The effect of age and individual differences in attentional control: A sample case using the Hayling test

BORELLA, Erika, et al.

Abstract

Individual differences in working memory (WM) have been shown to reflect the ability to control attention in order to prevent interference. This study examines the role of WM capacity in resisting interference in the Hayling task, in samples of younger and older adults. In each age group, high and low WM span individuals had to complete high-cloze sentences with either expected words (initiation) or words providing no meaning to the sentences (interference). Results showed increased response times and decreased correct responses in interference, as compared to initiation. As interference increased, older adults demonstrated lower accuracy than younger ones. Further, low spans demonstrated higher interference costs than high spans on accuracy, while the reverse pattern was found for response times. Our findings suggest that both age and individual differences in WM capacity need to be considered to account for differences in the ability to resist to interference.

Reference


DOI: 10.1016/j.archger.2010.11.005

Available at:
http://archive-ouverte.unige.ch/unige:87070

Disclaimer: layout of this document may differ from the published version.
The effect of age and individual differences in attentional control: A sample case using the Hayling test

E. Borella a,*, C. Ludwig b, D. Fagot c, A. De Ribaupierre c,b

a Faculty of Psychology, University of Padua, Via Venezia 8, 35131 Padova, Italy
b Center for Interdisciplinary Gerontology, University of Geneva, Route de Drize 7, CH-1227 Carouge, Switzerland
c Faculty of Psychology and Educational Sciences, University of Geneva, Boulevard du Pont d’Arve 40, CH-1205 Geneva, Switzerland

A R T I C L E   I N F O

Article history:
Received 10 July 2010
Received in revised form 2 November 2010
Accepted 3 November 2010
Available online 7 December 2010

Keywords:
Working memory
Interference
Individual differences
Cognitive aging

A B S T R A C T

Individual differences in working memory (WM) have been shown to reflect the ability to control attention in order to prevent interference. This study examines the role of WM capacity in resisting interference in the Hayling task, in samples of younger and older adults. In each age group, high and low WM span individuals had to complete high-cloze sentences with either expected words (initiation) or words providing no meaning to the sentences (interference). Results showed increased response times and decreased correct responses in interference, as compared to initiation. As interference increased, older adults demonstrated lower accuracy than younger ones. Further, low spans demonstrated higher interference costs than high spans on accuracy, while the reverse pattern was found for response times. Our findings suggest that both age and individual differences in WM capacity need to be considered to account for differences in the ability to resist to interference.

© 2010 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Most of the working memory (WM) models share the common feature of considering a supervisory attentional system or a central executive component, responsible for allocating attentional resources and managing controlled, intentional, conscious or effortful processes (Miyake and Shah, 1999). Because WM tasks imply simultaneous processing and storage, they entail controlled attention to conduct processing and/or to alternate between processing and storage in order to achieve the task goal. Hence, cognitive/attentional control appears as a central feature of WM. Several authors have further proposed that cognitive control accounts for either individual (e.g., Miyake and Shah, 1999; de Ribaupierre, 2000) or/and age differences (e.g., Craik and Byrd, 1982) in both WM performance and complex fluid cognition (e.g., Borella et al., 2006).

With respect to individual differences, Engle (2001) has proposed the construct of executive, or controlled, attention to account for quantitative and qualitative differences in processing across individuals. In this perspective, executive attention is viewed as a general content-free cognitive resource that can be reliably captured by means of complex span tasks, such as the reading span (see Conway et al., 2005).

Engle and Kane (2004) recently suggested that executive attention is important to maintain information in active memory, and to resolve conflicts resulting from competition between task-appropriate responses and prepotent but inappropriate ones. Engle and collaborators largely developed their view by means of an extreme group methodology: they first identified high and low span individuals on the basis of their performance on complex span tasks, and subsequently compared these individuals on various tasks. These authors reported that in conditions in which automatic responses were largely sufficient to achieve the tasks, high and low spans did not significantly differ. However, when attention was required, high spans outperformed low spans; high spans could maintain active a larger amount of information and were more efficient to resist interference (Engle and Kane, 2004; Kane et al., 2004). Accordingly, individual differences in WM capacity seem to account for differences in the ability to keep relevant information temporarily available, and most particularly, when inhibition of irrelevant information is also required. More specifically to the present purpose, Engle’s findings suggest that differences in content-free executive attention account for differences in the ability to use controlled processing to resist interference.

Interestingly enough, similar hypotheses can be advanced with respect to age differences. It is commonly reported that, as compared to younger adults, older adults show reduced perfor-
mannances in WM tasks such as the reading span (e.g., Borella et al., 2008). It has also been suggested that age-related differences come from a reduction in processing resources (Craik and Byrd, 1982), or from a decline in the ability to control for interference (Hasher and Zacks, 1988). Thus evidence tends to support an age-related decline in controlled attention, often manifest in tasks that require actively inhibiting, suppressing, or clearing irrelevant information (McDowd et al., 1995).

However, to our knowledge, no study has been interested in considering together age and individual differences in controlled attention, and in investigating whether they exert a joint influence in explaining performance in tasks requiring resistance to interference.

The present study aimed at specifically addressing this issue. Using an extreme group design, its objective was to compare the performance of younger and older adults with high and low WM spans on a test involving active inhibition of irrelevant responses: the Hayling test (Burgess and Shallice, 1996). In this task, participants have to complete the final word of series of 15 high-cloze sentences either with a word that is driven by the context (initiation) or with a word that is syntactically correct, but gives no meaning to the sentence (interference). The latter condition requires the participant to draw upon controlled attention to resist interference from the word that is highly activated by the sentence. Empirically, inhibition failures are reflected by a decrease in the proportion of correct responses, while the requirement of inhibiting irrelevant competing responses is reflected by an increase in response times.

With respect to the present study, predictions were that individuals with reduced WM capacity would be more hampered in actively suppressing the competing irrelevant information. Therefore, low span participants would be more hampered than high span ones in the interference condition. Similarly, older adults would, on average, be more hampered than younger adults in the latter condition. Finally, older low span individuals, who demonstrate the lowest WM capacity, were expected to be the most hampered when the task requires an active suppression of irrelevant responses.

2. Subjects and methods

2.1. Participants

The initial sample consisted in 241 young and 161 older adults, all French speakers. Younger participants aged 18–35, were University of Geneva undergraduates who participated to the experiment as part of course credit. Older participants, aged 60–88, were healthy community dwelling individuals, recruited by means of newspaper advertisement or from the University of the Third Age of the University of Geneva. All participants were individually tested. Participants with less than 85% of correct responses in the condition A of the Hayling task were excluded, leaving 237 young and 155 older adults. This criterion was chosen to ensure that the expected word in initiation condition had been provided.

In order to equate sample sizes across age groups, 155 younger adults were subsequently randomly selected from the 237 ones. In each of the remaining samples, that is 155 younger (mean age: 22.52 ± 3.27), and 155 older adults (mean age: 69.80 ± 5.88), participants with higher and lower WM scores were identified on the basis of their performance in the reading span task. A tercile split was applied within each age group. Individuals with scores falling in the upper tercile were qualified as high spans and individuals with scores in the lower tercile were qualified as low spans. Individuals with scores in the center tercile were discarded. The remaining sample consisted in 52 young high spans, 48 young low spans, 52 old high spans and 52 old low spans (Table 1). Results of the ANOVA age (younger, older) × span (high, low) on the WM score, showed a significant main effect of age, F(1,200) = 213.49, p < 0.01, ηp² = 0.51, of span, F(1,200) = 829.23, p < 0.01, ηp² = 0.81, and a significant age × span interaction, F(1,200) = 32.53, p < 0.01, ηp² = 0.14. Overall, older adults had a poorer WM capacity than younger adults, and low spans scored lower than high spans. Results of post hoc pair-wise comparisons revealed that younger high spans scored significantly higher than all three other groups. Older high spans scored higher than both younger and older low spans; however, older low spans scored lower than all three other groups (all comparisons at p < 0.01). It is worth stressing that old high spans and old low spans did not differ significantly on chronological age, as indicated by the results of a t-test for independent samples.

A series of 2 × 2 ANOVAs comparing age (younger, older) and span (high, low) on educational level and vocabulary score was also conducted (see Table 1 for descriptive statistics).

With respect to the number of years of education, results revealed that the main effect of age, F(1,200) = 45.22, p < 0.001, ηp² = 0.19, of span, F(1,200) = 4.62, p < 0.05, ηp² = 0.02, and the interaction age × span, F(1,200) = 4.62, p < 0.05, ηp² = 0.02, were significant. Planned comparisons indicated that the two groups of young adults underwent more years of education than high and low span older adults (all comparisons at p < 0.01). Furthermore, whereas young high spans did not differ from young low spans, old high spans had a significantly higher level of education than the old low spans (p < 0.01).

As concerns the vocabulary, assessed by the Mill Hill, part B (Deltour, 1998), the main effect of age, F(1,200) = 28.18, p < 0.001, ηp² = 0.12, of span, F(1,200) = 8.40, p < 0.01, ηp² = 0.04, and the interaction age × span, F(1,200) = 4.02, p < 0.05, ηp² = 0.02, were significant. Planned comparisons revealed that old high spans presented a significantly higher performance than both old low spans and the two groups of younger adults (all comparison at p < 0.01). In contrast, young high and low spans were not significantly different from each other.

2.2. Tasks

WM capacity was assessed by means of a computerized French adaptation of the reading span task (Delaloye et al., 2008; Robert et al., 2009). Participants were visually presented with series of individual sentences and had to provide a semantic judgment upon the content of each sentence, while temporarily maintaining the final word of each sentence. Series contained from 2 to 5 sentences, with each set defining an item. A total of 16 items were used, 4 at each set length, for a total of 56 sentences. Before the test phase, practice items were presented. At the end of each set, participants were required to orally recall the words in the original order of appearance. WM capacity was scored by the mean number of words correctly recalled independently of the recall order computed as the total number of correct words correctly recalled.

Table 1 Characteristics of the young and older adults, classified as high- and low-span participants, mean ± S.D.

<table>
<thead>
<tr>
<th></th>
<th>Young adults</th>
<th></th>
<th>Older adults</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High (N=52)</td>
<td>Low (N=48)</td>
<td>High (N=52)</td>
<td>Low (N=52)</td>
</tr>
<tr>
<td>Age¹</td>
<td>21.81 ± 2.41</td>
<td>23.04 ± 3.50</td>
<td>68.73 ± 5.80</td>
<td>70.62 ± 5.02</td>
</tr>
<tr>
<td>Edu.²</td>
<td>16.0 ± 0.0</td>
<td>16.00 ± 0.0</td>
<td>14.38 ± 3.71</td>
<td>12.87 ± 3.01</td>
</tr>
<tr>
<td>Vocab.²</td>
<td>37.03 ± 2.73</td>
<td>36.64 ± 2.74</td>
<td>40.31 ± 2.57</td>
<td>38.12 ± 4.37</td>
</tr>
<tr>
<td>RSpan.²</td>
<td>3.37 ± 0.06</td>
<td>2.68 ± 0.31</td>
<td>3.11 ± 0.16</td>
<td>2.07 ± 0.54</td>
</tr>
</tbody>
</table>

¹ Age in years.
² Number of years of formal education.
³ Vocabulary performance assessed by the Mill Hill Part B.
⁴ Performance at the reading span test (mean number of words correctly recalled).
Resistance to interference was assessed by means of a French computerized adaptation of the Burgess and Shallice (1996) Hayling task (see Borella et al., 2009). Participants were provided with lists of high-cloze sentences to be completed either with an expected word (initiation condition, A) or with a word providing no meaning to the sentence, but grammatically correct with respect to case and gender (interference condition, A'). From a larger pool of sentences, 30 were selected based on a pilot study conducted on a large sample of young adults. Sentences were chosen on the basis of the probability of completion by the expected word (between 0.97 and 0.99). The number of syllables, the starting phonemes and the length of the target word were further taken into account. In the interference condition considered, the sentences provided at initiation were presented a second time. The present adaptation of the Hayling task entailed two interference conditions: one in which new sentences were presented (as in the original Burgess and Shallice, 1996, task B), and one in which the sentences used at initiation were displayed a second time (A'). Because preliminary analyses showed no significant differences between these two conditions, we retained only the A' condition for subsequent analyses. The choice was driven by the fact that using the same sentences at interference than at initiation ensures that the words to be inhibited were actually previously activated (see Borella et al., 2009).

As in the original version of the task (Burgess and Shallice, 1996) each condition entailed 15 sentences individually presented on a computer screen. Within each condition, the sentences appeared in a random order for each participant. The presentation order of each condition was fixed, and initiation always preceded interference. A practice phase (5 sentences) was presented before each test condition. Participants were instructed to silently read each sentence and to complete the sentence with the appropriate, expected word that fitted the sentences (initiation, e.g., Les abeilles produisent du...MIEL - Bees produce...HONEY), or by syntactically correct, but semantically non-plausible word (interference, e.g.: Les abeilles produisent du...SABLE - Bees produce...SAND). Presentation was self-paced and each response triggered the following trial. Responses were provided orally. The experimenter manually recorded accuracy, whereas the computer recorded the response time latencies, which corresponded to the interval between the sentence display and the participant’s oral response in the voice key.

2.3. Statistical analyses

The dependent variables considered were the proportion of correct completions (expected words for the phase A and unexpected words for the phase A'), each divided by the total number of sentences), and the average response times (in ms) across trials, computed on response times for correct responses only. In interference, correct words corresponded to any word that fulfilled the case and gender agreement provided by the context, but neither was semantically related or relevant to the sentence, nor made any reference to the sentence.

Additionally, for each variable, an interference cost index was computed as the difference in performance between initiation and interference, weighted by performance at initiation. For correct responses, the score was computed as [(A - A')/A], and as [(A' - A)/A] for response times. In both cases, a positive score indicates a cognitive cost associated with interference. These scores allowed controlling for individual and/or age-differences in baseline performance (Borella et al., 2009).

3. Results

3.1. Proportion of correct responses

From the entries in Table 2, and with respect to the proportion of correct responses, one can see that for all groups, performance was at ceiling in initiation condition. This effect was expected because high-cloze sentences were purposely built to hold a very high probability of correct completion.

Further, for all groups, performance decreased in interference condition. Given the ceiling effect in the initiation condition, inferential statistics were conducted only on the cost index computed as [(A – A')/A] for correct responses, and as [(A' – A)/A] for response times.

A 2 × 2 ANOVAs with age (younger, older) and span (high, low) as between subject factors was conducted. All analyses were also conducted using either educational level or Mill Hill performance as a covariate, but the results were not affected. Results revealed a significant main effect of age, F(1,200) = 18.58, p < 0.01, η² = 0.09, and a significant main effect of span, F(1,200) = 7.46, p < 0.01, η² = 0.04. These results suggest that older adults demonstrate a higher cost (0.20 ± 0.14) than younger ones (0.13 ± 0.12) in resisting to interference, and that low spans (0.19 ± 0.14) are more hampered than high spans (0.14 ± 0.13). The age × span interaction was not significant, F(1,200) = 0.20, p = 0.65. It is also worth mentioning here that the majority of participants showed a cost associated with the interferences condition: 75% of the younger high spans, 80% of the younger low spans, 83% of the older high spans, and 93% of the older low spans. The remaining of the participants was not affected by the condition (interference score equal to 0), and no participant demonstrated a gain associated with the interference condition (negative score).

3.2. Response times

Turning to response times restricted to correct responses, the data displayed in Table 2 suggest that the interference condition is associated with larger response times than the initiation one. Inferential statistics were conducted on this variable using a mixed design 2 × 2 ANOVA with age (younger, older) and span (high, low) as between subject factors, and condition (initiation, interference) as repeated measure.

Results revealed a significant main effect of condition, F(1,200) = 1532.30, p < 0.01, η² = 0.88, indicating that response times were longer in interference condition (3675 ± 738 ms), as compared to initiation (1891 ± 362 ms, mean difference = M-diff. = 1780 ms). Results of the ANOVA further revealed a significant span × condition interaction, F(1,200) = 6.67, p < 0.05, η² = 0.03, and a significant age × span interaction, F(1,200) = 5.33, p < 0.05, η² = 0.03. The main effects of age, F(1,200) = 1.54, p = 0.11, and of span, F(1,200) = 1.42, p = 0.23, were not significant. Neither were the age × condition interaction, F(1,200) = 0.10, p = 0.75, nor the age × span × condition interaction, F(1,200) = 0.02, p = 0.89. The

Table 2
Results of the Hayling test by age and span, mean ± S.D.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>High Span</th>
<th>Low Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger</td>
<td>High span</td>
<td>Low span</td>
</tr>
<tr>
<td></td>
<td>Proportion of correct responses</td>
<td></td>
</tr>
<tr>
<td>Initiation (A)</td>
<td>0.98 ± 0.04</td>
<td>0.97 ± 0.05</td>
</tr>
<tr>
<td>Interference (A')</td>
<td>0.87 ± 0.11</td>
<td>0.83 ± 0.13</td>
</tr>
<tr>
<td>Cost</td>
<td>0.11 ± 0.09</td>
<td>0.15 ± 0.13</td>
</tr>
<tr>
<td>Response times (ms)</td>
<td>1827 ± 380</td>
<td>1866 ± 330</td>
</tr>
<tr>
<td>Initiation (A)</td>
<td>3704 ± 759</td>
<td>3521 ± 587</td>
</tr>
<tr>
<td>Interference (A')</td>
<td>1.07 ± 0.46</td>
<td>0.93 ± 0.39</td>
</tr>
</tbody>
</table>
two significant interactions were further decomposed using planned comparisons. With respect to the span × condition interaction, the results showed that the condition effect was significant for both the high spans (p < 0.01) and the low spans (p < 0.01). High and low spans significantly differed in the initiation (p < 0.01, Mdiff. = 201 ms in favor of the high spans), but not in the interference condition (p = 0.70, Mdiff. = 34 ms). Thus, overall, high spans were faster (1793 ± 353 ms) than low spans (1994 ± 345 ms) at providing the appropriate word at initiation (Fig. 1). Concerning the age × span interaction, the results demonstrated that high and low spans did not significantly differ (p = 0.97, Mdiff. = 73 ms) in the younger sample. In the older group, the difference was significant (p = 0.05, Mdiff. = 229 ms), in favor of the high spans. Younger and older high spans did not significantly differ (p = 0.89, Mdiff. = 47 ms), while for the low spans, the difference between younger and older was marginally significant in favor of the younger (p = 0.08, Mdiff. = 255 ms).

As for the proportion of correct responses, inferential statistics were conducted on the interference cost index computed for responses times by means of an age × span between-subject ANOVA. Results showed only a significant main effect of span, F(1,200) = 14.83, p < 0.01, ηp² = 0.07, demonstrating that overall, low spans (0.87 ± 0.35) were less affected than high spans (1.09 ± 0.452, Mdiff. = 0.22). Neither the main effect of age, F(1,200) = 0.46, p = 0.50, nor the age × span interaction, F(1,200) = 1.84, p = 0.18, were significant.

4. Discussion

The purpose of the present study was to examine the joint account of age and individual differences in WM capacity on the ability to inhibit irrelevant responses. High and low span younger and older adults were compared on the Hayling task, a task requiring completing high-cloze sentences either with a word syntactically prompted by the sentence (initiation) or by a syntactically correct word that made no meaning to the sentence (interference). Thereby, in the interference condition, prepotent or predominant response activation must be actively suppressed in order to give a correct response. It is worth pointing out that, contrary to the classical version of the task, the same sentences were presented both at initiation and at interference. This point is quite crucial because it ensures that the to-be-inhibited words at interference have been actually previously activated at initiation (Borella et al., 2009). Hence, only the sentences for which the expected word was provided at initiation, and thereby activated, were further considered for analysis at interference.

Results first revealed a significant condition effect on response times, reflecting an increase in response latencies at interference, as compared to initiation. This increase is attributed to the additional requirement of actively inhibiting the prepotent response semantically triggered by the sentence. Thus, as expected, and in line with previous findings (Belleville et al., 2006), performance was altered as a function of the task manipulation. Second, span effects were reported on the cost scores both for the proportion of correct responses and for the response times, although different patterns were observed. For the correct responses, results revealed that low spans demonstrated higher interference scores than high spans thereby demonstrating a larger susceptibility to interference, and less efficient inhibitory mechanisms. This finding replicates previous results showing that low spans are more hampered than high spans when irrelevant responses must be inhibited (Kane and Engle, 2003).

With respect to response latencies, a larger interference cost was found for the high spans, as compared to the low spans. This pattern of results can be explained by looking directly at the median response times: while high spans were faster than low spans at completing the sentence at initiation, both groups did not significantly differ at interference. Hence, the difference in response latencies was relatively larger for high spans than for low spans, which is also reflected by a larger interference cost. The difference in response times at initiation in favor of the high spans may be associated with the fact that high spans have more potential words available in WM than low spans (Cantor and Engle, 1993). High spans may either retrieve more quickly the expected word, activate it more efficiently and/or may have a larger spread of activation across multiple exemplars semantically cued by the context (Bunting et al., 2004). High spans may also call preferentially upon controlled attention while low spans mainly rely on automatic processes (Rosen and Engle, 1997). Consequently, at initiation, high spans could more rapidly focus on the appropriate word than low spans. In any case, higher activation at initiation could further result in a relatively larger slowdown in processing at interference. Compared to low spans, high spans might need relatively more time to achieve the active suppression of the no-longer relevant words, precisely because these words were previously in a higher activation state. Further, and provided that low spans rely more on automatic processing, timed performances of these participants may be less affected by the task manipulation than the performance of high spans (e.g., Rosen and Engle, 1997). As a counterpart, however, low spans should demonstrate a lower proportion of correct responses at interference, as compared to high spans. This was actually the case in the present study, as reflected by a significant span effect on the interference cost.

Turning to the age effects, results revealed that overall older adults were more hampered than younger ones at providing a task appropriate response at interference. Indeed, the interference cost associated with the task requirements for the proportion of correct responses was larger for older adults than for younger ones. This finding is in line with previous studies demonstrating that older adults have difficulties in tasks requiring inhibiting automatic but inadequate and no longer appropriate responses (e.g., Hasher and Zacks, 1988). Our results, though, are in contrast with those reported by Belleville et al. (2006) who surprisingly failed to find age-related differences in error scores. However, and contrary to our expectations, older adults were not significantly slower than younger adults to provide a correct response, either at initiation, or at interference. This finding appears contradictory with the well
established age-related reduction in processing speed (see Salt-house, 1996, for a review). However, age differences on response times are usually the most prominent on small time intervals and tend to decrease at larger time intervals, probably because of the associated increase in response time variability (Bherer and Belleville, 2004). In the present study, response times were fairly large and demonstrated large inter-individual variability, particularly in the interference condition. This may be due to the fact that, contrary to other studies (Burgess and Shallice, 1996; Belleville et al., 2006), reading times were included in the time measures, and no time limits were imposed to provide a response. Indeed, when reported, age differences in response times were measured from the offset of the sentence, and time constraints of 30 s (Belleville et al., 2006) or 60 s (Burgess and Shallice, 1996) were imposed to complete the sentences. Such procedures mainly allow focusing more directly on the processes of interest by avoiding confounding sources of variability as reading times could be. Probably associated with this response time issue is also the absence of a significant age × condition interaction on raw time measures, and of a significant age effect on the interference cost score. Further work is thus needed to investigate the embedded effects of reading and naming times in different age populations.

Finally, contrary to our initial hypothesis, older low spans were not more hampered than all three other groups. Indeed, the age × span × condition interaction was not significant on raw response times, and neither were the age × span interaction on cost indices for both variables. Hence, above and beyond age and span effects on the proportion of correct responses, and span effects on the response times, our findings do not point to a multiplicative account of age and individual differences in WM capacity in the ability to resist interference in the present version of the Hayling task. Notwithstanding, this issue remains to be further investigated. First because results demonstrated that on the proportion of correct responses, the frequency of participants that showed a cost associated with the interference condition (i.e., score > 0) was descriptively higher for older low spans than for all three other groups. Second, the analysis of the raw response times revealed a significant age × span interaction, suggesting that there was a trend for the older low spans to respond slower than all three other groups. Third, because the methodology employed deserves further consideration despite of partially satisfying results. To our knowledge, only few studies in the cognitive aging literature applied a methodology based on an extreme group design, and none of them identified the high and low span younger and older adults in exactly the same way than in the present study. For instance, some studies used a median split, rather than a tertile split, to identify individuals with high and low WM span (Kemtes and Kemper, 1997, 1999). Others used a procedure in which high and low span younger individuals were selected by matching their WM scores with the ones of high and low older adults (Kemper et al., 2004, Experiment 2). Finally, other researchers interested in this issue, only partially considered jointly age and individual differences in WM, either comparing high and low span younger adults to older adults (Oberauer, 2005), or the reverse, that is high and low span older adults compared to younger ones (Smiler et al., 2003). In both case, and considering the methodological recommendations formulated by Conway et al. (2005), methodological precautions were often only partially taken to reliably identify high and low spans. It remains however, that qualitative differences in processing may exist across younger and older adults in the WM task itself (e.g., Li and Lindenberger, 2002).

5. Conclusion

In summary, the results of the present study highlight the crucial role of controlled attention in tasks in which irrelevant information needs to be suppressed (Engle and Kane, 2004). Individual differences in WM capacity were indeed associated with differences in the ability to resist interference. Together, these findings support the idea that individual differences in WM capacity may be related to individual differences in the type of processes engaged preferentially in the task, with high spans relying mainly upon controlled processes, and low spans upon automatic ones. Further, our findings demonstrated that, with respect to response accuracy, older adults showed a lower ability to resist interference than younger ones, which was in line with the hypothesis of an age-related decline in inhibitory processes (Hasher and Zacks, 1988; Borella et al., 2008, 2009). However, no age differences were reported with respect to response times, and contrary to our expectations, older low spans were not more hampered than all other groups.

Although the present study yielded unexpected findings, it provided interesting highlights for considering jointly age and individual differences in WM capacity when accounting for the ability to resist interference. It has pointed to a methodology that has proven very constructive in the study of individual differences in WM capacity in younger adults, but was rarely extended in the field of cognitive aging. Future work using such a methodology will undoubtedly help disentangling both sources of differences in cognition, and provide an interesting mean to better understand individual differences in cognitive aging, not only in inhibitory tasks, but in all tasks reported to demonstrate an average age-related decline.

Conflict of interest statement

None.

Acknowledgements

The study reported in the present paper was part of a larger study financially supported by two successive grants from the Swiss National Research Foundation to Anik de Ribaupierre (grants 1213-065020 and 1114-052565).

References


