

2022

EEG neurofeedback and isolation stressor. A systematic review

Kacper Gotner

Gdansk University of Physical Education and Sport, Poland, kacper.gotner@awf.gda.pl

Marcin Dornowski

Gdansk University of Physical Education and Sport, Poland, marcin.dornowski@awf.gda.pl

Follow this and additional works at: <https://www.balticsportscience.com/journal>



Part of the [Health and Physical Education Commons](#), [Sports Medicine Commons](#), [Sports Sciences Commons](#), and the [Sports Studies Commons](#)

Recommended Citation

Gotner K, Dornowski M. EEG neurofeedback and isolation stressor. A systematic review. *Balt J Health Phys Act.* 2022;14(2):Article5. <https://doi.org/10.29359/BJHPA.14.2.05>

This Review is brought to you for free and open access by Baltic Journal of Health and Physical Activity. It has been accepted for inclusion in Baltic Journal of Health and Physical Activity by an authorized editor of Baltic Journal of Health and Physical Activity.

EEG neurofeedback and isolation stressor. A systematic review

Abstract

Introduction. One of the factors increasing the body's response to a stressful situation is isolation. The feeling of loneliness in isolation can be caused by biological, psychological or medical factors. **Material and methods:** This paper is a review of publications issued in 2009–2021, the most up-to-date in terms of information on the topic of stress and its links with EEG neurofeedback. **Results:** 5 publications on stress caused by isolation and the reaction of the human body in a stressful situation were selected. The papers were selected based on the use of EEG neurofeedback in reducing the body's stress reactions to isolation. **Conclusions:** There is a lack of studies in the available literature describing the direct application of EEG neurofeedback in the reduction of stress caused by isolation despite demonstrating its potential in individual studies.

Keywords

stress, EEG neurofeedback, isolation, physical health

Review

EEG neurofeedback and isolation stressor. A systematic review

Kacper GOTNER^{1*}, Marcin DORNOWSKI²

¹ Gdansk University of Physical Education and Sport, Poland, ORCID 0000-0002-7075-6298

² Gdansk University of Physical Education and Sport, Poland, ORCID 0000-0002-0464-1708

* Correspondence: Kacper Gotner, Gdansk University of Physical Education and Sport, 1 Gorskiego Street, 80-336 Gdansk, Poland; e-mail: kacper.gotner@awf.gda.pl

Abstract: Introduction. One of the factors increasing the body's response to a stressful situation is isolation. The feeling of loneliness in isolation can be caused by biological, psychological or medical factors. Material and methods: This paper is a review of publications issued in 2009–2021, the most up-to-date in terms of information on the topic of stress and its links with EEG neurofeedback. Results: 5 publications on stress caused by isolation and the reaction of the human body in a stressful situation were selected. The papers were selected based on the use of EEG neurofeedback in reducing the body's stress reactions to isolation. Conclusions: There is a lack of studies in the available literature describing the direct application of EEG neurofeedback in the reduction of stress caused by isolation despite demonstrating its potential in individual studies.

Keywords: stress, EEG neurofeedback, isolation, physical health.

Citation: Gotner K, Dornowski M. EEG neurofeedback and isolation stressor. A systematic review. *Balt J Health Phys Act.* 2022;14(2):Article5. <https://doi.org/10.29359/BJHPA.14.2.05>

Academic Editor:
Agnieszka Maciejewska-Skrendo

Received: September 2021
Accepted: January 2022
Published: June 2022

Publisher's Note: BJHPA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by Gdansk University of Physical Education and Sport.

Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC-BY-NC-ND) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Stress and stressful situations have always accompanied people in their lives. It is also known that the ability to deal with it is very important, i.e. lowering the level of its impact on our body. Stress reactions in human body may occur on a neurophysiological, psychomotor, psychological and molecular basis. Stress is a process by which environmental factors threaten the body's balance physiologically and mentally and affect the health of an individual under its influence [1]. Isolation is one of the factors causing the body's increased response to a stressful situation. There is evidence that the feeling of loneliness in isolation may be caused by biological, psychological or medical factors, including the so-called stress hormones or components of the immune system, or may be correlated with them [2]. The proper functioning of a human being depends not only on the physical needs of the species, such as eating and breathing, but also on the psychological needs. As humans, we have a need for acceptance, security, and emotional contact with other people. Disturbance of the possibility of contact with other people, i.e. isolation, can lead to a serious dysfunction not only psychologically but also physically. Certainly, persons left to themselves, despite a possibility of survival, are in a situation that will cause them stress due to the lack of contact with another person [3].

Nowadays, the current technological level allows studying and working on the level of the body's response to stress and effectively developing a strategy to combat it using various tests and techniques, mainly using computer techniques. One of these tests is, for example, the reaction test or the test of determination from the Vienna Test System [4]. The most common classic ways of coping with stress may be strategies leading to belonging to a given group or dedicating oneself to work [5]. A common strategy for coping with long-term stress, e.g. at work, is to run away or avoid work [6]. It is also known that social isolation negatively affects lipid levels and the cardiovascular system. One of the methods of classical medicine is EEG (neurofeedback) biofeedback, which enables self-control of the brain's work based on the modification of brain waves. It is a non-invasive and safe

method for the user [7]. Berger H stated that the EEG test and the following changes in the activity of nerve cells during the test are influenced by external factors affecting individual senses. The basis for neurofeedback is the knowledge of the brain's capabilities and the work of the nervous system, which is why it is often used also during psychiatric rehabilitation, e.g. in the fight against depression, neurosis or Alzheimer's disease [8]. The main purpose of the review is to understand the current uses of EEG and its possible use in reducing the negative effects of stress on the body.

2. Materials and Methods

2.1. Database search

The article search strategy was based on the following keywords: stress, EEG neurofeedback, isolation, physical health, and the specific time in which publications containing information on the given topic were issued. The papers were published in the years 2009–2021, so they present the most up-to-date information on the topic of stress and its connections with EEG neurofeedback. The articles contain the following keywords: stress, isolation, biofeedback, EEG. The search of the literature resources was completed on 01/03/2021 and included publications issued up to that date. The searched databases were PubMed, ResearchGate, and Google Scholar.

2.2. Data analysis

Considering the fact that there is not a large number of studies directly regarding the relationship between neurofeedback and its ability to reduce the body's response to the stressor – isolation, the focus was on its possible applications in various areas having direct or indirect relationships with stress of various grounds, such as, for example, stress caused by social isolation and its impact on the cardiovascular system [2], stress caused by a sense of loneliness (as a product of isolation) [9], neurofeedback as a method of reducing the level of post-traumatic stress [10], and the possibility of perceptual and cognitive training for using EEG biofeedback [11], as well as stress in isolation simulation during a manned flight to Mars [12]. An article on the possibility of using EEG during anxiety, i.e. at a time of increased stress level, was also used [13]. In addition, article describing possible applications of EEG in working with people who have high levels of stress caused by the same centers in the brain which are highly active during the feeling of loneliness and alexithymia was included [14].

3. Results

Seven sources in the form of scientific publications were collected from three databases: ResearchGate, PubMed, GoogleScholar and scientific reports, annals for behavioral medicine, public health with the use of key terms: stress, EEG neurofeedback, isolation, physical health. Seven were selected, of which one is a review of articles on the direct impact of the isolation stressor on the level of stress response, one is a cross-sectional study on the reaction of the cardiovascular system and cortisol levels during an acute stressful situation, and three concern the possibility of working with EEG as a stress measurement method. Two studies used the EEG neurofeedback method. All papers were selected based on the purpose of the review in the field of determining the possibility of using EEG neurofeedback in reducing the body's stress reactions to isolation (Table 1).

Table 1. Papers considering stress vs isolation used in this review.

Study (numbering from the References list)	Database	Study design	Main variables	Measurement methods	Key information helpful in meeting the purpose of this review
4	PubMed	review	stress, isolation, cardiovascular system	Medical and psychological databases review: PubMed, PsychINFO and Cochrane during the period 1975–2018 with keywords	The influence of stress on the functioning of the organism is described in a large research group
5	PubMed	cross-sectional study	stress, social isolation, cardiovascular system, cortisol	blood pressure level, salivary cortisol level, relatives questionnaire, cholesterol level	The influence of isolation stress
6	Research Gate	two case studies	neurofeedback, PTSD, EEG as a measurement before and after neurofeedback training	EEG	Possibility of using neurofeedback at work in the mental sphere
7	Research Gate	cross-sectional study	3D-MOD task, EEG as a measurement during attention training and working memory and the speed of visual information processing	EEG	Possibility of influencing the level of selected parameters (working memory and the speed of visual information processing) using neurofeedback
8	Research Gate	cross-sectional study	EEG during sleep, cortisol in urine, subjective feeling of stress	EEG and urine cortisol levels	Confrontation of the subjective feeling of stress with the result of the stress level assessment using EEG
12	PubMed	review	Biofeedback, anxiety disorders, EEG	Medical and psychological databases review: Medline and PsycINFO	Description of EEG activity during the operation of a stressor
14	Google Scholar	experiment	Biofeedback, stress	Brain activation – tasks during fMRI sessions	Influence of neurofeedback sessions in coping with stressful situations

3.1. Influence of isolation on the stress level

In this review, we see that social isolation significantly contributes to increasing the level of stress reactions in the respondents' bodies and that it can affect the work of the subjects' cardiovascular and endocrine systems [4]. Social isolation is associated with a slower recovery of normal blood pressure and increased levels of cortisol during the day in both men and women after performing a specific task. Additionally, in men, as a result of isolation stress, cholesterol levels are also raised [5]. This causes an increased risk of both cardiovascular diseases and problems with metabolic changes. Even with normal fluctuations in cortisol levels, stressful conditions alter the structure of sleep, which can lead to insomnia [8]. However, with the help of EEG, we are able to observe that diminished alpha activity indicates elevated levels of stress [12].

3.2. EEG neurofeedback as a way to reduce stress levels

Psychological questionnaires are used most often for subjective feeling of stress, most often in large research groups, e.g. conducted among respondents or their relatives [5]. In smaller groups, the EEG test will be a much more accurate and objective method to determine the stress level [6]. Using EEG, we can perform neurofeedback, i.e. brain training, in the study group. It allows people to improve parameters such as working memory or the speed of visual information processing [7]. This method is successfully used to combat post-traumatic stress disorder. After neurofeedback training, subjects with PTSD showed a much lower level of stress and activity related to excessive arousal in everyday life [6]. Thus, brain training allows people to relatively control and stabilize their stress level in situations where, for example, their correct assessment of the situation or the speed of reaction is necessary [7]. It will also bring benefits to people who, as actively engaged in physical activity, are exposed to higher levels of stress and when it is important to stabilize it quickly. The EEG neurofeedback can be used to increase the level of alpha waves. Raising it can induce relaxation in people who have high levels of anxiety [12], which can lead to high levels of stress, including during isolation [14].

4. Discussion

This review examines how isolation stress can affect the functioning of the body by, for example, disrupting the cardiovascular system, and how the level of this stress can be measured [4]. Based on the information from seven selected publications, we can see that the methods used to measure the level of stress include questionnaires regarding the subjective assessment of its level [5] or studies on the level of cortisol in urine and the EEG test [8]. Research shows that in the case of a smaller number of participants, the EEG method, as a non-invasive and safe method, is a more accurate method of measuring stress. With the help of the same electrode, EEG neurofeedback can be performed, which can help optimize the brain's work when it is influenced by a stressor, e.g. isolation [6]. Research using this method shows its high efficiency in terms of the possibility of developing working memory abilities and the speed of processing visual information [7]. Currently, for the purposes of the review, a large number of studies on the possibility of working with EEG neurofeedback during elevated isolation stress were not found in the databases, even though EEG was used to measure its level during a 105-day isolation test [8]. The only publication showing the possibilities offered by brain training presents the case of refugees, where isolation was not the only stressor, and yet EEG neurofeedback showed a significant normalization of markers after training [6]. Also thanks to EEG biofeedback, one can influence the level of alpha waves and thus help a person achieve the optimal level for the functioning and maintenance of the neurophysiological and psychomotor base [12].

Unfortunately, a large number of reports on working with EEG neurofeedback belong to research centers that do not have an open library of their data, so it becomes diffi-

cult to find a significant number of scientific reports that could be analyzed. More accessible and much more popular are works that use biofeedback as a method that enables the activation or control of selected biological signals (sEMG), e.g. during contraction of individual muscle groups [15].

5. Conclusions

The articles in this review mainly described the effects of isolation-induced stress on the functioning of the human body. Only in a study of PTSD sufferers EEG neurofeedback was used as a stress reduction method. This method turned out to be very effective. Also in the article describing the possibilities of working with neurofeedback, this method was described as training in the fight against increased levels of stress. There is a lack of studies in the literature describing the direct application of EEG neurofeedback in the reduction of stress caused by isolation.

References

1. Grygorczuk A. The notion of stress in medicine and psychology. *Psychiatry* 2008;5:111–115.
2. Grant N, Hamer M, Steptoe A. Social isolation and stress-related cardiovascular, lipid, and cortisol responses. *Ann Behav Med.* February 2009;37(1):29–37. DOI: 10.1007/s12160-009-9081-z
3. Skibinska B. „Skazani na samotność?” O konsekwencjach izolacji społecznej w wybranych jej kontekstach [“Doomed to Loneliness?” On the Consequences of Social Isolation in Selected Contexts]. *Studia Edukacyjne* nr 44, Poznań: Adam Mickiewicz University Press; 2017, 265–284. Polish. DOI: 10.14746/se.2017.44.16
4. Schuhfried G. *Vienna Test System Sport*. Moedling: Paul Gerin Druckerei, Wolkersdorf; 2013.
5. Sikorska R, Pisula E. Causes of stress and coping strategies in adolescents aged 14–16. *Polskie Forum Psychologiczne*. 2002;7(2):115–119.
6. Kwak M, Zaczyk I, Wilczek-Ruzyczka E. Stress and ways of coping with it by Polish nurses – a meta-analysis of research. *Medycyna Ogólna i Nauki o Zdrowiu*. 2018;24(2):120–125. DOI: 10.26444/monz/91633
7. Walkowiak H. *EEG Biofeedback: Characteristics, Application, Opinions of Specialists*. Poznań: Adam Mickiewicz University Press; 2015, 307–325.
8. Markiewicz R. The use of EEG Biofeedback/Neurofeedback in psychiatric rehabilitation. *Psychiatr Pol.* 2017;51(6):1095–1106. DOI: 10.12740/PP/68919
9. Campagne D. Stress and perceived social isolation (loneliness). *Arch Gerontol Geriatr.* 2019;82:192–199. DOI: 10.1016/j.archger.2019.02.007
10. Askovic M, Watters A, Aroche J, Harris A. Neurofeedback as an adjunct therapy for treatment of chronic posttraumatic stress disorder related to refugee trauma and torture experiences: two case studies. *Austr Psychiatr.* 2017;25(4):358–363. DOI: 10.1177/1039856217715988
11. Parsons B, Faubert J. Enhancing learning in a perceptual-cognitive training paradigm using EEG-neurofeedback. *Sci Rep.* 2021;4061. DOI: 10.1038/s41598-021-83456-x
12. Gemignani A, Piarulli A, Menicucci D, Laurino M, Rota G, Mastorci F, et al. How stressful are 105 days of isolation? Sleep EEG patterns and tonic cortisol in healthy volunteers simulating manned flight to Mars. *Int J Psychophysiol.* 2014;93(2):211–219. DOI: 10.1016/j.ijpsycho.2014.04.008
13. Tolin DF, Davies CD, Moskow DM, Hofmann SG. Biofeedback and Neurofeedback for Anxiety Disorders: A Quantitative and Qualitative Systematic Review. *Adv Exp Med Biol.* 2020;1191:265–289. DOI: 10.1007/978-981-32-9705-0_16
14. Morr M, Lieberz J, Dobbelstein M, Philippsen A, Hurlmann R, Scheele D. Insula reactivity mediates subjective isolation stress in alexithymia. *Sci Rep.* 2021;11(1). DOI: 10.1038/s41598-021-94799-w
15. Lekskulchai O, Wanichsetakul P. Effect of pelvic floor muscle training (PFMT) during pregnancy on bladder neck descend and delivery. *J Med Assoc Thailand.* 2014;97Suppl8:S156–S63.

Author Contributions: Study Design, KG, MD; Data Collection, KG, MD; Statistical Analysis, not applicable; Data Interpretation, KG, MD; Manuscript Preparation, KG, MD; Literature Search, KG, MD; Funding Acquisition, not applicable. All authors have read and agreed to the published version of the manuscript.

Funding: This systematic review has not been supported by any source of funds.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

