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Introduction

- Sound **pitch** (high vs. low) appears to be **represented spatially**, showing preferential associations with spatially compatible response locations, i.e. the spatial-pitch association of response codes (**SPARC**) effect [1,2].
 - Incompatible stimulus pitch–response location (S-R) mappings (e.g. high pitch – low response position) are thought to induce **interference** from conflicting response tendencies, calling for **top-down control**.
 - **Age-related differences** in the SPARC effect, impact of **response difficulty**, and **neural mechanisms** are not clear yet [3].
- **Aim:** To examine age modulations of pitch-induced response conflict processing and their neural correlates using fMRI.

Methods

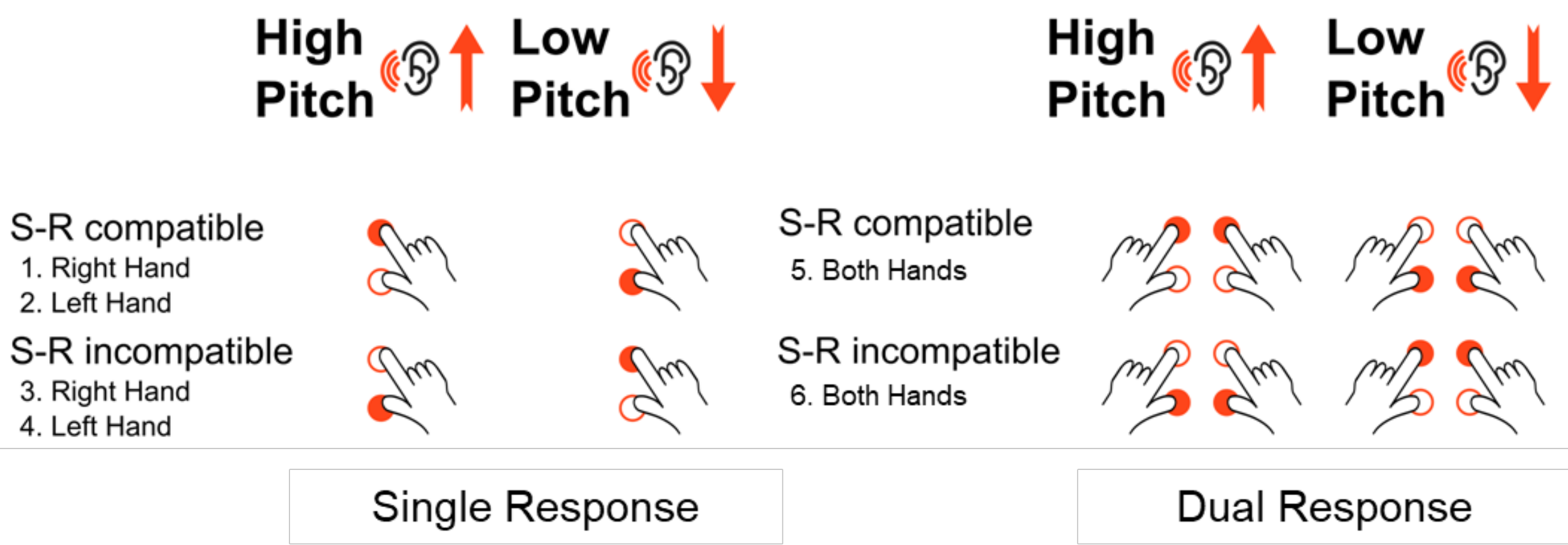
Participants: 43 young (Ø 25.6±3.4 yrs.) and 36 older (Ø 61.9±5.5 yrs.) healthy adults

Task: Speeded tone pitch discrimination paradigm: two-choice reaction task with high- or low-positioned button-press responses to binaurally presented high- or low-frequency pure sine wave tones [4,5], manipulating two factors:

- **S-R Compatibility:** Compatible vs. incompatible mapping of pitch- implied spatial response codes and actually required response locations
- **Response Execution Difficulty:** single-hand vs. concurrent two-hand responses to the tone

fMRI Data Acquisition: Siemens 3 T • whole-brain EPI with TR = 2.2 s and TE = 30 ms • 36 transversal slices • voxel size = 3.1 mm isotropic • flip angle = 80°

fMRI Data Preprocessing: Standard preprocessing with SPM12: Realignment & unwarping (incl. field map) • slice-time correction • normalization to MNI space • spatial smoothing (FWHM 8 mm)

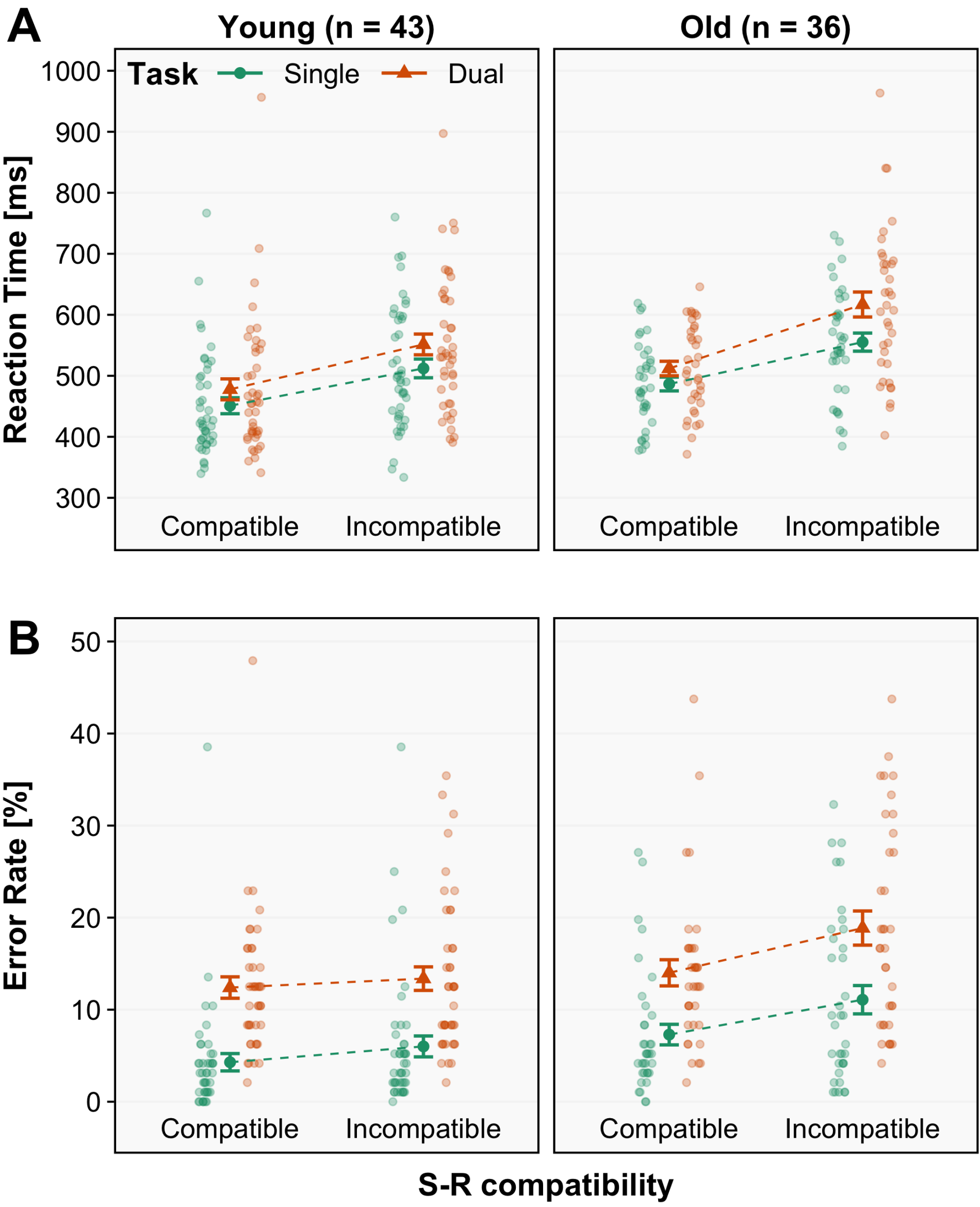


fMRI Data Analysis: 1st-level GLM: event-related model with regressors for each of the 4 experimental conditions, plus parametric modulation by response hand (right, left, both) as well as various nuisance regressors

2nd-level GLM: regressors for each of the 4 conditions (comp.-single, comp.-dual, incomp.-single, incomp.-dual), separately modelled per age group

Results

Behavioural Data

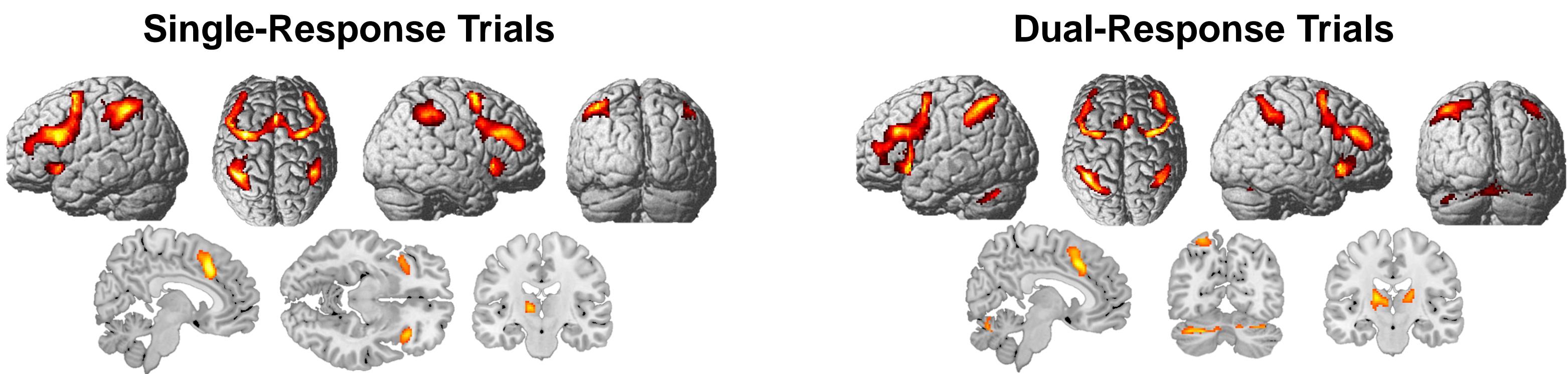


→ ANOVA for effects on RT:

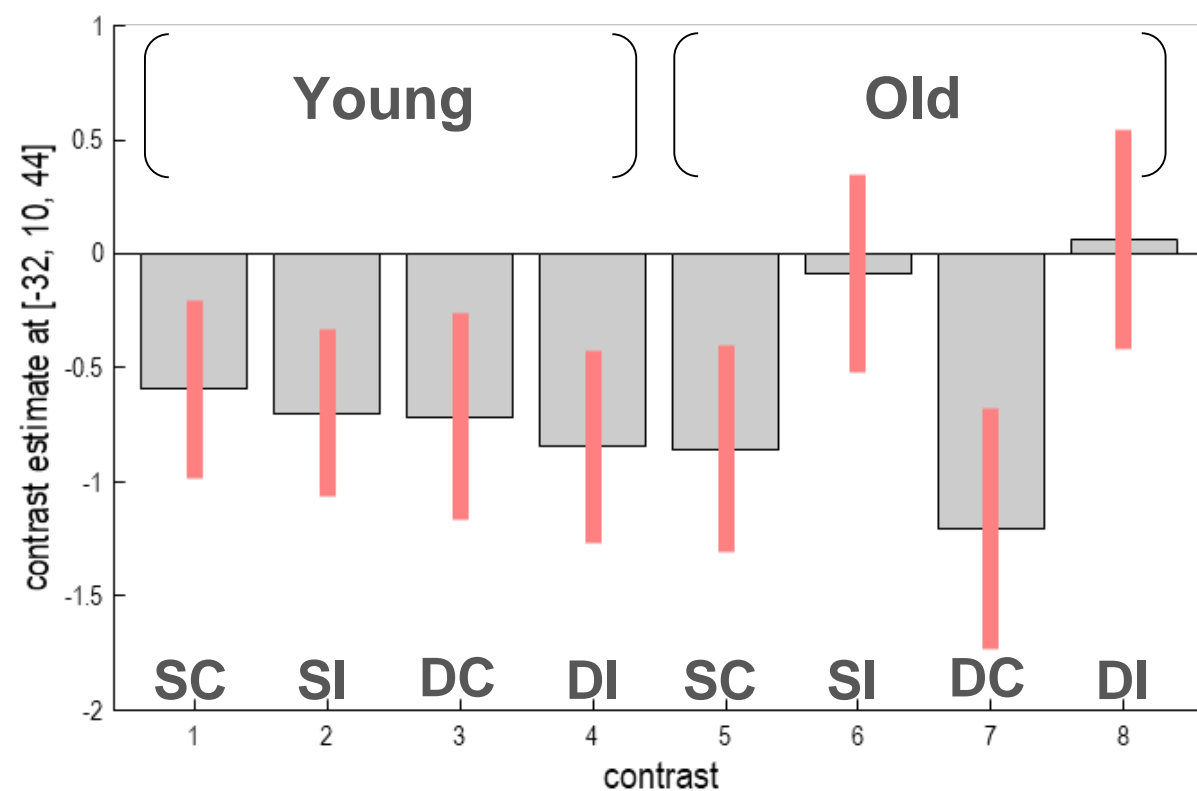
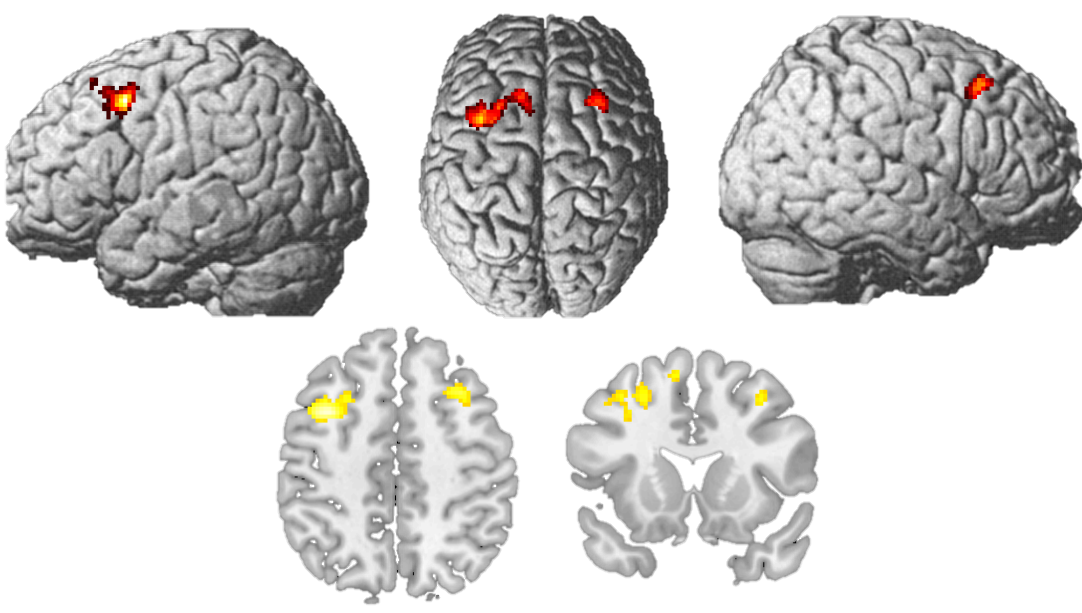
- Significant main effects (Compatibility, Response Difficulty, Age)
- Significant Comp. × RespDiff. interaction
- Tendency to Comp. × RespDiff. × Age interaction (p = .082)

fMRI Data

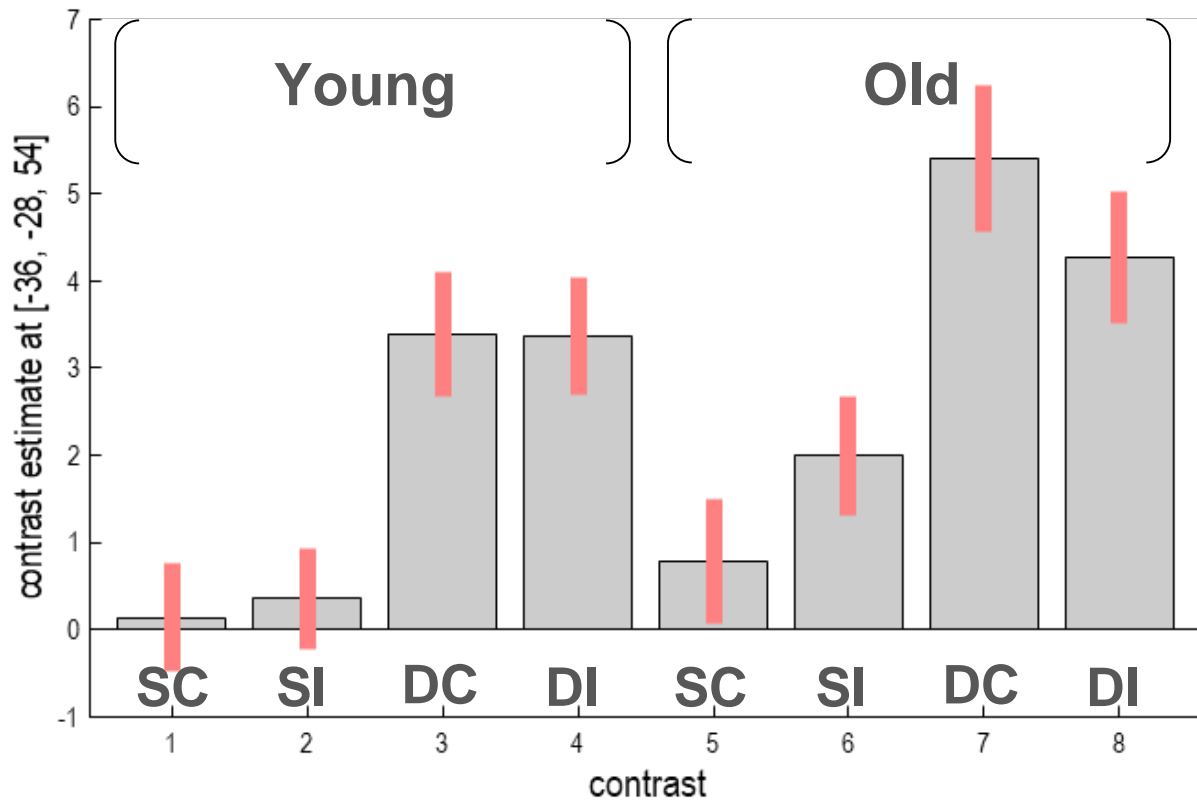
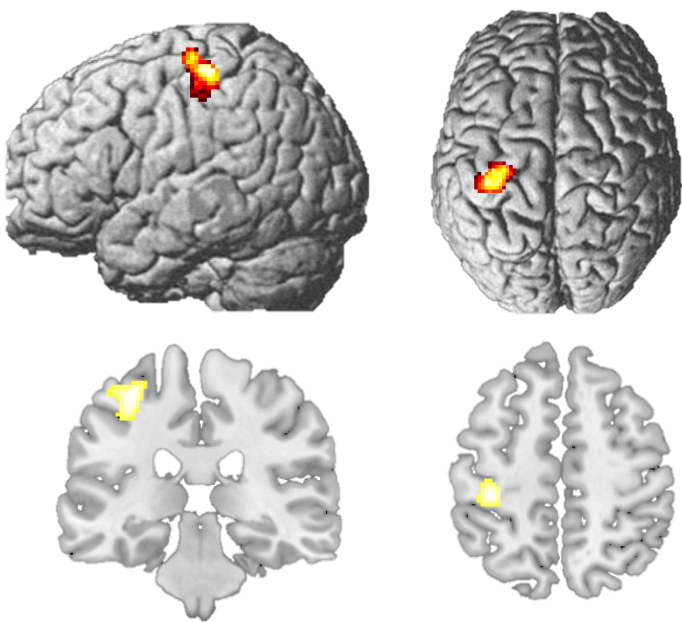
SPARC Effect: Incomp. > Compatible ∩ Incomp. Main Effect



SPARC × Age Interaction ∩ SPARC Effect in Older Adults



SPARC × RespDiff Interaction in Older Adults ∩ Dual-Compatible Main Effect



Conclusions

1. The SPARC effect was confirmed in both young and older healthy adults, revealing no age differences in overcoming inadequate pitch-induced response tendencies.
 2. Dual-execution costs were enhanced during SPARC-incompatible trials, especially in older adults, indicating interference between difficult response selection and response initiation processes in advanced age.
 3. SPARC incompatibility was associated with higher activation in bilateral prefrontal, parietal, midcingulate, and anterior insular cortices as well as left thalamus, in both young and older adults alike.
 4. SPARC-related cerebellar and right thalamic activity was mainly seen in dual-response trials but interaction was restricted to older adults' left M1, suggesting insufficient recruitment of execution-related areas under cognitive load as a neural mechanism behind increase in dual-execution costs with age.
- **SPARC incompatibility activates the well-known multiple-demand network [6,7], in line with the idea that pitch-associated spatial codes activate response tendencies which, if inadequate, require top-down control to be overruled.**

References: [1] Rusconi, E, et al. (2006) *Cognition*, 99:113–29. [2] Lidji, P, et al. (2007) *JEP:HPP*, 33:1189–207. [3] Weis, T, et al. (2015) *Neuropsychologia*, 77:331–8. [4] Huestegge, L, et al. (2009) *JEPHPP*, 35:352–62.
[5] Paas Oliveros, LK, et al. (2022) *Psychol Res*, in press:1–21. [6] Duncan, J (2010) *Trends Cogn Sci*, 14:172–79. [7] Camilleri, JA, et al. (2018) *NeuroImage*, 165:138–47.

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