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 Adaptive Minds

# How Effective are Monetary Incentives for Improving Context Updating in Younger and Older Adults?

# Age Differences in Context Processing

Maintenance of internal goals



*Adapted and modified from Braver, 2011*

Updating of internal goals

## Context information



Age-related shift  
from a proactive  
towards a reactive  
mode of context  
updating

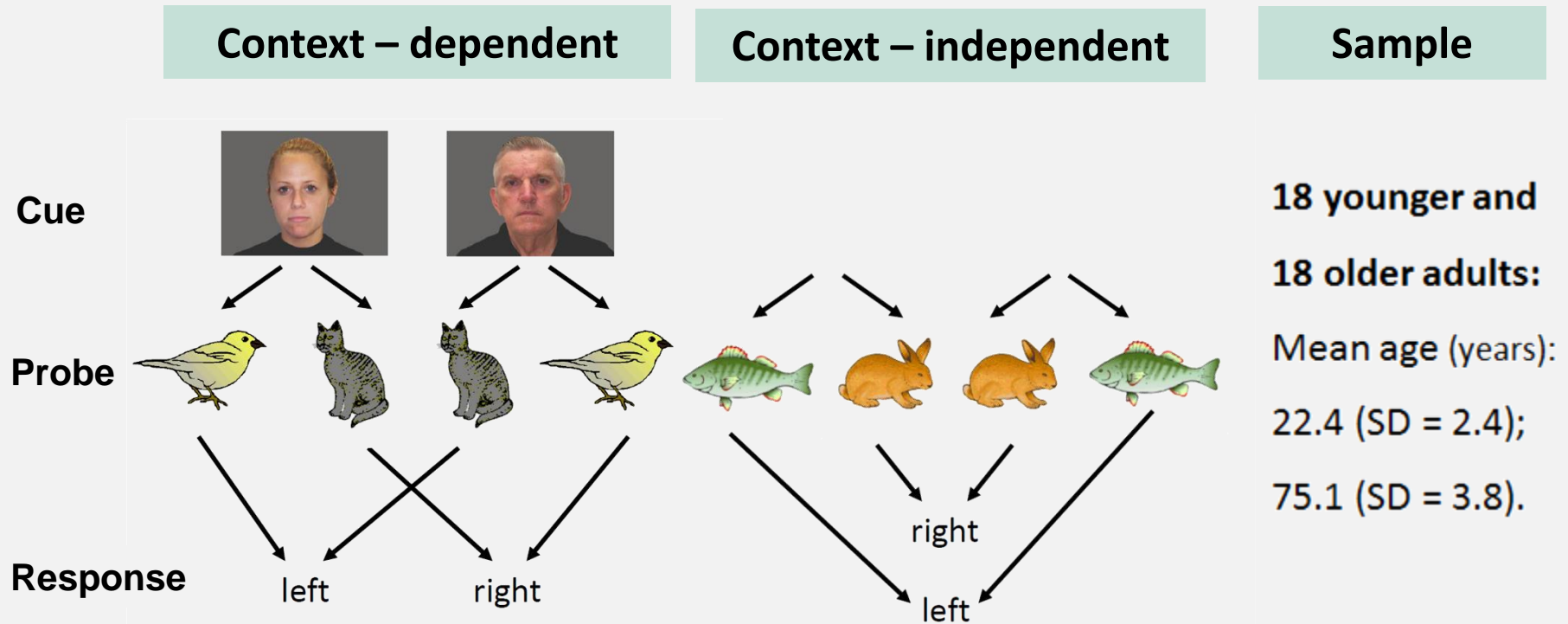
*(Braver & Barch, 2002;  
Karayanidis & Jamadar, in press)*

Goal 1: Age differences in the temporal  
dynamics of context updating  
– ERP approach

# Methods

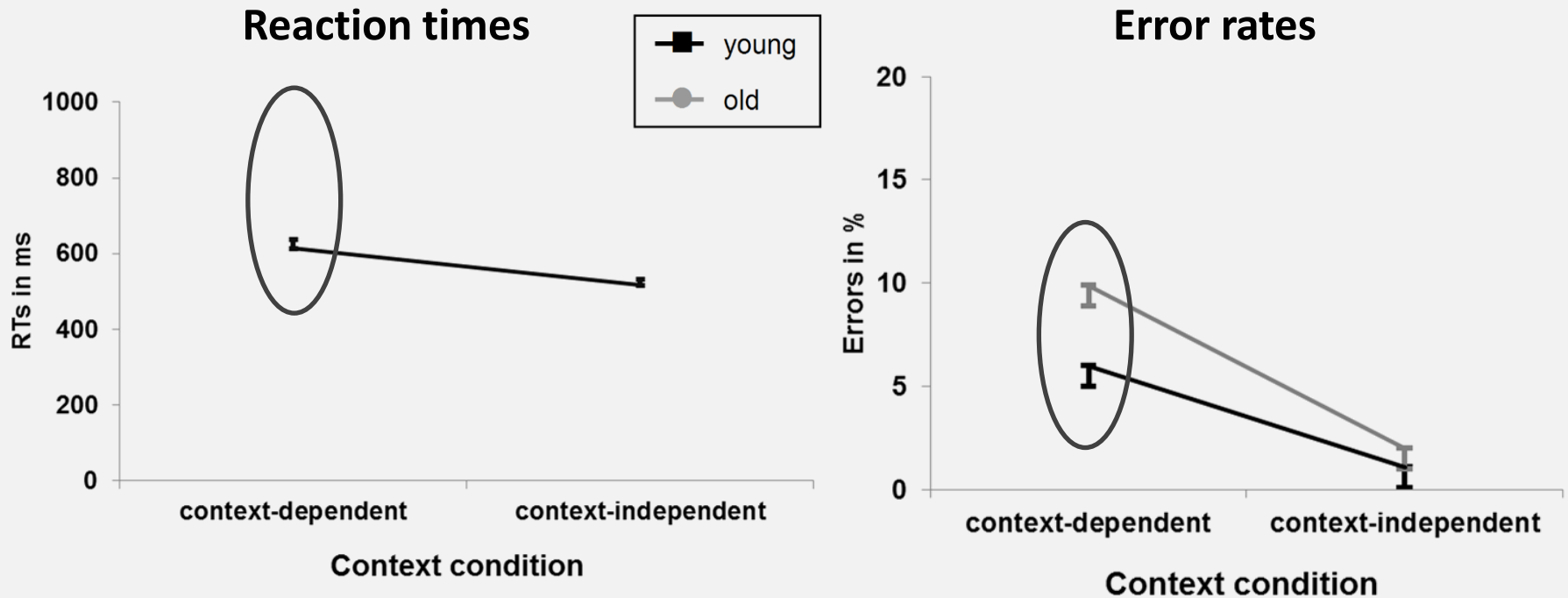
## Modified AX-Continuous Performance Task:

(Lenartowicz et al., 2010)



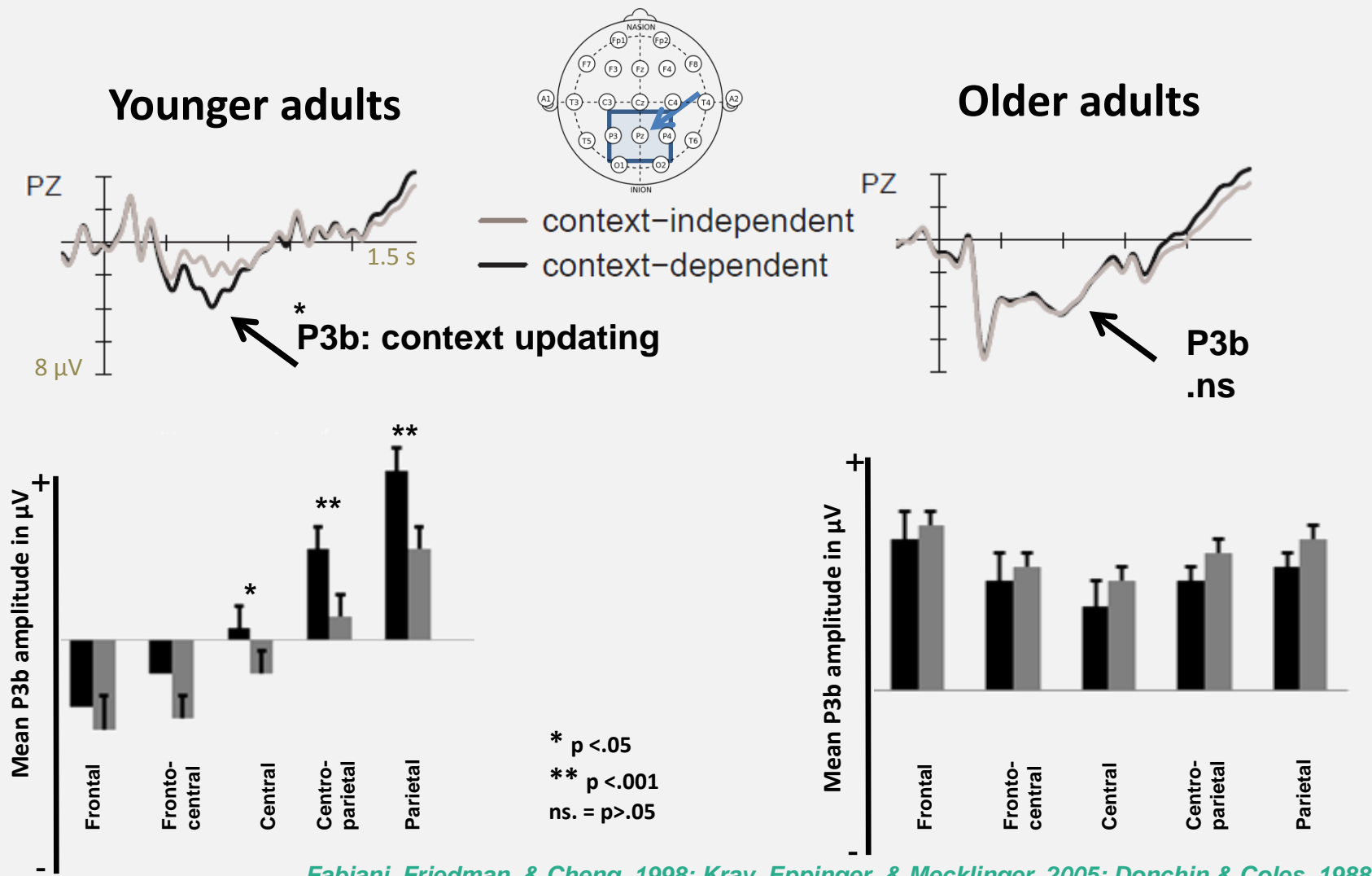
Schmitt, Wolff, Ferdinand, & Kray (in press); Facial stimuli: Minear & Park, 2004; Pictures of animals: Rossion & Pourtois, (2004)

# Behavioral Data



→ Age Differences were Most Pronounced on **Context-Dependent** Trials

# ERP Data: Cue-locked

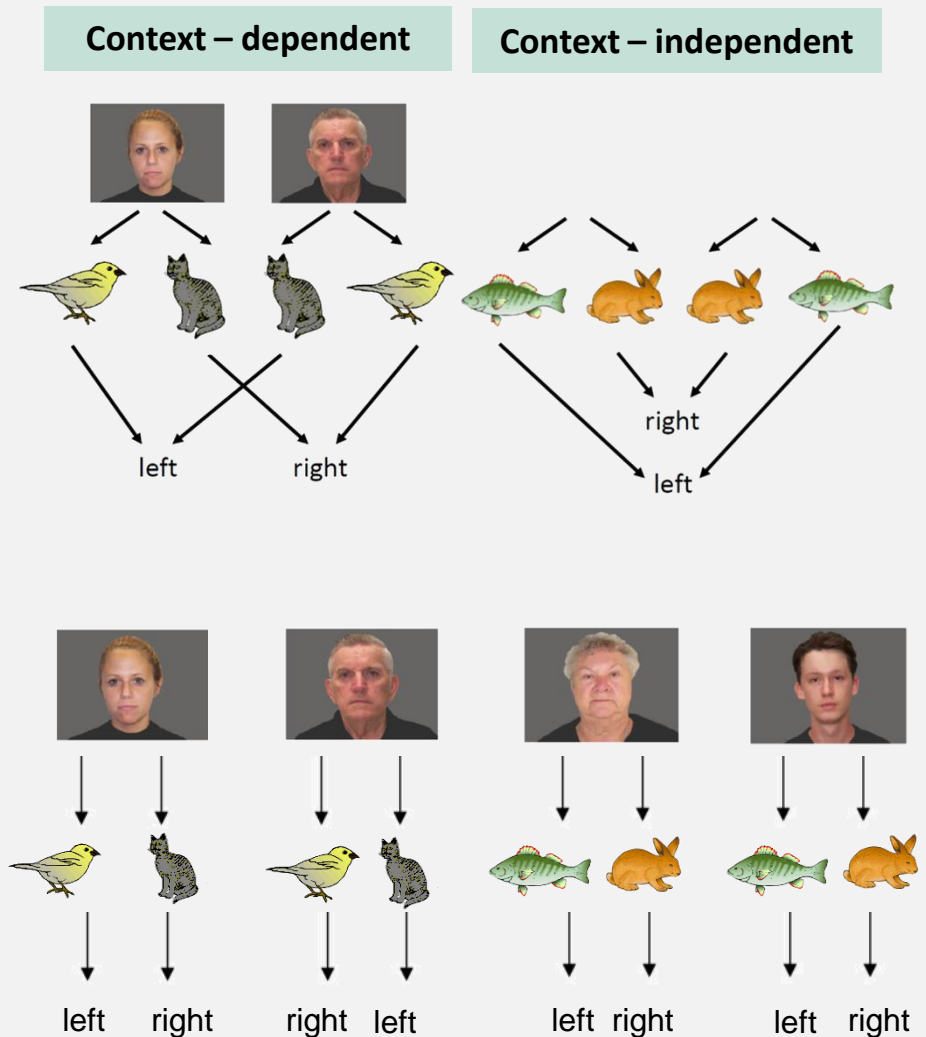


# ERP Data: Cue-locked

- Comparable P3b amplitudes on c-dep and c-indep trials in older adults
- Larger P3b amplitudes whenever perceptual cue information changed

→ Change in representation of context conditions, reliance on visual information (*Spieler, Mayr, & LaGrone, 2006*)

*Schmitt, Wolff, Ferdinand, & Kray (in press)*



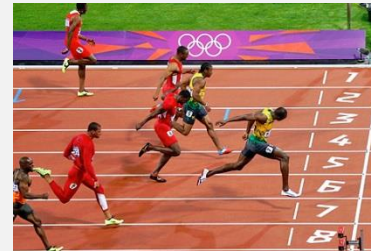
# Context Updating and Motivation

Updating of goals

**Context information**



**Reward  
Motivation**



→ Do motivational manipulations promote context updating?

# Context Updating and Motivation

- **Behavioral evidence:**

- Reward: Improvement in AX-CPT due to increased context updating/proactive control *(Braver, Paxton, Locke, & Barch, 2009; Chiew & Braver, 2013; Locke & Braver, 2008; Jimura, Locke, & Braver, 2010)*
- Inconsistent findings for penalty conditions: Same or different? *(Locke & Braver, 2008; Savine et al., 2010; Tversky & Kahneman, 1973)*

- **Neural evidence:**

- Reward: Phasic dopamine release to reward and reward-predicting cues
  - dopamine associated with gating of context updating in PFC
  - Reward increased activity in PFC at the time the context cue is presented
- Penalty: Dopamine neurons excited during salient (positive/negative) events

*(Bromberg-Martin, Mtsumoto, Hikosake, 2010; Ikemoto & Panksepp, 1999)*



# Do Motivational Manipulations Promote Context Updating?

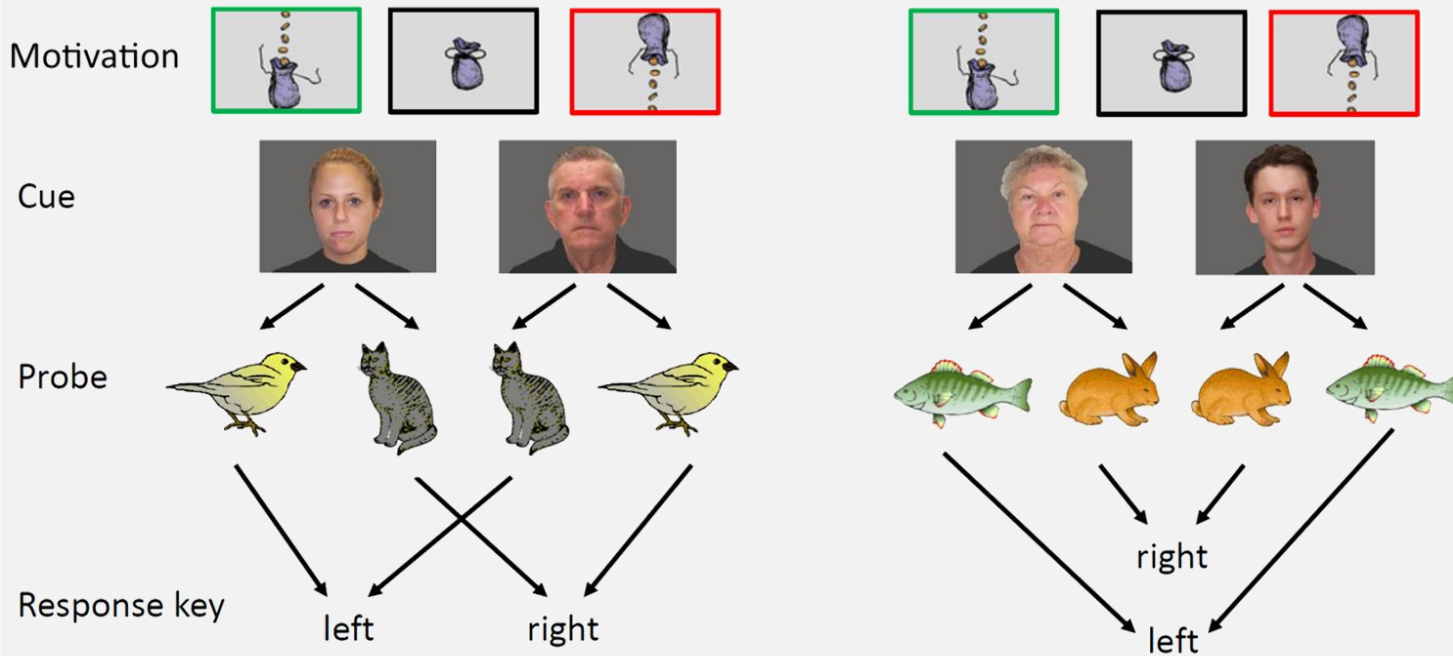
Modified AX-CPT with motivational cues:

(*Lenartowicz et al., 2010; Schmitt et al., 2014*)

Context – dependent

Context – independent

Sample



**18 younger and**

**18 older adults:**

Mean age (years):

23.8 (SD = 3.1);

73.0 (SD = 2.3).

*Schmitt, Wolff, Ferdinand, & Kray (in press); Facial stimuli: Minear & Park, 2004; Pictures of animals: Rossion & Pourtois, (2004)*

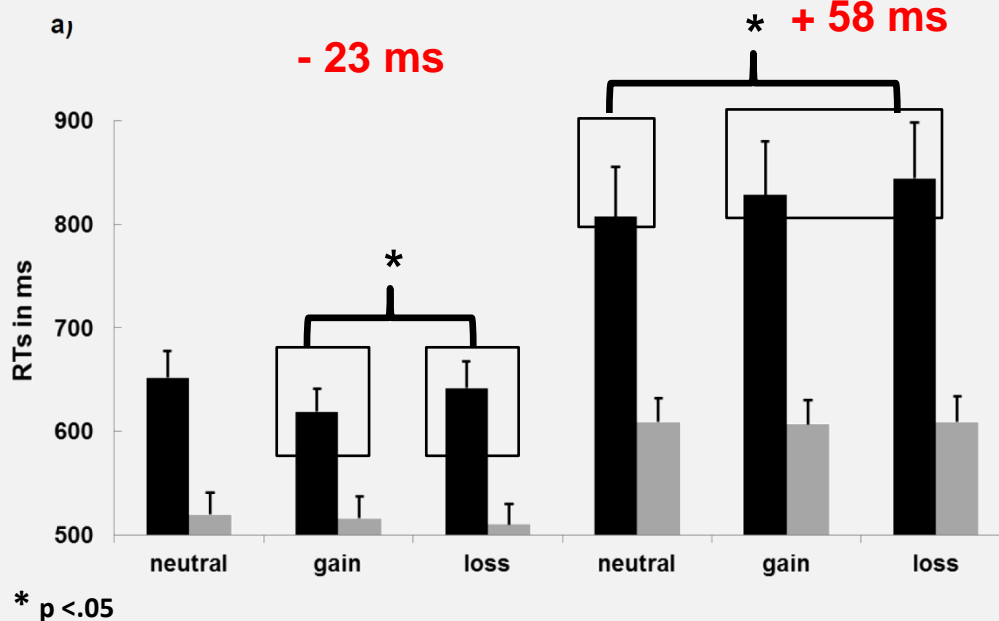
# Behavioral Data

## Reaction times

Younger

Older

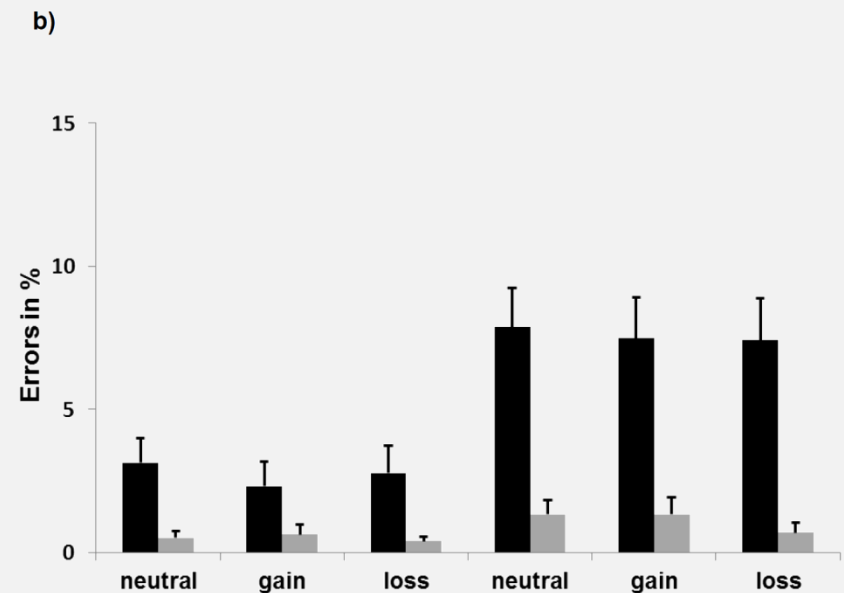
■ context-dependent  
■ context-independent



## Error rates

Younger

Older

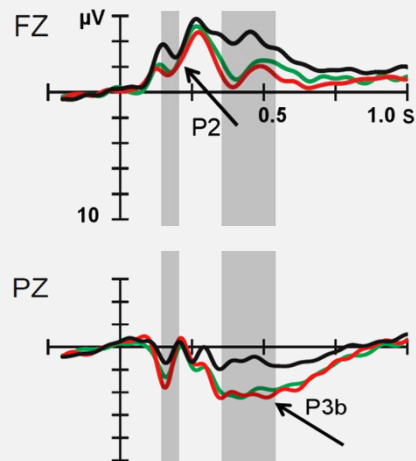


→ Modulation of Age Differences in Context Effects

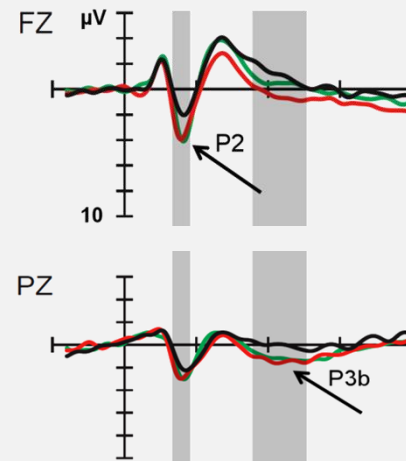
# ERP Data

## Motivational Cue

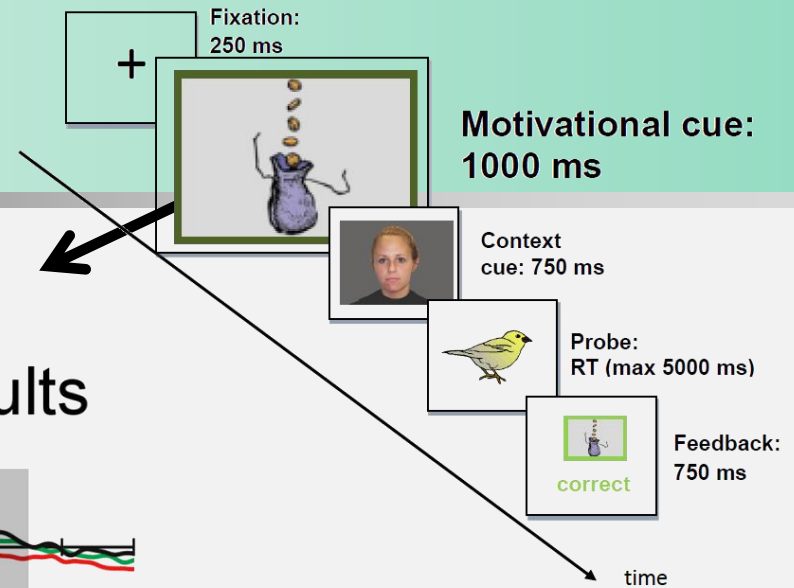
### Younger adults



### Older adults



Legend:  
 — gain  
 — loss  
 — neutral



- Anticipation of motivationally *salient* cues in both age groups

→ automatic attention capture (P2)

→ updating of relevant stimulus information (P3b)

(Oloffson et al., 2008, Krebs et al., 2014)

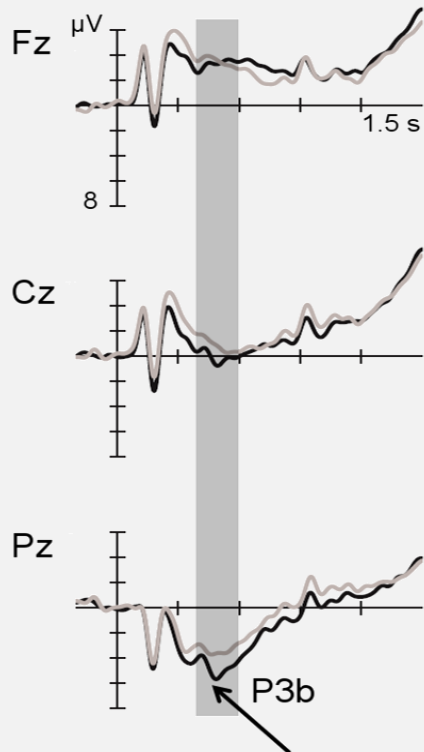
- No motivationally *valence* effects

# ERP Data

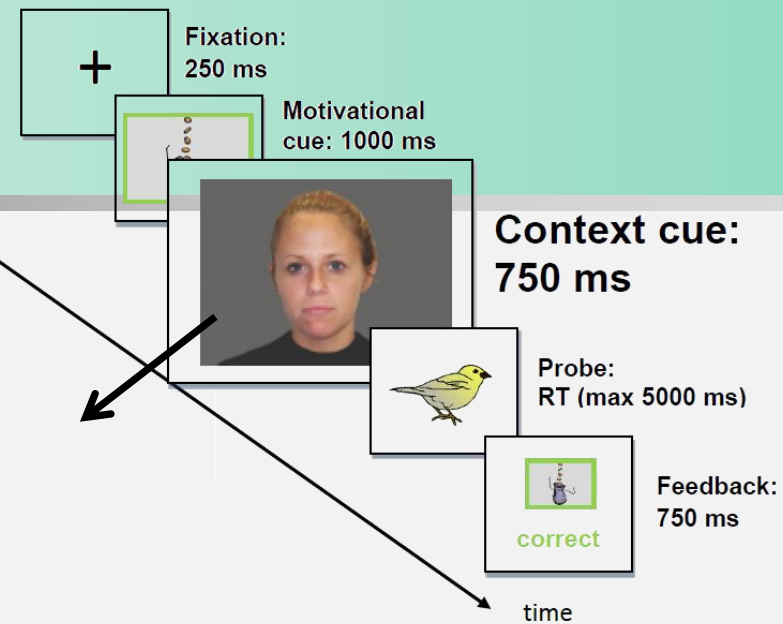
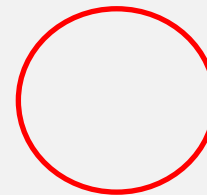
## Context cue

- context-independent
- context-dependent

neutral



Younger adults

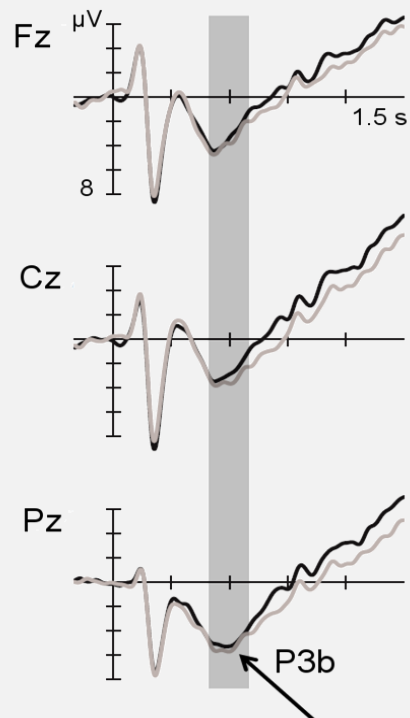


# ERP Data

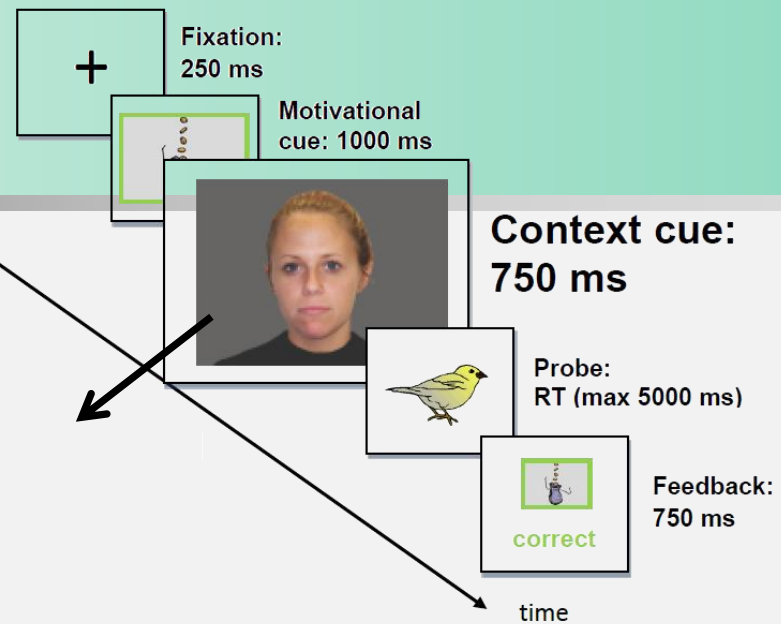
## Context cue

— context-independent  
— context-dependent

neutral



Older adults

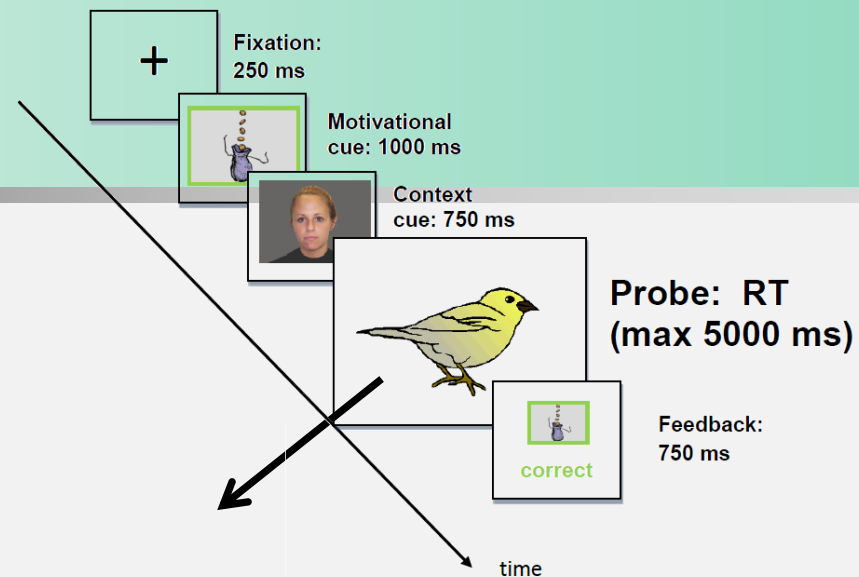
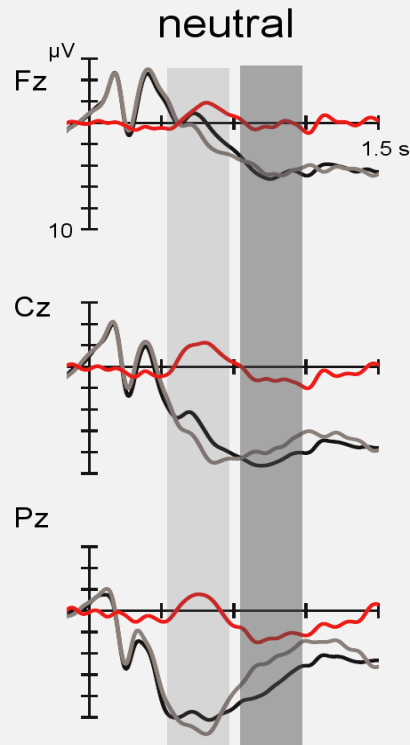


# ERP Data

## Probe

— context-independent  
— context-dependent

Younger adults



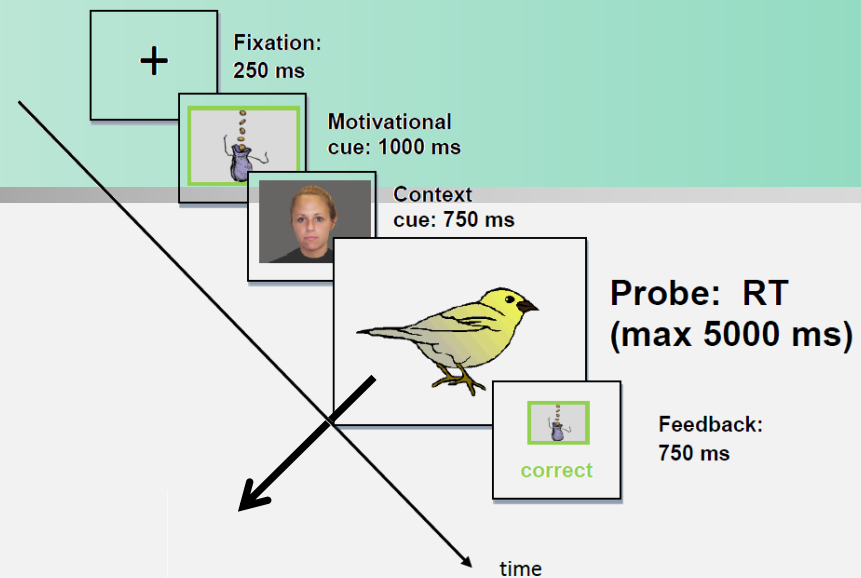
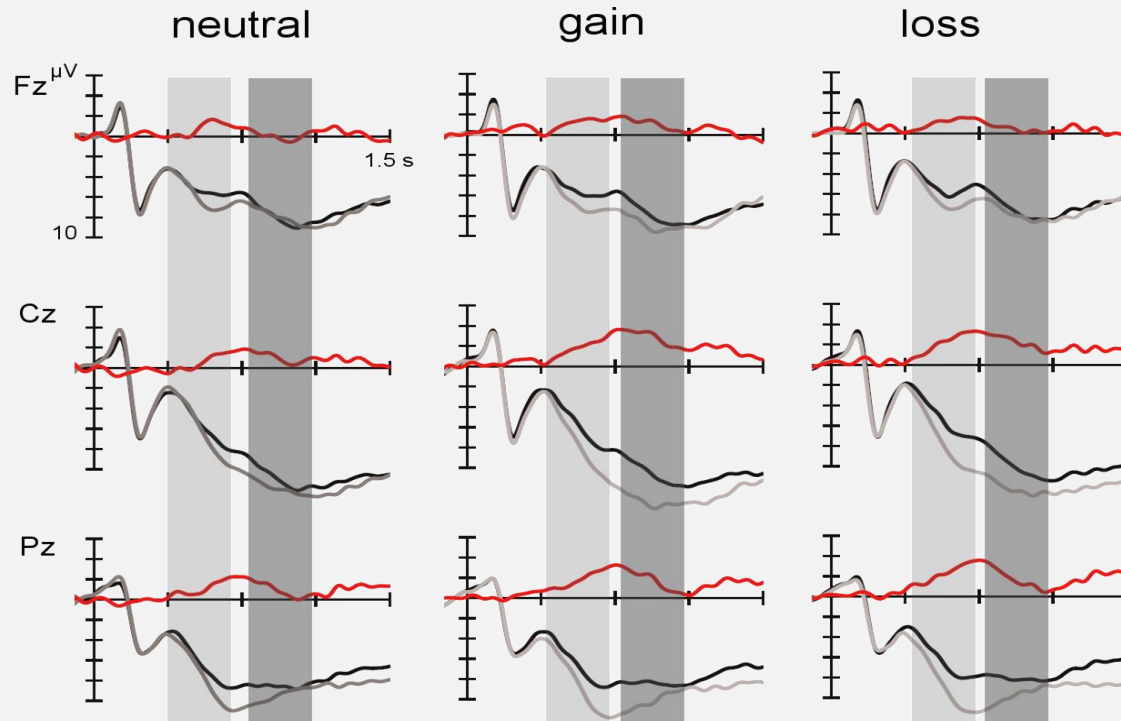
- Context effects in loss trials only (conflict –N450)
- Subsequently, reduced context effect in positive wave in loss trials (Late positive component, sustained potential)

# ERP Data

## Probe

— context-independent  
— context-dependent

Older adults



- Context effects in motivationally salient gain and loss trials
- No valence effects

# General Discussion

- Reliable **age differences** in context updating across studies (*Braver et al., 2002*)
  - Older adults: no difference between context conditions, but updating dependent on change in cue identity
- **Modulation by incentives:**
  - Younger adults benefit, while older adults are impaired/cautious
  - Motivational cues modulate context updating when **cognitive control demands** are highest (*Savine & Braver, 2010 ; Pessoa, 2008*)
  - No evidence for speed-accuracy-tradeoff: **Real** motivational effect /benefit (*Falkenstein, Hoormann, & Hohnsbein, 2003; Kleinsorge & Rinkenauer, 2012*)
  - **Age differential** motivational *salience* and *valence* effects



# General Discussion

## ERP data

- **Motivational Cue:** Attention capture seems to be age-invariant (*Oloffson et al., 2008, Samanez-Larkin et al., 2007*)
- **Context Cue and Probe:**
  - Younger adults: Loss Trials**
    - Reduced proactive context updating
    - Larger conflict processing and impaired conflict resolution/ response selection
  - Reactive control pattern in line with a fMRI study on loss trials in the AX-CPT
  - Assessment of individual differences in reward/penalty sensitivity  
(*Braver, Paxton, Locke, & Barch, 2009*)
  - Older adults: Salient Trials**
    - Context effects in motivationally salient conditions
  - Sharpened context representations by motivational cues

# Take home

- Age differences in approach to task and task-set representation
- Modulation by motivational cues

Younger adults are highly sensitive to loss cues

Older adults respond to motivational salient cues -  
irrespective of valence



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*Thank you for your attention!*

## Acknowledgments

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Annabelle Walle*

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# Methods

## Predictions Study 1

### (1) Behavioral data:

- Age differences will be more pronounced on c-dep than c-indep trials (*Braver et al., 2002*)

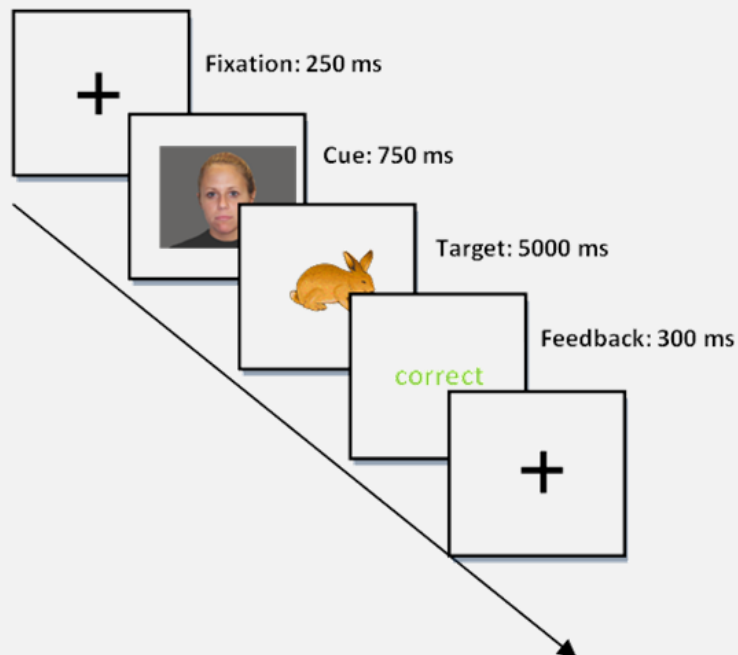
### (2) ERP data:

- Context **updating** associated with a parietal P3b amplitude (*Donchin & Coles, 1988*)
  - Larger P3b for c-dep than c-indep trials (*Lenartowicz et al., 2013*)
  - Older adults: reduced P3b on c-dep trials **or** no context effect at all (*Kray & Ferdinand, 2013*)
  - Age differences in the P3b-distribution (*Friedman, Kazmerski, & Fabiani, 1997*)
- Context **maintenance** associated with a central Contingent-Negative-Variation (CNV)
  - Larger CNV in the elderly especially on c-dep trials (*Kray, Eppinger & Mecklinger, 2005*)

# Sample Study 1

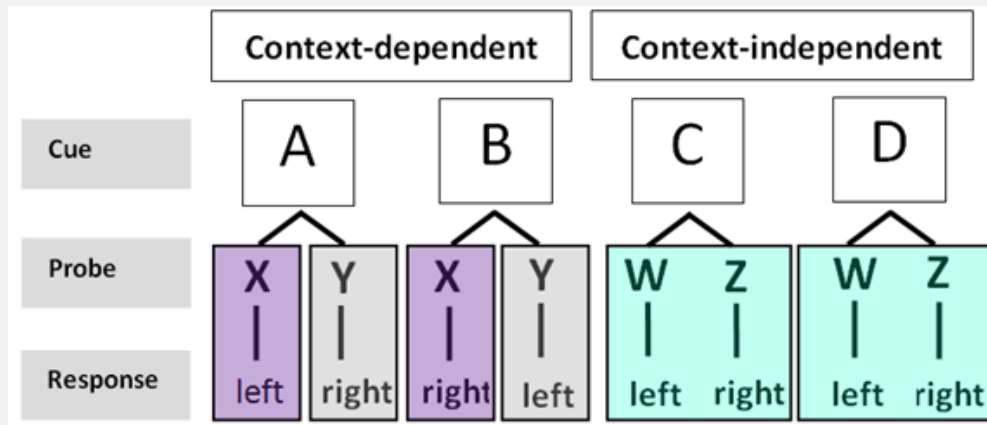
Measure	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>n</i>	18		18	
Age range (years)	19-27		68-82	
Gender distribution (% female)	44 %		44 %	
Mean age (years)	22.4	2.4	75.1	3.8
<i>Cognitive Variables</i>				
Digit Symbol Substitution Test	67.4	9.5	44.9	7.8
Backward Digit Span Task	7.8	3.0	5.8	1.8
Spot-a-word Task	22.2	3.0	28.9	3.0

- Presentation times



# Context updating vs. Cue switching

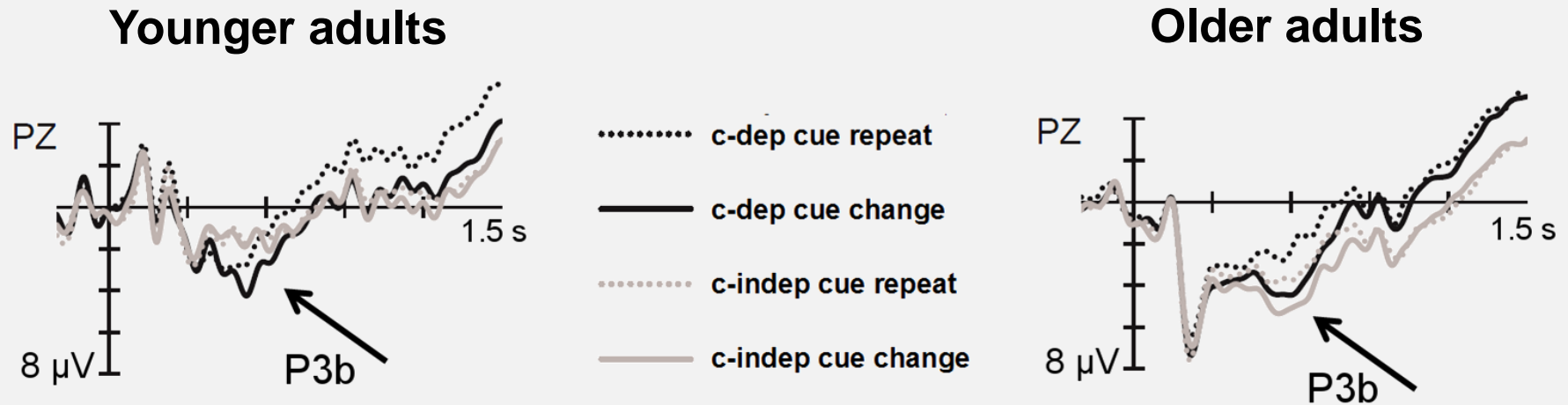
- Additional analysis: cue switch and repeat trials



1. Cue-**switches** on c-dep trials: AX/AY followed by BX/BY or vice versa  
→ Change in S-R mapping, requires context updating
2. Cue-**switches** on c-indep trials: CW/CZ followed by DW/DZ or vice versa  
→ No change in S-R mapping, no context updating necessary
3. Cue-**repeat** trials in both trial types: AX/AY followed by AX/AY or CW/CZ followed by CW/CZ  
→ No change in S-R mapping, no context updating necessary

# Context updating vs. Cue switching

- Additional analysis: switch and repeat trials



- Older adults are sensitive to perceptual changes in *cue identity* irrespective of context condition

→ impaired context representation?

→ Utilization of present cue information: Visual routine *Spieler, Mayr, & LaGrone, 2006*

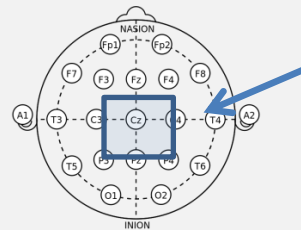


# Study 1 results: Cue-locked

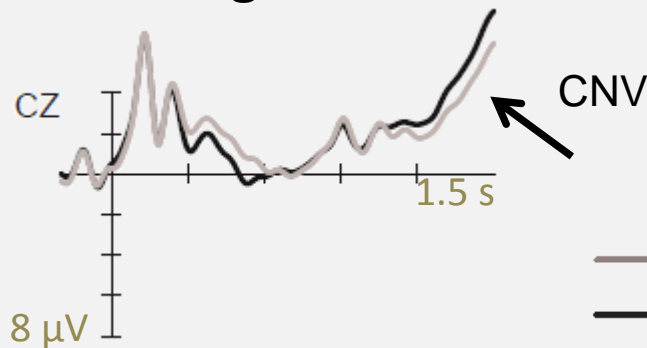


- **CNV**

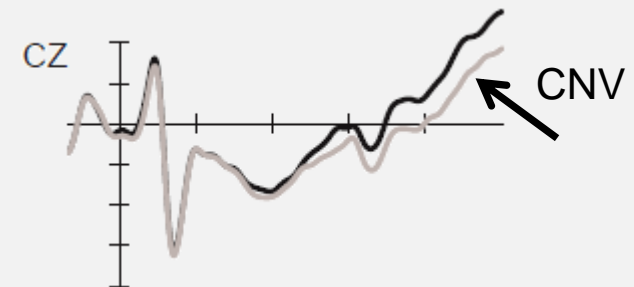
- C-dep trials require context maintenance to a larger extent
- No age differences



## Younger adults



## Older adults



— context-independent  
— context-dependent

# Individual differences

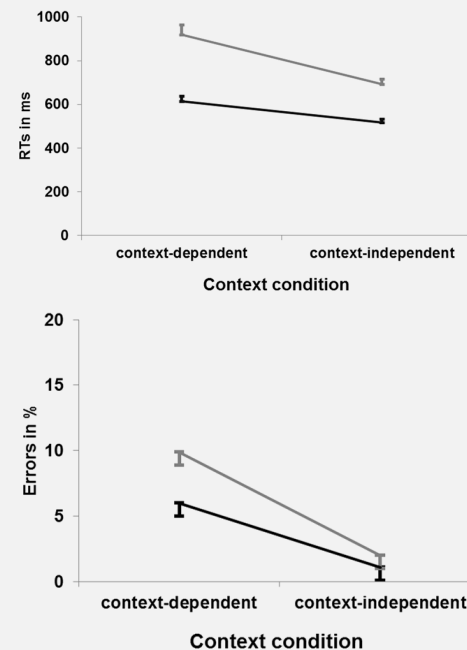
Age-related **temporal** differences in context updating in the P3b

- Do age differences in ERP of context updating remain when controlling for ***performance differences*** between age groups?

- Performance matched groups

Age	Performance	
	Older High	Younger Low

Age x Context,  $p$ 's > .05



Schmitt, Wolff, Ferdinand, & Kray, in press

# Results: Cue-locked

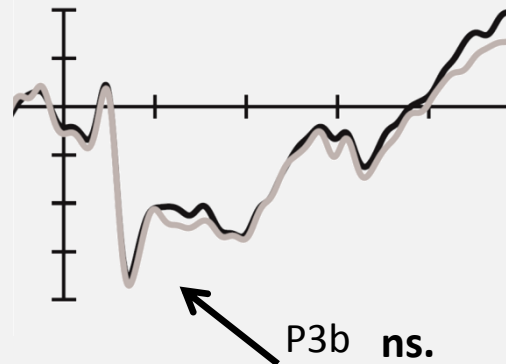
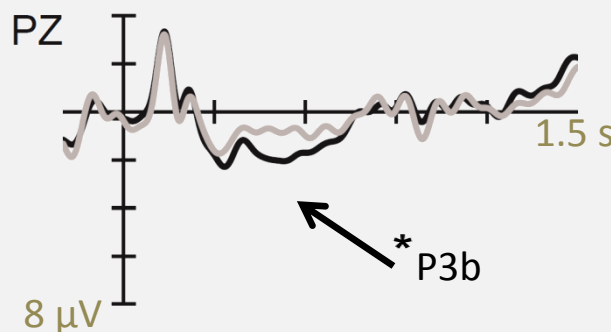
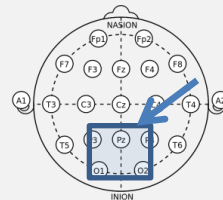


- Do age differences in ERP of context updating remain when controlling for **performance differences** between age groups?

Performance matched groups

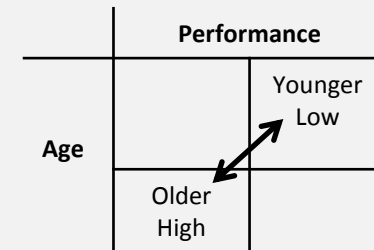
Younger low

Older high



— context-independent  
— context-dependent

\* $p < .05$ , ns. =  $p > .05$



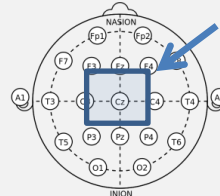
→ Age differences in context updating when controlling for performance differences

Schmitt, Wolff, Ferdinand, & Kray, 2014

# Results: Probe-locked



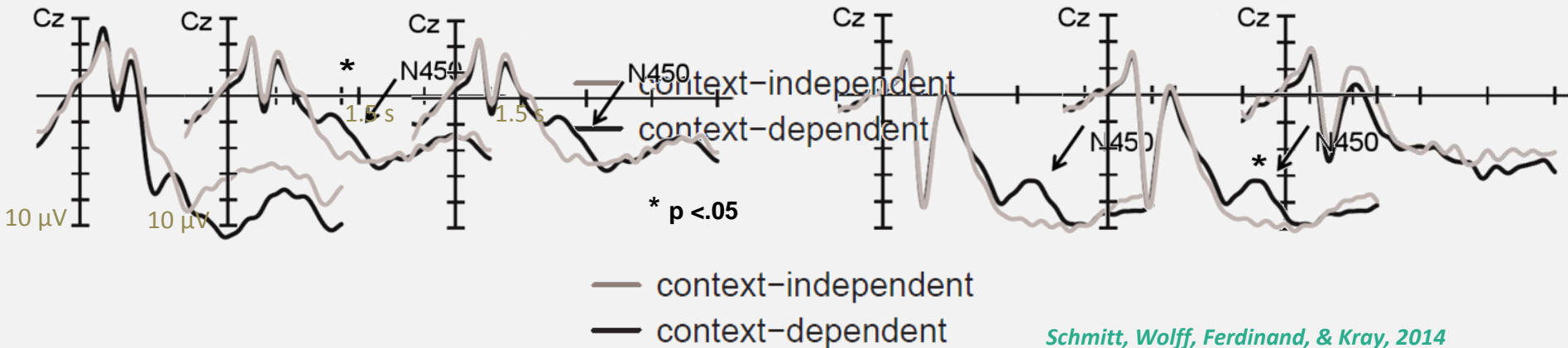
## Younger adults



## Older adults

High performer Low performer

High performer Low performer



# Methods

## Predictions Study 2 and 3

### (1) Behavioral data:

#### Study 2:

- Pronounced age differences on c-dep trials (*Braver et al., 2002*)
- Better performance on reward trials (*Chiew & Braver, 2013; Kleinsorge & Rinkenauer, 2012*) particularly in older adults (*Ferdinand & Kray, 2013; Mather & Carstensen, 2005*)
- Reward and penalty: same or different effects?

### (2) ERP data:

- Pronounced age differences in context updating linked to a parietal P3b (*Donchin & Coles, 1988*)
- Larger P3b and CNV on reward trials linked to increased cognitive control (*Chiew & Braver, 2013, Kleinsorge & Rinkenauer, 2012*) and in older adults (*Ferdinand & Kray, 2013; Mather & Carstensen, 2005*)
- Reward and penalty: same or different effects on P3b and CNV?

# Sample Study 2

Measure	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>n</i>	18		18	
Mean age (years)	23.8	3.1	73.0	2.3
Age range (years)	19-28		69-78	
Gender distribution (% female)	50 %		44 %	
Digit Symbol Substitution Test**	70.6	7.7	45.0	10.3
Counting Span				
• Positions*	35.0	7.5	26.7	7.5
• Sequences**	6.2	1.7	4.1	1.6
Spot-a-word**	23.8	3.4	28.8	2.6
Money won (euro)*	8.1	0.7	7.3	0.7

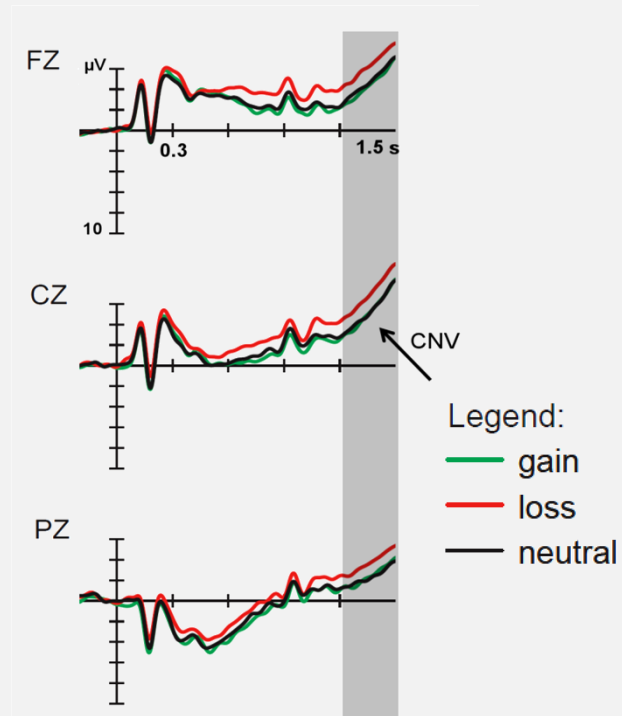
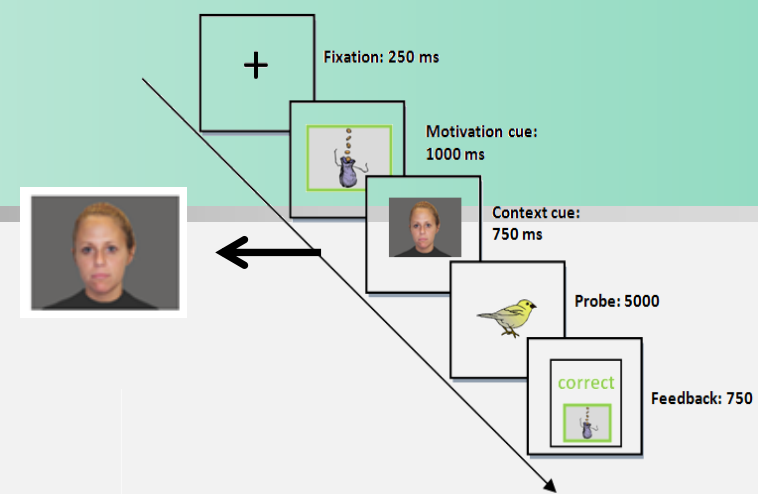
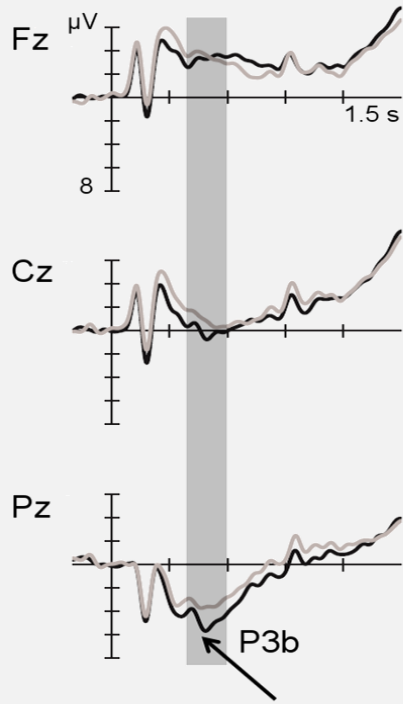
# Results

## ERP data: Context cue

— context-independent  
— context-dependent

Younger adults

neutral



# Results

## ERP data: Context cue

— context-independent  
— context-dependent

Older adults

neutral

