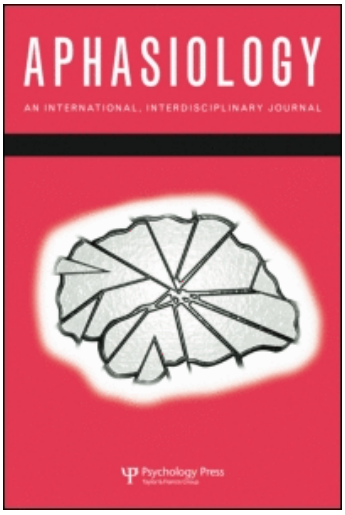

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Cohesion, coherence, and declarative memory: Discourse patterns in individuals with hippocampal amnesia

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Cohesion, coherence, and declarative memory: Discourse patterns in individuals with hippocampal amnesia

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Background: Discourse cohesion and coherence gives our communication continuity. Deficits in cohesion and coherence have been reported in patients with cognitive-communication disorders (e.g., TBI, dementia). However, the diffuse nature of pathology and widespread cognitive deficits of these disorders have made identification of specific neural substrates and cognitive systems critical for cohesion and coherence challenging.
Aims: Taking advantage of a rare patient group with selective and severe declarative memory impairments, the current study attempts to isolate the contribution of declarative memory to the successful use of cohesion and coherence in discourse.
Methods & Procedures: Cohesion and coherence were examined in the discourse of six participants with hippocampal amnesia and six demographically matched comparison participants. Specifically, this study (1) documents the frequency, type, and completeness of cohesive ties; (2) evaluates discourse for local and global coherence; and (3) compares use of cohesive ties and coherence ratings in amnesia and healthy participants.
Outcomes & Results: Overall, amnesia participants produced fewer cohesive ties per T-unit, the adequacy of their ties were more often judged to be incomplete, and the ratings of their local coherence were consistently lower than comparison participants.
Conclusions: These findings suggest that declarative memory may contribute to the discursive use of cohesion and coherence. Broader notions of cohesion, or *interactional cohesion*, i.e., cohesion across speakers (two or more people), time (days, weeks), and communicative resources (gesture), warrant further study as the experimental tasks used in the literature, and here, may actually underestimate or overestimate the extent of impairment.

Keywords: Cohesion; Coherence; Declarative memory; Hippocampus; Discourse.

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Defined as surface indicators of the relations within and between sentences (Halliday & Hasan, 1976), cohesive ties are a linguistic device that gives our communication continuity, allowing us to make connections across utterances, speakers, and topics. Given that we routinely return to and elaborate on conversations across long stretches of interaction (days and longer), cohesive ties also link our communicative histories across time. The linguistic elements that tie one part of a text to another can take multiple forms. Among the most common cohesive ties examined in the literature are references (e.g., John and Mary just moved to a new house. ***She*** has been busy cleaning ***it***.), conjunctions (e.g., Tom was busy working. ***And*** his movement kept me awake.), and lexical markers (e.g., We went to the rental house. It was a huge ***house***.) (e.g., Liles & Coelho, 1998). In addition to their linguistic function, these cohesive devices, particularly the use of repetition (through the use of lexical ties) have been identified as a key discourse resource for the ongoing display and creation of interpersonal and interactional connection among interlocutors (Tannen, 1989; also see Hengst, Duff, & Dettmer, 2010).

While cohesion refers to the continuity in the surface structure (word and sentence) of the discourse, coherence refers to continuity in meaning or the overall interrelatedness of the discourse (Louwerse & Graesser, 2005). Coherence can be further divided into global and local (Agar & Hobbs, 1982; Glosser & Deser, 1991). Local coherence refers to the interrelatedness, or topic maintenance, across adjacent utterances. Global coherence refers to the interrelatedness, or topic maintenance, across larger stretches of discourse (e.g., an entire conversation or narrative). Taken up by linguistics, sociolinguistics, and speech-language pathologists, cohesion and coherence are among the most common macrolinguistic measures of discourse.

Indeed, a number of investigations aimed at identifying discourse-level impairments in individuals with cognitive-communication impairments such as traumatic brain injury (TBI) and dementia have focused on cohesion and coherence (e.g., Coelho, 2002; Coelho, Liles, & Duffy, 1991; Davis & Coelho, 2004; Dijkstra, Bourgeois, Allen, & Burgio, 2004; Glosser & Deser, 1991; Liles, Coelho, Duffy, & Zalagens, 1989; Ripich, Carpenter, & Ziol, 2000; Van Leer & Turkstra, 1999; Youse & Coelho, 2005). Using a variety of discourse tasks (e.g., story generation, story retelling, procedural discourse) previous research has reported some evidence of impairments across measures of cohesion and coherence including cohesive adequacy, referential, conjunction, and lexical cohesion, and global and local coherence. However, the deficits reported across studies have been inconsistent both within and across populations (i.e., there is considerable variability in deficits across discourse tasks and measures). This is likely due, in part, to the heterogeneity of some of the populations (e.g., TBI) and the variability in methodology and experimental design across studies (e.g., Coelho 2002, Davis & Coelho 2004; Glosser & Deser, 1991; Hartley & Jensen, 1991; Liles et al., 1989).

Given the diffuse nature of the pathology and the widespread cognitive disruption associated with TBI and dementia, attributing observed deficits in coherence and cohesion to a specific cognitive domain has been difficult. Indeed, deficits have been attributed to various cognitive domains including working memory (Dijkstra et al., 2004; Youse & Coelho, 2005) and executive function (Coelho, 2002; Glosser & Deser, 1991), as well as broad cognitive dysfunction (Coelho et al., 1991; Davis & Coelho, 2004). While clinically important, studying patients with such diffuse damage and cognitive impairment makes it difficult to identify specific neural substrates

and cognitive systems critical for particular discourse level abilities, which are important for our understanding of brain–behaviour relationships and clinical decision making.

COHESION, COHERENCE, AND DECLARATIVE MEMORY

While the bulk of work directed at linking cohesion and coherence to an aspect of memory has focused on a relationship with working memory (e.g., Youse & Coelho, 2005), there are compelling reasons to investigate the contribution of declarative memory. First, the declarative memory system supports the creation of representations for successive events including information about the co-occurrences of people, places, and things, and the ability to link the spatial, temporal and interactional relations among them across time (Cohen & Banich, 2003; Eichenbaum & Cohen, 2001). In discourse terms, successive events could be individual utterances or events within a narrative or a conversational topic that is repeated and returned to across time (e.g., individual utterances or picking up the thread of conversation a week later). Within and across communicative interactions, reference to people, places, and things, as well as the spatial and temporal relations, are represented in discourse with cohesive ties. Second, declarative memory impairment is a hallmark deficit in TBI and Alzheimer's disease (Bourgeois & Hickey, 2009; Murray, Ramage, & Hopper, 2001; Richardson, 2000) and disruptions in discursive cohesion and coherence are well documented in these populations (e.g., Dijkstra et al., 2004; Youse & Coelho, 2005). Finally, related to the previous literature, when correlating cohesive ties with a variety of memory measures in the discourse of individuals with TBI, Youse and Coelho (2005) reported a robust correlation with a measure of declarative memory (verbal paired associate learning) while all but one correlation with working memory measures were non-significant.

However, the distinction between declarative memory and working memory has become blurred in recent years. It is well established that hippocampus is critical for the formation and retrieval of new long-term declarative memory (Cohen & Squire, 1980) and the traditional view of hippocampal amnesia is of a severe and selective deficit in long-term memory with preservation of short-term or working memory (Scoville & Milner, 1957). Recent evidence has challenged this notion suggesting that hippocampal dependent declarative memory is critical even over very short delays, or no delay at all, more on the timescale of what is traditionally considered short-term or working memory (e.g., Hannula, Tranel, & Cohen, 2006; Olsen, Moore, Stark, & Chatterjee, 2006; Ryan & Cohen, 2004; Warren, Duff, Tranel, & Cohen, 2010). In contrast to the traditional assessment of working memory, which focuses on memory for individual items (e.g., digit span, letter number sequencing), when the focus is on relational (declarative) memory, memory for the constituent or co-occurring elements of a scene or event (as described above; Cohen & Banich, 2003) patients with hippocampal damage and severe declarative memory deficits show impairments even at very short lags. For example, Hannula et al., (2006) tested patients with hippocampal amnesia (many of the same patients reported on here) for their relational memory of item-scene and face-scene memory and found that patients were impaired at long lags (5 and 9 back) but also at very short lags (1 back). While the deficit was more severe at the longer lags (at chance performance) the fact that patients with hippocampal amnesia

were impaired even at very short delays suggests that the hippocampal dependent declarative memory system is critical for both long-term and short-term or working memory.

THE CURRENT STUDY

The current study, examining cohesion and coherence, is part of a programmatic line of research examining the contribution of declarative memory to meeting the real-world demands that communication places on language-and-memory-in-use (Duff et al., 2008a; Duff, Hengst, Tranel, & Cohen, 2006, 2007, 2008b, 2009). Taking advantage of a rare patient group with selective and severe declarative memory impairments, this work attempts to isolate the contribution of declarative memory to the successful use of cohesion and coherence in discourse. Given what we believe are the declarative memory demands of cohesion and coherence in everyday discourse, this study allows us to specifically examine the impact of declarative memory impairments on discourse and is a potentially important first step in understanding the underlying cause(s) of such deficits in individuals with TBI and dementia. We predict that individuals with hippocampal amnesia will produce fewer cohesive ties, more incomplete ties, and have discourse that is rated to be less coherent than the healthy comparison participants. Given that the experimental literature on cohesion and coherence has employed tasks that sample discourse over relatively short spans (e.g., story retelling) (as opposed to longer stretches of interaction), and that we are using those gold standard tasks here, it is possible that any disruptions observed in the patients with amnesia in this study would be more subtle than if we sampled discourse over longer delays. Such a finding would be consistent with the recent literature showing more severe deficits at long delays and more mild, yet significant, deficits at shorter or no delays (e.g., Hannula et al., 2006; Warren et al., 2010).

METHOD

Participants

Target participants were six individuals (two females) with hippocampal amnesia, aged between 47 and 58 years, who were all in the chronic epoch of amnesia. These participants have been described extensively in the literature (see Duff et al., 2007, 2008a, 2009; Hannula et al., 2006). Neuropsychological testing revealed severe declarative memory deficits in the context of generally preserved cognition (e.g., language, attention, reasoning) and intellectual ability. For each amnesia participant, performance on the Wechsler Memory Scale-III was at least 25 points lower than on the Wechsler Adult Intelligence Scale-III (mean WMS-III General Memory Index = 68.6; mean WAIS-III Full Scale IQ = 100.7). Amnesia participants had intact working memory, as measured by standardised measures from the WMS (mean Working Memory Index = 94) (but see above and Hannula et al., 2006) and executive functioning, as measured by the Wisconsin Card Sorting Task (see Konkel, Warren, Duff, Tranel, & Cohen, 2008 for fuller characterisation). Speech and language abilities were within normal limits on standardised measures from the Multilingual Aphasia Examination and Boston Diagnostic Aphasia Examination. Of the six amnesia participants, four sustained bilateral hippocampal damage from an anoxic/hypoxic event and two sustained more extensive medial temporal lobe damage following herpes

simplex encephalitis. Structural magnetic imaging (MRI) examinations were completed in five of the six participants (computerised tomography was performed in patient 2563 (who wears a pacemaker) to confirm bilateral hippocampal damage.

Data analysis was performed on new data collected from the six amnesia participants described above as well as on existing data from the same six participants (see Duff et al., 2007, 2008a, and *Narrative* and *Procedural* methods below). Because the healthy participants studied previously were not available for new data collection (i.e., story generation task and story retell, see below), a new group of comparison participants were recruited. Accordingly there are two sets of healthy comparison participants, each set matched pair-wise to the participants with amnesia on age, sex, handedness, and education.

Discourse elicitation procedures

Story generation task. Participants viewed the Norman Rockwell painting *The Runaway* on a computer monitor. The picture depicts a small boy and a police officer at the local diner, as a counterman observes the boy with the police officer. Participants were asked, "Tell me a story about what you think is happening in this picture." The picture remained in view of the participant throughout the task. When a participant stopped talking, the examiner waited 10 seconds then asked, "Is that the end of your story?" If the participant said yes, the task ended.

Story retelling task. Participants were presented the picture story *The Bear and the Fly* (Winter, 1976), via Powerpoint presentation. The picture story had 19 frames and each frame was presented for 5 seconds. The story depicts how a family of bears' dinner is interrupted and the house is wrecked when a fly flies in the window and the father bear attempts to kill the fly. After watching the presentation, participants were asked to "Tell me that story". Procedures for terminating the task were identical to those above in the story generation task.

Narrative. Narrative samples were from a larger study on discourse in individuals with amnesia (Duff, Hengst, Nolan, Tranel, & Cohen, 2005) using the Mediated Discourse Elicitation Protocol (MDEP; Hengst & Duff, 2007). The MDEP was designed to elicit conversationally produced samples across four discourse types: conversation, narrative, picture description, and procedural. The two prompts included for this analysis were "Tell me about a frightening experience", and "Tell me a family story. This can be a story that you have told recently or one that you like to tell." Discourse data from both prompts were combined for analysis.

Procedural. Procedural discourse samples were also obtained from our larger data set (see Duff et al., 2005, 2007). The two prompts included for the analysis here were "Pretend I'm from Timbuktu and I don't know how to shop in a supermarket. Tell me everything I need to shop in an American supermarket", and "Tell me how to change a tyre on a car or truck". The clinician wrote down each step as the participants spoke. When the participant indicated s/he had finished, the clinician read back the steps and asked the participant if s/he wanted to add or change anything. For this analysis only the participants' description of the steps for each procedure was analysed. Discourse data from both prompts were combined for analysis.

Data analysis

All discourse was audio and video taped and transcribed using a consensus transcription process (see Duff et al., 2008b). Transcripts were coded for the number of words and utterances were distributed into T-units. Consistent with our previous work, words were broadly defined and fillers (e.g., uh = 1 word), contractions (e.g., don't = 1 word), and each word in a false start (e.g., and then put and then you should put = 8 words) were included in the total word counts. Comparison participants (CP) produced twice as many words (10133, $M = 422.21$, $SD = 404.60$) as amnesia participants (AP) (5812, $M = 242.17$, $SD = 192.69$) although this difference was not statistically significant ($t = 1.97$, $p > .05$). T-units were defined as an independent clause and any subordinate clauses associated with it (Hunt, 1970). Comparison participants produced more T-units (705, $M = 29.3$, $SD = 27.83$) than amnesia participants (451, $M = 18.79$, $SD = 13.68$) although this difference was not statistically significant ($t = 1.67$, $p = 0.10$).

Cohesion analysis

Following the literature (e.g., Coelho, 2002; Liles, 1985), cohesive markers were identified across three categories: reference, lexical, and conjunctive. A referential tie links the identity of a person, place, or time to the same referent in another part of the text through personal and demonstrative ties (e.g, This is Tommy and ***he*'s** stopping). A personal tie can include personal pronouns, possessive determiners, and possessive pronouns. A demonstrative tie is a form of verbal pointing, identifying the referent by location in place or time (e.g. He climbs up to take a swing at the fly ***there***.).

Lexical cohesion is achieved by selection of verbatim vocabulary (e.g., I see ***policeman*** and a uh ***young boy*** at a lunch counter and the ***policeman*** is talking to the ***young boy***) or synonym (e.g., The boy and man are having lunch and the ***child*** respects the ***adult*)**. Conjunctive ties extend the meaning of one unit (T-unit, sentence, etc.) to another. Conjunctive ties include causal (sentence meanings that cohere via the expression of a relationship that specifies result, reason and purpose; e.g. He is encouraging him to go back home ***because*** his parents are probably worried about him), adversative (sentence meanings that cohere via the expression of a relation that is contrary to expectation; e.g., They ran the licence plate and let us go, ***but*** we tried to find out why we were stopped), temporal (sentence meanings that cohere via the expression of a relation that specifies time; e.g. We were pulled over by a police car ***then*** there was two of them), and additive (sentence meanings that cohere simply by denoting added information, similarity of meaning, alternative meaning and de-emphatic afterthought; e.g., I went with my sister ***and*** her husband).

Each marker was then judged as to the adequacy using Liles' (1985) procedure. Cohesive ties were classified as complete (referent is easily located in preceding text; e.g., The boy is running away cause ***he*'s** got his bag of belongings), incomplete (referent was not supplied in the discourse or was not evident from the context; e.g., The policeman and boy are talking and the waiter is smiling looking at ***him***), or erroneous (more than one possible referent could be identified in the discourse; e.g., We got split up and I had no idea where I was supposed to meet him . . . uh huh split up from ***them***).

Coherence analysis

Coherence, as defined by Glosser and Deser (1991), is the appropriate maintenance of some aspect of the topic within a discourse. Each narrative was rated on global and local coherence according to a 5-point Likert scale (1 = Hard to follow, unrelated to topic; 5 = Related to topic, connected to preceding thoughts) adapted from Glosser and Deser (1991). Each T-unit was assigned a rating for global (relation of the meaning or content of each T-unit to established topic) and local (relation of one T-unit to that of the immediately preceding T-unit) coherence.

Reliability

Point by point inter- and intra-rater reliability for T-units, cohesive ties, cohesion adequacy, and coherence coding was calculated on 20% of the data. Intra-rater reliability for T-units, cohesive tie, cohesion adequacy, local and global coherence 99.0%, 99.2%, 99.4%, 99.0%, and 95.3%, respectively. Inter-rater reliability for T-units, cohesive tie, cohesion adequacy, local and global coherence was 92.9%, 93.1%, 89.4%, 97.3%, and 92.3%, respectively.

RESULTS

Frequency, type, and completeness of cohesive ties

Across the entire data set and all participants, 2385 cohesive ties were coded with 874 and 1511 ties coded in the discourse of the amnesia and comparison participants, respectively. Recall that comparison participants also had more T-units. The cohesive ties per T-unit across the entire data set for amnesia and comparison participants were 2.01 and 2.47 respectively. Row one in Table 1 presents the average number of cohesive ties per T-unit for each type of tie by discourse type and group. While amnesia participants consistently produced fewer total cohesive markers per T-unit than comparison participants across all discourse types, these differences were not statistically significant: story generation, $t(10) = 0.871$, $p = .40$; story retelling, $t(10) = 0.677$, $p = .51$; narrative, $t(10) = 1.57$, $p = .15$; procedural, $t(10) = 0.682$, $p = .51$.

Across the entire data set 35.2% (839/2385) of the cohesive ties were coded as referential, 18.3% (436/2385) were coded as lexical, and 46.5% (1110/2385) were coded as conjunctive. Across all participants the distribution of cohesive ties coded as referential, lexical, and conjunctive across tasks were as follows: story generation (49.5%, 18.9%, 31.6%, respectively); story retelling (31.3%, 32.7%, 36.0%, respectively); narratives (41.5%, 6.9%, 51.6%, respectively), and procedures (24.5%, 26.6%, 48.8%, respectively). Although comparison pairs produced more ties overall, the distribution of each cohesive tie type was remarkably similar: referential 34.8% and 35.4%; lexical 20.3% and 17.1%; and conjunctive 45.0% and 47.5%, for amnesia and comparison participants, respectively.

Referential ties. As shown in Table 1, the amnesia participants produced slightly fewer referential ties per T-unit than the comparison participants in the story generation task and the narrative task and slightly more than comparison participants in the story retell and procedural tasks. Examination of the number of ties coded as referential per T-unit produced by amnesia and comparison participants across the four

TABLE 1
Cohesion and coherence ratings by Discourse Type and Group

	Story generation		*Story retelling*		*Narrative*		*Procedural*		*Average across all discourse types*	
	AM	*CP*	*AM*	*CP*	*AM*	*CP*	*AM*	*CP*	*AM*	*CP*
Cohesion										
Ties/T-Unit	2.24 (1.15)	2.87 (1.35)	2.61 (1.28)	3.23 (1.84)	1.60 (0.45)	1.81 (0.60)	1.60 (0.45)	1.95 (0.32)	2.01 (0.96)	2.47 (1.27)
Referential	1.00 (0.67)	1.70 (0.72)	1.00 (0.60)	0.88 (0.69)	0.42 (0.24)	0.43 (0.19)	0.64 (0.33)	0.80 (0.11)	0.70 (0.20)	0.81 (0.17)
Lexical	0.47 (0.31)	0.38 (0.39)	**0.55 (0.36)**	**1.28 (0.93)**	0.42 (0.13)	0.53 (0.32)	0.15 (0.14)	0.12 (0.08)	0.39 (0.16)	0.43 (0.18)
Conjunctive	0.75 (0.45)	0.85 (0.44)	1.03 (0.50)	1.07 (0.49)	0.82 (0.32)	0.88 (0.35)	0.78 (0.29)	1.03 (0.17)	0.82 (0.30)	1.02 (0.12)
% Complete	85.2 (20.4)	96.1 (4.8)	87.4 (26.7)	100 (0)	79.0 (19.0)	90.0 (9.9)	91.3 (8.7)	98.0 (1.4)	**85.7 (19.0)**	**96.0 (6.4)**
Coherence										
Global	4.18 (0.66)	4.68 (0.41)	4.74 (0.36)	4.62 (0.52)	4.46 (0.29)	4.49 (0.19)	4.29 (0.28)	4.49 (0.19)	4.42 (0.45)	4.51 (0.39)
Local	3.82 (1.14)	4.81 (0.21)	4.15 (1.55)	4.66 (0.41)	4.67 (0.26)	4.77 (0.16)	**4.55 (0.21)**	**4.80 (0.08)**	**4.30 (0.97)**	**4.76 (0.24)**

Data are presented as Mean (*SD*). Ties/T-unit is the mean number of cohesive ties per T-unit across all coding categories. Referential, lexical, and conjunctive ties are presented as the mean number of ties per T-unit. Coherence ratings are presented as the mean rating on the 5-point scale. Data in bold indicate significant group differences at $p > .05$.

discourse types revealed no significant group differences—two-tailed Mann Whitney U test: story generation ($U = 9.0$, $p = .18$); story retell ($U = 12.5$, $p = .39$); narrative ($U = 15.0$, $p = .70$); and procedural ($U = 17.0$, $p = .94$).

Lexical ties. For cohesive ties coded as lexical, the amnesia participants produced more ties per T-unit than comparison participants in the story generation and narrative tasks but fewer ties in the story retell and procedural tasks (see Table 1). The examination of the number of ties coded as lexical per T-unit revealed a significant difference between amnesia and comparison participants for the story retelling task ($U = 5.5$, $p = .04$) but not for the story generation ($U = 12.0$, $p = .39$), narrative ($U = 16.0$, $p = .82$), or procedural ($U = 15.0$, $p = .70$) tasks.

Conjunctive ties. Although the amnesia participants frequently produced more cohesive ties coded as conjunctive than comparison participants across discourse types, (see Table 1) there were no significant group differences—two-tailed Mann Whitney U test: story generation ($U = 12.0$, $p = .39$); story retell ($U = 13$, $p = .48$); narrative ($U = 17.0$, $p = .94$); and procedural ($U = 16.0$, $p = .82$).

Completeness of ties. Across the entire data set, 2252 ties were coded as complete, with 812 and 1440 complete ties coded in the discourse of the amnesia and comparison participants, respectively. The scoring of cohesive ties as complete was consistently lower for amnesia participants than comparison participants, a difference that was statistically significant, $t(46) = 2.52$, $p = .018$. Ratings of cohesive tie completeness were consistently lower for amnesia participants than for comparison participants, although there were no significant differences by discourse task (e.g., story generation) (all ps $> .1$) or type of tie (e.g., referential) (all ps $> .7$).

Coherence

Across the entire data set and all individual discourse tasks there were no significant differences in the ratings of global coherence between amnesia and comparison participants (see Table 1). There were group differences, however, for the ratings of local coherence. Across the entire data set (all discourse tasks collapsed), the ratings of local coherence were lower for amnesia participants than for comparison participants, a difference that was significant, $t(46) = 2.256$, $p = .03$. Across the individual discourse tasks, local coherence ratings for the amnesia participants were consistently lower than comparison participants, although statistically significant differences were only observed in the procedural task, $t(10) = 2.65$, $p = .036$.

DISCUSSION

Deficits in cohesion and coherence have been well documented in the discourse of individuals with TBI and dementia. However, the diffuse nature of pathology and widespread cognitive impairments associated with both conditions has made the identification of the underlying cause(s) of impairment challenging. Given that declarative memory deficits are a hallmark characteristic of TBI and dementia, the current study was an initial attempt at understanding the contribution of declarative memory to the successful use of cohesion and coherence in discourse. Our findings suggest that declarative memory contributes to discourse cohesion and coherence.

Indeed, participants with amnesia routinely produced fewer cohesive ties per T-unit, the adequacy of their ties were more often judged to be incomplete, and the ratings of their local coherence were consistently lower than comparison participants. That amnesia participants demonstrated significant deficits in lexical cohesion in the story-retelling task and local coherence in the procedural discourse task may reflect the unique declarative memory demands of these genres (e.g., greater memory demand in a retelling task; see Shadden, Burnette, Eikenberry, & DiBrezzo, 1991) or of flexibly deploying declarative knowledge in social interaction (e.g., adopting the listener's perspective in procedural discourse; see Duff et al., 2008a). These potential interpretations warrant further investigation.

That declarative memory would be important in discourse cohesion and coherence seems intuitive, as it supports the construction and use of representations for successive events including information about the constituent elements of a scene or event (e.g., co-occurrences of people, places, and things, and the ability to link these various types of relations across time; Cohen & Banich, 2003; Eichenbaum & Cohen, 2001). The results from the current study in patients with severe yet selective declarative memory impairment are in line with previous work examining cohesion and coherence in patients with declarative memory impairments as part of a broader profile of neuropsychological deficit. Past studies in individuals with dementia and TBI have found deficits in the percentage of complete ties (Liles et al., 1989; Ripich et al., 2000) and a decrease in the overall number of cohesive ties (Hartley & Jensen, 1991; Ripich et al., 2000). Similarly, we found that patients with hippocampal amnesia produced fewer complete ties and fewer cohesive ties, overall, than healthy comparison participants. This is not to say that in these previous studies the observed deficits in cohesion and coherence are entirely attributable to impairments in declarative memory. Communication, like other complex human behaviours, is accomplished through the orchestration of multiple cognitive systems. The findings here, though, suggest that declarative memory plays a role in the discursive use of cohesion and coherence and likely contributes to the observed deficits in cohesion and coherence in patients with more complex cognitive-communication disorders such as TBI and dementia.

The fact that declarative memory has received little attention in the literature on cohesion and coherence is likely due to the presence of more, or seemingly more, deleterious cognitive disruptions. It is possible that in TBI the consequences, both on neuropsychological testing and in the impact on everyday functioning, of frontal or dysexecutive deficits has been more prominent and thus received more attention in the literature. Another reason for a lack of attention to declarative memory is the issue of timescale. Declarative memory, in the context of traditional assessment, has been associated with multiple learning trials and retrieval of that information after a 20- or 30-minute delay. While traditionally considered the purview of the fontal lobes, specifically dorsolateral prefrontal cortex, recent work reporting that patients with hippocampal amnesia are impaired at short or no delays suggests that hippocampal dependent declarative memory system is also critically involved in short-term or working memory (e.g., Hannula et al., 2006). Instead of a focus on the distinction between long-term (declarative) and working memory, the nature of the processing (relational vs single items) may prove more fruitful. These advances in our understanding of multiple memory systems and their instantiation in the brain may provide important insights and reconceptualisations in our understanding of the neural systems and cognitive domains critical for various aspects of language and language use.

A potentially interesting finding reported here is the trend for lower ratings for local coherence in the discourse of the amnesia participants with more comparable group ratings for global coherence. A consistent finding in the adult neurogenic literature is for global coherence ratings to be significantly lower than local coherence (e.g., Glosser & Deser, 1991; Dijkstra, Bourgeois, Petrie, Burgio, & Allen-Burge, 2002) leading to the interpretations that global and local coherence may depend on distinct cognitive processes, maintaining global coherence is more challenging, and global coherence is more vulnerable to the effects of cognitive impairment (e.g., Arbuckle & Gold, 1993; Glosser & Deser, 1991; Rogalski, Altmann, Plummer-D'Amato, Behrman, & Marsiske, 2010). As pointed out by Rogalski and colleagues, however, several researchers have found a trend for poorer local coherence or sporadically locally incoherent discourse (e.g., Glosser, Deser, & Weisstein, 1992; Van Leer & Turkstra, 1999) although there were no significant group differences in these studies. Relating this to the amnesia literature, although this is the first study to our knowledge of coherence in amnesia patients, Ogden and Corkin (1991) noted that while the verbal productions of the famous neuropsychological patient H.M., who had profound anterograde declarative amnesia similar to the patients here, were typically related to the current topic, his language could become markedly tangential. Given the theoretical and rehabilitative implications for dissociations in global and local coherence and changes over time in neurodegenerative diseases (e.g., AD), more research is warranted.

Finally, an important, yet seldom discussed, issue in the literature on cohesion and coherence in adult neurogenics is the communicative or clinical impact of any observed group differences (significant or not). Much of the work on cohesion and coherence has focused on the spoken productions of one individual using experimental measures that capture cohesion and coherence over relatively narrow units of discourse and time. Yet in face-to-face communication there are numerous multimodal means of establishing and displaying "interactional cohesion" (e.g., pointing, gesturing, eye gaze). Likewise, communicative interactions unfold over time as communication partners pick up the thread of a conversation across topics and across days or longer. Consequently, it is possible that the experimental tasks frequently used in the literature, and here, may actually overestimate or underestimate the extent of impairment across various cognitive-communication disorders in communicating in the real world. For example, it is possible that the focus on cohesion and coherence in only the verbal productions of the participants, with little to no consideration of other resources (e.g., pointing or directing eye gaze to a character in the stimuli which would resolve any ambiguity) has effectively overemphasised the impact the deficit has on successful everyday communication. On the other hand, the experimental tasks we frequently use may not tap the cognitive demands of communicating across time and across speakers, so that subtle (or non-significant) disruptions on these tasks actually underestimate the difficulty and challenges of producing and resolving cohesive ties in complex social interaction. We suspect the latter to be the case for the participants with amnesia or other individuals with severe declarative memory impairments. To increase ecological validity, future work should examine cohesion across speakers (as in conversational samples of two of more people), across time (days, weeks, or longer) and across communicative resources (talk, gesture, eye gaze). Such an approach may increase our basic understanding of the interdependences of memory, language, and social interaction and yield more sensitive information about the nature and scope of discourse impairments in patients who

have declarative memory deficits associated with traumatic brain injury, dementia, and healthy ageing.

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