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# The Usefulness of a Multilevel Procedure of Discourse Analysis in Determining the Characteristics of Discourse Production in Healthy Aging and Their Relation to Attention and Inhibitory Control

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**Title:** The usefulness of a multilevel procedure of discourse analysis in determining the characteristics of discourse production in healthy aging and their relation to attention and inhibitory control

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*Abstract*

Twenty-six adults (mean age 60.04 years; 14 females) and twenty-six older adults (mean age 79.35 years; 16 females) were administered a narrative production task and tests that explored their attentional and inhibitory control skills. Senior adults had reduced lexical selection and narrative organization skills that correlated with measures of sustained attention and inhibitory control.

*Keywords*: Discourse production; aging; Multilevel procedure of discourse analysis; Cognition

***The usefulness of a multilevel procedure of discourse analysis in determining the characteristics of discourse production in healthy aging and their relation to attention and inhibitory control***

Aging affects the efficiency of discourse production (Marini, 2022). At the microlinguistic level, the spontaneous speech of older individuals is usually characterized by an increased production of semantic errors (Marini et al., 2005) and reduced levels of syntactic complexity (Kemper & Sumner, 2001). At the macrolinguistic level, they tend to produce more errors of both local and global coherence (Juncos-Rabadán et al., 2005). A general decrease in discourse informativeness is also reported (Pistono et al., 2017). Importantly, healthy aging affects also cognitive abilities such as attention, shifting and inhibitory control that are involved in the generation of the story structure, the selection of the topics that make up the story, and the abilities to inhibit irrelevant information, update its contents, and monitor if the story is developing as planned (Cannizzaro & Coelho, 2013; Myiake et al., 2000). The relation between cognitive decline and the ability to produce adequate samples of narrative discourse is currently under investigation with mixed results (Byczewska-Konieczny & Kielar-Turska, 2017). This article explores this issue by applying a multilevel procedure of discourse analysis to the narrative samples produced in adults with healthy aging focusing on the alterations induced by healthy ageing on narrative production and their potential relation with the effects of a decline in sustained attention and inhibitory control.

## *Methods*

### *Participants*

52 Italian-speaking healthy adults participated in the study. They formed two age-groups: 26 adults aged 40 to 69 and 26 older adults aged 70-89. Inclusion criteria included the absence of neurological or neuropsychiatric diseases and above cutoff performance on the Montreal Cognitive Assessment (MOCA; Santangelo et al., 2015), on the Naming subtest of the Aachener Aphasie Test (AAT; Luzzatti et al., 1994), and on the short version of the Token test (De Renzi & Vignolo, 1962).

Additional information about the participants' cognitive reserve and level of formal education was obtained by administering the Cognitive Reserve Index questionnaire (CRIq; Nucci et al., 2012). No group-related differences were found in any of these tasks (See Table 1).

| | Adults<br>(40-69 years old) | Older adults<br>(70-89 years old) |
|---|---|---|
| Age | 60.04 (6.87) | 79.35 (5.08) |
| Sex | F=14 (53.85%) | F=16 (61.54%) |
| Handedness | Right: 25 (96%) | Right: 26 (100%) |
| MOCA | 23.01 (1.74) | 24.89 (2.43) |
| AAT_Naming | 117.33 (2.23) | 114.33 (2.24) |
| Token Test | 4.97 (.13) | 4.94 (.17) |
| Cognitive Reserve_Schooling | 108.54 (13.73) | 105.23 (14.26) |
| Cognitive Reserve_Total | 114.58 (17.98) | 115.73 (22.61) |

Table 1 – General information about the participants. The asterisk shows when a group-related difference was found.

*Cognitive assessment*

The cognitive assessment focused on attention and inhibitory control, as assessed by administering Parts A and B of the Trail Making Test (TMT; Giovagnoli et al., 1996). In Part A (TMT_A) participants are required to draw a line that connects 25 encircled numbers in progressive order. Part B (TMT_B) requires participants to draw a line to connect numbers and letters alternating between them. Both tasks must be completed as fast and accurately as possible. The time required for completing TMT_A reflects cognitive processing speed for sustained attention. The time for completing TMT_A was subtracted to that for completing TMT_B (usually considered as a measure

of speed for cognitive flexibility). The resulting variable (TMT_B-A) was considered as a measure of the efficiency of inhibitory control.

*Assessment of narrative discourse production*

Participants described a cartoon story made of six pictures presented on the same page ("Quarrel" story; Nicholas and Brookshire, 1993). Each storytelling was tape-recorded and transcribed by two independent coders. The transcripts underwent a multilevel analysis of discourse production focusing on micro- and macrolinguistic aspects of narrative production (Marini et al., 2011). Microlinguistic measures assessed productivity (i.e., words and speech rate), lexical (i.e., % Phonological errors, % Semantic Errors and % Paragrammatic Errors) and syntactic (% Complete Sentences) organization. Macrolinguistic measures included percentages of Local and Global Coherence Errors and a % Lexical Informativeness. The scoring procedure was performed independently by the two coders and then compared. Acceptable inter-rater reliability was set at Cohen's $k \geq 0.80$.

## ***Results***

*Cognitive assessment*

Older participants performed worse than younger adults on all cognitive measures with longer completion times on the task assessing sustained attention (i.e., TMT_A: $t(50) = 3.233$; $p < .002$; $d = .897$), and higher cost on inhibitory control (i.e., TMT_B-A: $t(50) = 4.064$; $p < .001$; $d = 1.127$) (see Table 2).

| | Adults (40-69 years old) | Older adults (70-89 years old) |
|---|---|---|
| TMT_A (seconds)* | 41.50 (15.32) | 61.50 (27.58) |
| B-A (seconds)* | 53.46 (30.33) | 122.92 (81.71) |

Table 2 – Results of the cognitive assessment. The asterisks show when group-differences are significant.

*Narrative assessment*

Group differences on narrative measures were explored with t-tests or Mann–Whitney nonparametric tests where appropriate. As for **Productivity**, the two groups produced stories with similar number of words (t (50) = 1.246; p =.218; d = .346) and speech rates (t (50) = 1.333; p =.189; d = .370). As none of the participants produced any morphological error (in terms of substitution of bound morphemes) the analysis of the participants' **lexical and grammatical skills** focused on the production of phonological and semantic errors and on the % of Grammatically complete sentences. The results showed the absence of group differences in the production of phonological errors and of grammatically complete sentences. However, older participants produced more semantic errors (U = 242.00, p<.022; rank biserial correlation = -.284). As for **macrolinguistic processing**, the analyses showed that older participants produced more errors of both local (U = 204.00, p<.014; rank biserial correlation = -.396) and global (U = 160.00, p<.001; rank biserial correlation = -.527) coherence and fewer informative words (U = 563.00, p<.001; rank biserial correlation = .666). (see Table 3).

| | Adults<br>(40-69 years old) | Older adults<br>(70-89 years old) |
|---|---|---|
| Words | 84.96 (50.89) | 69.96 (34.32) |
| Speech rates | 145.59 (121.61) | 112.93 (28.49) |
| % Phonological errors | .42 (.92) | .73 (1.47) |
| % Semantic errors* | .18 (.56) | .90 (1.43) |
| % Complete sentences | 79.94 (16.07) | 74.04 (17.45) |
| % Local coherence errors* | 11.86 (14.28) | 31.01 (31.07) |

| | | |
|---|---|---|
| % Global coherence errors* | 6.10 (6.24) | 19.83 (17.42) |
| % Lexical informativeness* | 88.74 (8.45) | 68.96 (18.99) |

Table 3 – Results of the narrative assessment. The asterisks show when group-differences are significant.

*Correlations between cognitive and narrative variables*

Spearman's rho correlation coefficient was used to assess the potential relationship between the narrative measures and between these and cognitive skills. Significant correlations were found between language measures. Namely, the % of semantic errors correlated with % local coherence errors ($r_s$ = .416; p<.002) and % lexical informativeness ($r_s$ = - .374; p<.006). The % local coherence errors correlated with % global coherence errors ($r_s$ = .494; p<.001) and % lexical informativeness ($r_s$ = - .689; p<.001). Finally, % global coherence errors correlated with % lexical informativeness ($r_s$ = - .798; p<.001).

Significant correlations were found also between the measure of sustained attention, inhibitory control, and language. Indeed, TMT_A correlated with % semantic errors ($r_s$ = .308; p<.026), % lexical informativeness ($r_s$ = -.512; p<.001), and both local ($r_s$ = .468; p<.001) and global coherence errors ($r_s$ = .348; p<.011). B-A correlated with % semantic errors ($r_s$ = .274; p<.049), % lexical informativeness ($r_s$ = -.504; p<.001), and both local ($r_s$ = .321; p<.020) and global coherence errors ($r_s$ = .369; p<.007).

***Discussion***

Senior adults were significantly slower in completing TMT_A and had a less efficient performance in TMT_B-A. This confirms that aging affects the ability to keep the attention focused on the completion of a task while inhibiting distracting stimuli. Aging also affected some aspects of narrative production such as lexical selection (as reflected by the enhanced production of semantic errors in older participants) and discourse organization and informativeness while preserving others (e.g., lexical access and production). The significant correlations between cognitive and narrative variables lend support to the hypothesis that the reduction in efficiency in lexical and macrolinguistic skills in the group of older participants may be at least partly related to their weakened abilities of sustained attention and inhibitory control. Crucially, a multilevel procedure of discourse analysis could detect these effects.

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