

How Age Modulates the Ability to Benefit from Sensory-Situated Semantic

Congruence

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Background: Some behavioral experiment data showed that a semantically meaningful context provided more benefit in the audio-visual modality relative to the audio-only modality for both young and older adults [1]. However, when multiple inputs are presented simultaneously, older adults may not effectively integrate relevant information as effectively as younger adults, especially under conflicting conditions [2]. ERP studies further indicate that older adults are less sensitive to congruence differences and are slower in detecting such differences [3]. However, research on semantic congruence in multimodal situated contexts among older adults remains scarce.

Design and Hypotheses: In this EEG study, 32 younger adults (18-31 years old) and 32 older adults (55-65 years old, self-reported normal hearing sensitivity) will perform a sentence verification task with sentences varying in action–verb congruence in a visual-only or audiovisual situation (Table 2). Reaction times, accuracy, and the N400 responses at the verb region will be analyzed. See Table 1 for the experiment procedure. It is hypothesized that older adults will respond less effectively to multimodal conflict situation: in the audiovisual mismatch condition, older adults will show smaller (or absent) N400 effects, lower accuracy, and slower responses compared to the visual-only mismatch condition.

Results: Pilot study results (4 younger adults, 4 older adults) revealed older adults seem more sensitive to the audiovisual condition. Reaction times (RTs) were analyzed using linear mixed-effects models, with significance assessed via Type III Wald chi-square tests. Responses were faster in audiovisual mismatch than visual-only mismatch conditions ($\chi^2(1)=138.14$, $p<.001$) in both groups (Figure 1). Accuracy was analyzed using a generalized linear mixed-effects model, revealing that older adults performed worse in the audiovisual mismatch condition (87.3%) (Figure 2) compared to the visual-only mismatch condition (94.3%). ERP amplitudes in the N400 time window were analyzed using linear mixed-effects models, showing that older adults showed a stronger right-hemisphere N400-like effect (350–575 ms) in the audiovisual mismatch condition compared to visual-only mismatch condition (Figure 3, 4).

References

- [1] Smayda, K. E., Van Engen, K. J., Maddox, W. T., & Chandrasekaran, B. (2016). Audio-visual and semantic context enhance speech perception and reduce listening effort in older adults. *Neuropsychologia*, 88, 19–30.
- [2] Cocks, N., Morgan, G., & Kita, S. (2011). Iconic gesture and speech integration in younger and older adults. *Journal of Speech, Language, and Hearing Research*, 54(3), 888–901.
- [3] Payne, B. R., & Federmeier, K. D. (2018). Contextual constraints on lexico-semantic processing in aging: Evidence from single-word event-related brain potentials. *Brain research*, 1687, 117-128.

Figures and Tables

Figure 1: Reaction time in pilot study (95% CI); Figure 2: Accuracy in pilot study (95% CI)

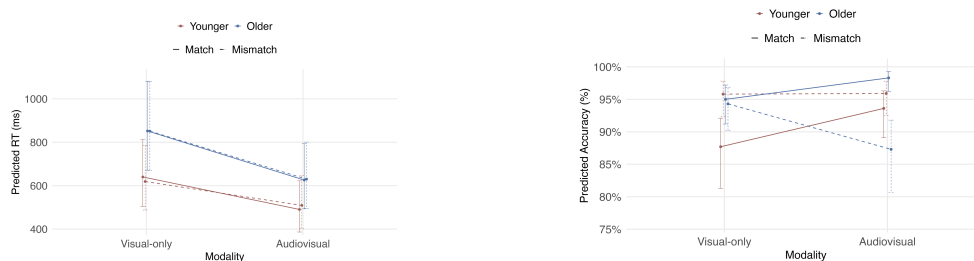


Figure 3 (left): Mapping view of the visual-only vs. audiovisual action-verb mismatch in N400 amplitude at verb region of older adults (black line: visual-only).

Figure 4 (right): Topography of visual-only vs. audiovisual action-verb mismatch conditions of older adults. A: visual only- mismatch; B: audiovisual- mismatch.

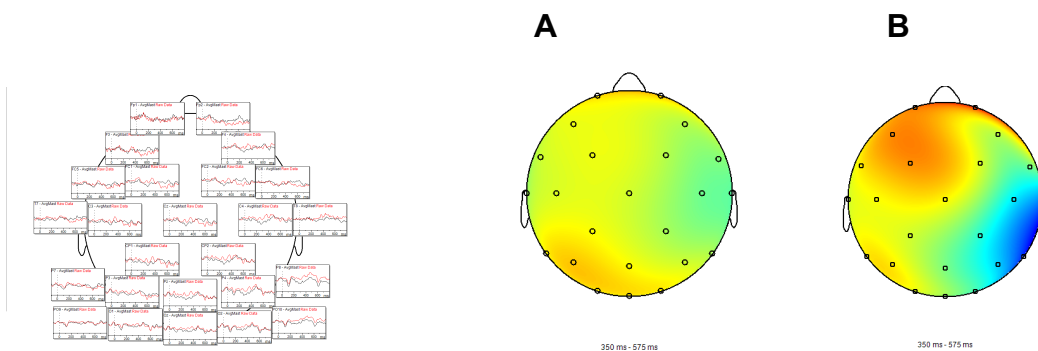
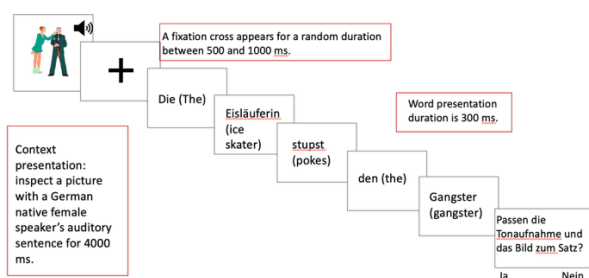
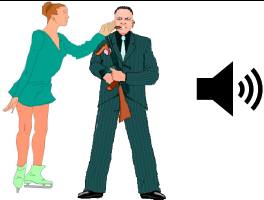


Table 1: Experiment procedure of audiovisual & action-verb mismatch condition.



Optional Supplemental Information

Table 2: Experimental conditions with corresponding contexts and example target sentences for the semantic congruence manipulation.

Conditions	Contexts	Target Sentences
Visual-only+ action-verb match		Die Eisläuferin stupst den Gangster (<i>The ice skater pokes the gangster</i>).
Visual-only+ action-verb mismatch		Die Eisläuferin stupst den Gangster (<i>The ice skater pokes the gangster</i>).
Audiovisual+ action-verb match		Die Eisläuferin stupst den Gangster (<i>The ice skater pokes the gangster</i>).
Audiovisual+ action-verb mismatch		Die Eisläuferin stupst den Gangster (<i>The ice skater pokes the gangster</i>).