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Targets and non-targets in the aging brain: A go/nogo event-related potential study

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ABSTRACT

This study tested whether older adults show enhanced suppression of inappropriate processing of non-target information, as marked with the nogo-P3 event-related potential (ERP). Healthy younger and older adults were tested on a simple go/nogo task with visually presented numbers. Unlike in most of the previous studies, go and nogo stimuli were matched for frequency and conflict level in order to minimize the impact of task difficulty, probability monitoring, or conflict detection and resolution on the age-related ERP differences. Older adults showed slower go responses but a comparable accuracy to younger controls. The parietal go-P3 latency was also delayed with aging, while the central nogo-P3 was more pronounced in older adults than in younger controls. The amplitude of this component negatively correlated with go-RTs. In line with previous studies, this suggests that a partial response preparation to nogo events is strongly suppressed in older adults, especially faster ones.

Suppressing the processing of irrelevant information becomes problematic with advancing age [7,5,8,15]. Older adults retroactively suppress this extra processing [21], probably to avoid behavioral impairments. Differences in the processing of non-target events occur even when the behavior is matched across age groups [23,24,22].

To test age-related differences in the neural processing of non-target information, event-related potentials (ERPs) can be recorded in a go/nogo task. This task typically produces a more pronounced fronto-central positive component (nogo-P3) around 300–500 ms in nogo as compared to go-ERPs (e.g., [12]). The nogo-P3 has been related to inhibition by several researchers (e.g., [16,19], but see [2]). This component seems to consistently reflect a more central, modality-independent inhibitory process than an earlier nogo-N2 component [3,18].

Pfefferbaum and Ford [11] found that the nogo-P3 component is delayed in older adults, although at a smaller extent than the go-P3. However, in their study, go and nogo events occurred with unpaired frequencies (also see [20]), thus possibly inducing age-related differences in processing infrequent events or in dealing with difficult nogo conditions. Moreover, they reported a general decrease in P3 amplitude (for both go and nogo stimuli) in the mid-line scalp electrodes Cz and Pz as a function of age, but no age differences in the more frontal Fz. Another study using a go/nogo version of the continuous performance test [4] reported a more anterior nogo-P3 in older adults than in younger individuals. However, the age range of the subjects in that study (22–60 years) was below that typically used in aging studies. A similar continuous performance test study [6], in which a larger portion of the life-span was covered, showed that older adults' (mean age: 71 years) had an enhanced P3 amplitude to conflicting nogo-stimuli (non-target following a go cue) with respect to three other age groups ranging from childhood to young adulthood. However, the nogo-P3 latency was not analyzed. Moreover, the P3 associated to less conflicting nogo conditions included in their task was not reported either (see [6], p. 4).

Thus, a delayed latency and reduced amplitude with age is a typical finding for the go-P3 (e.g., [3,13]). However, as it emerges from the studies reviewed above, the pattern is less clear for the nogo-P3. This component was recently studied by Vallesi and colleagues [21,22]. The tasks included conflicting go (50%) and nogo (25%) stimuli, obtained with complementary combinations of letters and colors. Moreover, colored numbers were also included as a low-conflict nogo condition (25%), which produced less conflict with the go stimuli, since they belonged to a different conceptual category (numbers vs. letters). The authors found that both age groups performed at ceiling on low-conflict nogo stimuli, which however elicited a more pronounced central nogo-P3 in older adults than in younger controls. Thus, even though the overt performance data showed no age difference for low-conflict nogo events, the electrophysiological results reveal that the putative process marked by the nogo-P3, namely response suppression, is exaggerated in normal

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aging. Moreover, older adults show a partial response preparation not only for high-conflict, but also for low-conflict nogo events, as indicated by the amplitude of the lateralized readiness potential [21].

The present experiment tested the boundary conditions of this age effect on the nogo-P3 amplitude. More specifically, it tested whether a pronounced nogo-P3 with age found in previous studies ([21,22]; also see [6]) was mainly due to: (i) the experimental context, namely low-conflict nogo stimuli probably 'pop out' when they are intermixed with conflicting go/nogo stimuli since they are less frequent (25% vs. 75%) and deviate from them conceptually (numbers vs. letters); or (ii) it is a more general characteristic of normal aging which marks the suppression of pre-activated responses to non-targets even when those are not deviant with respect to the context. Thus, the conflict level and frequency of the go and nogo stimuli were matched in the present study to focus on inhibitory processes while minimizing difficulty accounts or possible age-related differences in response conflict detection and resolution or probability monitoring. Notably, Falkenstein et al. [3] already used a paradigm in which go and nogo stimuli occur equiprobably, and did not found significant amplitude modulations with age in the nogo-P3. However the older sample tested in that study belonged to the younger-old age range (age: 54–65 years), and might not fully show the effects of cognitive aging. Thus, an older group of normally aging adults (from 65 to 81 years) was tested here. Finally, a classical age-related slowing of the parietal go-P3 latency was expected, as previously reported by others [3,11,6].

Fourteen healthy older adults (8 females; mean age: 73 years, range: 65–81) and 14 younger controls (8 females; mean age: 25 years, range: 19–34) volunteered for the study after giving their signed informed consent. This sample size is analogous to that typically used in similar ERP studies of aging [21,22,3]. None

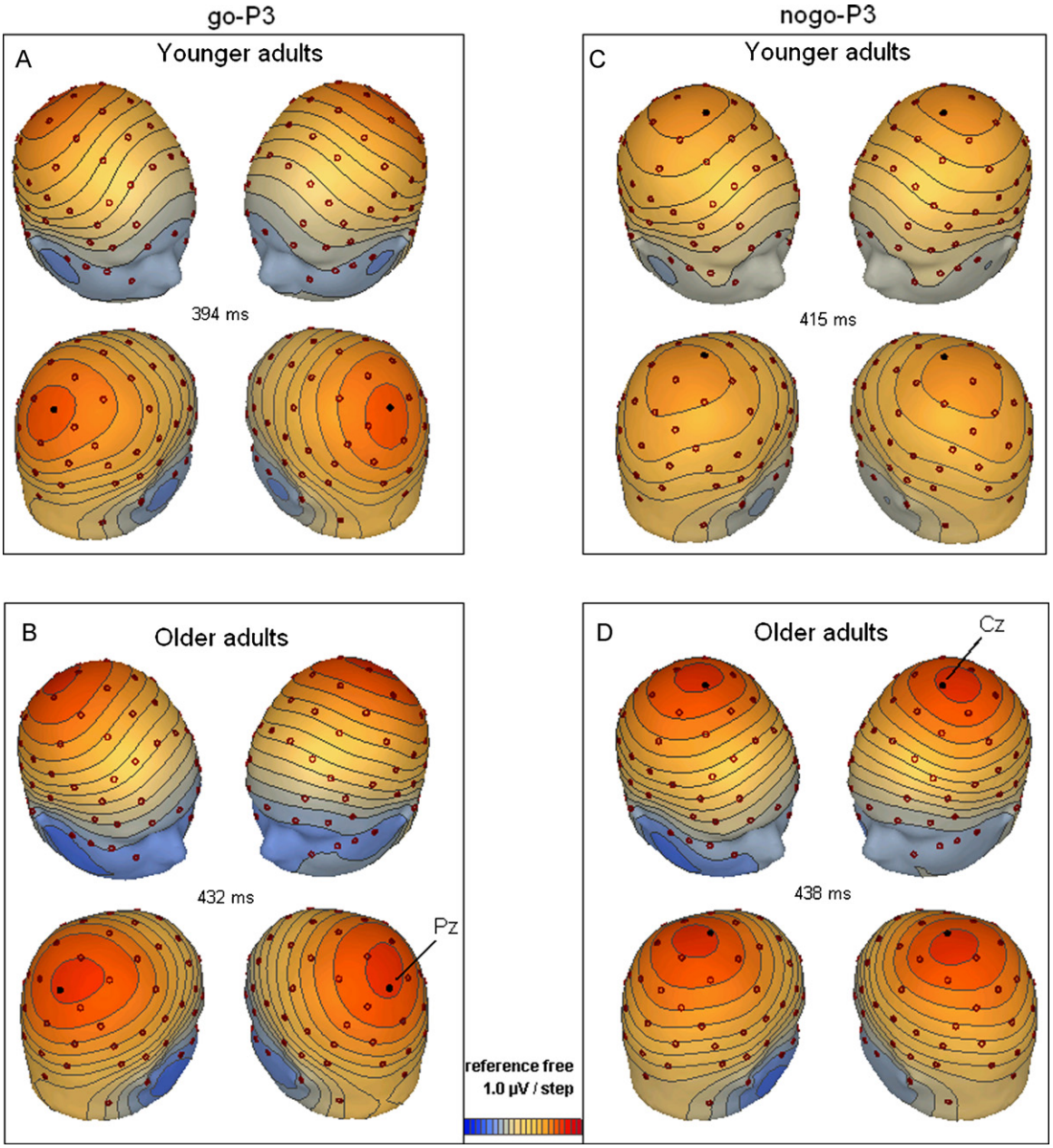

Fig. 1. Voltage maps of the go-P3 (Panels A and B) and nogo-P3 (Panels C and D), separately for each age group (younger adults: upper panels). Each map describes the topographic distribution of the P3 at the indicated peak latency for each group. Note that the peak occurs at the electrode Pz for the go-P3, and at the more anterior electrode Cz for the nogo-P3.