Archives of Gerontology and Geriatrics 59 (2014) 599–606

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Investigation of age-related differences in an adapted Hayling task

Isabelle Tournier [a,b,*], Virginie Postal [a], Stéphanie Mathey [a]

[a] Laboratoire de Psychologie, Santé et Qualité de Vie, Université Bordeaux Segalen, France
[b] INSIDE, University of Luxembourg, Luxembourg

ARTICLE INFO

Article history:
Received 6 December 2013
Received in revised form 28 July 2014
Accepted 29 July 2014
Available online 6 August 2014

Keywords:
Aging
Activation
Inhibition
Hayling task

ABSTRACT

The Hayling task is traditionally used to assess activation and inhibitory processes efficiency among various populations, such as elderly adults. However, the classical design of the task may also involve the influence of strategy use and efficiency of sentence processing in the possible differences between individuals. Therefore, the present study investigated activation and inhibitory processes in aging with two formats of an adapted Hayling task designed to reduce the involvement of these alternative factors. Thirty young adults (M = 20.7 years) and 31 older adults (M = 69.6 years) performed an adapted Hayling task including a switching block (i.e., unblocked design) in addition to the classical task (i.e., blocked design), and the selection of the response between two propositions. The results obtained with the classical blocked design showed age-related deficits in the suppression sections of the task but also in the initiation ones. These findings can be explained by a co-impairment of both inhibition and activation processes in aging. The results of the unblocked Hayling task, in which strategy use would be reduced, confirmed this age-related decline in both activation and inhibition processes. Moreover, significant correlations between the unblocked design and the Trail Making Test revealed that flexibility is equally involved in the completion of both sections of this design. Finally, the use of a forced-response choice offers a format that is easy to administer to people with normal or pathological aging. This seems particularly relevant for these populations in whom the production of an unrelated word often poses problems.

1. Introduction

The Hayling task was created by Burgess and Shallice (1996) to explore the initiation and suppression of expected semantic responses in patients suffering from frontal lobe lesions. It comprises two sections of 15 sentences in which the last word is omitted but is strongly cued by the semantic context of the sentence. As a result, the missing word is automatically activated during reading (e.g., "The child is crying for his... mother"). In section A (response initiation), the participants are required to provide an appropriate word to complete each sentence. In this response initiation section, the context and spreading activation in semantic memory cause the automatic activation of the missing word. On the contrary, in section B (response suppression), the participants are required to provide a word that makes no sense in the context to complete each sentence. Therefore, the production of an unrelated word in the response suppression section involves inhibiting the word automatically activated by the semantic context. The Hayling task is frequently used to assess semantic inhibition performances in various populations such as the elderly (Bélanger & Belleville, 2009), depressed (Gohier et al., 2009), or alcohol-dependent adults (Noël et al., 2013). However, findings are not always congruent, especially in the aging domain. In the initiation section, several studies have shown an impaired performance (Bielak, Mansueti, Strauss, & Dixon, 2006; Collette, Schmidt, Scherrer, Adam, & Salmon, 2009; Lin, Chan, Zheng, Yang, & Wang, 2007), whereas others did not show any age difference (Andrés & Van der Linden, 2000; Belleville, Rouleau, & Van der Linden, 2006; Borella, Ludwig, Fagot, & de Ribaupierre, 2011). Regarding the suppression section, most of the studies suggest an impaired performance in older adults (Andrés & Van der Linden, 2000; Belleville et al., 2006; Bielak et al., 2006; Collette et al., 2009). However, others failed to observe any age effect or even showed longer response times in young adults than in older ones (Borella, Delaloye, Lecerf, Renaud, & de Ribaupierre, 2009; Borella et al.,

* Corresponding author at: Integrative Research Unit on Social and Individual Development, University of Luxembourg, Route de Diekirch BP2, L-7220 Walferdange, Luxembourg. Tel.: +352 46 66 44 9298; fax: +352 46 66 44 39298.
E-mail addresses: isabelle.tournier@uni.lu, isabelle.tournier14@gmail.com (I. Tournier).

http://dx.doi.org/10.1016/j.archger.2014.07.016
0167-4943/

2011). Thus, most of the results suggest a decline in the suppression section during aging, whereas the data about modification in the initiation section are less consensual. Variations in populations studied (older adults vs. young adults, older adults vs. very old adults) or in paradigms used (sentences read or heard, format) could explain these discrepant findings. Moreover, as presented in the next section, the current Hayling task format is thought to have some limitations.

1.1. Adapted formats of the Hayling task

A limitation of the traditional Hayling task is the possibility to use non-inhibitory processes to perform the suppression section, such as anticipating the answer prior to hearing the sentence or not paying attention to the sentence (Burgess & Shallice, 1996). Although Burgess and Shallice (1996) considered the possible use of strategies as the consequence of good executive functioning, their utilization reduces the involvement of inhibition (Andrés & Van der Linden, 2004). Moreover, the efficiency of strategy use tends to decline with aging (Lemaire, 2010) and could penalize elderly adults. To counteract the use of strategies, Bélanger and Belleville (2009) proposed an adapted version of the task with an unblocked design in which the initiation and suppression sections were presented in a randomized order. A cue was provided upon completion of the sentence presentation to instruct participants about the task to be done (i.e., give an appropriate or inappropriate word). The authors' goal was to ensure that participants process the sentence completely and do not select their response in advance, which is possible in the blocked design. With this adapted Hayling task, Bélanger and Belleville tested young adults, older adults, patients with mild cognitive impairment (MCI), and patients with a diagnosis of Alzheimer's disease. Their results showed that older adults had longer response times and made more errors than younger adults on the sentences associated with the suppression instruction only. Interestingly, MCI patients showed poorer performance than older adults on suppression instruction, whereas a previous study using the classic Hayling task indicated normal performance in this population (Belleville, Chertkow, & Gauthier, 2007). The authors conceded that their new procedure increased the complexity of the task by requiring the task's goal to be maintained in working memory and by switching between initiation and suppression instructions. However, they considered that working memory and switching were equally involved in both sections and could not explain the impairments of MCI patients in the suppression section. Although these results are very promising, the absence of blocked sections, such as in the classical Hayling task, restricts comparisons between the two designs. Consequently, it would be interesting to propose an adapted Hayling task combining the classical presentation (i.e., blocked design) and the alternated presentation (i.e., unblocked design).

Another limitation of the Hayling task mentioned by Andrés and Van der Linden (2004) concerns the processing occurring during the suppression section. The very action of producing an inappropriate word requires the inhibition of the appropriate word and the complex search of a semantically unrelated word. The complexity of the suppression section is supported by neuroimaging data using positron emission tomography, showing an increased activity in middle and inferior frontal areas generally associated with complex processes such as planning or updating (Collette et al., 2001). The difficulty of producing an alternative response in the Hayling task is due to the fact that the response is not provided in the stimulus display (such as in the Stroop task) and requires being internally generated (Castner et al., 2007). The internal generation of an alternative response may be avoided by proposing a response choice. For example, by asking the participant to choose the inappropriate word between words on the computer screen, the alternative response is provided in the stimulus display. Delaloye et al. (2009) proposed this modification and used a task adapted from the Hayling task where two words appeared on the screen after the participants had heard the sentence. In the first part, participants chose as quickly as possible the word that completed the sentence correctly, and in the second part, they chose as quickly as possible the word that completed the sentence incorrectly. The fitting word and the competitor were comparable regarding lexical frequency, grammatical class, gender, number, and number of letters. Results obtained by Delaloye et al. (2009) with this adapted Hayling task suggest a decrease in inhibition with aging.

These adapted Hayling tasks have been proposed to improve the assessment of inhibition processes. However, other cognitive processes such as speed of processing and working memory might also influence Hayling task performance.

1.2. Cognitive processes associated with completion of the Hayling task

Processing speed and working memory decline has been regularly hypothesized as explanations of cognitive changes observed with aging (e.g., Hasher, Zacks, & May, 1999; Salthouse, 1991). These assumptions are central in the literature on cognitive aging, given that decline in processing speed (e.g., Finkel, Reynolds, McArdle, & Pedersen, 2007; Lemke & Zimprich, 2005) and working memory (e.g., Hertzog, Dixon, Hultsch, & MacDonald, 2003; Salthouse, 1994a) with aging is regularly reported. Although these two variables have been rarely adjusted statistically in aging studies using the Hayling task, a few data indicate that they influence performance (Andrés & Van der Linden, 2000; Collette et al., 2009). Andrés and Van der Linden (2000) reported that after the statistical control of processing speed, the positive correlation between age and the suppression section became non-significant for response latencies but remained significant regarding error score. Moreover, Collette et al. (2009) observed that the age effect disappeared in the initiation section but not in the suppression one when span size and processing speed were taken as confounding covariates. Thus, it seems important to take into account processing speed and working memory in case of age difference when assessing age-related changes in the Hayling task.

Moreover, it seems reasonable to assume that processing speed and working memory might also impact the processing of sentences during the task. Indeed, previous studies suggest an involvement of age-related slowing in the increase in reading time (Postal & Mathey, 2007) and listening difficulties (Tun, McCoy, & Wingfield, 2009) during aging. Likewise, older adults with high working memory span were faster readers than lower-span older adults (Kemtes & Kemper, 1997). Most of the Hayling task studies to date have used a blocked presentation of the sentences, the latter being read aloud by the experimenter or being recorded. One study allowed the participants to read the sentences at their own pace, but reading and response times were not distinguished and the study failed to find any age effect on inhibition (Borella et al., 2011). The fact that the participants did not control the presentation rate of sentences in most of the studies could have two different negative effects: (a) a too short a time could disturb the correct processing of the sentence, especially in older adults (i.e., less inhibition necessary because weakened activation), and (b) too long a presentation time could induce supplementary cognitive processes not controlled by the experimenter, especially in young adults (i.e., use of strategies limiting the need for inhibition). Consequently, even if the sentences in the Hayling Task are relatively simple and strongly constrained regarding context, it would be interesting if sentence presentation was self-paced,