Cognitive Bias Modification in Mental

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Abstract

Cognitive biases refer to a tendency to favor a particular way of processing information, such as habitually attending to threatening information in the environment, or interpreting ambiguous information in a negative way. Importantly, cognitive biases are linked to a number of emotional problems, such as anxiety and depression, raising the question of whether altering cognitive biases could relieve the symptoms of these disorders. *Cognitive bias modification* (CBM) refers to a group of interventions typically delivered via computer that alter cognitive biases through repeated practice in processing information in a healthy way (e.g., learning to attend to neutral, rather than threatening, cues). Some research suggests that CBM can ameliorate symptoms of mental illness and reduce emotional vulnerability to stressors. Moreover, CBM's computerized format offers a potentially cost-effective option for wide dissemination, which could prevent and reduce the public health burden of mental illness. At the same time, mixed research findings suggest more research is needed before CBM can be considered a frontline treatment for psychopathology. The current essay describes CBM's theoretical framework, reviews the CBM outcome literature, and explores key questions for future research, such as how CBM works, for whom it works best, and optimal delivery conditions.

INTRODUCTION

Cognitive biases reflect a tendency for individuals to favor one way of processing information over others, such as anxious individuals preferentially attending to threatening information, or depressed people selectively remembering failure-related information (MacLeod & Mathews, 2012). Biases have been identified in many areas of cognitive processing, including attention, interpretation, and memory. Some cognitive biases facilitate adaptive processing. For example, some individuals habitually attend to friendly faces at a party, which leads to their social engagement and enjoyment. Other cognitive biases, however, may contribute to maladaptive information processing. For example, a college student whose attention gets stuck on the one hostile face at a party may experience anxiety and avoid similar

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situations in the future. These patterns of thinking can be so powerful that they play a causal role in the onset and maintenance of anxiety, depression, and other mental illnesses.

Cognitive bias modification (CBM) interventions are a group of "therapist-free" treatments that are administered on a computer or via other technology, and involve sustained practice processing information in an adaptive way. CBM training programs aim to change cognitive biases, and test whether changing biases can cause changes in emotional distress and maladaptive behaviors, such as social avoidance. In addition to this critical theoretical test, CBM may have important clinical implications. CBM interventions have sometimes been shown to reduce symptoms of psychopathology, and diminish avoidance behavior and distress in the face of stressors. Yet, results across studies have been quite mixed. Thus, for CBM to achieve its full promise, there is considerable need to replicate earlier findings; understand how CBM works (i.e., mechanisms underlying change); increase the reliability, strength, and durability of CBM's effects; and explore new ways of delivering CBM interventions.

FOUNDATIONAL RESEARCH

Cognitive Models of Mental Illness

Cognitive models posit that individuals are constantly attending to and interpreting information in their environment in a biased way that can dramatically influence how the world is perceived and understood (Clark & Beck, 2010). For example, individuals with panic disorder preferentially attend to bodily signs of potential danger, such as a rapid heartbeat, and may interpret them as threatening (e.g., assume the rapid heartbeat signals an impending heart attack, as opposed to resulting from racing up the stairs). This biased processing style is theorized to lead to negative emotions such as anxiety or sadness, and makes it more difficult for the individual to respond effectively in emotionally stressful situations (e.g., a person may avoid the situation altogether).

While numerous cognitive biases have been identified, we focus on attention and interpretation biases because the majority of CBM research has focused on shifting these biases. *Attention bias* refers to a tendency to preferentially attend to negative or threatening information in the environment, and/or difficulty withdrawing attention from this information. When the college student's attention is drawn to the one unfriendly face at the party, she is exhibiting an attention bias. Interpretation bias occurs when an individual habitually makes one type of inference when a situation is ambiguous and could be interpreted either positively or negatively. For

example, when the college student notices that others at the party are looking at her, she may infer that they think she looks stupid, instead of assigning a more positive meaning, such as that they think she is wearing a nice outfit.

These thinking patterns are closely associated with depression, anxiety, and related emotional disorders. Depressed individuals show selective attention to information consistent with their sad mood, a tendency to interpret ambiguous information negatively, and a pattern of remembering the negative aspects of an event, (i.e., memory bias; Hallion & Ruscio, 2011). Several cognitive biases have also been linked to specific anxiety disorders (MacLeod & Mathews, 2012). For example, individuals with panic disorder may preferentially attend to bodily sensations, such as feeling short-of-breath following physical exertion, and interpret it as sign of an impending health catastrophe. In social situations, people with social anxiety tend to focus attention on themselves, as well as faces perceived as hostile or unfriendly, and assume others are negatively evaluating them.

Assessing and Modifying Cognitive Biases

Several computerized tasks have been designed to detect cognitive biases, and many of these same tasks have been altered to train particular response styles using classic reinforcement principles. By introducing feedback aimed at increasing desired responses and decreasing others, these tasks attempt to shift cognitive biases. In the dot probe paradigm (MacLeod, Mathews, & Tata, 1986), one of the most commonly used assessments of attention bias, participants are briefly presented with a pair of either words or pictures on a computer screen. Typically, one item is threatening while the other is benign. For example, a dot probe for spider phobia may feature a close-up image of a tarantula (threatening image) next to an image of a teaspoon (benign image). Immediately after the pictures disappear, a letter (e.g., E or F) appears in the location of the screen formerly occupied by one of the items, and participants are directed to press a button that corresponds to the letter as quickly as possible. A quick response indicates that the participant may have already been attending to the location on the screen where the letter appears, and a longer response suggests that their attention had been focused elsewhere. Comparing participants' response times to letters replacing threatening versus benign items provides a measure of attention bias. To train a more positive bias, the letter consistently appears in the location where the benign item had appeared, so participants learn to direct their attention to the benign item before the letter is presented.

Tasks that assess or alter interpretation bias often involve resolving ambiguous information in either a threatening or benign way (MacLeod & Mathews,

2012). In one interpretation bias assessment, participants are asked to spell homophones that have both a negative and positive/neutral referent (e.g., die or dye, guilt or gilt). How often a participant provides the negative referent suggests a negative interpretation bias (Mathews, Richards, & Eysenck, 1989). In another task, participants read ambiguous scenarios that could be interpreted in either a threatening or benign light, such as "you walk into the party and guests begin laughing." The sentence could indicate the person walking in is being ridiculed, or the guests could be laughing at something completely unrelated to the person. Both the homophones and the scenarios tasks can be used to train a more positive interpretation style by designing the task so participants are forced to assign benign, nonthreating meanings to resolve the ambiguity. For example, in the scenarios task, participants would be asked to fill in the missing letter in a word that finishes the scenario in a positive way (e.g., the guests at the party must have been laughing at a j_ke; participants would press "o" to make the word "joke").

There are now numerous forms of bias training, including, but not limited to, tasks to shift memory biases to encourage less selective recalling of negative information (Joormann, Hertel, LeMoult, & Gotlib, 2009); tasks to shift implicit associations, which are automatic associations in memory (Clerkin & Teachman, 2010); tasks that encourage less negative imagery (Torkan *et al.*, 2014); tasks to train approach and avoidance tendencies (Asnaani, Rinck, Becker, & Hofmann, 2014); and tasks to inhibit ruminating on depressing thoughts (Daches & Mor, 2014).

CBM FOR MENTAL HEALTH PROBLEMS

Cbm for Anxiety

CBM studies targeting anxiety have yielded some promising findings. In two studies (Amir, Beard, *et al.*, 2009; Schmidt, Richey, Buckner, & Timpano, 2009), clinically diagnosed socially phobic participants who underwent CBM-A showed symptom reduction commensurate with the current gold standard treatment for social anxiety, cognitive behavior therapy. Symptoms of generalized anxiety disorder, characterized by pervasive and persistent worrying, have also been significantly alleviated with CBM-A (Amir, Beard, Burns, & Bomyea, 2009). CBM-I has been similarly effective in reducing symptoms of social anxiety (Hirsch, Mathews, & Clark, 2007) and worry (Hirsch, Hayes, & Mathews, 2009), among other domains. In a recent demonstration of the potential clinical utility of CBM-I, height fearful participants who received CBM-I improved as much as participants who received exposure therapy, the current gold standard treatment for height phobia (Steinman & Teachman, 2014). This suggests that CBM-I may potentially

provide a palatable, accessible, low-cost, therapist-free intervention for anxiety.

Notwithstanding such advances, the literature also includes many lackluster findings (e.g., improvements by the CBM training group were no greater than those of a control group that received no intervention; Fox, Mackintosh, & Holmes, 2014). A recent statistical analysis integrating findings from a large number of studies, known as a *meta-analysis*, found only small effects of CBM-I and CBM-A on anxiety, although larger effects on changing bias (Hallion & Ruscio, 2011). Generally, results were stronger for CBM-I (vs CBM-A), when participants received multiple training sessions, and when symptoms were measured during or after a stressful task designed to show whether training reduced emotional vulnerability. Another meta-analysis of only CBM-A studies (Beard, Sawyer, & Hofmann, 2012) corroborated a small, but significant effect of CBM-A.

CBM for Depression

The Hallion and Ruscio (2011) meta-analysis presents a somewhat sobering picture of CBM for depression, suggesting positive findings could be due to chance. However, several CBM studies have found reductions in depressive symptoms, and some of the earlier null findings used training programs that did not focus specifically on depression-linked biases or lacked some key features that we now know can enhance effects (e.g., incorporating imagery into the training). For example, when participants were instructed to imagine training scenarios, rather than thinking about only their verbal meaning, CBM with imagery was linked to better coping during a task designed to evoke negative mood (Holmes, Lang, & Shah, 2009). Moreover, imagery-based CBM-I has reduced depressive symptoms in clinically depressed samples (Lang, Blackwell, Harmer, Davison, & Holmes, 2012). Clearly, more research is needed to determine whether CBM can help treat or prevent depression, but we see these early results and other novel CBM paradigms designed to shift depression-linked biases (e.g., related to autobiographical memory; Schartau, Dalgleish, & Dunn, 2009) as promising.

CBM for Other Disorders

Given evidence that alcohol-related cognitive biases are tied to severity of addiction, craving, and relapse, alcohol dependence is a natural target for CBM. In one study (Schoenmakers, de Bruin, Lux, Goertz, Van Kerkhof, & Wiers, 2010), alcohol-dependent participants trained to disengage their attention from alcohol-related images improved faster than untrained participants. CBM for alcohol dependence has also aimed to alter patients'

tendencies to approach (vs avoid) alcohol-related images, such as by training an individual to "push away" a picture of a beer bottle using a joystick. Participants who received CBM targeting avoidance as an adjunct to traditional cognitive behavioral therapy showed greater treatment outcomes 1 year later, compared to those who received cognitive behavioral therapy only (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). These results were replicated in a later study (Eberl, Wiers, Pawelczack, Rinck, Becker, & Lindenmeyer, 2013) that also found that change in approach/avoid bias toward alcohol partly accounted for treatment outcomes 1 year later. These findings highlight the causal role of cognitive biases in psychopathology and the promise of CBM to ameliorate hazardous drinking.

The CBM research literature includes attempts to intervene in several other mental health problems and related areas, including (but not limited to) cigarette addiction (Attwood, O'Sullivan, Leonards, Mackintosh, & Munafo, 2008); eating disorders (Smith & Rieger, 2009); chronic pain (Sharpe, Ianiello, Dear, Perry, Refshauge, & Nicholas, 2012); and anxiety symptoms occurring simultaneously with schizophrenia (Steel, Wykes, Ruddle, Smith, Shah, & Holmes, 2010). Testing novel applications for CBM may hold promise for reducing symptoms of many disabling conditions, but the literature suggests it does not work well in all cases. Thus, it will be important to determine what problem areas (e.g., type of disorder) and which individuals can benefit from CBM.

CBM for Youth

Given that cognitive biases may increase vulnerability to later disorder, youth may provide a critical opportunity for prevention efforts (Lau, 2013). Several studies involving youth have reported changes in interpretation following training, an indication that youths' cognitive bias may be malleable. However, studies that show improvements in mood or functioning following interpretation change are rare, raising questions about CBM's clinical utility for youth. Notwithstanding, similar to the trend seen in adult CBM studies, effects on mood and functioning have emerged when training is followed by a stressful task. In one CBM-I study (Lau, Belli, & Chopra, 2013), teens who received positive training reported less anxiety after a challenging task (i.e., solving math problems out loud while being videotaped) than those who received negative training, highlighting positive cognitions as a possible buffer against stress.

Studies of CBM-A in children and adolescents are also mixed but include some promising results. In one study, 12 out of 16 clinically diagnosed anxious youth no longer met diagnostic criteria following attention training (Rozenman, Weersing, & Amir, 2011). However, a study that included a

larger sample of children without anxiety disorders failed to show training effects (Eldar, Ricon, & Bar-Haim, 2008). CBM-A has also been studied as an adjunctive treatment to cognitive behavioral therapy. In a recent study that paired an active and placebo CBM-A treatment with cognitive behavioral therapy, *both* the active and placebo groups achieved greater reductions in anxiety than a group receiving only cognitive behavioral therapy, as reported by their clinicians. The active CBM-A group, however, improved most according to the children themselves and their parents (Shechner *et al*., 2014). Considering that up to 50% of youth fail to make significant gains after cognitive behavioral therapy, the prospect of improving these outcomes with the addition of CBM-A is exciting.

KEY ISSUES FOR FUTURE RESEARCH

The research reviewed above provides compelling evidence that CBM has important theoretical and clinical applications. However, much of the research on CBM has occurred in the past decade. As such, the field is ripe with questions for future researchers to explore. In this section, we review several key questions for future research, including: how can we strengthen CBM's effects, who is CBM most likely to help, how does CBM work, how should we deliver CBM, and what challenges are expected for CBM research moving forward?

How Can We Strengthen CBM's Effects?

While a growing number of CBM studies have shown significant shifts in bias in expected directions, some CBM studies have found shifts in bias in unexpected directions or none at all (Fox *et al*., 2014). To increase the strength, reliability, and durability of CBM's effects on bias change, future research should investigate the type of training materials that lead to the strongest results (e.g., pictures vs words for CBM-A); the optimal number of trials in a CBM session (e.g., number of ambiguous scenarios in CBM-I); and the optimal number of CBM sessions (e.g., six vs eight sessions). Drawing from other literatures may be useful in this pursuit. For example, the cognitive science and learning literatures may inform study design decisions regarding the optimal amount of time needed between sessions to consolidate learning, and the effects of increasing the difficulty of completing CBM paradigms to maintain participants' motivation (Hertel & Mathews, 2011).

For CBM to have true clinical utility, future researchers must evaluate not only how to increase CBM's ability to shift cognitive biases, but also how to strengthen CBM's effects on reducing psychopathology (also known as

far transfer effects; see Hertel & Mathews, 2011). Several additions or modifications to existing designs may lead to stronger far transfer effects. These include conducting CBM training in situations that are closely related to the patient's psychopathology (e.g., completing CBM related to height phobia while on a balcony); individualizing training (e.g., using participant's name or picture in CBM training stimuli; e.g., Clerkin & Teachman, 2010); or reinforcing CBM when participants encounter stressors in the future (e.g., providing brief "booster" sessions in the stressful context using a portable device, such as a smartphone).

Who is CBM Most Likely to Help?

Another goal for future research is to understand which individuals are most likely to benefit from CBM. For instance, individuals with higher levels of cognitive bias may be more likely to benefit, because they presumably have more "room" to change. On the other hand, individuals with lower levels of cognitive bias may be most likely to benefit, because their biases may be more flexible and less ingrained. Also currently unknown is which types of psychopathology are most likely to be alleviated via CBM. Additional factors that may predict who is most likely to benefit from CBM include demographics (e.g., age, gender, race), symptom severity, and genetic predisposition (see Fox, Zougkou, Ridgewell, & Garner, 2011, for a study on alleles and CBM).

How Does CBM Work?

Understanding the mechanisms (i.e., how it works) underlying CBM is another interesting avenue for future research. Cognitive theory posits that CBM's effect on psychopathology is via shifting cognitive bias, and several CBM studies have found evidence that change in bias mediates (i.e., accounts for) change in psychopathology symptoms (Steinman & Teachman, 2014). However, CBM may affect psychopathology via exposing individuals to cues relevant to their disorder (e.g., showing spider phobic individuals scenarios about spiders), which is similar to more traditional types of therapy (e.g., exposure therapy for anxiety; though see Beadel, Smyth, & Teachman, 2014, for evidence against an exposure-based mechanism). Other possible mechanisms of CBM include increases in cognitive flexibility (i.e., the ability to redirect cognitive processes) and changes in explicit learning (i.e., consciously learning what to pay attention to, or how to interpret ambiguous cues). Clearly, augmenting our current understanding of the mechanisms underlying CBM is likely to strengthen its effects.

How Should We Deliver CBM?

Another important question for CBM researchers is how best to deliver CBM. Much CBM research currently takes place on computers in the laboratory, but some studies have begun testing CBM paradigms online (Salemink, Kindt, Rienties, & van den Hout, 2014) and on other portable devices, such as smart-phones and tablets (e.g., Enock, Hofmann, & McNally, 2014). However, results for these early studies delivering CBM outside the lab have been mixed. For instance, See, MacLeod, and Bridle (2009) found that web-based CBM-A significantly reduced attentional bias to negative cues and anxiety in response to a stressor, relative to a control condition. On the contrary, Salemink *et al*. (2014) found that while web-based CBM-I successfully modified interpretations to be more positive and less negative relative to a control group, both CBM-I and control conditions led to similar changes in psychopathology symptoms (i.e., anxiety, depression, and distress). These mixed results highlight the need to evaluate different delivery methods to determine which are most likely to be cost-effective and accessible, while still producing the desired effects of bias shift and symptom reduction, compared to control conditions. Further, formats that make CBM more engaging, such as those resembling video games, might enhance delivery of CBM in environments that do not have the high level of control and minimal distraction available in the laboratory (Fox *et al*., 2014).

What Challenges are Expected for CBM Research Moving Forward?

Coordinating the mix of interdisciplinary investigators that can optimize CBM's effects is an important challenge to making real progress in CBM research. Cognitive scientists can contribute knowledge regarding learning, memory, automatic processing, and optimal paradigms for measuring cognitive bias. Clinical psychologists can contribute a theoretical understanding of the role of bias in psychopathology, and what is needed to reduce the burden of psychopathology. Psychologists and public health experts who specialize in dissemination of treatments can help evaluate the best ways to deliver CBM to those who could benefit from it. As CBM paradigms become more elaborate, collaboration with computer scientists and program developers will need to increase. Further, it is likely that future researchers will want to better understand the role of genetics and neurological processes in CBM.

Another challenge is achieving the optimal scope for CBM studies. Larger sample sizes are needed to test moderators (i.e., factors that influence the effectiveness of training) and mediators (i.e., mechanisms explaining how CBM works). Additionally, studies are needed to test durability of treatment

effects and transfer of gains beyond cognitive change and immediate symptom reduction.

As the CBM field continues to expand, it will spark debate. Under what conditions should CBM provide a stand-alone treatment, versus an adjunct or preventative treatment? Does CBM rely on the same mechanisms as other established treatments? Does CBM devalue the role of clinicians? (We hope not, given the authors of this essay are also practicing evidence-based clinicians!) How much research support is needed before CBM should be included in mainstream clinical care?

CBM research has mostly occurred in the clinical and health psychology fields, but these emerging research trends and debates are likely relevant to several other fields. For example, CBM may be used to modify biases that result in prejudice against marginalized groups. CBM findings also lead to intriguing philosophical quandaries: does being told to change your thinking (e.g., forced to select a positive word or assign a positive meaning) really constitute a change in thinking, or is it simply an ephemeral effect following from experimental demands?

In sum, CBM is a field ripe for future research that integrates multiple disciplines. Current and future CBM findings have the potential to dramatically shift mental health treatment delivery systems, and to greatly advance theoretical understanding of psychopathology.

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REFERENCES

Amir, N., Beard, C., Burns, M., & Bomyea, J. (2009). Attention modification program in individuals with generalized anxiety disorder. *Journal of Abnormal Psychology*, *118*(1), 28–33. doi:10.1037/a0012589

Amir, N., Beard, C., Taylor, C. T., Klumpp, H., Elias, J., Burns, M., & Chen, X. (2009). Attention training in individuals with generalized social phobia: A randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *77*(5), 961–973. doi:10.1037/a0016685

Asnaani, A., Rinck, M., Becker, E. S., & Hofmann, S. G. (2014). The effects of approach-avoidance modification on social anxiety disorder: A pilot study. *Cognitive Therapy and Research*, *38*, 226–238. doi:10.1007/s10608-013-9580-x

Attwood, A. S., O'Sullivan, H., Leonards, U., Mackintosh, B., & Munafo, M. R. (2008). Attentional bias training and cue reactivity in cigarette smokers. *Addiction*, *103*(11), 1875–1882. doi:10.1111/j.1360-0443.2008.02335.x

Beadel, J. R., Smyth, F. L., & Teachman, B. A. (2014). Change processes during cognitive bias modification for obsessive compulsive beliefs. *Cognitive Therapy and Research*, *38*, 103–117. doi:10.1007/s10608-013-9576-6

Beard, C., Sawyer, A. T., & Hofmann, S. G. (2012). Efficacy of attention bias modification using threat and appetite stimuli: A meta-analytic review. *Behavior Therapy*, *43*(4), 724–740.

Clark, D. A., & Beck, A. T. (2010). *Cognitive therapy of anxiety disorders: Science and practice*. New York, NY: Guilford.

Clerkin, E. M., & Teachman, B. A. (2010). Training implicit social anxiety associations: An experimental intervention. *Journal of Anxiety Disorders*, *24*(3), 300–308. doi:10.1016/j.janxdis.2010.01.001

Daches, S., & Mor, N. (2014). Training ruminators to inhibit negative information: A preliminary report. *Cognitive Therapy and Research*, *38*(1), 160–171. doi:10.1007/s10608-013-9585-5

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? *Developmental Cognitive Neuroscience*, *4*, 38–51.

Eldar, S., Ricon, T., & Bar-Haim, Y. (2008). Plasticity in attention: Implications for stress response in children. *Behaviour Research and Therapy*, *46*(4), 450–461. doi:10.1016/j.brat.2008.01.012

Enock, P. M., Hofmann, S. G., & McNally, R. J. (2014). Attention bias modification training via smartphone to reduce social anxiety: A randomized, controlled multi-session experiment. *Cognitive Therapy and Research*, *38*(2), 200–216. doi:10.1007/s10608-014-9606-z

Fox, E., Mackintosh, B., & Holmes, E. A. (2014). Travellers' tales in cognitive bias modification research: A commentary on the special issue. *Cognitive Therapy and Research*, *38*(2), 239–247. doi:10.1007/s10608-014-9604-1

Fox, E., Zougkou, K., Ridgewell, A., & Garner, K. (2011). The serotonin transporter gene alters sensitivity to attention bias modification: Evidence for a plasticity gene. *Biological Psychiatry*, *70*(11), 1049–1054. doi:10.1016/j.biopsych.2011.07.004

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin*, *137*(6), 940–958. doi:10.1037/a0024355

Hertel, P. T., & Mathews, A. (2011). Cognitive bias modification: Past perspectives, current findings, and future applications. *Perspectives on Psychological Science*, *6*(6), 521–536. doi:10.1177/1745691611421205

Hirsch, C. R., Hayes, S., & Mathews, A. (2009). Looking on the bright side: Accessing benign meanings reduces worry. *Journal of Abnormal Psychology*, *118*(1), 44–54. doi:10.1037/a0013473

Hirsch, C. R., Mathews, A., & Clark, D. M. (2007). Inducing an interpretation bias changes self-imagery: A preliminary investigation. *Behaviour Research and Therapy*, *45*, 2173–2187.

Holmes, E. A., Lang, T. J., & Shah, D. M. (2009). Developing interpretation bias modification as a "cognitive vaccine" for depressed mood: Imagining positive events makes you feel better than thinking about them verbally. *Journal of Abnormal Psychology*, *118*(1), 76–88. doi:10.1037/a0012590

Joormann, J., Hertel, P. T., LeMoult, J., & Gotlib, I. H. (2009). Training forgetting of negative material in depression. *Journal of Abnormal Psychology*, *118*, 34–43.

Lang, T. J., Blackwell, S. E., Harmer, C. J., Davison, P., & Holmes, E. A. (2012). Cognitive bias modification using mental imagery for depression: Developing a novel computerized intervention to change negative thinking styles. *European Journal of Personality*, *26*(2), 145–157. doi:10.1002/per.855

Lau, J. Y. F. (2013). Cognitive bias modification of interpretations: A viable treatment for child and adolescent anxiety? *Behaviour Research and Therapy*, *51*(10), 614–622. doi:10.1016/j.brat.2013.07.001

Lau, J. Y. F., Belli, S. R., & Chopra, R. B. (2013). Cognitive bias modification training in adolescents reduces anxiety to a psychological challenge. *Clinical Child Psychology and Psychiatry*, *18*(3), 322–333. doi:10.1177/1359104512455183

MacLeod, C., & Mathews, A. (2012). Cognitive bias modification approaches to anxiety. *Annual Review of Clinical Psychology*, *8*, 189–217. doi:10.1146/annurev-clinpsy-032511-143052

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*(1), 15–20. doi:10.1037/0021-843X.95.1.15

Mathews, A., Richards, A., & Eysenck, M. (1989). Interpretation of homophones related to threat in anxiety states. *Journal of Abnormal Psychology*, *98*(1), 31–34. doi:10.1037/0021-843X.98.1.31

Rozenman, M., Weersing, V. R., & Amir, N. (2011). A case series of attention modification in clinically anxious youths. *Behaviour Research and Therapy*, *49*(5), 324–330. doi:10.1016/j.brat.2011.02.007

Salemink, E., Kindt, M., Rienties, H., & van den Hout, M. (2014). Internet-based cognitive bias modification of interpretations in patients with anxiety disorders: A randomised controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, *45*(1), 186–195. doi:10.1016/j.jbtep.2013.10.005

Schartau, P. E. S., Dalgleish, T., & Dunn, B. D. (2009). Seeing the bigger picture: Training in perspective broadening reduces self-reported affect and psychophysiological response to distressing films and autobiographical memories. *Journal of Abnormal Psychology*, *118*(1), 15–27. doi:10.1037/a0012906

Shechner, T., Rimon-Chakir, A., Britton, J. C., Lotan, D., Apter, A., Bliese, P. D., … , Bar-Haim, Y. (2014). Attention bias modification treatment augmenting effects on cognitive behavioral therapy in children with anxiety: Randomized controlled trial *Journal of the American Academy of Child & Adolescent Psychiatry*, *53*(1), 61–71. doi:10.1016/j.jaac.2013.09.016

Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology*, *118*(1), 5–14. doi:10.1037/a0013643

Schoenmakers, T. M., de Bruin, M., Lux, I. F. M., Goertz, A. G., Van Kerkhof, D. H. A. T., & Wiers, R. W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence*, *109*(1–3), 30–36. doi:10.1016/j.drugalcdep.2009.11.022

See, J., MacLeod, C., & Bridle, R. (2009). The reduction of anxiety vulnerability through the modification of attentional bias: A real-world study using a

home-based cognitive bias modification procedure. *Journal of Abnormal Psychology*, *118*(1), 65–75. doi:10.1037/a0014377

Sharpe, L., Ianiello, M., Dear, B. F., Perry, K. N., Refshauge, K., & Nicholas, M. K. (2012). Is there a potential role for attention bias modification in pain patients? Results of 2 randomised, controlled trials. *PAIN*, *153*(3), 722–731. doi:10.1016/j.pain.2011.12.014

Smith, E., & Rieger, E. (2009). The effect of attentional training on body dissatisfaction and dietary restriction. *European Eating Disorders Review*, *17*(3), 169–176. doi:10.1002/erv.921

Steel, C., Wykes, T., Ruddle, A., Smith, G., Shah, D. M., & Holmes, E. A. (2010). Can we harness computerised cognitive bias modification to treat anxiety in schizophrenia? A first step highlighting the role of mental imagery. *Psychiatry Research*, *178*(3), 451–455. doi:10.1016/j.psychres.2010.04.042

Steinman, S. A., & Teachman, B. A. (2014). Reaching new heights: Comparing interpretation bias modification to exposure therapy for extreme height fear. *Journal of Consulting and Clinical Psychology*. doi:10.1037/a0036023

Torkan, H., Blackwell, S. E., Holmes, E. A., Kalantari, M., Neshat-Doost, H. T., Maroufi, M., & Talebi, H. (2014). Positive imagery cognitive bias modification in treatment-seeking patients with major depression in Iran: A pilot study. *Cognitive Therapy and Research*, *38*(1), 132–145. doi:10.1007/s10608-014-9598-8

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science*, *22*(4), 490–497. doi:10.1177/0956797611400615

FURTHER READING

Beard, C., Sawyer, A. T., & Hofmann, S. G. (2012). Efficacy of attention bias modification using threat and appetite stimuli: A meta-analytic review. *Behavior Therapy*, *43*(4), 724–740.

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N. A., Leibenluft, E., … , Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry*, *68*, 982–990. doi:10.1016/j.biopsych.2010.07.021

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin*, *137*(6), 940–958. doi:10.1037/a0024355

Lau, J. Y. F. (2013). Cognitive bias modification of interpretations: A viable treatment for child and adolescent anxiety? *Behaviour Research and Therapy*, *51*(10), 614–622. doi:10.1016/j.brat.2013.07.001

MacLeod, C., & Mathews, A. (2012). Cognitive bias modification approaches to anxiety. *Annual Review of Clinical Psychology*, *8*, 189–217. doi:10.1146/annurev-clinpsy-032511-143052

Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology*, *118*(1), 5–14. doi:10.1037/a0013643

Steinman, S. A., & Teachman, B. A. (2014). Reaching new heights: Comparing interpretation bias modification to exposure therapy for extreme height fear. *Journal of Consulting and Clinical Psychology*. doi:10.1037/a0036023

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Shari A. Steinman is a predoctoral intern at the Institute of Living, and a doctoral candidate at the University of Virginia. She received her MA from the University of Virginia, and her BS. from Washington University in St. Louis. Shari's research interests include evaluating and modifying cognitive biases among individuals with anxiety disorders. Shari's clinical interests include using evidence-based treatments to help individuals with anxiety, OCD, and depression.

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Care (2002, Guilford Press) and *Helping Your Child Overcome an Eating Disorder: What You Can Do at Home* (2003, New Harbinger). Dr. Teachman is associate editor for the journal *Perspectives on Psychological Science*, winner of the 2012 American Psychological Association (APA) Distinguished Scientific Award for Early Career Contribution to Psychology, and is the 2014 President of the Society for a Science of Clinical Psychology.

Lab Webpage: www.teachman.org

Project Implicit Mental Health: www.ImplicitMentalHealth.com

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