Intraindividual Variability of Proactive Control in Cognitive and Motor Aging

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Introduction

- Older adults (OA) exhibit a significantly greater risk of falling than young adults (YA) partially as a function of normative age-related declines in executive control processes[1]
- The Dual Mechanisms of Control (DMC) model examines age-sensitive executive functions with proactive and reactive modes of cognitive control[2]
- However, age differences in cognitive control processes have yet to be examined in the context of intraindividual variability (IIV)[3]
- Additionally, the role of intraindividual variability of proactive control in postural recovery, operationalized as anticipatory postural adjustments, remains elusive[4]

Objectives

- The current research investigated the role of intraindividual variability of proactive control in YAs and OAs using a computerized AX-CPT paradigm
- Further investigations as to whether variability would translate to the postural domain were examined using an adapted Balance AX-CPT paradigm

Hypotheses

1) OAs would exhibit greater cognitive intraindividual variability of proactive control than YAs
2) OAs would exhibit greater postural intraindividual variability of anticipatory postural adjustments than YAs
3) Cognitive variability would be a significant predictor of postural variability

Methods

Participants

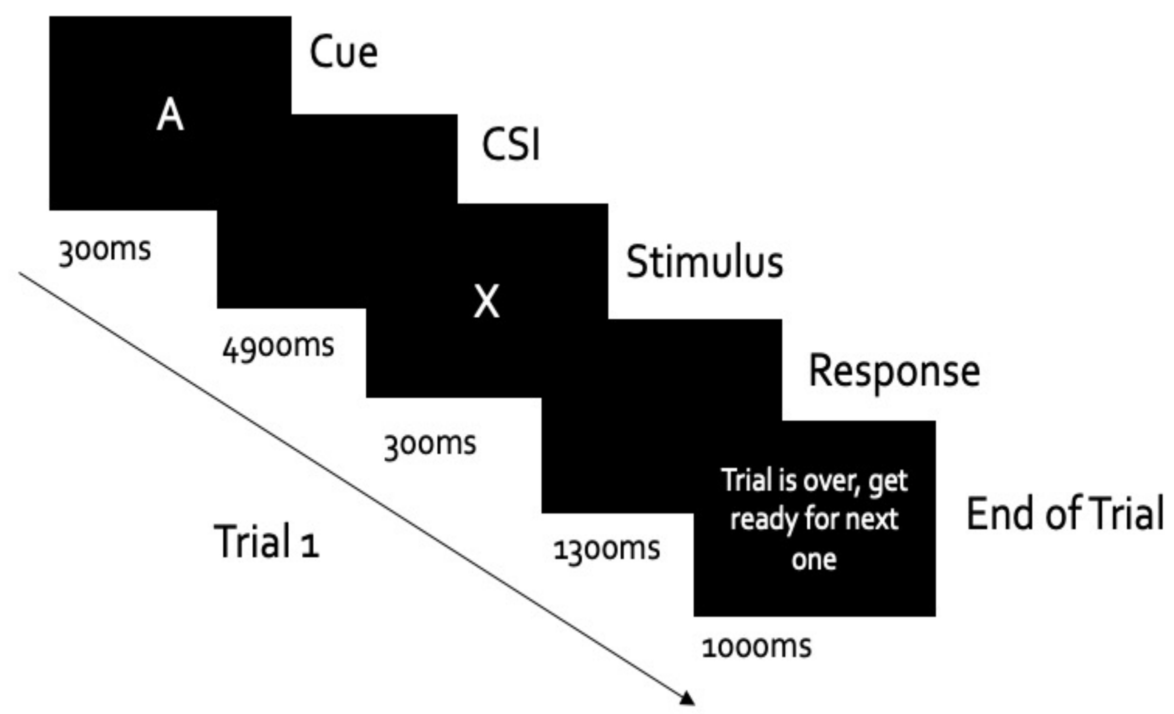
- 26 community-dwelling OAs (aged 60-80 years old) were recruited through advertisements
- 25 YAs (aged 18-30 years old) were recruited through Concordia University's Psychology participant pool

Session 1

- Participants were asked to fill out a demographic questionnaire and complete a set of background measures (Montreal Cognitive Assessment, Trail Making Tasks A & B, Stroop Test, Letter-Number Sequencing, Digit Symbol Coding, and ABC Scale)
- Participants then completed the computerized AX-CPT with a trial type distribution of AX70%, BX10%, AY10%, BY10%, to assess their use of proactive and reactive control

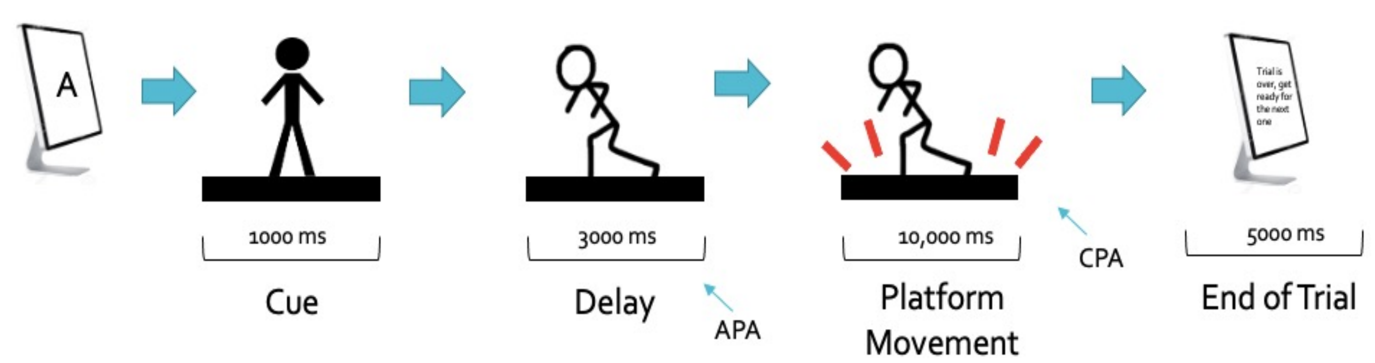
Methods

Computerized AX-CPT – Press target button when you see an AX pair

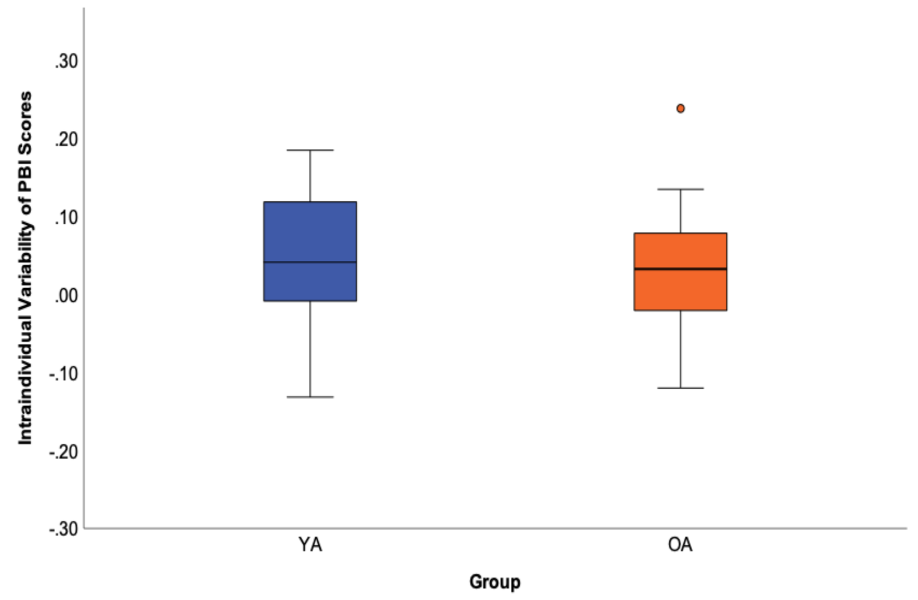


Session 2

- Participants completed an adapted version of the AX-CPT in a postural recovery paradigm, called the Balance AX-CPT
- X-stimuli were replaced by platform perturbations



Results: Hypothesis 1



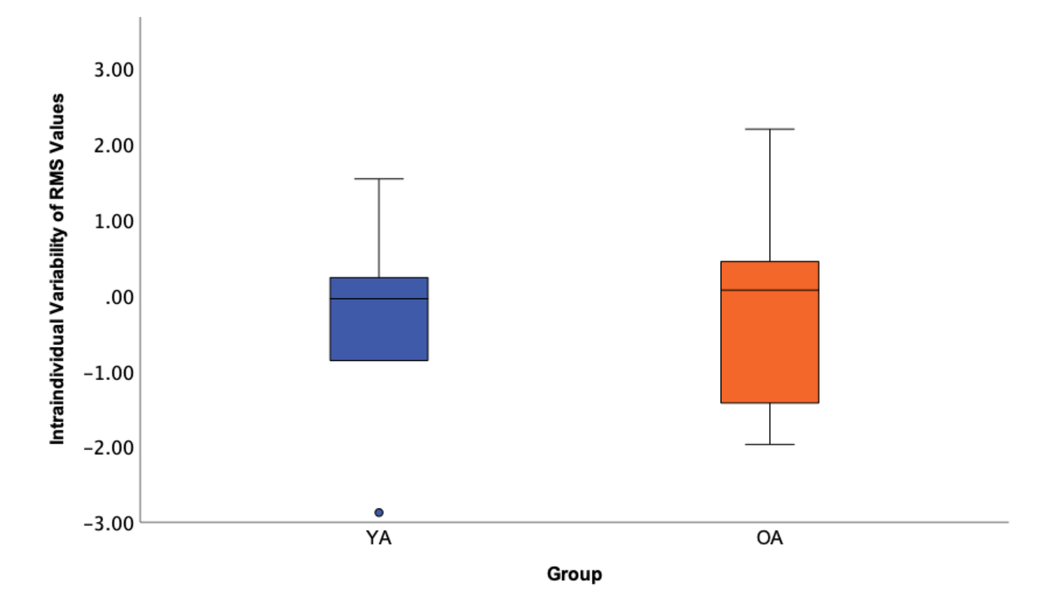
OA performance was comparable to that of YA using our four measures of IIV:

1) AY change in accuracy
2) BX change in accuracy
3) IIV of Proactive Behavioral Index (based on RT)
4) IIV of Proactive Behavioral Index (based on errors)

IIV of Proactive Control and Working Memory

- Statistically significant predictors of Letter Number Sequencing scores: AY change in accuracy (t = 2.17, p = .035, s_r^2 = .087), BX change in accuracy (t = -3.01, p = .004, s_r^2 = .167), and IIV of PBI based on error rate (t = 2.38, p = .021, s_r^2 = .105)

Results: Hypothesis 2



On the Balance AX-CPT, OA performance was comparable to that of YAs using all four measures of IIV of anticipatory postural adjustments. Root Mean Square (RMS) values were derived using EMG to record anticipatory muscle activation

Results: Hypothesis 3

Results of Multiple Regression Analysis of Predictors of Postural Intraindividual Variability

	Unstandardized coefficients						
Predictor	*B*	*95% CI for B*	*SE*	Standardized coefficients	*t* (22)	*p*	s_r^2
AY Change in Accuracy	-15.60	[-46.86, 15.65]	14.88	-.502	-1.049	.308	.045
BX Change in Accuracy	-4.46	[-49.86, 40.93]	21.61	-.104	-.207	.839	.000
IIV of PBI (reaction time)	9.11	[-9.46, 27.68]	8.84	.208	1.030	.316	.043
IIV of PBI (error rate)	-3.34	[-13.62, 6.94]	4.89	-.484	-.683	.504	.019

Note. N = 23, R = .518, R^2 = .268, adjusted R^2 = .105. *p < .05

Cognitive Variability as a Predictor of Postural Variability

- Two individual predictors of cognitive variability accounted for a moderate amount of variance in postural variability, suggesting the practical significance of the model
- AY change in accuracy uniquely explained 4.5% of the variance in IIV of anticipatory postural adjustments, after accounting for the effects of the other predictors
- IIV of proactive control, calculated using Proactive Behavior Index (PBI), as a function of reaction time, uniquely explained 4.3% of the variance in intraindividual variability of anticipatory postural adjustments, after accounting for the effects of the other predictors

Discussion

Hypothesis 1

- The similar levels of IIV in YAs and OAs may be attributable the high functioning characteristics of OAs in our sample.
- 10 OAs scored high, compared to reported norms, on the Letter Number Sequencing task, which assesses working memory
- The involvement of working memory processes in IIV of proactive control strengthens the validity of the computerized AX-CPT, which was designed to capture executive functions involved in cognitive control

Hypothesis 2

- Similar levels of IIV of anticipatory postural adjustments between YAs and OAs can be tied back to the cognitive similarities between the groups
- YAs and OAs demonstrate similar methods of postural control in the Balance AX-CPT, but the functions of these strategies may differ (dynamic vs. muscle stiffening)

Hypothesis 3

- The cognitive mechanisms described in the DMC model and assessed in the computerized AX-CPT, appear to be captured in measures of postural control in the novel Balance AX-CPT.

Conclusions

Limitations

- A form of self-selection bias may have been introduced, resulting in a subset of high-functioning older adults choosing to participate in the study
- Additionally, due to errors in EMG signal processing, sample size was severely reduced for the Balance AX-CPT analyses
- The number of AY and BX trials was fairly limited throughout the paradigm

Future Directions

- Other executive functions could also be considered for future research, such as processing speed and inhibition

Implications

- OAs are not reaping the potential adaptive benefits of increased variability, while simultaneously not being affected by any maladaptive effects of increased variability
- Preliminary support for the involvement of working memory processes in age-related declines in postural control
- Our novel Balance AX-CPT paradigm yields relevant postural information

References

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