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Exercise and Cognitive-Related Semantic Memory Function

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Dear Editor,

Unlike episodic memory, which refers to the retrieval of a previous episode, semantic memory involves retrieval of factual information that is learned over a period of time (e.g., the definition of a word) (Slotnick, 2017b) and is not bound to any specific experience in which the memory was acquired (Eichenbaum, 2012). Regarding the brain regions of this unique type of memory, semantic memory is associated with neuronal activity in the left dorsolateral prefrontal cortex, the anterior temporal lobes, and sensory cortical regions (Gabrieli, Poldrack, & Desmond, 1998; Martin & Chao, 2001; Slotnick, 2017a).

Emerging work demonstrates that exercise behavior may help to enhance episodic memory (Loprinzi, Edwards, & Frith, 2017). At this point, however, *there are no published systematic review papers describing the effects of exercise on semantic memory function*. Such an effect is plausible given that acute exercise has been shown to increase neural activity in brain regions associated with semantic memory (e.g., dorsolateral prefrontal cortex (Yanagisawa et al., 2010), the anterior temporal lobes (Chen, Zhu, Yan, & Yin, 2016), and sensory cortical regions (Vissing, Andersen, & Diemer, 1996)). Thus, from an acute exercise paradigm, exercise may help to activate the internal representation of the semantic memory. From a chronic exercise paradigm, habitual exercise may help to preserve semantic memories by attenuating age-induced memory decline via exercise-related changes related to neural structure and function (Hayes, Alosco, & Forman, 2014). This latter possibly is of critical importance, as semantic fMRI activation has been shown to serve as a better predictor of cognitive change when compared to episodic fMRI tasks (Hantke et al., 2013). *In response to a clear gap in the literature*, the purpose of this study was to perform a brief systematic review to summarize the literature on exercise and semantic memory function.

See the Appendix for the methodology and results of our computerized searches. As noted in the Appendix, only one article was retrieved from the literature that evaluated the effects of exercise on semantic-related memory function. This study were conducted by Smith and colleagues (2013). The study population was community dwelling older adults (ages 60-88 years) with and without mild cognitive impairment who were inactive at baseline. Participants in both groups completed a progressive 12-week treadmill-based walking intervention (44 total exercise sessions; thus, there was not a non-treatment

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group that did not exercise). At baseline and post-intervention, participants underwent an fMRI session while completing the name recognition task. This task involved participants viewing 30 names of easily recognized famous individuals (e.g., Frank Sinatra) and 30 names of non-famous individuals chosen from a local phone book. Using finger presses, participants were instructed to indicate if the name was a famous or non-famous person. Both accuracy and reaction time (in milliseconds) were recorded.

For both groups (mild cognitive impairment and healthy controls), there was no evidence of a main effect for time or a group x time interaction effect for the name recognition performance scores. However, both groups demonstrated reduced neuronal activity when reading the famous names post-intervention (compared to pre-intervention). This suggests that in both groups (mild cognitive impairment and cognitively intact older adults), semantic memory retrieval-related neural activation became more efficient from before to after the 12-week exercise intervention.

Exercise may help to facilitate semantic memory neuronal processing via exercise-induced cerebral blood perfusion, thereby improving the blood-oxygen level fMRI signal and associated network efficiency. Further, exercised-induced changes in dopamine may attenuate neural interference during semantic memory retrieval (Smith et al., 2013). Further, exercise-related changes in adiposity may also contribute to improvements in semantic memory (Nilsson & Nilsson, 2009). Given the infancy of this field, it is challenging to provide clear guidance on which specific research studies should be investigated. Future work should consider exploring intensity-related effects of exercise on semantic memory, as well as acute bouts of exercise and shorter-duration interventions (e.g., 6-8 weeks).

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Appendix

We conducted this systematic review in alignment with the PRISMA guidelines. Studies included were published in English; indexed in PubMed, Sports Discus or PsychInfo; employed an experimental, cross-sectional or prospective study design; and evaluated some aspect of semantic memory (e.g., behavioral or neuronal response to a semantic memory task). Outside these criteria, no specific exclusionary criteria were applied. Thus, both human and animal papers were considered herein. We employed the following PubMed searches on September, 20 2017, with the searches listed below:

("exercise"[MeSH Terms] OR "exercise"[All Fields]) AND ("semantics"[MeSH Terms] OR "semantics"[All Fields] OR "semantic"[All Fields]) AND ("memory"[MeSH Terms] OR "memory"[All Fields])

Following this search, 26 studies were identified. Author PDL screened these studies based on the study's title and abstract, and identified 2 papers that appeared to meet the inclusion criteria for review. Author PDL read the full text of these 2 articles and determined that 1 met the study criteria. We also employed other keywords, such as physical activity, physical workload, and physical training, but such efforts did not result in the retrieval of additional articles. Additionally, other databases, such as Sports Discuss and PsychoInfo, were searched, but this did not result in the retrieval of additional articles.