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The efficacy of determinants of attention bias training in mental disorders

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Summary

This paper focuses on a method of attention bias training, considering in particular its efficacy and usability in several mental disorders. The results of current meta-analyses and selected experiments indicate possible efficacy of training in case of some anxiety disorders (generalised anxiety disorder and social phobia), particularly in young individuals. Its efficacy in other previously tested disorders such as depression and addictions seems questionable. We analysed moderators of training efficacy considered in previous studies: subjects' age, type of training task, type and location of emotional stimuli, duration of training, awareness of test objective and place of testing (research laboratory or subjects' homes). It seems that greater efficacy of attention bias can be achieved by conducting longer trainings, located in a laboratory, rather than in-house, and using verbal rather than visual stimuli. It is not clear whether participants should be informed of the training objective or whether arranging stimuli vertically is more efficient than horizontally.

Key words: attention, bias, computer-assisted therapy

Introduction

Studies on attention bias modification using computer procedures constructed especially for this purpose have developed dynamically in the past several years. The studies are frequently referred to as CBM-A (Cognitive Bias Modification-Attention) and are based on the cognitive model of psychopathology which recognises cognitive bias as playing an important part in the onset and maintenance of disorders [1, 2].

Attention bias is a usually involuntary tendency to direct attention towards emotional stimuli linked to a particular mental disorder. For instance, people with anxiety

The study was not sponsored.

are particularly sensitive to any threat related stimuli. Numerous studies confirm that attention bias can be found in people suffering from: anxiety disorders [3], depressive disorders [4], eating disorders [5], alcohol abuse [6], nicotine addiction [7], or sexual dysfunctions [8].

The so-called 'dot-probe task' is the most frequently used tool measuring attention bias. In a typical version of this procedure there are two stimuli presented simultaneously: one neutral and one associated with a given disorder. After the termination of the display of these stimuli, lasting usually approx. 500 ms, a target stimulus appears and a subject's task is to react to it as quickly as possible (Figure 1). Target stimuli are displayed with the same frequency in the location of neutral stimuli and disorder related stimuli. Attention bias occurs when a subject reacts faster (or slower), depending on whether a target stimulus appeared in the location of the disorder-related one [9].

The dot-probe task, if properly modified, can be used to alter attention bias and consequently reduce symptoms of disorders. The first study to manipulate cognitive bias was conducted by McLeod et al. [10]: students with low and average level of trait anxiety were trained to direct their attention to threatening stimuli (in this group a target stimulus always appeared in the location of a threatening stimulus). Individu-

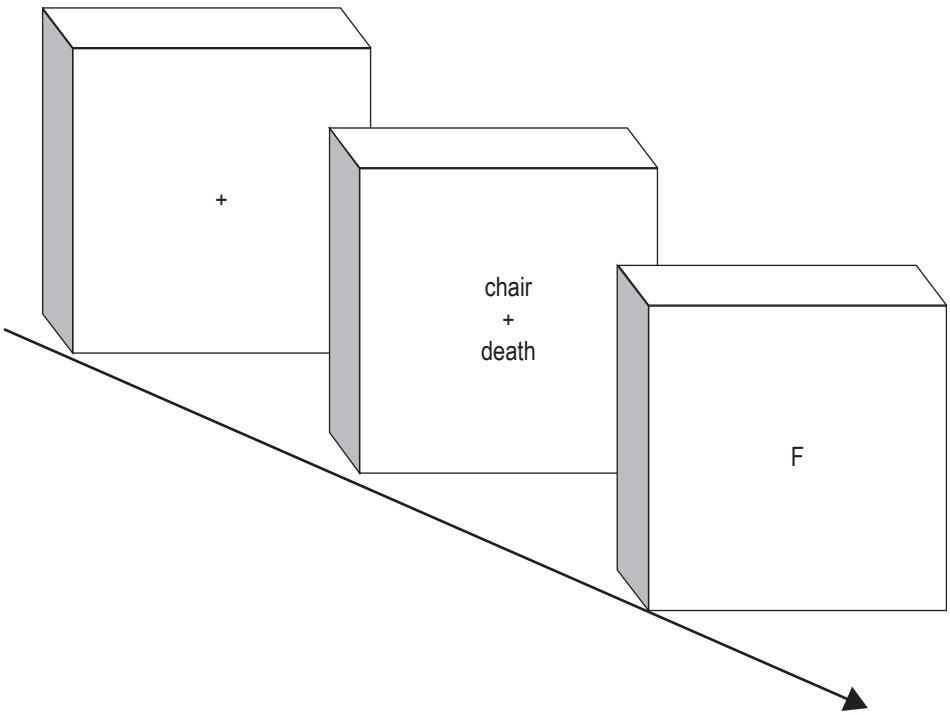

Figure 1. **Dot-probe task – version requiring the identification of a target stimulus**

als in the experimental group manifested more symptoms of anxiety in response to stressors than those in the control group.

The results of these studies have become an inspiration for many experiments, conducted both on clinical and sub-clinical groups with an objective to test the efficacy of attention bias training in reducing symptoms of disorders such as: depression [11], anxiety disorders [3], alcohol addiction [12], nicotine addiction [13] or pain [14]. Previous results indicate that attention bias training is not equally efficient in all types of disorders. Its efficacy may depend on participants' age and differences in the training process, among other factors. These factors will be discussed later in this paper.

The efficacy of CBM-A training and its determinants

Four meta-analyses of CBM-A have been conducted so far. The meta-analysis by Hakamata et al. [15], which looked at 12 studies, was devoted exclusively to attention bias training of anxious individuals using only the dot-probe task. It was concluded that training has a strong influence on attention bias (Cohen's d effect size = 1.16) and a medium size influence on symptoms of anxiety (d = 0.61). Analysing only studies on clinical groups (individuals with anxiety disorders), the influence on symptoms of anxiety was found to be even higher (d = 0.78).

In the meta-analysis by Hallion and Ruscio [11] 45 studies on both attention bias modification and interpretation bias in anxiety and depression were considered. The results proved less promising and the size of the estimated effect proved significant but small (attention bias change: Hedges's g effect size = 0.22; change in symptoms: g = 0.13). However, this meta-analysis also included studies on attention training using relatively non-standard methods. For instance, the training by Dandeneau et al. [16] was based on a visual search task where subjects are asked to find a smiling face among neutral ones, whereas in a study by Johnson a basic, non-training version of the dot-probe task was used and subjects were instructed to consciously notice positive stimuli and ignore negative ones [17].

Beard et al. [18] included data from 41 experiments. They analysed the efficacy of attention training using different methods, not only the dot-probe task, in healthy individuals, as well as in those with anxiety, depression, addiction to alcohol and nicotine. They concluded that there is a significant influence of training on attention bias (between g = 0.24 and g = 1.41 depending on the conditions compared) as well as on the reduction of symptoms measured with a behavioural task (g = 0.4; $p < 0.001$). However, the efficacy of training in reducing subjective symptoms of disorders was not demonstrated.

Mogoase et al. [19] in their meta-analysis looked at 43 experiments studying the efficacy of attention bias training using different methods in healthy individuals, those demonstrating symptoms of anxiety, depression, addicted to substances and experiencing pain. They demonstrated a significant influence of training on the change of

attention bias ($g = 0.312$; $p = 0.003$), as well as a smaller but still significant influence on the reduction of symptoms of analysed disorders ($g = 0.16$; $p = 0.003$).

The efficacy of training and type of disorder

So far, there have been relatively few publications devoted to the comparison of the efficacy of attention bias training in different mental disorders. The meta-analysis by Beard et al. [18] compared the efficacy of training in anxiety (and anxiety-related disorders) as well as in addiction to nicotine and alcohol, in several different experimental settings. Training proved to be more effective in anxious individuals than in addicts (i.e., it was associated with a reduction in psychopathological symptoms more visible than in the case of people suffering from addiction).

Hallion and Ruscio [11] compared the efficacy of CBM-A in anxiety disorders and depression, demonstrating greater efficacy of training in the former.

CBM-A training seems to be more effective in some anxiety disorders than others. For instance, previous studies on specific phobias suggest a limited efficacy of CBM-A in reducing animal-related phobias [20, 21], whereas at least several experiments indicate substantial improvement in generalised anxiety disorder and social phobia [22, 23]. Mogoase, et al. [19] demonstrated that attention bias training significantly influences the reduction of symptoms of generalised anxiety disorder and social phobia but does not significantly reduce the symptoms of specific phobias or PTSD. The researchers additionally demonstrated that although CBM-A is effective in reducing anxiety symptoms, and lowers the level of distress in healthy individuals, it does not significantly influence the symptoms of depression, addiction or perception of pain.

The age of training participants

The efficacy of attention bias training appears to depend on subjects' age at least to some extent. Mogoase et al. [19] observed that CBM-A influences the change of attention bias as well as the reduction of disorder symptoms more effectively in younger subjects. This may result from the fact that attention bias in those individuals is more prone to change. It is also worth remembering that younger individuals typically use the computer with greater ease.

Attention bias modification studies also differ significantly in aspects such as the type of methods used in training, as well as in procedural details, such as the placement of stimuli used, duration of training etc. Potentially important procedural differences are discussed below.

Attention training method

The dot-probe task is the most frequently used method in training attention bias. Some experiments, however, also use other tasks, for instance, a modified version of

the emotional spatial cueing task (ESCT), or the visual search task. In case of ESCT, an emotional stimulus is displayed in one of two locations, followed by a target stimulus appearing in its location or on the other side. If the objective of the training is to reduce attention bias towards a stimulus related to a disorder, the target stimulus is not displayed (or it is displayed significantly less frequently) in the location of a disorder-related stimulus [24]. In a training based on visual search, subjects' task is to find a stimulus not related to a disorder in the shortest time possible, e.g. a smiling face among stimuli related to a disorder, e.g. face expressing disgust [16]. It is assumed that by repeating this task subjects learn to direct their attention towards neutral/positive stimuli rather than towards disorder-related stimuli. Previous analyses [19] demonstrate that a training based on a dot-probe task is more effective than ESCT.

The characteristics of stimuli used in attention training

Attention training usually involves the use of stimuli associated with the disorder whose symptoms are to be reduced. For instance, in case of phobias, stimuli related to the object of fear are used – images of spiders in arachnophobia, faces or words expressing danger or disapproval in social phobia. The choice of stimuli also depends on their more basic properties, such as modality. It could be argued that words could be particularly effective in case of disorders in which anxiety is not related to specific objects or situations, but rather to more general notions and themes – as is the case in generalised anxiety disorder. Some authors suggest that in disorders such as specific phobias, where anxiety is more focused, the use of specific presentations in form of images can be more effective [25]. However, the results of the meta-analysis conducted by Hakamata et al. [15] indicate greater efficacy of training using verbal rather than non-verbal stimuli. Similarly, Beard et al. [18] in their meta-analysis concluded that a training based on words rather than images influences greater reduction of psychopathological symptoms.

Further procedural differences refer to the type of stimuli which are used in addition to disorder-related stimuli. Most studies train to divert attention away from negative stimuli and direct it towards emotionally neutral ones. In other studies subjects learn to direct their attention towards positive stimuli [26]. So far, there have not been many studies which would directly compare the efficacy of these two methods. Mogoase et al. [19] in their meta-analysis notice no significant differences in the efficacy of training, whether subjects learn to divert their attention to positive or neutral stimuli.

Location of stimuli

Attention trainings using a dot-probe task differ also in terms of the placement of emotional stimuli. Some experiments present neutral/positive and disorder-related stimuli one above the other (see Figure 1), while other studies, in particular those

using non-verbal stimuli, present stimuli one next to the other. The meta-analyses by Hakamata et al. [15] and Beard et al. [18] demonstrated that arranging stimuli vertically is more efficient than horizontally. This, however, has not been confirmed by the latest meta-analysis [19].

Duration of training

Studies on attention training differ considerably in terms of the number of sessions and trials in each session, from one session composed of several dozen trials to many sessions spread over a few days and composed of thousands of training trials in total. Shorter trainings save time and other costs and are associated with a smaller risk of dropouts, however, longitudinal studies suggest greater stability of the effects of trainings divided into a few sessions [25]. The previously mentioned meta-analysis by Hallion and Ruscio [11] concludes that the intervention had a greater influence in studies using more than one training sessions than in those with only one session – this, however, applies only to studies with a simple post-test of the therapeutic effect, usually in the form of a questionnaire. Experiments where the efficacy of training in reducing symptoms was measured by exposure to a stress-inducing situation did not demonstrate a significant influence of training duration on the scale of the effect. However, we cannot exclude the possibility that the influence of training duration has not been demonstrated due to a relatively small number of such studies conducted. Beard et al. [18] concluded that the number of training sessions moderates the influence of attention training on subjects' individual experience – the more sessions the greater the training effect.

Awareness of a study objective

It is not clear whether participants should be informed of the training objective. In most studies it is not revealed before the training, and additionally at the end of the experiment researchers try to test whether the subjects did not guess the idea behind the study or which group (control or experimental) they were assigned to. In some trainings a number of additional trials inconsistent with the trained rule is introduced to lower the risk of subjects guessing the study objective [23]. Implicit learning can be more effective in changing attention bias, as it bypasses potential resistance or conscious avoidance. Some authors [27] claim that the awareness of attention training objective could significantly limit its effects, and intentional diversion of attention from threatening stimuli can have effects opposite to those intended. The study by Grafton et al. [28] provides some support for this thesis. They concluded that a training in which subjects are directly informed about the rule of target stimulus presentation modifies attention bias but the influence of subjects' reactivity to a subsequent stressor was not found. On the other hand, some results indicate that conscious learning to avoid threatening stimuli can be faster and have a more lasting effect on anxiety. One

of such studies [29] demonstrated that informing subjects about the fact that a target stimulus will always appear in the location of a specific type of words enhanced the influence of training both on attention and worry.

Location of training

The efficacy of attention bias training can depend on the place where it is conducted [30]. In the last years there have been more and more online studies of CBM-A efficacy partly because such a training can be easily conducted outside of a laboratory. So far, however, there has not been convincing evidence testifying to the efficacy of this form of CBM-A [31–33] and the results of meta-analyses indicate greater efficacy of trainings conducted in laboratories [19]. The study by Kuckertz et al. [30] provided one explanation of poor results of online CBM-A. Researchers assumed that one of the factors moderating the influence of attention training on the reduction of anxiety symptoms could be exposure to situations which activate anxiety. This exposure is one of the factors which could distinguish a training conducted in a laboratory from online training, as conducting CBM-A in laboratory conditions is stressful, especially to subjects suffering from disorders such as social anxiety. After all, participation is associated with being observed and answering personal questions. A person participating in an online training is not exposed to such stressors. In order to test whether exposure to stressful situations modifies the effects of online training, Kuckerz et al. [30] compared the results gathered in a group subjected to attention training (AMPonly), a control group (ACC), a group participating in an online cognitive-behavioural therapy (iCBT) and a group subjected to attention training whose participants were additionally asked to perform an anxiety-inducing activity directly before the training (AMP + FACT). The AMP + FACT procedure proved more effective than ACC and AMPonly in reducing both negative attention bias and anxiety symptoms, and its results where comparable with iCBT whose efficacy has so far been confirmed by many studies [34, 35].

Recapitulation

In the future, attention bias training could serve an important supplementary role in the treatment of some mental disorders. Taking into account the results of studies collected so far, this method seems to be of value first and foremost in anxiety disorders, generalised anxiety disorder and social phobia in particular. The efficacy of trainings in other disorders tested so far, such as depression and addiction to psychoactive substances seems questionable. However, we need to bear in mind the fact that anxiety disorders have so far been studied considerably more extensively than other mental disorders. For instance, the latest meta-analysis [19] looked at 22 studies conducted on individuals with anxiety disorders, only 7 on individuals with depression and 5 on individuals with addiction to psychoactive substances.

So far, the results of meta-analyses indicate that longer trainings are more effective, and that using verbal stimuli rather than visual ones is associated with greater efficacy. Training is more effective in younger individuals, and trainings conducted in a laboratory are considerably more effective than those performed by subjects at home.

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