the aforementioned syntactic measures. Again, since co-occurrence measures were not used in this study, aspects of syntax are evaluated on word-level constraints, just as punctuation and word count. Related to the expectation that in a search for event specifics a trauma survivor will produce more clauses, it was hypothesized that trauma texts would yield more punctuation compared to neutral texts. It was also hypothesized that punctuation would demonstrate a positive correlation with PCL scores. Studies have shown that word count is reduced in traumatic narratives written by those diagnosed with PTSD when compared to traumatic narratives written by non-diagnosed persons having experienced the same trauma (Rubin, 2011). Due to findings such as this, word count was expected to be lower in trauma texts when compared to neutral texts, as well as demonstrate a negative relationship with PCL scores. The last structural measure considered here is the type-token ratio (TTR). Considering the difficulty in communicating specifics related to the traumatic event, it was hypothesized that TTR would be greater in trauma texts, as an increase in lexical density would suggest a lack of clarity in the recall, despite the texts having been written by the individual who experienced the trauma. A higher type-token ratio would indicate that the subject matter is more difficult to communicate. TTR was also expected to share a positive relationship with PCL scores.

A variety of categories from the LIWC model have been used in previous trauma narrative studies (see D'Andrea, Chiu, Casas, & Deldin, 2012; Gamber, Lane-Loney, & Levine, 2013; Jelinek et al., 2010; Römisch et al., 2014; Rubin, 2011). For trauma narratives, the categories from LIWC most frequently used and consistently reported as significant are as follows: words of anger, anxiety, causation, cognitive mechanisms,

death, insight, negative emotion, positive emotion, and words of social relations. All categories featured here, excluding positive emotions, were expected to be greater in trauma texts; positive emotions were expected to be higher in neutral texts. A negative relationship between PCL scores and positive emotion words was expected, whereas a positive relationship was expected for the other featured measures from LIWC.

Method

Participants

Forty-three participants were selected from the University of Memphis's Department of Psychology research subject pool. Eight hundred thirty-six potential participants from the subject pool first completed an online prescreen questionnaire to identify whether they had experienced an MVA and to assess the severity of their trauma symptomology. For instance, a question from this questionnaire asked, "Have you ever been involved in a motor vehicle accident?" If the potential subjects selected "yes" to this question, they then completed the remaining questions (see Appendix A for questionnaires). Following this MVA questionnaire, if the subject was identified as having experienced an MVA, the participant was asked to complete a PCL screening to assess the presence of trauma-related thoughts, emotions, and behaviors. Once participants completed the questionnaire and the PCL, an email invitation was sent to the potential subjects, asking for their participation in the final portion of the study. One hundred fifty potential participants were invited to participate in the final study, with 43 electing to do so. Subjects who chose to participate in the final portion were directed to complete a computer-executed activity used to capture trauma-related anecdotal texts and texts of neutral form. Based on percentage estimates of PTSD prevalence, it was

hypothesized that 8 to 10 of the potential participants would score high enough on the PCL to consider a PTSD diagnosis.

One participant was removed from the analysis due to an interface malfunction that caused the trauma narrative instructions to appear twice, rather than once, eliminating the balance of contrasting text types necessary for each participant in this study. The average age for the remaining 43 participants (31 female, 12 male) was 22.14 years (SD = 6.15) with an overall range of 18 to 44 years of age. PCL scores ranged from 17 to 65 (M = 25.07, SD = 9.38). Two participants from the study (both female) produced PCL scores high enough to suggest a PTSD diagnosis (i.e., composite score of 44 or higher; Ruggiero, Del Ben, Scotti, & Rabalais, 2003). Our sample falls short of earlier reported PTSD prevalence estimates of 6.8% lifetime PTSD and 10% PTSD prevalence in subjects one-year post-accident (Kuch, Cox, & Evans, 1996).

Design

A 2 × 2 design was employed, both counterbalanced and randomized, where half of the participants first wrote about their MVA, while the others wrote the neutral text first. The neutral text asked participants to describe their day-to-day experiences on campus. Each condition included both tasks. All instructions were delivered electronically. Half of the selected participants first wrote about their MVA for 10 min, and then wrote for 10 min about an emotion-neutral memory task; the other half reversed this order. Each task, regardless of order, was partitioned by a cognitive distractor task to minimize carryover effects. A Sudoku puzzle was used as the cognitive distractor task. (Sudoku is a number-based puzzle game, configured in a 4 × 4 square, where puzzlers

must correctly place numbers into specific locations.) All texts were captured and stored by Qualtrics survey software.

Procedure

Following the provision of informed consent, participants were seated in front of a computer screen. Instructions for each task were included in the survey presentation. Depending on random assignment, participants were presented with instructions relevant to their condition. Regardless of condition, the text-capture tasks were 10 minutes in length. The participant typed into the text input box for 10 minutes, until the imbedded survey timer expired. Following the text capture from Phase 1, the experimenter administered the Sudoku puzzle to the participant. Subjects then worked on the Sudoku puzzle for 10 min. Once 10 min had expired, the experimenter prompted the participants to return their attention to the computer where they would find the instructions for completing Phase 2 of the text capture. In total, 86 texts were collected, one neutral text and one trauma text from each participant.

Measures

All participant texts were analyzed using the linguistic category algorithms discussed earlier. All linguistic category values were normalized to account for different text sizes, transforming the raw frequencies to a basis per 1,000 words of a text. These normalized scores were used as the dependent variables between text-type, and participant PCL scores.

Results

Mixed-effects models were built and compared for model fit using log-likelihood ratio tests. For the 21 linguistic model categories, using restricted maximum likelihood

estimation (REML), the best model fit to our data considered PCL scores, text type (trauma or neutral), and condition/order (trauma text written first or neutral text first) as fixed factors, and participants as random factors (Baayen, Davidson, & Bates, 2008; Brysbaert, 2007; Clark, 1973). *F*-test denominator degrees of freedom were estimated using the Kenward-Roger's degrees of freedom adjustment to reduce the chances of Type I error (Littell, Stroup, & Freund, 2002). Results demonstrated a significant relationship between PCL scores and 4 of the 21 featured linguistic models, as well as a significant relationship between text type for 15 of the 21 featured linguistic models. Results for analyses with and without participants as a random factor are reported in Table 2. Since PCL scores are a self-reported variable, it can be assumed that these scores are directly bound to the participant. Therefore treating participants as random factors could remove variance that is otherwise important to these results. However, only the significance of word count was affected by the removal of participants as a random factor; with random factors, word count was not significant, but was significant in the model without random factors. Due to this, only the results from the model with participants as random factors will be reported in-text.

Regarding order effects, only words of anger were affected by writing condition $F(1, 40) = 5.298$, $p = .027$. Participants who wrote about their MVA first were found to use words of anger more frequently in their neutral text than participants who wrote the neutral text first. The carryover effect found here could demonstrate an emotional sensitivity initiated by the trauma recall that persists beyond cognitive distraction. This pattern might partially explain why significant differences for words of anger were not found with any other independent variable.

Text Type Differences for the Syntactic Dimension

Text type differences were found for all categories from the syntactic dimension excluding positive causal connectives. *BE* as the main verb was found to be greater in trauma texts, $F(1, 42) = 22.965$, $p < .001$, as well as *determiners*, $F(1, 42) = 9.735$, $p = .003$, and the pronoun *It*, $F(1, 42) = 4.975$, $p = .031$. Categories found to be lower in trauma texts included *emphatics*, $F(1, 42) = 17.245$, $p < .001$, *prepositions*, $F(1, 40) = 8.244$, $p = .009$, *private verbs*, $F(1, 42) = 9.437$, $p = .004$, *seem-appear*, $F(1, 42) = 14.779$, $p < .001$, and *negative causal connectives*, $F(1, 55.53) = 4.044$, $p = .049$.

The findings here do not conform to the hypothesized pattern. All but one category reached significance, but the direction of difference for four of the syntactic measures was contrary to the hypothesis. The relationship of negative causal connectives and text type exhibited a pattern opposite from what was predicted, as the frequency of negative causal connectives was less in trauma texts than neutral texts.

The remaining syntactic measures came from the Biber model and were expected to align with the genre distinction of personal letters. It was expected that all syntactic measures, excluding prepositions, would be higher in trauma texts rather than neutral. However, emphatics, private verbs, and the seem-categories were all greater in neutral texts, just as was found with prepositions. This discrepancy might be explained by a lack of genre conformity or by the nature of the writing tasks.

Text Type Differences for the Structural Dimension

From the structural dimension, only type-token ratios reached significance and were found to be greater in trauma texts, $F(1, 42) = 12.991$, $p = .001$. The finding here

adheres to the hypothesized pattern; recounting a traumatic event is difficult to communicate.

Text Type Differences for the Semantic Dimension

From the semantic dimension, six of the eight categories demonstrated significant differences in text type. Words of *anxiety*, $F(1, 42) = 15.033$, $p < .001$, *death*, $F(1, 113.40) = 12.163$, $p = .001$, *negative emotion*, $F(1, 83) = 14.658$, $p < .001$, *positive emotion*, $F(1, 42) = 20.003$, $p < .001$, and *interpersonal relationships and behaviors (social)*, $F(1, 83) = 16.003$, $p < .001$, were all found to be greater in trauma texts. Only words of insight were found to be greater in neutral texts, $F(1, 83) = 5.340$, $p = .023$. For words of anxiety, death, and negative emotion, the predicted pattern was found. These categories were found to be greater in trauma texts.

Two of the categories that reached significance did not match the hypothesized relationship. Both words of insight and positive emotion words failed to adhere to predictions. For words of insight, it was expected that a greater frequency would be found in trauma texts; however the greater frequency of this category was found in neutral texts. For positive emotions, a greater frequency was expected in neutral texts rather than trauma texts.

Results of PCL Participant Scores

Only 4 of the 21 linguistic categories demonstrated a significant relationship with PCL scores. Two categories from the syntactic dimension reached significance, both determiners, $t(41) = –2.914$, $r(83) = –.29$, $p = .006$, and negative causal connectives, $t(148.45) = 2.217$, $r(83) = .23$, $p = .028$. From the structural dimension, only punctuation reached significance, $t(41) = 2.835$, $r(83) = .37$, $p = .007$. From the semantic dimension,

only words of death reached significance in relation to PCL scores, $t(113.40) = 2.603$, $r(83) = .27$, $p = .01$.

PCL scores and determiners demonstrated a negative relationship; as PCL scores increased, use of determiners decreased. This finding was opposite from what was expected. Negative causal connectives and PCL scores demonstrated a positive relationship in that there was an increase in use of negative causal connectives as PCL scores increased. The findings here align with what was predicted. As predicted, use of punctuation shared a positive relationship with PCL. As trauma symptom severity increased, there was an increase in use of punctuation. Words of death and PCL scores shared a positive relationship demonstrating the hypothesized pattern. As PCL scores increased, the use of words related to death increased.

Discussion

Most trauma narrative studies have looked at the types of language that arise in a text that describes the traumatic event. However, few have considered the impact of trauma symptom severity on a survivor's use of language. The study presented here sought to achieve two goals. The first was to utilize linguistic categories in the analysis of trauma narratives—measures that have not previously been used in a computational method. The second was to use these measures to not only test for textual differences between documents written by trauma survivors, but to also test whether trauma symptom severity can affect language use regardless of discourse method. There were discrepancies between some of the hypothesized relationships, but of the 21 featured linguistic categories, only 4 failed to demonstrate any relationship between text types and/or trauma symptom severity. From the findings presented here, there is support to

suggest that the structural and syntactic components of language might offer insight into trauma symptom severity, whereas semantic measures perform better at distinguishing text types.

Differences in text type were found for all three of the overarching dimensional categories: syntactic, structural, and semantic. However, many of these measures exhibited patterns opposite from what was predicted. From the syntactic dimension, negative causal connectives were found to be less frequent in trauma texts than in neutral texts, but the opposite was expected. The deficit of connectives in trauma texts could suggest a directness in thoughts related to the traumatic event, as opposed to the hypothesis that there would be a divergence in thoughts, or doubt in recall, due to a lack of event specifics. Although positive causal connectives failed to differ between text types, there is evidence that the use of connectives was consistent across texts (i.e., comparable frequencies for each text). Further study is required for a more accurate understanding of this counterintuitive finding.

All categories from the Biber model reached significance, but four were in opposition to the predicted directions. The seven categories used in this study were expected to demonstrate more involved production in trauma texts rather than informational production. This discrepancy could arise due to the fact that Biber's model represents dimensional constructs to classify genres, and the texts collected here might not conform to a traditional genre classification. Despite the intent of the neutral writing task to provide a control text, when comparing two texts written by the same person that capture different observations, it is possible both texts would gravitate to the 'involved' side of the 'Involved versus Informational Production' distinction. Both texts procured

from participants in this study could be considered similar in content to that of personal letters, which would not provide a distinct relationship between texts needed to correctly identify which factors would be present only in a trauma-related text. A more distinct collection of texts could be established if the neutral writing task required a participant to write instructions for a simple task, write a fictional anecdote, etc. Further experimentation is required in order to validate these findings.

From the structural distinction, as expected, TTR was found to be greater in trauma texts. This finding could indicate that more unique words are used in an attempt to accurately describe the traumatic event. Despite the potential for a trauma survivor to re-experience the event, there might still be a deficit in event specifics, as well as a lack of clarity in emotional integration of the event. These facets of PTSD symptomatology could explain why the TTR is higher for trauma texts as compared to neutral texts. As well, the increase in lexical density could demonstrate the difficulty in communicating traumatic events.

Previous trauma narrative studies utilizing computational linguistic measures traditionally used measures from the LIWC model. The semantic measures considered in this study were from this model and mostly conformed to patterns previously reported. However, not all reached significance, and two demonstrated a pattern opposing earlier findings, most notably, words of insight and positive emotion words. Words of insight were found to be more frequent in neutral texts, whereas positive emotion words were more frequent in trauma texts. As mentioned above, the problem here could be a similar issue with the subject of the neutral writing task; however, less frequent use of insight words in trauma texts could indicate avoidance, as insight words reflect the cognitive

activity necessary for evaluating and understanding a given situation (Barnes, Lawal-Solarin, & Lester, 2007). In this regard, it would be expected that this category would be lower for trauma texts. But again, a more distinct neutral text could alleviate this discrepancy.

Interestingly, the mean frequency of positive emotion words and negative emotion words was almost identical, with positive emotion words having a greater overall frequency in trauma texts than the negative emotion words (see Table 2). This seems counterintuitive to what should be expected; however in recounting a traumatic event, participants might use positive emotion words to demonstrate their current perspective (e.g., "I'm so happy that the accident wasn't worse"). It is still notable that trauma texts contained a greater magnitude of emotion-related terms than was found in neutral texts. Whether using positive or negative emotion words, participants were expressing more emotion in their recounting of the traumatic event.

The investigation into the predictive ability of trauma symptom severity as measured by the PCL yielded significant results, but was less fruitful than the findings related to text type. Only four of the featured linguistic variables reached significance in relation to PCL scores. However, for those that did, the hypothesized relationship was observed. As well, measures from each of the linguistic dimensions were represented. From the syntactic dimension, use of determiners decreased as PCL scores increased, whereas negative causal connectives increased.

Based on a trauma survivor's difficulty with remembering event specifics, use of determiners could decrease when recalling the traumatic event, as was found here. Since determiners are used for specificity and personalization in discourse, it is reasonable that

the traumatic event could impact the recall of trauma event specifics, but not necessarily the specifics for other personal experiences. Interestingly, this relationship between PCL scores and determiners was found to affect the participant's language irrespective of text type. However, it is difficult to say to what extent this relationship holds. The findings here suggest that the more intense the trauma symptoms, the less likely words of specificity will be used. Notably, this finding might not translate into other forms of discourse. It is possible that the relationship between determiners and trauma symptom severity is only present in the recalling of personal events. For example, trauma symptom severity might not affect use of determiners when a trauma survivor writes a speech or work email. Further study is required to determine the extent of this relationship.

An increase in the use of these connectives could indicate doubt and hesitation when recounting events; however this pattern does not match well with the pattern found in the text type differences. If the trauma survivors do experience doubt and second-guessing in their thoughts, and trauma symptom severity affects their language use, then negative connectives should have been higher in trauma texts than neutral texts. The finding here suggests that trauma symptom severity impacted the use of negative causal connectives, but inconsistently across text type. Further study is required to investigate this inconsistency.

From the structural dimension, there was a significant positive relationship with punctuation use and PCL scores. The pattern here was as expected, and adds support to the findings from the Römisch et al. (2014) study, that an increase in clauses demonstrates narrative fragmentation. In this regard, more punctuation could indicate more clauses. However, without co-occurrence measures to accurately identify clauses,

there is little support for this notion. More experimentation is needed to properly explain this finding.

Lastly, from the semantic dimension, only words related to death were significant in relation to PCL scores. As predicted, a higher PCL score yielded more frequent use of words in this category. Considering the nature of a traumatic event, words related to death are likely to arise in texts related to the trauma, as was found here. It is interesting that the use of these words shares a link to trauma symptom severity, which can potentially reveal itself regardless of the type of discourse. If the trauma experience was severe enough that death could have been a factor, considering the indeterminable prognosis for a trauma survivor, it is possible that the intensity of the experience was great enough that it would impact language use as a means of representing the intensity of the experience. However, it is doubtful that words of death would find greater usage in other types of discourse despite the finding here. This is difficult to pinpoint with the data collected here, as the personal reflective nature of the writing tasks potentially limits generalizability. Further study is required to see if this pattern is stable for other forms of discourse.

The study outlined here investigated the predictive ability of trauma symptom severity on a trauma survivor's language use. As well, the procedures and measures utilized here mirror previous trauma narrative studies in an attempt to validate earlier findings while identifying linguistic variables previously unconsidered in this type of experiment.

Considering only 4.6% of the participant population scored high enough on the PCL to possibly warrant a PTSD diagnosis, there is not strong support for reflection of

trauma symptom severity in language. It is possible that with a sample population representing higher-end PCL scores, these patterns would still hold, but the converse is just as plausible as a higher concentration of these scores could invalidate the findings here. However, despite this shortcoming, there is support that trauma texts share a distinct pattern of language use irrespective of trauma symptom severity. The majority of categories featured in previous trauma narrative studies were also found to be significant here, although the population of participants in this study were not diagnosed as having PTSD, as was the case with earlier studies (D'Andrea et al., 2012; Gamber et al., 2013; Römisch et al., 2014).

With this in mind, it is odd to find that these same categories would arise in a text written by a trauma survivor, but one who was not diagnosed with PTSD. In this regard, there seem to be consistent factors that differentiate trauma texts from other forms of narrative text, but not necessarily the presence of PTSD. Thus, it could be that the experience of a traumatic event alone affects aspects of language, irrespective of PTSD presence. Since the findings here produced the same patterns as a clinical sample, the linguistic variables might say more about the nature of a traumatic event experience, rather than PTSD symptom severity. In other words, texts procured from a clinical sample of PTSD patients demonstrated similar patterns to the trauma texts procured in this study, where only 4.6% of the population might be suffering from PTSD. As Römisch et al. (2014) pointed out, trauma narrative studies are often limited by clinical samples and lack of control group/tasks. The findings here lend credence to their observations. It is difficult to disentangle the absolute differences between a trauma narrative written by a trauma survivor and one written by a trauma survivor suffering

from PTSD. These linguistic components could aid in the classification of trauma texts, as in a genre of trauma experience, but not necessarily in the identifying of trauma symptom severity or PTSD.

In considering these data, it is important to recognize limitations. First, due to the PCL being a self-report measure, ratings of trauma symptom severity might not match with a clinical diagnosis, despite studies assuring its efficacy. It is possible that participants might be suffering from PTSD despite their lower PCL scores, or it could be the opposite—that participants scoring high enough might have a confounding influence producing their higher scores. There was also a lack of data related to the date and time of the accident. The prescreening questionnaire did address this; however most respondents either chose not to answer this question or could not remember the necessary information. This is a crucial variable for understanding the lingering nature of trauma exposure.

Despite the shortcomings of the study presented here, there is evidence that supports previous findings related to the language of trauma recall, while offering new measures previously unused in this type of narrative study. As well, there is evidence that trauma symptom severity can affect a trauma survivor's language use. From the findings presented here, a linguistic model for trauma narrative will be built and used to test a clinical sample of texts written by trauma survivors diagnosed with PTSD. Future directions include investigating the potential to detect PTSD in undiagnosed individuals, as well as testing the integrity of the relationship between trauma exposure symptom severity and language, by repeated measure observation of therapeutic interventions involving narrative production. For an individual diagnosed with PTSD, increases or

decreases in linguistic category use over time could be used to identify recovery or regression.

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Appendix A

Prescreen Questionnaire

1. Have you ever been involved in a Motor Vehicle Accident?
   Yes/No

2. Have many times have you been involved in a Motor Vehicle Accident?
   Once
   Twice
   3 Times
   4 Times
   More than 4 Times

3. What was the date of your most distressing Motor Vehicle Accident?
   Month:___
   Year:____

4. Were you seriously injured?
   Yes/No

5. Did you receive medical attention?
   Yes/No

6. Was anyone else badly injured or killed in the accident?
   Yes/No

7. Did you experience intense fear helplessness, or horror during or after this accident occurred?
   Yes/No

8. If Yes, rate your feelings of fear, hopelessness, and/or horror that you experienced during your most distressing Motor Vehicle Accident:

   SCALE: 0 (none at all) to 100 (most I have ever experienced)

   Fear: How afraid were you? ___
   Helplessness: How helpless did you feel? ___
   Horror: How overwhelmed or shocked were you? ___

Posttraumatic Stress Disorder Checklist (PCL)

Instructions: Below is a list of problems and complaints that people sometimes have. I'd like to know how much you have been bothered by each problem in the last week. The response scale is:

Not at all (1) - A little bit (2) - Moderately (3) - Quite a bit (4) – Extremely (5)

1. Repeated, disturbing memories, thoughts, or images of your Motor Vehicle Accident?
2. Repeated, disturbing dreams of your Motor Vehicle Accident?
3. Suddenly acting, or feeling as if the Motor Vehicle Accident was happening again?
4. Feeling very upset when something reminded you of the Accident?
5. Having physical reactions (e.g. heart pounding, trouble breathing, sweating) when something reminded you of the accident?
6. Avoiding thinking or talking about the Accident, or avoiding having feelings related to the Accident?
7. Avoiding Activities or situations because they remind you of the Accident?
8. Trouble remembering important parts of the Accident?
9. Loss of interest in activities that you used to enjoy?
10. Feeling distant or cut-off from other people?
11. Feeling emotionally numb or being unable to have loving feelings for those close to you?
12. Feeling as if your future somehow will be cut short?
13. Trouble falling asleep or staying asleep?
14. Feeling irritable or having angry outbursts?
15. Having difficulty concentrating?
16. Being "superalert" or watchful or on-guard?
17. Feeling jumpy easily startled?

Appendix B

Table 1

Linguistic Category Dimensions, Names, and Examples

Syntactic Category Measures	*Examples*
BE as Main Verb	be
Determiners	a, an, the, that
Emphatics	for sure, really, a lot
It Pronouns	it
Prepositions	at, by from, over
Private Verbs	anticipate, decide, recognize
Seem-Appear	seem, appear
Negative Causal Connectives	although, nevertheless
Positive Causal Connectives	because, if, only if
Structural Category Measures	*Examples*
Punctuation	. , ? ! ' ; " :
Word Count	count of words
Type-Token Ratio	(see in-text description)
Semantic Category Measures	*Examples*
Anger	cruel, enemy, hate
Anxiety	afraid, desperate, fear
Causation	allow, comply, changed
Cognitive Mechanisms	accept, believe, reason, understand
Death	alive, dead, dying, deceased
Insight	admit, decide, recall
Negative Emotion	aching, crying, horror
Positive Emotion	calm, love, openness
Social	cellphone, wife, listen

Table 2

PCL and Text Type Results

Linguistic Category	With Random Factors		Without Random Factors		Trauma	Neutral	
	t	*p*-value	*t*	*p*-value	*M*	*M*	*p*-value
BE as Main Verb	–0.698	.489	–0.731	.467	5.26	3.86	.001**
Determiners	–2.914	.006**	–2.942	.004**	10	8.9	.003**
Emphatics	0.892	.378	0.953	.343	0.67	1.34	.001**
It Pronouns	–0.565	.575	–0.618	.538	1.16	0.86	.031*
Prepositions	–1.31	.198	–1.332	.187	9.6	10.7	.009**
Private Verbs	0.807	.424	0.888	.377	1.59	2.15	.004**
Seem-Appear	0.454	.653	0.505	.615	0.04	0.22	.001**
Negative Causal	2.217	.028*	2.16	.034*	0.01	0.04	.049*
Positive Causal	–0.629	.533	–0.687	.494	1.41	1.54	.406
Punctuation	2.835	.007**	3.652	.000***	7.61	7.52	.723
Word Count	1.446	.156	1.998	.049*	333.65	340.16	.455
Type-Token Ratio	–0.508	.614	–0.605	.547	75.25	71.42	.001**
Anger	–0.34	.736	–0.358	.722	0.45	0.38	.538
Anxiety	1.018	.314	1.098	.276	0.75	0.35	.001**
Causation	–1.495	.139	–1.495	.139	1.69	1.87	.494
Cognitive Mechanisms	–0.288	.775	–0.342	.734	14.88	15.37	.287
Death	2.603	.01*	2.603	.011*	0.35	0.09	.001**
Insight	1.548	.129	1.637	.105	1.56	2.06	.018*
Negative Emotion	0.921	.36	0.921	.36	2.47	1.55	.001**
Positive Emotion	–0.425	.673	–0.443	.659	2.98	1.76	.001**
Social	0.012	.99	0.012	.99	6.95	4.59	.001**

Notes. Negative *t*-value indicates an inverse relationship with PCL scores. *$p < .05$. **$p < .01$. ***$p < .001$.

IRB Approval

THE UNIVERSITY OF MEMPHIS

Institutional Review Board

To: Jeremy A. Luno
Psychology

From: Chair, Institutional Review Board
For the Protection of Human Subjects
irb@memphis.edu

Subject: Tell Us Your Story (091311-864)

Approval Date: September 22, 2011

This is to notify you of the board approval of the above referenced protocol. This project was reviewed in accordance with all applicable statuses and regulations as well as ethical principles.

Approval of this project is given with the following obligations:

1. At the end of one year from the approval date, an approved renewal must be in effect to continue the project. If approval is not obtained, the human consent form is no longer valid and accrual of new subjects must stop.
2. When the project is finished or terminated, the attached form must be completed and sent to the board.
3. No change may be made in the approved protocol without board approval, except where necessary to eliminate apparent immediate hazards or threats to subjects. Such changes must be reported promptly to the board to obtain approval.
4. The stamped, approved human subjects consent form must be used. Photocopies of the form may be made.

This approval expires one year from the date above, and must be renewed prior to that date if the study is ongoing.

_____
Chair, Institutional Review Board
The University of Memphis

Cc: Dr. Max Louwerse