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Collaborative Discourse Facilitates Efficient Communication and New Learning in Amnesia

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Abstract

In previous work we reported robust collaborative learning for referential labels in patients with hippocampal amnesia, resulting in increasingly rapid and economical communication or “common ground” with their partners (Duff et al., 2006). The current paper reports the results of discourse analysis, describing the communicative resources and practices used in extended, repeated collaborative interactions, as partners successfully referenced the target cards, managed the task itself, and engaged in non-task talk. Although amnesic pairs showed a normal rate of reduction across trials in the number of words and time-to-completion, their communicative effort was higher overall, particularly the discourse associated with task management, they exhibited a general lack of flexibility in their referential expressions, and they showed a number of striking differences in use of personal and communal knowledge and of multiple perspectives. The interactive sessions provided a potent learning environment, but also a very challenging task in the face of memory impairment. The results give insight into the acquisition of common ground and the manner in which amnesic patients accommodate their memory deficits during real-world interactions, and they have significant implications for memory intervention.

Keywords

amnesia; hippocampus; memory; semantic; communication; discourse; learning; common ground; intervention; social interaction

1. Introduction

The hallmark deficit in anterograde hippocampal amnesia is a profound impairment in acquiring new declarative memory for both semantic (facts, vocabulary) and episodic (events of daily life) information (Cohen & Eichenbaum, 1993; Eichenbaum & Cohen, 2001; Gabrieli, 1998; Squire, 1992). While the traditional view of amnesia has been one of a pure memory

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deficit, some researchers (e.g., MacKay, Burke, & Stewart, 1998; MacKay, James, & Hadley, in press) have challenged this view by pointing to language impairments in the amnesic patient H.M., which may suggest that language and memory are not autonomous, but rather interdependent and vulnerable to simultaneous disruption. Research examining memory and language in amnesia has drawn on protocols designed to differentiate abilities and deficits across distinct cognitive processes. In these studies participants typically complete isolated tasks in structured laboratory environments. Studies of semantic learning in particular have been criticized for the rigidity and hyperspecificity of training that may artificially eliminate the variability that defines semantic information and constrain the flexible expression of newly acquired information (Stark, Stark, & Gordon, 2005). Another drawback of such approaches is that they do not address memory and language use in naturalistic contexts (cf. Neisser & Hyman, 2000), and provide little insight into how such isolated abilities or deficits may be accommodated to support everyday communication. We have taken a different approach by working to create rich communicative/learning environments that support examination of interactional aspects of language-and-memory-in-use (Duff, Hengst, Tranel, & Cohen, 2006, 2007) and social interaction in clinical settings (Hengst & Duff, 2007).

We examined language-and-memory-in-use in amnesia in a study investigating the ability of individuals with hippocampal amnesia to acquire and use referential labels for novel picture cards across repeated collaborative interactions with a familiar partner (Duff et al., 2006). Despite profound declarative memory impairments, amnesic patients displayed collaborative learning across trials, resulting in increasingly rapid and efficient communication, or “common ground,” at a rate equal to that of healthy comparison participants. The observed learning of referential labels expands the domain of preserved learning abilities in amnesia, and stands in contrast to the typically modest and painfully slow semantic learning seen in amnesia when tested formally in the laboratory. Further, it suggests that these interactive communication sessions are potent learning environments.

At the same time, the collaborative learning task was exceptionally demanding, particularly of those individuals with profound memory impairment, and the interactive communication sessions provided an exceptionally rich corpus of data on the particular communication practices and resources used in conversational language in amnesia. It was noted in our original data set that despite the normal rate of learning of referential labels across trials, the communication between amnesic patients and their partners involved more resources, requiring more words and more time, overall, than what was required by comparison pairs. Here, we extend the analysis of language output and communication practices, in a more systematic in-depth examination of the interactive discourse, thereby providing a more detailed look at language-in-use as a function of the particular pattern of sparing and loss of memory functions in amnesia. This analysis affords a unique glimpse into the interaction of language and memory, as well as of communication practices that support the development and use of common ground in an example of real-world collaborative interaction.

1.1 Collaborative Referencing

In sharp contrast to studies designed to isolate production of morpho-syntactic form, early studies of collaborative referential communication were designed to follow the way speakers adjusted and modified their utterances over time in response to changes in the listeners’ knowledge and social roles (Clark, 1992; Yule, 1997). Methodologically, these studies employed a controlled referential task, or a “barrier task.” Originally devised and used by Krauss and colleagues (Krauss & Glucksberg, 1969, 1977; Krauss & Weinheimer, 1964, 1967), barrier tasks allow for elicitation of participants’ spontaneous and unscripted conversational language. Conventionally, barrier tasks consist of two people sitting across from one another while their view of the other is completely obscured. Each person is assigned a

role (director or matcher) and the director provides verbal directions to the matcher on how to complete the task (e.g., match pictures to specific locations on a board). Across these early studies, when referencing to the same person using the same materials, a consistent finding emerged: referencing expressions simplify and shorten across trials (see Clark, 1992; Yule, 1997 for a summary of this work).

Clark and Wilkes-Gibbs (1986, reprinted in Clark 1992) extended the work of Krauss and colleagues by focusing not only on the evolving form of the referential expression, but also on how speakers and listeners coordinated their activities to collaborate on the development and use of references across trials. In an experiment similar to those by Krauss and colleagues, Clark and Wilkes-Gibbs (1986) had eight stranger pairs of undergraduate students complete a barrier task across six trials. Each participant was assigned the role of either director or matcher and the director was instructed to quickly, accurately, and sequentially, tell the matcher where to place 12 cards on a numbered board. The pairs' view of each other and their individual workspaces were obscured by a barrier. In order to examine development of referential labels, novel stimuli cards were used. These cards each presented a picture of a Chinese tangram: complex, black and white geometric shapes which can resemble human figures, but have no established names.

Consistent with the earlier studies, the referencing expressions shortened and simplified across trials. Clark and Wilkes-Gibbs (1986) interpreted this finding through the concept of common ground - the beliefs, attitudes, and knowledge about current and previous communicative exchanges that are shared between speakers and listeners, and that are heuristically utilized to facilitate rapid and economical communication. Based on these findings, Clark (1992) introduced a model of collaborative referencing which states that the interactive processes of collaboration or the "intricate back and forth interchange on each and every reference" (p. 104) contributes to the communicative pairs' common ground, allowing them to, over time, reduce the amount of overt collaborative effort (number of words and turns) necessary to successfully establish and resolve individual references. The communicative work of collaboration is distributed across multiple activities including working to establish a shared perspective, negotiating and settling on shared labels, and although not described by Clark in this way, *managing* the task, whereby participants negotiate social roles, task rules and acknowledge card placements. Critically, the effects of the collaborative model cannot be attributed to repetition alone. Without an interlocutor present with whom to interact and collaborate, but with repeated repetition of the same referential expression, the amount of overt collaborative effort *does not* decrease across trials (Hupet & Chantraine, 1992).

Drawing on interactional sociolinguistic perspectives of discourse and sociohistoric theories of language-in-use, Hengst (2003) examined collaborative referencing in aphasia. To optimize communicative success, Hengst adapted Clark and Wilkes-Gibbs' (1986) controlled experimental protocol by using familiar partners, alternating the role of director, using a partial barrier to allow nonverbal and verbal communicative resources, and increasing the number of referential opportunities (four sessions of six trials) and targets (multiple sets of stimuli). These modifications allowed Hengst (2003; 2006) to show that communicative pairs managing aphasia displayed the reduction in overt collaborative effort, but also that by preserving the emergent nature of social interaction, pairs drew on more complex and diverse referential practices (e.g., contextualized histories, verbal play, nonverbal references) not observed (or reported) by Clark and Wilkes-Gibbs and/or not afforded by the more controlled experimental protocol.

1.2 Collaborative Referencing and Amnesia

Postulating on the memory requisites of common ground, Clark (1992) suggested that common ground involves the ability of speakers and listeners to track, recall, and continuously update

their records of new events. Accordingly, each participant in a conversational exchange is assumed to have a model of what is in the other person's mind, a model that is built up from previous contact and is continuously updated as the exchange continues (Clark, 1992). In the first study designed to test the memory determinants of common ground, and of collaborative referencing more broadly, we examined whether or not individuals with hippocampal amnesia, who have profound impairments in acquiring new semantic and episodic information, and more generally, in forming the very records of experience that Clark speculated were essential for the development of common ground, were capable of arriving at increasingly efficient labels to reference novel pictures across a series of communicative interactions (Duff et al., 2006). Consistent with sociocultural approaches to intervention (cf. Ylvisaker & Feeney, 1998) which view communicative practice as fully integrated with learning, the study was designed to preserve the dynamic aspects of social interaction permitted by the Hengst (2003) protocol (e.g., partial barrier, familiar partners) while maintaining the experimental control afforded by the Clark and Wilkes-Gibbs protocol (e.g., stable participant roles and stimuli across trials).

In our study, participant pairs (amnesic participant and familiar partner) sat at a table facing each other and each member of the pair had a board with 12 numbered spaces and a set of 12 cards displaying Chinese tangrams. Between them was a low barrier that obscured the view of the others' stimulus cards but allowed participants to see each others' facial expressions and gestures. Amnesic patients, assigned the role of director, began with their cards on the board and communicated to the matcher (familiar communication partner) how to complete their board with the cards so that at the end of the trial the two boards look alike. The task was presented as a game and participant pairs were instructed to communicate freely and to have fun. The pairs played the game 24 times, with 6 trials conducted in each of 4 sessions, 2 sessions per day. Because we were interested in the issues of memory and learning related to common ground, we also tested subsequent memory retention for the labels, outside of the context of the task.

We found that despite severe declarative memory impairments, amnesic participants showed robust collaborative learning across trials, at a rate equal to that of normal comparison subjects (Duff et al., 2006). The amnesic participants' learning resulted in their arriving at labels that facilitated increasingly efficient communication and they displayed the reduction in overt collaborative effort seen in Clark's collaborative referencing work with neurological intact individuals. Impressively, learning of the labels endured long after the task ended as measured at 30 min and 6 month intervals (and at 2 years for one participant). These findings provided the first empirical evidence that individuals with hippocampal amnesia can acquire and use common ground in their communicative interactions with a familiar partner. Furthermore, these findings challenged views of the memory determinants of common ground suggesting that common ground can be supported, in part, by less explicit and more procedural or non-declarative forms of memory.

Other work has also suggested that non-declarative memory systems may support some amount of new semantic learning, with the knowledge acquired differing quantitatively and qualitatively from knowledge acquired by healthy participants (e.g., Bayley & Squire, 2002, O'Kane, Kensinger, & Corkin, 2004; Skotoko et al., 2004). Thus, even the severely amnesic patient H.M. can, with enough repetition and time, learn *some* information about new vocabulary and public-domain facts (O'Kane et al., 2004); however, the new information that H.M. can acquire seems sparse and inflexible – he knows far less about such information than any healthy participant. Similarly, while acquisition of semantic knowledge was demonstrated in the profoundly amnesic patient E.P. (Bayley & Squire, 2002), 48 trials were required for him to learn materials as compared to only 4 trials for healthy subjects and what E.P. learned was rigidly organized.

The learning exhibited by the amnesic participants in our collaborative referencing task (Duff et al., 2006) differed from any earlier example of semantic learning by involving an entirely normal rate of acquisition. However, it remains to be determined whether the underlying bases of the learning and nature of the conversational language used in the collaborative interactions were comparable for amnesic vs non-amnesic participants. The richness of the discourse data collected in the collaborative referencing task permits detailed analysis of language-in-use throughout the course of the development of common ground. Our initial analyses indicated that although amnesic patients and their communication partners showed a normal rate of reduction across trials in the number of words and the amount of time to get through the description and placement of all the tangrams, it was nonetheless the case that the word counts and time-to-completion for amnesic pairs were higher overall, throughout the task, than what was observed in comparison pairs. This combination of fully intact learning rates but differences in overall language production sets the stage for the analyses to be reported here.

1.3 The current analyses

The analyses presented here extend Duff et al. (2006) by providing a systematic examination of the interactive discourse displayed by communication partners with vs. without amnesia using situated discourse analysis to characterize in detail the collaborative communication practices displayed during the sessions. Such analyses of the discourse of amnesic and comparison pairs are directed both (1) at characterizing the changes that occur across trials, so as to provide a better description of the nature of the collaborative learning that serves as the basis for acquiring common ground, and (2) at characterizing aspects of language-in-use, for the entire collaborative interaction, so as to illuminate the interaction of memory and language in real-world communication.

The collaborative referencing paradigm provides an especially rich opportunity for observing language-in-use during extended, repeated collaborative discourse, as well as a special challenge to both language and memory capabilities, compared to prior testing paradigms, with which to evaluate the performance of amnesic patients. Even the more formal, circumscribed investigations of the language in the amnesic patient H.M. have reported inappropriate, ambiguous, and confusing use of references (MacKay et al., 1998; Schmolck, Kensinger, Corkin, & Squire, 2002). If impairments in referential practices are a general feature of amnesia, we would expect to see greater communicative effort (more words, more turns) across both members of the pair as they work to disambiguate confusing references in the current paradigm, with these novel materials. Similarly, if the findings from laboratory-based testing of new semantic memory in amnesia, showing that the expression of newly acquired information is constrained by the characteristics of the non-declarative memory system, resulting in rigid and inflexible expressions, is a generalizable feature, the discourse analysis here should reveal differences between groups in what was learned and how it is expressed.

In addition, the extraordinary demands that the extended, repeated interactions would seem to place on memory leads to predictions about other possible differences in the communications practices with vs without amnesia. We might expect amnesic pairs to require additional resources to manage their memory impairment, using discourse measures beyond time-to-completion and word counts. For example, it is easy to imagine the amnesic participants asking their partner to remind them of the task rules and procedures or to indicate which cards have been described. From a communicative accommodation perspective (e.g., Giles, Coupland, & Coupland, 1991) we would predict that these requests by amnesic participants would shape the subsequent productions of the familiar partners as well, perhaps in ways that scaffold (e.g., Bruner, 1985; Ylvisaker & Feeney, 1998) the observed learning of the amnesic participants. These analyses to be reported here are the first, to our knowledge, to address how individuals with amnesia and their communication partners work together to manage and accommodate

memory impairments while engaging in communicative interactions; only a paradigm providing as rich an environment for collaborative interaction over extended periods, as this one, could provide adequate illumination of such an example of language-and-memory-in-use.

2. Methods

2.1 Participants and Data Set

Analysis was performed on interactional data obtained as four amnesic participant pairs (individuals with amnesia and their familiar communication partners) and four comparison participant pairs (normal participants and their familiar communication partners) completed a collaborative referencing task (Duff et al., 2006). To complete the task, participant pairs sat at a table facing each other and each member of the pair had boards with 12 numbered spaces and identical sets of 12 playing cards displaying Chinese tangrams. Figure 1 displays the tangram figures. A partial barrier obscured the view of the others' stimulus cards but allowed participants to see each others' facial expressions and gestures. The director (individuals with amnesia) began with his/her cards on the board and communicated to the matcher (familiar partner) how to fill the numbered spaces with the cards so that at the end of the trial the two boards look alike. The task was completed on a total of 24 trials, with 6 trials conducted in each of 4 sessions, 2 sessions per day with at least 30 min between sessions. All sessions were videotaped.

The amnesic participants were two males and two females and age ranged from 47 to 54. Three participants (0001, 2563, 2363) sustained bilateral hippocampal system damage from an anoxic/hypoxic event (e.g., cardiac arrest) and one from a closed head injury (0002). For patient 2363, a structural magnetic resonance image (MRI) examination was completed confirming bilateral hippocampal damage and significantly reduced hippocampal volumes (studentized residual differences in hippocampal volume relative to a matched comparison group down by 2.6 z-scores) (Allen, Tranel, Bruss, & Damasio, 2006). Volumetric information is not available for patients 2563, 0001 or 0002. For patient 2563 anatomical analysis was based on computerized tomography (he wears a pacemaker and was unable to undergo the MRI examination) and only damage in the hippocampal region was visible. For patient 0001, MR images of coronal and transverse sections through the mid-portion of the hippocampus clearly displaying bilateral hippocampal volume reductions have been published previously (see Hannula, Tranel, & Cohen, 2006, Figure 1). Anatomical analysis of patient 0002, reported previously in Ryan & Cohen, 2004, revealed shearing lesions of white matter tracts, producing punctuate lesions distributed around white matter areas that were denser closer to the center of the brain. White matter lesions were observed in the temporal stem region containing the white matter pathways running between medial and more lateral temporal structures, and in the more inferior pathways to and from the hippocampal region in the forebrain. The structure and volume of the hippocampal region itself appear intact.

At the time of data collection, participants were medically stable and in the chronic epoch of amnesia, with time-post-onset ranging from 3 to 18 years. Neuropsychological testing confirmed a selective and severe memory impairment disproportionate to any deficits in general cognitive or intellectual functioning. Performance on the Wechsler Memory Scale-III (General Memory Index) was at least 25 points lower than performance on the Wechsler Adult Intelligence Scale-III (Full Scale IQ) (mean FSIQ-GMI difference = 41.25), with an average delay score on the memory scale (62.75) that was nearly 3 standard deviations below population means. Participants were severely impaired in delayed recall on the Rey Auditory Verbal Learning Test; only 1 of the participants could report even a single item (out of 15) despite multiple study opportunities. While participants displayed intact visuo-spatial and visuo-perceptual abilities with normal performance on the copy portion of the Rey Complex Figure Test, their memory for the image was severely impaired at a 30-minute delay. Critically, and

consistent with the neuroanatomical analysis of cortical damage being restricted to medial aspects of the temporal lobes, speech and language abilities are within normal limits on standardized measures from the Multilingual Aphasia Examination and Boston Diagnostic Aphasia Examination and participants were free of aphasia and dysarthria. Semantic knowledge more broadly is intact (average to above average performance) on the Information subtest of the Wechsler Adult Intelligence Scale-III. The healthy comparison participants were matched pair wise to amnesic participants on age, sex, education, and handedness.

Each amnesic and comparison participant selected a familiar communication partner with whom they completed all collaborative referencing task trials. Familiar partners were required to have at least 5 years of frequent (monthly) communication with the participant although the length of communicative history was much longer for many participant pairs (e.g., siblings, spouses). For the four amnesic participants the familiar partners were two spouses, a friend, and a sibling. For the four comparison participants, three friends and one sibling served as partners. The familiar partners of the amnesic and comparison participants were similar in years of age (49 vs. 45) and education (14 vs. 14). Finally, the familiar partners had normal corrected vision and hearing, and a negative history of neurological disease, motor speech impairments, premorbid learning disabilities, per self report, and were all monolingual American English speakers.

Participants were recruited from the Amnesia Research Laboratory at the Beckman Institute at the University of Illinois and the Patient Registry of the Division of Behavioral Neurology and Cognitive Neuroscience at the University of Iowa. All participants gave informed consent, which were approved by the Human Subjects Committees of the Universities of Illinois and Iowa.

2.2 Extended Data Analysis

2.2.1 Transcribing the Interactions—Sessions were transcribed in their entirety including task instructions, each of the 24 trials and conversations between trials. Transcript preparation involved three stages performed by an original and consensus transcriber. In the first stage, the audio portion of the taped interactions was transcribed by the original transcriber who listened to the audio tape and transcribed all utterances, audible sounds, and pause times. In the second stage, the original transcriber watched the videotaped interactions and added card placements and made corrections to the audio content of the transcript. In the third stage, the consensus transcriber (the first author) and the original transcriber viewed the video together and generated a final version of the transcript – the consensus transcription. Corrections and additions were made through discussion and consensus.

2.2.2 Coding Communicative Resources—In the current analysis, we examined communicative resources employed across each of the 24 trials and by both participants in a pair (not just the number of words in the director's initial description of each card as reported in our initial analysis). The communicative resources analysis, however, was conducted only on data from the 24 individual trials and not from the task instructions or between trial talk. Data from the transcripts were obtained to quantify the amount of overt collaborative effort displayed across trials. Two types of resources were identified: interactional turns and words. *Interactional turns* were defined as utterances produced by one individual and could include both verbal and nonverbal resources. Some turns consisted of a gesture or non-verbal back-channel response (e.g., head nod) alone. Turn boundaries were denoted by a change in speaker. When two individuals spoke simultaneously, each speaker's utterance was counted as a turn. Words were broadly defined with little emphasis placed on morphological or syntactic form. Each word in a false start was counted (e.g., *they both have, they are both facing left* = 8 words). Following Clark and Fox Tree (2002), who argue that fillers (i.e., *uh, um*) are conventional

English words used to indicate speaking delays, fillers were counted as words (e.g., *um they both* = 3 words). Contractions were counted as one word (e.g., *can't* = 1 word). Finally, verbal back-channel or continuer responses (i.e., *uh huh, yeah, m hm*), common in conversational speech to indicate understanding (Schegloff, 1982), were each counted as one word (e.g., *uh huh* = 1 word).

2.2.3 Coding Communicative Functions—A coding system was developed to identify the communicative work or function of each interactional turn with the goal of quantifying how pairs directed their communicative effort during the sessions and to account for possible group differences. The protocol had three steps. First, each interactional turn from the consensus transcript was assigned to one or more functions using seven broad categories (referencing target card, referencing target place, referencing other card/place, transitions, non-task talk, task management, and discourse). Second, the broad category criteria and the results from the first pass of coding were reviewed. Of particular interest was refining the categories and operational definitions to reduce redundancies in the coding procedures and to reduce the likelihood of coding an interaction turn as having multiple functions. To accomplish this, the coding categories were revised. Three communicative functions were selected for the final coding: referencing; task management; and non-task talk. Finally, the first author re-coded the data set using the final communicative functions.

The referencing category was used to capture talk dedicated to establishing labels and perspectives (e.g., *This one looks like a dog*), placing the cards (e.g., *That's number two*), and general discussion of target and non-target cards (e.g., *Is the triangle on top of the chimney*). Referencing occurred directly (e.g., *Siesta man is number two*) and indirectly (e.g., *No, your thinking of the other one*). This category also included meta-card talk such as talk about the label (e.g., *Let's call this one the angle*).

The management category was designed to account for and document how participant pairs overtly managed the task through their discourse. These utterances included direct discussion and review of rules (e.g., *Can I just show you the cards?*) and participant roles (e.g., *You're supposed to be describing them to me*), strategies (e.g., *Let's try a new system Paul*), and routines (e.g., *Let's do the houses first again*). Management also included utterances that were overt displays of transitions between cards (e.g., *Okay, the next one is the Viking Ship*), transitions from task to non-task talk (e.g., *Okay we're supposed to be doing this.*) or management routines (e.g., *Let me ask you a question. Which ones have we done?*). It does not include all metatalk (e.g., *I don't see a bunny rabbit. I think it looks like a squirrel*), just task related (e.g., *Good, we got the easy ones done first*).

Non-task talk indicated talk that was not in direct reference to the stimuli or the task itself including: 1) turns that could have occurred in the absence of the cards, materials, or setting (e.g., Director: *Like when women have a more muscular back than I do.*, Matcher: *Yeah, that's scary*); and 2) turns which seemed irrelevant to completing the task but which supported subsequent referencing (e.g., Director: *Your fish. But what kind of fish? Tropical?*; Matcher: *It's a Piranha*; Director: *Have you ever seen one of those?*; Matcher: *Well, in the movies*).

2.2.4 Reliability of Coding—Reliability ratings were obtained for approximately 12% of the trials (3 trials randomly selected per pair). Ratings for open-ended categories (e.g., words) were accomplished by comparing category totals across trials. Interjudge agreement for the number of turns and words was .99 and .99, respectively. Intrajudge agreement was .99 and .99 for number of turns and words, respectively. Reliability ratings for categories with a fixed number of possible responses (e.g., communicative functions) were determined by point-by-point agreements. Interjudge agreement for referencing was .99; non-task was 1; and

management was .96. Intrajudge agreement for referencing was .96; non-task was .99; and management was .94.

3. Results

3.1 Accounting for greater communicative effort

3.1.1 Communicative resources—Across the 24 trials and the productions of both the director and matcher of a pair, 8,400 interactional turns were coded with 4,719 and 3,681 total interactional turns in amnesic and comparison sessions, respectively. Analysis revealed that the use and distribution of interactional turns across trials was similar between groups. The mean number of interactional turns dropped from 127.0 and 127.5 on trial one, for amnesic and comparison pairs, respectively, to 31.8 and 23.7, respectively, on trial 24 (no main effect for group ($F(1, 6) = 2.831, p = .143$)) and there was a significant linear trend across trials ($F(1, 6) = 13.419, p = 0.011$) indicating that the rate of change in the use of interactional turns across trials did not differ between the two groups.

The greater communicative effort exhibited by amnesic pairs was not accounted for in the number of interactional turns. That is, amnesic and comparison pairs did not differ in the *number of their back and forth negotiations*. Instead, the increased communicative effort is seen in the amnesic pairs' production of nearly twice as many words as comparison pairs across the 24 interactional trials. A total of 54,710 words were coded with 36,004 and 18,706 words for amnesic and comparison pairs, respectively. The mean number of words dropped from 1187.5 and 1051.8 on trial 1, for amnesic and comparison pairs, respectively, to 152.3 and 65.8, respectively, on trial 24 (main effect for group ($F(1, 6) = 9.555, p = .021$)). Although amnesic pairs used more words overall, this was seen from the very first trial onward, and there was no interaction of group with the learning across days, sessions, and trials ($F(5, 30) = 0.654, p = .576$). There was a significant linear trend across trials ($F(1, 6) = 11.338, p = 0.015$) indicating that the rate of change in the use of words across trials did not differ between the two groups. These data suggest that amnesic pairs had longer interactional turns as measured by words. Indeed, the mean length utterance for amnesic pairs was 2.5 words longer (7.63) than for comparison pairs (5.08). Figure 2 displays the session-by-session linear trends across trials for number of interactional turns (a) and words (b).

3.1.2 Distributed effort across referencing, task management, and other contexts

—The analysis of communicative functions revealed that all three communicative functions, *referencing*, *management*, and *non-task talk*, were represented in the sessions of both amnesia and comparison pairs. Across all sessions, 95.1% (7,987/8,400) of the interactional turns were coded as referencing, 19.7% (1,651/8,400) were coded as management, and only 0.88% (74/8400) were coded as non-task. Table 2 shows the total number of turns for each communicative function for amnesic and comparison pairs. Despite efforts to reduce the likelihood of coding interactional turns as having multiple functions, the data presented in Table 2 suggest that participants produced complex interactional turns that attended to multiple task and communicative goals. This is perhaps not surprising given the real-world nature of the task.

The number of interactional turns coded as referencing was remarkably similar between amnesic and comparison pairs; 95.3% (4497/4719) and 94.8% (3490/3681), respectively. The mean number of referencing turns dropped from 112.0 and 114.0 on trial one, for amnesic and comparison pairs, respectively, to 30.5 and 23.5, respectively, on trial 24 (no main effect for group ($F(1, 6) = 3.001, p = .134$)) and there was a significant linear trend across trials (in polynomial trend analyses, linear trend: ($F(1, 6) = 14.026, p = 0.010$)) indicating that the rate of change in the use of referencing turns across trials did not differ between the two groups.

Perhaps not surprisingly, amnesic pairs produced more interactional turns coded as management than comparison pairs, 23.4% (1102/4719) and 14.9% (549/3681), respectively, a difference that was statistically significant (main effect for group ($F(1, 6) = 38.73, p = 0.001$)). Despite these differences, both comparison and amnesic pairs steadily decreased the number of management turns across trials. The mean number of management turns dropped from 43 and 36 on trial one, for amnesic and comparison pairs, respectively, to 3.0 and 2.0, respectively, on trial 24. Although amnesic pairs had more interactional turns dedicated to management overall, there was no interaction of group with the learning across days, sessions, and trials ($F(5, 30) = 0.654, p = .576$). There was a significant linear trend across trials (in polynomial trend analyses, linear trend: ($F(1, 6) = 9.885, p = 0.020$) indicating that the rate of change in the use of management across trials did not differ between the two groups.

Only 77 interactional turns were coded as non-task with 0.17% (8/4719) and 1.79% (66/3618) of interactional turns coded as non-task for amnesic and comparison pairs, respectively. Although statistical analysis was not possible due to the small number of turns, the raw data suggest group differences. All four comparison pairs produced non-task talk with each pair producing at least two (range 2–52) non-task turns. In contrast, only two amnesic pairs had non-task turns; one pair produced one non-task turn and another pair produced 7 non-task turns.

3.1.3 More elaborated card descriptions—The semantic content of the labels for the 12 tangrams were remarkably similar across groups. For example, for one amnesic pair, labels such as *mountain with box sliding down*, *siesta man*, *barn with the arrow*, and *dog with the tail up* were developed for cards 3, 4, 10, and 12, respectively (See Figure 1). The matched comparison pair generated labels such as *messed up mountain*, *lazy person*, *barn with the arrow*, and *dog with a fin* for the same cards. Despite the similarities in semantic content of the expressions, the amnesic and comparison pairs displayed differences in the conciseness of the linguistic expression of their labels. By the final trial, 72.9% (35/48) of the references produced by comparison directors were less than or equal to 3 words (e.g., *the Viking ship*, *Dow Jones chart*) with a mean of 2.5 words, whereas only 35.4% (17/48) of the references produced by amnesic directors were equal to or less than 3 words with a mean of 6.5 words (e.g., *a horse with a square rug carpet*, *the guy sleepin' sittin' down*).

We were surprised to discover that comparison directors were using telegraphic speech, omitting all words that were not essential for identifying target cards. For example, comparison directors gradually omitted verbs (e.g., *leaning against a tree is one* → *leaning against a tree eleven*), articles (e.g., *the bird* → *bird*), and place numbers (e.g., *four is the kicker* → *the kicker*). Some comparison directors even dropped morphological endings to further shorten their one word labels (e.g., *kicking* → *kick*). Interestingly, the move towards telegraphic speech was a strategic and explicit attempt by comparison pairs to increase their speed and if possible, to use only one word labels (e.g., *The one word one cards we know do those first; Let's see how short we can make it*). None of the amnesic pairs explicitly decided to go for speed or to make the referencing expressions as short as possible. Even the participant with amnesia (0002) who had the fastest time and lowest total word count of all the amnesic pairs kept the verbs, articles, and place numbers in her referencing expressions. Figure 3 displays the final trial for a comparison and amnesic director on the last trial of the last session and highlights the comparison director's use of telegraphic speech. In that final trial, although the content of the references were quite similar, the comparison director produced nearly 50% fewer words (30 words) than the amnesic director (56 words) simply by omitting the verbs, articles, and at the end of the trial, the place numbers. Note too that the matcher in the comparison pair also produced 50% fewer words (5 words) than the matcher in the amnesic pair (11 words) by not verbally confirming each card placement and using the audible card snap instead.

3.1.4. Managing task and small talk—The communicative function analysis revealed differences in the number of turns dedicated to task management and talking about contexts beyond the scope of the task with amnesic pairs producing more interactional turns coded as management and fewer small talk or non-task talk turns than comparison pairs. The use of management turns across sessions was quite similar between groups and there were no types of management turns (e.g., discussion of rules, strategies, transitions, meta talk) that occurred in one group and not the other. However, the increased use of management in the discourse of the individuals with amnesia appeared to reflect the increased effort associated with managing the memory impairment. For example, a striking difference in management turns between groups was related to reviewing the rules. Although comparison directors discussed task rules (e.g., *Can I refer back to another card; Do we have to go in order*), these were typically single exchanges that occurred in the midst of the task. In contrast, many amnesic directors required more extensive discussions with their partners about the rules and their role in completing the task. In the transcript below, for example, immediately after the researcher had finished explaining the task instructions and left the room, an amnesic director (A) asks his familiar partner (P) what he is supposed to do:

A: *So this, so I gotta*

P: *So you gotta, describe what card so, in the number one.*

A: *Okay. Can I just show you the card?*

P: *No.*

A: *Oh.*

P: *I don't think so. That wouldn't be [laughing]*

A: *No I guess it wouldn't.*

P: *So you're gonna start with number one.*

A: *Number one ... Are you ... do you have your cards all laid out?*

P: *Yeah, I mean they're ... I didn't put them on the board yet.*

A: *But they're all*

P: *They're all laid out, so I can see them all*

A: *Okay. Well, let's go.*

P: *Start with number one.*

Management of the amnesic participants' memory impairments was an ongoing activity throughout the trials. Like the referencing expressions, the amnesic pairs' evolving common ground and learning resulted in increasingly abbreviated management exchanges on subsequent trials, as shown in the transcript below as the same amnesic director (A) and his familiar partner (P) were able to negotiate the procedures at the beginning of session three on the following day, using significantly fewer communicative resources (both words and turns):

A: *So, who goes?*

P: *You tell me.*

Group differences were also evident in the way directors overtly marked their discourse to facilitate organization and orientation of task procedures. A pervasive example was the amnesic directors' use of management turns to overtly indicate transitions, signaling that the director was moving on to another card or activity (e.g., *Then there is one with ...; Okay, now back to number five; Okay on to the next one*). In early trials, these transitional markers were common

in the discourse of all directors. For comparison directors, however, these transitional markers were omitted from their utterances almost entirely by the sixth trial of the first session and then used only sporadically whereas amnesic directors continued to use these transitional markers more routinely throughout 24 trials.

The use of management turns by *matchers* was also similar between groups. Differences in how partners overtly marked their discourse to facilitate successful task completion were evident. This could be seen in the amnesic matchers' scaffolding of amnesic participants to support and orient them to the ongoing task and progress in ways that were less frequent in the comparison pair sessions. For example, in the first session matchers in both groups routinely used expressions such as *I have that one* or *Got it* to convey confirmation that the target card had been placed. These expressions, coded as management, were effective in terminating a card placement sequence and signaled to the director to move on to the next target card. In later trials, these expressions were typically substituted with the less overt *okay*. Although matchers in the amnesic pairs eventually converted to these more subtle confirmations, they did so later (session 2 or 3) than did comparison matchers (session 1). As mentioned earlier and shown in Figure 3 comparison matchers frequently did not provide any verbal confirmation, opting instead to convey the placement of a target card by audibly snapping the edge of the card on the numbered board, a response seldom observed in amnesic sessions.

For comparison and amnesic pairs, the majority of turns dedicated to non-task talk, 97% or 64/66, and 100% or 6/6, respectively, occurred after the first session suggesting that non-task talk was only introduced after pairs felt comfortable with the task itself and as the labels became more streamlined. The matchers in comparison pairs produced slightly more non-task turns than directors, 36 and 30, respectively, whereas the non-task turn productions were equal for matchers and directors in the amnesic pairs, 4 each. In comparison sessions, non-task talk turns were multi-turn exchanges containing rich and elaborate discussions of events from their daily lives. For example, in the transcript below, from the fourth trial of the third session, a comparison director (C) asks her familiar partner (P) about her hair, a theme from a conversation the pair initiated before the beginning of the session:

C: *Did you highlight?*

P: *No: Kathy was busy making her daughter's skirts.*

C: *How dare she?*

P: *Bad bad um*

C: *What kind of skirts?*

P: *Um*

C: *Okay we're supposed to be doing this. Oh well, we'll save this for the next ... Messy.*

These multi-turned non-task conversations could also span multiple card placements or sessions. For example, below, a comparison director (C) substitutes a new label, *Tippi Hedren* for a previously established label *The bird* initiating a series of non-task turns with his familiar partner (P) that crosses over the boundary of the next target card, *messed up Christmas tree*:

C: *Tippi Hedren.*

P: *Huh?*

C: *[laugh] The bird. Tippi Hedren was the actress from the Birds. Um.*

P: *[laugh] Oh. I didn't watch that it was scary.*

C: Um ...messed up Christmas tree4 That was scary when I was a kid.

P: Yeah.

C: Uh-

P: Yeah. Actually it was very scary.

In contrast, in amnesia sessions, the majority of non-task turns were restricted to comments regarding the immediate environment (e.g., *And the, the other one is the uh what the heck is that?* referring to a piece of lint on the table) or task (e.g., *I'm gonna tell Glen that we named a card after him*).

3.2 Identifying communicative patterns

3.2.1 Using personal and communal knowledge for referencing—The importance of shared personal (autobiographical) and communal (semantic) knowledge and histories in the process of developing references has been illustrated by Clark and Schaefer (1992) and Hengst (2003) as a resource available to and routinely used by both college-aged students and individuals with aphasia for successfully manage referencing. In the current analysis, comparison directors routinely drew on communal knowledge as a resource for referencing. For example, one comparison pair drew on their knowledge of the popular sitcom *Seinfeld* as a resource developing labels such as *Elaine dancing*, *Kramer*, and *Jerry's cereal*. Other comparison pairs made reference to *Sister Bertille* from the TV show *The Flying Nun*, that character from *Monster's Inc.*, and *Tippi Hedren* from the Hitchcock movie *The Birds*. For amnesic participants, whose ability to form new declarative memories for daily events of their personal lives and for recent cultural events is profoundly impaired, the overt display of shared personal history and specific references to personal and communal knowledge were largely missing from their discourse. Across all sessions, there was only one example of a personal label used by an amnesic pair who settled on the label *Glen* for card 4, the name of the matcher's husband (a referent offered by the matcher).

3.2.2 Using multiple perspectives for referencing—In our initial analysis of these data (Duff et al., 2006) we reported that in the first session, comparison matchers were more active than amnesic matchers in their respective interactions, contributing 25% more words than amnesic matchers. Furthermore, comparison matchers also had a more significant role in identifying perspectives and generating labels that were ultimately used throughout the sessions, generating 22% of the final labels, while matchers in amnesic pairs generated only 14%. In our current analysis, we saw that this increased activity (as measured by words) of the comparison matchers was, in part, directed at offering their own competing perspective (e.g., *I think it looks more like a squirrel than a boat*) and engaging in playful banter about the director's labels (e.g., *well only you can see a rabbit in there*). A common strategy used by comparison directors for managing the multiple perspectives was to maintain in memory the directors' own perspective as well as their partners' perspective until one became shared or favored. Maintaining multiple perspectives was particularly beneficial for cards that were previously problematic. For example, directors used the matcher's perspectives to help the matcher find the target card (e.g., *The crazy one that doesn't look like anything to you, except a squirrel*) but would also document the multiple perspectives and to whom they belonged (e.g., *Your bird, my Elaine dancing; Number two is to me an Indian, to you the stock market*). These pairs even blended the two perspectives into a single label (e.g., *Squirrelly Viking Ship; Indian stock exchange*). Consistent with Clark's model of collaborative effort, however, one of the perspectives was eventually adopted, minimizing the linguistic resources necessary for referencing (e.g., *Viking, Dow Jones*). The matchers in the amnesic pairs were generally more passive in shaping the references, typically supporting and accepting labels offered by the amnesic directors and seldom offered competing perspectives.

3.2.3 Maintaining multiple frames – playing with the collaborative referencing task

One modification to the Clark and Wilkes-Gibbs (1986) protocol was instructing participants to treat the task as a game and to have fun. Using this modification, Hengst (2006) reported verbal play to be pervasive throughout the interactions of individuals with aphasia and their partners, a finding not reported by Clark (1992). All the comparison pairs creatively took up the barrier task sessions, engaging in multiple play activity frames (c.f. Goffman, 1981) which were simultaneously layered across the activity frames associated with successful completion of the barrier task itself. The most common way comparison pairs played with the task was to try to perform the task as quickly as possible, like a race, to make the task more interesting. For example, in the third session, one comparison director commented *I'm getting kinda bored* [yawn], and the matcher replied *We need to spice it up*. As they started to go for speed, this comparison pair started recording their own time for each trial and celebrated when they got their time below a minute (*Whoa! We rule!*). For another comparison pair, the matcher pretended that she was psychic, anticipatorily placing cards on her numbered board before the director would give the label (*No! Let me guess!*). Other pairs, as previously mentioned, worked to make their referencing expressions as short as possible. Comparison pairs also teased each other throughout the sessions. For example, one comparison director consistently referenced the cards out of order just to frustrate her partner (e.g., Matcher: *See, if you go in order, you wouldn't have this problem. Why are you skipping?*; Director: *Because you know I like to skip*. [laughing], Matcher: *You are driving me nuts. Go in a row*). Not only did the comparison pairs initiate these playful episodes but the playful themes extended across trials, sessions, and the two days of the collaborative referencing sessions. In Table 3, we see the conclusion of the playful episode presented in the last example regarding the order the cards are described that began on the first trial of the first day, as the matcher says, *Mmm, I'm savoring it*, joking with the director who is finally describing the cards sequentially!

For the amnesic pairs, across their two days of participation, these extended playful episodes were strikingly absent. That is not to say that the amnesic pairs were not playful; they laughed and joked throughout the sessions but these instances were fleeting and were typically responses directed to a previous utterance or the immediate environment. These playful frames never extended across trials, sessions, or days.

4. Discussion

The collaborative referencing paradigm presented here offers a rich environment for learning and a rich corpus of data for observing language-in-use across extended, repeated collaborative interactions. The analysis of the interactive discourse practices of amnesic patients and their partners provides a unique window into the interaction of language and memory, and to how real-world memory demands are met in the course of everyday conversations, providing a powerful example of language-and-memory-in-use.

Consistent with our previous analyses (Duff et al., 2006), we did not find significant group differences for the *rate of learning* (in linear trend analysis) across trials for any variables. Amnesic and comparison pairs did not differ in the rate of reduction in the number of interactional turns or words produced across trials, nor in the number of interactional turns dedicated to referencing or task management.

At the same time, the amnesic pairs exhibited greater communicative effort (more time and words) in managing the extended and dynamic demands of the task. Most notable were differences apparently related to the successful management and accommodation of their profound memory impairments. More words and more turns were dedicated specifically to managing the task in amnesic pairs than comparison pairs. Interestingly, we see this increased communicative effort not just in the discourse of the amnesic participants, but also in the

discourse of their partners. Even while the amnesic participants were displaying impressive learning, the familiar partners exhibited greater communicative effort to keep the context of the task and its ongoing progress apparent and accessible for their amnesic partners. Since the familiar partners did not receive any special instruction on how to communicate to facilitate the successful completion of these interactive sessions with their memory impaired partners, we believe these overt communicative practices may be common in their daily interactions. Moreover, given the greater communicative effort shown by both members of each amnesic pair associated with managing the memory impairment to meet the demands of the collaborative referencing task, the normal rate of learning shown by the amnesic pairs is all that more impressive.

Turning to the content of the discourse, the labels generated by the amnesic and comparison pairs were remarkably similar in their semantic content. Yet, amnesic pairs produced twice as many words overall than comparison pairs. The increased word production was not only in service of managing the task but also in the rigid expression and use of the knowledge they acquired collaboratively. In contrast, comparison pairs demonstrated flexibility in their ability to move towards telegraphic speech for their descriptions of the tangrams, resulting in shorter linguistic expressions. Thus, we see the impact of hippocampal damage not so much on the retrieval of previously acquired semantic information that could be used for the appropriate and meaningful description of novel tangrams, but rather in the flexibility of language production.

However, is it possible that we are observing a trade off or some form of competition of learning resources between the effort directed towards learning the task (seen as the steady decline in management turns) and the simplification of the referential expressions (seen as the decrease in the number of words to describe the tangrams). That is, with enough trials perhaps the amnesic pairs would also have moved towards telegraphic speech, thus displaying greater linguistic flexibility, as they implicitly learned the procedures of the task. We find this scenario unlikely. The inability of individuals with amnesia to express newly acquired knowledge flexibly is well documented (Bayley & Squire, 2002; Cohen & Eichenbaum, 1993; Eichenbaum & Cohen, 2001; Kapur, Glisky, & Wilson, 2002; Skotko et al., 2004) and is perhaps the most compelling evidence that new learning in amnesia is likely supported by procedural or non-declarative memory systems.

In contrast to previous studies on new learning in amnesia, here we have extended the unit of analysis beyond individual words or phrases (the unit of analysis of many semantic memory tasks) and beyond the performance of an isolated individual to the emergent aspects of social interaction. In doing so, we can begin to document the impact of hippocampal amnesia on communicative practices more broadly. In addition to the lack of flexibility seen at the level of producing individual referencing expressions, we see this lack of flexibility impacting higher order communicative patterns between individuals with amnesia and their partners. For example, comparison pairs moved seamlessly between interactional play frames (the task itself and a game like frame) interweaving non-task talk with talk about the task. For amnesic pairs, we saw very little non-task talk and none of the extended interactional play frames. Consistent with our work suggesting that hippocampal amnesia impairs the flexible and creative use of interactive discourse practices requiring management of multiple temporal frames, such as reported speech (Duff et al., 2007), here we see the impact of the hippocampal amnesia on real-world and routine discourse practices as a limitation in the range and/or capacity for flexibly maintaining and integrating different forms of talk across tasks, speakers, time, and settings. Taken together, these findings suggest that when memory is sufficiently challenged, at least in memory-impaired individuals, changes in language practices can be seen.

Common Ground and Language-and-Memory-in-Use

The current work contributes to our understanding of the neural processing of language, and common ground specifically, and its dependence on the hippocampus. Clark's (1992) original view of the memory requisites of common ground involves an explicit record of an individual's personal experiences with various communication partners and a continually updated model of the knowledge they share. That individuals with hippocampal amnesia, who have profound deficits in declarative memory and explicit remembering, can nonetheless develop and use common ground in this task provides obvious constraints on theories of the memory determinants of at least *some aspects or forms* of common ground. It is probably best to conceive of common ground as having multiple determinants, dependent upon the contributions of different memory systems in the brain, with at least some aspects of common ground likely supported by less explicit and more procedural forms of memory (see Duff et al., 2006)..

An explicit record of previous interactions and a model in each communication partners' minds of their shared knowledge, of the kind suggested by Clark (1992), would provide a very powerful underpinning for common ground. And, indeed, the neurologically intact pairs displayed some high-level discourse features, such as acknowledging and using multiple perspectives, and explicitly drawing upon personal and communal knowledge, that were strikingly absent from the interactions of the amnesic pairs and that might well rely upon the very kind of declarative memory-dependent explicit record just mentioned. These features were not critical in order to show intact learning, and hence the amnesic participants were not particularly disadvantaged in our various measures of learning. Nonetheless, such features should probably be seen as part of what acquiring common ground can include, pointing to the types and the aspects of common ground that rely upon declarative memory, explicit remembering, and intact hippocampal functioning.

Does the absence of these more declarative-memory-dependent discourse features have other social or communicative implications for individuals with amnesia and their communication partners? According to Enfield (2006), common ground is as much a social-affiliational resource, important for maintaining and communicating interpersonal trust and intimacy, as a referential or informational resource. The absence of explicit references to personal and communal histories, as discussed above, does not necessarily impact the informational aspects of common ground, or at least not in our experimental protocol, but it could have effects on the social-affiliational aspect of common ground. Tannen (1989) has argued that imagery and detail are key discourse resources for the ongoing display and creation of interpersonal and interactional involvement among interlocutors. Indeed, other researchers have used language production as the way to explore the role of the hippocampus in recollecting vivid and detailed episodic memory (e.g., Gilboa, Winocur, Grady, Hevenon, & Moscovitch, 2004) and constructing detailed imagined episodic events (e.g., Hassabis, Kumaran, Vann, & Maguire, 2007). From a language-and-memory-in-use perspective, hippocampal amnesia may disrupt the ability to contextualize and imbue discourse with imagery and detail to enrich interpersonal communicative interactions. Thus, the vivid and rich referential practices (e.g., personal and communal knowledge, playing with the task, incorporating non-task talk) that were largely missing from the amnesic pairs as a possible consequence of hippocampal amnesia, may also negatively impair social and emotional bonds created in interpersonal communication.

Rehabilitation and Clinical Applications

The rehabilitation implications for this line of work are exciting. What is so special about the collaborative referencing task that permits a fully intact rate of learning in amnesia, differing so markedly from the learning obtained from other approaches? The majority of experiments in the area of new learning in amnesia use a particular learning strategy that emphasizes

“errorless learning,” in which the experimenter presents correct information in ways that minimize the possibility of incorrect responses by requiring participants to produce experimenter-generated responses verbatim. That such an approach has been successful in getting individuals with amnesia to learn some material has been well documented (e.g., Wilson, Baddeley, Evans, & Shiel, 1994; Squires, Aldrich, Parkin, & Hunkin, 1998). Errorless learning has been particularly beneficial for individuals with the most severe amnesia and/or extensive medial temporal lobe damage, as the technique capitalizes on preserved procedural or non-declarative memory systems. Learning using these procedures, however, is far from normal and typically has poor generalization outside of the narrow training context. Our work with the collaborative referencing task, however, does not depend upon errorless learning, and hence is more akin to real-world learning situations, and yet the learning occurs at a fully normal rate.

We have been motivated, theoretically and clinically, to create rich environments that promote and facilitate robust learning and more closely approximate real-world communication. The theoretical perspective that motivates our work, and that is embodied in our modified collaborative referencing protocol, is one that views language and learning as fully integrated and situated in the contexts of their use (Vygotsky, 1978; Wertsch, 1998; Ylvisaker & Feeney, 1998). Accordingly, our paradigm examines how people engage and interact in a goal-directed communicative activity. Here, in contrast to paradigms where participants are required to regurgitate experimenter-generated responses through *rote learning*, the collaborative referencing task creates a complex, observable and salient environment that allows individuals to *problem-solve* collaboratively, an important distinction made by Hebb (1949) in his early observations and comments on ‘enriched environments’ for laboratory rats. In addition, the very nature of the collaborative interactions among the participants allow for heterogeneity and flexibility to be incorporated in the sessions, a practice that has been shown to be beneficial in modifying typical errorless learning paradigms (Stark et al., 2005). That we now see it to be beneficial in patients with hippocampal amnesia suggests it to be a potentially powerful tool in rehabilitation of memory impairment for use in real-world interactions.

Finally, we believe that developing rich communicative/learning environments that support new learning and permit the examination of interactional aspects of language-and-memory-in-use has direct clinical application. For example, an interesting finding not fully explored here concerns some of the sophisticated discourse and referencing practices that were seen in the comparison pairs but were strikingly absent in all but one of the amnesic pairs (e.g., non-task talk, use of personal knowledge). The one amnesic patient whose collaborative discourse showed these high-level features turns out to be the participant with the most dense amnesia. This participant is noteworthy in terms of her remarkable functional outcome, her success in establishing and maintaining interpersonal relationships, and the real-world abilities she maintains despite the severity of memory impairment (see Duff, Tranel, & Cohen, 2004). The extent to which the presence of some of these high-level discourse practices may contribute to her successful outcome or may be trained in other individuals with memory impairments awaits further investigation. More generally, we suggest that this approach may offer the theoretical framework and a set of methodological tools to address the theoretical and clinical challenges of targeting new learning and language-and-memory-in-use in naturalistic contexts, with greater ecological validity than many laboratory-based tasks used elsewhere in the literature and, consequently, with greater promise of success than previous approaches.

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Figure 1.
Tangram Figures

Figure 2.
Number of turns (a) and words (b); each plotted with the session by session linear trends.

Comparison Pair, Trial 6, Session 4

G: One, K. Two, Viking. [laughing] Three, leaning against a
M: * *Mmm, I'm savoring it.
 *snap *snap

G: tree. Four, on your head. Five, kicker. Six, bunny. Seven, nun. Eight, race
M: * * * * *
 *snap *snap *snap *snap *snap

G: horse. Nine, almost a race horse. Pointy. Straight. S.
M: * * * * *
 *snap *snap *snap *snap *snap

Amnesic Pair, Trial 6, Session 4

A: Okay number one is praying. Two is the tall dude.
S: Okay. Okay.

A: Three is Gary. Four is reading a book. Five is kicking.
S: Okay. Okay.

A: Six is a windmill. Seven is an angel. Eight is a dog.
S: Okay. Okay. Okay.

A: Nine is a camel. Ten is the pine tree and barn.
S: Okay. Okay. Okay.

A: Eleven is the barn and silo, and twelve is bending the knees.
S: Okay.

Figure 3.
 Comparison Pair's Use of Telegraphic Speech to Abbreviate Referencing

Table 1
Demographic and Neuropsychological Data for Participants with Amnesia

	Participants with Amnesia			
	2563	2363	0001	0002
Demographic Data				
Year of Birth	1955	1956	1948	1955
Sex	M	M	F	F
Handedness	L	R	R	R
Etiology	Anoxic	Anoxic	Anoxic	CHI
Neuropsychological Data				
WAIS-III FSIQ	102	98	90	126
Information Subtest	12	13	7	13
WMS-III GMI	75	73	54	49
AVLT Trial 5/30-min Delay	7/1	9/0	7/0	3/0
Boston Naming Test	52	58	56	59
Token Test	44	44	44	44
CFT-Copy/30-min Delay	27.5/7	33/5	34/2	36/0

Note. M = male; F = female; L = left; R = right; CHI = Closed Head Injury; WAIS-III = Wechsler Adult Intelligence Scale-III; FSIQ = Full Scale Intelligence Quotient; WMS-III = Wechsler Memory Scale-III; GMI = General Memory Index; AVLT = Auditory Verbal Learning Test; CFT = Complex Figure Test.

Table 2

Number of Turns by Utterance Function

Turn Type	Amnesic Pairs	Comparison Pairs
Total Turns across 24 trials	4719 (100%)	3681 (100%)
Referencing	4497 (95.3%)	3490 (94.8%)
Management	1102 (23.4%)	549 (14.9%)
Non-Task	8 (0.17%)	66 (1.79%)

Note. The total number of turns dedicated to each of the three utterance function types does not add up to the total number of turns. Each turn could be coded as having more than one function.