HHS Public Access

Author manuscript

Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. Author manuscript; available in PMC 2017 July 01.

Published in final edited form as:

Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. 2016 July ; 23(4): 445–463. doi: 10.1080/13825585.2015.1118006.

Microlinguistic Processes that Contribute to the Ability to Relay Main Events: Influence of Age

Gilson J. Capilouto*,

Department of Rehabilitation Sciences, University of Kentucky, 900 S. Limestone Street, CTW 124G, Lexington, KY 40536-0200

Heather Harris Wright, and

College of Allied Health Sciences, 3206 F Allied Health Sciences, MS 668, East Carolina University, Greenville, NC 27834, wright@ecu.edu, Phone: 252-744-6088, Fax: 252-744-6109

Katherine McComas Maddy

Department of Rehabilitation Sciences, University of Kentucky, 900 S. Limestone Street, CTW 124G, Lexington, KY 40536-0200, katie.mccomas@uky.edu, Phone: 859-218-0555, Fax: 859-323-8957

Abstract

The purpose of the current study was to determine the microlinguistic processes that contribute to picture description in healthy adults across the life span. Two-hundred forty healthy adults were separated into three groups, young ($n = 80$; 20-39), middle ($n = 80$; 40 - 69), and older ($n = 80$; 70 - 89). Participants provided language samples in response to two single and two sequential pictures analyzed for total number of words, informativeness, lexical diversity, syntactic complexity, and main events. The older group produced a significantly lower proportion of main events for the single and sequential pictures compared to the other groups. Group differences on the microlinguistic measures varied depending on the measure and the stimulus type. Further, regardless of task, total number of words significantly related to main event production for the young and middle aged groups, but not the older group. Results of the current study extend previous findings by researchers who have investigated discourse production in cognitively healthy, older adults. Using a multi-level approach, we found that linguistic processes across different levels interact; however, the relationship is age-dependent. By including a middle-aged group we identify the potential course of documented change and our results indicate that the changes in language processes with age may not be linear.

Keywords

discourse; aging; main ideas; narratives; microlinguistic processes

Picture description is a frequently used method for eliciting narrative discourse in age-related studies of language production (Cannizzaro & Coelho, 2013). Picture description tasks involve describing a visual scene to another person and stimuli include single pictures

*Corresponding Author: gilson.capilouto@uky.edu, Phone: 859-218-0555, Fax: 859-323-8957.

(Cooper, 1990; Mackenzie, 2000; Mackenzie, Brady, Norrie, & Poejianto, 2007; Marini, Boewe, Caltagirone, & Carlomagno, 2005) and/or picture sequences (Capilouto, Wright, & Wagovich, 2005; Duong & Ska, 2001). As a discourse elicitation task, picture description has advantages over spontaneous tasks (e.g., conversation, interview) because it provides an ecologically-valid approach to language sampling (Cooper, 1990), allows for performance comparison within and across groups (Mackenzie et al., 2007), and can serve as a marker of linguistic change over time (de Lira, Oritiz, Campanha, Bertolucci, & Minett, 2011; Ross & Wertz, 1999; Sherratt, 2007). Investigations of narrative discourse ability in the context of picture description have the potential to help us better understand changes in language structure and content that occur across the adult lifespan.

Linguistic processes of discourse have been measured using both within utterance (microstructure) and beyond utterance (macrostructure) approaches. For example, word-by-word analyses provide information regarding informativeness and efficiency (Nicholas & Brookshire, 1993), lexical diversity (Duran, Malvern, Richards, & Chipere, 2004), syntactic complexity (Schneider, Dube, & Hayward, 2005), and words per minute (Prins, Snow, & Wagenaar, 1978). Researchers investigating sentence-level processes have focused on discourse features such as number of episodes and episode length (Coelho, 2002), the ability to describe an episode from beginning to end (Chapman et al., 1992), global narrative coherence (Glosser & Deser, 1992; Marini et al., 2005), and the degree of logical coherence and referential cohesion (Davis & Coelho, 2004).

Investigations of the integration of multiple levels of linguistic knowledge have been informative for improving our understanding of how age effects discourse performance and communication abilities (Glosser & Deser, 1991). Sherratt (2007) applied such an approach to examine the relationships among various linguistic aspects of narrative and procedural discourse in cognitively healthy adults. Results indicated significant correlations among discourse measures. For example, the between utterance analyses of topic relevance significantly correlated with within utterance analyses of syntactic complexity (Sherratt, 2007). Sherratt concluded that interactions exist across the micro- and macrostructural levels of discourse, and that certain aspects of discourse, which are simpler and easier to measure (e.g., syntactic complexity, discourse length), can be evaluated for the role they play in the maintenance of more conceptual processes of discourse. Similar approaches have also been employed to examine and compare the narrative discourse abilities of persons with acquired neurological conditions to healthy controls. For example, Marini, Andreeta, del Tin, and Carlomagno (2011) reported that persons with traumatic brain injury demonstrated impaired maintenance of the macrostructural process of global coherence, despite the preserved microstructural processes syntax and lexical diversity. They concluded that such approaches to the analysis of discourse may be more sensitive to changes in linguistic processes compared to standardized test batteries; making such an approach particularly useful for identifying linguistic changes.

In the current study we were interested in investigating how the within utterance processes of informativeness, syntactic complexity, and lexical diversity contribute to an individual's ability to communicate the relations and causal links depicted in a pictorial scene (van Dijk & Kintsch, 1983). Researchers have used different terminology to refer to the ability to relay

relevant and relational information when describing a pictured scene; such as, ‘completeness of concepts’ (Mackenzie et al., 2007; Nicholas & Brookshire, 1995); ‘information imparted’ (Cooper, 1990); ‘main ideas’ (Duong & Ska, 2001); ‘story completeness’ (Le, Coelho, Mozeiko, Krueger, & Grafman, 2012); ‘faithful content’ (Juncos-Rabadan, Pereiro, & Rodriguez, 2005); and, ‘main events’ (Capilouto et al., 2005; Wright, Capilouto, Wagovich, Cranfill, & Davis, 2005), among others. Age-related studies investigating the ability to relay main ideas from picture descriptions have yielded equivocal results.

Cooper (1990) found no effect of age on the number of relevant observations imparted in response to single pictures for adults 20 to 78 years old. Similarly, Mackenzie (2000) found no significant difference in the number of interpretive units relayed (i.e. content related to interpretation of characters and events), in response to a single picture, between middle-aged, young elderly, and older elderly (i.e., 44-88 years). However, an age-related trend toward a decrease in number of interpretive units was noted. Capilouto, Wright, and Wagovich (2005) compared healthy younger (20-24) and older (63-79) adults’ ability to relay main events in single and sequential pictures. Their results provided further support for the findings of Mackenzie (2000) and Cooper (1990); they reported no significant difference in the proportion of main events relayed between the two groups. Similar to the findings of Mackenzie (2000), Capilouto et al., (2005) reported a trend in the data of an age-related decrease in proportion of main events between younger and older, regardless of stimulus.

In contrast, Duong and Ska (2001) analyzed language samples elicited from both single and sequential pictures for percent of main ideas conveyed. They found young elderly participants (65-74) produced a significantly higher percentage of main ideas as compared to older participants (75-84). Marini, Boewe, Caltagirone, and Carlomango (2005) reported similar findings using both single picture and sequential picture descriptions. They reported middle-aged (40-59) and young elderly (60-74) participants provided a higher ratio of details and main themes than the younger (20-24; 25-39) and oldest (75-84) groups. However, these findings were for the single picture description only. Finally, Wright, Capilouto, Wagovich, Cranfill, and Davis (2005) found younger participants (mean age = 23.9) produced a significantly greater proportion of main events compared to older participants (mean age = 67.6) in response to sequential pictures; no differences between groups was reported in response to a single picture.

Researchers investigating the impact of aging on within utterance processes such as informativeness, syntactic complexity and lexical diversity have also reported mixed results. Investigations of informativeness aim to quantify the degree of information imparted in an utterance. Measures of informativeness distinguish ‘words’ from ‘information’ as the former just needs to be intelligible, and the latter must also be relevant, accurate, and informative to the stimulus. Saling and colleagues (2012) reported that elderly adults produced significantly less information content as compared to young adults in a narrative elicited from a sequential picture (Saling, Laroo, & Saling, 2012). Similarly, Juncos-Rabadan and colleagues (2005) found the narrative samples of older participants had significantly less informational content compared to younger participants in language samples elicited from a cartoon strip story (Juncos-Rabadan et al., 2005). With respect to syntactic complexity, the general consensus in the literature confirms an age-related decline (Kemper, 1987; Marini et

al., 2005; Shadden, 1997), though it appears this decline may be task dependent (Marini et al., 2005). Conversely, previous research examining lexical diversity across the lifespan indicates that lexical diversity, although also task dependent remains fairly resistant to age-related changes (Fergadiotis, Wright, & Capilouto, 2011).

Taken together, these results demonstrate that the relative vulnerability of micro- and macrostructural processes to the effects of age remains unclear. Understanding the linguistic variables that contribute to the ability to relay main events has the potential to contribute to our knowledge of changes in language structure and content that occurs across the adult lifespan. The purpose of the current study was to determine the microstructural processes that contribute to relaying main events in healthy adults across the life span. The specific aim was to understand the relationship between the within utterance processes informativeness, lexical diversity, and syntactic complexity and the between sentence process of relaying main events as a function of age and stimulus task type. The within utterance measures included total number of words, percent information units, the lexical diversity measure D , and a syntactic complexity index. The between sentence measure for relaying main events included the main event measure described by Capilouto et al. (2005). We hypothesized that percent information units and lexical diversity would be significantly related to the proportion of main events but syntactic complexity would not, regardless of age or task. Our hypothesis is based on previous work with impaired populations (Wright & Capilouto, 2012) that relaying a 'main idea' is more closely linked to one's productive vocabulary (lexical diversity) for informing a message (percent information units) and less related to the level of syntactic complexity of the message.

Method

Participants

Participants were recruited following approval from the Institutional Review Boards of the universities where the work was carried out. Data used in the present study were taken from a larger study investigating discourse processing in healthy adults across the lifespan. Data from 240 participants were randomly selected. Participants were separated into three cohorts, young group ($n = 80$), middle group ($n = 80$), and older group ($n = 80$). The distribution of males and females was the same across groups with 45 females and 35 males per group. Participants met the following inclusion criteria set by the larger study which included: (1) hearing within functional limits as measured by the CID List of Everyday Speech; (2) Native English speakers as documented by self-report; (3) negative history for cognitively deteriorating conditions such as Alzheimer's or Parkinson's per self-report as well as measured by a scaled score of 30 or above on the *Mini-Mental Status Examination* (MMSE; Folstein & Folstein, 2001); (4) aided or unaided visual acuity within normal limits, as indicated by passing a vision screening; (5) no depression at the time of the experiment as measured by a score of 0-6 on the Geriatric Depression Scale-Short Version (GDS; Van-Marwijk, Wallace, de-Bock, Hermans, Kaptein, & Mulder, 1995); and (6) no previous neurological condition (i.e., stroke, head injury). The scaled score from the MMSE adjusts the raw score by considering age and years of education completed. Data reported for participants include the MMSE scaled score. Table 1 provides means, standard deviations

and ranges (minimum and maximal values) for demographic variables of interest including age, years of education, MMSE scores and GDS.

Assessments and Measures

Picture description task—Participants provided a language sample in response to two single pictures and two picture sequences from Nicholas and Brookshire (1993); referred to as Cat in the Tree, Birthday, Argument, and Directions, respectively. In the single picture ‘Cat in the Tree’ a dog has chased a little girl’s cat up a tree and her father tried to help but also gets stuck requiring rescue from the fire department. In the single picture ‘Birthday’ a five-year old boy is crying, because the family dog has destroyed his birthday cake as guests are arriving. The ‘Argument’ is a six-frame picture sequence, displayed on a single page, depicting a husband and wife arguing to the extent she leaves, wrecks the car and returns. ‘Directions’ is also a six-framed picture sequence displayed on a single page. The sequence shows a couple out for a drive in their convertible when they stop and ask a farmer for directions. The directions are less than adequate as the couple returns to the exact same spot.

All picture descriptions were audio or video recorded and transcribed orthographically by trained research assistants. Following orthographic transcription, transcripts were segmented into C-units. A C-unit is a communication unit and includes an independent clause and its modifiers, and is commonly used to segment oral discourse samples. 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 decided 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.

Linguistic Measures—To ensure good inter- and intra-rater reliability for linguistic analyses, scorers followed a multi-step training protocol. In the training protocol, the scorers reviewed all discourse scoring procedures. Next, the scorers reviewed two transcripts that had been marked up indicating scores for all analyses. For each score, an explanation was provided indicating why the utterance received the assigned score. For the final step, the scorers completed the analyses on two transcripts. They compared their results to previously scored transcripts for the same discourse samples. Scorers tallied the number of agreements and disagreements. For any disagreements, the scorers referred to the explanation provided on the previously scored transcript. Once the scorers were in 100% agreement with the previously scored transcripts, training was considered complete.

Total Number of Words: Total number of words (TNW) refers to the total words produced for the sample. These include all words; those that are accurate and relevant to the stimulus and also words that are intelligible but not necessarily accurate and relevant to the

stimulus. Unintelligible words, fillers, partial words, and commentary on the task were not included in the total number of words count.

Percent information units: An information unit was defined as a word that was intelligible, relevant, accurate, and informative to the stimulus. To be counted as words, the words had to be intelligible but not necessarily relevant, accurate or informative to the stimulus. To calculate the percent information units (%IU), the following formula was used: total number of information units / total number of words (excluding unintelligible words, fillers, partial words, and commentary on the task). To determine what constituted an information unit, rules were adapted from a number of sources (Dijkstra, Bourgeois, Allen, & Burgio, 2004; Nicholas & Brookshire, 1993; Shadden, 1997; Tomoeda, Bayles, Trosset, Azuma, & McGeagh, 1996).

Lexical Diversity: Lexical diversity (*D*) refers to a person's range of vocabulary (Duran et al., 2004; Fergadiotis & Wright, 2011 ; Fergadiotis, Wright, & Capilouto, 2011). Nonwords, hesitations, revisions, repetitions and onomatopoeia were coded via transcription codes in Computerised Language Analysis (CLAN; MacWhinney, 2000) and were excluded from subsequent analysis. For the current study, *D* was estimated using the voc-*D* program in CLAN providing a measure of vocabulary diversity robust to variations in sample length (McKee, Malvern, & Richards, 2000). *D* has been shown to be a valid measure (McCarthy & Jarvis, 2010; McKee et al., 2000).

Syntactic Complexity: To measure syntactic complexity of language samples, a complexity index (CI) was calculated. The index was developed by Wright and Capilouto (Wright & Capilouto, 2012) and modeled after the work of Schneider, Dube, and Hayward (Schneider et al., 2005). The purpose of the CI was to quantify the relative complexity of an individual's discourse sample by examining it for clausal structure and embedding. The CI was calculated using the following formula: (independent clauses + dependent clauses) / total independent clauses.

Main Events: The main event (ME) measure has been described in detail elsewhere, and therefore only a brief review is provided here (for more information, see Capilouto et al., 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 and the measure has been shown to be valid and reliable (Wright et al., 2005). The main event measure extends beyond what is captured in calculation of %IU as it focuses on the ability to verbalize relationship(s) between characters and events. For example, when viewing the 'Cat in the tree' picture described above, an individual could simply provide heaps of information: "I see a man sitting in a tree. And there is a cat in the tree. And there is the fire department". These comments result in an acceptable %IU score, yet relationships among the characters, actions, and ideas are not conveyed, nor is a temporal line provided as in the following: "The little girl's cat climbed the tree and it got stuck. The father tried to get it and

his ladder fell so he is stuck too". The main event measure quantifies this level of linguistic knowledge.

Each picture stimulus had a different number of main events. The total number of MEs an individual could produce for the single pictures was nine (Cat in Tree: 4 + Birthday Cake: 5 = 9). The total number of MEs an individual could produce for the sequential pictures was 15 (Fight: 7 + Directions: 8 = 15). We computed proportion of ME produced for each and subjected these numbers to statistical analysis. For example, the formula used with the single picture stimuli was as follows: number of ME produced for the Birthday Cake and Cat in Tree pictures/9. This permitted comparison across the different stimulus types without biasing the results based on raw numbers. Our previous research indicated no significant difference in the proportion of ME relayed within each stimulus type (Capilouto et al., 2005; Wright et al., 2005). Therefore, for analyses, the proportion of ME for both single stimuli and both sequential stimuli were combined. These are referred to as the 'single stimuli' and the 'sequential stimuli', respectively. Main events for one single and one sequential picture can be found in Appendix A.

Procedure

Participants were tested individually in a laboratory setting. Testing lasted no more than two hours. Participants gave consent, were screened to determine eligibility to complete the study, and provided medical and demographic data. The data reported here were part of a larger study investigating discourse processing across the lifespan and included a series of cognitive measures as well as eleven discourse tasks, all randomized across participants. Only results of the picture description tasks are reported here. All discourse samples were either audio recorded or video recorded.

The picture description task was demonstrated using the Cookie Theft picture from the Boston Diagnostic Aphasia Exam (BDAE; Goodglass, Kaplan, & Barresi, 2001). The examiner read from a script so data collection was uniform across participants. Once the examiner finished, the participant practiced the task using the Picnic Scene from the Western Aphasia Battery (WAB; Kertesz, 1982) after receiving the following scripted directions: "Now it is your turn. Take a minute to look at this picture. When you are ready, tell me a story with a beginning, a middle, and an end." If the participant stopped after 15 seconds the examiner prompted by asking, "Is there anything else you can tell me?" After the practice, directions and prompts used for demonstration and practice were once again provided for the experimental stimuli. No time limits were imposed and each picture remained visible throughout the telling. Order of presentation of the pictures was randomized and counterbalanced. Trained research assistants served as examiners and obtained the language samples. Though different examiners collected the language samples from participants across the cohorts, they followed the same script for elicitation.

Reliability measures—Inter and intra-rater agreement for word-by-word transcription, C-unit segmentation, and linguistic analyses were determined for 10% of samples, randomly chosen. Agreements and disagreements were subjected to the following formula: (total

agreements / [total agreements + total disagreements] $\times$ 100). Both inter- and intra-rater reliability for all variables of interest were above 90%.

Results

Preliminary Analyses

SPSS (v.21) was used for all statistical tests. Preliminary analyses were conducted to ensure that none of the demographic variables of interest contributed to the study results. Results indicated no significant difference in years of education $F(2, 237) = 2.55, p = .080$ or depression scale scores $F(2, 237) = 1.85, p = .159$ between cohorts and so these variables were not considered in subsequent analyses. A significant difference in MMSE scaled scores between the three cohorts was found $F(2, 237) = 14.26, p < .000$. However, because all participants met the MMSE score for inclusion in the study, this variable was not considered a covariate in subsequent analyses. See Table 2 for means, standard deviations and ranges for all measures of interest, by stimulus, for each group.

Shapiro-Wilk normality tests indicated that data for all of the outcome variables of interest were not normally distributed. Box-Cox analyses suggested that the simple inversion was a reasonable transformation for each of the outcome variables. Each variable was transformed using the inverse of the variable (e.g., $\text{invSCcat} = 1/\text{SCcat}$). The transformed variables were used for all remaining analyses.

Main Event Production—To compare the proportion of MEs relayed, a mixed analyses of variance (ANOVA) with group as the between group factor and stimulus type as the within group factor was performed. The stimulus type main effect and stimulus by group interaction were not significant; however the group main effect was statistically significant, $F(2, 236) = 10.95, p < .000$. Planned comparisons using the Bonferroni correction indicated that the mean proportion of ME for the older group was significantly lower than the mean proportion of ME for the young group and middle group. There was no significant difference in the proportion of MEs relayed between the young group and middle group.

Microlinguistic Measures—A series of mixed ANOVAs were conducted to compare relative performance of microstructural variables of interest across cohorts (between group factor) and stimulus type (within group factor). All planned comparisons used the Bonferroni correction. For TNW, the stimulus type and group main effects were not significant; however, the stimulus type by group interaction was statistically significant, $F(2, 237) = 35.17, p < .000, \eta_p^2 = .229$. Simple comparisons indicated that the young group produced significantly greater TNW for the sequential picture stimuli compared to the single picture stimuli; whereas the middle and older groups did not differ significantly for TNW produced for the stimuli types. For %IU, the stimulus type main effect and stimulus type by interaction were not significant; however the group main effect was statistically significant, $F(2, 236) = 14.22, p < .000, \eta_p^2 = .108$. Planned comparisons indicated that the young group and middle group produced significantly better %IU compared to the older group; no difference was found between the young and middle group. For *D*, the stimulus type main effect was not significant. The group main effect and stimulus type by group interaction were statistically significant, $F(2, 237) = 5.64, p = .004, \eta_p^2 = .045$ and $F(2, 237) = 5.24, p$

= .006, $\eta_p^2 = .045$, respectively. Planned comparisons indicated that the young group and middle group produced significantly more diverse vocabulary compared to the older group; no difference was found between the young and middle group. Simple comparisons indicated that the young and middle group produced more diverse vocabulary in response to the single picture stimuli compared to the older group and the groups did not differ for sequential picture stimuli. For, CI, only the group main effect was statistically significant, $F(2, 237) = 16.20, p < .000, \eta_p^2 = .120$. Planned comparisons indicated that the young group and middle group produced significantly more syntactically complex utterances compared to the older group; no difference was found between the young and middle group.

Microstructural Contributions to ME Relayed

To investigate the relationship between microstructural measures on the proportion of ME relayed, Pearson correlation coefficients were computed for our variables of interest for both stimuli, within cohorts (see Tables 3-5). Cohen's (1988) conventions were used to interpret the effect size of the correlations (Cohen, 1988).

Young group—For the young group, regardless of stimulus, total number of words significantly correlated with the proportion of main events relayed, $r = .421, p = .000$, **a moderate to large effect size**; $r = .279, p = .012$, **a small to moderate effect size**, single and sequential respectively. Similarly, for both single and sequential stimuli, lexical diversity significantly correlated with proportion of main events relayed, $r = -.265, p = .018$, **a small to moderate effect size**; $r = -.236, p = .035$, **a small to moderate effect size**, respectively. As proportion of main events increased, lexical diversity decreased.

Middle group—For the middle group, regardless of stimulus, total number of words significantly correlated with the proportion of main events relayed, $r = .261, p = .019$, **a small to moderate effect size**; $r = .387, p = .000$, **a moderate effect size**, single and sequential respectively. No other significant correlations with proportion of ME relayed were found.

Older group—For the older group, regardless of stimulus, none of the within utterance measures significantly correlated with the proportion of ME relayed.

Discussion

The purpose of the present study was to investigate the relative contribution of microstructural processes to relaying main events in young, middle and older aged adults when describing single and sequential picture stimuli. Our specific interest was in the relationship between informativeness, lexical diversity, and syntactic complexity and main event production, as a function of age and task. In general, we found that the older group produced a significantly lower proportion of main events for both the single and sequential picture stimuli compared to the young and middle age groups. We found further that regardless of task, the within utterance measure total number of words was significantly related to main event production for the young and middle aged groups, but not the older group. Lastly, none of the microstructural processes included for study was significantly related to the ability to relay main events in our older group. As follows is a discussion of

the results and potential implications for our understanding of narrative production performance in healthy aging; specifically production performance as measured by picture description tasks.

Main Event Production

The method employed for evaluating an individual's ability to communicate the relations and causal links depicted in a picture stimulus was proportion of main events conveyed. As conceptualized, main events are similar to other measures used in the literature; such as, main concepts (Nicholas & Brookshire, 1995), main ideas (Duong & Ska, 2001), and story completeness (Le et al., 2012). Our finding that the older group relayed a significantly lower proportion of ME compared to the middle and young groups, extends and supports our previous work (Wright et al., 2005), as well as the work of others (Duong & Ska, 2001; Marini et al., 2005). Duong and Ska (2001) and Marini et al. (2005) found that older adults (75-84) produced significantly fewer main ideas compared to younger adults (40-74) for single pictures. For sequential picture stimuli, Duong and Ska (2001), Marini et al. (2005), and Wright et al. (2005) all found fewer main ideas/events conveyed by older adults compared to younger age group participants. Marini et al. (2005) hypothesized that a weakened working memory capacity in the older adults contributed to the decline. However, no measure of working memory was included in their study to confirm this hypothesis. For that study, and the current study, participants had visual access to the stimuli throughout the collection of the language samples; and, no time constraints were imposed. Both of these factors limited the degree to which participants were required to hold information in storage while producing the narrative; consequently, reducing demands. This may suggest that the single pictures required participants to acquire and maintain new information to an extent not required by the sequential stimuli and not differentially dependent on age. Though both single and sequential picture stimuli were unfamiliar to the participants, the single pictures may have increased the amount of information that had to be accessed and retained, since the scaffold of the frames was absent. A working memory measure would be important to include in future studies to further investigate this hypothesis.

It is important to note that despite the statistically significant difference in ME production between our older versus young and middle cohorts, the older group was still performing quite well with regard to this ability. Overall, we found an age-related, declining trend in the ability to relay main events for both single and sequential picture stimuli. However, the proportion of main events relayed was comparable for the young and middle groups suggesting that the processes contributing to a decline in main event production observed in our population occurs at some point after the seventh decade (i.e., 60s).

Microstructural Measures

We found a number of interesting differences across age cohorts and stimulus types for our microstructural variables of interest. Notable were the results relative to our total number of words measure. TNW was included as a measure since sample length has been shown to be influenced by age and/or stimulus type (Fergadiotis, Wright, & Green, 2015; Wright, Capilouto, Srinivasan, & Fergadiotis, 2011; Wright, Silverman, & Newhoff, 2003) and can potentially confound results. Interestingly, the young adults in this study used significantly

greater mean total number of words to relay the relationships and causal links depicted in the sequential picture as compared to the other groups. Kober, Schmiedek, and Habermas (2015) reported that the ability to convey thematically coherent discourse continues to develop and improve in young adult years up to 40 years of age. The increase in words produced may be a strategy employed as part of the development process to convey a complete discourse. Alternatively, it is possible that the temporal ordering of events 'built in' to a sequential frame of pictures provided speakers greater license to embellish and the young group took greater advantage of that opportunity. At the same time, the older groups' narratives were significantly less informative compared to the young and middle groups, regardless of stimulus. It has been suggested that as we age, changes in executive function occur that may contribute to older adults reduced efficiency in producing narratives (James, Burke, Austin, & Hulme, 1998; Kemper & Sumner, 2001; Wright et al., 2011). Further, the incidence of off-topic speech (OTS) significantly increases with age (Arbuckle & Gold, 1993; Arbuckle, Nohara-LeClair, & Pushkar, 2000; Beaudreau, Storandt, & Strube, 2006; Cooper, 1990; Glosser & Deser, 1992; Gold, Andres, Arbuckle, & Zieren, 1993; James, Burke, Austin, & Hulme, 1998; Juncos-Rabadan, Pereiro, & Rodriguez, 2005; Pushkar et al. 2000; Trunk & Abrams, 2009) and the less informative output may reflect an increase in OTS. Changes in executive functions during healthy aging are believed to influence the incidence of OTS observed in language samples of healthy older adults (Arbuckle & Gold, 1993; Arbuckle et al. 2000). Future investigations should consider impact of OTS on informativeness of discourse produced by older participants.

When describing picture stimuli, lexical diversity varied as a function of age and stimulus type. The young and middle age participants produced more diverse vocabulary than older participants, but for the single picture stimuli only. Fergadiotis and colleagues (2011) found that lexical diversity using D varied as a function of discourse type and age, but favored older adults. Interestingly, Fergadiotis et al. did not find age-related differences for the stimulus similar to that used in the current study. D was selected as the measure of lexical diversity as it has been previously shown to be less sensitive to sample length as compared to earlier measures of lexical diversity such as type token ratio (Malvern & Richards, 1997; McKee, Malvern, & Richards, 2000; Owen & Leonard, 2000; Silverman & Ratner, 2003; Wright et al., 2003). However, recent work by Fergadiotis, Wright and Green (2015) suggest that D may be influenced by method factors such as length or number of themes introduced by the speaker. Possibly, then with the younger and middle-aged groups producing greater proportion of main events, subsequently themes, compared to the older groups, this may have influenced the results with the lexical diversity measure. Further, regardless of age group the sequential picture stimuli resulted in greater mean lexical diversity as compared to the single stimuli. This result could be explained by Fergadiotis and colleagues' (2015) findings as well. The sample lengths for all groups were longer for the sequential picture stimuli and greater proportion of main events produced for sequential picture stimuli were also greater compared to the single picture stimuli.

We found a linear, age related decline in mean syntactic complexity with the older group producing significantly less complex utterances as compared to the young and middle groups. The observed age-related decline was irrespective of stimulus. Our findings are similar to those reported by Nippold and colleagues (2014) who found that syntactic

measures in spoken discourse remain stable for adults in their 20s, 40s and 60s (Nippold, Cramond, & Hayward-Mayhew, 2014). Similar to Kemper et al., (2001) and Marini et al., (2005), we found a statistically significant drop in utterance complexity beginning with the seventh decade. Age-related changes in memory and executive functions have been suggested and as contributing factors to changes in syntactic complexity but warrant further investigation.

Microstructural Contributions to Main Event Production

Based on previous work with impaired populations, we hypothesized that informativeness and lexical diversity would be significantly correlated with the proportion of main events relayed for both tasks. Both total number of words and lexical diversity were significantly related to main event production for the young group and total number of words alone was significantly related to main event production for the middle group; no significant correlations of interest among the measures were found for the older group.

The microstructural measures of lexical diversity and total number of words impacted the proportion of main events relayed for the young group, regardless of stimulus. Lexical diversity is operationalized as a measure of vocabulary knowledge and proficiency (Jarvis, 2013); both of which have been shown to increase with age as a result of experience and world knowledge (Hulit, Howard, & Fahey, 2011). There are two possible explanations for the disparate finding. The different patterns of results found for lexical diversity and proportion of main events may have been driven by the stimuli, rather than by age. Alternatively, as has been reported by Jarvis (2013), studies by researchers Dillard and Pfau suggest that listener perception of speaker credibility and competence is affected by lexical diversity. The young participants in the study were close in age to the graduate assistants collecting language samples, and the motivation for high likability might have differentially impacted the results for this group.

Regardless of stimulus, total number of words was the only microstructural measure significantly related to main event production for the middle age group, which did not support our hypothesis. This finding suggests that by simply speaking longer, middle age adults were likely to relay a greater proportion of main events. This finding is difficult to interpret and suggests the possibility that the longer samples might be indicative of higher levels of commentary or tangential conversation. However, the comparable levels of informativeness between the middle group and the young and older groups, suggest this is not the case, as informativeness does not give credit to words unrelated to the stimulus

We found no support for our hypothesis with respect to the older group as none of our microstructural measures directly related to main event production. The older group had the lowest mean score for the proportion of main events relayed (macrostructural) and for all of the microstructural variables sampled here. It is possible that age-related difficulties with these microstructural processes affected the macrostructural discourse dimension of their discourse. Andreetta and Marini (2015) assessed micro- and macrostructural aspects of discourse in adults with fluent aphasia and age-matched controls. They reported reduced levels of cohesion and coherence were associated with poor sentence formation and reduced levels of informativeness, respectively (Andreetta & Marini, 2015). Alternatively, other

factors, such as psychosocial factors not measured here may have contributed to the ability to relay the temporal and causal relationships depicted in picture stimuli for older adults. A number of studies have provided evidence for the influence of psychosocial factors on communication in general and narrative discourse in particular. Researchers suggest these factors may account for the individual differences observed in cognitive aging (Pushkar et al., 1999) as well as narrative performance (Arbuckle, Nohara-LeClair, & Pushkar, 2000; Pushkar et al., 2000).

Conclusions and Limitations

Results of the current study extend previous findings by researchers who have investigated discourse production in cognitively healthy, older adults. Using a multi-level approach, we found that linguistic processes across different levels interact; however, the relationship is age-dependent and also stimulus-dependent. Further, our results are consistent with previous researchers' work in demonstrating that language processes at the discourse level change with age. Interestingly, we included a middle-aged group to provide initial evaluation of the trajectory of documented change and our results indicate that the noted decline in language processes with age may not be linear. Additionally, it appears that the middle-aged group has optimal language use on the measures included and relative to the younger and older groups. Furthermore, the impressive number of study participants as compared to previous studies, strengthens the integrity of the findings.

These results are informative and promising, but there are limitations that should be addressed in future work. To investigate changes in discourse production across the adult lifespan, a cross-sectional study design was used. This allowed for comparison of age groups that spanned over 60 years. However, as adults age, life experiences, health, and other issues can lead to increased heterogeneity within groups of similar age. Future investigations should consider employing a longitudinal study design to capture changes in discourse production. Our participants were highly educated averaging 15 and 16 years of education. Consequently, it is not clear how these results might have been influenced by education. Meijer, van Boxtel, Van Gerven, van Hooren, and Jolles (2009) have found that high education lessens age-related cognitive decline, which should be considered in future studies. Lastly, though there is not complete agreement on the stages of discourse processing fundamental to successful discourse production, there is general consensus that, with age, discourse production may rely increasingly on cognitive resources and so future studies should consider cognitive processes and their influence on micro- and macrostructural processes over the lifespan (Frederiksen, Bracewell, Breuleux, & Renaud, 1990; Indefrey & Levelt, 2000, 2004; Levelt, Roelofs, & Meyer, 1999).

Acknowledgements

This research was supported by the National Institute on Aging Grant R01AG029476. We are especially grateful to the study participants and to the undergraduate and graduate students in our respective labs for their assistance with transcription and language analyses.

APPENDIX A. Main events for the picture stimuli

Cat in the Tree

1. The dog chased the cat up the tree/cat ran up tree to get away from the dog.
2. The girl is trying to coax the cat into jumping from the tree/into getting down from the tree.
3. The man (father) tried to get (rescue) the cat, but his ladder fell, and now he's stuck (too).
4. The firemen (firefighters) arrive to rescue the man and the cat.

The Birthday Cake

1. It is the boy's birthday (birthday party).
2. The boy is crying because the dog ate (some of) his cake.
3. The dog is hiding under the sofa/couch.
4. The mother is mad at the dog/is scolding the dog (with a broom).
5. The guests are arriving.

The Fight

1. The husband (man) and wife (woman) are yelling at each other/get into a huge fight.
2. She packs a bag (suitcase) and leaves the husband/heads for the door.
3. The husband (man) is sad/upset/distraught.
4. The wife (woman) comes back in the house/opens the front door/peeks in the door.
5. She (wife/woman) is crying.
6. The husband (man) hugs his wife (woman).
7. She explains that/He looks out the door and sees that/She is crying because... she drove the car into a tree/wrecked the car.

The Farmer and His Directions

1. A man and a woman are driving/traveling and see/greet/say hello to a farmer on the side of the road.
2. The farmer is planting a tree.
3. The couple/the man ask(s) for directions.
4. The farmer directs them/gives them directions/tells them which way to go.
5. (The farmer watches as...) the man and woman take off/they continue on their way.
6. The farmer goes back to work digging the hole/planting the tree.
7. A little while (a few minutes) later, the couple sees the farmer (stops in front of the farmer) on the side of the road again.

8. They are angry with the farmer because he misdirected them /gave them bad directions/did not give them good directions.

Note: The numbered statements are the main events. The essential information for each main event is underlined. Information in parentheses represents alternative ways a component of the main event could be stated. [/] represent alternative information that could have been stated to complete the main event.

References

- Andreetta S, Marini A. The effect of lexical deficits on narrative disturbances in fluent aphasia. *Aphasiology*. 2015; 29(6):705–723.
- Arbuckle TY, Nohara-LeClair M, Pushkar D. Effect of off-target verbosity on communication efficiency in a referential communication task. *Psychology and Aging*. 2000; 15(1):65–77. [PubMed: 10755290]
- Cannizzaro MS, Coelho CA. Analysis of narrative discourse structure as an ecologically relevant measure of executive function in adults. *Journal of Psycholinguistic Research*. 2013; 42(6):527–549. [PubMed: 23192423]
- Capilouto GJ, Wright HH, Wagovich SA. CIU and main event analyses of the structured discourse of older and younger adults. *Journal of communication disorders*. 2005; 38(6):431–444. doi: 10.1016/j.jcomdis.2005.03.005. [PubMed: 16199238]
- Chapman SB, Culhane KA, Levin HS, Harward H, Mendelsohn D, Ewing-Cobbs L, Bruce D. Narrative discourse after closed head injury in children and adolescents. *Brain and language*. 1992; 43(1):42–65. [PubMed: 1643511]
- Coelho CA. Story narratives of adults with closed head injury and non-brain-injured adults: influence of socioeconomic status, elicitation task, and executive functioning. *Journal of Speech, Language, and Hearing Research*. 2002; 45(6):1232–1248.
- Cohen, J. Statistical power analysis for the behavioral sciences (2nd Ed.). Lawrence Earlbaum Associates; Hillsdale, NJ: 1988.
- Cooper PV. Discourse production and normal aging: performance on oral picture description tasks. *Journal of gerontology*. 1990; 45(5):P210–214. [PubMed: 2394918]
- Davis GA, Coelho CA. Referential cohesion and logical coherence of narration after closed head injury. *Brain and language*. 2004; 89(3):508–523. doi: 10.1016/j.bandl.2004.01.003. [PubMed: 15120542]
- de Lira J, Ortiz K, Campanha A, Bertolucci P, Minett T. Microlinguistic aspects of the oral narrative in patients with Alzheimer's disease. *International Psychogeriatrics*. 2011; 23(3):404–412. [PubMed: 20699046]
- Dijkstra K, Bourgeois MS, Allen RS, Burgio LD. Conversational coherence: Discourse analysis of older adults with and without dementia. *Journal of Neurolinguistics*. 2004; 17:263–283.
- Duong A, Ska B. Production of narratives: picture sequence facilitates organizational but not conceptual processing in less educated subjects. *Brain and cognition*. 2001; 46(1-2):121–124. [PubMed: 11527309]
- Duran P, Malvern D, Richards B, Chipere N. Developmental trends in lexical diversity. *Applied Linguistics*. 2004; 25(2):220–242.
- Fergadiotis G, Wright HH. Lexical diversity for adults with and without aphasia across discourse elicitation tasks. *Aphasiology*. 2011; 25:1414–1430. [PubMed: 23125474]
- Fergadiotis G, Wright HH, Capilouto GJ. Productive vocabulary across discourse types. *Aphasiology*. 2011; 25:1261–1278. [PubMed: 22904592]
- Fergadiotis G, Wright HH, Green SB. Psychometric Evaluation of Lexical Diversity Indices: Assessing Length Effects. *Journal of Speech Language Hearing Research*. 2015; 58(3):840–852. doi: 10.1044/2015_JSLHR-L-14-0280.

- Frederiksen, CH.; Bracewell, RJ.; Breuleux, A.; Renaud, A. The cognitive representation and processing of discourse: Function and dysfunction. In: Joannette, Y.; Brownell, HH., editors. *Discourse Ability and Brain Damage*. Springer; New York: 1990. p. 69-110.
- Glosser G, Deser T. Patterns of discourse production among neurological patients with fluent language disorders. *Brain and language*. 1991; 40(1):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*. 1992; 47(4):P266–272. [PubMed: 1624704]
- Hulit, LM.; Howard, MR.; Fahey, KR. *Born to talk: An introduction to speech and language development*. Pearson; Upper Saddle River, NJ: 2011.
- Indefrey, P.; Levelt, WJ. The neural correlates of language production. In: Gazzaniga, MS., editor. *The new cognitive neurosciences*. 2nd ed.. MIT Press; Cambridge, MA: 2000.
- Indefrey P, Levelt WJ. The spatial and temporal signatures of word production components. *Cognition*. 2004; 92(1-2):101–144. doi: 10.1016/j.cognition.2002.06.001. [PubMed: 15037128]
- James LE, Burke DM, Austin A, Hulme E. Production and perception of “verbosity” in younger and older adults. *Psychology and Aging*. 1998; 13(3):355–367. [PubMed: 9793112]
- Jarvis S. Capturing the diversity in lexical diversity. *Language Learning*. 2013; 63(Suppl. 1):87–106.
- Juncos-Rabadan O, Pereiro AX, Rodriguez MS. Narrative speech in aging: quantity, information content, and cohesion. *Brain and Language*. 2005; 95(3):423–434. [PubMed: 15913755]
- Kemper S. Syntactic complexity and elderly adults’ prose recall. *Experimental aging research*. 1987; 13(1-2):47–52. doi: 10.1080/03610738708259299. [PubMed: 3678351]
- Kemper S, Sumner A. The structure of verbal abilities in young and older adults. *Psychology and Aging*. 2001; 16:312–322. [PubMed: 11405318]
- Le K, Coelho C, Mozeiko J, Krueger F, Grafman J. Predicting story goodness performance from cognitive measures following traumatic brain injury. *American Journal of Speech Language Pathology*. 2012; 21(2):S115–125. doi: 10.1044/1058-0360(2012/11-0114). [PubMed: 22294408]
- Levelt WJ, Roelofs A, Meyer AS. A theory of lexical access in speech production. *The Behavioral and Brain Sciences*. 1999; 22(1):1–38. discussion 38-75. [PubMed: 11301520]
- Mackenzie C. Adult spoken discourse: the influences of age and education. *International Journal of Language & Communication Disorders*. 2000; 35(2):269–285. [PubMed: 10912255]
- Mackenzie C, Brady M, Norrie J, Poejianto N. Picture description in neurologically normal adults: Concepts and topic coherence. *Aphasiology*. 2007; 21(3/4):340–354.
- MacWhinney, B. *The CHILDES project: Tools for analysing talk, Volume 1: Transcription format and programs*. Lawrence Erlbaum Associates; Mahwah, NJ: 2000.
- 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.
- Marini A, Boewe A, Caltagirone C, Carlomagno S. Age-related differences in the production of textual descriptions. *Journal of Psycholinguistic Research*. 2005; 34(5):439–463. doi: 10.1007/s10936-005-6203-z.
- McCarthy PM, Jarvis S. MTL-D, vocd-D, and HD-D: a validation study of sophisticated approaches to lexical diversity assessment. *Behavior research methods*. 2010; 42(2):381–392. doi: 10.3758/BRM.42.2.381. [PubMed: 20479170]
- McKee G, Malvern D, Richards B. Measuring vocabulary diversity using dedicated software. *Literacy and Linguistic Computing*. 2000; 15(3):323–337.
- Nicholas LE, Brookshire RH. 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]
- Nicholas LE, Brookshire RH. Presence, completeness, and accuracy of main concepts in the connected speech of non-brain-damaged adults and adults with aphasia. *Journal of speech and hearing research*. 1995; 38(1):145–156. [PubMed: 7731205]
- Nippold MA, Cramond PM, Hayward-Mayhew C. Spoken language production in adults: examining age-related differences in syntactic complexity. *Clinical Linguistics and Phonetics*. 2014; 28(3):195–207. doi: 10.3109/02699206.2013.841292. [PubMed: 24093162]

- Prins RS, Snow CE, Wagenaar E. Recovery from aphasia: Spontaneous speech versus language comprehension. *Brain and Language*. 1978; 6(2):192–211. [PubMed: 728786]
- Pushkar D, Basevitz P, Arbuckle T, Nohara-LeClair M, Lapidus S, Peled M. Social behavior and off-target verbosity in elderly people. *Psychology and Aging*. 2000; 15(2):361–374. [PubMed: 10879589]
- Pushkar D, Etezadi J, Andres D, Arbuckle T, Schwartzman AE, Chaikelson J. Models of intelligence in late life: comment on Hultsch et al. (1999). *Psychology and Aging*. 1999; 14(3):520–527. discussion 528–534. [PubMed: 10509704]
- Ross KR, Wertz RT. Comparison of impairment and disability measures for assessing severity of, and improvement in, aphasia. *Aphasiology*. 1999; 13:113–124.
- Saling LL, Laroo N, Saling MM. When more is less: failure to compress discourse with re-telling in normal ageing. *Acta Psychologica*. 2012; 139(1):220–224. [PubMed: 22074895]
- Schneider, P.; Dube, RV.; Hayward, D. The Edmonton Narrative Norms Instrument. 2005. from <http://www.rehabmed.ualberta.ca/spa/enmi>
- Shadden BB. Discourse behaviors in older adults. *Seminars in speech and language*. 1997; 18(2):143–156. quiz 156–147. doi: 10.1055/s-2008-1064069. [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]
- van Dijk, TA.; Kintsch, W. Strategies for discourse comprehension. Academic Press; San Diego: 1983.
- Wright HH, Capilouto GJ. Considering a multi-level approach to understanding maintenance of global coherence in adults with aphasia. *Aphasiology*. 2012; 26(5):656–672. doi: 10.1080/02687038.2012.676855. [PubMed: 22962509]
- Wright HH, Capilouto GJ, Srinivasan C, Fergadiotis G. Story processing ability in cognitively healthy younger and older adults. *Journal of Speech Language Hearing Research*. 2011; 54(3):900–917. doi: 10.1044/1092-4388(2010/09-0253).
- Wright HH, Capilouto GJ, Wagovich SA, Cranfill TB, Davis JE. Development and reliability of a quantitative measure of adults' narratives. *Aphasiology*. 2005; 19(3-5):263–273.
- Wright HH, Silverman SW, Newhoff M. Measures of lexical diversity in aphasia. *Aphasiology*. 2003; 17(5):443–452.

Table 1

Means (standard deviations) and ranges of demographic variables of interest, by cohort (N = 80)

	Cohorts		
	Young Group	Middle Group	Older Group
F:M ¹	45:35	45:35	45:35
Age (SD)	29.2 (5.5)	54.2 (9.0)	78.4 (5.7)
Range	20-39	40-69	70-89
Years of Education	16.3 (2.8)	16.3 (2.7)	15.4 (2.8)
Range	12-30	12-25	10-26
MMSE ² *	54.4 (8.0)	54.2 (5.0)	60.2 (10.5)
Range	30-61	40-64	38-83
GDS ³	1.3 (1.4)	0.91 (1.2)	1.02 (1.1)
Range	0-6	0-6	0-5

¹Female to Male Ratio;²MMSE: Mini-Mental Status Examination Scaled Score;³Geriatric Depression Scale- Short Version;

* Significant difference between cohorts

Table 2

Means (standard deviations) of variables of interest, by group (N = 80), by stimulus

	Proportion of Main Events	Total Number of words	Percent Information Units	Complexity Index	Lexical Diversity
Single Picture					
Young	.4991 (.1603)	184.7 (80.7)	.9222 (.0443)	1.74 (.303)	63.8 (14.4)
Middle	.5186 (.1715)	234.7 (98.6)	.9092 (.0541)	1.72 (.373)	61.6 (15.6)
Older	.4277 (.1472)	230.7 (96.0)	.8924 (.0545)	1.55 (.285)	53.8 (16.6)
Sequential Picture					
Young	.6112 (.1795)	304.0 (164.9)	.9237 (.0795)	1.69 (.359)	67.6 (15.9)
Middle	.6433 (.1367)	251.5 (92.6)	.9044 (.0459)	1.65 (.338)	70.0 (19.5)
Older	.5537 (.1321)	235.0 (72.8)	.8665 (.0695)	1.44 (.231)	65.2 (11.7)

Table 3

Pearson correlations between variables of interest, by task, for the young group

<i>Variable</i>	<i>Single Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.421 **	I			
III. Percent information units	.034	-.277 *	I		
IV. Complexity Index	-.027	.091	.263 *	I	
V. Lexical Diversity	-.265 *	.123	.117	.059	I

<i>Variable</i>	<i>Sequential Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.279 *	I			
III. Percent information units	.091	-.208	I		
IV. Complexity Index	.094	.173	.227 *	I	
V. Lexical Diversity	-.236 *	.05	-.013	-.096	I

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

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

Table 4

Pearson correlations between variables of interest, by task, for the middle group

<i>Variable</i>	<i>Single Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.261 *	I			
III. Percent information units	.109	-.270 *	I		
IV. Complexity Index	-.100	-.068	.308 *	I	
V. Lexical Diversity	-.104	.176	.008	.028	I

<i>Variable</i>	<i>Sequential Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.387 **	I			
III. Percent information units	.129	-.196	I		
IV. Complexity Index	.078	.036	.310 **	I	
V. Lexical Diversity	-.064	.052	.250 *	.116	I

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

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

Table 5

Pearson correlations between variables of interest, by task, for the older group

<i>Variable</i>	<i>Single Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.101	I			
III. Percent information units	.103	-.255 *	I		
IV. Complexity Index	.124	.208	-.089	I	
V. Lexical Diversity	.209	.153	.231 *	.079	I

<i>Variable</i>	<i>Sequential Picture Task</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
I. Proportion of main events	I				
II. Total number of words	.189	I			
III. Percent information units	.015	-.316 **	I		
IV. Complexity Index	.018	.102	.196	I	
V. Lexical Diversity	-.026	.089	.197	-.333 **	I

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

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