Published in final edited form as:
Aphasiology. 2012 January 1; 26(5): 656–672. doi:10.1080/02687038.2012.676855.

Considering a multi-level approach to understanding maintenance of global coherence in adults with aphasia

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Abstract

Background—Discourse is a naturally occurring, dynamic form of communication. Coherence is one aspect of discourse and is a reflection of the listener's ability to interpret the overall meaning conveyed by the speaker. Adults with aphasia may present with impaired maintenance of global coherence, which, in turn, may contribute to their difficulties in overall communicative competence.

Aims—The aim of the study was to determine if microlinguistic processes contribute to maintenance of global coherence in adults with and without aphasia.

Method and Procedures—Participants included 15 adults with aphasia (PWA) and 15 healthy controls (HC). Study participants told stories conveyed in wordless picture books. The discourse samples were transcribed and then analyzed for percent of information units produced, lexical diversity, syntactic complexity, and maintenance of global coherence.

Outcomes and Results—Several linear regression models were carried out to investigate the relationship among the microlinguistic and macrolinguistic measures. For the control group, percent of information units conveyed was a significant predictor of maintenance of global coherence for stories told. For the aphasia group, percent of information units conveyed and lexical diversity were significant predictors of maintenance of global coherence for stories told.

Conclusions—Results indicated that microlinguistic processes contribute to the maintenance of global coherence in stories told by adults with aphasia. These findings have important clinical implications for using a multi-level discourse model for analyzing discourse ability in adults with aphasia and measuring individual response to treatment.

Discourse is a naturally occurring, dynamic form of communication that involves the activation and interaction of multiple interconnected cognitive and linguistic subsystems. Coherence is one aspect of discourse that is an important indicator of communicative ability and necessary for the speaker to be communicatively competent[1] (Olness & Ulatowska, 2011). Discourse coherence is a reflection of the listener's ability to interpret the overall meaning/message conveyed by the speaker. For the listener, coherent messages have several characteristics that aid in recreating an accurate mental representation. For example, several researchers have identified different "levels" of coherence that contribute to maintenance of thematic unity in discourse –*local* and *global* (Agar & Hobbs, 1982; Glosser & Deser, 1992; Kintsch & van Dijk, 1978). Local coherence refers to how well the content of one unit of

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[1]We feel privileged to contribute to this special issue of *Aphasiology*. The purpose of this paper is to consider what linguistic factors contribute to the maintenance of coherence. In doing so, we can achieve Bob Marshall's vision for PWA – impacting communicative competence in ways that help them communicate with family and friends and enjoy a good quality of life.

discourse (e.g., sentences, propositions, utterances) relates to the content of the preceding unit. Global coherence is the focus of the current study and is measured by how well discourse units maintain the overall topic/theme (Glosser & Deser, 1992). Global coherence, then, is operationalized as a reflection of how easily the listener is able to perceive the speaker's discourse units as maintaining the semantic unity of the whole discourse. For example, if asked to recount a previous weekend's activities, responses similar to “Last weekend we went to the shore” would be considered *good* maintenance of global coherence. A response such as “You don't get much when you are retired” would be considered *poor* maintenance of global coherence since it is not related to the topic.

Adults with aphasia present with language deficits that negatively affect their communicative ability. Due to their language deficits, PWA may present with impaired maintenance of global coherence, thus contributing to difficulties in overall communicative competence. Several researchers have investigated coherence ability in PWA. Christiansen (1995) rated coherence ability in terms of coherence violations. The study included adults with anomic, conduction, and Wernicke's aphasia and healthy controls. Participants described pictures, and the discourse samples were then transcribed and segmented into semantic propositions or violations. The violations were coded as violations of completeness, progression, and relevance. Type and number of violations were compared among groups. Participants with anomic aphasia and conduction aphasia produced more coherence violations than healthy controls. Christiansen attributed the greater number of coherence violations by these two groups to the use of compensatory strategies for accommodating for their anomia. Participants with Wernicke's aphasia also significantly differed from healthy controls; they produced irrelevant propositions, provided limited detail, and had poor organization, leading Christiansen to conclude they presented with impaired coherence ability.

Ulatowska, Olness, and Williams (2004) investigated coherence ability in adults with and without aphasia in the context of a recount of a frightening experience. Though no statistical analyses were performed, they reported that the aphasia group demonstrated maintenance of coherence, but the strategies they used differed from healthy controls. Individuals with aphasia used more direct expressions of fear, whereas, the healthy controls were more likely to “state reactions to the event” (p. 42). The authors attributed these differences to the linguistic deficits experienced by the PWA; however, this was not explored further.

Rating scales have also been used as a method for measuring coherence ability in PWA. Glosser and Deser (1990) developed a 5-point rating scale to measure maintenance of global coherence in adults with acquired neurogenic communication disorders (fluent aphasia, dementia, and traumatic brain injury) and cognitively healthy adults. The discourse elicitation tasks included describing family and work experiences. The language samples were transcribed and segmented into verbalizations. Each verbalization received a global coherence score and then a mean global coherence score was computed for each participant's discourse sample. Verbalizations that provided substantive information related to the overall topic received high global coherence scores (i.e., 5); whereas, those that were incoherent received low global coherence scores (i.e., 1). Glosser and Deser found no difference in maintenance of global coherence between healthy controls and participants with fluent aphasia and suggested that results indicated relatively preserved linguistic functioning by the participants with fluent aphasia.

Coelho and Flewellyn (2003) used the same 5-point rating scale and followed Glosser and Deser's procedures for computing mean scores. Coelho and Flewellyn conducted a longitudinal study investigating coherence ability in one participant with anomic aphasia. The discourse elicitation tasks included a story retelling and a story generation collected at nine different time points over a 12-month period. Three healthy controls were included for comparison to the performance by PWA. For global coherence, Coelho and Flewellyn's results differed from Glosser and Deser's. Although the PWA's mean global coherence score improved some over the 12-month period, scores stayed well below the healthy controls' mean global coherence score, suggesting impaired ability to maintain global coherence and impaired ability with macrolinguistic organization.

Wright, Fergadiotis, Koutsoftas, and Capilouto (2010) developed a 4-point scale to measure global coherence ability in adults with and without aphasia. They investigated measurement reliability of both the 4-point scale and 5-point scale as well as concurrent validity of the 4-point scale. Participants included adults with and without aphasia who told stories depicted in two wordless picture books. Similar to Coelho and Flewellyn's (2003) results, the healthy controls performed significantly better on the global coherence measures compared to the aphasia group. The authors concluded that PWA present with impaired ability to maintain global coherence. For the aphasia group, global coherence scores significantly correlated between the two stories for both scales; however the correlation was stronger for the 4-point scale (4-point scale: $r = .955$; 5-point scale; $r = .614$) suggesting that it may be a more reliable measure. Finally, for the aphasia group the two scales significantly correlated across the stories providing evidence for the concurrent validity of the Wright et al.'s 4-point scale.

Fergadiotis and Wright (2011a) further examined the validity of the 4-point scale as well as the 5-point scale and a latent semantic analysis (LSA) measure for estimating global coherence. Study participants included 15 PWA who told stories depicted in two wordless picture books. The intercorrelations among the three measures were strong and significant (all r values > .64). To determine if global coherence predicted aphasia severity, three regressions were run with aphasia quotients from the *Western Aphasia Battery-Revised* (WAB-R AQ; Kertesz, 2007) serving as the measure of aphasia severity. Results indicated that global coherence as measured with the 4-point scale was the strongest predictor of aphasia severity ($R^2 = .62$). Fergadiotis and Wright concluded that the results are promising in establishing validity of the three measures, but acknowledged that further investigations are needed. For example, understanding the cognitive structures (e.g. memory and attention) and linguistic variables (e.g. information units, vocabulary diversity) that underlie maintenance of global coherence is necessary to have a good understanding of what global coherence entails and subsequently interpreting results using these measures. Applying a multi-level approach to evaluate narrative samples produced by PWA may be useful for understanding the linguistic processes that underlie global coherence ability in PWA.

Language processing at the discourse level is a dynamic system, and Jakobson (1980) suggests that the different levels of language are highly connected. Brownell (1988) identifies discourse as requiring within-sentence or microlinguistic processes and between-sentence or macrolinguistic processes. Within-sentence processes focus on linguistic units of discourse; these include lexical and syntactic features. Between-sentence processes focus on the interrelatedness of discourse units and include discourse grammar, cohesion, and coherence. Sherratt (2007) applied a multi-level approach to examine the interactions among different linguistic aspects of narrative and procedural discourse in cognitively healthy adults. Several correlations among the measures were found. Sherratt concluded that linguistic processes across different levels of discourse interact. She suggested that applying a multi-level approach would be useful to comprehensively evaluate linguistic skills and determine the interaction among different discourse elements in individuals with communication disorders.

Following Sherratt's (2007) multi-level discourse model, Marini, Andreeta, del Tin, and Carlomagnolia (2011) present a multi-level approach for comprehensively quantifying narrative discourse ability in adults with communication disorders and demonstrate its utility by applying the method to discourse samples collected from two adults with aphasia. Using a multi-level approach to analyze narrative language produced by adults with aphasia may be sensitive to changes in language processes following treatment that go undetected in standardized testing. Further, a multi-level approach may be better for determining residual discourse abilities in PWA and provide relevant information useful for planning treatment. Finally, a multi-level approach has clinical utility, is grounded in linguistic and psychological theories of linguistic structure and functioning (Marini et al., 2011), and may be informative to better understanding the linguistic processes involved in maintenance of global coherence.

Many researchers have included measures of global coherence and other linguistic processes when investigating discourse ability in adults with aphasia. However, they have not considered the interrelatedness among the linguistic processes; specifically, what linguistic processes are involved in maintenance of global coherence. PWA with different aphasia symptoms will differ in how linguistic impairments present. These variations may partly account for why different results in global coherence ability in PWA across studies have been reported. Understanding linguistic variables that underlie global coherence, will allow for a more comprehensive understanding of what is required to maintain global coherence, what impacts discourse production ability, and potentially what influences the PWA's communicative competence.

The purpose of the current study was to determine if microlinguistic processes contribute to maintenance of global coherence in adults with aphasia. Christiansen (1995) suggested that adults with milder forms of fluent aphasia (anomic and conduction) had a greater number of coherence violations because they were compensating for their word retrieval difficulties. Ulatowska et al's (2004) participants with aphasia differed in how they maintained discourse coherence compared to cognitively healthy peers, which could be compensatory as well. For the current study, our specific aim was to understand the relationship between three microlinguistic processes (informativeness, syntactic complexity, and lexical diversity) and the macrolinguistic process, global coherence. The microlinguistic measures included percent of information units produced, syntactic complexity index, and the lexical diversity measure *D*. The macrolinguistic measure for global coherence included Wright et al.,'s (2010) 4-point global coherence scale. We hypothesized that percent information units and lexical diversity would be more predictive of the maintenance of global coherence as compared to syntactic complexity in narratives produced by adults with aphasia.

METHOD

Participants

Participants included 15 cognitively healthy adults (HC) and 15 adults with aphasia (PWA), ages 30 - 80, matched for age, education level, and gender. Inclusion criteria for the HC group included: (1) hearing within functional limits; (2) Native English speakers by report; (3) negative history for cognitively deteriorating conditions; (4) aided or unaided visual acuity within normal limits; (5) no depression at the time of the experiment; and (6) no previous neurological condition per report. Inclusion criteria for the PWA group were as follows: (1) monolingual, English speakers; (2) at least 6 months post onset of stroke; (3) single, left-hemisphere cerebrovascular accident (CVA), and (4) sufficient hearing and visual acuity as indicated by passing hearing and vision screenings. Aphasia presentation was confirmed through performance on the WAB-R as well as clinical judgment. Participants' aphasia quotients (AQ) on the WAB-R ranged from 47.6 – 90.9 (see Table 1).

Experimental Task

Participants viewed and told the stories depicted in two wordless picture books; *Picnic* (McCully, 1984) and *Good Dog Carl* (Day, 1985). *Picnic* is a story about a family of mice going on a picnic. Along the way, their pick-up truck hits a bump in the road, the baby mouse falls out of the truck and onto the road, and no one notices. The story proceeds with the family settling in for their picnic while the baby mouse waits on the side of the road to be found. The family realizes the baby is gone once they sit down to eat, and they pile back in the truck to search for the baby. Once they find the baby, they decide to have the picnic right there on the side of the road. In *Good Dog Carl*, a mother asks the family dog, Carl, to look after the baby in his crib while she is gone. Carl proceeds to entertain the baby while Mom is out, makes a mess of the baby and the house, but manages to get it looking perfect by the time Mom arrives back; she is unaware of everything that happened while she was gone.

Wordless picture books were selected as the experimental task for several reasons. Because these stories have limited-to-no text, they required participants to generate a story. As such, the task is more similar to spontaneous communication as compared to a story-retelling task or a picture description task. At the same time, the detail in the pictures provides participants with a scaffold to support language generation; a feature that is important for eliciting a sufficient amount of language from individuals with aphasia.

Experimental Procedures

All participants were tested individually in a quiet, well-lit setting. Participants in the HC group attended 2 sessions, each lasting no more than 2 hours. In the initial session, they provided consent for study participation, completed the screening measures to ascertain they met the study's inclusion criteria, and provided their demographic and medical history information. Next, HC participants completed either a cognitive test battery or a set of discourse tasks; referred to as the cognitive session and discourse session, respectively. Session order was randomized. For the discourse session, participants completed 11 discourse tasks; only results of the story telling task are reported here. Order of discourse tasks was also randomized. For participants in the PWA group, experimental procedures included administration of cognitive measures and the WAB-R and collecting the discourse samples (i.e. story telling). In some instances, participants completed the protocol in one session; however, some participants in this group required two sessions. For this group, the WAB-R was administered first and then the cognitive tests and discourse tasks were randomized across participants. The cognitive test results are not reported here.

For the story telling task, the examiner read the following script: “These are children's books without words – so that a person can make up their own story. First, I will look through the children's book and get an idea of the story. Then, I will start at the beginning and tell you the story that goes with the pictures.” To demonstrate the task, the examiner read a scripted story telling of *The Great Ape* (Krahn, 1978). Then, the examiner gave the participant one of the wordless picture books—either *Picnic* or *Good Dog Carl* – and then said, “Now, it is your turn. Look at this book and when you are ready tell me the story that goes with the pictures.” No additional prompts were given and the participant was given an unlimited amount of time to look through the book. He or she was also allowed to view the pictures in the book while telling the story. All discourse language samples were either audio recorded or video recorded.

Language Transcription, Measures and Scoring

Trained research assistants orthographically transcribed story tellings from an audio or video recording. To meet the aims of the study, microlinguistic (syntactic complexity, information units, lexical diversity) and macrolinguistic (global coherence) analyses of the transcripts were completed. To score the transcripts, verbal productions were first segmented into C-units. A C-unit is a syntactic unit consisting of an independent clause with all its modifiers or dependent clauses (Loban, 1976).

To ensure good inter-rater and intra-rater reliability, scorers followed multi-step protocols for C-unit segmentation and all analyses prior to transcribing and independently scoring the transcripts. Scorers were provided with the rules for transcription and scoring which included correct and incorrect examples of transcription/scoring along with explanations as to why a verbalization was segmented or scored incorrectly. This was followed by a series of practice activities whereby scorers could compare their results to previously scored transcripts of the same language samples, again with explanations provided. Scorers were required to tally the number of agreements and disagreements for segmentation and each analysis procedure. Once they were in 100% agreement with the previously scored transcript, their training was considered complete. An excerpt from the scoring procedures and training protocols can be found in Appendices A and B (complete scoring procedures and training protocols are available upon request).

Syntactic complexity—To measure syntactic complexity of the language samples a complexity index (CI) was calculated. The index was developed by the authors and fashioned after the work of Schneider, Dube, and Hayward (2005). The purpose of the index was to determine the relative complexity of an individual's given sample by examining it for clausal structure and embedding (Schneider et al., 2005). CI was calculated using the following formula: total clauses (independent clauses + total dependent clauses)/total independent clauses. Inter- and intra-rater agreement for calculating CI was completed for a random selection of 10% of the transcribed samples. All agreements were above 90%.

Percent information units—An information unit was defined as a word that was intelligible, relevant, accurate, and informative relative to the stimulus. The ‘percent information units’ for each story was calculated by dividing the total number of information units, by the total numbers of words (excluded unintelligible words, made-up words, fillers, partial words and commentary on the task) and multiplying by 100. Rules for what constituted an information unit were adapted from a number of sources (Dijkstra, Bourgeois, Allen, & Burgio, 2004; Nicholas & Brookshire, 1993; Shadden, 1997; Tomoeda, Bayles, Trosset, Azuma, & McGeagh, 1996). Inter- and intra-rater agreement for calculating percent information units was completed for 10% of the transcribed samples selected at random. All agreements were above 90%.

Lexical diversity—Lexical diversity is defined as a speaker's range of vocabulary (Durán, Malvern, Richards, & Chipere, 2004; see also Fergadiotis et al., 2011; Fergadiotis & Wright, 2011b). Nonwords, hesitations, revisions, repetitions, and onomatopoeia were coded via transcription codes in Computerized Language Analysis (CLAN; MacWhinney, 2000) and were excluded from subsequent analysis. For this study, *D* was estimated using the voc-*D* program in CLAN. *D* provides a measure of linguistic diversity that is robust to variations in language sample length (McKee, Malvern, & Richards, 2000) and has been shown to be a valid measure (Malvern & Richards, 1997; McCarthy & Jarvis, 2010; McKee, et al., 2000).

Global coherence—Coherence refers to the listener's perception of the speaker's ability to maintain a unified theme during discourse. Global coherence refers to how units of discourse maintain the overall topic. We used a 4-point scale to measure global coherence, which has been shown to be reliable and valid (Fergadiotis & Wright, 2011a; Wright et al., 2010). Global coherence scores for each utterance could range from significantly important to the main details of the stimulus (4) to entirely unrelated to the stimulus or topic (Table 2). Inter- and intra-rater agreement for calculating percent information units was completed for 10% of the transcribed samples selected at random. All agreements were above 90%.

RESULTS

Prior to performing the statistical analyses for addressing the study questions, preliminary analyses were conducted. To determine whether the total number of words (TNW) for a given language sample was a contributing factor to the results, paired sample t-tests were conducted for both groups. Results indicated no significant difference in TNW between the two stories for the HC or the PWA, $t(14)= -1.044$, $p = .314$ and $t(13)= -.339$, $p = .740$, respectively. Therefore, TNW was not considered in the remaining analyses. See Table 3 for means and standard deviations for all measures of interest, by story, for each group.

Healthy Controls

A series of paired sample t-tests were conducted to investigate the influence of story stimuli on the variables of interest. To account for multiple comparisons, familywise error rate was set at .0125 (.05/4). Results indicated a significant difference in lexical diversity, $t(14) =3.259$, $p = .006$; mean lexical diversity was greater for *Picnic* as compared to *Good Dog Carl*. No other story dependent significant differences were detected.

To address the main purpose of the study, Pearson correlation coefficients were computed for the variables of interest, by story (Table 4). For the *Picnic* story, both information units and syntactic complexity were significantly correlated with global coherence, $r = .871$; $p < .001$ and $r = .632$; $p = .011$, respectively. In addition, percent information units and syntactic complexity were also significantly correlated, $r = .552$; $p =.033$. With resepct to the *Good Dog Carl* story, percent information units significantly correlated with global coherence, $r = .872$; $p <.001$; no other significant correlations were found.

Two linear regression models were performed to understand the relationship between the microlinguistic and macrolinguistic measures, one for each story. In both cases, the dependent variable was the macrolinguistic measure, global coherence, with all three microlinguistic measures entered as predictors. We employed a backward elimination model due to the likelihood of continued collinearity among our predictor variables. For the *Picnic* story, results indicated three significant models; however, the only significant predictor across the three models was percent information units, which alone, explained 76% of the variance in global coherence, $p < .001$, adjusted $R^2= .759$ (See Table 5). For Good Dog Carl, results again indicated three significant models with percent information units being the only significant predictor across all three models, explaining 76% of the variance in global coherence, $p < .001$, adjusted $R^2= .760$ (See Table 5).

Participants with Aphasia

A one-way ANOVA was conducted to compare global coherence scores between HC and PWA for the two stories. Results indicated a significant difference in global coherence bewteen HC and PWA for both *Picnic* and *Good Dog Carl*, $F(1,28) = 31.90$, $p < .001$; $F(1,28) = 23.30$, $p < .001$, respectively. To investigate the influence of story stimuli on the variables of interest for PWA, paired sample t-tests were completed. Results indicated no story dependent significant differences for the variables of interest. As with the HC, Pearson correlation coefficients were computed for the variables of interest, by story (Table 6). For the *Picnic* story, all variables were found to be signficantly correlated. In contrast, for *Good Dog Carl*, results indicated that only lexical diversity and syntactic complexity were significantly correlated with global coherence, $r = .786$, $p =.001$ and $r = .648$, $p =.012$, respectively. In addition, linguistic diversity and syntactic complexity were also significantly correlated, $r = .663$, $p = .010$.

To understand the relationship between microlinguistic and macrolinguistic discourse processes for the PWA group, two linear regression models were performed, one for each story. For both models, the dependent variable was global coherence, and all three microlinguistic measures entered as predictors. Again, we employed a backward elimination model due to the likelihood of continued collinearity among our predictor variables. For the *Picnic* story, results indicated two significant models, $F(1, 12) = 21.681$, $p < .001$, adjusted $R^2 = .838$ and $F(1, 12) = 33.655$, $p < .001$, adjusted $R^2 = .845$, respectively. The first model had one significant predictor, percent information units whereas the second model had two significant predictors, percent information units and lexical diversity; the second model accounted for approximately 85% of the variance in global coherence scores for the story (see Table 7). For *Good Dog Carl*, results indicated three significant models with lexical diversity being the only significant predictor across all three models, explaining 59% of the variance in global coherence, $p = .001$, adjusted $R^2 = .586$ (see Table 7).

DISCUSSION

The purpose of this study was to identify the microlinguistic processes that contribute to maintenance of global coherence in stories told by adults with and without aphasia. The groups performed differently on the global coherence measure. The healthy control group performed at ceiling level on the measure (mean score = 4.0); whereas, the aphasia group yielded significantly lower mean global coherence scores (2.8). For the control group, the utterances produced to tell the stories depicted in the wordless picture books were overtly related to the stimulus and included mention of characters, actions, and/or objects that were of significant importance to the main details of the stimulus (See Table 2). For the aphasia group, their utterances related to the stimulus but substantive information was not consistently provided and the utterances required more inferencing by the listener to determine the topic.

When considering the influence of microlinguistic processes on maintenance of global coherence different results were found across the two groups. For the healthy control group, percent of information units conveyed accounted for 76% of the variance in maintenance of global coherence for both stories. For the aphasia group, the microlinguistic processes that contributed to maintenance of global coherence differed, depending on the story. Percent of information units conveyed and lexical diversity accounted for 85% of the variance in maintenance of global coherence for the *Picnic* story. Whereas, only lexical diversity contributed to maintenance of global coherence for *Good Dog Carl*, accounting for 59% of the variance. A discussion of the results, future directions, and clinical implications follows.

Group Differences for Maintaining Global Coherence

Our findings that the healthy controls performed significantly better than the PWA for maintaining global coherence in stories they told are similar to Coelho and Flewellyn's (2003) results. However, our findings differ from Glosser and Deser's (1990). There was some variability in aphasia type and severity across the studies which may have partly accounted for the different results. Coelho and Flewellyn's study participant presented with anomic aphasia. Glosser and Deser's fluent aphasia group consisted of adults with anomic aphasia and Wernicke's aphasia. In the current study, the aphasia group included participants presenting with anomic aphasia, conduction aphasia, and Broca's aphasia. With the small Ns across the studies it is not possible to determine if aphasia type contributed to the different findings, and this should be explored in future studies. It is interesting to note that the participant in Coelho and Flewellyn's study presented with a milder aphasia severity and a different aphasia presentation as compared to many participants in the current study. Yet, the participant in that study still performed more poorly than the control-matched peers, suggesting that other factors may also contribute to the different findings across studies.

Another plausible explanation for why group differences were not similar across studies may be related to the type of discourse elicited. Though different stimuli were used, Coelho and Flewellyn elicited a similar type of discourse to the type elicited in the current study – story narratives. Glosser and Deser had participants recount family and work experiences; so, no external stimuli were used. Possibly, Glosser and Deser had greater variability in the types of narratives elicited in response to their discourse task, which in turn may have masked potential differences in global coherence between adults with and without aphasia.

There is general agreement in the literature that different cognitive and linguistic demands are imposed for different types of discourse (Bliss & McCabe, 2006; Brady, Armstrong, & Mackenzie, 2005; Nicholas & Brookshire, 1993; Ulatowska, Allard, & Chapman, 1990). Wright, Koutsoftas, Capilouto, and Fergadiotis (under review) investigated global coherence ability in cognitively healthy adults. Several types of discourse were elicited, including stories and recounts. Global coherence ability was measured using the 4-point global coherence scale. Wright et al. found that study participants yielded significantly lower mean global coherence scores for recounts compared to story narratives. The recounts included having the participant describe their most recent vacation, most recent weekend, and a past holiday. Wright et al. suggested that participants produced less structured narratives and were more likely to stray from the overall topic when providing recounts as compared to the stories. For the stories, participants viewed wordless picture books and told the story depicted. The story narrative task was more structured and the content more controlled by use of pictured stimuli. Fergadiotis (2011) suggested that the discourse produced for story narratives is determined by the stimulus materials which ‘constrains’ the speaker to the story schema that is depicted. Recounts, however, may be influenced by other cognitive processes, such as activation of representations in long-term memory, and are less guided by external structures (Fergadiotis, 2011). Further, recounts may vary more across individuals in terms of the complexity of the discourse produced and their structure; thus resulting in greater variability on measures of interest across participants. Using one of Glosser and Deser's (1990) elicitation tasks as an example, two individuals telling about their work experiences may differ greatly for numerous reasons. For example, they held different jobs, or the narrative they share reflects different components of their work experience (e.g., actual work responsibilities, company information, social relationships established in the work environment, etc). Fleshing out the within-subject variability for maintaining global coherence across a variety of discourse elicitation tasks is beyond the scope of this study. Future investigations are warranted to determine the influence of type of discourse on maintenance of global coherence in adults with aphasia. It may be that certain discourse types allow for a more accurate comparison of the ways in which specific linguistic processes vary between persons with and without aphasia.

Microlinguistic Processes and Global Coherence

For the healthy control group, percent of information units conveyed was a significant predictor of their ability to maintain global coherence for the stories they told. Though the two stories differed in their story structure, results were similar across the stories for the control group. Possibly, because of how well they performed on the linguistic measures of interest. Not surprisingly, they performed at ceiling level on the global coherence measure and conveyed a high percent of information units (~88%) suggesting that their stories were informative and coherent. This was not the case for the aphasia group.

For the aphasia group, slightly different results were found across the two stories, and the different story structures may partly account for these differences. The *Picnic* story has a more complex story structure, and it is temporally and spatially driven. *Good Dog Carl* includes many details, but the story structure is sequential and only temporally driven. For the *Picnic* story, percent of information units conveyed and the richness of the vocabulary produced were significant predictors of the aphasia group's ability to maintain global coherence. Christiansen (1995) suggested that coherence violations made by her participants with anomic and conduction aphasia were a result of compensating for their lexical retrieval difficulties. Ulatowksa et al. (2004) suggested that maintenance of coherence for adults with aphasia qualitatively differed from maintenance of coherence for adults without aphasia because of their linguistic deficits. Our results add empirical support for these conclusions by demonstrating that lexical factors significantly contribute to maintenance of global coherence in stories told by adults with aphasia. Word retrieval difficulties for the aphasia participants are reflected in their lower informativeness and lexical diversity scores as compared to the healthy controls. The adults with aphasia had more difficulty retrieving accurate and relevant words to convey the stories as well as using a robust and diverse vocabulary in their story tellings. Moreover, their word retrieval deficits contributed to their difficulties in conveying relevant details, and substantive information about the story. For the participants with aphasia who produced more intelligible, accurate, and relevant words and used a richer vocabulary, their story narratives were perceived as maintaining the semantic unity of the *Picnic* story. Alternatively, those participants who produced fewer accurate and relevant words and used a limited vocabulary were unable to produce story narratives that listener's could easily perceive as maintaining the semantic unity of the *Picnic* story.

Good Dog Carl has a temporally driven story structure, and the story includes many details. Because of the structure of the story, each story element includes a new location with new objects and actions. The characters, the dog (Carl) and baby, are the only constants throughout the story. For a speaker to tell the story coherently, s/he needs to present the different locations with the respective objects and actions that are occurring as the story progresses. To do so requires producing new lexical items for each story element. For example, the speaker needs to provide details about the events that occur in the bedroom and the living room and the kitchen. In each location, different events are occurring and different objects are involved. A robust and diverse vocabulary, then, plays an important role in providing a coherent telling of the *Good Dog Carl* story. As suggested by Christiansen (1995) and Ulatowska and colleagues (2004), the lexical retrieval difficulties that adults with aphasia present with may negatively affect their ability to produce coherent discourse. We found that for both stories, word retrieval difficulties experienced by PWA contribute to their reduced ability to maintain global coherence. However, for the *Good Dog Carl* story, the ability to produce a rich and diverse vocabulary because of their word retrieval difficulties was the only significant predictor of global coherence ability. Though lexical diversity significantly contributed to maintenance of global coherence for *Good Dog Carl* stories, it accounted for only 59% of the variance, suggesting that other factors may contribute as well. The order of story elements presented in the story may be critically important for the listener to percieve the story as coherent. Possibly then, story grammar is a macrolinguisitic process that contributes to maintenance of global coherence in temporally-driven stories told by adults with aphasia. Testing this hypothesis should be considered in future investigations.

Conclusions and Clinical Implications

Results of the current study extend previous findings by researchers who have investigated global coherence ability in adults with aphasia. Using a multi-level approach, we found that linguistic processes across different levels of discourse interact. Moreover, different lexical factors including informativeness and lexical diversity contributed to maintenance of global coherence in stories told by adults with and without aphasia, but syntactic processes did not. Results support Marini et al.'s (2011) and Sherratt's (2007) assertion that a multi-level discourse model should be applied to comprehensively quantify discourse ability in adults with and without aphasia. A multi-level approach is informative and strengthens our understanding of the linguistic processes involved in maintenance of global coherence. For persons with aphasia, including such an approach as part of the diagnostic evaluation may be useful when developing functional treatment goals. As suggested by Marini and colleagues, a multi-level approach to analyzing discourse produced by adults with aphasia may be sensitive to changes following treatment that are not detected by standardized tests. Further, treatment directed at improving specific linguistic processes (e.g., informativeness) may indirectly improve other linguistic processes (e.g., global coherence) and applying a multi-level approach may be more sensitive to detecting such changes.

The results of the study are informative and add empirical evidence for the utility of using a multi-level approach for investigating discourse ability in PWA; however, limitations persist that should be considered in future investigations. The study included 15 PWA who presented with different aphasia types. It was not possible to determine if global coherence ability differed depending on type of aphasia presentation because of the small number of participants within each subgroup. In future studies, researchers should investigate if maintenance of global coherence differs depending on aphasia type. Further, researchers should also consider if microlinguistic processes influence maintenance of global coherence differently depending on aphasia presentation type. Finally, investigating global coherence in PWA in the context of a variety of discourse tasks (e.g. recounts, picture description, procedural) has the potential to help us better understand the interrelationship between aphasia type and narrative on the maintenance of global coherence in this population.

Acknowledgments

This research was supported by the National Institute on Aging Grant R01AG029476. We are especially grateful to the study participants. We also thank the volunteers and graduate assistants in the Aging and Adult Language Lab at ASU and the Discourse Processing Lab at UK for assistance with transcription and language analyses.

Appendix A

Excerpt from Scoring Procedures for Global Coherence (Wright & Capilouto, 2010)

GLOBAL COHERENCE PROCEDURES

1. Higher global coherence ratings assigned to verbalizations which provided substantive information directly related to the *designated topic*
2. Samples need to be segmented into C-units prior to completing coherence analyses.
3. Audio recordings need to be accessible while performing coherence analyses.
4. Use the scale to rate each C-unit for global coherence (complete training and practice items prior to beginning analyses).
5. Calculate Global Coherence Scores by dividing the total rating by the total number of C-units *rated*.

*Note:

- Disregard/do not rate ending commentary (e.g. “That's it.” “The end.” “That's the story.”) when rating global coherence. This applies only when there is no other information given in the utterance (e.g. “And that was all I did this weekend” would be accounted for).

- Disregard/do not rate direct responses to examiner unless additional information is provided. Do not count first utterances that are questions to examiner requesting clarification of task instructions.

Appendix B

Excerpt from Training Protocol for Scoring Global Coherence (Wright & Capilouto, 2010)

PROCEDURES

Key: *Italicized* = egocentric or requires inferencing

Rating	Line #	Stories: “Picnic” Transcript	Explanation
3	1	I hadn't really figured out what I wanna call these animals.	Related to the topic but tangential
3	2	habits hobbits or uh I don't know.	Same as above
3	3	they kinda uh really don't look like much of an animal.	Tangential/Extraneous
2	4	mouse *I don't like mouses.*	Inserting opinion (inappropriately egocentric) that really has nothing to do with the topic. Not scored a one because of the relationship with “mouse” to the general topic
3	5	and so anyway we'll call them hobbits.	Same as lines 1 and 2 above
4	6	they're all getting ready to go.	
4	7	the whole family's getting together	
4	8	they just decide they really going to go have a great day.	
4	9	one of them can drive a truck.	
4	10	and they all jump in.	

References

Agar M, Hobbs JR. Interpreting discourse: Coherence and the analysis of ethnographic interview. Discourse Processes. 1982; 5:l–32.

Bliss LS, McCabe A. Comparison of discourse genres: Clinical implications. Contemporary Issues in Communication Science and Disorders. 2006; 33(2):126–137.

Brady M, Armstrong L, Mackenzie C. Further evidence on topic use following right hemisphere brain damage: Procedural and descriptive discourse. Aphasiology. 2005; 19:731–747.

Brownell HH. The neuropsychology of narrative comprehension. Aphasiology. 1988; 2:247–250.

Christiansen JA. Coherence violations and propositional usage in the narratives of fluent aphasics. Brain and Language. 1995; 51:291–317. [PubMed: 8564473]

Coelho C, Flewellyn L. Longitudinal assessment of coherence in an adult with fluent aphasia: A follow-up study. Aphasiology. 2003; 17:173–182.

Day, A. Good dog, Carl. Green Tiger Press; New York: 1985.

Dijkstra K, Bourgeois M, Allen R, Burgio L. Conversational coherence: Discourse analysis of older adults with and without dementia. Journal of Neurolinguistics. 2004; 17:263–283.

Durán P, Malvern D, Richards B, Chipere N. Developmental trends in lexical diversity. Applied Linguistics. 2004; 25(2):220–242.

Fergadiotis, G. Doctoral Dissertation. Arizona State University; Tempe. AZ: 2011. Modeling lexical diversity across language sampling and estimation techniques..

Fergadiotis, G.; Wright, HH. New Trends in Experimental Psycholinguistics. Madrid, Spain: 2011a. Global discourse coherence in normal and aphasic discourse..

Fergadiotis G, Wright HH. Lexical diversity for adults with and without aphasia across discourse elicitation tasks. Aphasiology. 2011b; 25:1414–1430.

Fergadiotis G, Wright HH, Capilouto GJ. Productive Vocabulary across Discourse Types. Aphasiology. 2011; 25:1261–1278. [PubMed: 22904592]

Glosser G, Deser T. Patterns of discourse production among neurological patients with fluent language disorders. Brain and Language. 1990; 40:67–88. [PubMed: 2009448]

Glosser G, Deser T. A comparison of changes in macrolinguistic and microlinguistic aspects of discourse production in normal aging. Journal of Gerontology: Psychological Sciences. 1992; 47:266–272.

Jakobson, R. On aphasic disorders from a linguistic angle.. In: Jakobson, R., editor. Theframework of language. University of Michigan Press; Ann Arbor, MI: 1980.

Kertesz, A. Western aphasia battery- revised. Grune and Stratton; New York: 2007.

Kintsch W, van Dijk T. Toward a model of text comprehension and production. Psychological Review. 1978; 85:363–394.

Krahn, F. The great ape. Viking Press; New York: 1978.

Loban, W. Language development: kindergarten through grade twelve. National Council of Teachers of English; Urbana, Ill: 1976.

MacWhinney, B. The CHILDES project: Tools for analyzing talk, Volume 1: Transcription format and programs. 3rd Ed.. Lawrence Erlbaum Associates Publishers; Mahwah, NJ, US: 2000.

Malvern, D.; Richards, B. A new measure of lexical diversity.. In: Ryan, A.; Wray, A., editors. Evolving Models of Language. Multilingual Matters; Clevedon, UK: 1997. p. 58-71.

Marini A, Andreetta S, del Tin S, Carlomagno S. A multi-level approach to the analysis of narrative language in aphasia. Aphasiology. 2011; 25:1372–1392.

McCarthy P, Jarvis S. MTLD, vocd-D, and HD-D: A validation study of sophisticated approaches to lexical diversity assessment. Behavior Research Methods. 2010; 42(2):381–392. [PubMed: 20479170]

McCully, E. Picnic. Harper Collins Publishers; 1984.

McKee G, Malvern D, Richards B. Measuring vocabulary diversity using dedicated software. Literary and Linguistic Computing. 2000; 15(3):323–337.

Nicholas L, Brookshire R. A system for quantifying the informativeness and efficiency of the connected speech of adults with aphasia. Journal of Speech and Hearing Research. 1993; 36(2): 338–350. [PubMed: 8487525]

Olness GS, Ulatowska HK. Personal narratives in aphasia: Coherence in the context in use. Aphasiology. 2011; 25:1393–1413.

Schneider, P.; Dube, R.; Hayward, D. [March 14, 2011] The Edmonton Narrative Norms Instrument. 2005. from http://www.rehabmed.ualberta.ca/spa/enni

Shadden B. Discourse behaviors in older adults. Seminars in Speech and Language. 1997; 18(2):143–156. quiz 156-147. [PubMed: 9195687]

Sherratt S. Multi-level discourse analysis: a feasible approach. Aphasiology. 2007; 21(3/4):375–393.

Tomoeda CK, Bayles KA, Trosset MW, Azuma T, McGeagh A. Cross-sectional analysis of Alzheimer disease effects on oral discourse in a picture description task. Alzheimer disease and associated disorders. 1996; 10(4):204–215. [PubMed: 8939280]

Ulatowska, HK.; Allard, L.; Bond Chapman, S. Narrative and procedural discourse in aphasia.. In: Joanette, Y.; Brownell, HH., editors. Discourse ability and brain damage: Theoretical and empirical perspectives. Springer-Verlag; New York: 1990. p. 180-198.

Ulatowska HK, Olness G, Williams LJ. Coherence of narratives in aphasia. Brain and Language. 2004; 91:42–43.

Wright, HH.; Capilouto, GJ. Global coherence procedures. 2011. Unpublished procedures

Wright H, Fergadiotis G, Koutsoftas A, Capilouto G. Coherence in stories told by adults with aphasia. Procedia Social and Behavioral Sciences. 2010; 6:111–112.

Wright HH, Koutsoftas A, Capilouto GJ, Fergadiotis G. Global coherence in younger and older adults: Influence of cognitive processes and discourse type. under review.

Table 1

Means and standard deviations of demographic variables of interest, by group

	PWA Group (N=15)	HC Group (N=15)
Age (yrs)	*M* = 62.4 (*SD=13*)	*M* = 62.4 (*SD=13*)
Gender	8 females, 7 males	8 females, 7 males
Education	*M* = 14.5 (*SD=2.5*)	*M* = 14.5 (*SD=2.5*)
MMSE[1]		*M* = 57.5 (7.5)
WAB-R AQ[2]	*M* = 69.6 (*SD=15.6*)	

[1]Mini Mental State Exam Scaled Score

[2]Western Aphasia Battery- Revised, Aphasia Quotient

Table 2

Scoring Criteria for Four-Point Global Coherence Rating Scale

Score	Criteria
4	The utterance is overtly related to the stimulus as defined by mention of actors, actions, and/or objects present in the stimulus which are of significant importance to the main details of the stimulus. In the case of procedural descriptions and reactions when a designated topic acts as the stimulus, overt relation is defined by provision of substantive information related to the topic so that no inference is required by the listener.
3	The utterance is related to the stimulus or designated topic but with some inclusion of suppositional or tangential information that is relevant to the main details of the stimulus; *or* substantive information is not provided so that the topic must be inferred from the statement. In recounts, appropriate elaborations that are not essential but are related to the main topic are scored a 3.
2	The utterance is only remotely related to the stimulus or topic, with possible inclusion of inappropriate egocentric information; may include tangential information or reference some element of the stimulus that is regarded as non-critical.
1	The utterance is entirely unrelated to the stimulus or topic; the utterance may be a comment on the discourse or tangential information is solely used.

Table 3

Means (standard deviations) of variables of interest, by group, by story

	Percent Information Units	Lexical Diversity	Syntactic Complexity	Global Coherence	Total Number of Words
			Picnic		
Healthy	88.3 (8.3)	56.5 (12.5)	1.4 (.24)	4.0 (.09)	611 (316)
Controls	N = 15	N = 15	N = 15	N = 15	N = 15
People with	64.6 (17.2)	27 (14.2)	1.2 (.14)	2.8 (.78)	309 (227)
Aphasia	N = 15	N = 14	N = 15	N = 15	N = 15
			Good Dog Carl		
Healthy	88.6 (7.6)	45 (15)	1.4 (.21)	4.0 (.12)	642 (323)
Controls	N = 15	N = 15	N = 15	N = 15	N = 15
People with	68.2 (12.8)	22.4 (12)	1 (34)	2.8 (.87)	332 (264)
Aphasia	N = 14	N = 14	N = 14	N = 14	N = 14

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Table 4

Pearson correlations between variables of interest, by story, for HC Group

Picnic				
Variable	I	II	III	IV
I. Percent information units	I			
II. Lexical diversity	.048	I		
III. Syntactic complexity	.552*	-.124	I	
IV. Global Coherence	.871*	-0.94	.632*	I

Good Dog Carl				
Variable	I	II	III	IV
I. Percent information units	I			
II. Lexical diversity	.236	I		
III. Syntactic complexity	.422	.274	I	
IV. Global Coherence	.872*	.174	.493	I

*Correlation is significant at the .05 level (2-tailed)

*Correlation is significant at the .01 level (2-tailed)

Table 5

Results from linear regression predicting global coherence for PICNIC and GOOD DOG CARL for the HC group

	B (SE)	β	*p*-value	adjusted R^2
Model 3- *Picnic*				.759
Constant	3.137 (.126)		.000	
Percent Information Units	.009 (.001)	.871	.000	
Model 3- *Good Dog Carl*				.760
Constant	2.682 (.192)		.000	
Percent Information Units	.014 (.002)	.872	.000	

Note. B = unstandardized coefficient; SE = standard error; β = standardized coefficient

Table 6

Pearson correlations between variables of interest, by story, for PWA Group

Picnic				
Variable	I	II	III	IV
I. Percent information units	I			
II. Lexical diversity	.582*	I		
III. Syntactic complexity	.613*	797**	I	
IV. Global Coherence	.804**	794**	.795**	I

Good Dog Carl				
Variable	I	II	III	IV
I. Percent information units	I			
II. Lexical diversity	.236	I		
III. Syntactic complexity	.407	.663**	I	
IV. Global Coherence	.161	786**	.648*	I

*Correlation is significant at the .05 level (2-tailed)

**Correlation is significant at the .01 level (2-tailed)

Table 7

Results from linear regression predicting global coherence for PICNIC and GOOD DOG CARL for PWA

	B (SE)	β	*p*-value	adjusted R^2
Model 2- *Picnic*				.845
Constant	.844 (.290)		.000	
Percent Information Units	.024 (.005)	.651	.001	
Lexical Diversity	.019 (.007)	.387	.020	
Model 3- *Good Dog Carl*				.586
Constant	1.529 (.328)		.001	
Percent Information Units	.057(.013)	.786	.001	

Note. B = unstandardized coefficient; SE = standard error; β = standardized coefficient