

Reduced Syntactic Processing Efficiency in Older Adults in Reading Sentences

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1. Introduction

Sentence comprehension is one of the key components of human language. In order to construct a meaningful representation of a given sentence, one has to recognize single words and integrate word-level semantic blocks into a larger semantic utterance under the guidelines of semantic and syntactic rules. While research has documented this age-related decline in semantic processing, there is still debate concerning whether syntactic processing also declines during aging. The aim of the present study was to test whether syntactic processing, in addition to semantic processing, declines during aging.

2. Methods

To control for the confounding effects of other cognitive skills, the recruited 26 younger and 20 older adults were well matched on working memory capacity, general intelligence, verbal intelligence, and verbal fluency. The study included congruent sentences (CON, 妹妹把窗户擦洗干净了/ The younger sister **cleaned up** the window.), sentences with semantic violation (SEM, 妹妹把窗户抄袭了/ The younger sister **plagiarized** the window.), and sentences with both semantic and syntactic violation (SEM+SYN, 妹妹把窗户茶叶了/ The younger sister **tea** the window.) (Wang et al., 2008). The sentences differ from each other only on the critical words, which were matched for word frequency and number of strokes. The three conditions showed significant differences in terms of semantic acceptability. The two incongruent conditions were both rated as significantly less acceptable than the congruent condition, and there was no significant difference between the two incongruent conditions. The SEM vs. CON and SEM+SYN vs. SEM contrasts would reveal semantic and syntactic effect, respectively. EEG data were recorded with 64 channel Neuroscan system. After preprocessing, ground averaged event-related potential (ERP) data were used for comparison.

3. Results and Discussion

The behavioral results revealed that the older adults had significantly lower accuracy on measures of semantic and syntactic processing compared to younger adults. For ERP data, the older adults showed delayed peak latency of N400 and P600 compared to the younger adults for semantic analysis. For the N400 amplitude, there was a significant Condition by Region by Hemisphere by Group interaction, simple main effects revealed significantly higher N400 amplitude in the SEM condition compared to the CON condition in anterior and posterior regions in both the left and right hemisphere for younger adults, whereas the same was true only in the right hemisphere for older adults.

In the syntactic analysis, the older adults showed delayed peak latency of N400 and P600 compared to the younger adults. For N400 amplitude, there was a significant Condition by Hemisphere by Group interaction. Simple main effect revealed that the N400 effect was found in both anterior and posterior regions and in the left and right hemispheres for younger adults, and was found in the posterior region but not in the anterior region in the older adults. For the syntactic processing related P600 amplitude, there was no significant Group by Condition interaction in either the left anterior, left posterior, right anterior or right posterior regions. Critically, a larger P600 effect was associated with lower accuracy in the SEM+SYN condition compared to the SEM condition for the older adults but not for the younger adults.

While the P600 effect suggests that the older adults were able to respond to the syntactic violation as younger adults did (Kemmer et al., 2004), the key finding of the present study was that syntactic processing was less efficient in older adults. During syntactic processing, older adults also showed delayed peak latency for P600 relative to younger adults. Moreover, behavior-ERP correlation analysis revealed that the larger P600 effect was linked with less accuracy in the SEM+SYN condition compared to the SEM condition in the older group only. The correlation results suggested that the P600 effect in the older adults reflected a less efficient response (Zhu et al., 2015) indicating they failed to effectively use syntactic information during reading. In summary, the present study is the first to document that syntactic processing declines during aging in addition of semantic processing decline.

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5. Bibliographical References

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