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COMMENTARY
Aging and brain fitness (Commentary on Voelcker-Rehage *et al.*)

EJN FEATURED ARTICLE

Kristin E. Flegal and Patricia A. Reuter-Lorenz
Department of Psychology, University of Michigan, 530 Church Street, Ann Arbor, MI 48109, USA

What is bodily fitness and how does it affect brain fitness? Compelling evidence indicates that the two are closely related, especially in older age (Colcombe & Kramer, 2003; Colcombe *et al.*, 2004). Indeed, the cognitive benefits of physical fitness through cardiovascular and strength training have been demonstrated cross-sectionally, longitudinally, and by intervention studies, thereby constituting one of the most reliable messages about successful aging (Kramer & Erickson, 2007; Hertzog *et al.*, 2008; Lustig *et al.*, 2009).

Against this encouraging backdrop, Voelcker-Rehage *et al.* (2010) have made an important set of discoveries that are reported in this issue of *EJN*. Drawing from animal research, they distinguish between motor fitness (balance, agility, coordination and flexibility) and physical fitness (muscle strength and cardiovascular fitness). They predict that these two forms of fitness will differentially impact both cognitive and neurophysiological functioning in healthy older adults. Their hypothesis is borne out by their behavioral and brain imaging results. Consistent with prior research, performance on executive control tasks was positively related to physical fitness. The novel behavioral result is that motor fitness was associated with both executive control and perceptual speed tasks. This result is important because it specifically links motor fitness to perceptual speed, a processing resource viewed as fundamental to cognitive aging (Salthouse, 1996; Park & Reuter-Lorenz, 2009).

Voelcker-Rehage *et al.* (2010) also collected functional brain imaging data from their older adult sample during a flanker task that places demands on executive control processes, which they analyzed with respect to participants' fitness. High physical fitness and high motor fitness alike were associated with less activation in frontal regions and parts of temporal and occipital cortex. Voelcker-Rehage *et al.* (2010) discuss the relationship between increased fitness and decreased task-related activation with reference to the compensation hypothesis (Reuter-Lorenz & Cappell, 2008), which accounts for patterns of greater activation often observed, particularly in frontal regions, in older adults matched for task performance with young adults (Cabeza, 2002). Reduced activation in the brains of high-fit older adults in the present study made them appear 'younger' than those of their low-fit peers, independent of the fitness dimension, suggesting that fewer neural resources were needed to perform the task and thus compensatory overactivation was unnecessary. Moreover, different dimensions of fitness had different neural signatures: high physical fitness was selectively associated with activation in frontal and temporal areas engaged by executive control processes, and high motor fitness was selectively associated with activation in parietal areas involved in visuo-spatial processing.

As the authors note, these intriguing findings deserve further investigation in a longitudinal training study, joining initial research efforts that have shown cognitive training (Erickson *et al.*, 2007) and cardiovascular training (Colcombe *et al.*, 2004) in older adults can alter activity in brain networks associated with executive control. Future research should pursue crucial follow-up questions. Do both forms of fitness build cognitive reserve, or do they improve neural efficiency whereby there is less dependence on compensatory recruitment? Are both dimensions of fitness equally responsive to interventions? Might motor fitness be more closely related to dedifferentiation of perceptual and motor circuitry than physical fitness because of its link to perceptual speed?

The present study contributes significantly to the literature by identifying an understudied dimension of fitnes – motor fitness – that relates to cognitive and neural functioning in older adults. Moreover, an interpretative quandary that often plagues cross-sectional fitness studies – does bodily fitness increase cognitive fitness, or are better agers just better at keeping fit in both mind and body? – is less troublesome for the present study because it identifies two partially dissociable aspects of fitness, and documents their dissociable neurocognitive correlates. The results underscore the complex interactions between brain regions that are inherent to gaining a comprehensive understanding of the effects of age and fitness on functional change. With this report, Voelcker-Rehage *et al.* (2010) advance the research agenda which has been focused on physical, cardiovascular training, and present an important directive for the design of future interventions to maximize brain fitness in older adults.

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