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Story Grammar Analyses Capture Discourse Improvement in the First 2 Years Following a Severe Traumatic Brain Injury

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ABSTRACT

Purpose: Narration within a story grammar framework requires speakers to organize characters and events logically. Despite abundant research characterizing narrative deficits following a traumatic brain injury (TBI), the evolution of narrative story grammar over the first 2 years post-TBI has rarely been explored. This study analyzed story grammar in complex narratives of adults with and without severe TBI to (a) examine between-group differences and (b) investigate longitudinal changes over the first 2 years post-TBI.
Method: Story grammar analyses of *Cinderella* narratives from 57 participants with TBI and 57 participants with no brain injury yielded measures of productivity (total number of episodes, total number of story grammar elements), elaboration (total number of elaborated–complete episodes, mean number of episodic elements per episode), and completeness (total number of incomplete episodes). Mann–Whitney *U* tests compared measures across groups; generalized estimating equation (GEE) models identified predictors of change, including recovery time (3, 6, 9, 12, and 24 months post-TBI) and demographic/injury-related characteristics.
Results: Between-group differences were statistically significant for all productivity and elaboration measures at 3, 6, and 9 months post-TBI; one productivity measure and one elaboration measure at 12 months; and none of the measures at 24 months. GEE models showed significant improvements in all productivity and elaboration measures over the first 24 months post-TBI, with educational attainment and duration of posttraumatic amnesia affecting recovery. Incomplete episodes only showed between-group differences at 12 months and did not capture recovery.
Conclusion: Productivity and elaboration are key story grammar variables that (a) differentiate complex narration in individuals with and without severe TBI and (b) capture narrative improvements over the first 2 years post-TBI.
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Narrative discourse, or storytelling, is often impacted following a traumatic brain injury (TBI; e.g., Coelho, 2002; Marini et al., 2017). Given narration's essential role in everyday communication, narrative deficits in adults with TBI have unsurprisingly been linked to poorer employment, relationship, community reintegration, and quality-of-life outcomes (Elbourn, Kenny, Power, & Togher, 2019; Galski et al., 1998). Substantial research documents that, compared to controls, adults with TBI tell shorter stories that omit key elements, lack cohesion, and are disorganized (Carlomagno et al., 2011; Elbourn, Kenny, Power, Honan, et al., 2019; Hartley & Jensen, 1991; Lê et al., 2011; Norman et al., 2022). Although narrative organization in TBI has been studied, few studies have analyzed complex storytelling using a story grammar framework (i.e., a

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predictable structure used to tell a linear, causally connected event sequence; Coelho, 2002; Liles et al., 1989; Mozeiko et al., 2011; Snow et al., 1999). Even fewer have examined longitudinal story grammar changes post-TBI. Furthermore, although often analyzed in child narratives (Gillam et al., 2017; Heilmann et al., 2010), elaboration has rarely been addressed in adult narration. The present study analyzed story grammar in a complex story retell, *Cinderella*, to (a) compare productivity, completeness, and elaboration in adults with and without severe TBI and (b) examine the impact of time and demographic/injury-related factors on changes in these variables over the first 2 years post-TBI. Understanding how adults with TBI tell stories, how their performance changes over time, and how other factors influence narration may guide services designed to optimize community reintegration and quality-of-life outcomes.

Narrative Analyses

Macrostructural narrative analyses assess the overarching meaning and organization of storytelling (Peach & Hanna, 2021). Such analyses begin with transcription, including division of content into T-units, C-units, or propositions. T-units and C-units are both defined as an independent clause plus any embedded or attached subordinate clauses; C-units include elliptical responses to a partner's message, whereas T-units do not (Hunt, 1965; Loban, 1976). Finally, a proposition is defined as each verb phrase (i.e., predicator) plus all related arguments (Roth & Spekman, 1986). Once divided, narration can be characterized by macrostructural measures of productivity, completeness, and elaboration within or outside a story grammar framework.

Story Grammar Analysis in Adults With TBI

Story grammar is a macrostructural analysis that examines how closely a narrator adheres to expectations for organizing characters; events; and their interrelationship within a causally connected, linear sequence (Coelho, 2002; Mozeiko et al., 2011; Power et al., 2020; Stein & Glenn, 1975, 1979). Narrators who adhere to story grammar introduce characters, time, and location (setting); describe events forming the "middle" of the story (episodes); and draw the story to an end (conclusion/coda). In episodes, narrators establish problems/goals (initiating events), explain how characters try to address the problems/goals (attempts), and describe the attempts' success or failure (direct consequences). These three basic elements must all be present for an episode to be complete (Coelho, 2002; Liles et al., 1989). Stories may have multiple episodes before reaching their conclusion. Beyond these three elements, episodes also may describe characters' thoughts or feelings in response to initiating events (internal responses) or direct consequences (reactions) and their intended approaches to addressing the problem/goal (plans; Stein & Glenn, 1979). Characters, objects, or time/location also may be described within an episode (setting; e.g., "She lost her slipper *that was made of glass*"; Stein & Glenn, 1979).

Story grammar analysis can yield various outcomes. For example, researchers have calculated the total number of episodes (Coelho, 2002; Mozeiko et al., 2011), the total number of story grammar elements (Snow et al., 1999), the total number of complete (Coelho, 2002) or incomplete (Coelho, 2002; Power et al., 2020) episodes, and the proportion of T-units within the episodic structure (Story Goodness Index: story grammar measure; Lê et al., 2011; Lindsey et al., 2019; similar score in Power et al., 2020). Table 1 summarizes these and other methods for analyzing narrative productivity, completeness, and elaboration and prior TBI research using these methods. It is unclear which outcomes (e.g., logically sequencing ideas, providing sufficient information) will best capture difficulties post-TBI (Douglas et al., 2000). Measures of narrative productivity, completeness, and elaboration within a story grammar framework may reveal macrostructural challenges that align with clinical observations of these difficulties.

Narrative Productivity

Narrative productivity, often used to characterize narrative production post-TBI, captures the quantity of information shared, as measured by the total number of words, utterances, T-units, or C-units (Jorgensen & Togher, 2009; Norman et al., 2022). Metrics of productivity within a story grammar framework, such as the total number of story grammar elements or episodes, have been reported less frequently, with mixed results when comparing participants with TBI versus controls with no brain injury (NBI). In story retells, some studies have found no differences in the number of story grammar elements (Snow et al., 1999) or episodes (Coelho, 2002; Liles et al., 1989). Yet in a complex 16-picture story sequence retell, Mozeiko et al. (2011) found that a large sample of adults with penetrating TBIs produced significantly fewer episodes (complete or incomplete) than NBI controls. Similarly, mixed evidence has been found with story generation. Specifically, Liles et al. (1989) found fewer complete episodes in speakers with TBI, whereas Coelho (2002) found no difference in the total number of episodes. Evidence suggests that participant (severity/type of TBI) and task (retell vs. generation, number of expected episodes) characteristics may affect productivity. Overall, it is unclear if story grammar productivity measures have clinical utility post-TBI.

Table 1. Summary of narrative analysis methods and their use in adults with traumatic brain injury (TBI).

Level of analysis	Type of analysis	Measures	Usage in adults with TBI (or aphasia)
Microlinguistic	Productivity	Number of words, number of utterances, number of T-units/C-units	Jorgensen & Togher (2009), Norman et al. (2022)
Macrostructural: story grammar	Productivity	Number of episodes	Coelho (2002), Mozeiko et al. (2011)
		Number of story grammar elements	Snow et al. (1999)
	Completeness	Number of complete episodes (includes all 3 basic elements: initiating event, attempt, direct consequence) Number of incomplete episodes (Coelho: includes 2 basic elements; Power et al.: includes 1–2 basic elements)	Coelho (2002), Power et al. (2020)
		Story Goodness Index: story grammar (proportion of T-units within episodic structure; story grammar score from Power et al., 2020, is similar)	Lê et al. (2011), Lindsey et al. (2019)—based on T-units within episodes but not focused on completeness
	Elaboration	Number of elements per episode (total number of basic elements plus setting statements and descriptions of characters' mental states included within the story's episodes divided by the total number of episodes)	Not assessed in adults; existing pediatric measures based on the inclusion of complex/elaborate episodic components (e.g., complicating events that hinder attempts, 2^+ events motivating distinct attempts; Gillam et al., 2017)
	Completeness + elaboration	Number of elaborated–complete episodes (includes ≥ 1 of each basic element and ≥ 1 of the following: multiple basic elements, mental states, or settings; see Figure 1)	
Macrostructural: other	Completeness	Completeness of essential elements: Story Goodness Index: completeness (characters, events)	Lê et al. (2011), Lindsey et al. (2019)
		Main concept analysis: accuracy and completeness of main concepts	Nicholas & Brookshire (1995), Richardson & Dalton (2016)

Narrative Completeness

Narrative completeness aims to capture whether essential details are provided to build a logically sequenced story. As with productivity, narrative completeness often has been analyzed outside a story grammar framework. For example, main concept analysis (Nicholas & Brookshire, 1995; Richardson & Dalton, 2016) and the Story Goodness Index's story completeness score (Lê et al., 2011; Lindsey et al., 2019) evaluate the inclusion of essential story content, such as characters or events, rather than completeness of *episodes* within a story grammar framework. Interestingly, the Story Goodness Index (Lê et al., 2011; Lindsey et al., 2019) evaluates episode completeness but only as a step toward calculating the story grammar measure (i.e., the proportion of T-units within complete or incomplete episodes; similar story grammar score in Power et al., 2020). This research has not focused on episode completeness because Coelho (2002) found that the number of complete or incomplete episodes was not sensitive to differences between TBI and NBI groups. However, Power et al. (2020) found that participants with severe TBI describing the *Cat Rescue* picture produced fewer *complete* episodes at 3 and 6 months post-injury than an NBI group but did not differ in their production of *incomplete* episodes. Importantly, even controls in this study generated few episodes (average of one to two complete and incomplete episodes; Power et al., 2020). Thus, a more complex narrative (e.g., *Cinderella*, for which controls generated a mean of four episodes; Greenslade et al., 2020) has the potential to capture more subtle recovery-related changes due to an increased score range.

Narrative Elaboration

Finally, narrative elaboration captures the provision of nonessential details that embellish upon characters, events, and their interrelationship. Although elaboration has not been researched in adults, it has been incorporated into child narrative measures (e.g., Gillam et al., 2017). For example, scores on the Monitoring Indicators of Scholarly Language (MISL) capture children's development from simple descriptions to complex, multi-episode narratives. Each story grammar component (e.g., initiating event) is rated as not present, emerging, mastered, or elaborated, where elaborated knowledge reflects more complex/embellished episodic elements (e.g., at least two events that motivate distinct attempts, use of complicating events to hinder characters' attempts). Given observations of macrostructural challenges in TBI, narrative elaboration could be an important metric for characterizing this population's discourse deficits. Existing measures, such as the MISL, provide excellent models for developing elaboration measures for adults.

Overall, limited research has examined productivity, completeness, or elaboration within a story grammar framework in adults with TBI. Many studies investigating these variables have used simple stories requiring few episodes. Furthermore, TBI research has not examined longitudinal changes in productivity, completeness, or elaboration within a story grammar framework using a complex story, covarying for demographic/injury-related factors that relate to recovery. Because effective narration is essential to interpersonal relationships and vocational success, narrative difficulties post-TBI can negatively impact these psychosocial outcomes. Hence, improving our understanding of narrative difficulties, methods for effectively capturing those difficulties, and the evolution of narration over time post-TBI is critical for guiding effective service provision.

Research Questions

The present study applied traditional story grammar analyses to a complex narrative retell—*Cinderella*. The first research question asked whether the TBI and NBI groups' *Cinderella* retells would differ in productivity, completeness, and elaboration. We hypothesized that between-group differences would exist early in recovery but might become nonsignificant later in recovery, similar to Power et al.'s (2020) findings regarding complete episodes. The second research question asked how productivity, completeness, and elaboration would change at 3, 6, 9, 12, and 24 months post-TBI, accounting for age, gender, education, injury severity, and memory recovery. We hypothesized that story grammar variables would reveal improvements in narrative production over the first 2 years post-TBI, with recovery trajectories associated with injury severity and educational attainment, as observed in Elbourn, Kenny, Power, Honan, et al. (2019).

Method

Study Design and Participants

Transcripts of *Cinderella* narratives from 57 participants with severe TBI and 57 participants with NBI were accessed through the online, password-protected databases TBIBank (Elbourn, Kenny, Power, & Togher, 2019) and AphasiaBank (MacWhinney et al., 2011) and were retrospectively analyzed. TBI transcripts were collected in Australia as part of the Togher corpus (The University of Sydney). Because no Australian NBI transcripts were available, NBI transcripts from U.S. speakers were accessed through AphasiaBank's control corpora contributed by the following institutions (investigators): University of Kentucky (Capilouto), Montclair State University (Boyle), The University of New Mexico (Richardson), and East Carolina University (Wright). All participants consented to sharing their data with TalkBank, permitting future research use.

Participants with TBI all met the following inclusion criteria: (a) a diagnosis of severe TBI (i.e., posttraumatic amnesia [PTA] duration > 24 hr and/or a Glasgow Coma Scale [GCS] score[1] < 8); (b) reported fluency in English; (c) age between 16 and 65 years at the time of injury; (d) medical stability and recovery from PTA prior to participation; and (e) residing within 3 hr of Sydney, Australia. Exclusion criteria included (a) being unable to obtain consent from the participant or a surrogate, (b) being more than 7 months post-injury, (c) having persisting PTA, (d) having a significant medical history (e.g., developmental delay, prior neurological illness/injury), and (e) being unable to complete at least one follow-up session (Elbourn, Kenny, Power, & Togher, 2019). For the current study, participants had to report familiarity with *Cinderella* and retell it at two or more sessions. *Cinderella* retells were available for 44, 53, 44, 46, and 43 participants at 3, 6, 9, 12, and 24 months post-injury, respectively. Reasons for missing data and loss to follow-up included inability to be

[1]Timing for the GCS's delivery was inconsistent (in the ambulance, upon arrival at the hospital, after receipt of medicine), so GCS scores were used as part of inclusion criteria, but not as a predictor variable.

contacted, lack of time due to other commitments (e.g., work, study, family commitments), and lack of interest.

NBI participants all resided in the United States and reported adequate vision/hearing and no history of a neurological injury (e.g., stroke, head injury) or speech/language disorder. Included NBI participants reported familiarity with the *Cinderella* story and told it once (single time point).

Table 2 summarizes each group's demographic characteristics. Most participants spoke English as their primary language and were monolingual. The average educational attainment in each group was some college. Participants were matched pairwise for age (age at participation/at injury) and, whenever possible, for sex. However, insufficient older male controls resulted in a significant between-group sex difference (p = .038). Importantly, in NBI subsets that had TBI matches at each time point, no sex differences were observed for any narrative variable (see Supplemental Material S1). No other demographic variable differed significantly between groups.

Procedure

Examiners at each contributing site elicited *Cinderella* retells according to TBIBank Protocol Instructions (Elbourn, Kenny, Power, Honan, et al., 2019), which are available at https://tbi.talkbank.org/protocol/instructions-TBI.doc. Two graduate students (including the fourth author) and their mentor (first author) evaluated the participants' *Cinderella* retells using a traditional approach to story grammar analysis. Each transcript was assigned a random identification number to blind coders to diagnosis and time post-TBI; however, differences in lexical selection between Australian (TBI) and U.S. (NBI) speakers may have biased some coding.

Analyses were conducted in three stages. First, narratives were divided into propositions, defined as each verb phrase (predicator) plus all related arguments (Roth & Spekman, 1986). Whereas single infinitives were not divided from the main verb phrase, compound infinitives (such as compound predicates) were separated.

Table 2. Demographic characteristics of the traumatic brain injury (TBI) and no brain injury (NBI) groups as well as significance testing results.

Demographic variable	**TBI (*n* = 57)**	**NBI (*n* = 57)**	**Chi-square test**	***p***	***w***
Sex (M:F)	46:11	35:22	5.16	.038	.213
Race	40 Oceanian (non-Indigenous) 4 Northwest European 4 Central Asian 3 Southeast Asian 2 "The Americas" 1 North African/Middle Eastern 1 Sub-Saharan African 1 Oceanian (Indigenous) 1 NR	53 Caucasian 2 African American 2 Hispanic or Latino/a	N/A		
Primary language	52 English 5 other	56 English 1 NR	5.14[a]	.057[a]	.213
Language status	46 monolingual 11 other (8 bilingual, 3 multilingual)	35 monolingual 3 other (3 multilingual) 19 NR	2.36[a]	.150[a]	.157
	***M* (*SD*)** **Range**	***M* (*SD*)** **Range**	***z***	***p***	***d***
Age (years)	35.25 (13.11) 16–66	35.61 (13.03) 18–66	−0.20	.843	0.028
Years of education	13.58 (2.99) 8–20	14.43 (1.54) 12–18	−1.84	.065	0.357
GCS score	6.83 (3.47) 3–15	—	—	—	—
Length of PTA	52.88 (40.03) 6–215	—	—	—	—
HVLT-R at 6 months	−2.17 (1.76) −7.19 to 1.07	—	—	—	—
HVLT-R at 12 months	−1.49 (1.759) −7.19 to 0.61	—	—	—	—

Note. M:F = male-to-female sex ratio; NR = not reported; N/A = not applicable; GCS = Glasgow Coma Scale; PTA = posttraumatic amnesia; HVLT-R = Hopkins Verbal Learning Test–Revised z score. [a]Statistic excludes participants who did not report their primary language/language status.

Second, each proposition was assigned a story grammar code based on its purpose within the story, namely, setting (S), initiating event (IE), attempt (A), direct consequence (DC), conclusion (C), or mental state (MS), or the proposition was assigned a non–story grammar (NSG) code. Table 3 lists each code and its operational definition. Propositions that described or were dependent upon a character's mental state were assigned a code of MS—either on its own or in conjunction with another code if the mental state occurred within another story event. For example, plans, such as "The prince *decided* to try the slipper on all the women in the village to see who it fit," were coded as a mental state and an attempt. All other story grammar codes were mutually exclusive.

After all propositions were assigned a story grammar code, episode numbers and types were assigned (see Figure 1 for episode types and examples). To assign episode types, coders first labeled episodes as "complete" if they contained at least one initiating event, attempt, and direct consequence or "incomplete" if they lacked one or more of these basic elements (following Coelho, 2002). Next, coders labeled episodes as "simple" if they included only a single initiating event, attempt, and direct consequence or "elaborated" if they included elements beyond these three basic elements, such as (a) multiple basic elements (more than one initiating event, attempt, and/or direct consequence; following the MISL; Gillam et al., 2017); (b) terms describing a character's mental state (one or more propositions coded as MS), which often correspond to internal responses, plans, or reactions; and/or (c) setting statements (one or more propositions coded as S). Elaborated episodes could be elaborated in a single way or more than one way. Thus, four types of episodes were possible: simple–complete, simple–incomplete, elaborated–complete, and elaborated–incomplete.

Overall, coding yielded the following dependent variables of interest:

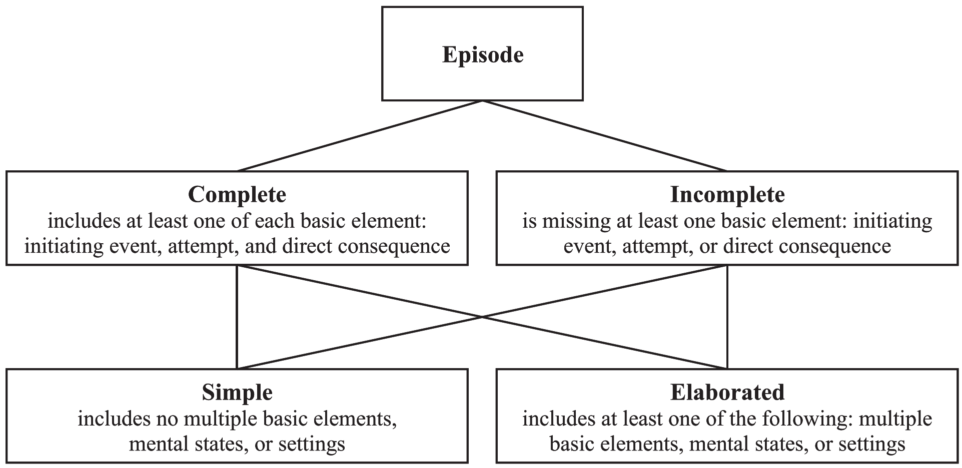
- total number of episodes (complete or incomplete episodes; productivity)
- total number of story grammar elements (setting statements + initiating events + attempts + direct consequences + conclusions + mental states; productivity)
- total number of incomplete episodes (simple–incomplete + elaborated–incomplete; episodic completeness)
- total number of elaborated–complete episodes (complete episodes that include nonessential story elements; episodic completeness + *presence* of elaboration)
- the mean number of episodic elements per episode (initiating events + attempts + direct consequences + mental states + episodic setting statements divided by the total number of episodes; *quantity* of elaboration)

Thus, elaboration variables quantified the inclusion of nonessential story elements, whereas productivity variables did not differentiate between basic versus nonessential elements.

Table 3. Operational definitions of story grammar codes.

Story grammar code	Operational definition	Example
Setting statement (S)	A description of the story's location, time, characters, or relationship between characters, which is provided before the first episode begins OR a description or reference to known ("status quo") information after the first episode begins	• "So Cinderella is known as the servant for a house with two girls and their mum" • "The slipper was made of glass"
Initiating event (IE)	An occurrence or event that propels the story forward by describing a change in the status quo (e.g., introduction of a new character) or presenting a problem	• "And a fairy godmother appears" • "(Be)cause it's nearly midnight"
Attempt (A)	An action in response to the initiating event, often designed to solve whatever problem has been presented	• "So the fairy godmother casts a spell" • "And so she rushes down to the car"
Direct consequence (DC)	The consequences of an attempt; must directly follow and be causally attributed to the attempt	• "So she turns some of the other farm animals into prancing horses" • "And (she) loses a shoe on the way"
Conclusion (C)	Statements that provide resolutions to the overall story arc and signal the end of the story	• "And then she got married to the prince"
Mental state (MS)	Description of a character's internal thoughts, feelings, or responses (expressed with a cognitive, affective, or desire term) or proposition dependent on such a description/term	• "And Cinderella'd like to go." • "Cinderella felt sad / because she couldn't go to the ball"—both propositions coded as MS

Figure 1. Hierarchy for assigning episode types with examples. Ep = episode; IE = initiating event; A = attempt; DC = direct consequence; MS = mental state; NSG = non–story grammar; MB = multiple basic elements; SC = simple–complete; SI = simple–incomplete; EC = elaborated–complete; EI = elaborated–incomplete.



Example of simple–complete episode:

&-um anyway and then there ends up being this [/] this man	IE	2	
who asks her to come .	A	2	
And so he [//] she ends up going to the dance .	DC	2	Ep2: SC

Examples (3) of simple–incomplete episodes:

156 &-um she went to the ball and her two sisters .	IE	1	Ep1: SI
157 and her mother wouldn't let her go for some reason .	IE	2	Ep2: SI
158 and then the two sisters &-um attacked her .	A	3	
159 and she runs out .	DC	3	Ep3: SI

Example of elaborated–complete episode:

and &-um prince charming &-uh realizes	MS/IE	6	
there is the last lady of 140 the house ,	MS/IE	6	
which the ugly stepmother does not want him to try the 141 slipper on her .	MS/A	6	
&-um he actually does try the slipper on Cinderella's foot .	A	6	
and it fits perfectly .	DC	6	
therefore he realizes	MS/DC	6	
that Cinderella was the beautiful lady	MS/DC	6	
that he met at the ball .	MS/DC	6	Ep6: EC-MB, MS

Example of elaborated–incomplete episode:

so then in another book the king hadta find the wearer of the slipper	NSG		
and then went round the town	IE	4	
and tested	IE	4	
if your [*] foot fit the slipper or not .	IE	4	Ep4: EI- MB
that wasn't in the book though . [+ exc]	NSG		

Reliability

Training for story grammar coding was completed in 39 hr across 9 weeks, using 25 transcripts outside this study's data set and 40 transcripts in the data set (14%). Training was completed when accuracy of independent coding of story grammar elements for four of five transcripts in a set reached a Cohen's κ value of .75. Following training, a random selection of transcripts was coded for reliability within sets of 20–30 to prevent coder drift. Random selection of reliability transcripts using coding numbers resulted in nonequivalent samples across diagnostic groups and time points: 17 NBI transcripts plus 12 at 3 months, 14 at 6 months, 12 at 9 months, 15 at 12 months, and four at 24 months in the TBI group (total: 74 of 287 transcripts; 25.78%). Two-way random intraclass correlations (ICCs) with absolute agreement found excellent interrater reliability, ICC(2, 1) ≥ .90 (Cicchetti, 1994) for the full sample and the TBI group for all dependent variables, except the total number of incomplete episodes, which had moderate reliability, full: ICC(2, 1) = .63, TBI: ICC(2, 1) = .67.

Declarative Memory

The Hopkins Verbal Learning Test–Revised (HVLT-R; Brandt & Benedict, 1997) documented verbal declarative memory at 6 and 12 months post-TBI by presenting a list of 12 words. Immediate free recall of the words/designs is probed after each of three presentations; delayed recall is probed after 25 min. Evidence supports the reliability and construct validity of the HVLT-R (Benedict et al., 1998; Shapiro et al., 1999). Change in HVLT-R scores from 6 to 12 months documented memory changes related to recovery and were used to examine the potential influence of memory recovery on narrative trajectories.

Analysis

SPSS (Version 27) was used to generate descriptive statistics, skew and kurtosis, and Shapiro–Wilk normality tests for the five dependent variables. All variables had non-normal distributions based on Shapiro–Wilk test p values < .05 and/or skew/kurtosis z scores exceeding ±2.58 (Laerd Statistics, n.d.). Thus, to examine between-group differences, Mann–Whitney U tests were conducted to compare performance of the TBI and NBI groups for all variables. A Bonferroni correction was applied to significance testing of between-group differences, for an α of .002.

To examine trajectories of change post-TBI, generalized estimating equation (GEE) models were constructed using a first-order autoregressive correlation structure and Poisson distribution for the total number of episodes, story grammar elements, incomplete episodes, and elaborated–complete episodes. Based on the unique properties of the mean number of episodic elements per episode (continuous variable, skewed, contains zeros), this variable's GEE model used a first-order autoregressive correlation structure and a Gamma distribution with a log link function; also, a small constant (0.001) was added to each value of this dependent variable to account for issues related to taking the log of zero. Selected GEE models accounted for data being missing at random, but not missing completely at random (e.g., missing 3-month data often reflected persistent PTA). Each model examined one dependent variable using time point (3, 6, 9, 12, and 24 months) as the repeated-measures factor. To account for demographic/injury-related factors (e.g., injury severity, memory recovery), covariates that were significantly correlated with each dependent variable were included in corresponding models. Thus, age, years of education, and PTA duration (as an index of injury severity) were included for the total number of episodes, story grammar elements, and elaborated–complete episodes as well as mean episodic elements per episode; gender and memory recovery (ps > .05) were not included. For the total number of incomplete episodes, only gender was included. Resulting coefficients were exponentiated to obtain incidence rate ratios (IRRs), which were interpreted as the estimated rate of change in the dependent variable for every one-unit increase in the independent variable, holding other variables constant. IRRs less than 1 signaled a decreasing trend in that dependent variable over time; IRRs greater than 1 signaled an increasing trend over time. Last, 95% confidence intervals for IRRs were reported.

Finally, to account for potential impacts of practice effects on TBI trajectories, the Leeds Reliable Change Indicator (Morley & Dowzer, 2014, following Jacobson et al., 1999) was calculated for each participant with TBI, using their first and last data points for each dependent variable. The Reliable Change Indicator identified the number of participants whose change was reliable, accounting for measurement error, and could not be explained by practice effects.

Results

Tables 4 and 5 summarize descriptive and inferential statistics comparing the TBI and NBI groups for the five

Table 4. Descriptive and inferential statistics comparing the traumatic brain injury (TBI) and no brain injury (NBI) groups for productivity measures at 3, 6, 9, 12, and 24 months.

Dependent variable		Total number of episodes						Total number of story grammar elements					
Group		TBI		NBI		Comparison		TBI		NBI		Comparison	
Time point	*n* per group	*M*	*SD*	*M*	*SD*	*z*	*p*	*M*	*SD*	*M*	*SD*	*z*	*p*
3 m	44	3.64	1.74	5.42	1.58	–4.58	< .001*	27.34	19.88	62.23	32.45	–5.01	< .001*
6 m	53	4.30	1.95	5.42	1.49	–3.30	.001*	34.38	24.00	63.25	35.71	–4.55	< .001*
9 m	44	4.16	1.68	5.57	1.40	–3.89	< .001*	36.80	24.99	66.43	36.68	–4.12	< .001*
12 m	46	4.57	1.60	5.41	1.57	–2.56	.011	41.80	28.84	64.04	35.73	–3.30	.001*
24 m	43	4.60	1.66	5.33	1.52	–1.61	.107	45.93	31.55	62.44	36.53	–2.31	.021

Note. For NBI participants, data represent a single time point; however, NBI values vary slightly across time points due to missing TBI data and the inclusion of only matched NBI samples at each time point. m = months post-TBI.

*Significant at or below .002 (adjusted α).

Table 5. Descriptive and inferential statistics comparing the traumatic brain injury (TBI) and no brain injury (NBI) groups for measures of completeness and elaboration at 3, 6, 9, 12, and 24 months.

Dependent variable		**Total incomplete episodes**						**Total elaborated–complete episodes**						**Mean number of episodic elements per episode**					
Group		**TBI**		**NBI**		**Comparison**		**TBI**		**NBI**		**Comparison**		**TBI**		**NBI**		**Comparison**	
Time point	***n* per group**	***M***	***SD***	***M***	***SD***	***z***	***p***	***M***	***SD***	***M***	***SD***	***z***	***p***	***M***	***SD***	***M***	***SD***	***Z***	***p***
3 m	44	1.70	1.09	1.23	1.00	2.01	.044	1.80	1.69	4.00	2.07	–4.59	< .001*	5.10	3.24	8.52	3.90	–4.05	< .001*
6 m	53	1.75	1.36	1.17	0.98	2.19	.029	2.34	1.87	4.04	1.95	–4.16	< .001*	5.85	3.42	8.76	4.46	–3.51	< .001*
9 m	44	1.43	1.42	1.14	1.03	0.58	.564	2.52	1.84	4.18	1.93	–3.81	< .001*	6.31	3.64	9.16	4.60	–3.37	.001*
12 m	46	1.78	1.23	1.04	0.87	3.22	.001*	2.65	1.74	4.15	1.85	–3.75	< .001*	6.76	4.31	8.97	4.38	–2.73	.006
24 m	43	1.44	1.35	1.16	1.00	0.73	.465	2.98	1.87	3.95	1.93	–2.23	.025	7.73	4.64	8.93	4.56	–1.49	.136

Note. For NBI participants, data represent a single time point; however, NBI values vary slightly across time points due to missing TBI data and the inclusion of only matched NBI samples at each time point. m = months post-TBI.

*Significant at or below .002 (adjusted α).

narrative variables at 3, 6, 9, 12, and 24 months. Table 4 reports data for productivity measures (total number of episodes and total number of story grammar elements), whereas Table 5 reports data for measures of completeness and elaboration (total number of incomplete episodes, total number of elaborated–complete episodes, and the mean number of episodic elements per episode). Figure 2 presents paneled line graphs that illustrate the TBI group data for each variable at each time point along with NBI group comparisons.

The TBI group demonstrated statistically significantly lower total number of episodes, story grammar elements, and elaborated–complete episodes and had a lower mean number of episodic elements per episode as compared to the NBI group at 3, 6, and 9 months post-TBI. At 12 months, statistically significant between-group differences were observed only in the total number of story grammar elements and elaborated–complete episodes. By 24 months, significant differences were not found for any measure. Finally, for the total number of incomplete episodes, a statistically significant difference was observed only at 12 months.

In the TBI group, GEE models investigated predictors of within-subject changes in narrative production over the first 2 years post-TBI, using time point as the repeated-measures factor and covarying for demographic/injury-related factors (see Table 6). Models revealed that for each one-unit increase in time (e.g., change from a 3-month to a 6-month time point), the expected rate of increase was 1.056 for the total number of episodes, 1.123 for the total number of story grammar elements, 1.135 for the total number of elaborated–complete episodes, and 1.115 for the mean number of episodic elements per episode, all representing statistically significant

Figure 2. Trajectories across the first 2 years post–traumatic brain injury (TBI) with no brain injury (NBI) comparisons for (a) the total number of episodes, (b) the total number of story grammar elements, (c) the total number of incomplete episodes, (d) the total number of elaborated–complete episodes, and (e) the mean number of episodic elements per episode. NBI data are not connected by a line, illustrating the fact that data represent a single time point. NBI values vary slightly across time points due to missing TBI data and the inclusion of only matched NBI samples at each time point. Error bars are ±1 *SE*.

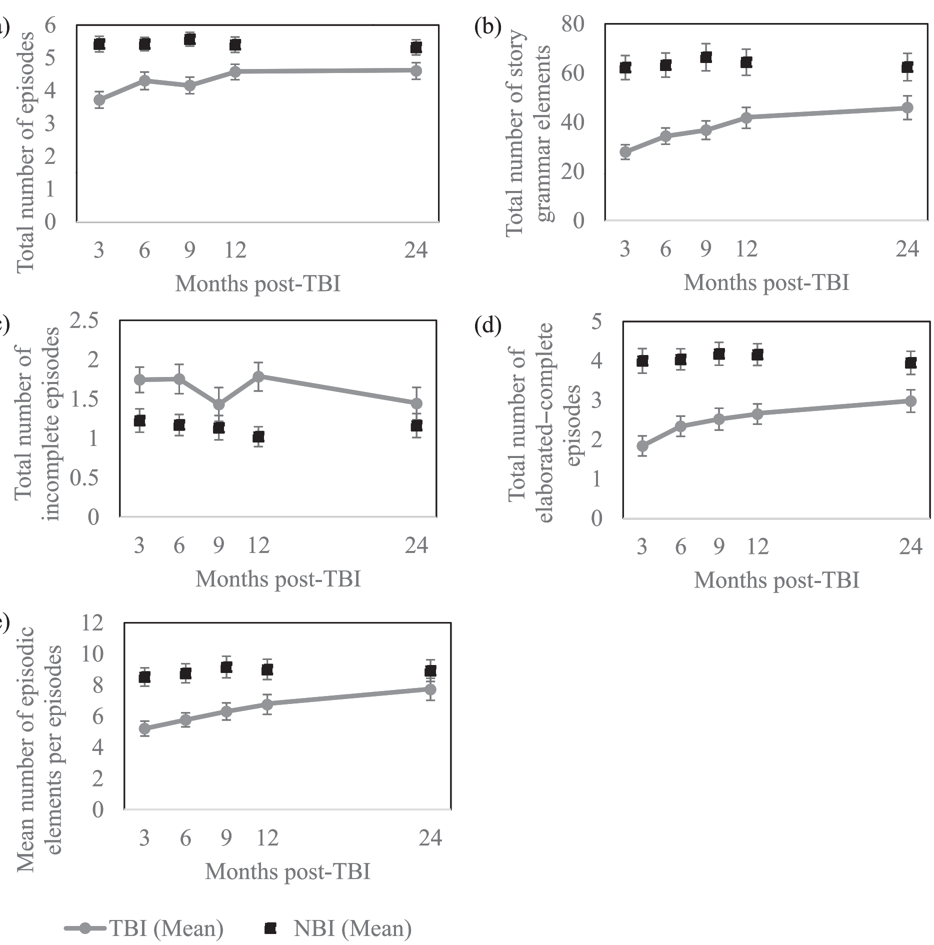


Table 6. Generalized estimating equation model results, including the effect of time and demographic/injury-related factors (i.e., age, years of education, posttraumatic amnesia [PTA], gender) that significantly correlated with each dependent variable.

Variable	*B*	*SE*	IRR	95% CI	*p*
Model 1: total number of episodes					
Time	0.055	0.015	1.056	[1.026, 1.087]	< .001*
Age	0.003	0.003	1.002	[0.997, 1.008]	.342
Years of education	0.032	0.012	1.033	[1.008, 1.059]	.009
PTA	−0.008	0.002	0.992	[0.989, 0.996]	< .001*
Model 2: total number of story grammar elements					
Time	0.116	0.023	1.123	[1.073, 1.175]	< .001*
Age	0.010	0.005	1.010	[1.000, 1.021]	.058
Years of education	0.091	0.025	1.095	[1.042, 1.151]	< .001*
PTA	−0.009	0.002	0.991	[0.987, 0.995]	< .001*
Model 3: total number of elaborated–complete episodes					
Time	0.127	0.025	1.135	[1.081, 1.193]	< .001*
Age	0.005	0.005	1.005	[0.995, 1.016]	.353
Years of education	0.078	0.023	1.081	[1.033, 1.131]	< .001*
PTA	−0.012	0.002	0.988	[0.984, 0.992]	< .001*
Model 4: total number of incomplete episodes					
Time	−0.035	0.036	0.966	[0.900, 1.036]	.332
Gender	−0.017	0.120	0.983	[0.777, 1.244]	.890
Model 5: mean number of episodic elements per episode					
Time	0.109	0.023	1.115	[1.067, 1.166]	< .001*
Age	0.012	0.006	1.012	[1.001, 1.023]	.029
Years of education	0.076	0.018	1.079	[1.041, 1.119]	< .001*
PTA	−0.008	0.002	0.992	[0.987, 0.996]	.001*

Note. IRR = incidence rate ratio; CI = confidence interval.
*Significant at or below .002 (adjusted α).

improvements over time (*p*s < .001). In contrast, the expected rate of decrease in the total number of incomplete episodes was 0.966, which did not reflect a statistically significant change over time (*p* = .332).

GEE models also identified the influence of select demographic/injury-related factors on narrative performance. Specifically, holding all other independent variables constant, each 1-day increase in PTA predicted (*p*s < .001) a decrease in the total number of episodes (IRR = 0.992), story grammar elements (IRR = 0.991), and elaborated–complete episodes (IRR = 0.988) as well as the mean number of episodic elements per episode (IRR = 0.992), indicating poorer narrative macrostructure. In contrast, each additional year of education predicted (*p*s < .001) an increase in the total number of story grammar elements (IRR = 1.095) and elaborated–complete episodes (IRR = 1.081) as well as the mean number of episodic elements per episode (IRR = 1.079), indicating better narrative macrostructure. Applying the adjusted α (.002), the trend toward years of education predicting an increase in the total number of episodes (IRR = 1.033, *p* = .009) was nonsignificant. Age did not have a statistically significant impact on change in any of these four dependent variables across time points. For the total number of incomplete episodes, gender did not have a statistically significant impact.

Based on the significant main effect of time in the GEE models, post hoc pairwise comparisons between time points for each dependent variable were conducted using Wilcoxon signed-ranks tests to determine when statistically significant improvements in narrative performance were first evidenced during the first 2 years post-TBI. As with between-group differences, α was set at .002. Statistically significant median increases were noted between 3 and 6 months post-TBI for the total number of episodes (z = 3.118, p = .002), between 3 and 9 months post-TBI for the total number of story grammar elements (z = 3.274, p = .001), and between 3 and 12 months post-TBI for the total number of elaborated–complete episodes (z = 3.541, p < .001) as well as the mean number of episodic elements per episode (z = 3.257, p = .001).

Of the study's 57 participants with TBI, the Leeds Reliable Change Indicator documented reliable change in the number of episodes for 14 and the number of story grammar elements for 42. Reliable change was also identified in the number of elaborated-complete episodes for 17, the number of incomplete episodes for 11, and the mean number of episodic elements per episode for 26 participants with TBI.

Discussion

The current study investigated complex narration within a story grammar framework following a severe TBI as well as changes over the first 2 years post-injury. Overall, results highlight the value of measuring story grammar productivity and elaboration for individuals with TBI during early to mid-recovery. Based on *Cinderella* retells, differences in productivity and elaboration were noted between NBI and TBI groups at 3, 6, and 9 months post-injury. By 12 months, group differences were observed only for the total number of story grammar elements and elaborated–complete episodes; by 24 months, no statistically significant differences remained for any variable. GEE models found significant improvements in all productivity and elaboration measures over the first 2 years post-TBI. Post hoc comparisons revealed that improvements were first detected between 3 and 6 months post-TBI for the total number of episodes (productivity), between 3 and 9 months for the total number of story grammar elements (productivity), and between 3 and 12 months for both elaboration measures. Improvements in narrative production over time were related to participants' duration of PTA and their educational attainment, but not age, gender, or memory recovery. Given the potential for practice effects in the TBI group and coding biases due to country-specific lexical variations, these results should be interpreted with caution. Yet, implications of these results still warrant consideration.

Recovery After TBI

The current study documented improvements in narrative performance up to 2 years post-injury, with statistically significant improvements occurring within the first year following the TBI. Changes were the most reliable, clearly documenting improvements above and beyond practice effects, for the two variables with wide score ranges: the number of story grammar elements (74% of participants) and the mean number of episodic elements per episode (46% of participants). Although fewer participants demonstrated reliable change for the three variables with narrower score ranges, namely, the number of episodes (25% of participants), elaborated–complete episodes (30% of participants), and incomplete episodes (19% of participants), prior research suggests that practice effects were unlikely to account for observed changes in these variables, as complex tasks (such as the *Cinderella* retell) show low susceptibility to practice effects in clinical populations (Calamia et al., 2012; Temkin et al., 1999).

Measurable improvements in narrative production were documented in the first 12 months post-TBI (see Figure 2). The most rapid gains (between 3 and 6 months post-TBI) were observed in the inclusion of more content in terms of the total number of episodes (complete + incomplete). It took longer (between 3 and 9 months) for participants to improve the amount of content shared across story grammar categories (setting + episode + conclusion), as measured by the total number of story grammar elements. Of note, improvements in this variable reflected the sharing of additional content *within* episodes as well as *before* and *after* episodes to set up the story (setting) and draw it to a close (conclusion). Such additions outside the episodic structure provide critical context, resulting in a more complete story.

Significant improvements in elaboration variables (elaborated–complete episodes, mean number of episodic elements per episode) were first observed between 3 and 12 months post-TBI, in the subacute to chronic phase of recovery. Thus, the most prolonged period of recovery related to organizing content well, including all three basic episodic elements plus one or more nonessential "elaborated" elements (i.e., multiple basic elements, setting statements, and/or characters' mental states; elaborated–complete episodes), and increasing the *quantity* of that elaboration (mean number of episodic elements per episode). These results were consistent with the expectation that producing elaborated and well-organized/complete episodes would represent this study's most sophisticated narrative behavior, relying on the ability to plan, organize, and provide both essential and nonessential content. Therefore, improvements in telling elaborated (and complete) episodes took longer to observe than improvements in other variables.

Protective/Risk Factors

Across the four productivity and elaboration variables, two demographic/injury-related factors affected recovery: the participant's duration of PTA (injury severity) and educational attainment. Specifically, the longer the PTA lasted (i.e., the more severe the injury), the fewer episodes, story grammar elements, elaborated–complete episodes, and average number of elements per episode an individual was likely to include in their *Cinderella* retell. Conversely, the more years of education an individual had, the more story grammar elements, elaborated–complete episodes, and average number of elements per episode they were likely to include. Although there was a trend toward an association between higher educational attainment and the inclusion of more episodes, the effect was not significant, possibly due to this variable including both complete and incomplete episodes. Thus, although educational attainment affected productivity, its primary impact was observed with complex linguistic behaviors (e.g., providing additional context before/after the story's episodes, sharing more elaborated and complete event sequences). Overall, these findings suggest that lengthier

PTA (more severe injury) is a risk factor for poorer narrative recovery, whereas greater educational attainment is a protective factor associated with better discourse recovery, consistent with the cognitive reserve theory (Kesler et al., 2003; Steward et al., 2018). Age, gender, and memory recovery were not associated with discourse recovery. Overall, these findings could inform service delivery recommendations. For example, those with lengthy PTA and lower education levels may require increased treatment/supports that focus on narrative production, especially explicit training of elaboration.

Comparison to NBI Controls

Based on between-group differences, narrative macrostructure measured within a story grammar framework was impacted in many individuals for the first 9 months following a severe TBI, with differences for one productivity measure and one elaboration measure persisting to 12 months post-TBI. By 24 months, no significant differences remained. Thus, although all productivity and elaboration measures showed significant within-group improvements during the first year post-TBI, it was not until 2 years post-TBI that between-group differences disappeared for all four variables, suggesting that narration might continue improving into the chronic stages of recovery. Current results also highlight the value of more complex narratives when assessing discourse production post-TBI. Specifically, this study's complex narrative retell captured group differences through 9 months post-TBI, whereas a simpler story (*Cat Rescue*) administered in the same TBI sample only detected group differences in episode completeness at 3 months post-TBI, with a nonsignificant trend at 6 months (Power et al., 2020). Thus, narrative complexity (e.g., production of a multi-episode story) may be a critical factor affecting the utility of story grammar analysis in this population. However, these results must be interpreted with caution. Further research is needed to confirm findings regarding (a) narrative changes in the chronic stages of recovery and (b) the potential benefits of complex narration when analyzing story grammar post-TBI, while accounting for potential practice effects using longitudinal NBI data.

Incomplete Episodes

Incomplete episodes showed a unique pattern of recovery. Specifically, between-group differences were only noted at one time point (12 months post-TBI), and no improvements were noted over time. As shown in Figure 2, incomplete-episode production in the TBI group was inconsistent over time, which could reflect individual differences (e.g., some participants consistently produced incomplete episodes but did not participate at each time point) or individual variability (e.g., incomplete-episode production was inconsistent over time). Participant-level data support the latter explanation. Interpreted in connection with other variables, it appears that individuals shared more content as they recovered, but "keeping up" with content organization was inconsistent. Further supporting this explanation, the total number of episodes reached levels comparable to NBI participants by 12 months post-TBI, but elaborated–complete episodes did not reach comparable levels until 24 months post-TBI.

Psychometrics and Sensitivity of Story Grammar Measures for Detecting Cognitive-Communication Disorders

This study's narrative productivity and elaboration variables, measured within a story grammar framework, demonstrated strong interrater reliability and expected group differences (construct validity) during the first 9 months post-TBI. Thus, preliminary reliability and validity evidence supports using proposition-level story grammar analysis to analyze discourse-level language in those with cognitive-communication disorders—a critical finding given that such psychometric evidence has been identified as a gap in the literature (Pritchard et al., 2017).

Sensitivity of measures is, likewise, a core issue in detecting cognitive-communication disorders. Current findings suggest that although valuable up to 2 years, story grammar–based productivity and elaboration measures may be less suited to detecting subtle deficits at 2 years post-TBI and beyond. This finding is consistent with prior research showing that measures that can detect cognitive-communication disorders in severe TBI may be unable to do so in mild TBI (mTBI; Norman et al., 2022). For example, main concept analysis scores for *Cinderella* retells, capturing the accuracy and completeness of essential story content, can identify differences between controls and those with severe TBI through 12 month post-injury (Elbourn, Kenny, Power, Honan, et al., 2019), but not between adults with mTBI and controls (Norman et al., 2022). The present study may have captured a similar phenomenon: After 2 years of recovery, remaining cognitive-communication deficits may be more subtle, and tools such as main concept analysis and story grammar analysis may be less sensitive to such deficits than conversational participation/support measures (e.g., Adapted Kagan Rating Scale; Togher et al., 2010, 2023).

Clinical Implications of Story Grammar Analyses of Productivity and Elaboration

This study's findings have important clinical implications for using narrative macrostructure measures to quantify early cognitive-communication difficulties and recovery following a severe TBI. Narration is an authentic task that relies on complex language production; relates directly to social language use in daily life; and is linked to employment, relationship, community reintegration, and quality-of-life outcomes in TBI (Elbourn, Kenny, Power, & Togher, 2019; Galski et al., 1998; Steel et al., 2021). Narrative production difficulties post-TBI may manifest as omitting key details and failing to logically sequence and embellish upon ideas, leading to challenges with social connection and reintegration. Although story retells are infrequent in everyday exchanges, this study's use of *Cinderella* retells permitted standardization of analyses, due to the expectation of similar content across time and speakers. The current analyses highlighted narrative challenges post-TBI and provided a template for approaching measurement of productivity and elaboration in more authentic tasks, such as personal recounts.

This study's narrative analyses measured productivity and elaboration within a story grammar framework. These variables offered insight into storytellers' ability to provide a large quantity of information that included essential details for building a logically sequenced, causally connected story as well as nonessential details that embellished upon characters, events, and their interrelationship. These analyses appear well suited to early to mid-recovery (acute through early chronic) stages when individuals are typically engaging in rehabilitation and reintegrating into their pre-injury roles. Thus, this approach could support narrative assessment, particularly when storytelling is a focus of rehabilitation (Steel et al., 2021). Clinical indicators for using these analyses include observations of an individual omitting key details; failing to present ideas in a logical sequence; or generating a story that lacks embellishment of characters, events, and/or their interrelationship, with any of these factors leading to listener confusion. Results support the clinical utility of this study's narrative productivity and elaboration measures for identifying between-group differences up to 2 years post-injury. Thus, these measures have potential for identifying discourse-level targets for rehabilitation and progress monitoring.

Furthermore, this study's findings have important implications for long-term chronic TBI management. Specifically, individual data revealed that although story grammar skills returned to the average range by 1–2 years post-TBI for most, a subset of those with TBI continued to show narrative differences, despite receiving standard care. For the latter group, more intense supports may be needed to effect long-term discourse-level changes. Research regarding narrative intervention in adults post-TBI is limited, but INCOG guidelines along with Steel et al.'s (2021) systematic review of such interventions provide guidance regarding treatment structure and strategies. Specifically, strategies to address narrative discourse could include metacognitive/metalinguistic approaches within the context of a structured framework, including scaffolding within storytelling and video-based self-reflection and feedback following narration; target behaviors might include improved awareness of macrostructural elements and self-regulation (Steel et al., 2021; Tate et al., 2014; Togher et al., 2014). These strategies provide concrete "rules" for organizing narratives, with potential transfer to conversation and other discourse genres. Furthermore, narration is a high-impact target. By improving narrative production, fewer communication breakdowns will occur, facilitating improved personal, work, and community interactions that contribute to stronger relationships and overall quality of life. Although not all individuals may need such intervention following a severe TBI, the current study's narrative macrostructure measures could identify those who continue to struggle with discourse 1–2 years post-TBI and highlight their elevated need for targeted treatment.

Finally, this study's approach to story grammar analysis is manualized and accessible, supporting its potential utility (Steel & Togher, 2019). Although extensive training requirements to reach reliability remain a barrier, researchers and clinicians interested in using these analyses can access our manual and coding sheets at the following links:

- Manual: https://docs.google.com/document/d/1MYKQMSdfA85_D1xcoNT7j7UDR52mDWSyEVAx4THWxVU/edit?usp=sharing
- Coding sheets: https://docs.google.com/spreadsheets/d/1EKg5NHYa4-C6sMWJ_nsf0qvlAhEdzY05Phgwi8eVeKM/edit?usp=sharing

Limitations and Future Directions

Although the current study offers new insights into the macrostructural deficits and recovery of individuals post-TBI, we must acknowledge some limitations. First, this study compared NBI controls from the United States to TBI participants from Australia. Although speakers in both regions are expected to adhere to story grammar organization, cultural/linguistic differences might be responsible for some observed differences. Future research should collect TBI data in the United States and/or NBI data in Australia. Furthermore, this study's NBI sample contributed only one data point. Collecting longitudinal NBI data would more accurately capture typical storytelling variability as well as practice effects, providing a better comparison group. Also, expanding the age range of recruited adults with TBI and gathering information about the speech-language services this group received would better account for the effect these variables may have on recovery.

Prior research suggests that narrative macrostructure relates to executive functioning (Lê et al., 2014; Marini et al., 2014; Mozeiko et al., 2011) and declarative memory (Lê et al., 2014). Theoretically, these relationships are logical as narrative macrostructural measures capture a speaker's planning, organization, and linguistic problem solving (executive functions) as well as their ability to recall story-related facts and events (declarative memory). Although this study found no association between *changes* in memory scores and *changes* in narrative scores, this does not preclude relationships between memory *scores* and narrative *scores*. Thus, future work should explore relationships between executive functioning; declarative memory; and story grammar variables reflecting productivity, completeness, and elaboration.

The present study was the first to identify elaboration as a key measure of narrative deficits in TBI and during recovery. The specific nature of elaboration deficits and recovery warrants further exploration. For example, the use of mental state terms is one aspect of narrative elaboration that reflects not only complex narration but also social cognition (e.g., Byom & Turkstra, 2012, 2017). Future research should explore whether mental state term use within complex narration plays a defining role in the elaboration deficits and recovery observed in this study, providing insight into social cognition post-TBI.

The current study used a complex narrative retell, which facilitated the standardization of analyses. Yet, people rarely tell fictional stories in everyday interactions, limiting the task's ecological validity (Steel et al., 2021). Future research should develop psychometrically sound, sensitive methods for analyzing personal recounts to capture deficits, target narration in intervention, and monitor intervention progress. Using ecologically valid tasks in intervention should increase the likelihood of generalization to functional outcomes (Steel et al., 2021).

Finally, feasibility is important to consider. Although the current story grammar analyses were promising, their clinical utility is threatened by the extended training time (39 hr) required to reach 80% reliability. Improving training efficiency and/or simplifying measures would be essential for making these analyses practical for clinicians. At the same time, advances in automating language sample analysis (e.g., through batchalign) may improve the efficiency and practicality of narrative analysis for clinicians (Liu et al., 2023).

Conclusions

Narrative productivity and elaboration are key story grammar variables that (a) differentiate complex narrative production in individuals with and without severe TBI and (b) capture narrative improvements over the first 2 years of recovery post-TBI. Importantly, recovery trajectories were influenced by PTA (risk factor) and educational attainment (protective factor). Preliminary evidence supported the reliability and validity of this study's story grammar scores, which could help identify individuals following a severe TBI who need targeted supports over an extended period of time to maximize discourse outcomes. More research is needed to determine these measures' sensitivity to cognitive-communication difficulties post-TBI. Overall, story grammar analysis provides promising metrics that offer a window into discourse-level language production post-TBI and warrant further investigation.

Data Availability Statement

Videos and transcripts used for the current work are archived through the online password-protected databases TBIBank and AphasiaBank. Specifically, data for participants with traumatic brain injury are archived in TBIBank's Togher corpus (https://doi.org/10.21415/T5R018), and control data are archived in AphasiaBank's Capilouto (https://doi.org/10.21415/HTMN-5P65), MSU (https://doi.org/10.21415/XBVQ-E342), Richardson (https://doi.org/10.21415/8KZF-5X33), and Wright (https://doi.org/10.21415/X12Y-GE35) control corpora.

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