Multitasking costs across the adult lifespan and the neural basis of remediation through video game training

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Introduction

As multitasking becomes more ubiquitous in today's technological society, it is important to consider how performance varies between individuals of different age groups, whether cognitive training can improve this skill in those who are most deficient, and which neural mechanisms underlie age-related multitasking differences.

To evaluate each question, we designed a novel action driving videogame (NeuroRacer) to challenge multitasking abilities through the integration of a target discrimination task that conditionally called for visuomotor tracking.

Characterization of multitasking abilities across the adult lifespan was first evaluated by having 174 adults (~30 participants in each decade of life) perform this task. Our 2nd experiment involved 46 older adults completing either a multi-task or single-task training regime to examine the possibility of multitasking improvements in those most deficient. Our 3rd experiment characterized age-related differences in neural activity on this platform, facilitating comparisons between any observed training effects.

Methods

NeuroRacer Experimental Conditions

a) Drive Only
Sign Only
Sign & Drive
Single task
Multi-task

b) No Contact
Control

Training Intervention

1 hr x 3/week x 1 month.

Prior to testing in each experiment, participants were thresholded to an 80% performance level for both visuomotor tracking and target discrimination under the setting of no interference using a dynamic staircase algorithm. These levels were then used throughout each experiment, including the 1-month and 6-month follow-up sessions for the training experiment.

Results

Multitasking costs across the lifespan

Figure 2. NeuroRacer multitasking costs. a) Costs across the lifespan, b) Costs prior to, 1 month after, and 6 months after training.

**Methods**

- NeuroRacer Experimental Conditions
- Initial Visit
- One Month
- Six Months
- NeuroRacer EEG & Cognitive Testing
- DDD25 805.15

**Conclusions**

Multitasking showed an age-related linear decline (p < .0001) across the adult lifespan, with thirty year olds exhibiting a greater cost than twenty year olds (p < .05, Figure 2).

Older adults who engaged in a multi-task training program reduced their multitasking costs compared to both an active and no contact control group, with these benefits persisting 6 months later. These individuals also showed improved sustained attention abilities through improvements on the TOVA and midline frontal theta activity (Figures 3-5).

Those individuals who showed the greatest increase in midline frontal theta activity following multi-task training also exhibited the greatest savings in their multitasking performance at 6 months (Figure 6a). Similarly, the significant relationship with TOVA improvement and midline frontal theta change is indicative of the specificity of this training directly affecting sustained attention abilities (Figure 6b).

While aging was associated with less midline frontal theta during multitasking (Figure 7a & b), the multi-task training effects were specific in nature as they led to conditionally specific increased activity at a local and network level.

The present findings provide the first mechanistic evidence of how a scientifically-inspired video game can not only characterize multitasking costs across the lifespan, but can also have a significant and enduring impact on cognitive health.

Acknowledgements

Thanks to N Babahaji, M Gogel, C Vong, B Yang, and D Yogeshim for help with data collection, and B Benson for assistance with NeuroRacer behavioral analysis. Thanks to D Ellington, N Faistian, and M Omenick for assistance with game development. Thanks to B Voytek, J Mishra, and T Zanto for assistance on ERSP analyses. Support provided by a grant from Health Games Research, a national program of the Robert Wood Johnson Foundation (AG). JAA is supported by a UCSF Institutional Research and Career Development Award (IRACDA).

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