Task Specificity in Age-Related Slowing: Word Production Versus Conceptual Comparison

Guillaume Doose and Pierre Feyereisen

Department of Experimental Psychology, Catholic University of Louvain at Louvain-la-Neve, Belgium.

We analyzed age-related slowing in 29 younger ($M = 22$ years) and 30 older adults ($M = 70$ years) who performed a conceptual comparison task, a naming task, and a simple reaction time task. Both vocal and manual responses were elicited in all except the naming task. Results did not support the hypothesis that there is greater age-related slowing in comparison tasks than in production tasks. In contrast, we found an interaction between age and response modality in the conceptual comparison task. Response latencies of younger participants were shorter in the manual modality whereas those of older participants were shorter in the vocal modality. In the simple reaction time task manual responses were faster in the two age groups. These findings are discussed in relation to models assuming task-specific slowing factors.

VAST research has been devoted to the study of age-related changes in processing speed. According to the general slowing theory (e.g., Myerson & Hale, 1993), the response time of older adults in a speeded task is a simple multiplicative function of the time needed by younger adults to perform the same task under the same conditions. According to process-specific theories (e.g., Amrhein, 1995; Fisher, Fisk, & Duffy, 1995), age-related slowing varies depending on several factors. First, differences have been found between domains: slowing is larger in the nonlexical than in the lexical domain (e.g., Hale & Myerson, 1996). Second, differences have been reported between tasks, for instance between visual search and memory search (Fisk, Fisher, & Rogers, 1992; Slivinski & Hall, 1998). Third, age-related slowing might affect some specific component of a task. Madden, Pierce, and Allen (1993) interpreted the finding of lower slowing rates in oral than in manual responses in lexical decision tasks by assuming “a disproportionate age-related increase in the time required for selecting a manual response” (p. 505). Amrhein (1995) concluded from a meta-analysis that in picture-word processing, age-related slowing rates were higher in comparison tasks (e.g., conceptual identity judgment) than in production tasks (e.g., word naming). However, such a conclusion may be questionable. It was drawn from a meta-analysis pooling results from several experiments. A within-subject experiment comparing performance in various tasks might yield more reliable results. Furthermore, some experimental findings did not support the hypothesis (vocal naming vs. categorizing: Feyereisen, Demaeght, & Samson, 1998; lexical decision versus word pronunciation: Madden et al., 1993).

The aim of this article was to test the hypothesis of Amrhein (1995) within Theios and Amrhein’s (1989) framework. We compared response latencies in the same group of younger and older adults performing production and comparison tasks. We also included a simple reaction time measure (i.e., a task that did not require response selection), and we controlled the response modality factor by eliciting manual and vocal responses. We contrasted the prediction of the general slowing theory (intervention of a single multiplicative factor) to the assumption of a disproportionate slowing factor in conceptual comparison versus naming.

Methods

Participants

Fifty-nine right-handed native French speakers volunteered for the experiment: 29 younger adults (range = 19–26 years) and 30 older, independently living adults (range = 64–76 years) in good mental and physical health, with an equal proportion of women and men in both age groups. Preliminary investigations did not reveal any case of cognitive impairment among elderly participants.

Procedure

Participants faced a microcomputer Macintosh Performa 450 (Apple Computer Inc., Cupertino, CA) at a comfortable distance. We presented all items on the center of the computer screen. We recorded latencies and the nature of the manual responses through a Response Box (Cedrus RB-400, Cedrus Corp., San Pedro, CA). We recorded latencies of vocal responses through a microphone and manually noted their nature. We eliminated response times corresponding to errors or to recording problems (mainly because of the use of the microphone) from the analyses.

The experiment consisted of three tasks: a conceptual comparison task, a naming task, and a simple reaction time task. Before beginning each task, we instructed the participants to respond as quickly and as accurately as possible. The order of tasks was balanced across participants. The whole session took less than 1 hour. Stimuli were either single written words (carrés [squares], étoiles [stars], coeurs [hearts], and anneaux [rings]), or strings of shapes corresponding to the same four concepts. Two sizes were used: small (1.5 mm × 2.5 mm for each letter or shape) and large (6 mm × 10 mm). A training session preceded all the tasks.
Conceptual comparison task.—The presentation time of the first item was 1 s. During the next 0.5 s, the item was masked by a black rectangle. The second item was presented until there was a response. The interstimulus interval was fixed at 1.5 s. In half of the trials the two items referred to the same concept. In one block, we instructed participants to verbally respond yes if two successive stimuli had the same meaning and no otherwise. In another block, the participants made the same/different decision through manual responses (right and left index fingers). Order of key assignment and of vocal/manual conditions were balanced across participants.

Naming task.—Participants had to give the name of the shapes (16 items; 4 concepts $\times$ 2 sizes $\times$ 2 presentations) and to read words (16 items). Items were separated by a blank screen of 1 s duration and were presented until response occurred. The two stimulus modalities were mixed.

Simple reaction time.—Participants were required, in two different blocks, to respond orally yes and manually with the right hand as soon as an item appeared. The interstimulus interval varied from 0.5 to 1.5 s. The order of the blocks was balanced across participants.

RESULTS

Dependent variables were errors (except in the simple reaction time task in which no error was possible) and latencies of correct responses. We computed medians of response latencies in order to minimize the influence of outliers without eliminating them. Throughout the analyses, we used a conventional significance level of .05.

Analysis of the Response Modality Effect on Age-Related Slowing

We conducted analyses of variance (ANOVA) to examine the influence of age and response modality (manual, vocal) in the different tasks. We performed ANOVAs on response latencies twice, once with the original values (Fu tests) and once after a logarithmic transformation (Ft). Such a transformation should remove the multiplicative factor involved in general age-related slowing. Main findings are presented in Table 1.

As expected, younger adults responded faster than older adults in the simple reaction time task, $Fu(1, 57) = 8.8, p = .004$, in the conceptual comparison task, $Fu(1, 57) = 21.7, p < .001$, and in the naming task, $Fu(1, 57) = 33.44, p < .001$. Older adults did not make more frequent errors than younger adults. Response modality influenced latencies of simple reactions: manual responses were faster than vocal ones $Fu(1, 57) = 320.8, p < .001$. This factor did not interact with age, $Fu(1, 57) < 1$, and $Ft(1, 57) < 1$. On average, manual responses were not faster than vocal responses in the conceptual comparison task, $Fu(1, 57) = 1, p = .32$.

However, age interacted with response modality, $Fu(1, 57) = 31.1, p < .001$, $Ft(1, 57) = 30, p < .001$. Whereas younger adults were slower in vocal responses than manual responses, older adults were slower in the manual than in the vocal modality. Errors were more frequent in the manual than in the vocal modality, $F(1, 57) = 37.56, p < .001$; however, the interaction between age and response modality was not significant, $F(1, 57) < 1$.

Comparison of Latencies of Vocal Responses in Naming and Conceptual Comparison Tasks

First, we selected data of the conceptual comparison task to be compared to the data of the naming task. The most comparable data were the latencies of vocal responses to the “same” pairs. A preliminary two-way ANOVA of response times (2 Age Groups $\times$ 2 Tasks) showed a significant effect of age, $Fu(1, 57) = 22.94, p < .001$, but did not reveal a task effect or interaction with age. Next, we computed slowing rates by dividing the individual data of each older participant by the mean of the younger adults in the corresponding condition. For example, mean latency of responses of a given elderly participant in the conceptual comparison task was divided by 613, the mean response time of the 29 younger participants in that condition (Table 1). We found that slowing rates were significantly higher in the naming task ($M = 1.20$) than in the vocal comparison task, “same” responses ($M = 1.09$), $t(29) = 3.87, p < .001$.

DISCUSSION

The aim of the present study was to test Amrhein’s (1995) hypothesis that higher rates of age-related slowing would be evidenced in comparison rather than production tasks. Thus, we compared the performance of younger and older participants in several tasks. Age-related slowing, however, was higher in the naming task (about 1.2) than in the vocal comparison task (about 1.1) and, thus, the findings did not support the hypothesis. Instead, we found a significant interaction between age and response modality in the conceptual comparison task. Whereas younger adults showed faster responses in left–right manual key pressing than vocal yes–no responses, older adults showed the reverse effect without age difference in the number of errors. A comparable effect of response type was reported by Madden and colleagues (1993) who found that among older adults lexical decision was faster in the vocal than in the manual modality. Inversely, Baron and Journey (1989) reported that responses to spatial location of stimuli were faster in the manual modality for both younger and older participants. In the simple reaction task, we found, as did Nebes (1978), that manual responses were faster than vocal ones in both age groups. Thus, there is a global advantage of the manual modality because of the mechanisms of response execution or the technique of response recording with the major exception of older adults making lexical decisions or conceptual judg-

<table>
<thead>
<tr>
<th>Task Condition</th>
<th>Younger Adults</th>
<th>Older Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Manual SRT</td>
<td>242</td>
<td>60.1</td>
</tr>
<tr>
<td>Vocal SRT</td>
<td>346</td>
<td>66</td>
</tr>
<tr>
<td>Word naming</td>
<td>599</td>
<td>76.2</td>
</tr>
<tr>
<td>Manual CCT, “same”</td>
<td>566</td>
<td>105.2</td>
</tr>
<tr>
<td>Vocal CCT, “same”</td>
<td>613</td>
<td>99</td>
</tr>
</tbody>
</table>

Note: SRT = simple reaction time; CCT = conceptual comparison task.
ments. Consequently, slowing was found to be higher in the manual comparison task than in the vocal one. To account for this result, we suggest that the manual comparison task specifically requires participants to hold an arbitrary stimulus–response (S–R) mapping in working memory. Older adults experienced greater difficulty in activating key assignment than in using verbal yes–no labels. This problem did not arise in the task used by Baron and Journey (1989) in which left–right and up–down manual responses were congruent with stimulus presentation. Further experiments are needed to test these explanatory hypotheses. Age-related changes in the capacity to store material for further comparison can be analyzed by varying the size of the memory set and the duration of the interval between items to be compared. Age-related changes in the capacity to hold S–R mapping in working memory can be analyzed by manipulating the strength of the associations between input and output nodes. In conclusion, results of the present experiment were inconsistent with the general slowing theory. Several interactions continued to be evident even after logarithmic transformation. The general slowing theory cannot account for the interaction between age and response modality.

Acknowledgments

This research was supported by the Action de Recherche Concertée 98/03-215 of the Communauté Française de Belgique. Pierre Feyereisen is also funded as Research Director by the National Fund for Scientific Research, Belgium.

Address correspondence to Guillaume Doose or Pierre Feyereisen, Department of Experimental Psychology, 10, Place du Cardinal Mercier, B-1348 Louvain-la-Neuve, Belgium. E-mail: doose@neco.ucl.ac.be and feyereisen@neco.ucl.ac.be

References


Received December 8, 1999

Accepted June 14, 2000

Decision Editor: Toni C. Antonucci, PhD