Task-Related Interference in Older Adults: Behavioural and Electrophysiological Correlates of On- and Off-Task Thoughts.

Sarah E. Henderson[1], A. Dawn Ryan[2], Luke Atack[3] & Karen L. Campbell[1]
Brock University, Canada

Introduction

Despite well-established declines in inhibitory control (Campbell et al., 2020), older adults typically report fewer instances of mind wandering in the lab (e.g., Giambra, 1989; McVay et al., 2013) and in daily life (Maillet et al., 2018).

Older adults' self-reported mind wandering episodes result in similar behavioural detriments as younger adults (e.g., greater reaction time variability, more task errors; McVay et al., 2013). However, the relatively few studies investigating the neural correlates of mind wandering in aging have revealed mixed findings, with some showing similar effects across age groups (Maillet & Rajah, 2016) and others showing age-related differences (Maillet et al., 2019).

These mixed neural findings are mirrored in the mind wandering literature more broadly, possibly due to the variability in methodology across studies (e.g. probe types, trial segmentation methods, probe timing; Kam et al., 2022). This has prompted some to suggest that more systematic methods of mind wandering identification may be beneficial (Hawkins et al., 2015).

The current study investigated the utility of objective methods for mind wandering identification in older adults by comparing them to commonly used subjective thought probes and applying them to two EEG correlates of mind wandering (diminished P1 and P3).

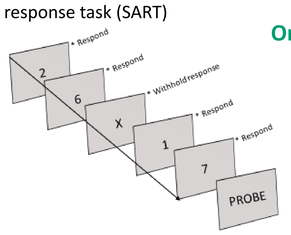
Method

Participants

49 young adults aged 18-30 years (M_{age} = 19.6, *SD* = 2.10; 45 female) and 40 older adults (M_{age} = 72.10, *SD* = 4.79; 26 female). A subset of 26 young and 24 older adults had EEG recorded while completing the same task.

Procedure

Sustained attention to response task (SART)



Probe options:

On-task ***(a) the task***
TRI ***(b) task approach***
(c) task evaluation
(d) everyday things
(e) current state of being
TUT ***(f) personal worries***
(g) daydreams
(h) other

Analysis

Subjective Measures:
Calculated % of On-task, TRI, & TUTs; RT variability (RTCV = SD/mean) and no-go accuracy in the 8 trials before each type of probe response.

Objective Measures:
Calculated rolling RTCV across 8 trial window, smoothed across all trials using locally weighted polynomials with a 2% smoothing window (Cleveland, 1979) → continuous variability index (CVI). Off-task = upper quartile of CVI, On-task = remaining trials

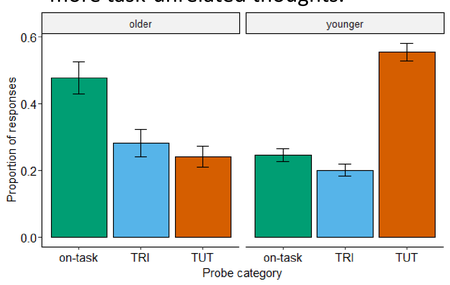
EEG

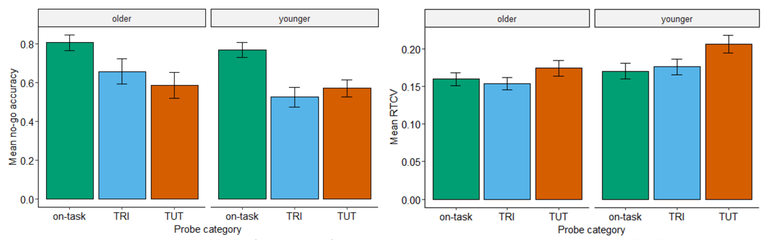
- 128-channel Active Two BioSemi system, CMS/DRL referencing, sampled at 512 Hz.
- Pre-processed using the EEG-IP-L pipeline (Desjardins et al., 2021) to remove artefacts and periods of non-stationarity.
- ERP analyses comparing objectively defined on-task vs off-task trials in STATSLAB (Campopiano et al., 2018).

Results

Subjective Mind Wandering

Older adults report more on-task periods, while younger adults report more task-unrelated thoughts.





Across age groups, subjectively reported on-task periods are associated with higher no-go accuracy than either TRI or TUT.

Across age groups, TUTs have higher RTCV than either TRI or on-task periods.

Error bars = 1 *se* about mean

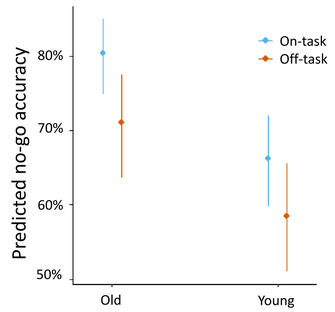
Results

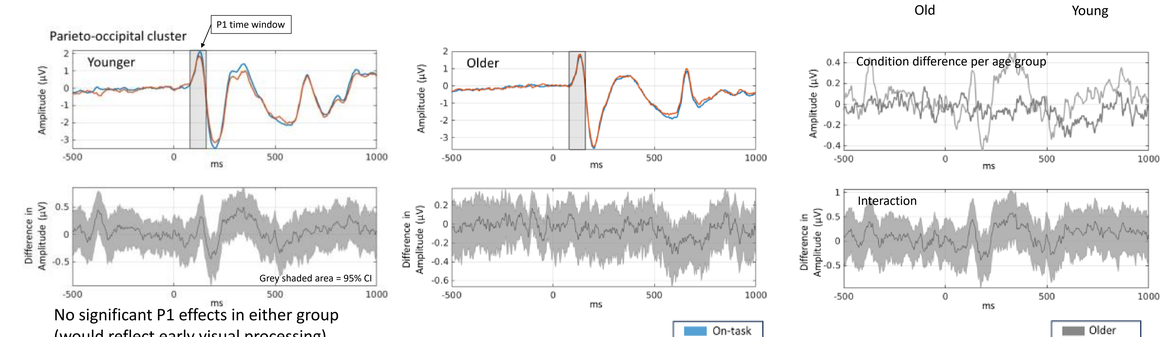
Objective Mind Wandering

First, confirmed that objectively categorized trials predicted subjective reports:

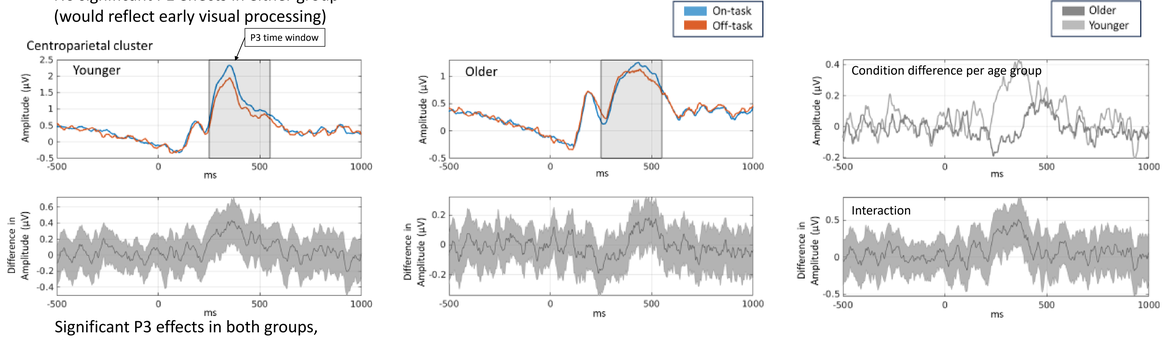
Logistic mixed effects model predicting objective trial sorting from subjective response, age group, and interaction found that TUTs were more likely than on-task reports to be categorized as off-task, *B* = .145, *SE* = .068, *z* = 2.13, *p* = .033, while TRIs were no more likely to be categorized as on- than off-task, *B* = -.032, *SE* = .70, *z* = -.462, *p* = .644.

Objectively defined mind wandering predicts no-go accuracy similarly to subjective probe responses. **Fewer errors of commission when on task.**





No significant P1 effects in either group (would reflect early visual processing)



Significant P3 effects in both groups, though larger in younger adults.

Conclusions

Older and younger adults show different frequencies of subjectively reported thought types, with older adults more frequently reporting being on-task and younger adults reporting more TUTs.

Subjectively defined mind wandering predicted the objectively determined attentional states based on RT variability across both age groups.

Using this method, we showed that older and younger adults show similar behavioural (more no-go errors) and neural evidence of mind wandering (reduced P3 amplitude) albeit with a smaller difference observed in older adults.

Overall, the frequency of different attentional states differs substantially between older and younger adults, but the behavioural and neural consequences of these states was similar across age groups.

References

Campbell, K. L., Lustig, C., & Hasher, L. (2020). Aging and inhibition: Introduction to the special issue. Psychology & Aging, 35, 605-613.
Campopiano, A., Van Noordt, S. J. R., & Segalowitz, S. J. (2018). STATSLAB: An open-source EEG toolbox for computing single-subject effects using robust statistics. *Behavioural Brain Research*, *347*, 425–435.
Desjardins, J. A., Van Noordt, S., Huberty, S., Segalowitz, S. J., & Elsabbagh, M. (2021). EEG Integrated Platform Lossless (EEG-IP-L) pre-processing pipeline. *J Neur Methods*, *347*, 108961.
Giambra, L. M. (1989). Task-Unrelated-Thought Frequency as a Function of Age: A Laboratory Study. *Psychology and Aging*, *4*(2), 136–143.
Hawkins, G. E., Mittner, M., Boekel, W., Heathcote, A., & Forstmann, B. U. (2015). Toward a model-based cognitive neuroscience of mind wandering. *Neuroscience*, *310*, 290–305.
Kam, J. W. Y., Rahnuma, T., Park, Y. E., & Hart, C. M. (2022). Electrophysiological markers of mind wandering: A systematic review. *NeuroImage*, *258*, 119372.
McVay, J. C., Meier, M. E., Touron, D. R., & Kane, M. J. (2013). Aging ebbs the flow of thought: Adult age differences in mind wandering, executive control, and self-evaluation. *Acta Psychologica*, *142*(1), 136–147.
Maillet, D., Beaty, R. E., Jordano, M. L., Touron, D. R., Adnan, A., Silvia, P. J., Kwapil, T. R., & Turner, G. R. (2018). Age-Related Differences in Mind-Wandering in Daily Life. *Psychology and Aging*, *33*(4), 643–653.
Maillet, D., & Rajah, M. N. (2016). Assessing the Neural Correlates of Task-unrelated Thoughts during Episodic Encoding and Their Association with Subsequent Memory in Young and Older Adults. *J Cog. Neur*, *28*(6), 826–841.
Maillet, D., Beaty, R. E., Adnan, A., Fox, K. C. R., Turner, G. R., & Spreng, R. N. (2019). Aging and the wandering brain: Age-related differences in the neural correlates of stimulus-independent thoughts. *PLOS ONE*, *14*(10).

sh14jm@brocku.ca