

Innovations in Neurofeedback training

Integration of learning theory and adaptation of multimedia

Robert Kozlowski
Biomed Neurotechnologie

Neurofeedback therapy (NFB) is a method that helps people learn to control their brain activity in order to improve their everyday functioning. To date, however, we still do not have clear answers to many questions, especially when it comes to planning a training regimen that takes into account the large number of variables that can be important in achieving ultimate therapeutic success. There is a widespread belief that learning in NFB therapy is somehow automatic. From the point of view of planning training sessions, the predominant focus is on choosing a protocol with maximum precision in terms of electrode location or EEG frequency flt settings, which is of course important, but not the only one that determines ultimate success. Such an approach often ignores a number of other factors that can significantly influence the achievement of the therapeutic goal. In this article, we will only focus on two: learning theory and the multimedia nature of feedback.

From automation to personalization - a new approach to neurofeedback

While it is true that neurofeedback uses solutions derived from instrumental conditioning, i.e. the task at hand is designed in such a way that a specific reinforcement reward is given for achieving a certain state, which in effect perpetuates favorable brain activity, the notion that this is automatic, arriving outside of the conscious process, is highly debatable. A recent study by Kuznetsov, E. et al (2023) points to the need to consider other factors that influence how well people learn to control their brain activity. For example, the results of Veilanti and colleagues (2021) showed that the results achieved in NFB therapy may be related to the individual characteristics of the participants. Nor does the process automatically proceed in isolation from a number of variables not previously considered. In some cases, the aforementioned therapy may provide additional benefits when combined with other forms of treatment, such as psychological therapy, coaching, or attention to sleep hygiene (Arns, 2020).

This new approach is being recognized and gradually implemented. As an example, the German recommendations for biofeedback indicate that processes known from learning theory or skill transfer-oriented exercises should also be included in the planning of protocols. Austrian recommendations, on the other hand, recommend incorporating relaxation methods, autogenic training, or progressive muscle relaxation into biofeedback (Kuznetsova, E. et al. 2023).

Multimedia in neurofeedback according to learning theory

As we can see, the problem is complex and requires a great deal of care in the choice of management strategy, both at the technical level, i.e. with which exact visual or auditory means we deliver the success information to the patient, and in the context of taking into account individual differences in the learning process. So far, we have few studies available that analyze the effectiveness of neurofeedback depending on the nature of the feedback. Those that have addressed this topic indicate that the nature of the stimulus used as feedback is not irrelevant to the ultimate effectiveness of the intervention. A good example

is a study by Ono and colleagues (2013), who compared three types of visual feedback, such as a simple graph, an animated hand that changes position and an animated hand displayed from the perspective of the biofeedback trainer. All conditions led to changes but the latter was the most effective. On the other hand, a study by Fernández et al. (2016) indicated that people with disabilities may have lower processing speed and show difficulties in semantic processing in the visual modality, which in a sense necessitates either a reduction in the content of the information so conveyed or the choice of another modality such as audio. In contrast, another study (Bastaiin, 2011) showed greater effectiveness of vibration-touch feedback than auditory feedback aimed at improving balance through stimulation of the vestibular system in children with disabilities.

And here we touch on an interesting issue. The lack of research in this area means that the use of multimedia as feedback by therapists is often very casual. Very often it is either games or videos from streaming services that, by adding an image modification mechanism, discreetly, or perhaps just too discreetly, provide information about success. What is behind the decision 'to make it attractive' is not necessarily the best possible solution.

Below I describe why this may be the case.

Information overload and learning theories

It is intended that the feedback signal should clearly transmit information about physiological changes without generating distracting or anxious information (Schwartz 2004).

When using films in therapy, it is worth taking into account that the patient's working memory capacity may be lower than that of peers. A brain overloaded with incoming information may find it difficult to simultaneously process the content of a film and control and modify its own responses. While this may be an interesting form of consolidation of skills already developed, it may fail completely at the learning stage.

In the case of such complex visual-sound feedback options as films or video games, we are provided with an avalanche of stimuli unrelated to the biofeedback itself (dialogue, fast-paced action), which can mask the correct signal and reduce the ability to focus on the task. In this context, the film may have rather distracting properties, acting as a tool to draw attention away from the correct goal in therapy.

The apparent 'success' measured by the numerical change of parameters in the EEG, in this context, should not be at all gratifying. The lower theta seen on the report printed after biofeedback training, may under such conditions be the result of the stimuli in the video, rather than the patient's own activity in interacting with the biofeedback system.

As a result, after 40 'training' sessions, the patient will still not have developed the ability to maintain attention on homogeneous tasks similar to school tasks.

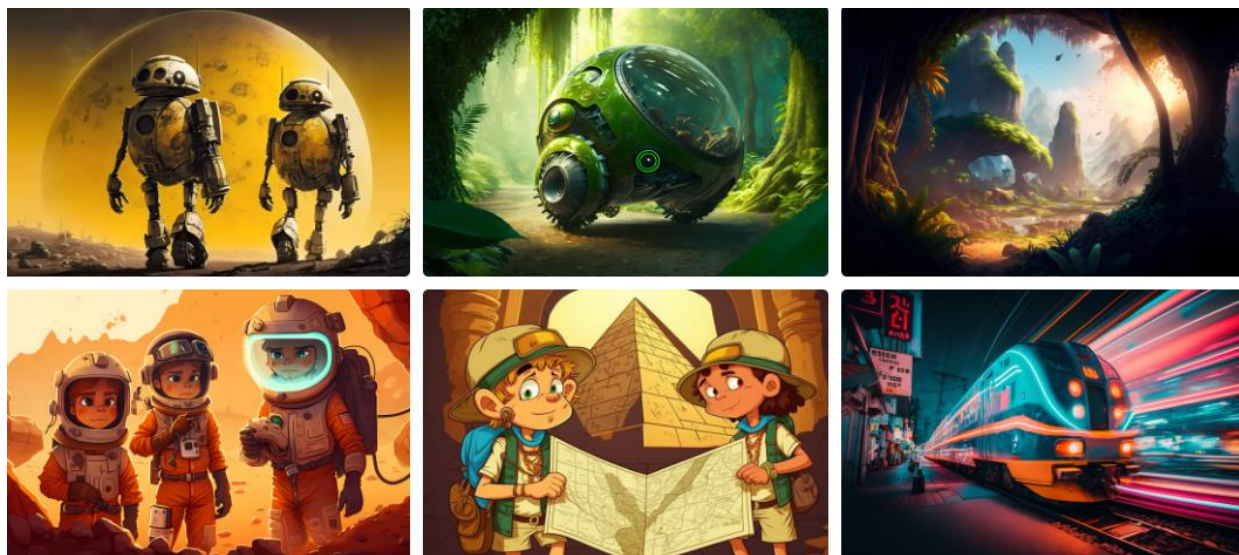
I do not mean to say that these forms of biofeedback should be completely abandoned. However, it is necessary to look for films adapted in content to the aim of the therapy, but also films that do not obscure the essence of the training with their storyline. If we know that the patient in question has not yet understood what we expect of him or her in biofeedback training, it is advisable to provide a more homogeneous environment that allows the attention to be directed to the task and not to the passive processing of the

content.

The importance of fixation and distractor resistance training

Although research has shown that effective attentional training for ADHD patients should include strategies such as learning to breathe consciously, fixation training (on an object, a stationary object), concentration on a learned task with additional distraction, concentration on a moving object (to gain awareness of what causes distraction in static and dynamic situations) (van de Weijer-Bergsma E, 2012), few of these strategies are commonly incorporated into biofeedback. In order to pursue this goal with the right feedback material, it is clear that we could benefit here from both static or quasi-static material (a kind of slides with feedback added) and videos or animations, but with a constantly moving object in the screen area.

To get at least a little closer to achieving these goals in neurofeedback, it is useful to use appropriate training materials. One such solution is Imagine Infinity - a series of quasi-static images-animations that, presented as slow-moving graphics, solve several of the problems described above:



Different categories of "IMAGINE INFINITY" boards

When compared to dynamic videos and games, it's important to limit the amount of information provided. Slow changes every 10 seconds can help. It's also helpful to allow for longer eye fixation on still images, which strikes a balance between an attractive visual form and the feedback given. Creating an environment that is homogeneous but interesting can effectively form the ability to focus attention without generating distractors. This can also enable the formation of persistence and patience in the learning process.

Despite the lower amount of complex and often chaotic stimuli present in the videos, the emphasis in Imagine Infinity is on sustaining motivation through the use of a large amount of material - a total of more than 700 high-resolution images are used, with themes ranging from fantasy through to topics attractive to children e.g. small animals, interesting vehicles, artistic, surprising scenery, etc. These images are not just displayed in a static form but provide feedback to the subject through the use of image shrinking techniques, pixelation, darkening, and stopping when the patient stops achieving the set goals.

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Different categories of "IMAGINE INFINITY" boards

In summary, neurofeedback therapy is an effective method to help people control their brain function and improve their day-to-day functioning. However, many variables need to be taken into account to plan effective training, not just the choice of a protocol with maximum precision. The new approach to neurofeedback, taking into account learning theories and the multimedia nature of feedback, allows for more personalized therapy and better achievement of therapeutic goals. It is also important for therapists to be aware of the impact of information overload and distractors on the patient's learning process and to select appropriate feedback materials to maximize the effective development of attentional capacity. In this way, neurofeedback can be an even more effective treatment method in the future, bringing real benefits to patients and improving their quality of life.

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