Enhancing olfactory functioning with olfactory training and physical activity – a mini-review

IFSCC Mexico Conference 2021

BI_359

Pieniak, M.[1, 2], Abriat, A[3], Hummel, T. [1]

1 – Smell and Taste Clinic, Department of Otorhinolaryngology, TU Dresden, Dresden, Germany

2 – Institute of Psychology, University of Wroclaw, Wroclaw, Poland

3 – Smell and Taste Lab, Geneva, Switzerland

Introduction:

Olfactory functioning is related to human well-being[1]. Olfaction guides people's social behaviors[2] and helps avoiding environmental threats[3]. Thus, people who lose their sense of smell report diminished quality of life and experience symptoms of depression[4,5], which may result from negatively affected social interactions [6] and increased fear of missing spoiled food or chemical hazards[7]. Considering both prevalence of olfactory dysfunction reaching up to 20% of general population[8,9] and negative psychological consequences of that impairment, effective interventions are needed in order to prevent deterioration of olfactory functions or rehabilitate the sense of smell after sensory loss.

In this mini-review we summarize findings from studies examining effectiveness of two non-pharmaceutical and non-invasive interventions targeting olfactory loss – olfactory training and physical activity.

Results & Discussion:

To date, it was observed that Olfactory Training mitigates the age-related cognitive decline[14] and improves verbal fluency[15,16]. It also positively affects mood in older people[16] but does not influence severity of depressive symptoms in people with major depressive disorder[17]. More complex smell-based memory training benefits both olfactory and visual memory[18].

Physical activity has a neuroprotective role in syndromes affecting neuronal functioning[19]. Although most studies do not measure olfactory sensitivity, there is compelling evidence showing beneficial influence of physical activity on brain regions related to olfaction, including entorhinal cortex[20, 21,22].

Materials & Methods:

Olfactory Training (OT)

OT is an intervention consisting of systematic, repeated smelling of four odors twice a day for a period of 12 weeks or longer.

Number of studies demonstrate the effectiveness of OT on people with olfactory dysfunction. However, there is also evidence that OT may benefit people whose sense of smell is not impaired.

Physical Activity

Various types of physical activity have demonstrated to have a positive impact

- Running stimulates neurogenesis in hippocampal area[10] and induces changes in neuronal physiology and circuitry[11]
- An 8-week course of aerobic exercise, designed for patients with Parkinson's disease, showed a stabilization of their olfactory functions, whereas individuals in non-exercising group showed a significant olfactory decline[12]
- Swimming has been shown to improve the nasal airflow in post-laryngectomy patients, which resulted in improved sense of smell and heightened quality of life [13].

Conclusions:

OT is an effective tool in rehabilitation of olfaction in patients with smell loss and improvement of the sense of smell in healthy people. Its effects are observed with both psychophysical tests of olfactory functioning and neuroimaging methods.

At the same time, Physical Activity seems to benefit olfactory sensitivity by enhancing brain functioning in olfactory-related areas [20,22] or possibly improve nasal airflow [13].

Taken together, both OT and Physical Activity appear to have a positive influence on olfactory functioning. Considering that these interventions affect different aspects of olfactory-processing, it appears to be possible that there is an additive effect of a combined treatment. Research is needed to verify whether employing these two interventions at the same time would lead to more favorable clinical outcomes.

Aknowledgments:

Thank you to Michal Pieniak and to Professor Thomas Hummel for their dedicated contribution and research with clinical experiments at Klinikum Dresden (Germany) on this topic

References:

1. Boesveldt, S., & Parma, V. (2021). The importance of the olfactory system in human well-being, through nutrition and social behavior. *Cell and Tissue Research* , *383*(1), 559–567. https://doi.org/10.1007/S00441-020-03367-7
2. Mahmut, M. K., Pieniak, M., Resler, K., Schriever, V. A., Haehner, A., & Oleszkiewicz, A. (2021). Olfactory training in 8-year-old increases odour identification ability: a preliminary study. European Journal of Pediatrics. https://doi.org/10.1007/s00431-021-03970-y
3. Stevenson, R. (2010). An Initial Evaluation of the Functions of Human Olfaction. Chemical Senses, 35, 3–20.
4. Croy, I., Negoias, S., Novakova, L., Landis, B. N., & Hummel, T. (2012). Learning about the Functions of the Olfactory System from People without a Sense of Smell. *PLOS ONE*, *7*(3), e33365. https://doi.org/10.1371/JOURNAL.PONE.0033365
5. Croy, I., Nordin, S., & Hummel, T. (2014). Olfactory disorders and quality of life-an updated review. *Chemical Senses*, *39*(3), 185–194. https://doi.org/10.1093/chemse/bjt072
6. Schäfer, L., Mehler, L., Hähner, A., Walliczek, U., Hummel, T., & Croy, I. (2019). Sexual desire after olfactory loss: Quantitative and qualitative reports of patients with smell disorders. Physiology & Behavior, 201, 64–69. https://doi.org/10.1016/J.PHYSBEH.2018.12.020
7. Ahmedy, F., Mazlan, M., Danaee, M., & Abu Bakar, M. Z. (2020). Post-traumatic brain injury olfactory dysfunction: factors influencing quality of life. *European Archives of Oto-Rhino-Laryngology 2020 277:5*, *277*(5), 1343–1351. https://doi.org/10.1007/S00405-020-05823-0
8. Brämerson, A., Johansson, L., Ek, L., Nordin, S., & Bende, M. (2004). Prevalence of Olfactory Dysfunction: The Skövde Population-Based Study. *The Laryngoscope*, *114*(4), 733–737. https://doi.org/10.1097/00005537-200404000-00026
9. Mullol, J., Alobid, I., Mariño-Sánchez, F., Quintó, L., Haro, J. de, Bernal-Sprekelsen, M., Valero, A., Picado, C., & Marin, C. (2012). Furthering the understanding of olfaction, prevalence of loss of smell and risk factors: a population-based survey (OLFACAT study). BMJ Open, 2(6), e001256. https://doi.org/10.1136/BMJOPEN-2012-001256
10. Brown, J., Cooper-Kuhn, C. M., Kempermann, G., Praag, H. Van, Winkler, J., Gage, F. H., & Kuhn, H. G. (2003). Enriched environment and physical activity stimulate hippocampal but not olfactory bulb neurogenesis. *European Journal of Neuroscience*, *17*(10), 2042–2046. https://doi.org/10.1046/J.1460-9568.2003.02647.X
11. Vivar, C., Peterson, B. D., & van Praag, H. (2016). Running rewires the neuronal network of adult-born dentate granule cells. NeuroImage, 131, 29–41. https://doi.org/10.1016/J.NEUROIMAGE.2015.11.031
12. Rosenfeldt, A. B., Dey, T., & Alberts, J. L. (2016). Aerobic Exercise Preserves Olfaction Function in Individuals with Parkinson's Disease. Parkinson's Disease, 2016, Article ID 9725089. https://doi.org/10.1155/2016/9725089
13. Manestar, D., Tićac, R., Maričić, S., Malvić, G., Čorak, D., Marjanović Kavanagh, M., Prgomet, D., & Starčević, R. (2012). Amount of airflow required for olfactory perception in laryngectomees: A prospective interventional study. Clinical Otolaryngology, 37(1), 28–34. https://doi.org/10.1111/J.1749-4486.2012.02442.X
14. Oleszkiewicz, A., Abriat, A., Doelz, G., Azema, E., & Hummel, T. (2021). Beyond olfaction: Beneficial effects of olfactory training extend to aging-related cognitive decline. Behavioral Neuroscience. https://doi.org/10.1037/bne0000478
15. Oleszkiewicz, A., Bottesi, L., Pieniak, M., Fujita, S., Krasteva, N., Nelles, G., & Hummel, T. (2021). Olfactory training with Aromastics: olfactory and cognitive effects. European Archives of Oto-Rhino-Laryngology, 1, 3. https://doi.org/10.1007/s00405-021-06810-9
16. Wegener, B.-A., Croy, I., Hähner, A., & Hummel, T. (2018). Olfactory training with older people. International Journal of Geriatric Psychiatry, 33(1), 212–220. https://doi.org/10.1002/gps.4725
17. Pabel, L. D., Murr, J., Weidner, K., Hummel, T., & Croy, I. (2020). Null Effect of Olfactory Training With Patients Suffering From Depressive Disorders—An Exploratory Randomized Controlled Clinical Trial. Frontiers in Psychiatry, 11. https://doi.org/10.3389/fpsyt.2020.00593
18. Olofsson, J. K., Ekström, I., Larsson, M., & Nordin, S. (2021). Olfaction and Aging: A Review of the Current State of Research and Future Directions: Https://Doi.Org/10.1177/2041669521020331, 12(3), 204166952110203. https://doi.org/10.1177/2041669521020331
19. Etchegoyen, M., Nobile, M. H., Baez, F., Posesorski, B., González, J., Lago, N., Milei, J., & Otero-Losada, M. (2018). Metabolic Syndrome and Neuroprotection. *Frontiers in Neuroscience*, 196. https://doi.org/10.3389/FNINS.2018.00196
20. Erickson, K. I., Weinstein, A. M., & Lopez, O. L. (2012). Physical Activity, Brain Plasticity, and Alzheimer's Disease. *Archives of Medical Research*, *43*(8), 615–621. https://doi.org/10.1016/J.ARCMED.2012.09.008
21. Kim, Y. S., Shin, S. K., Hong, S. B., & Kim, H. J. (2017). The effects of strength exercise on hippocampus volume and functional fitness of older women. *Experimental Gerontology*, *97*, 22–28. https://doi.org/10.1016/J.EXGER.2017.07.007
22. Whiteman, A. S., Young, D. E., Budson, A. E., Stern, C. E., & Schon, K. (2016). Entorhinal volume, aerobic fitness, and recognition memory in healthy young adults: A voxel-based morphometry study. NeuroImage, 126, 229–238. https://doi.org/10.1016/J.NEUROIMAGE.2015.11.049