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Preliminary findings of expository discourse in older adults: the impact of cognition, social support, and gender

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Abstract. Aims: The purpose of this study was to: 1) examine older adults' ability to deliver coherent discourse in expository discourse elicitation tasks; and 2) explore whether cognitive ability and social behavior activity predict coherent discourse production in healthy older adults, separately by gender. Methods: Study participants included 58 neurologically healthy older adults — male (n = 19) and female (n = 39). For the discourse elicitation task, participants provided their opinion in response to four controversial topics. They also completed executive function measures and social engagement questionnaires. Results: Years of education significantly differed between the two groups; thus, education was used as a covariate. A 2×4 mixed analysis of covariance (ANCOVA) was conducted. Main effect differences for gender and topic for discourse coherence were not found. In order to examine the contributions of executive function and social engagement on discourse coherence by gender, multiple regression analysis was conducted. For the male group, social activity and social network were significant predictors of the ability to convey coherent discourse on the healthcare topic. For the female group, only executive function was a significant predictor of the coherent discourse production on the marriage topic. Conclusions: The findings suggest that in the same type of discourse elicitation task, the nature of topic influences performance in elicited expository discourse. Moreover, results indicated that the influence of cognitive ability and social engagement on discourse coherence differed between the two gender groups.
Keywords. expository discourse, executive function, social participation, social activity, gender bias

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1 Introduction

Age-related differences in discourse have consistently shown that older adults are less successful in maintaining the topic of discourse (Glosser and Deser 1992; James et al. 1998; Marini et al. 2005; Wright, Capilouto, and Koutsoftas 2013; Heather Haris Wright et al. 2014). Much of the research has used structured discourse elicitation methods to elicit language samples, such as picture descriptions (Brady, Armstrong, and Mackenzie 2005; Cooper 1990; Mackenzie 2000; Mackenzie et al. 2007; Marini et al. 2005). Such elicitation methods are comparatively easy for controlling the quality and quantity of language samples, and prompt speakers to produce more connected speech. However, these methods may not be reflective of naturalistic language contexts and everyday discourse (Whitworth et al. 2015). Expository discourse is a discourse genre with the goal of "imparting information to a listener or reader" (Lundine and McCauley 2016, 306). When used to simply impart information, it may be called "exposition," "informative discourse," or "language of curriculum." However, it also covers when a speaker or writer expresses their own opinion about a specific topic (Heath 1986). This is also known as "argumentative discourse" or "opinion discourse" (hereafter referred to as "expository discourse"). Expository discourse is generally considered to be more difficult compared to other discourse genres, such as procedural or narrative, due to its linguistic complexity compared to other discourse types, such as narrative or procedural (Bloom et al. 2015). According to Lundine and McCauley (2016), expository discourse often requires more technical, low-frequency vocabulary, as well as more frequent nominalizations and pronominalizations. The syntax is generally more complex with frequent embedding, subordinate clauses, and pre- and post-modification of nouns. This genre also has a distinct and more complex organizational framework that includes the speaker's overall stance on the topic, as well as supporting statements and restatement of opening statement (Whitworth et al. 2015). Further, it requires proficiency in manipulating logical connectors to create reasonable linkages to convey thematic organization (Ulatowska and Olness 2000), as well as a complex macrostructure that is often unique to the subtype of expository discourse. Despite these characteristics, expository discourse has not received much attention in the literature on aging (Kintz and Kim 2023).

Whitworth et al. (2015) investigated how healthy adults in three age groups structure different types of discourses (recounts, procedural discourse, and expository discourse). Referencing patterns (specific, non-specific, pronoun only) and conjunctions

(reasoning, conditional) were analyzed across the three genres, and across the three topics for each genre. They found that variability in quality of language differs across topic. For example, the Obesity topic brings out greater variability than other topics (Global Warming and Bullying). Significant differences were found between the three topics in the younger and older groups. The younger group produced a greater number of statements in the Obesity topic than the Global Warming topic. In the older group, the two topics of Global Warming and Bullying had a significantly greater number of statements compared to the Obesity topic. The researchers suggested that some topics within the same genre are better at eliciting a higher quality of language samples. Whitworth and colleagues 2015 conceded that the statistical findings are limited by the small number of participants (30 participants across the three groups). They did not provide further explanation regarding the underlying mechanisms that accounted for these findings. Thus, the current study is an attempt to examine discourse production of the expository genre in older adults, providing potential benchmarks for comparison to clinical populations such as individuals with acquired neurogenic disorders. Additionally, we are interested in providing a more comprehensive picture of coherence ability in expository discourse produced by cognitively healthy older adults. There are a number of potential factors affecting discourse performance in older adults. A long-recognized factor is speakers' cognitive ability (Arbuckle and Gold 1993; Cannizzaro and Coelho 2013; McDowd and Shaw 2000; Heather Harris Wright et al. 2011). For example, reduced executive function (EF) ability may be attributable to less coherent discourse. In the literature with clinical populations, strong relationships between EF and language ability have been reported (Alexander 2006; Blair et al. 2007; Coelho 2002; Frankel, Penn, and OrmondBrown 2007). However, comparatively limited investigations in aging populations have been reported. Hoffman and colleagues (2018) examined the relationship between EF and narrative discourse production in younger adults (N = 30, age range: 18–30 years old) and older adults (N = 30, age range: 61-91 years old). The researchers used 14 discourse tasks that included narrative and expository discourses (e. g., describe a typical visit to a restaurant, which is your favorite season and why). They found that domain-general executive functions measured by the Trail Making Test contribute to the maintenance of coherence in discourse. They concluded that this is because executive functions regulate the content of discourse not only at the lexical level, but also at the message or macro-level. However, different discourse tasks were collapsed during analysis, which does not allow us to confirm the relationship between EF and expository discourse performance. Another factor that may affect discourse performance is social engagement (Keller-Cohen et al. 2006). Social engagement refers to meaningful social behavioral activities, such as social support, social activity, social integration, and social participation (Mendes de Leon 2005). Although many investigations have reported an association between cognition and social engagement (Bourassa et al. 2017; Casey et al. 2021; Harling et al. 2020; La Fleur and Salthouse 2016), few studies have addressed the potential influence of social engagement on language performance. According to Ryan (1995), language ability may be deteriorated with limited social engagement as a 'use it or lose it' mechanism (see Keller-Cohen et al. 2006, for a review). Keller-Cohen and colleagues examined the associations between social relations and language abilities for older adults aged 85 or more. They found that those who had a greater number of different relationships and interactions with friends performed better on the Boston Naming Test (BNT; Kaplan, Goodglass, and Weintraub 2001).

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However, because the outcome measure of language performance is associated with word production, there is the need for further research with discourse, which is a better reflection of communication abilities. We hypothesized that social engagement would be a predictor of coherent discourse in expository discourse. Additionally, gender bias in discourse elicitation tasks and its effect in discourse performance has been often ignored in aging studies. Earlier, Correia, Brookshire, and Nicholas (1990) demonstrated that a gender-bias of picture stimuli to elicit language samples exist, but it is not substantial enough to affect language. Later, Sherratt and Bryan (2019) attempted to investigate how gender bias of discourse topic and procedural tasks affect cohesive use in older adults (age range: 50-94). They included different discourse elicitation tasks (recount, picture description, procedural discourse) and the topics of the procedural discourse task consisted of male oriented or gender-neutral topics (e. g., fixing a window, borrowing library books). They found age-related difference in cohesive errors in the picture description task, but effect of gender-bias topic was not found. Because the studies mentioned above did not include females in the study populations, a clear picture of the effect of gender-bias discourse elicitation topics/tasks was not available. In the field of sociolinguistics, gender is known to be a factor contributing to quantity and quality of language use (Teso et al. 2018; Xia 2013). For example, females are more likely to be engaged in conversational topics related to family affairs, whereas males prefer to choose different topics such as economy and politics in social interactions (Xia 2013). In older generations, the effect of gender is likely to be more apparent (Sherratt and Bryan 2019). The purpose of the study, then, was to examine the relationship among EF, social engagement, and discourse coherence in healthy older adults. For the current study, expository discourse was selected; though it is fairly under-investigated, it is a more naturalistic, structured discourse task. Since it is considered as a cognitively and linguistically more demanding discourse genre, we expected to capture the relationship between performance on the task and cognitive ability. We also expected that certain topics may affect speakers' discourse performance due to the nature of expository discourse. The specific aims of the study were as follows: (1) examine gender differences in expository discourse; and (2) explore whether cognitive ability and social engagement predict coherent discourse production in healthy older adults. To the best of our knowledge, the current study is the first to investigate the intertwined relationship among discourse performance, cognition, and social support with expository discourse. Understanding how discourse production of the expository genre varies in healthy populations will allow us to determine age and gender-related differences and provide potential benchmarks for comparison in clinical populations.

2 Methods

2.1 Participants

The study included 58 (Male = 19; Female = 39) neurologically healthy older adults. The participants were on average 69.38 (SD = 5.92) years old and had 15.59 (SD = 2.62) years of education. All participants met the following inclusionary criteria: (a) no reported history of brain injury, (b) no history of psychiatric or neurodegenerative disorders, (c) no depression at the time of study as measured by the Geriatric Depression Scale (GDS; Brink et al. 1982) (d) aided or unaided visual acuity (e) aided or unaided

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hearing within functional limits, and (f) normal cognitive function as indicated by the Mini-Mental State Examination (MMSE; Folstein and Folstein 2010). Demographic information for the participants can be found in Tab. 1.

Groups	Male (N = 19)	Female (N = 39)
Age	70.32 (6.22)	68.92 (5.80)
Years of Education	16.95 (2.52)	14.92 (2.43)
MMSE	28.82 (1.02)	28.69 (1.39)
SA	17.11 (3.07)	17.54 (3.60)
SN	13.00 (8.58)	18.44 (11.86)
PPE (%)	22.22 (22.50)	20.53 (11.90)
PPR (%)	19.06 (16.78)	18.71 (10.05)

Table 1: Mean and (standard deviations) for older group's demographic information: Mini-Mental State Examination (MMSE, Folstein and Folstein 2010), Social activity (SA), Social network (SN), Percent perseverative errors (PPE), Percent perseverative responses (PPR). Years of education was significantly different between the male and female groups ($p < 0.05$)

2.2 Experimental Tasks

- Discourse Tasks. According to (Olness and Ulatowska 2011), topics that are suitable for clinical purposes may depend on the norms of community. Among topics relevant to culturally shared experiences, those which contain emotive themes may be appropriate to elicit sufficient quality and quantity of language samples (Stein, Hernandez, and Trabasso 2008). Due to the limited number of studies on expository discourse, we collected pilot data to determine what topics met the above criteria by eliciting speakers' strong reaction. A convenience sample of six younger adults who reside in North Carolina participated. Potential topics that were current events and controversial in North Carolina were selected, such as gun control and school bullying. Additionally, six younger adults provided their own opinion on the topics. Considering the quantity and quality of language that younger adults provided, four topics were selected. The topics selected included: healthcare reform, the legalization of marijuana, homeschooling, and gay marriage.

- Executive Function Task. The Wisconsin Card Sorting Test (WCST; Grant and Berg 1948) was administered as the measure for estimating executive function. The WCST has been used in previous research to estimate EF (Alvarez and Emory 2006; Baddeley 1996; Barceló and Knight 2002; Reitan and Wolfson 1994; Spreen and Strauss 1998). The WCST consists of 128 response cards and four stimulus cards that have geometric figures. The four stimulus cards were placed on the table. Participants were asked to deduce the rule to sort out response cards using the reference cards. Performance feedback was briefly provided (e. g., correct or incorrect). The WCST provides 16 assessment indicators that were calculated using specific software for this study. In the current study, perseverative-related responses and learning to learn were the variables of interest. The perseverative scores indicate the respondents' ability to inhibit

their tendency of the previous sorting principle (Heaton and PAR staff 2008). Increased perseverative tendencies are considered to be a reflection of aging (Hartman, Bolton, and Fehnel 2001; Ridderinkhof, Span, and van der Molen 2002). The manual offers the use of the percent scores for research investigations because the number of trials administered are controlled. Thus, percent perseverative responses (PPR) and percent perseverative errors (PPE) were used in the current study. Learning to learn (LTL) has been extensively used in many studies (Ashendorf and McCaffrey 2008; Everett et al. 2001; Lin et al. 2011; Silva-Filho, Pasian, and Vale 2007). LTL may be of use to assess conceptual efficiency during the test (Heaton and PAR staff 2008; Puente 1985).

- Social Engagement. To measure social engagement, participants completed a questionnaire about social networks, social support, and participation in social activities. The current study included separate measures of social network size and social activities. Social network size (SN) was quantified with standard questions that have been widely used in research (Barnes et al. 2004; Cornoni-Huntley et al. 1990; Krueger et al. 2009); questions included the number of family and friends that respondents have seen at least once a month. Social activity (SA) was assessed by asking how often respondents engaged in common types of activities (e. g., going to restaurants and sporting events, and visiting relatives / friends) (Mendes de Leon 2005; Krueger et al. 2009). The measures consisted of both closed and open-ended questions. The close-ended questions used a Likert Scale from 1 to 5 (1 = once a year or less; 5 = Nearly every day).

2.3 Transcription Procedures

To analyze coherence, language samples were video recorded and transcribed into the CHAT format, which is compatible with Computerized Language Analysis (CLAN, MacWhinney 2000) and devised for the analysis of linguistic and discourse structures. Then, the language samples were segmented into c-units. A c-unit is an independent clause with its modifiers (Loban 1976) and is commonly used to segment discourse samples (Hughes, McGillivray, and Schmidek 1997). All discourse samples were transcribed for discourse analysis purposes. Inter-rater and intra-rater reliability for word-by-word agreement and c-unit segmenting were determined for 10 % of the samples collected from the participants. Inter- and intra-rater agreement for word-by-word transcription were 95.7 % and 97.6 %, respectively. For c-unit segmenting, inter-rater agreement was 85.6 % and intra-rater agreement was 87.2 %.

2.4 Coherence Analysis Procedures

Coherence was operationally defined and subsequently measured as the maintenance of topic within discourse based on raters' impressions of the meaning of the whole verbalization with respect to discourse topic. To determine coherence, a novel coherence density measure was used. To apply this method, individual c-units were segmented into different phrases: (a) noun phrases, (b) verb phrases, (c) prepositional phrases, etc. The phrases were then determined to be coherent or not by trained raters. For a phrase to be considered coherent, it had to maintain thematic relevance to the discourse topics. Moreover, considering that expository discourse is used to elicit speakers' opinion regarding the topics, any variation of "I think" was counted as

coherent. Filler phrases, tangential phrases, conceptually incongruent phrases, and repetitions / rephrasals were not counted as coherent. Additionally, ending commentary (e. g., *that's it*) was not considered towards the coherence score. Raters followed these rules and counted the number of coherent phrases present in each c-unit. Once all of the coherent phrases were counted for each c-unit (see examples (1) and (2)), the counts were averaged together creating a coherent density score for each individual and discourse task. The coherence density unit has been moderate correlation with other coherence measures, even in other languages (Galetto et al. 2013). Examples (3) and (4) demonstrate how to measure coherence density. (See Appendix A for more instructions.) An example of the scoring procedure follows.

C-unit segmented samples for two c-units (1) and (2):

(1) I'm not for the use of marijuana because it is a drug

(2) and it doesn't seem to provide much positive benefit in most people's cases

Coherence unit segmented; example (3) is scored as 5 points and example (4) is scored as 4 points:

(3) *I / 'm not for / the use / of marijuana / because it is a drug*
1 / 1 / 1 / 1 / 1

(4) *and it / doesn't seem to provide / much positive benefit / in most people's cases*
1 / 1 / 1 / 1

To ensure the reliability for scoring, a multi-step training protocol was provided. To ensure intra- and inter-reliability, 10 % of the samples were recoded for coherence. For the coherence re-analysis, inter- and intra-rater agreement were 96 % and 98 %, respectively.

2.5 Procedures

All participants were tested individually in a laboratory setting during one session lasting no more than two hours including any break upon participants' request. Participants completed vision screening, hearing screening, GDS, and MMSE to determine if they met inclusion criteria. Then, participants completed the experimental tasks — expository discourses, computerized version of the WCST, and the SA and SN questionnaires. Order of the tasks was randomized across participants. For the expository discourse tasks, the order of the four topics was also randomized across participants. For the expository discourse task, the examiner read the following script:

I would like you to think about each question and explain your stance. Some of these questions might be considered controversial, but we are not looking for a specific answer. Instead, we are looking for how people construct arguments to potentially emotional prompts.

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Next, the examiner provided an example (argument for separation of church and state) to show the participant how to complete the task. Then, the examiner asked the participant to provide his / her own opinion to the examiner on the experimental topic assigned. In cases where the participants produced discourses that were less than 15 seconds, the examiner prompted them by asking if they had more information to provide. Discourse samples were video recorded for later transcription. For the WCST, the test was administered to participants following the test instructions. For the SE scales, participants were provided with written forms and asked to read and complete the questionnaires.

3 Results

Prior to performing statistical analyses for addressing the study aims, the presence of outliers, normality, sphericity, and homogeneity of variance were conducted. For outliers, standardized *z* scores (univariate) and Mahalanobis distances (multivariate) were computed for the variables within group. Learning to learn (LTL) was initially planned to be included in the statistical analysis. However, due to missing values for about 20 % of the participants who achieved fewer than three categories, LTL index was excluded. To examine whether demographic characteristics were contributing factors to study results, preliminary analyses were conducted. The male and female groups differed significantly for years of education completed, $t56 = 0.938$, $p > 0.05$, with the male group ($M = 16.95$, $SD = 2.52$) having completed more years of education than the female group ($M = 14.92$, $SD = 2.43$). To address the first aim, examining gender differences in discourse coherence, a 2×4 mixed analysis of co-variance (ANCOVA) was performed with group (male vs female) as the between-subject factor, the topic of discourse (healthcare reform vs marijuana vs homeschooling vs gay marriage) as the within-subject factor and years of education completed as the covariate. Mean and standard deviations for proportion of coherence units are presented in Tab. 2. Results indicated no significant main effects for gender and discourse topics when education was a covariate, $F(1,55) = 3.364$, $p = 0.072$ and $F(3, 165) = 0.658$, $p = 0.579$, respectively. The interaction between gender and discourse topics was not statistically significant, $F(3, 165) = 1.56$, $p = 0.202$. To address the second aim regarding the contributions of EF (PPR, PPE) and social engagement (SA, SN) on coherent discourse production by gender, multiple stepwise regression analysis was performed for each topic. Given the exploratory nature of the study, a backward elimination model was selected to reduce type 1 error (Appelbaum and McCall 1983; Ochs and Roessler 2004). Prior to the regression analysis, multicollinearity among our predictor variables was detected. Results showed major collinearity (variance inflation factor; $VIF > 10$) between scores from PPR and PPE. Thus, the average score of the two measures was computed, and then entered as a predictor (EF). For the male group, the final multiple regression model revealed that the SA and SN scores together predicted 26 % of the variability in coherent discourse production on the health care topic, Adjusted $R^2 = 0.262$, $F(2, 17) = 4.01$, $p = 0.05$. For the female group, results indicated that only the EF score was retained in the model, which explained 14 % of the variance in coherent discourse on the marriage topic, Adjusted $R^2 = .0144$, $F(1, 37) = 6.08$, $p < 0.05$. Tab. 3 presents the multivariate regression analysis and significance levels for the variables included in the final regression model.

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Discourse topic	**Male**	**Female**
Healthcare	3.95 (2.46)	4.37 (2.40)
Marijuana	3.84 (2.50)	5.16 (2.18)
Homeschooling	5.26 (2.86)	4.84 (1.93)
Gay marriage	3.79 (2.20)	4.50 (2.22)
Total	3.87 (3.84)	4.87 (2.64)

Table 2: Mean and standard deviations for coherence units produced by older adults by discourse topic

Group	**Variable**	**B (SE)**	β	**p-value**
Male	Model 2: Healthcare			
	Constant	-2.243 (2.773)		0.431
	SA	0.428 (0.163)	0.561	0.019
	SN	-0.098 (0.060)	-0.351	0.122
$R^2 = 0.348$ (adjusted $R^2 = 0.262$, $R = 0.59$); $F\ (2,\ 17) = 4.010$, $p < 0.05$				
Female	Model 3: Marriage			
	Constant	5.960 (0.736)		0.000
	EF	-0.081 (0.033)	-0.380	0.019
$R^2 = 0.144$ (adjusted $R^2 = 0.121$, $R = 0.59$); $F\ (1,\ 37) = 6.078$, $p < 0.05$				

Table 3: Results from multiple regression predicting coherent expository discourse by gender: unstandardized coefficient (B), Standard error (SE), Standardized coefficient (β), p-value (< 0.05)

4 Discussion

The purpose of this study was to investigate older adults' ability to convey coherent expository discourse in different topics, and examine the relationship among EF, social engagement, and maintenance of discourse coherence. Our findings suggest that gender does not influence the ability to convey coherent expository discourse. However, for the female group, executive function ability was a significant predictor of the ability to convey their position on the topic of gay marriage. For the male group, social activity and social network were significant predictors for conveying coherent discourse production for their position on healthcare reform.

4.1 Discourse coherence in older adults

Gender differences for conveying coherent expository discourse were not found. These results are in agreement with other studies investigating gender differences in older adults for conveying coherent discourse, although some variability in discourse elicitation techniques, scoring methods, and age range across the studies exists (Arbuckle

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et al. 2004; Ardila and Rosselli 1996; Bluck et al. 2016; Mackenzie 2000; Mackenzie et al. 2007). For example, Mackenzie (2000) used a 5-point scale to measure discourse coherence for adults (age range 40–88 years old) on a topic previously discussed in conversation. Mackenzie et al. (2007) counted the number of clauses or noun phrases related to a main topic and did not find gender differences for adults (age range 40–90 years old) in concept and topic coherence of discourse using a picture description task. Arbuckle et al. (2004) and Bluck et al. (2016) investigated coherence ability of older adults in the context of recount discourse tasks (e. g., asking participants to remember a memorable vacation and describing it). Both studies examined the degree to which their participants produced off-topic speech and reported no gender-related differences. Taken together, the findings provide a clearer picture of the absence of gender difference in coherent discourse production in expository discourse tasks.

However, it cannot be overlooked that a general pattern was observed in expository discourse, despite no statistical difference. Females produced greater coherent output than their male counterparts, and this is consistent with previous studies (Arbuckle et al. 2004; Bluck et al. 2016; Mackenzie 2000; Mackenzie et al. 2007). It may be attributable to women's speaking style. Women traditionally use the standard forms of English because speech forms act as a criterion to determine their social hierarchy (Bucholtz 2003; Holmes 2007). In this sense, discourse coherence may be of great advantage to the female group. Moreover, though not statistically significant, our older male group produced more coherent discourse when conveying their position only on homeschooling compared to the older female group. It may be the case that certain topics or discourse stimuli are more gender-biased than others (Correia, Brookshire, and Nicholas 1990; Sherratt and Bryan 2019). It should be noted that for the male group homeschooling was judged to be the most coherent. For the female group, the most coherent topic was judged to be marijuana. While a more formal linguistic analysis was beyond the scope of this study, the research team agrees that it appears the male group's shortest sample was homeschooling, and the shortest samples from the female group was marijuana. It is possible these shorter, to-the-point, samples had less chance to include off-topic information. Future investigations are warranted to determine the influence of gender bias on different discourse stimuli and topics. Moreover, the preliminary nature of this investigation may not have found a significant difference due to being underpowered due to small sample size.

Additionally, education has been considered a critical factor that impacts language performance. Those who are well-educated tend to have higher scores on language assessments (Beausoleil et al. 2003; Cohen 1979; Mackenzie et al. 2007; Marien et al. 1998; Mathuranath et al. 2003; Neils et al. 1995). However, our study provides a contrasting pattern that the female group with fewer years of education outperformed the male group with greater years of education. Mackenzie (2000) suggested that an educational effect in language performance may be confined to those who attain less than 12 years of education. In the current study, all participants experienced more than 12 years of education. Future investigations should include both variables (gender and education) to systematically disentangle the intricate factors linked to language performance.

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4.2 Executive Function and Discourse Coherence

There is general agreement in the aging literature that cognitive decline contributes to a reduced ability to maintain topic in connected speech (see Marini 2023 for review). However, studies on the influence of EF on narrative discourse are scant. In the current study, EF was a significant predictor of females' ability to coherently deliver their position on the marriage topic only. Our results add to the literature regarding the involvement of cognitive processes on discourse processing (Grafman 1995; Wood and Grafman 2003; Ylvisaker et al. 2008). One possible explanation for our significant finding is that the EF indices (PPR and PPE) may be indicators of other cognitive components underlying the rubric of EF. It has been suggested that EF is more of an umbrella concept for various cognitive functions such as working memory, attention, and problem solving (Connor, MacKay, and White 2000; Lapointe and Erickson 1991). Despite the fact that it is difficult to decompose the cognitive functions for each index that the WCST provides, greater perseverative behaviors during the WCST may be attributed to poor working memory (Hartman, Bolton, and Fehnel 2001). The two perseverative indices used in our study are associated with the number of incorrect responses that would have been correct for the previous trial set. During the WCST, respondents have to store information of a previous matching rule and process it to figure out how to sort the new trials (Berman et al. 1995; Cohen and O'Reilly 1996; Dehaene and Changeux 1991; Hartman, Bolton, and Fehnel 2001; Kimberg and Farah 1993). During the course of generating a coherent stance on a topic, speakers are required to hold their initial statement in storage to proceed with the incoming statements.

Interestingly, the influence of EF on coherent discourse is both gender and topic dependent. That is, only for the female group, both indices (PPR and PPE) were related to discourse coherence for the gay marriage topic. The complexity of the tasks may account for these findings (e. g. Blake 2021). When considering the performance of the female group across four topics, they achieved the third greatest score and demonstrated the second greatest variability for the gay marriage topic. Possibly, this topic is suitably difficult to challenge the female group's cognitive limits; however, it still leads to more questions about the complexity of topics. Thus, an important next step should be to determine the complexity hierarchy for the four expository topics by using a subjective measure for speakers.

It's also possible EF loaded onto the gay marriage topic for women due to the women making more cognitive effort to "toe-the-line" and prevent losing face in an unknown environment with the unknown beliefs of the examiner. Women are often corrected more and often forced into the emotional role of maintaining connections within a community and relationship. Gay marriage was considered the most controversial topic during piloting, and it was the only topic where several women politely refused to answer. In fact, an informal analysis of the female groups marriage samples also shows some women produced very short and to the point answers while others would take much more time to explain their reasoning. The male group generally appeared to have longer samples for the gay marriage topic. This probably also accounts for the variability. So it may also be beneficial to understand the cognitive processes used by participants when examining expository discourse.

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5 Conclusions and limitations

Results of the current study are informative, as they contribute to the literature investigating discourse coherence in older adults' expository discourse and broaden our understanding of the influence of cognitive abilities and social engagement on discourse coherence. We did not find gender-related differences in older adults' discourse coherence. However, we did find that when investigating the groups independently different factors predicted their coherence, despite EF and SN / SE not being significantly different between the groups. The female group's coherence was only predicted by EF on only the gay marriage topic. The male group's coherence was only predicted by SN / SE on only the healthcare reform topic. It should be noted though, that this does not mean there are differences between the two groups. To make inference about group differences, a formal analysis with sex as a moderator variable would be required, but the unequal group size and small n made this impossible. The goal of our study was to offer a starting point for future research into the nature of older adults' communicative ability, which is influenced by various, potential factors (e. g., gender, cognition, social engagement). Though our participants did not differ significantly for proportion of coherence units produced, it is premature to exclude gender effects in contributing to discourse performance. Depending on topics or stimuli, an advantage or disadvantage of producing language samples in either females or males may be inherent (Argamon et al. 2007; Correia, Brookshire, and Nicholas 1990; Herring and Paolillo 2006; Janssen and Murachver 2004; Sherratt and Bryan 2019). Moreover, understanding how cognitively healthy adults perform in expository discourse tasks is fundamental to differentiating performance in clinical populations. Previous studies have demonstrated that subtle language changes in pathological aging (e. g., mild cognitive impairments) are more pronounced in cognitively demanding discourse tasks rather than simple discourse tasks (e. g., picture descriptions) (Beltrami et al. 2018; Drummond et al. 2015; Fleming 2014; Fleming and Harris 2008; Forbes-McKay and Venneri 2005; Harris et al. 2008). Although these results are preliminary and require replication with larger samples of both healthy and pathological aging populations, this study serves as a potential guide for providing discourse profiles on expository discourse. A final implication related to intervention is that it is important to consider external dimensions (e. g., social activity, and support) to enhance or maintain language performance in clinical populations, specifically in male populations. Social relations may contribute to lexical diversity, and syntactic complexity.

There are some limitations of this study which should be considered in future research. Our study included more female participants than male participants, which is often the case, and future studies should seek to have larger and equivalent Ns for gender groups with similar levels of education. The expository discourse topics were selected based on prevalence of discussion in the media and topics considered controversial; an alternative approach may be to seek input from the intended age group targeted for topics that are meaningful and relevant to them. Further, a refinement of social engagement measures should be considered because our questionnaires were dependent on a participant's report of information over a multi-week time period. Capturing real-time data for social engagement may be more sensitive for detecting relationships among cognitive ability, discourse performance, and social engagement. To further investigate a direct link between cognitive abilities and language abilities,

different executive function batteries and / or additional cognitive measures should be administered. Finally, future investigations should include additional linguistic measures to determine if gender differences are isolated to maintenance of coherence or extend to other micro- and macro-linguistic processes.

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Ethics statement

Participants provided informed consent before participating in the study. Procedures outlined in this manuscript received approval from East Carolina University Institutional Review Board.

Conflict of interest

None of the authors have a conflict of interest to report. The authors received no specific funding for this work.

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Appendix A

Coherence procedures

1. Coherence is the maintenance of topic within discourse based on raters' impressions of the meaning of the whole verbalization with respect to discourse topic. item
   (a) Coherence can be conceptualized as representing the listener's / rater's ability to interpret the overall meaning conveyed by the speaker.
2. To complete the coherence analysis:
   (a) Samples need to be segmented into C-units prior to completing coherence analysis.
   (b) Audio / video recordings need to be accessible while performing coherence analysis.
3. Calculate Coherence Density Scores for each discourse type: divide the total number of coherence units by the total number of c-units that were appropriate for scoring (do not count *not rated* utterances in the total number of utterances rated).

Note:

- Do not rate ending commentary (e. g. *That's it*; *The end*; and *That's the story*) when rating coherence.
- e. g., *And that was all I did on my recent holiday*—do not score because it is commentary ending the *holiday* recount
- Do not rate direct responses to examiner unless additional information is provided. Do not count first utterances that are questions to examiner requesting clarification of task instructions.

Coherence density measure

Useful information to help with coherence unit coding . . .

- You need to know the difference between Open Class and Closed Class words
  - Open class words (carry semantic meaning): nouns, verbs, adjectives, and adverbs
  - Closed class words (do not carry semantic meaning): prepositions, conjunctions, and determiners
    - Determiners: *the*, *a*, *an*, *this*, *that*, *those*, etc.
    - Prepositions: *about*, *above*, *after*, *along*, *before*, *below*, *by*, *for*, *from*, *in*, *on*, *up*, etc.
    - Conjunctions: *and*, *or*, *but*, *nor*, *so*, *for*, *yet*
  - Open class words and their modifiers are grouped into phrases

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- Noun phrases: *the dog*, *the red house*, *the house of my friend*, etc.
- Verb phrases: *went*, *had gone*, *had been coming*, *run quickly*, etc.
- Prepositional phrases: *to the store*, *after the test*, etc.
- These phrases may be segmented into coherence units if they are related to the topic/theme of the discourse both locally and globally.
- These phrases may be: actors, agents, actions, or objects.
- A coherence unit must adequately contain each phrase in sequence and continuously maintain thematic relevancy to the discourse topic.

Steps in coherence unit segmentation

1. Verify all C-units are correctly segmented.
2. Mark the possible coherence units. These may include:
   (a) Nouns, noun phrases (can be a noun, pronoun or a noun, pronoun and its modifiers)
   (b) Verbs, verb phrases (can be a verb or a verb and its modifiers)
   (c) Prepositions, prepositional phrases (can be a preposition or a preposition and another phrase and its modifiers)
3. Review the possible coherence units to make sure they are correct.
4. Coherence is relative to the discourse topic. These coherence units may be actions, locations, time, objects, people, and positions that relate to the discourse topic and follow subject-predicate structure. Not all possible coherence units will count — they are marked first and then the rater needs to go back and determine if they are valid coherence units for the given discourse sample. An example with Cat in Tree picture:
   (a) *John / is up in the tree / rescuing / the cat.* — 4 possible coherence units but only 3 count as valid coherence units. *John would not count because that is not accurate to the stimulus because the man in the picture is not named.*

Notes on Counting Coherence Units

1. Figurative language such as colloquial sayings, maxims, idioms, are one coherence unit as long as they are not inserted commentary.
   (a) For example: *fighting like cats and dogs*, *playing around*, *all of a sudden*
2. Fillers Utterance are not counted
   (a) For example: *I think*, *I believe*, *it looks like*, *what pretty pictures*, *it looks like a beautiful day in the neighborhood*, etc.
3. Tangential Utterance are not counted
   (a) For example: *I once had a red truck just like that, but it was blue*, etc.
4. Utterance that do not make sense should not be counted

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   (a) For example: *The aliens are the one that took the mouse, I [/] I dislike hate in the moving time*, etc.

5. Repetitions and rephrasal are not counted towards coherence units. If the participant repeats him or herself, do not count because it does not add new information to the story.

6. *To be* verbs carry little grammatical information and are often auxiliaries. Do not count them towards the coherence score. For example:

   (a) John / is going / on a plane: 3 coherence units because *is* is an auxiliary

   (b) The ball / is / green: 2 coherence units because *is* is merely a copula construction connecting green and ball

7. **Expository Discourse** is different

   (a) I think, I believe, etc. are acceptable. Count these phrases as coherence.

   (b) Be mindful of repeated phrases. If the person say I think or any variation more than once to the same idea, do not count it as a coherence unit

8. Inferences by the participant about the content are acceptable if they are reasonably justified and supported by the stimuli. This can include

   (a) Dialogue / conversations (if it can be reasonably assume the character is talking)

   (b) Thoughts / feelings (if the agent can be reasonably given said thought or feeling)

9. Information outside the realm of the stimuli is scored zero. This could include:

   (a) Back-story

   (b) Semantic paraphasias

   (c) Actions not identified in the stimulus

   (d) Embellishments

   (e) Names, etc.

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Below is some additional information that may be helpful as you are segmenting c-units into possible coherence units (Tab. 4).

Part of Speech	**Definition**	**Example**
Noun	person, place, thing, or idea	*Kittens* are adorable
Determiner	articles, particles, and contextually sensitive accusative or demonstrative pronouns	*the* fish, *his* fish
Pronoun	subset of closed-class representations of nouns treated semantically as nouns	*She* looks nice
Verb	an action, in any case or tense	Thom *kicks* the ball
Preposition	a closed-class word that describes position, location, time, or origin	The werewolves *of* London; Go *to* the shower
Adjective	a word that modifies attributes of a noun; is part of noun phrases	the *red* ball
Adverb	a word that modifies of a verb; is part of verb phrases	the snow fell *softly*
Contraction	separate a contraction from its stem and indicate it as a separate verb	It'*s* hot in the lab
Possessive	contraction or a pronoun that indicates ownership between subject and object	*Her* shoes. Jane'*s* shoes.

Table 4: Overview of Parts of Speech