2013

Are physical, cognitive, and perceptual exercises effective at improving abilities associated with driving (such as behavioral speed, visual attention, psychomotor performance, speed of perception, and executive functioning) in older adults compared to a control group of older adults not participating in an exercise group?

Caitlin Danae McIntyre
Dominican University of California

Regina Okun
Dominican University of California

Josue Julian Zamora
Dominican University of California

Kitsum Li
Department of Occupational Therapy, Dominican University of California

AOTA Critically Appraised Papers Series

Evidence Exchange

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

CRITICALLY APPRAISED PAPER

FOCUSED QUESTION

Are physical, cognitive, and perceptual exercises effective at improving abilities associated with driving (such as behavioral speed, visual attention, psychomotor performance, speed of perception, and executive functioning) in older adults compared to a control group of older adults not participating in an exercise group?

Marmeleira, J., Godinho, M., & Fernandes, O. (2009). The effects of an exercise program on several abilities associated with driving performance in older adults. *Accident Analysis and Prevention, 41*(1), 90–97. http://dx.doi.org/10.1016/j.aap.2008.09.008

CLINICAL BOTTOM LINE:

In recent years, private and public entities have shown increased interest in issues regarding older drivers' safety and ability to continue operating a vehicle on the road. Driving is a complex task that requires multiple abilities in cognition, perception, and motor functions. Declines in all of these functions often are associated with the aging process; however, there is strong evidence that physical activity is the key to healthy aging. In addition, the effects of physical activity, especially those that demand greater attention resources and in a multiple-task environment, have shown to have positive effects on several perceptive, cognitive, and physical abilities and, thus, enhance driving performance in older adults.

The researchers showed that regular exercise could enhance several abilities relevant for driving performance and safety in older adults and, therefore, should be promoted. The researchers used two frameworks to guide the exercise interventions. The first framework incorporates the idea that physical activities that require large amounts of cognition may have a bigger effect on cognitive functioning than repetitive activities. The second framework is based on the idea that an exercise program that incorporates multiple energetic physical activities will improve various abilities related to driving fitness in older adults.

RESEARCH OBJECTIVE(S)

List study objectives.

To study the effect of a specific exercise program on changes in performance in the areas of behavioral speed, visual attention, psychomotor performance, speed of perception, and executive functioning in older adult drivers.

DESIGN TYPE AND LEVEL OF EVIDENCE:

Randomized controlled trial (RCT) Level I

Limitations (appropriateness of study design):

Was the study design type appropriate for the knowledge level about this topic? *Circle yes or no, and if no, explain.*

YES/NO	The authors did not provide detail of the randomization process, therefore, one cannot conclude whether it is a true RCT.

SAMPLE SELECTION

How were subjects selected to participate? Please describe.

Convenience sampling by putting out flyers and making announcements over the local radio station.

Inclusion Criteria

Participants had to be 60 years of age or older and live independently in the community. They also needed to be healthy, without serious cardiovascular or musculoskeletal disease, and possess a valid driver's license. The participants needed to have 20/40 or greater corrected binocular vision with a Snellen Chart and normal cognitive status on the Mini-Mental State Examination. The participants could not be engaged in any structured exercise program regularly more than once per week over the past year.

Exclusion Criteria

NR, but three subjects were excluded due to severe osteoarthritis (n = 1) and refusal to participate (n = 2).

SAMPLE CHARACTERISTICS

N = 32

% Dropouts	0		
#/ (%) Male	25 (78%)	#/ (%) Female	7 (22%)
Ethnicity	NR		
Disease/disability diagnosis	Community-dwelling adults 60 years or older with valid driver's license		

Check appropriate group:

< 20/study group ✓	20–50/study group	51–100/study group	101–149/study group	150–200/study group

INTERVENTION(S) AND CONTROL GROUPS

Add groups if necessary

Intervention Group

Brief Description	This group participated in an hour-long exercise program 3 days a week for 12 weeks. The group participated in multiple exercises that demanded simultaneous physiological, cognitive, and perceptual skills. Exercise interventions used included: "dual-task situations (e.g., walking in different directions while executing another motor task with the arms); activities that work on peripheral vision (e.g., maintaining several balloons in the air); actions that require planning efforts and decision making (e.g., orienteering in the gymnasium and in an open space); activities strongly dependent on working memory (e.g., selecting and completing a specific walking course in the gymnasium after the presentation of the associated auditory signal; auditory cues-walking courses correspondence was previously established); tasks that target speed processing (e.g., while walking, different auditory/visual signs are presented that imply fast and specific psychomotor responses); activities focused on response inhibition (e.g., while maintaining balloons in the air, all auditory numeric signs but one require rapidly catching specific colored balloons)", p. 93.
Setting	Gymnasium and open space
Who Delivered?	NR
Frequency?	1 hour of exercise, 3 days a week
Duration?	12 weeks

Control Group

Brief Description	This group continued to follow normal daily activities and did not participate in an exercise group.
Setting	NR
Who Delivered?	NR
Frequency?	NR
Duration?	12 weeks

Intervention Biases: *Circle yes or no and explain, if needed.*

Contamination

YES/NO

Co-intervention

YES/NO | NR. The authors did not report whether they advised the experimental group in not participating in any form of additional structured or unstructured exercise program during the experimental period.

Timing

YES/NO	

Site

YES/NO	

Use of different therapists to provide intervention

YES/NO	NR

MEASURES AND OUTCOMES

Complete for each relevant measure when answering the evidence-based question:

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Behavioral speed in a single-task condition using a driving simulator measuring reaction time (time it took participant to react to a change in the environment), movement time (time it took participant to complete a movement in response to a change in the environment), response time (time it took participant to notice change in the environment and complete movement in response to change), 2-choice reaction time (time it took participant to react to two different changes in the environment), and 3-choice reaction time (time it took participant to react to three different changes in the environment). The foot pedal data were collected using micro-switches, which were connected to a MP100 Biopac® data-acquisition system, and all signs were detected (sample rate of 200 sample/s) and treated with Acqnowledge® 3.7.2 software (p. 92). Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Behavioral speed in dual-task condition using a driving simulator measuring reaction time, movement time, and response time. The primary task was similar to the single-task condition, in which the participants had to brake as fast as possible whenever the leading car brake lights were activated. The secondary task required participants to sum up the pairs of numbers presented by the researcher. Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Visual attention using three subtests of the Useful Field of View (PC version), measuring speed of visual processing, divided attention, and selective attention. Data were collected in time (ms). Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Psychomotor performance tests (foot tap tests, timed up-and-go test, and functional reach tests) that measure lower-limb mobility, basic mobility function, and balance. These psychomotor tests were included because an increased risk of fall has been shown to correlate to crash risk and driving difficulties in older drivers. Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Speed of perception using target-only in motion (target was moving, participant was stationary), measuring absolute error, constant error, and variable error. Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Speed of perception using self-only in motion (target was stationary, participant was also stationary but perceived self to be moving), also measuring absolute error, constant error, and variable error. Reliability and validity were not reported. Measurements were taken at the beginning and at the end of the 12- week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Executive function using Trail-Making Test, part B, which measures divided or alternating attention. Reliability and validity were not reported, but the authors stated that the association between trail-making B and driving performance were previously established. Measurements were taken at the beginning and at the end of the 12-week study.

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article—yes/no/NR [not reported]), and how frequently the measure was used.

Stroop Color–Word test, which measures executive function, especially inhibition. Reliability and validity were not reported. However, previous research indicated that drivers who had crashes during the previous 5 years performed poorly on measures of executive functioning, including a Stroop color-word test. Measurements were taken at the beginning and at the end of the 12-week study.

Measurement Biases

Were the evaluators blind to treatment status? *Circle yes or no, and if no, explain.*

YES/NO | The authors did not indicate if the evaluators were blinded to the study or not.

Recall or memory bias. *Circle yes or no, and if **yes,** explain.*

YES/NO

Others (list and explain):

The authors failed to report or state the psychometric properties of all chosen measurements. Only two measurements were reported to have established associations with driving performance

RESULTS

List results of outcomes relevant to answering the focused question

Include statistical significance where appropriate ($p < 0.05$)
Include effect size if reported

Compliance in the exercise program was very high, exceeding 85% for all participants. Behavioral speed was evaluated using the single-task condition and dual-task condition tests. The single-task condition test showed improvement in movement time (–15%; p = 0.002 for exercise group vs. 2%; p = 0.026 for control group), and response time (–10%; p = 0.001 for exercise group vs. 0%; p = 0.035 for control group). The dual-task condition test showed improvement in reaction time (–11%; p = 0.001 for exercise group vs. 1%; p = 0.018 for control group) and response time (–13%; $p < 0.001$ for exercise group vs. –2%; p = 0.018 for control group). There were significant improvements made in visual attention after the 12-week exercise program, specifically in speed processing (–66%; p = 0.004 for exercise group vs. 2%; p = 0.032 for control group). Psychomotor performances were significantly increased in the exercise group (–15%; p = 0.002) compared to baseline. For other outcomes such as time-to-contact, which were the target-only and self-only in motion tests, and the executive functions, differences were not found within or between groups.

Was this study adequately powered (large enough to show a difference)? *Circle yes or no, and if no, explain.*

YES/NO

Were appropriate analytic methods used? *Circle yes or no, and if no, explain.*

YES/NO

Were statistics appropriately reported (in written or table format)? *Circle yes or no, and if no, explain.*

YES/NO

CONCLUSIONS

State the authors' conclusions that are applicable to answering the evidence-based question.

The authors concluded that a specific exercise program, such as one that stresses physiological, perceptive, and cognitive skills, may improve significant driving abilities (movement time, response time, reaction time, speed of processing, and psychomotor skills) for older adults. The outcomes of this study can be applied by occupational therapists who work with older adults. These outcomes are especially useful when working with older adults who depend on driving to

maintain their independence. Although the researchers found that an exercise program could have a positive effect on various abilities related to driving, not all of these abilities were enhanced. The results of the time-to-contact assessments (target-only in motion and self-only in motion) were very similar between the two groups at the end of the 12 weeks, thus not providing evidence for a positive effect from the exercises. The authors concluded that the exercise program may not have an effect on speed perception, and further explained that because time-to-contact is directly related to perception, one could not expect changes to occur when measurements were being taken at two different moments in time while under the same conditions. Another area that was not affected by physical activity was executive functions. Prior research has shown that executive functions could be positively affected by regular exercise. The authors explained that the differences may be due to using behavioral–motor tasks to target driving-related abilities instead of a general aerobic exercise program. Another possible reason for this difference is that executive functions may require exercise programs with a longer duration to have a positive effect.

Limitations of the study include small sample size; using multiple measurements without reporting their psychometric properties; participants were predominantly males; actual driving was not compared before or after the exercise intervention; and it was not possible to identify obtained improvements by specific characteristics of the exercise program. One additional limitation is that the study population was adults 60 years or older who resided in Portugal only, and the results may not be generalized to other populations. Recommendations for future studies include that general measures of physical fitness should be included as one of the measurements, and an additional intervention group to engage in a typical aerobic exercise program should be included.

This work is based on the evidence-based literature review completed by Kitsum Li, OTD, OTR/L (faculty adviser), and Caitlin McIntyre, Regina Okun, and Josue Zamora (students at Dominican University of California, BS–MS program).