More modifications in older adults despite slower competitor activation

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Introduction: Previous studies have shown how cognitively taxing context affects language production in cognitively healthy adults.[1] For example, the presence of semantic competitors (e.g., pine tree – maple tree) makes language production more difficult. It results in increased error rates and delays in producing the target word. Domain-general inhibitory control is responsible for suppressing the activation of competitor representations. Less explored is how language production is impacted by declines in inhibitory control. We investigated this question in older adults undergoing healthy cognitive aging, leading to a decline in inhibitory control. Major theories of cognitive aging in executive functioning propose distinct outcomes. The inhibition deficit hypothesis[3] posits that older adults will be less effective at suppressing competitor activation compared to younger adults.

Method: We employed eye-tracking in the Visual Word Paradigm to examine how older adults produce target words when faced with competition from a semantic competitor. Eighteen younger (Mean Age = 20.06 (SD=0.73)) and 17 older (Mean Age = 77.08 (SD=7.53)) adults were shown four pictures on a screen and were instructed to describe a target image, which was indicated by a black box (Fig. 1). We manipulated the presence of a competitor on the screen. In the competitor-present condition, a semantically related competitor image was displayed (e.g., target: pine tree, competitor: maple tree), while in the competitor-absent condition, the target was semantically unrelated to all other images on the screen (e.g., laptop). In E1, the target-competitor pair was semantically associated, but did not necessarily require modification to identify the target (e.g., king vs. queen). In E2, the target-competitor pair was from the same category and required modification (e.g., pine tree vs. maple tree).

Results: We first transcribed picture descriptions and analyzed whether the participants produced modified expressions on each trial (Table 1). In both E1 and E2, the mixed effects models revealed significant main effects of group (older adults (OA) vs. younger adults (YA); E1: $z=-4.66$, $p<.05$; E2: $z=-6.33$, $p<.05$) and condition (competitor present vs. absent; E1: $z=-5.51$, $p<.05$; E2: $z=-3.45$, $p<.05$). The interaction was only significant in E2 ($z=-4.80$, $p<.05$), not in E1 ($z=-1.06$, $p=.29$). This result suggests that participants in both groups are sensitive to the discourse context and provide appropriate modifications, but older adults tend to produce more modification even when unnecessary compared to younger adults.

Further, we analyzed participants' eye gaze in two time windows (Fig 2-3). (T1) 200-700ms and (T2) 700-1200ms post-stimulus. A mixed-effects model includes group (OA vs. YA) and condition (competitor present vs. absent) as fixed effects. The dependent measure was Target Advantage Scores (TAS), representing the empirical logit for the ratio of target fixations to competitor fixations. In E1, the TAS was larger in YA vs. OA during T1, and the pattern was reversed in T2. The mixed effects model revealed significant main effects of group (T1: $t=-6.29$, $p<.05$; T2: $t=4.03$, $p<.05$) and condition (T1: $t=2.58$, $p<.05$; T2: $t=10.52$, $p<.05$), and a significant interaction (T1: $t=-2.13$, $p=.03$; T2: $t=-5.35$, $p<.05$) in both T1 and T2. The interaction was driven by a larger condition effect in YA vs. OA in T1 (YA: $t=4.50$, $p<.05$; OA: $t=0.87$, $p=.39$) and in T2 (YA: $t=6.76$, $p<.05$; OA: $t=1.94$, $p=.05$). The results of E2 were consistent with those of E1: significant main effects of group and condition, and significant interactions in both T1 and T2.

The planned comparisons revealed that in both E1 and E2, the effect of condition during T1 was only significant in YA, but not in OA (higher TAS in the absent vs. present condition) in both T1 and T2. The condition effect in OA became significant only during T2. This suggests that OA were slower to activate representations of competitors than YA, activating the target similarly at the beginning of the process regardless of the competitor presence.

Conclusion: Taken together, OA produced more modification than YA even in the absence of the competitor. Consistent with the limited processing capacity hypothesis, OA were slower to activate competitors and to a lesser extent compared to YA.

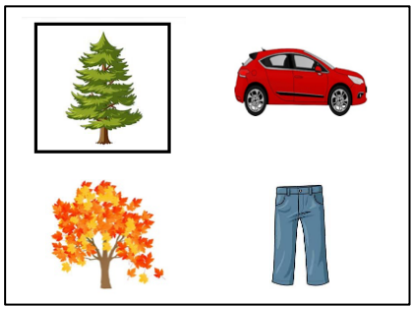

Figure 1. Example stimuli in the competitor present condition.

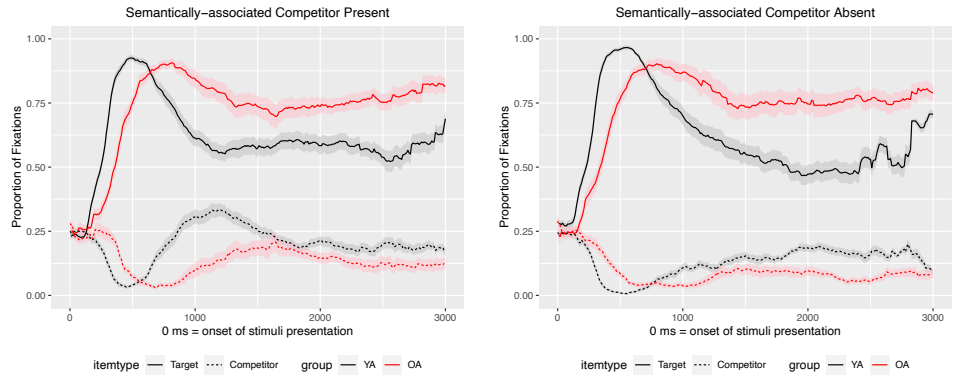

Figure 2. Proportion of fixations following the onset of stimulus presentation by group (Older Adults vs. Younger Adults) in E1: competitor-present condition (left) and competitor-absent condition (right).

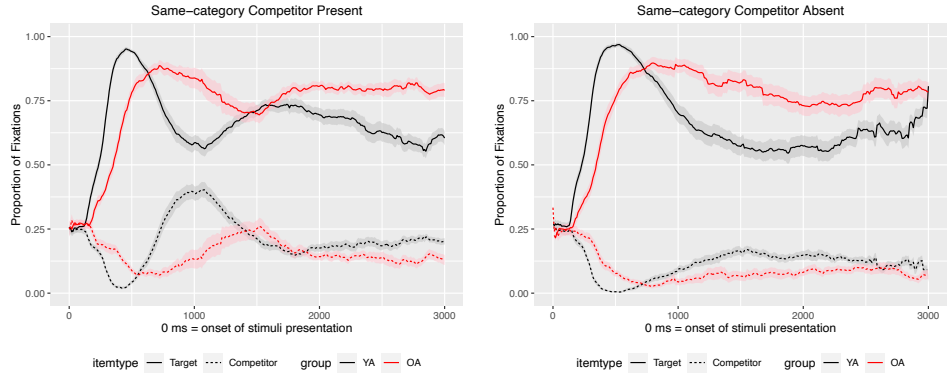

Figure 3. Proportion of fixations following the onset of stimulus presentation by group (Older Adults vs. Younger Adults) in E2: competitor-present condition (left) and competitor-absent condition (right).

Table 1. Proportion of modified expressions in Experiments 1 and 2.

	Experiment 1		Experiment 2	
	Competitor Present	Competitor Absent	Competitor Present	Competitor Absent
Older Adults	0.76	0.69	0.88	0.79
Younger Adults	0.38	0.26	0.83	0.38

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