LETTER

Increasing exercise's effect on mental health: Exercise intensity does matter

Thomas Gronwald[a,1], Bruna Velasques[b,c], Pedro Ribeiro[b,c], Sergio Machado[d,e], Eric Murillo-Rodríguez[f], Sebastian Ludyga[g], Tetsuya Yamamoto[h], and Henning Budde[i,j,k]

Suwabe et al. (1) composed a well-written and interesting study examining the relationship between mild exercise and hippocampal memory function. It is interesting that the neurobiological mechanisms responsible for the effects of exercise are systematically investigated. A prominent finding was that a short bout (10 min) of mild exercise increased activity, specifically in hippocampal subregions and in the entorhinal and parahippocampal cortices. This can be understood as a neurobiological mechanism that has contributed to exercise-induced cognitive benefits. We concur with Suwabe et al. (1), although we can identify one main problem in this study pointing to the intensity of exercise, which moderates the magnitude of the exercise-induced effect on cognition. A single bout of exercise at very light intensity (the authors specified this as 30% peak oxygen uptake) was chosen to prescribe a stress-free intervention, which was not supposed to trigger increases in cortisol. However, it appears that the term "very light intensity" was not specified accurately. Based on the American College of Sports Medicine (ACSM) guidelines, values of up to 37% of maximal oxygen uptake (V_{O2max}) are defined as very light intensity (2). However, in relation to their internal load during exercise, displayed in the supporting information for ref. 1, the participants were actually in the "light" intensity range according to ACSM (~58% of the peak heart rate). It appears that there was a mismatch between the prescribed intensity level, the actual heart rate, and Borg's (3) rating of perceived exertion (participants stated ~10.5 instead of <9 according to ACSM) during exercise. Therefore, the recommendations given should also be adjusted: People should be asked to do brisk walking rather than slow walking (2, 4). Given the highly practical relevance of the findings, future studies are encouraged to pay attention to the accurate dose–response relationship and distinction between different exercise intensities. The neurobiological effects of acute exercise depend on the duration and intensity of the exercise, and on the training status of the participants (5, 6). From studies with 15- to 16-y-old healthy adolescents we know that a 12-min exercise bout with an intensity of 70–85% maximum heart rate (HR_{max}) is needed to increase steroid hormone levels, in contrast to a group exercising stress-free with 50–65% HR_{max} [meaning no elevation of cortisol, according to Suwabe et al. (1)] but with an increase in memory functions (7). In the limitations, Suwabe et al. (1) admit that the intensity required to optimize the effect of exercise is unknown, mentioning findings in rodents showing that mild exercise training, compared with intense exercise training, enhances neurogenesis (8). However, the rapid form of plasticity observed in this acute study differs from neurogenesis-mediated effects of exercise training, which operate on a much longer timescale (see ref. 9). Taken together, the acute exercise intensities were higher than stated in the article, which from a dose–response point of view makes sense because higher intensities (up to moderate; see ref. 2) should be recommended to promote beneficial effects on neurocognitive functions (6, 7, 10).

Acknowledgments

H.B. is supported by DFG Grants BU 1837/5-1 and BU 1837/5-2.

[a]Department of Performance, Neuroscience, Therapy and Health, Faculty of Health Sciences, Medical School Hamburg, 20457 Hamburg, Germany; [b]Bioscience Department, School of Physical Education, Federal University of Rio de Janeiro, Rio de Janeiro 21941-901, Brazil; [c]Institute of Applied Neuroscience, Rio de Janeiro 22640-100, Brazil; [d]Panic and Respiration Lab, Institute of Psychiatry, Federal University of Rio de Janeiro, Rio de Janeiro 21941-901, Brazil; [e]Physical Activity Sciences Postgraduate Program, Salgado de Oliveira University, Niterói 24030-060, Brazil; [f]Escuela de Medicina, División Ciencias de la Salud, Universidad Anáhuac Mayab, 97310 Mérida, Yucatán, Mexico; [g]Department of Sport, Exercise and Health, Sport Science Section, University of Basel, 4001 Basel, Switzerland; [h]Graduate School of Technology, Industrial and Social Sciences, Tokushima University, Tokushima 770-8501, Japan; [i]Faculty of Human Sciences, Medical School Hamburg, 20457 Hamburg, Germany; [j]Lithuanian Sports University, Kaunas 44221, Lithuania; and [k]Physical Activity, Physical Education, Health and Sport Research Centre, Sports Science Department, School of Science and Engineering, Reykjavik University, 101 Reykjavik, Iceland

Author contributions: T.G., B.V., P.R., S.M., E.M.-R., S.L., T.Y., and H.B. wrote the paper.

The authors declare no conflict of interest.

[1]To whom correspondence should be addressed. Email: thomas.gronwald@medicalschool-hamburg.de.

Published online December 12, 2018.

1 Suwabe K, et al. (2018) Rapid stimulation of human dentate gyrus function with acute mild exercise. *Proc Natl Acad Sci USA* 115:10487–10492.
2 Garber CE, et al.; American College of Sports Medicine (2011) American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Med Sci Sports Exerc* 43:1334–1359.
3 Borg GA (1982) Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 14:377–381.
4 Ainsworth BE, et al. (2000) Compendium of physical activities: An update of activity codes and MET intensities. *Med Sci Sports Exerc* 32(9, Suppl):S498–S504.
5 Budde H, Machado S, Ribeiro P, Wegner M (2015) The cortisol response to exercise in young adults. *Front Behav Neurosci* 9:13.
6 Ferris LT, Williams JS, Shen CL (2007) The effect of acute exercise on serum brain-derived neurotrophic factor levels and cognitive function. *Med Sci Sports Exerc* 39:728–734.
7 Budde H, et al. (2010) Steroid hormones in the saliva of adolescents after different exercise intensities and their influence on working memory in a school setting. *Psychoneuroendocrinology* 35:382–391.
8 Inoue K, et al. (2015) Long-term mild, rather than intense, exercise enhances adult hippocampal neurogenesis and greatly changes the transcriptomic profile of the hippocampus. *PLoS One* 10:e0128720.
9 Budde H, et al. (2016) The need for differentiating between exercise, physical activity, and training. *Autoimmun Rev* 15:110–111.
10 Budde H, et al. (2018) Does intensity or youth affect the neurobiological effect of exercise on major depressive disorder? *Neurosci Biobehav Rev* 84:492–494.