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Global Coherence in Younger and Older Adults: Influence of Cognitive Processes and Discourse Type

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Abstract

The purpose of the present research was to examine the influence of cognitive processes on discourse global coherence ability measured across different discourse tasks and collected from younger (n = 40; 20–39 y.o.) and older (n = 40; 70–87 y.o.) cognitively healthy adults. Study participants produced oral language samples in response to five commonly used discourse elicitation tasks and they were analyzed for maintenance of global coherence. Participants also completed memory and attention measures. Group differences on the global coherence scale were found for only one type of discourse – recounts. Across discourse elicitation tasks the lowest global coherence scores were found for recounts compared to the other discourse elicitation tasks. The influence of cognitive processes on maintenance of global coherence differed for the two age groups. For the younger group, there were no observed significant relationships. For the older group, cognitive measures were related to global coherence of stories and procedures.

Keywords

discourse; aging; coherence; narratives; cognitive processes

Discourse coherence can be conceptualized as representing the listener's ability to interpret the overall meaning conveyed by the speaker. Factors such as discourse schema, cognitive demands, and age may contribute to how well discourse is perceived as coherent. However, these factors have not been investigated collectively to determine their influence on discourse coherence ability. Further, cognitive functions that may contribute to maintenance of global coherence have not been readily specified in the literature and empirical evidence is lacking. The purpose of the present research was to examine the influence of cognitive processes on discourse coherence ability measured across different discourse elicitation tasks collected from younger and older cognitively healthy adults.

Discourse schemas serve as organizing frameworks for placing the essential discourse elements within a language sample (Bloom, Borod, Santschi-Haywoor, Pick, & Obler, 1996; Peterson & McCabe, 1983). The speaker's knowledge about discourse schemas contributes to his/her ability to produce coherent discourse; and, the speaker and listener must have a shared knowledge about what ordinarily happens in the discourse context being conveyed

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(Duchan, 1994). When telling a story, for example, the speaker follows a story schema that includes essential story elements such as setting, initiating event, direct consequences, resolution, and ending (Hughes, McGillivray, & Schmidek, 1997). Alternatively, in the case of procedural discourse, the discourse schema includes a temporally-sequenced, step-by-step description of how to achieve a goal (Longacre, 1996). When the essential elements are provided and a logical consistency of the discourse schema is maintained then the listener will perceive the discourse as coherent (Ditman & Kuperberg, 2010; Trabasso, van den Broek, & Suh, 1989; van den Broek, Virtue, Everson, Tzeng, & Sung, 2002).

There is general agreement that coherence also reflects the speaker's ability to maintain thematic unity at the suprasentential level (e.g., Glosser & Deser, 1992; Trabasso & Sperry, 1985). To further refine the concept of thematic unity, several researchers have identified different "levels" of coherence – *global* and *local* (Agar & Hobbs, 1982; Glosser & Deser, 1992; Kintsch & van Dijk, 1978). Global coherence refers to how the measured units of discourse (i.e., utterance, proposition, sentence) maintain the overall topic; whereas, local coherence refers to how the content from one unit of discourse relates to the content of the preceding unit. Discourse organization is realized through global coherence (Ditman & Kuperberg, 2010) and is the focus of the current study. Global coherence has been investigated in cognitively healthy adults and adults with acquired neurogenic communication disorders (e.g., aphasia, dementia, right hemisphere brain disorder, traumatic brain injury) across a variety of discourse tasks (Bloom et al., 1996; Christiansen, 1995; Coelho & Flewellyn, 2003; Dijkstra, Bourgeois, Allen, & Burgio, 2004; Fergadiotis & Wright, 2011; Glosser & Deser, 1990, 1992; Hough & Barrow, 2003; Laine, Laakso, Vuorinen, & Rinne, 1998; Mackenzie, Brady, Norrie, & Poedjianto, 2007; McCabe & Bliss, 2006; Olness, 2006; Rogalski, Altmann, Plummer-D'Amato, Behrman, & Mariske, 2010; van Leer & Turkstra, 1999).

Glosser and Deser (1992) measured global coherence ability in discourse samples obtained from two groups of cognitively healthy adults – middle aged (mean age = 51.9) and elderly (mean age = 76.2). The discourse elicitation tasks included describing family and work experiences. Language samples were transcribed and segmented into verbalizations. Each verbalization was scored and then a mean global coherence score for each sample was computed. Global coherence was defined as the degree to which the overall topic was maintained. A high global coherence score indicated the verbalization included "substantive information directly related to the designated topic" (Glosser & Deser, 1992, p. 268). A low global coherence score indicated the verbalization was incoherent. Glosser and Deser found that the middle-aged group had a significantly better mean global coherence score compared to the older group. Further, the middle-aged group had significantly fewer incoherent verbalizations compared to the older group (5.1% v. 17.9%) suggesting that the older group abandoned the topic and became tangential with greater frequency than the middle-aged group, subsequently disrupting discourse organization (Glosser & Deser, 1992).

Marini, Boewe, Caltagirone, and Carlomagno (2005) investigated microlinguistic and macrolinguistic aspects of discourse production ability and one of the macrolinguistic processes of interest was global coherence. They included five age groups (20–24, 25–39, 40–59, 60–74, 75–84). Participants described a single picture scene and two six-frame sequential picture scenes. Following Ewing-Cobb, Brookshire, Scott, and Fletcher's (1998) conceptualization of global coherence, Marini et al. defined global coherence as a measure of completeness of the story gist and measures included the degree of global coherence and global coherence errors. The degree of global coherence was calculated as the proportion of main propositions elicited divided by the maximum number of main propositions for a given story. Global coherence errors included instances of utterances that were unrelated or conceptually incorrect. Results indicated that the oldest group performed significantly worse

on the degree of global coherence maintained for the stories compared to all groups except the young elderly (i.e., 60–74 y.o.). However, no differences on the number of global coherence errors produced across age groups were found. Similar to Glosser and Deser (1992), Marini et al. (2005) concluded that older adults experience a decline in macrolinguistic organization.

A variety of discourse elicitation tasks have been used to study global coherence. For example, van Leer and Turkstra (1999) found that adolescents with and without brain injury yielded significantly better coherence scores for personal narratives (i.e., describe your accident) compared to current event narratives (i.e., tell the OJ Simpson murder trial story). Whereas, Marini et al. (2005) found significantly better coherence scores for narratives elicited from describing sequential pictures compared to single pictures. The common explanation for the difference in coherence scores has been that the cognitive demands required to produce discourse samples in response to different elicitation tasks vary (Marini et al., 2005; van Leer & Turkstra, 1999). For example, providing coherent narrative samples involving current events is more cognitively demanding than providing coherent, personal narrative samples (van Leer & Tursktra, 1999).

Glosser and Deser (1990) investigated global coherence ability in several clinical populations (dementia, head injured, aphasia). Participants in the dementia and head injury groups' demonstrated impaired maintenance of global coherence compared to the control group. Glosser and Deser hypothesized that their reduced cognitive abilities contributed to their impaired global coherence abilities; however, they did not empirically test the hypothesis. Ash, Moore, Antani, McCawley, Work, and Grossman (2006) investigated global coherence ability in individuals with frontotemporal dementia (FTD) who presented with executive function impairments. The FTD group demonstrated impaired maintenance of global coherence ability. Ash and colleagues hypothesized that their executive function impairments contributed to their impaired ability to maintain global coherence; though this was not empirically investigated. Glosser and Deser (1992) suggested that for cognitively healthy adults several cognitive processes are important for maintaining global coherence and they include executive functions, working memory, and long term memory. Yet, no empirical evidence was reported to support this hypothesis.

A few studies have included cognitive measures in their investigations of discourse coherence. Recently, Rogalski et al. (2010) examined the relationship between cognitive variables and discourse coherence in 13 mobility-impaired stroke survivors. Several measures of attention (selective and sustained), working memory, and processing speed were also administered. Rogalski et al. found a significant relationship among mean global coherence scores and performance on the sustained attention and processing speed measures (i.e., Digit Symbols Test and Digit Symbol Copy Test). Rogalski et al.'s findings provide initial empirical support for previous researchers' hypothesis that cognitive processes contribute to maintenance of global coherence.

Similarly, Arbuckle and Gold (1993) suggested that age-related changes in cognitive ability contribute to the increase in off-topic speech observed in older adults' discourse productions. McDowd and Shaw (2000) reported that age-related declines in shifting and selective attention abilities contribute to the increase in off-topic speech in older adults' discourse. When the speaker abandons the topic and an increase in off-topic speech occurs, the speaker is not able to maintain the global coherence of the discourse. Cognitive processes known to be susceptible to age may influence maintenance of global coherence ability. Cognitive changes in healthy aging have been implicated as influencing the maintenance of global coherence; however, few studies have included measures of cognition

and general conclusions about the specific cognitive processes involved are speculative at best.

The purpose of the current study was to systematically evaluate global coherence ability in cognitively healthy adults by considering the influence of cognitive ability, discourse elicitation task, and age. The aims of the study were threefold. The first aim was to determine if maintenance of global coherence differs depending on the type of discourse elicitation task. It was expected that global coherence scores would vary according to the degree of constraint imposed by the task. Specifically, lower scores of global coherence would be associated with personal recounts compared to the procedural, story telling, and picture description discourse tasks. The second aim was to determine if younger and older adults differ for maintaining global coherence ability across different discourse elicitation tasks. We expected that the younger group would have better global coherence scores compared to the older group. The third aim was to determine if there was a relationship among cognitive processes and maintenance of global coherence in discourse samples produced by younger and older adults. Based on our previous work, it was expected that selective attention and episodic memory abilities would significantly predict global coherence ability for the older group but not the younger group.

METHOD

The data presented are a subset of data from a larger study examining discourse processing across the lifespan. Participant data were randomly selected from this larger data set with the parameter of age; such that, 40 participants were randomly selected from the pool of participants between 20 and 39 years old and 40 were randomly selected from the pool of participants that were between 70 and 89 years old.

Participants

Eighty cognitively healthy adults participated in the study and comprised two groups – young adults (20–39 years old) and older adults (70–87 years old). Mean age for the younger group was 28.98 years (SD = 5.75) and mean age for the older group was 76.98 years (SD = 4.69). There were 24 females in the younger group and 26 females in the older group. There was no significant between-group difference in the number of years of education completed, $F(1, 78) = .85$, $p = .36$, with the younger group reporting a mean of 16.18 (SD = 2.94) years of education and the older group reported a mean of 15.60 (SD = 2.64) years of education.

All participants met the following study inclusionary criteria: (a) aided or unaided visual acuity within normal limits, as indicated by passing a vision screening (Beukelman & Mirenda, 1998); (b) aided or unaided hearing within functional limits as measured by the CID List of Everyday Speech (Davis & Silverman, 1978); (c) no presence of depression at time of study participation as measured by performance on the short form of the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986); (d) normal cognitive functioning as indicated by performance on the Mini Mental State Examination (MMSE; Folstein & Folstein, 2002); (e) no history of stroke, head injury, or progressive or acquired neurogenic disorder per self report; and (f) English as their first language per self report.

Cognitive Measures

Several measures of memory and attention were administered to study participants. These measures included: Wechsler Memory Scale-III (WMS-III; Wechsler, 1997), Comprehensive Trail Making Test (CTMT; Reynolds, 2002), and STROOP Color and Word Test (STROOP; Golden, 2002). Table 1 provides means and standard deviations by group

for each of the cognitive measures. Estimates of participants' episodic and working memory ability were determined from their performance on the WMS-III. Results on the forward spatial span, backward spatial span, and letter-number sequencing subtests are combined to determine participant's working memory index score. The general memory index score, which includes participant's scores on logical memory II recall, verbal paired associates II recall, faces II recognition, family pictures II recall, and auditory recognition delayed subtests, was used to estimate episodic memory ability and is referred to here on as episodic memory index. To address the study's aims, the working memory index and episodic memory index raw scores were computed and subjected to statistical analyses for group comparison; scaled scores were not used.

The attention measures included the CTMT and STROOP. For the CTMT, raw data included time in seconds it took to complete each trail. Participants' performance on Trail 5, the most difficult trail, was the only data that were subjected to statistical analyses. Trail 5 requires the participant to shift attention between letters and numbers, connecting them in ascending order. The STROOP includes three tasks. The final task, the Color-Word Page, is the most attention demanding and only raw scores from this task are reported and subjected to statistical analyses. Raw scores include the number of words read in 45 seconds. Color words (i.e., RED, BLUE, GREEN) are printed in different ink colors. Participants are instructed to state the ink color and not read the word itself. To perform the task, the individual must selectively attend to the ink color and inhibit the irrelevant stimulus; that is, reading the written color word. The CTMT Trail 5 task is the measure for estimating shifting attention ability and the STROOP Color-Word task is the measure for estimating selective attention ability.

Discourse Tasks

Structure of discourse is dependent on the type of information conveyed, which is driven by the discourse genre of interest. For the current study two discourse genres are targeted - narrative and procedural. Narrative discourse includes a description of events unfolding over time and/or space and typically includes a beginning and an ending. Procedural discourse is an account of the steps involved in an activity or routine. Eleven different discourse samples across these two discourse genres were obtained from each participant. According to Heath (1986) there are four forms of narrative discourse: eventcasts, stories, recounts, and accounts. The different types of narrative discourse included in the current study are eventcasts, stories, and recounts. Eventcasts are narratives that explain a scene of activities and typically consist of single or sequential picture descriptions, stories are fictionalized, highly structured narrative forms, and recounts are verbal reiterations of an event.

For the eventcasts, participants viewed and described the scenes depicted in Nicholas and Brookshire's (1993) two single pictures and two six-frame, sequential picture scenes. The stimuli are referred to as Cat in the Tree (single picture), Birthday (single picture), Argument (sequential picture), and Directions (sequential picture). For the storytelling task, participants viewed then 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 who ride into the forest on the back of a truck for a family picnic. In *Good Dog Carl*, a mother says to the family dog, Carl, to look after the baby in his crib while she is gone and Carl and the baby get into all sorts of mischief while the mother is gone but Carl cleans up the mess before the mother returns. The recounts included participants recounting three different personal events: what they did last weekend, what they did during their last holiday, and what they did during their last vacation. The procedural discourse samples included the participants telling how to make a peanut butter and jelly sandwich and how to plant a flower in a garden.

Experimental Procedures

All participants were tested individually. Participants attended two sessions, each lasting no more than two hours. In the initial session, participants provided consent for study participation, completed the screening measures to ensure they met the study's inclusion criteria, and provided their demographic and medical history information. Next, the participant completed either the cognitive test battery or the discourse tasks; referred to as the cognitive session and discourse session, respectively. Session order was randomized across participants.

For the cognitive session, participants completed the WMS-III, STROOP, and CTMT. Order of test administration was randomized across participants. Each measure's standardized instructions were followed for test administration. For the discourse session, participants completed the 11 discourse tasks described earlier and task order was randomized across participants. All discourse samples were either audio or video recorded. For each discourse type (i.e., stories, eventcasts, recounts, and procedures) a practice task preceded participants' discourse productions of the experimental stimuli.

The examiner read a script for the storytelling task, informing study participants that the books are children's books and they do not include words so that a person can make up their own story. The examiner read the scripted story for *The Great Ape* (Krahn, 1978) to show the participant how to complete the task. The examiner then gave the participant one of the wordless picture books and instructed him/her to look at through the book and when ready tell the story that went with the pictures. Participants were provided an unlimited amount of time to look through the book and they were also allowed to look at the pictures in the book during the storytelling. Order of picture books was randomized across participants.

For the eventcasts, the examiner read a scripted narrative using the Cookie Theft picture from the Boston Diagnostic Aphasia Examination-3 (BDAE-3; Goodglass, Kaplan, & Barresi, 2001). Then, the participant practiced producing an eventcast narrative with the Picnic Scene picture from the *Western Aphasia Battery-Revised* (WAB-R: Kertesz, 2007) serving as the practice stimulus. The examiner then asked the participant to look at the picture and when ready, tell a story that had a beginning, middle, and end. The examiner then gave the participant one of the eventcast stimuli and provided the same instructions. If the participant stopped speaking after providing only 15 seconds of discourse the examiner asked, "Is there anything else you can tell me?" Picture order was randomized across participants.

For the recounts, the examiner modeled the task by providing a recount about a recent trip to San Diego. Following the example, each participant was asked to recall and share three past experiences; what they did last weekend, what they did during their last holiday, and what they did during their last vacation. If the participant stopped speaking after 15 seconds the examiner asked, "Is there anything else you can tell me?" Recount order was randomized across participants.

Finally, for the procedural tasks, the examiner read a scripted procedure about how to make a pot of coffee. Then, the participant responded to the following two prompts, randomized across participants: "tell me how to make a peanut butter and jelly sandwich"; and "tell me how to plant a flower in a garden."

Language Measure: Global Coherence Analysis

Prior to completing the global coherence analysis, all discourse samples were audio or video recorded, then orthographically transcribed and segmented into communication units (c-units). A c-unit is an independent clause with its modifiers (Loban, 1976) and is a common

method for segmenting oral discourse samples (Hughes et al., 1997). As follows is an example of a c-unit:

Pre-c-unit segmented sample—There's a family of mice that live in a house in the forest and one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family.

C-unit segmented

1. There's a family of mice that live in a house in the forest.
2. And one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family (Wright & Capilouto, 2009; p. 1299).

Reliability and Validity of the Global Coherence Measure—To address the study's aims, global coherence was determined for each discourse elicitation task. Global coherence was calculated using a 4-point rating scale whereby each c-unit received a score for global coherence. Wright and colleagues (Wright & Capilouto, 2012; Wright, Fergadiotis, Koutsoftas, & Capilouto, 2010) developed the 4-point scale to measure global coherence ability. Using the 4-point measure and van Leer and Turkstra's (1999) adapted version of Glosser and Deser's (1990) 5-point rating scale, Wright et al. (2010) investigated global coherence ability in stories told by adults with and without aphasia. The group without aphasia performed significantly better on both global coherence scales compared to the aphasia group. Further, the two global coherence scales significantly correlated across stories providing evidence for the 4-point scale's convergent validity. Fergadiotis and Wright (2011) applied three different measures, the 4-point and 5-point scales and latent semantic analysis (LSA), to investigate global coherence ability in stories told by adults with aphasia. LSA is a cognitive computational model of human knowledge acquisition and has been used to quantify discourse coherence in individuals with schizophrenia (Elvevåg, Foltz, Weinberger, & Goldberg, 2007). Performance on the 4-point scale correlated strongly with LSA scores and the 5-point rating scale scores providing further evidence for the scale's convergent validity. Further, performance on the 4-point scale, 5-point scale, and LSA were found to be strong predictors of aphasia severity (R^2= .62, .22, and .35, respectively); thus providing evidence for the construct and postdictive validity of the measures. Finally, in a recent study Wright, Capilouto, and Koutsoftas (in press) evaluated reliability and validity for the 4-point scale. Participants included 50 cognitively healthy adults (28–58 years old) who told stories depicted in two wordless picture books. Convergent validity and measurement reliability were effectively estimated for the 4-point scale.

4-point Global Coherence Scoring Procedures—The mean global coherence score was then computed for each discourse task. The mean score for discourse tasks in the same discourse type were averaged so that there was one mean global discourse score per participant representing five different discourse types: single picture eventcasts, sequential picture eventcasts, stories, recounts, and procedures. For example, a participant's mean scores for *Good Dog Carl* and *Picnic* were averaged and represented a single mean global coherence score for stories.

To ensure good inter-rater and intra-rater reliability for completing the global coherence analysis, scorers followed a multi-step training protocol prior to independently scoring study participants' transcripts. First, the scorer reviewed the discourse task stimuli and the scoring procedures. Second, the scorer reviewed pre-scored transcripts that included explanations for the global coherence scores applied to each c-unit. Lastly, the scorer completed the global coherence analysis on two transcripts and their results were compared to previously scored transcripts for the same discourse samples. The number of agreements and

disagreements were tallied and for any disagreements, the scorer reviewed the explanation provided on the previously scored transcript. Once 100% agreement was achieved with the previously scored transcript, the scorer's training was complete. Scoring procedures and training protocol are available upon request. See Table 2 for scoring criteria for the scale.

Transcription and Measurement Reliability

Inter-rater and intra-rater reliability for word-by-word agreement and c-unit segmenting were determined for 10% of the samples (n = 8) collected from the participants. Agreements and disagreements were subjected to the following formula: (total agreements / [total agreements + total disagreements] X 100). Word-by-word transcription inter-rater agreement was 93.81% and intra-rater agreement was 95.65%. C-unit segmentation inter-rater agreement was 84.34% and intra-rater agreement was 90.94%.

Inter- and intra-rater agreement for global coherence were computed using two methods. First, agreement was calculated initially as point-to-point agreement for global coherence scores assigned to each c-unit. Inter-rater reliability for global coherence ratings was calculated on a random selection of 12 transcripts (15%) where a second research assistant applied the same scoring procedures to the transcripts. Inter-rater reliability was 87.04%. Intra-rater reliability was calculated by having the same rater score a random selection of 10 transcripts (13%), which they previously scored for global coherence and intra-rater reliability was 80.53%. Agreement percentages are comparable to previous studies that have included coherence measures. Glosser and Deser (1992) reported interrater scoring agreement for all measures included in their study as ranging from 78–98%. Rogalski et al's (2010) inter-rater agreement for global coherence was 85.09% and 88.49% for intra-rater agreement for global coherence. Second, Cohen's Kappa (Cohen, 1968) was also computed. Cohen's Kappa is an appropriate method to use to determine agreement between two raters when an ordinal scale is used, such as the 4-point global coherence scale; however, to our knowledge it has not been used in previous studies that have included global coherence rating scales. The inter-rater reliability for the raters was found to be Kappa = 0.36 ($p < .001$, 95% CI (0.312, 0.402) suggesting fair agreement across raters (Landis & Koch, 1977). The intra-rater reliability for the raters was found to be Kappa = 0.40 ($p < .001$), 95% CI (0.371, 0.437) suggesting fair to moderate agreement within raters (Landis & Koch, 1977).

RESULTS

The dependent variables used for analysis were the mean global coherence scores for each of the following five discourse types: (a) single picture eventcasts; (a) sequential picture eventcasts; (c) stories; (d) recounts; and (e) procedures. Means and standard deviations by group for the dependent measures are presented in Table 3. Visual inspection of histograms for each of the dependent measures of interest by group indicated no violation of normality assumptions. Likewise, visual inspection of histograms for each of the cognitive measures of interest by group indicated no violation of normality assumptions. However, because of the ordinal nature of the global coherence scores, non-parametric procedures were used to address the research questions.

Differences by Task

To address the first aim of the study, to identify differences in maintenance of global coherence by discourse type, we conducted a Friedman's two-way analysis of variance (ANOVA) by ranks for related samples. The null hypothesis for this test is that distributions are the same across discourse types and results indicated the test was significant ($p < .001$); therefore, we rejected the null hypothesis. Post-hoc comparisons were conducted using related-samples Wilcoxon Signed Ranks Tests with a Bonferroni correction made for the 10

different comparisons ($\alpha = .05/10 = .005$). Results indicated that recounts yielded significantly lower coherence ratings compared to the other four discourse types with no differences among the remaining discourse types.

Between Group Differences for Global Coherence

The second aim of the study was to identify whether there were significant differences in global coherence between younger and older groups across all the discourse types. Mann-Whitney U tests were used to detect between-group differences for each of the five discourse types. Adjustments for five comparisons were made using a Bonferroni correction ($\alpha = .05/5 = .01$). Results indicated the only significant difference between groups observed was on recounts where the older group received significantly lower global coherence scores ($p < .01$). There were no significant differences between groups on single picture eventcasts ($p = .20$), sequential picture eventcasts ($p = .66$), stories ($p = .17$), or procedures ($p = .07$). See Appendix for an example of scored discourse samples.

Relationships among Cognitive and Coherence Measures

The third aim of the study was to identify relationships between global coherence scores and cognitive measures representing episodic memory, working memory, and selected and sustained attention. We conducted Spearman's rho correlations across all participants and by group (younger, older). Results are provided in Tables 4, 5, and 6. Correlations across all participants help to demonstrate how cognitive abilities are related to global coherence by discourse type. Correlations by group provide insight into how these relationships differ as a function of age.

When collapsing the two groups together, two significant positive correlations were observed; the episodic memory score and global coherence score for stories, $r = .25$, $p = .03$, indicating that as episodic memory scores increased so did the global coherence scores. Also, the STROOP color and word test score and global coherence score for stories, $r = .29$, $p = .01$, indicating that as STROOP scores increased so did the global coherence scores. A significant negative correlation was observed between Trail 5 CTMT raw scores and global coherence scores for recounts, $r = -.25$, $p = .03$, indicating longer times for completing Trail 5 correlated with lower global coherence scores.

Two significant positive correlations were observed among the cognitive measures and global coherence scores across discourse types for the older group. Episodic memory index and the STROOP color-word task significantly correlated with global coherence scores for stories, $r = .38$, $p = .03$ and $r = .34$, $p = .05$, respectively. A significant, negative correlation was observed between the working memory index and global coherence scores for procedures, $r = -.41$, $p = 01$; indicating lower working memory scores correlated with better global coherences scores. For the younger group there were no statistically significant correlations.

DISCUSSION

The overall purpose of the study was to systematically examine the influence of cognitive processes and age on global coherence ability measured across different discourse elicitation tasks that were collected from cognitively healthy adults. Results of the study provide preliminary evidence regarding maintenance of global coherence across age groups and discourse elicitation tasks. Group differences on the global coherence scale were found for only one type of discourse–recounts. The younger group performed significantly better on the measure compared to the older group. Across discourse elicitation tasks and regardless of age, the lowest global coherence scores were found for recounts compared to the other

discourse elicitation tasks (i.e., single picture eventcasts, sequential picture eventcasts, stories, and procedures). The influence of cognitive processes on maintenance of global coherence differed for the two age groups. For the younger group, there were no observed significant relationships between cognitive measures and global coherence scores. For the older group, cognitive measures were related to global coherence of stories and procedures in two ways. For stories, better episodic memory and selective attention abilities related to better maintenance of global coherence; however, for procedures better working memory ability related to lower maintenance of global coherence.

Age-Related Differences for Maintaining Global Coherence

The younger group maintained better global coherence when recounting personal events as compared to the older group. These results support Glosser and Deser's (1992) findings. They also used a rating scale (5-point global coherence scale) and collected recount narratives from two age groups. They compared middle-aged adults (mean age = 51 years) to older adults (mean age = 76 years), whereas, we compared younger adults (mean age = 29 years) to older adults (mean age = 77 years). They suggested that their older group became tangential with greater frequency than the middle-age group, in turn, disrupting discourse organization and maintenance of global coherence. This was also the case in our study as demonstrated by significantly lower coherence scores for recounts in the older group.

Marini and colleagues (2005) investigated maintenance of global coherence in single and sequential picture description discourse samples collected from adults across the lifespan. Two of their age groups match closely to our two age groups. One of their younger groups (25–39) was comparable to our younger group (mean age = 30 v. 29, respectively) and their oldest group (75–84) was comparable to our older group (mean age = 79 v. 77, respectively). However, our results differ from Marini et al. We did not find a difference in maintaining global coherence in narratives collected in response to single and sequential picture stimuli; whereas, they did. There are differences across the studies that may partly account for the conflicting results. Different measures of global coherence were used across the studies and the respective measures were developed and based on different concepts of what global coherence represents. Marini et al. followed Ewing-Cobbs et al.'s (1998) conceptualization of global coherence; which was a measure of the completeness of the story gist. The degree of global coherence maintained was measured by the proportion of main propositions produced divided by the total number of propositions available for a given stimulus. This conceptualization more closely aligns with a main events measure used in previous studies, where younger adults outperformed older adults and produced a significantly greater proportion of main events for both single and sequential pictured stimuli (Capilouto, Wright, & Bush, 2011; Wright, Capilouto, Wagovich, Cranfill, & Davis, 2005). The measure was developed for use with Nicholas and Brookshire's (1993) picture stimuli and allows for comparison of *a priori* main events for each of the stimuli to those offered by participants. A main event captures the extent to which participants understand and express relationships among characters, actions, and ideas depicted in the pictures (Capilouto, Wright, & Wagovich, 2005; Wright, et al., 2005). Similar to Marini et al., we computed a proportion of main events produced for the single stimuli and a proportion for the sequential stimuli. We interpreted these scores to be reflective of the degree to which the speaker 'got' what was going on in each picture; hence, the gist of the events depicted. In contrast, our conceptualization of global coherence more closely aligns with Glosser and Deser's (1992); that is, how well the units of discourse relate to the overall topic. Conceivably, an individual may provide components of a story that maintain the overall topic and receive high scores but not provide the complete story. These results suggest that one's definition of global coherence and the method used for quantifying it can yield conflicting results. Future studies are warranted to explore the relationship among different

macrolinguistic processes (e.g., global coherence and story grammar); and, future studies should investigate the relationship among different global coherence methods, such as, Marini and colleague's (2005) measure.

Maintenance of Global Coherence across Different Discourse Elicitation Tasks

In previous studies, researchers who have investigated maintenance of global coherence have included only a single type of discourse, such as recounts or picture description narratives (e.g., Coelho & Flewellyn, 2003; Glosser & Deser, 1992; Hough & Barrow, 2003; Laine et al., 1998; Marini et al., 2005; Rogalski et al., 2010). Procedural discourse tasks have not been included in previous studies investigating maintenance of global coherence. We extended previous work in this area by examining maintenance of global coherence across different discourse types. In general, across the different discourse elicitation tasks, our study participants maintained global coherence rather well with mean scores close to the maximum score of 4 (i.e., range of mean scores = 3.49 – 3.90). However, the lowest global coherence scores were for the recounts. For this task, participants recounted three different personal events. Though the topics were the same across participants, the narratives that were produced varied because they reflected each individual's own experiences. Because of the nature of the task, narrative structure for the recounts was not as predictable as with the other discourse tasks. The content of the participant's response also was not known. Recounts allowed the participants to direct their own discourse whereas picture stimuli provide a direction (goal) for the purpose of the discourse. For the narratives elicited from pictured stimuli (eventcasts and stories), narrative structure was more predictable because participants' discourse productions were in response to the same stimulus. As a result, when participants recounted personal events, they were more likely to stray from the overall topic. This finding has important methodological implications. The type of discourse elicited needs to be considered when maintenance of global coherence is explored in discourse. Further, caution should be taken when comparing global coherence ability across studies if different discourse elicitation tasks are used.

Cognition and Global Coherence

Previous researchers have suggested that cognitive processes influence maintenance of global coherence (e.g., Marini et al., 2005; van Leer & Turkstra, 1999). In the aging literature, age-related changes in cognitive ability have been implicated as contributing to increases in off-topic speech observed in older adults, which, in turn may affect the speaker's ability to maintain discourse global coherence (Arbuckle & Gold, 1993; McDowd & Shaw, 2000). In the current study, we found no relationships among cognitive processes and maintenance of global coherence for the younger adults and few relationships among cognitive processes and maintenance of global coherence for the older adults. However, as in our previous work investigating discourse processes across the lifespan (Capilouto et al., 2011; Wright, Capilouto, Srinivasan, & Fergadiotis, 2011), we found that the influence of specific cognitive functions on discourse processes is age dependent. Wright et al. (2011) found that episodic memory contributed to the completeness of stories told by older adults but not younger adults. As suggested by Wright and colleagues, the ability to acquire and maintain new information may facilitate better stories produced by older adults; and, in the case of the current study, this is evidenced by maintenance of global coherence.

For maintenance of global coherence in stories told by the older adults, positive relationships with episodic memory and selective attention were observed. This is promising in that prior studies have only speculated as to the influence of cognitive processes and the current study provides empirical evidence for these assertions. Surprisingly, however, was the negative relationship between working memory and maintenance of global coherence for procedures. The procedural discourse tasks represented common procedures that may be

considered less cognitively demanding because of general familiarity with the tasks; however that was not the case. This finding is not entirely clear and leads to more questions about the involvement of cognitive processes on maintenance of global coherence in cognitively healthy adults.

Conclusions

Our findings are informative and extend current research investigating maintenance of global coherence ability in cognitively healthy adults across the adult lifespan. We examined how discourse elicitation task type, age, and cognitive abilities contribute to maintenance of global coherence. Narrative recounts were most sensitive to age-related differences for maintaining global coherence ability when measured with the 4-point global coherence scale. Further, regardless of age the lowest global coherence scores were found on the narrative recounts. Finally, similar to previous work but with different discourse measures (e.g., Wright et al., 2011), the influence of cognitive processes on maintenance of global coherence differed between the two age groups. Future investigations should include additional cognitive and linguistic measures, such as executive functions and pragmatic factors to determine their influence on maintenance of global coherence. Further, both groups performed relatively well on the global coherence measure so there was minimal within-group variability. The discourse elicitation tasks included in the current study were structured tasks. It is possible that maintenance of global coherence for less structured discourse elicitation tasks such as conversation may be more variable, predicted by cognitive ability, and sensitive to age. This warrants further investigation.

We used a rating scale to estimate maintenance of global coherence ability. The 4-point scale has been used in previous investigations (Fergadiotis & Wright, 2011; Koutsoftas, Wright & Capilouto, 2009; Wright & Capilouto, 2012; Wright et al., in press; Wright et al., 2010) and validity of the measure has been estimated with narrative discourse tasks across different populations (aphasia and cognitively healthy adults). Future investigations should further determine validity of the measure using different discourse elicitation tasks and other clinical populations (e.g., dementia, right hemisphere brain disorder, traumatic brain injury, schizophrenia). Rating scales have been extensively used to quantify maintenance of coherence (e.g., Glosser & Deser, 1990, 1992; Reese, Haden, Baker-Ward, Bauer, Fivush, & Ornstein, 2011; Rogalski et al., 2010; van Leer & Turkstra, 1999), however, with few exceptions (i.e., Marini et al., 2011; Wright & Capilouto, 2012) lacking have been studies investigating the linguistic variables that underlie maintenance of global coherence. Building from the results of the current study, future investigations should systematically evaluate linguistic factors that contribute to maintenance of global coherence across different discourse elicitation tasks and age. Finally, applying different methods for estimating global coherence, such as a global coherence error measure (e.g., Marini et al., 2005) or off-topic speech measure (e.g., Arbuckle & Gold, 1993; James et al., 1998) to different discourse elicitation tasks may also provide a more comprehensive picture of coherence ability in discourse produced by cognitively health adults and would provide further evidence for the validity of the measure.

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Appendix A. Discourse Samples with Global Coherence (GC) Scores. Samples include participants recounting their last weekend

Participant 1 **(global coherence score = 1.64)**

GC	C-Unit
4	That was last weekend sure Martin Luther King Holiday weekend.
2	Ah my friend is having a party on Saturday night.
2	So I am probably going to go to that probably.
1	And tonight or today my friend's sister who lives in Tucson.
1	The one that I had was going to have to pickup at the airport.
1	But she is coming later.
1	So I am going to pick her up.
1	We're going to go to another friend's house and hang out.
1	Well that's what I plan to do anyways.
2	Tonight and then we are going to go to that part Saturday night.
2	And she has work on Sunday so I'm going to drive her back up to Tucson Sunday morning.

Participant 2 (global coherence score = 4.0)

GC	C-Unit
4	My last weekend I wrote a paper.
4	I, let's see went to Sam's Club and got a lot of stuff.
4	I hosted a Super Bowl party.
4	And then I got ready for school.
4	Then Monday came along.

Appendix B. Discourse Samples with Global Coherence (GC) Scores. Samples include participants telling the story conveyed in the wordless picture book: Good Dog Carl

Participant 1 **(first 20 c-units out of 35; global coherence score = 4.0)**

GC	C-unit
4	A mother is getting ready to leave to run an errand.
4	And her baby is sleeping there in the crib.
4	Or it looks like he might be a little awake but anyway resting in the crib.
4	And the lady tells the dog to look after the baby.
4	And the lady leaves.
4	And the dog looks to make sure she's left.
4	And the child meanwhile is ready to get out and play.
4	And so the dog comes over to the crib.
4	And the child gets on top of the dog.
4	And they start to run around the house.
4	And they go in the child's parent's bedroom.
4	And they and they play on the bed in there.
4	And the child proceeds to go ahead and start to put some make-up on and dress-up and dresses the dog up a little bit.
4	Meanwhile the child then discovers the laundry chute.
4	And the dog kind of looks over.
4	And the child jumps in the laundry chute.
4	And the dog runs down the stairs keeps running and finds the child at the very bottom of the laundry chute where the child proceeds to then get on top of the dog.
4	And they run some more.
4	And they run all over and knock over a pil a little table with a bunch of papers on it.
4	They come up to a fish aquarium.

Participant 2 (first 20 c-units out of 81; global coherence score = 3.01)

GC	C-unit
4	Now uh this is a story about the uh uh good dog Carl.
1	And it reminds me it's akin to a story about a dog named Rex and my granddaughter stayed with.
1	But Rex only guarded Courtney when she was a little baby.
2	He would just sleep well he would just lie down right at the under the crib and just like this dog Carl.
1	Uh and um if she waked up he would run to the mother and get her
1	And he he was he was really a a big uh police dog.
1	And uh that's that's what he did.
3	Okay now but this dog Carl.
4	He the mother told the dog to behave.
3	And the dog didn't behave.
2	I think that he had plans of what to do.
4	And after the dog saw the mother go he went over near the crib so the baby could get out of the crib.
4	So this baby was pretty agile.

Participant 1 **(first 20 c-units out of 35; global coherence score = 4.0)**

GC	C-unit
4	She could move pretty well out of the crib.
4	And the dog got her on her back.
4	Or the baby assumed the position on her back.
4	And there's where she uh how how she moved around the house.
3	And uh that's an old fashion bed.
3	This this is a old fashion story.
2	They have well they have a bureau.

Table 1

Means (Standard Deviations) for Cognitive Measures by Group (N = 80)

	Younger Group (N = 40)	Older Group (N = 40)
Wechsler Memory Scale – III		
Episodic Memory Index Raw Score*	174.35 (15.11)	145.97 (23.26)
Working Memory Index – Raw Score*	29.23 (5.02)	24.14 (5.53)
Comprehensive Trail Making Test		
Trail 5 – Time in Seconds*	40.54 (13.11)	94.69 (48.24)
STROOP		
Color-Word Task – Raw Score*	50.13 (10.26)	31.83 (12.38)

Note. Wechsler Memory Scale-III (Wechsler, 1997); Comprehensive Trail Making Test (CTMT; Reynolds, 2002); and STROOP Color and Word Test (STROOP; Golden, 2002).

* $p < .01$

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, and Cohen's *d* for Comparing Group Performance on Global Discourse Measures Group (*N* = 80)

	Younger Group (n = 40)		Older Group (n = 40)		
	M	**SD**	**M**	**SD**	**Cohen's *d***
Eventcasts					
Single Picture	3.84	.28	3.83	.22	.04
Sequential Picture	3.83	.32	3.87	.25	.14
Stories	3.90	.15	3.87	.18	.18
Recounts*	3.73	.27	3.40	.42	.65
Procedures	3.88	.17	3.80	.25	.36

Note. Cohen's *d* was calculated by dividing the mean difference by the larger standard deviation.

* $p < .01$

Table 4

Spearman's rho Correlations Between Cognitive and Global Discourse Measures for All Participants (n = 80)

	Cognitive Measures			
	EMI	**WMI**	**CTMT**	**STROOP**
Eventcasts				
Single Picture	.10	−.08	−.08	.11
Sequential Picture	.21	.08	−.09	.14
Stories	.25*	.10	−.22	.29*
Recounts	.16	.10	−.25*	.19
Procedures	.17	−.17	−.15	.12

Note. EMI = Episodic memory index raw score from the Weschler Memory Scale III (Weschler, 1997); WMI = Working memory index raw score from the Weschler Memory Scale III; CTMT = Comprehensive trail making test, trail 5 (Reynolds, 2002); STROOP = STROOP Color and Word Test raw score (STROOP; Golden, 2002).

* $p < .05$

Table 5

Spearman's rho Correlations Between Cognitive and Global Discourse Measures for the Younger Group (*n* = 40)

	Cognitive Measures			
	EMI	**WMI**	**CTMT**	**STROOP**
Eventcasts				
Single Picture	.05	−.19	.03	.02
Sequential Picture	.29	.03	−.15	.25
Stories	.10	.01	−.21	.27
Recounts	.02	−.19	−.04	−.12
Procedures	−.01	−.12	−.06	.12

Note. EMI = Episodic memory index raw score from the Weschler Memory Scale III (Weschler, 1997); WMI = Working memory index raw score from the Weschler Memory Scale III; CTMT = Comprehensive trail making test, trail 5 (Reynolds, 2002); STROOP = STROOP Color and Word Test raw score (STROOP; Golden, 2002).

Table 6

Spearman's rho Correlations Between Cognitive and Global Discourse Measures for the Older Group (n = 40)

	Cognitive Measures			
	EMI	**WMI**	**CTMT**	**STROOP**
Eventcasts				
Single Picture	.08	−.16	−.01	.01
Sequential Picture	.31	.14	−.21	.20
Stories	.38*	.12	−.29	.34*
Recounts	−.13	.07	.03	−.03
Procedures	.13	−.41*	.04	−.14

Note. EMI = Episodic memory index raw score from the Weschler Memory Scale III (Weschler, 1997); WMI = Working memory index raw score from the Weschler Memory Scale III; CTMT = Comprehensive trail making test, trail 5 (Reynolds, 2002); STROOP = STROOP Color and Word Test raw score (STROOP; Golden, 2002).

* $p < .05$