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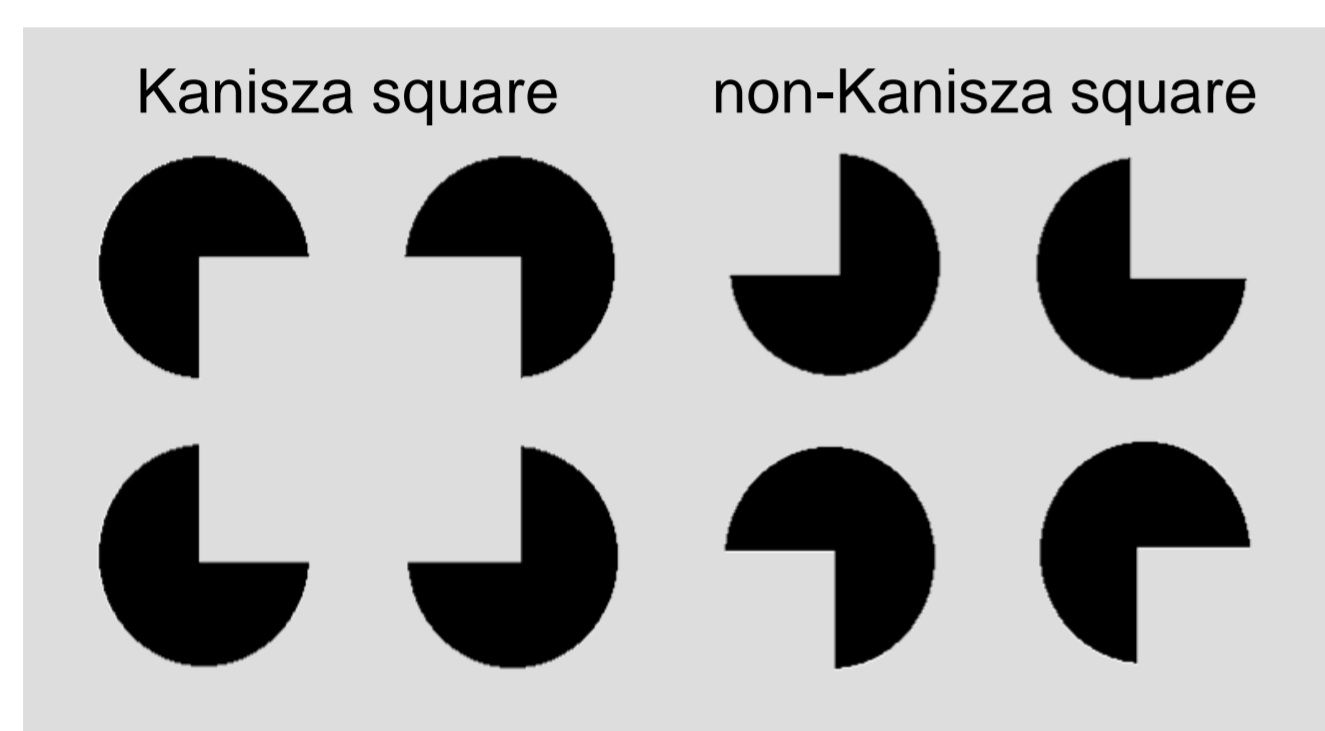
# Event-related potentials reveal increased distraction by salient global objects in older adults

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## Introduction

- **Age-related visual decline** affects older individuals' perception and their interaction with objects in the environment (Madden, 2007)
- An **inhibitory deficit** has been suggested to cause age-specific difficulties (Hasher & Zacks, 1988): Older individuals have problems to select relevant visual information when salient distracting information is present
- A highly salient visual object is the **Kanizsa figure** (Kanizsa, 1976):



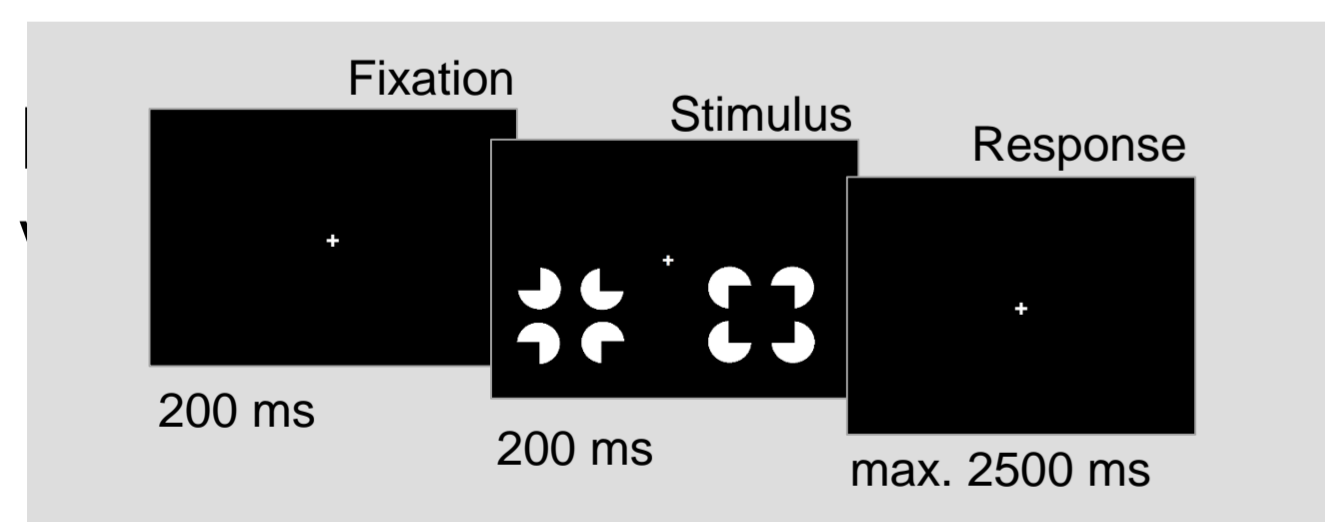
- **Global precedence:** The global object representation induced by the figure is preferentially processed relative to configurations composed of physically similar local elements (Conci et al., 2007)

→ The difference in salience between Kanizsa- and non-Kanizsa figures is purely phenomenological (i.e. not caused by physical differences)

## Methods

### Participants

- N=24, 12 younger and 12 older
- Screening of older participants:
  - no history of chronic somatic, psychiatric, and neurological diseases (self-report)
  - no signs of beginning dementia (all scored  $\geq 27$  in the Mini-mental state examination; Folstein & Folstein, 1975)
  - Adequate visual acuity (all 0.63; Snellen, 1963)



### Global Task:

- Selection of the Kanizsa-figure, ignoring the non-Kanizsa figure

### Local Task

- Selection of the non-Kanizsa-figure, ignoring the Kanizsa-figure

### Statistical Analyses

- Mixed ANOVAs were run on
  - Reaction times (RT)
  - Error rates (Error%)
  - Z-transformed reaction times (zRT)
  - ERPs and ERLs (see Table above)

with the factors

- Task (global, local) - within-subjects
- Age (young, old) - between-subjects
- Electrode (PO7, PO8) - within-subjects, only for ERPs

Interactions were followed-up by separate ANOVAs and t-tests

## Approach & Hypotheses

- We manipulated the phenomenological salience of target- and distracter-stimuli in a visual selection task using Kanizsa- vs. non-Kanizsa stimuli
- We measured event-related potentials (ERPs) and lateralizations (ERLs), to investigate age differences in target- and distracter-processing on several perceptual and attentional processing stages (Conci et al., 2011; Luck, et al., 2000; Töllner et al., 2011; Forthier-Gauthier et al., 2012; Wascher & Beste, 2010)

- **Visual P1 and N1:** Visual sensory encoding and discrimination
- **Posterior Contralateral Negativity (PCN):** Spatial allocation of Attention
- **Positivity Posterior Contralateral (PPC):** Salience-related processing

- We expected that a general performance decline in older age would be reflected in age-dependent (task-independent) ERP modulations (ME Age)
- We assumed that potential qualitative age differences – such as impaired inhibition of irrelevant global shape information – may become manifest in over-additive effects of global-local task conditions on age differences in the ERPs (Age  $\times$  Task interaction)

## EEG Recording and Processing

- 64 Ag/ AgCl electrodes, 10-10 system
- SR 1000Hz; 0.1-100 Hz BP-filter
- Online reference Cz; offline re-referenced to mastoids
- ICA-based correction of eye blinks and movements
- Epochs of -200 – 800ms, pre-stimulus baseline correction
- Exclusion of epochs containing artifacts ( $\pm 60 \mu V$ , voltage step  $< 50 \mu V$ , activity  $< 0.5 \mu V$  within 500 ms)
- ERLs = ERPs contra-minus-ipsilateral to the target location

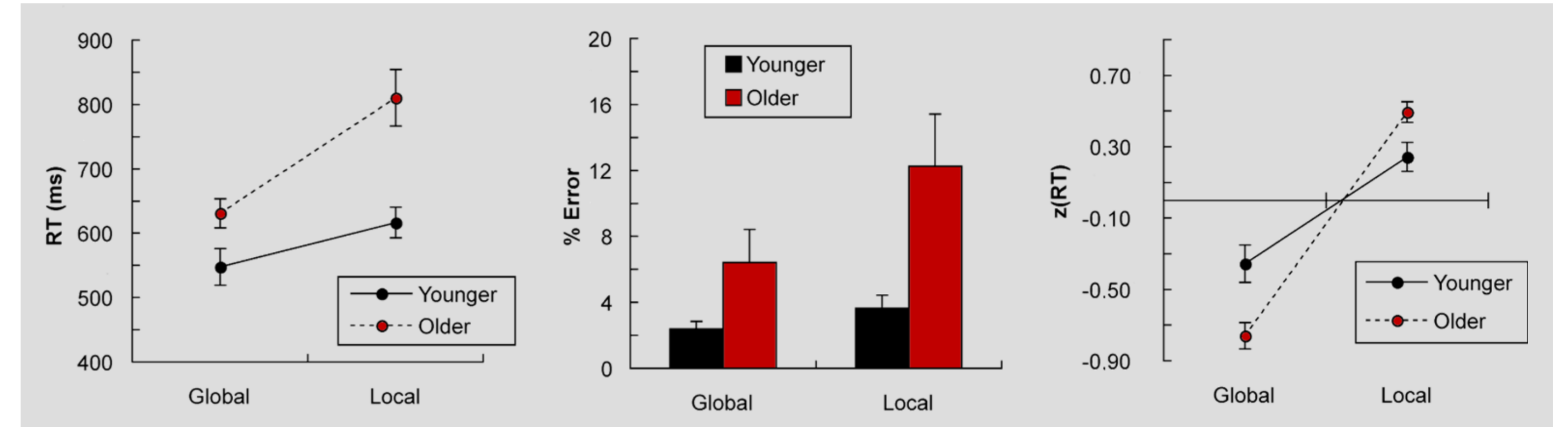
	Time (in ms)	Measurement (at PO7/PO8)
<b>P1</b>	75-125	ERP mean amplitude
<b>N1</b>	150-200	ERP mean amplitude
<b>PPC</b>	150-200	ERL mean amplitude
<b>PCN</b>	250-500	ERL peak amplitude & latency

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## Results & Discussion

### Behavioral Data



### Age-related decline

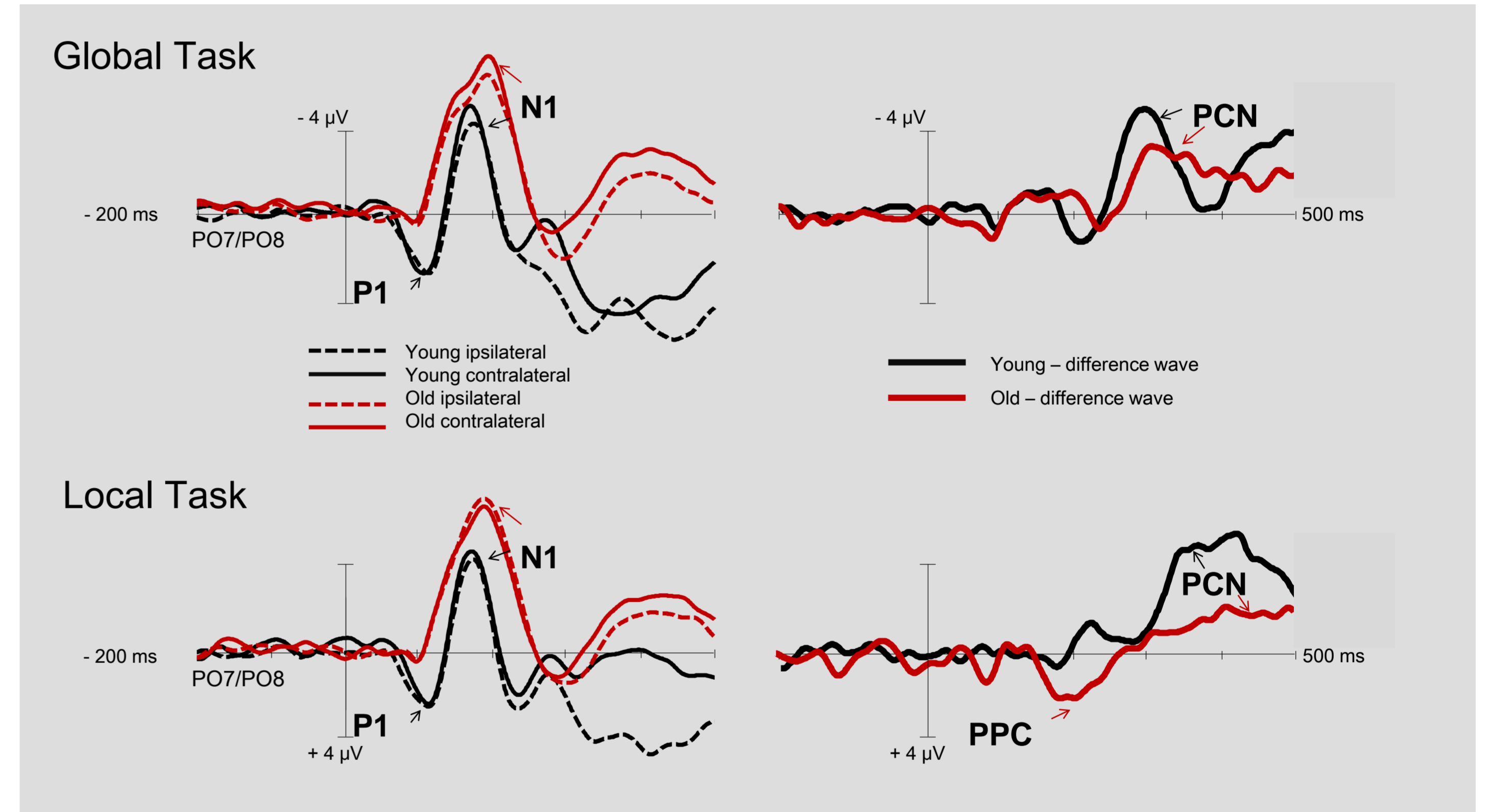
- Older participants responded slower and less accurate and than younger participants (ME Age on RT and % Error; both  $p < .025$ )

### Global precedence

- Slower and less accurate responses in the global as compared to the local task across age groups (ME Task on RT and % Error; both  $p < .05$ )

### Increased global precedence with age

- The global processing advantage, i.e. faster responses to global relative to local targets, was stronger in the older than the in the younger group, independent of generalized slowing (Task  $\times$  Age on RT and z(RT), both  $p < .02$ )



Aging affects **sensory coding**; this may impede an **early processing distinction** between global and local stimuli

- The **P1** was more pronounced for younger than older participants (ME Age,  $p = .01$ )
- Only in the younger group, the **P1** was larger in the global than in the local task (Age  $\times$  Task:  $p = .06$ ; follow-up: ME Task (global>local) young:  $p = .01$ ; old:  $p = .84$ )

Visual discrimination efficiency is reduced in older age

- The **N1** was enhanced for older relative to younger participants (ME Age:  $p < .05$ )

## Summary & Conclusions

- Age-related visual decline originates at multiple stages within the information-processing stream: sensory encoding (P1) and discrimination (N1) of objects is affected, and allocation of focal attention to objects in space (PCN) is slowed

- Beyond general decline, older individuals have a specific deficit in suppressing processing of task-irrelevant, but salient global shape information (PPC), which leads to increased global precedence with aging

**Salient, irrelevant, global objects** attract older individuals resources

- Only older participants showed a **PPC** in the local task, i.e. a negative ERL to the global distracter (Age  $\times$  Task:  $p < .05$ ; follow-up: ME Task [local>global]; old:  $p < .003$ ; young:  $p = .5$ )

**Spatial allocation of attention** is slowed in older age, and - independent of age - speeded for selecting Kanizsa (relative to non-Kanizsa) squares

- The **PCN** was reduced and delayed for older relative to younger participants (ME Age: both  $F(1,22) = 4.5$   $p < .05$ )
- The **PCN** peaks earlier in the global compared to the local condition (ME Task:  $F(1,22) = 8.96$ ;  $p < .007$ )

Older, in contrast to younger, participants, could not override the strong saliency signal when it interfered with the task. This **inhibitory deficit of global object salience** might be a distinctive aspect of aging, as top-down control in other tasks is often preserved in older age (Madden, 2007)

Our findings contribute to clarify as yet inconsistent age effects on **hierarchical processing** tasks: age differences may depend on the requirement to select lower-salient over higher-salient global-local stimuli (Tsvetanov et al., 2013)

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