# Assisting Social Conversation between Persons with Alzheimer's Disease and their Conversational Partners

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## Abstract

The number of people with dementia of the Alzheimer's type (DAT) continues to grow. One of the significant impacts of this disease is a decline in the ability to communicate using natural language. This decline in language facility often results in decreased social interaction and life satisfaction for persons with DAT and their caregivers. One possible strategy to lessen the effects of this loss of language facility is for the unaffected conversational partner (Facilitator) to "co-construct" short autobiographical stories from the life of the DAT-affected conversational partner (Storyteller). It has been observed that a skilled conversational partner can facilitate co-constructed narrative with individuals who have mild to moderate DAT. Developing a computational model of this type of co-constructed narrative would enable assistive technology to be developed that can monitor a conversation between a Storyteller and Facilitator. This technology could provide context-sensitive suggestions to an unskilled Facilitator to help maintain the flow of conversation. This paper describes a framework in which the necessary computational model of co-constructed narrative can be developed. An analysis of the fundamental elements of such a model will be presented.

## 1 Introduction

According to the Alzheimer's Association [2009], 13% of Americans over the age of 65 present with AD [Alzheimer's Disease]. The decline in language associated with AD can result in decreased social interaction and life satisfaction for persons with AD and their caregivers. In particular, persons with AD begin to feel a loss of their personal identity. "Reminiscent therapy is an example of an intervention activity that can reveal and support a person's identity. Even the family can participate and play a major role to support their relative" (Cohene et al. 2005).

It has been suggested that if caregivers can learn communication techniques to enhance social conversation with individuals affected by dementia of the Alzheimer's type (DAT), it may make a significant difference in the quality of life of the persons with DAT, as well as reduce stress on their caregivers (Dijkstra et al. 2004). One recommended technique (Moore and Davis 2002; Waller 2006) is for the unaffected conversational partner (called the Facilitator in this paper) to "co-construct" short autobiographical vignettes with the DAT-affected conversational partner (called the Storyteller in this paper). Typically, such "small stories" (Bamberg and Georgakopoulou 2008) present the teller's self-identity (e.g., hard-working, frugal, etc.). According to Cheepen (1988), co-constructed narrative is common in social conversation. Furthermore, skilled conversational partners can facilitate co-constructed narrative with individuals who have mild to moderate DAT (Davis 2005; Davis & Maclagan 2009; Davis 2010). A co-constructed narrative produced by a person with DAT in conversation with skilled Facilitators is illustrated in Figure 1. Increased social interaction can improve quality of life by enabling persons with DAT to remain socially engaged, which in turn may reduce their health problems as well as delay memory loss (Davis and Pope 2009; Lenchuk and Swain 2010).



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/* orientation: */
1. GM: I just lived in a regular farm home. Farmed cotton, corn, eh-everything you…grow on a farm.
2. BD: That's right.
/* complicating action: */
3. GM: I had a big ol' cotton bag tied around me, pickin' a hundred pounds of cotton … UhhmmHmm.
4. BD: A hundred pounds? An' you so tiny!
5. GM: Huh?
6. LM: You're a tiny person to be carrying that much cotton.
7. GM: I decided one day I'd pick a hundred pounds. Guess how much!
8. LM: How much?
/* resolution: */
9. GM: A hundred and three.
10. LM: Oooohh.
11. BD: Wow.
12. GM: I went over.
13. BD: That's fantastic.
/* evaluation: */
14. GM: A hundred and three—you've got to grab it to…get a hundred and three pounds of cotton in one day.

**Figure 1.** An excerpt from Shenk et al. (2002, p. 409) of a conversation between GM, a person with early moderate DAT, and her skilled conversational partners BD and LM. We added annotations highlighting narrative elements (Labov 1972).

While there have been several notable efforts in the area of communication training for caregivers of persons with DAT (see section 2.1), none have focused on assistive technology for improving communication in real-time as the conversation is occurring. This paper presents a framework for developing a natural language processing system, ASSIST (Assistive Story Intervention Technology), which can listen to the conversation between a person with DAT and his conversational partner and provide context-sensitive suggestions to the unaffected participant to help maintain the flow of conversation. In particular, ASSIST will help the unaffected partner to co-construct the autobiographical stories of the participant with DAT. To build a system such as ASSIST will require development of a novel computational model of narrative co-construction and other communication-enhancing techniques for conversation with persons with DAT. After reviewing related research efforts, we present an analysis of the unique elements of the required computational model including an NLU component designed to interpret the sometimes disfluent utterances of a Storyteller with DAT, a Dialogue/Story Manager which recognizes the discourse goals of the Storyteller and plans dialogue acts that the Facilitator could use to co-construct the narrative, and an NLG/Coach that provides the Facilitator with suggestions on what to say next to co-construct the narrative and sustain the conversation.

## 2 Related Research

### 2.1 DAT Caregiver Communication

For the most part, communication training for caregivers of persons with DAT has used non-technological modes of active instruction such as role playing with human trainers (Ripich et al. 1998, Burgio et al. 2001) and individualized one-on-one coaching (McCallion et al. 1999, Bourgeois et al. 2004). Irvine et al. (2003) describe a computer program that enables a user to observe videos of conversations in which nurse aids demonstrate use of recommended communication techniques in conversation with patients. Davis and colleagues have developed a range of computer-based training materials (Davis and Smith 2009; Smith, Davis et al. 2010) providing information on stereotypes of aging and dementia, communication changes in dementia, and communication techniques such as "quilting" (Moore and Davis 2003), in which the caregiver repeats or paraphrases statements given by the person with DAT that seem to be elaborations or evaluations of elements of a narrative. Green and colleagues developed and evaluated a menu-based interactive system for training caregivers to engage more effectively in social conversation with persons with DAT (Green 2002; Green and Davis 2003; Green, Lawton and Davis 2004; Green 2005a; Green and Bevan 2009).

## 2.2 Augmentative and Alternative Communication Technology

There has been recent interest in developing reminiscence technology for the general population, e.g., (Cosley et al. 2009; Petrelli et al. 2009). Waller (2006) cites the need to develop augmentative and alternative communication systems for people with complex communication needs (CCN) to engage in conversational narrative. One assistive software package, Talk:About, enables someone with CCN to edit pre-stored text during a conversation, enabling the user to retell autobiographical stories. Phototalk (Allen et al. 2008) allows people with aphasia to manage personal photographs to support face-to-face communication. Non-technology-based reminiscence therapy has been used in dementia care (Hsieh 2003; Woods et al. 2005) and gerontological nursing (Burnside 1996).

CIRCA is a computer system that people with dementia and caregivers can use together to prompt reminiscing by providing multimedia stimuli (Alm et al. 2007). CIRCA provides touch-screen access to hypermedia presenting non-personalized reminiscence materials (e.g., photographs and music of a certain era). In a controlled study, CIRCA was compared to traditional reminiscence (TRAD) sessions with materials provided by caregivers (Astell et al. 2010). In TRAD sessions, "the caregivers worked very hard to keep the interaction going, particularly by asking lots of questions. These were typically closed questions … that did not encourage either initiation or choosing [topics] by people with dementia … caregivers offer more choice during CIRCA sessions and are much more likely to encourage the people with dementia to decide what they want to look at and talk about" (p. 7).

Baecker and colleagues (Cohene et al. 2005; Massimi et al. 2008; Smith et al. 2009; Damianakis et al. 2010) have been investigating creation and use of personalized DVD-based multimedia biographies by persons with AD and mild cognitive impairments. These researchers note that organizations such as the National Institutes of Health recommend creation of personal reminiscence aids such as photographs to help maintain the affected individual's sense of identity (Smith et al. 2009). "The loss of identity is among the most devastating effects of Alzheimer's disease … it is possible that sensitively designed technologies may help compensate for identity loss by acting as external memory or conversational aids" (Massimi et al. 2008). Roark et al. (2011) report on an initial study of technology-assisted co-construction. However, their emphasis is very different from ours and is focused on assisting with word and phrase completion of general conversation involving typewritten communication.

## 2.3 Narrative Technology

Cassell's research group has focused on systems that interact with human storytellers. In GrandChair, an embodied conversational agent (ECA) portrays a grandchild who elicits autobiographical stories from elderly users by providing feedback (through speech recognition technology) while the stories are recorded (Smith 2000). Story Listening Systems (SLS) use technology to encourage young children to create personally relevant stories in order to improve their oral linguistic skills (Cassell 2004). Sam the CastleMate (Ryokai, Vaucelle, & Cassell 2003) is an SLS in which SAM, an ECA, listens to the child's stories (also using speech recognition technology) and tells stories to the child. Natural language processing and statistical machine learning tools have been applied to the problem of automatic plot analysis of children's stories (Halpin et al. 2004; Passonneau et al. 2007) and to creation of story understanding tools (Elson and McKeown 2009).

Other researchers have focused on story generation. Narrative scholars distinguish the *fabula* – events in a fictional world – and *sujhet* – the author's choices in presentation of selected elements of the fabula. (Note that in our future ASSIST system, the fabula is already established when the user's stories are collected; the role of ASSIST is to facilitate the retelling, i.e., the sujhet.) Most past natural language generation research in narrative has focused on prose rather than dialogue (Callaway 2000; Theune et al. 2007; Hervás et al. 2006). Piwek and Stoyanchev (2010) have investigated automatically transforming human-authored narrative prose into dialogue performed by virtual characters as a way of presenting educational information.

## 3 Corpus Analysis

Most previous computationally-oriented research on human-human dialogue has focused on task-driven dialogue, i.e., dialogue intended to achieve an agent's (or agents' collaborative) task goals such as making a travel reservation. In contrast, ASSIST is modeling social conversation containing co-constructed narrative. That is, through certain conversational moves one participant (the Facilitator) can enable the other participant (the Storyteller) to retell short autobiographical stories, despite the Storyteller's language and memory problems associated with DAT. The model will be informed by interdisciplinary research on retained language competencies of speakers with DAT (Davis 2005; Guendouzi and Muller 2006), as well as by our own statistical and qualitative analyses of the Carolina Conversations Collection (CCC) Corpus (Davis and Pope 2009; Pope and Davis 2011). The CCC corpus includes 400 recorded and transcribed conversations between researchers and students and 125 persons with DAT. Our model will be constructed by annotating and analyzing a set of the DAT conversations as described in more detail in Section 4. The overall goal is to analyze the efficacy of narrative co-construction and other communication-enhancing techniques proposed in previous studies of language of persons with DAT (e.g., Ripich and Wykle, 1996; Ramanathan 1997; Moore and Davis 2002; Santo Pietro and Ostuni, 2003) and to possibly identify other effective techniques. As context for discussion of the necessary analysis of the CCC, we will first present a high-level description of the necessary system architecture.

## 4 System Architecture

The ASSIST architecture is shown in Figure 2. While a Storyteller and Facilitator converse, ASSIST listens with the goals of detecting potential problems in the flow of conversation and of providing suggestions to the Facilitator on what to say next to co-construct the narrative and sustain conversation. The tasks of the **NLU component** include syntactic and semantic interpretation and reference resolution; note that these tasks may require use of biographical information about the Storyteller to help interpret disfluencies characteristic of AD language. Another key task of NLU is to recognize the Facilitator's use of grounding acts, which play a key role in narrative co-construction and in sustaining conversation in general. One of the **Dialogue/Story Manager's** tasks is to recognize the conversational goals of the Storyteller's contributions, including narrative goals. Having recognized the Storyteller's current goal, the other task of the Dialogue Manager is to plan the next dialogue act that the Facilitator could use to continue to co-construct the Storyteller's narrative. The Dialogue Manager may use biographical information about the Storyteller in both tasks, i.e., to help recognize narrative goals and to select content when planning the next suggested narrative act. The **NLG/Coach component** is responsible for providing the Facilitator with one or more suggested utterances that the Facilitator could say next. Based upon the current discourse state, the suggested dialogue acts provided by the Dialogue/Story Manager, and a coaching model, the NLG/Coach component chooses one or more Facilitator acts and realizes them. In the remainder of this section we will describe the required analyses of the corpus needed to inform the development of the computational model for each of these main architectural components.

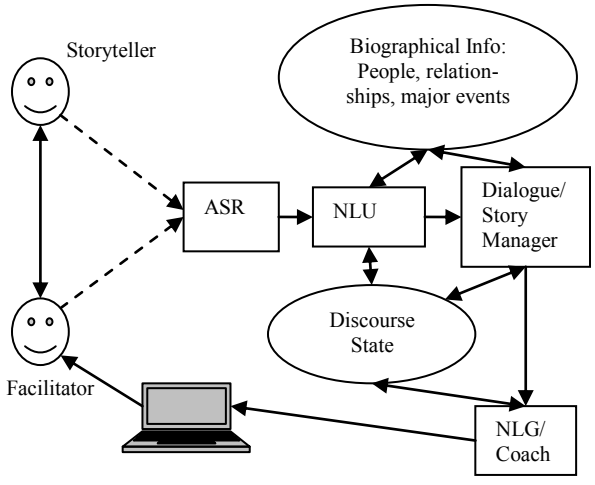


**Figure 2.** ASSIST system architecture.

### 4.1 Dialogue/Story Manager

Part of the CCC corpus study will analyze narrative features of the dialogue and related pragmatic and affective features. Coelho (1998) surveys vari-

ous approaches to narrative analysis in discourse of communicatively impaired adults. Our analysis will reflect the following characteristics of conversational narrative identified in narrative studies (Georgakopoulou and Goutsos 1997; Polkinghorne 1996):

- Conversational narratives have a characteristic structure, consisting of an abstract, orientation, one or more complicating actions, resolution, evaluation, and coda (Labov 1972). Note that only the complicating action and resolution are required. We will annotate this structure, as shown in Figure 1.
- They often convey the teller's attitudes and feelings about narrated events, i.e., although not required the evaluation is often present. Furthermore, the objective truth of the events is not important. We will also annotate polarity and intensity of the evaluation (Wiebe et al. 2005).
- Conversational narrative is context-dependent, i.e., dependent upon the audience and the situation in which it is told. We will also annotate features of the social context such as the age, gender, and relationship of the conversational participants.
- There are culture-specific properties that make a story tellable. We will annotate the recurrent cultural themes in the corpus informed by previous studies of narrative themes as in, e.g., (Polanyi 1985; Shenk et al. 2002).

Although the above characteristics were derived from studies of narrative in other populations than in speakers with DAT, there is preliminary evidence of their applicability to ASSIST. For example, by examining retellings of the same stories over time, Davis and Maclagan (2009) found that "With AD story-tellers, components vanish from surface retellings, particularly the abstract/orientation. Instead, the listener is presented with parts of the story's complicating action or an evaluative comment that includes a fragment of the complication and its result"; yet, "even when full stories are not retrieved … the emotion is still conveyed to the listener" (p. 152). Comparing life-history narratives of two rural American older women, one with dementia and one without, Shenk et al. (2002, p. 410) found similar "major themes that are consistent with rural American cultural values", e.g., strong family ties, hard work, and religious faith.

Based on analysis of the stories in the CCC, we plan to define a set of abstract narrative schemas. A schema will include constraints on tellability with respect to audience characteristics (e.g., age, gender, social relationship) and current topic, and a specification of narrative goals (e.g. present the Storyteller as having been hard-working and thrifty). Each schema will be structured according to Labov's elements of a well-formed narrative. The schemas will be derived by analysis of the CCC corpus and informed by previous studies of narrative themes.

In addition to analysis of features suggested by previous narrative studies, we will analyze occurrences of pragmatic features that may be used by a speaker with DAT to compensate for difficulties when telling a story. For example, Davis and Maclagan (2009) studied both how use of unfilled pauses and pauses with fillers (e.g., "oh", "um", or a formulaic phrase) changed over time in DAT discourse, and also the placement of filled and unfilled pauses with respect to narrative components. Pauses in earlier stages of DAT correlated with word-finding problems, while pauses in later stages marked narrative components. Thus, Davis and Maclagan hypothesize that pauses in the later stages correlate with search for the next component of the story. Also, the Facilitator's contribution to the co-constructed narrative will be analyzed, e.g., when the Facilitator invites the Storyteller to begin a particular story and responds appropriately to an element supplied by the Storyteller. Development of the computational model for the Dialogue/StoryManager requires consideration of both the narrative structure and these related pragmatic and affective features.

### 4.2 Natural Language Understanding (NLU)

A skilled Facilitator tries to anticipate the kinds of problems that a Storyteller with DAT might have in a conversation and provide appropriate support so that the frequency and severity of DAT-related disfluencies will be reduced. In the event that a disfluency does occur, the Facilitator tries to provide support either by trying to resolve the particular kind of disfluency via a direct or indirect repair

or by trying to advance the story without necessarily resolving the disfluency. Therefore, in order for ASSIST to facilitate conversation between a Storyteller and his or her conversational partner, the NLU module must be able to listen to a conversation and be able to determine the following: (1) How fluent was the Storyteller in the prior utterances? (2) If the Storyteller exhibited any issues with fluency, what was the nature of the problems? (3) What conversational strategies did the Facilitator use to help alleviate issues related to fluency, if any, before, during or after the Storyteller's utterances? Addressing these questions requires an analysis of the Carolina Conversations Collection (CCC) as discussed below.

**Fluency**

Considerable research has investigated the language of individuals with DAT (Bucks et al. 2000; Martin and Fedio 1983; Phillips et al. 1996; Sabat 1994). Linguistic features such as long pauses, restarts, repetitions, unfinished sentences, pronominal reference mistakes, and filler phrases are prevalent in the spontaneous speech of persons with DAT. Further, research has shown deviations from the norm in syntactic measurements such as part-of-speech rates (nouns, verbs, adjectives, pronouns), richness of vocabulary (Type Token Ratio, Brunet's Index, Honore's Statistic), and semantic cohesion in text (Singh and Bookless 1997). It is necessary to analyze the CCC corpus to determine the statistical prevalence of these phenomena within the corpus with a goal of making predictions about the relative fluency of an utterance based on the presence or dearth of these measurements.

**Conversational Repair Strategies**

Once we have a calculation for the level of fluency of each turn that a person with DAT (the Storyteller) takes in the dialog, we can then look at the surrounding behavior of the Facilitator. One of our hypotheses is that there are certain strategies that will be beneficial in increasing the fluency of DAT utterances. For example, narrative co-construction techniques recommended for caregivers of persons with DAT (Moore and Davis 2002) will be annotated in the corpus, including two-syllable go-ahead phrases (e.g., "uh huh", "really", "ok"), paraphrases and repetitions, and indirect questions. Most of these strategies can be described as

1. BD: You were telling me about your husband.
2. Did he preach sermons?
3. GM: My husband?
4. BD: Would he be a preacher?
5. GM: Yes. He was a preacher that preached "hell hot and heaven beautiful!"
(*They both laugh.*)
6. BD: Heaven beautiful …
7. GM: Yes. "Hell hot and heaven beautiful!" That was one of his messages. I don't know… he preached all right. He was an Evangelistic-type preacher.
8. BD: I bet you went many places!
9. GM: Well, I had my family while I was young and couldn't go. I mean … you can't go with a bunch of little kids.
10. BD: No you can't.

**Figure 3.** An excerpt from Davis (2005, p. 141) of a conversation between GM, a person with early moderate DAT, and her skilled conversational partner BD.

*grounding acts* (Clark and Schaefer 1989). The following seven types of grounding acts occur in co-constructed narratives:

- **Continued attention**. These utterances, such as "That's right" (line 2 in Figure 1), indicate that the listener is paying attention to the speaker.
- **Relevant next contribution**. By these utterances, which we call *forward grounding* moves, the conversational participant continues the conversation with a question or comment that requires that he or she understood the previous speaker's utterance (e.g. lines 2, 4, and 8 in Figure 3).
- **Acknowledgement**. In addition to showing continued attention, these utterances provide an assessment, e.g. "wow" (line 11 in Figure 1).
- **Demonstration**. The conversational participant paraphrases a previous utterance of his own or of the other participants (e.g. line 4 of Fig. 3).
- **Display**. The listener repeats all or part of the previous utterance verbatim (e.g. line 6 in Figure 3).

- **Completion**. The conversational participant completes the utterance of the previous speaker.
- **Request for repair**. The listener indicates that he or she did not understand all or part of the previous utterance (e.g. line 3 in Figure 3).

The first five types are described in Clark and Schaefer (1989) while *Completion* and *Request for Repair* have been described in Traum (1994) and elsewhere. Of particular importance is the use of the *Relevant next contribution* or forward grounding move. Persons with DAT have difficulty with lexical retrieval and other memory tasks associated with generating language (Martin and Fedio 1983). An effective Facilitator will provide lexical priming and syntactic structures to help these memory tasks (Ramanathan 1997; Orange 2001).

Unlike previous research on techniques for automatic grading of children's written stories (e.g. Halpin et al. 2004), the contributions of the partner with DAT will not necessarily be counted as disfluent when details are missing, incorrect, or presented out of temporal sequence. As discussed previously, in conversation with people with DAT narrative elements are often missing and a narrative may consist of as little as a fragment of the complicating action and the evaluation. The Facilitator's role is not to correct inaccuracies, to demand clarification, or to tell the story for the Storyteller. For example, suppose the Storyteller said, "I uh used to have a farm there." Suppose that the word "there" is not something that the Facilitator can resolve based on the context of the conversation. So, from the Facilitator's point of view, to understand the story better, it might make sense to resolve the word "there" by asking, "Where was your farm?" However, a more appropriate response would be a grounding move that prompts the continuation of the story without asking a wh-question: "Really? You were a farmer?"

By analyzing the CCC corpus, we can determine the prevalence of the above grounding actions by the Facilitator. Based on the fluency of the Storyteller's subsequent utterances, we can determine the relative effectiveness of these strategies on increasing or decreasing Storyteller fluency. This analysis can be further refined by examining the types of disfluency exhibited by the Storyteller before and after these grounding actions. In turn, this data can be used to make predictions about what repair strategies a conversational participant might use in response to a particular type of disfluent utterance. Based on the analysis techniques presented in Cherney et. al. (1998), we will be able to examine the extent to which greater fluency in the Storyteller utterances leads to more complete and coherent narrative. This anaylsis is also used in the development of the NLG/Coach module as described below.

### 4.3 NLG/Coach

Based upon the current discourse state and the suggested dialogue acts provided by the Dialogue/Story Manager, the NLG/Coach component must choose one or more Facilitator acts and realize them. The coaching model will be based upon empirical studies of the CCC of effective repair strategies for conversing with persons with AD, as well as a study of particular syntactic forms used with specific strategies. This analysis makes great use of the necessary analysis about fluency and especially conversational repair strategies described in the previous section about NLU.

## 5 Summary

Co-constructed narrative between a person with DAT, and a skilled conversational partner offers a means by which persons with DAT and their caregivers may improve their social interaction and life satisfaction. Assistive technology can play a role in enabling even an unskilled conversational partner in maintaining the flow of the conversation. This paper presents an architecture for such a system, ASSIST, and describes how analysis of an existing corpus, the Carolinas Conversation Collection (CCC), can inform the development of the computational model for co-constructed narrative in ASSIST. We have begun preliminary analysis of excerpts from the CCC.

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