Reading Comprehension in Aging: The Role of Working Memory and Metacomprehension

ROSSANA DE BENI, ERIKA BORELLA AND BARBARA CARRETTI
Department of General Psychology, University of Padova, Italy

ABSTRACT

This study examines age-related differences in reading comprehension analyzing the role of working memory and metacomprehension components in a sample of young (18–30 years), young-old (65–74 years), and old-old (75–85 years) participants. Text comprehension abilities were measured by a standardized test, including two texts: a narrative and an expository text. The elderly’s reading comprehension performance, when compared to the norm, emerged to be adequate. More specifically, the young-old showed an equivalent level of comprehension as the young adults for the narrative text. However, a clear age-related decline was found in the case of the expository text. Hierarchical regression analyses showed that working memory capacity, as well as different metacomprehension components but not age, are the key aspects in explaining the different patterns of changes in the comprehension of narrative and expository texts.

It is well established that aging is associated with a decline in most cognitive processes, especially in such mechanisms, general or specific, that weigh on attentional resources (e.g., Verhaeghen et al., 2003). These cognitive changes are central in explaining age-related differences in various aspects of cognition. A large part of recent research shows that individual differences in basic cognitive processes can explain age-related differences in reading comprehension (Cohen, 1979; Kemtes & Kemper, 1997; Light & Capps, 1986; Stine & Wingfield, 1988, 1990; Tun, 1989).

However, it is worth noticing that most of these studies, showing impairment in the older adults’ performance, measured reading comprehension in terms of the ability to memorize and remember information stated in the text.
Thus, a possible explanation for the elderly’s decline is that task requirements, almost entirely based on learning skills, are not relevant to their everyday functioning (Hultsch & Pentz, 1980). In contrast, the higher level of comprehension accuracy in young adults (generally students), compared to the elderly, could be due to their familiarity with tasks requiring the memorization of information independently of their relevance (Schaie, 1978).

Consistently with this view, using more naturalistic reading comprehension tasks, De Beni et al. (2003) found that older adults reach a sufficient level of reading comprehension compared with normative values of adequacy, supporting the hypothesis that the elderly’s comprehension skills are intact for everyday life functioning.

Furthermore, focusing on studies that examine reading comprehension per se, that is, not the recall of text content but the ability to build a representation of the text (Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998), age-related changes are less evident (Radvansky et al., 2003; Soederberg & Stine, 1995; De Beni et al., 2003) or absent (Ehrlich et al., 1994; Burke et al., 2000; Meyer & Rice, 1983; Borella, De Beni & de Ribau Pierre, in press). Older adults are, indeed, similarly able to young adults updating their situation models during comprehension. (e.g., Morrow et al., 1992, 1997) or integrating information into situation models to reduce retrieval interference (Radvansky et al., 1996).

The hypothesis of a maintenance of comprehension skills is in agreement with Baltes and Mayer’s (1999) findings. According to Baltes, reading comprehension abilities, being part of the so-called crystallized pragmatic abilities, are maintained in the third age (young-old adults), whereas in the fourth age (adults over age 75), a more pronounced general decline is supposed to begin (Baltes, 1997; Baltes & Mayer, 1999; Baltes & Smith, 2003). Though during the maintenance phase, young-old adults are able to compensate to a certain extent for losses in the fluidity of their abilities, in some cases their performance could be affected by particular factors such as the propositional content and syntactic complexity of the test (Stine & Wingfield, 1988; Light & Capps, 1986).

Another factor usually mentioned is whether the prose is narrative or expository. However, analysis of the literature highlighted contrasting results on age-related differences in text genre. Several studies have pointed out age-related differences for the expository text and not for the narrative one (Tun, 1989; Wingfield & Stine-Morrow, 2000). Authors that agree with this view explain this data claiming that expository texts are more demanding of attentional resources because of their internal structure more densely laden with content (van Dijk & Kintsch, 1983; Budd et al., 1995) and less cohesively organized by temporal and causal relationships (Tun, 1989). As expository texts are more unfamiliar and may place greater demands on the reader (Budd et al., 1995), they are harder to process than the narrative ones.
Narrative passages, on the contrary, are easier to process because of their greater familiarity and predictability and their well-defined structure and content (Graesser et al., 1980). Moreover, as the narrative text has a higher degree of cohesion, the reader can access the information related to the causal structure of the text more quickly than information that is not included in the causal chain. The reader differently allocates its processing resources according to the text genre focusing more on the propositional text base in the case of the expository texts, and on the situation model in the case of the narrative ones (Zwaan, 1994). Different studies have shown an age-related decline in the surface level but not in the use of situation model; thus the elderly’s difficulty in the comprehension of expository text can be ascribed to the lower attention they devoted to the propositional level of the text (Radvansky et al., 2003, 2001). More globally, older adults would meet more difficulty in understanding expository texts because of the necessity of relying on a larger pool of cognitive processes. Consistently with this hypothesis, Zabrucky and Moore (1999) have shown that narrative passages are more quickly read and recalled by elderly people than expository ones (Tun, 1989), supporting age-related differences in the comprehension of expository texts (Johnson, 2003).

Again, it is important to note that in most of the cited studies, reading comprehension was measured in terms of the ability to recall a text. This load on memory could lead to confounding results making it more difficult to understand the real nature of age-related differences in reading comprehension.

The first goal of this study was to examine reading comprehension in an everyday reading situation. To this aim the procedure adopted allowed the reader to reread the text during the testing phase whenever he/she wanted, thus partialling out the role of memory. The texts (a narrative and an expository one) were taken from an Italian standardized test, devised for students who had completed the minimum level of compulsory education in Italy. The completion of compulsory education guarantees a reading comprehension sufficient for life’s average requirements; thus a comparison of the elderly group’s reading ability with the norms on this standardized test would allow us to judge their level of adequacy. Different predictions regarding the age-related differences in text comprehension are made depending on the two types of texts. Similar levels of performance between the young and young-old participants for the comprehension of narrative text are expected, in contrast with a pronounced age-related decline in the comprehension of the expository text. Since the higher cognitive resources involved in the processing of the expository text should inhibit the compensatory mechanisms used by the young-old to balance out the effects of cognitive aging.

To further analyze the age-related differences in text comprehension two aspects of cognition, which are broadly considered to be involved in reading comprehension, were studied: working memory and metacomprehension skills.
The Role of Working Memory

In order to understand a prose, the reader must be able to hold information in memory while computing the relations between successive words and sentences in order to construct a coherent, integrated representation of the text. In reading comprehension, the information contained in the text is both processed and maintained (i.e., storing the information from one sentence while reading the next one) in working memory (e.g., Fischer & Glanzer, 1986; Kintsch & van Dijk, 1978).

The crucial role of working memory in reading comprehension has largely been demonstrated (for a review, see Daneman & Merikle, 1996; Siegel, 1994) as well as the fact that the working memory capacity declines with advancing age (for a meta-analysis, Verhaeghen et al., 1993; Engle et al., 1990). The decline in working memory is considered as a source of the age-related decline in text comprehension (Kemper, 1992; van der Linden et al., 1999), since the elderly’s working memory capacity limitation increases the probability that recently processed propositions will be forgotten compromising the construction of text representation (Hultsch & Pentz, 1980). Several studies have shown that due to their smaller working memory span, older adults reach a lower sentence comprehension and text memory compared to younger adults (Norman et al., 1992; Tun et al., 1991).

In the current study, the classical working memory task devised by Daneman and Carpenter (1980) was administrated to measure working memory capacity. Besides the measure of correct recall, a measure of errors during recall, called intrusion errors, was computed. Intrusion errors are often considered an index of inhibition failure and this measure has been shown to characterize the performance of particular groups of subjects such as: poor comprehenders at different ages (Carretti et al., 2004; De Beni et al., 1998; De Beni & Palladino, 2001), poor problem solvers (Passolunghi et al., 1999), older adults (De Beni & Palladino, 2004), children with Attention Deficit Hyperactivity Disorder (ADHD) (Cornoldi et al., 2001) and, more generally, people with low working memory performance or low span (Carretti et al., 2004; Osaka et al., 2002; Kane & Engle, 2002). Several studies, indeed, suggest that both working memory and the difficulty in inhibiting irrelevant information can influence comprehension (Hartman & Hasher, 1991; Hamm & Hasher, 1992).

The Role of Metacomprehension

Metacomprehension is another factor considered critical for good comprehension (Baker, 1989). Metacomprehension skills allow the reader to monitor the comprehension process, for example, by helping to catch reading mistakes or alter reading speed depending on text content (Walczyk, 1995). Developmental studies have shown that metacognitive knowledge and control vary with reading levels (Cornoldi, 1990; Ehrlich, 1999). Poor comprehenders
often have misconceptions about their reading goals: they do not check the level and the quality of their understanding of the text and they are not aware of the strategies used to attain their goals as readers (Brown et al., 1986). The few studies on age-related differences in metacomprehension have shown a similar pattern of results. Older adults seem to use metacognitive abilities more poorly than young adults (De Beni & Cornoldi, 1985). This issue has been studied in relation to the text genre effect. Zabrucky and Moore (1999) demonstrated that with narrative texts, metacognitive skills do not affect the young and older adults’ comprehension performance, whereas they do so in the case of an expository text. The authors showed that older adults were less likely than younger adults to use effective strategies (e.g., rereading inconsistent passages) to better understand the meaning of an expository text (Moore et al., 1997; Brigham & Pressley, 1988).

The Present Study

The purpose of the current study was to better understand which factors are involved in reading comprehension, considering simultaneously the role of working memory and metacomprehension. Two types of texts, a narrative and an expository one, measured reading comprehension, allowing for a clarification of the mechanisms that make one text harder to process than the other. Differential patterns of age-related decline depending on text genre were expected. In particular, the performance in the expository text is expected to be more affected by the changes that occur with age than performance in the narrative one. Furthermore, due to the different text genre presented, working memory and metacomprehension components were expected to be differently involved in text comprehension. We predicted that a more complicated, more cognitively demanding text structure, such as an expository text, would require a greater involvement of working memory (Brebion, 2003) and metacomprehension skills than a simpler one.

METHOD

Participants

The sample for this study consisted of 30 young adults (20–30 years of age: 16 women, 14 men) and 60 older adults (64–85 years of age: 35 women, 25 men). The group of older adults was split into two groups: participants with an age range from 64 to 74 years old comprised the young-old group \((n = 30; 16 \text{ women}, 14 \text{ men})\) and participants older than 74 years comprised the old-old group \((n = 30; 19 \text{ women}, 11 \text{ men})\).

Participants were all Italian native speakers and volunteered for the study. They were recruited through an advertisement in a newspaper kiosk of a city in Northern Italy. Older adults were selected on the basis of a
physical and health questionnaire. All participants that fit the “exclusion criteria,” proposed by Crook et al. (1986) (i.e., history of head trauma; any neurological or psychiatric illness; history of brain fever; dementia or any other state of consciousness alteration; use of benzodiazepines in the last 3 months; use of illicit drugs; visual, auditory, and/or motor impairment; any symptomatic cardiovascular condition, breathing problems or pathologies causing possible cognitive impairments) were excluded from the study. Older participants were active in the cultural and social activities of the neighborhood.

Average ages were 25.07 ($SD = 3.11$, range = 20–30) for the young adults, 70.20 ($SD = 2.82$, range = 65–74) for the young-old adults and 78.30 ($SD = 2.71$, range = 75–85) for the old-old adults. Age differences in education level were not significant, $F(2, 87) = .07$, $p = .93$ (young, $M = 14.17$, $SD = 3.39$; young-old, $M = 13.93$, $SD = 3.95$; old-old, $M = 13.80$, $SD = 4.02$).

**MATERIALS**

**Reading Comprehension Test**

Reading comprehension was measured by administering two reading comprehension texts taken from a standardized battery normed on high school students (eighth graders) (*New MT tests of reading for high school – Nuove prove di lettura MT per la scuola media inferiore*, Cornoldi & Colpo, 1995). The MT battery is the most popular Italian tool for evaluating reading comprehension. It has been recently revised updating the normative scores.

The battery provides two texts for evaluating reading comprehension twice within a grade (two texts at the beginning and the end of the scholastic year). The two texts available are distinctive in terms of genre. The texts are equivalent in terms of syntactic and lexical complexity (see Cornoldi & Colpo, 1995). Furthermore, those texts presented common topics to limit the influence of an individual’s familiarity (background knowledge) with a particular domain (Cornoldi & Colpo, 1995).

The decision to adopt these materials in the current article was driven by their statistical robustness and genre distinctiveness. These characteristics could in some way compensate for the use of only one measure for each text genre. Moreover, these texts had already been used in other Italian studies with adults (young and older participants,) thus allowing for a comparison (e.g., with the data of De Beni et al., 2003).

The narrative text (40 lines long), entitled “Deafness” described a conflict situation between an adolescent and his parents. The expository text (25 lines long), entitled “Japan: Leaders in the cartoon world,” was about an experiment carried out in Japan to understand the degree of television dependence of an average Japanese family.
Inferential multiple-choice questions followed the texts: 15 for the narrative text and 10 for the expository one; each question had four choices, only one of them correct. The questions, for both the texts, required the drawing of unstated inferences necessary to deeply understand the text (texts and examples of questions are provided in the Appendix).

Each participant was instructed to silently read the passages and then to answer the questions. The texts were presented with no time limits. According to the standard procedure, participants could review passages in the texts during the response phase. This procedure, similar to our daily reading habits, gives ecological validity to the task.

The total number of correct answers for the narrative and the total number of correct answers for the expository texts assessed the participants’ reading comprehension ability.

**Working Memory: Listening Span Test**

Working memory capacity was evaluated by an Italian version of the listening span test devised by Daneman and Carpenter (1980) and adapted by Pazzaglia et al. (2000).

As in the original version, the task consisted of an increasing number of 2, 3, 4, 5, 6 sequences of simple sentences. The sequences were grouped into four sets comprised of four sequences each. For each set, 20 sentences were presented (for a total of 80 sentences), each of them was divided by an interval of 1.5 s. The sentences varied between 6 and 12 words in length. The last words of the sentences could be composed of 2, 3, 4, or 5 syllables.

Participants were instructed to listen to each sentence, judge its plausibility (saying whether it was true or false), and retain the last word. Half of the sentences were true and half were false. At the end of each set, participants were required to recall all the final words following the correct order of presentation. Two training trials preceded the task.

The total number of final words correctly recalled in the correct order during the whole test was considered the measure of their working memory capacity.1

The number of intrusion errors (words presented in the task that were not in the final position but recalled) was also computed.

**Metacomprehension Questionnaire**

Metacomprehension was measured using the Italian standardized Metacomprehension Questionnaire (Prova di Metacomprensione) designed by

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1 This scoring method produces the best distribution (Pazzaglia et al., 2000; Friedman & Miyake, 2004). Several studies with different age groups and populations using this working memory score have shown good correlations with reading comprehension tests (see Pazzaglia et al., 2000; De Beni et al., 1998, 2003; De Beni & Palladino, 2001).
Pazzaglia et al. (1994). In particular, three specific aspects of metacomprehension were measured: text sensitivity, strategic knowledge, and self-monitoring. Text sensitivity refers to the ability to discern important ideas from unimportant ones, the awareness of varying levels of text difficulty and the variety of text genre. Binary or multiple-choice questions measured genre sensitivity and a relevant information selection task measured text sensitivity. Strategy use refers to the individuals’ use and knowledge of strategies to improve reading and comprehension (e.g., “skimming” and “reread”). Binary or multiple-choice questions measured the efficacy of reading strategies and the appropriateness of their use according to literary genre. Self-monitoring assessed the ability to check one's own comprehension, detecting semantic and syntactic errors. A brief paragraph or sentences were presented with the request to identify inconsistencies. The scores used were the total number of correct answers for each of these components.

PROCEDURE

At first, participants were given an overview of the general aim of the research and the tasks they were going to carry out during two testing sessions of approximately 1 hour each.

In the first session, participants completed a health and demographic questionnaire and then performed the narrative reading comprehension test and the listening span test. In the second session, participants had to fill out the expository text and the metacomprehension questionnaire.

The reading comprehension texts and the metacomprehension questionnaire were administrated in “paper and pencil” modality, whereas the listening span test was presented in an auditory modality. To limit the influence of sensory variables (sight and hearing) (see Lindenberger & Baltes, 1997) on test results, the auditory presentation for the listening span test was adjusted to the participants’ hearing level. Moreover, for the reading comprehension tests and metacognitive test, all participants were asked whether they could easily read the text.

All the tasks were administrated individually. The order of the tasks within session was fixed.

For the reading comprehension tasks, the procedure followed the MT manual procedure closely. Thus, the order of text presentation was fixed: the narrative text was always presented first. Since the elderly performance was compared to normative control scores to assess for their level of reading comprehension adequacy, it was necessary to follow the manual procedure.

RESULTS

All the ANOVA analyses were conducted with age group (young vs. young-old vs. old-old) as the between-subjects factor and measures of reading
comprehension, working memory, and metacognition components as within-subjects variables. Post-hoc analyses were conducted using either Dunnett’s T3 or Tukey’s Honestly Significant Difference (HSD) statistic. The post-hoc method was adopted after considering whether or not measures violated the homogeneity of variance assumption, according to the Levene’s test. For all the analysis, alpha value was set to .05.

**Reading Comprehension Test: Narrative and Expository Text**

First, to evaluate the level of adequacy of the elderlies’ performance, their scores were compared with normative scores—for 8th grade students—(narrative text, \(M = 8.41; SD = 2.48\); expository text, \(M = 7.20; SD = 1.74\)). The young-old adults’ performance in the comprehension of the narrative text were significantly above the normative control scores (\(t = 2.53, df = 468, p < .05\)), but it did not differ in the comprehension of the expository text (\(t = −.2, df = 764, p = .84\)) (narrative text, \(M = 9.66; SD = 2.63\); expository text, \(M = 7.13; SD = 1.88\)). The level of comprehension reached by the old-old group did not differ from normative control scores for both the narrative (\(t = −1.07, df = 468, p = .29\)) and the expository text (\(t = −1.61, df = 7641, p = 11\)) (narrative text, \(M = 7.96; SD = 2.22\); expository text, \(M = 6.56; SD = 2.14\)).

Moreover, referring to the classification given by the manual, based on quartiles distribution, the comprehension of narrative and expository text for the young-old and old-old corresponds to an adequate level of performance for both the elderly groups.

Multivariate General Linear Models (GLM) analysis was used to examine the effect of age on two reading comprehension dependent variables: the correct answers in the narrative and in the expository text. The multivariate \(F\) for the main effect of age for the correct answer in narrative text was significant, \(F(2, 87) = 13.13, p < .001, \eta^2 = .23\), as was the multivariate \(F\) for correct answer in the expository one, \(F(2, 87) = 15.34, p < .001, \eta^2 = .26\) (see Table 1).

For the narrative text, post-hoc comparison (Tukey’s procedure) yielded significant age differences between young and old-old adults (\(M_{diff} = 3.16, p < .001\)) and young-old and old-old adults (\(M_{diff} = 1.7, p < .05\)). The group of young-old adults, on the contrary, performed as efficiently as the group of young adults. For the expository text, post-hoc comparisons (Dunnett’s procedure) showed that young adults rated higher than both the young-old (\(M_{diff} = 1.83, p < .001\)) and the old-old (\(M_{diff} = 2.4, p < .001\)); however, the latter two did not differ from each other.

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2 The approximate values given by the manual, used in Italy for diagnostic and rehabilitative purposes, refers to the clinical/educational classification of the DSM-IV. The comprehension skills are divided into four comprehension performance bands: deficient, poor, adequate, and good.
These results are consistent with age-related differences in the sensitivity to text structure. Whereas the comprehension of narrative text is preserved until late adulthood, comprehension of an expository text shows a decline, replicating the data obtained in De Beni et al.’s study (2003, Experiment I). The expository text, because of its more complex internal structure and content shows an age-related decline in comprehension for both groups of elderly participants.

Nevertheless independently of the text genre, the old-old adults showed an accentuated slowing down in reading comprehension. The results have to be taken with caution because the fixed order of text presentation should have affected the results.

**Working Memory**

The split-half reliabilities for the total number of words correctly recalled and the intrusion errors in the reading span task was calculated as correlation between the first and second half of the task, adjusted with the Spearman-Brown Prophecy formula. The reliability coefficients were satisfactory: total number of words correctly recalled, $r = .87$; intrusion errors, $r = .83$.

For the working memory measures the means, standard deviations and ANOVA statistics are presented in Table 1.

Two analyses of variance with age (young, young-old, old-old) as a between-subjects factor were conducted on the number of correct words recalled consistent with order presentation and on the total number of intrusions. Results showed a main effect of age on the total number of recalled words, $F(2, 87) = 120.451, p < .001, \eta^2 = .74$, and on the total number of intrusions, $F(2, 87) = 14.69, p < .001, \eta^2 = .25$. 

<table>
<thead>
<tr>
<th>Table 1. Descriptive Statistics (Mean, Standard Deviation) for Indicators of Reading Comprehension Measures (in Percentages), Working Memory, and Metacomprehension Measures (in Percentages) by Age Group</th>
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<tbody>
<tr>
<td>Reading Comprehension</td>
</tr>
<tr>
<td>Narrative text</td>
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<tr>
<td>Young</td>
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<tr>
<td>M 74.22 SD 15.43</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 64.44 SD 17.53</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 53.11 SD 14.8</td>
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<tr>
<td>Expository text</td>
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<tr>
<td>Young</td>
</tr>
<tr>
<td>M 89.66 SD 10.33</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 71.33 SD 18.88</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 65.66 SD 21.44</td>
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<tr>
<td>Working memory</td>
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<tr>
<td>Recalled words</td>
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<tr>
<td>Young</td>
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<tr>
<td>M 62.93 SD 6.89</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 37.63 SD 11.17</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 29.66 SD 7.27</td>
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<tr>
<td>Intrusion errors</td>
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<tr>
<td>Young</td>
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<tr>
<td>M 2.40 SD 1.67</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 4.46 SD 4.91</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 10.16 SD 8.49</td>
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<tr>
<td>Metacomprehension</td>
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<tr>
<td>Self-monitoring</td>
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<tr>
<td>Young</td>
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<tr>
<td>M 86.99 SD 7.06</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 78.06 SD 12.66</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 72.36 SD 13.22</td>
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<tr>
<td>Strategy use</td>
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<tr>
<td>Young</td>
</tr>
<tr>
<td>M 89.67 SD 9.99</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 74.33 SD 11.65</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 76.67 SD 11.84</td>
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<tr>
<td>Text sensitivity</td>
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<tr>
<td>Young</td>
</tr>
<tr>
<td>M 85.64 SD 12.57</td>
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<tr>
<td>Young-Old</td>
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<tr>
<td>M 75.64 SD 15.39</td>
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<tr>
<td>Old-Old</td>
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<tr>
<td>M 63.33 SD 19.45</td>
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</table>
Dunnett’s T3 post-hoc showed that the young adults recalled a higher number of correct words than the old-old (Mdiff = 33.26, p < .001) and young-old (Mdiff = 25.30, p < .001). This last group also showed a better recall for last words than the old-old group (Mdiff = 7.97, p = .01), whereas the number of intrusions the young-old and young did not differ from each other, both producing significantly less intrusion errors than the old-old (young vs. old-old: Mdiff = −7.26, p = .01; young-old vs. old-old: Mdiff = −5.70, p < .001).

This pattern is consistent with the extensive literature demonstrating an age-related decline in the working memory capacity. Elderly people perform less well in tasks that require the storage or processing operations of working memory.

On the other hand, it is curious to notice that there is no difference in the number of intrusions between the young and the young-old participants. Nevertheless, these results are consistent with the view that elderly adults do not show impaired attentional inhibition compared with young adults (see Gamboz et al., 2002; Borella, Carretti & Mammarella, 2006).

**Metacomprehension Test**

The reliability of the metacomprehension aspects was assessed by calculating Chronbach’s alpha over items. The reliability coefficients were satisfactory: text sensitivity, \( \alpha = .76 \); strategic knowledge, \( \alpha = .76 \); self-monitoring, \( \alpha = .79 \).

Three analyses of variance were run to examine the effect of age (young, young-old, old-old) on scores obtained in self-monitoring, strategic knowledge, and text sensitivity metacomprehension skills. A significant main effect of age for self-monitoring, \( F(2, 87) = 12.70, p < .001, \eta^2 = .23 \), strategic knowledge, \( F(2, 87) = 16.34, p < .001, \eta^2 = .27 \), and text sensitivity, \( F(2, 87) = 14.53, p < .001, \eta^2 = .25 \) was observed. Dunnett’s T3 post-hoc comparisons yielded significant age difference between the young and the two groups of elderly participants on self-monitoring (young vs. young-old: Mdiff = .70, p < .01; young vs. old-old: Mdiff = 1.14, p < .001). Tukey’s post-hoc analyses were used for the two others metacognitive components. The young group showed a higher strategic knowledge than the young-old (Mdiff = 1.18, p < .001) and the old-old (Mdiff = 1.00, p < .001) (see Table 1). The young were also more sensitive to the type of text than the elderly (respectively, young – young-old: Mdiff = .54, p < .05; young – old-old Mdiff = 1.21, p < .001); moreover, in this skill the young-old differed significantly from the old-old (Mdiff = 67, p < .05) (Table 1).

These analyses indicate that young adults have a higher performance on metacognitive components than the elderly groups which do not differ from each other except in the text sensitivity component (see Table 1).
Whereas for the metacognitive monitoring and the strategic knowledge components, there is a sort of stability in the performance for the young-old and old-old, for the text sensitivity component the difference between the young-old and the old-old seems to reflect an age-related decline.

Correlation Analyses

Intercorrelations among all study variables are provided in Table 2. The correlations have a size effect ranging from medium to large (Morse, 1999). The significant correlations between the working memory measures, the metacomprehension components, and the two reading comprehension tasks provide evidence in favor of the convergent validity of the constructs measured by the measures presented.

Contrary to our expectations, the pattern of associations between predictor variables and dependent measures was similar for narrative and expository text. Moreover, age, working memory measures, and metacomprehension skills correlated to the same extent with comprehension scores independently of text genre.

Hierarchical Regression Analyses

A stepwise hierarchical regression analysis was used to provide an estimate of the percentage of variance in the comprehension of narrative and expository texts (criterion variables), which is accounted for by three blocks of predictor variables: age, working memory measures (recalled words and intrusion errors), and metacognitive components (self-monitoring, strategy use, and text sensitivity). In Step 1, working memory was entered as a block followed by metacomprehension component measures in Step 2 and age variable in Step 3. The order of entrance of the blocks was based on theoretical considerations.

<table>
<thead>
<tr>
<th>Table 2. Pearson Product Moment Intercorrelations Among Narrative Text, Expository Text, and All Key Variable Used in the Study (N = 90)</th>
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</thead>
<tbody>
<tr>
<td>1. Age</td>
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<tr>
<td>2. Wm recalled words</td>
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<tr>
<td>3. Wm intrusion errors</td>
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<tr>
<td>4. Self-monitoring</td>
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<tr>
<td>5. Strategy use</td>
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<tr>
<td>6. Text sensibility</td>
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<tr>
<td>7. Narrative text</td>
</tr>
<tr>
<td>8. Expository text</td>
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</tbody>
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WM = working memory.
All correlation coefficient are significant at $p < .001$. 
To detect outliers on the criterion and predictor variables, Cook’s Distance was computed. No outlier cases (Cook’s Distance > 1) were found. Moreover, variance inflation factor values, and tolerance criterion indicated no significant multicollinearity (Hair et al., 1995).

Together the predictors (working memory, metacomprehension components, and age) accounted for a significant part of the variance in the comprehension of the narrative text ($R^2 = .41, p < .01$) and the expository text ($R^2 = .55, p < .001$). In the comprehension of the narrative text, the working memory accounted for 31% of the variance. Recalled words ($\beta = .46, p < .05$) made a unique contribution to the explained variance in the comprehension of the narrative text. The metacomprehension variables in Step 2 accounted for a significant increase in the explained variance (10%). Within this block, the self-monitoring component ($\beta = .28, p < .05$) was the only salient predictor of comprehension for the narrative text. The age variable entered in Step 3 did not contribute significantly to any additional variance. In the comprehension of expository text, the working memory accounted for 35% of the variance and the recalled words contributed significantly ($\beta = .50, p < .001$) towards the explained variance as for the narrative text. When the metacomprehension components were entered in the regression in Step 2, the findings showed that the self-monitoring ($\beta = .30, p < .01$) component, as in the narrative text, and the strategy use ($\beta = .25, p < .01$) made a significant contribution to the prediction of the comprehension for the expository text (20%). As for the narrative text, the age variable did not contribute significantly in the explained variance for the expository text in Step 3.

It should be noted that for both types of text, age did not make a significant additional contribution to the variance in both the narrative and the expository text. Moreover, as expected different predictors made a different contribution to the explained variance. Recalled words (working memory) and self-monitoring were the salient significant predictors for the comprehension of the narrative text. Whereas, not only recalled words and self-monitoring for the narrative text, but also strategy use were important predictors contributing to the explained variance of expository text comprehension.

DISCUSSION

The goal of the study was to analyze the changes that occur with age in reading comprehension. The procedure adopted to assess reading comprehension, due to its ecological features, allowed us to obtain a measure of reading comprehension ability per se, partialling out the role of memory. Moreover, due to the nature of the text questions presented, the reading comprehension performance obtained can be considered representative of the ability to build a coherent representation of the text and not simply the capacity to find information stated in the text or the texts’ verbatim memory.
To further understand reading comprehension and aging, groups of participants of different ages were compared (young, young-old 65–74, old-old > 75 adults). Little is known regarding the reading comprehension changes in adults over 75 years of age, even though this population has grown. Two measures of reading comprehension were used in this study: the comprehension performance for a narrative text and for an expository text. Moreover, the involvement of working memory and metacomprehension in relation to text comprehension was examined.

The comparison of the elderly groups’ scores with normative values highlighted that their performance is within the range of an adequate performance for everyday living for both types of texts. On the basis of this result, it is possible to affirm that age-related difference in comprehension skills do not compromise the elderlies’ quality of life. Hence, this suggests that aging is not associated with serious comprehension deficits even for adults over 75 years of age.

Nevertheless, different patterns of change in function of text genre were found. In the case of the narrative text, old-old participants were outperformed both by the young adults and the young-old group, which, however, did not differ from each another. This result is consistent with our predictions that comprehension problems are to be expected from the age of 75 (Baltes & Mayer, 1999). As other studies have shown, when samples are composed mainly of the young-old, aging is not associated with a decline but with a maintenance in verbal abilities (Burke et al., 2000).

When the expository text was considered, a clear age-related decline was found given that the two groups of elderly individuals differed significantly from the young adult group. It is likely that in this type of text also the young-old could not build a coherent and stable representation of the text. This is probably due to the fact that expository texts are more cognitively demanding or resource demanding than the narrative ones (Van den Broek, 1994; Radvansky et al., 2001, 2003). In the narrative text, the young-old adults being more expert comprehenders are able to compensate for age-related decline in resource allocation focusing on text information essential to the construction of a coherent situation model. On the contrary, in the expository text, more based on the propositional textbase level (Zwaan, 1994), young-old are not able to compensate for their cognitive losses. In fact, it is possible that older adults, as Radvansky et al. (2001) suggested, use the surface level to build their situation models thus to comprehend the text but without maintaining it. The old-old participants, in contrast, seem to be impaired also in situation model processing, as we observe lower comprehension scores for the narrative text with respect to the young and young-old participants. This supports the hypothesis that comprehension processes are expected to vary depending on text genre and age.

Strong age-related differences were found in the working memory capacity measure. The analyses on intrusion errors, measuring the efficacy
of the inhibitory processes, showed that the old-old participants were less able to control for irrelevant information in comparison with the young and young-old adults. This measure, conceived as the ability to manage information currently in the focus of working memory on the basis of its relevance to the task goal (Carretti et al., 2004; De Beni et al., 1998; Palladino et al., 2001), is often considered as an expression of the efficient/inefficient inhibitory mechanism in a working memory task (De Beni et al., 1998).

This age-related difference could suggest that aging might be associated with a decrease in the efficacy in inhibiting irrelevant information in text comprehension, especially for participants older than 75 years. Inhibitory processes play an important role in regulating the access of information to working memory (e.g., Hasher & Zacks, 1988). Deficient inhibitory mechanisms in the old-old are coupled with an accentuated decline in working memory capacity. Herein the results showed a linear decline in working memory capacity: age-related differences were found also between the young-old and the old-old participants, the latter recalling significantly fewer words. The old-old adults also showed a lower working memory capacity compared to the other two groups and committed a significantly higher number of intrusion errors. The old-old group’s inefficient inhibitory mechanisms during reading comprehension difficulties overload their working memory system, damaging the final comprehension of the text (e.g., De Beni & Palladino, 2001). The preservation of an efficient inhibitory mechanism in the young-old adults, on the other hand, could explain their maintenance of comprehension skills in the narrative text.

The comparison between the three groups on metacomprehension components showed no change in performance level between the two elderly groups, with the exception of the text sensitivity component that has a linear decline across age groups. This result seems to be in contrast with previous work showing that text sensitivity (considered as the ability to recall the more relevant part of the text) is not the major source of adult age-related differences in prose memory (Petros et al., 1989). Nevertheless, in the current article, the tool measuring text sensitivity considers a broader range of abilities associated to text sensitivity, such as reader’s awareness about the varying level of text difficulty. Thus the request of reflecting on their cognitive processes and on the characteristics of the text could be the critical point that highlighted the differences between the three age groups. This decrease in metacomprehension abilities with age is consistent with previous works (De Beni & Cornoldi, 1985).

The results of group comparisons were better clarified by the finding that considered the relationship between age, reading comprehension, working memory, and metacognitive skills. Correlational analyses showed that age is negatively associated with metacomprehension skills and working
memory, but positively with intrusion errors. In other words, becoming old is related with a decrease in metacomprehension components, working memory capacity, and an increase in the number of irrelevant information entering the working memory. Participants who made more intrusion errors showed a poorer performance both in working memory tasks and in the metacomprehension components.

Regression analyses showed that the predictors that best explained the variance in the comprehension of narrative and expository texts changed depending on text genre. Thus, different processes seem to be associated with reading comprehension depending on text genre. All predictors explained, respectively, 41% of the variance for the narrative text comprehension and 55% for the expository text comprehension. In both texts, the working memory measures plus the metacomprehension components accounted for a significant part of the global model’s variance. Nevertheless, depending on the type of text, different metacomprehension components are involved.

In the case of the narrative text, only self-monitoring, such as being able to adequately evaluate and regulate our own understanding, predicts a higher performance. Whereas for understanding an expository text, a larger pool of processes has to be involved. Due to the presence of a higher amount of information, usually not linked by a story plot, the reader needs to maintain more information in memory (Singer & O’Connell, 2003). At the same time, the individual has to choose the right strategies to effectively understand each part of the text such as reread difficult passages, fixing up meaning representation, and more frequently, monitor comprehension to make conjunctions between parts of the text. Therefore, to carry out those more demanding jobs, the reader has to rely more on his/her metacomprehension skills and on working memory capacity. For the above reasons, the elderly could be more sensitive to text structure, showing a more accentuated impairment in the comprehension of an expository text. It is important to note that in both cases, the age variable did not contribute to the variance of the global model. Consistently with individual difference comparisons, aging is not the major source of differences in comprehension abilities.

CONCLUSION

It is well known that reading comprehension is the product of an interaction between the reader (verbal abilities, prior knowledge, and the participants’ level of education), the task (e.g., presentation mode), and text variables (e.g., organizational level of the text, type of questions presented). Since reading comprehension is a complex ability, those aspects become increasingly crucial with age (Meyer, 1987).
Several studies have focused attention on age-related differences in reading comprehension trying to identify which differences in the general mechanisms, such as working memory, inhibition, and processing speed, could explain the age-related changes (Salthouse, 1997). Nevertheless, the majority of cross-sectional studies on reading comprehension consider the elderly as a homogeneous group overestimating the age-related decline in comprehension abilities. Thus, a separate sample of the old-old was included in this study. With the use of two standardized reading comprehension texts and strict criteria in the selection of participants, we tried to control for some of the variables mentioned above.

Although comprehension abilities for the two groups of older participants can be considered as adequate according to the norm, an age-related decline seems to be present with the expository text where the young-old group performed similarly to the old-old group, both reaching lower levels of comprehension than the young group. In the case of the narrative text, a change was detected only for the old-old group, whereas the young and young-old showed comparable levels of performance. According to these findings, we can state that a clear decline in comprehension is evident only in the fourth age. The young-old seem to show a preservation of reading comprehension skills except in cognitively demanding texts.

Indeed, our findings suggest that age-related differences in reading comprehension are mainly due to a decline in cognitive processes such as working memory or metacognitive flexibility. When older adults can rely on other aspects of their mental functioning, such as background information, or more globally their expertise as “old-readers,” reading comprehension is almost completely spared.

To summarize, findings from our study contribute to the understanding of the changes occurring in reading comprehension in aging, considering the role of working memory and metacomprehension in different types of texts. The working memory capacity and the self-monitoring metacomprehension component better predicted the comprehension of narrative texts, whereas working memory, self-monitoring, and strategy use metacomprehension skills were stronger predictors of expository text comprehension.

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**APPENDIX**

Text comprehension material and examples of questions for the narrative and expository texts (literally translated from Italian).

**Narrative Text**

**Deafness**

He had just thrown his things on the bench near the front door, and was in the bathroom washing his hands when he endured the usual attack, causing the usual effects of stiffening of the body and paralysis of the mind.

How was it at school today?—the mother asked.

Anything new?—said the father, almost in unison. They still hadn’t understood, thought the boy, and he resorted to instinct, which was
to pretend that he hadn’t heard. He didn’t do this out of spite, as they accused him of, nor was he one that didn’t like speaking, which was how it was often portrayed to the outsiders. He liked doing it, but they couldn’t understand that stories had their own time, that they had to be slowly pieced together in the loneliness of a dialogue with oneself, before being uncovered, before being offered to the others.

So?—the father caught him as he entered, taking it for granted that there was no need to repeat the question, and so the lack of reply was taken as a simple delay. The boy mumbled a minimal sentence to himself.

What?—the father asked with a lightly ironic tone which became a repeated habit as time went on.

Nothing—summarized the son and, to show that he was starving hungry, which he really was, he filled the plate and attacked it, as a signal that, for a while, he would be busy.

Yes, there was something. An unpleasant matter, injustice on the part of the teacher as a result of an confusing and ambiguous exchange and only the exact words would have been able to restore the truth about this matter, and so to have, in exchange, consolation and maybe even be rewarded. He felt that he couldn’t run the risk. He tried to organize the story in his mind as he cleaned his plate, but he wasn’t able to, because also he would have preferred to first concentrate on his food and then think about the rest, each thing in its own time and above all because his mother insisted with exasperating tenderness:

So, come on, tell us.

The more the irritation spread as the ritual followed its relentless stages (“is it possible that you never tell us anything?,” “you know that we like to know what goes on in your life,” and also, terribly threatening in its reassuring intention “it’s not out of curiosity that we ask but out of interest,” as if the engulfing interest was more inoffensive than just simple curiosity), the more the story was kept inside, it became poor and silly, an insignificant event, an indescribable chaos of uncertain and uneasy sensations; and the distrust had grown so much that the chance of being understood, that what came out at the beginning sounded and was incomprehensible.

Speak up—said the father—and look me in the eyes when you speak.

The boy raised his head and started again, in a loud voice but hastily.

Speak clearly and don’t eat your words—interrupted the father.

The boy said something else, but again, quietly and trailing off.
Eh? Eh? What?—the mother shouted.

Come on, you can speak freely, but be clear.—asked the father.

The boy continued to talk, in a quiet voice, looking down, eating his words.

Can’t you say the same thing loudly and clearly?—the father pretended to ask.

Nothing. I said nothing has happened—articulated the son.

**Questions**

1. The boy doesn’t want to talk to his parents because:
   - nothing happened at school worth mentioning
   - he doesn’t want to tell his parents what happened
   - he is tired of always having to tell the same things
   - he needs to be able to tell his last adventure with calm*

2. How is it that when the boy decides to speak he is not understood?
   - because he is convinced that he won’t be understood*
   - because he is eating with his mouth full
   - because his story is confusing
   - because as he is speaking his parents are doing something else

**Expository Text**

*Japan: Leaders in the Cartoon World*

In 1979 in Japan, an experiment was carried out: forty-two families accepted to live for a certain period of time without watching television. After a few days four families gave in. All of the participants turned on the television before the end of the first month. “It was noted that in general the women tended to follow the rules more meticulously”—states Masasci Kawaike, the founder of the experiment—whereas a considerable number of men went secretly round to their neighbors to watch television, especially the sports programs. In terms of the youngsters, many stated that they felt isolated at school because they couldn’t discuss the programmes of the day with their classmates; the teenagers complained that they were not up to date on the fashions and were not able to learn the latest dance moves shown on television. The adults complained about not being able to fall asleep after an

* correct answers
evening without TV, and a number of fathers admitted to turning to drink to make up for the lack of TV.

Japan, is nowadays, one of the biggest powers in television, the prototype of the communication industry. On the inside, they have not been thrown into confusion, as has been seen elsewhere in the world. Here, the invention of the television has not brought about the death of reading. In the rest of the world, the development of the electronic media has provoked the collapse of its predecessors: books and newspapers. To keep up-to-date, the Japanese continue to read books, magazines and newspapers. They listen to the radio and watch television for enjoyment. The progress in technology combined with enterprise puts the Japanese in first place in production, appliance sales and programmes’ export.

The heroes created by the Japanese production companies are known worldwide. The Japanese production dominates a large part of the cartoon market. They export about one thousand new episodes a year. Around 25% of the total production is made up of the science fiction series, the rest are those of the literary characters. “Remi” is taken from the French romance “Without family.” Heidi from the German romance of the same name. “Anne of Green Gables” is taken from the romance by the Anglosaxon writer Lucy Maud Montgomery. These cartoons only make a short appearance on the Japanese television. In fact, they are designed and produced with exportation in mind.

Questions

1. In the passage, the Japanese are referred to as :
   independent people and conquerors of Europe
   people who want to be first in the world for artistic ability
   people who have abandoned their social and cultural traditions
   people with initiative*

2. Why is the production of Japanese cartoons so impressive?
   because the Japanese are ruthless television viewers
   because it mirrors the average Japanese culture
   because they are made for the international market*
   because the main arguments are science fiction and electronics

* correct answers