THE ROLE OF ATTENTIONAL BIAS IN PRENATAL AND POSTPARTUM DEPRESSION

Helena J.V. Rutherford[1,2] and Jutta Joormann[2]

[1]Yale Child Study Center, Yale University, [2]Department of Psychology, Yale University

***Corresponding Author:** Helena J.V. Rutherford, Yale Child Study Center, Yale University, 230 South Frontage Road, New Haven, CT, 06520, USA, Phone: 203-737-3408; Fax: 203-785-7926; Email: helena.rutherford@yale.edu

ABSTRACT

While depression affects a significant number of women during pregnancy and the postpartum period, few women seek out clinical services. Prenatal depression predicts depression postpartum, and is associated with detrimental consequences for the developing child. Therefore, prenatal and postpartum depression has a two-generation impact on health and well-being. Novel approaches are needed to identify and treat women vulnerable to depression, recognizing the unique demands of motherhood that may impede access to diagnostic and treatment services. Recent research has emphasized the importance of biased attentional processing in increasing risk for depressive episodes. Importantly, this work has led to the development of cognitive training interventions that modify attention biases and improve depressive symptoms. This attention bias modification training (ABMT) approach is feasible, flexible, and effective in reducing depression symptoms. Web-based implementations of these trainings have shown great promise in depression treatment and prevention. ABMT has yet to be used during pregnancy or postpartum but may hold great promise for depression treatment and prevention while allowing for flexibility in implementation.

Keywords: attention; attention bias modification training; depression; pregnancy; postpartum

The Role of Attentional Bias in Prenatal and Postpartum Depression

Despite increasing attempts to screen depression during pregnancy and the postpartum period, incidence rates remain high. In the United States, approximately 12% of women report depression symptoms during their pregnancy[1, 2]. Incidents of prenatal depression are higher than rates of postpartum depression, with depression during the first year postpartum likely reflecting the progression of depression during pregnancy [3]. Even when engaged with clinic staff, a significant number of women with depression remain undiagnosed [4], and even when depression symptoms are characterized, few women seek out clinical services [5]. As well as impacting mothers, depression during pregnancy is associated with a host of negative outcomes for the developing child, including preterm delivery [6], miscarriage and low birth weight [7], and cognitive, affective, and behavioral disruptions across development [8-10].

Depression clearly impacts two generations and necessitates access to clinical services for pregnant and postpartum women. However, the uncertainty surrounding the use of antidepressants during pregnancy and their impact on the developing child precludes many women from seeking medication [11]. Further, while cognitive behavioral therapy (CBT) has been shown to be effective in the treatment of depression [12, 13], the demands of pregnancy and caring for a newborn postpartum may also prevent women from seeking regular treatment at outpatient clinics. Therefore, novel approaches are needed to identify and treat women vulnerable to depression, recognizing the unique demands of pregnancy and motherhood that may otherwise impede access to diagnostic and treatment services. The focus of this review is to consider the suitability of attention bias modification training (ABMT) as a therapeutic tool for women with depression during pregnancy and the postpartum period. As will be discussed, existing empirical research has documented that biased attentional processing of negative stimuli increases the risk for depressive episodes in non-parents, which has led to the development of cognitive training interventions that modify attention biases and improve depressive symptoms. The advancement of this work is to address the associations between attentional processing of infant cues and depression symptoms, which may link maternal depression to poorer child outcomes postpartum. ABMT can be implemented remotely through web-based and smartphone applications, therefore allowing for the first-time an easily accessible treatment and prevention approach for prenatal and postpartum women that could be completed at home without the burden of engaging in outpatient clinical services.

Attention and the Transition to Motherhood

The transition to motherhood is accompanied by significant psychological and neurophysiological re-organization thought to facilitate the onset of caregiving [14]. Many women report compromised cognitive functions, including with attentional processes, during pregnancy and the postpartum period. Despite these self-reported deficits, objective measures of cognitive functioning have not yielded reliable and replicable differences between pregnant, postpartum, and control participants [15-17]. However, it is worth noting that women experiencing complicated and high-risk pregnancies may have more compromised attentional processes than women experiencing a low-risk pregnancy [18]. Importantly, the complexity of pregnancy may represent a proxy for other risk factors, and further research is needed.

These past investigations of attentional and cognitive functions during pregnancy and the postpartum period have typically incorporated standard neuropsychological assessments, failing to take into consideration the increasing salience of caregiving cues and their potential importance to adaptive functioning in the transition to motherhood. During pregnancy and the postpartum period, mothers (and fathers) become increasingly preoccupied with their developing child [19, 20], which is thought to promote sensitivity at behavioral and brain levels during caregiving interactions [21]. Therefore, investigation of changes in attentional processes during pregnancy and the postpartum period, specifically within the context of cues of motherhood, may provide a greater mechanistic understanding of compromised caregiving postpartum and novel directions for intervention approaches [22].

As will be reviewed here, studies have begun to examine whether infant emotional faces represent a motivationally-relevant category of visual stimuli that modulate attentional processes. Lorenz [23] hypothesized that the physical characteristics of infant faces may attract caregivers, promoting nurturing care. Activation in the nucleus accumbens, a brain region important to reward processing and approach motivation, increases with parametric enhancement of these infant face characteristics in non-parents [24]. While viewing infant faces, increased activity is observed in numerous brain regions implicated in appetitive motivation in parents [25]. Therefore, infant faces may be sufficiently salient to attract and hold attention both in parents and non-parents. However, when experimental tasks are specifically employed to manipulate attentional processes (versus passive viewing of infant stimuli), mothers evidence greater attentional capture by infant faces than non-mothers, with no between-group differences observed when employing adult faces [26, 27]. This apparent motivated attention towards infant cues may be mediated by reward neural circuitry and the oxytocinergic system – both systems that are honed by the transition to parenthood rendering infant cues especially salient in mothers [28].

Attentional Bias and Depression

Attentional bias encompasses the rapid allocation and delayed disengagement of attention to salient visual stimuli. A breadth of research has evidenced attentional bias toward motivationally- and emotionally-relevant stimuli, including emotional faces as well as phylogenetic threats such as snakes and spiders [29, 30]. Attentional bias has adaptive value in prioritizing the processing of affective and other salient, i.e. threat-relevant stimuli, thereby facilitating detection of danger in the environment and helping the organism to respond effectively. Attentional biases in the processing of threat-related or depression-relevant material, however, have also been assigned a prominent role in the etiology and maintenance of depression and anxiety disorders [31-35]. Several authors have suggested that the attentional system in depression and anxiety is distinctly sensitive to, and biased in favor of, disorder-relevant stimuli in the environment. Reviews of the empirical literature further suggests that whereas anxiety disorders are associated with an early detection of and orientation towards threat-related material [36], depression is mostly associated with difficulties disengaging attention from negative stimuli [30, 37]. Critically, studies not only show an association of attention biases with current anxiety and depressive disorders but also show evidence of biased processing in high-risk samples [38]. In a recent longitudinal study Disner et al. [35] reported that attentional biases in depression predicted symptom worsening over time. These findings suggest that attentional biases are not just a symptom of depression but may indeed play a causal role in increasing risk for the

first onset of depressive disorders and may maintain depressive episodes over time. Examining attention biases during pregnancy and the postpartum period may help identify an important risk factor for the onset and maintenance of depression and anxiety during these important periods of life. Attentional processing of infant cues may therefore provide a particularly critical area of inquiry given that it may also clarify the link between maternal depression, caregiving responses, and poorer child outcomes.

Attentional Bias, Depression, and Pregnancy

Only a handful of behavioral studies have begun to examine attentional bias towards infant affective cues during pregnancy and the postpartum period. Importantly, many studies have examined variation in attentional biases amongst different infant facial expressions; specifically comparing reaction times in tasks containing distress, happy, and neutral infant faces. Given that infants expressing distress provide the most salient signal that caregiving is needed, these studies hypothesize a greater attentional bias towards infant distress as compared to infant non-distress faces. Consistent with this hypothesis, Pearson and colleagues [39] evidenced that women in their third trimester of pregnancy were slower to disengage their attention to distress infant faces as compared to non-distress (i.e., happy or neutral) infant faces. Moreover, greater attentional bias toward infant distress measured in pregnancy was associated with higher levels of self-reported bonding postpartum. Attentional biases toward infant distress has also been reported earlier in pregnancy: Non-depressed women in their first trimester of pregnancy also evidence an attentional bias to infant distress as compared to non-distress faces [40]. In the context of pregnancy and postpartum, attentional bias towards infant distress seems adaptive and may be central to the formation of mother-child relationship [39].

Depression symptoms may modulate attentional processing of infant affective cues. For instance, the attentional bias toward infant distress faces observed in non-depressed pregnant women early in their pregnancy was not observed in depressed women [40]. Another approach that has examined the potential impact of depression on attentional processing of infant faces has examined the P300 event-related potential (ERP) component elicited by infant faces [41]. More salient stimuli, including infant faces, are associated with a greater P300 responses, which is thought to reflect heightened allocation of attention to salient visual stimuli [42, 43]. A study of women in their third trimester of pregnancy evidenced that higher levels of self-reported depression symptoms were associated with a decreased P300 response to infant distress faces – with only weak associations reported between depression symptoms and the P300 elicited by neutral or happy infant faces [44]. These initial behavioral and ERP results suggest that depression may blunt reactivity to infant distress cues during pregnancy – perhaps by decreasing their salience and engagement of attentional resources.

Although initial research suggests that attentional bias to infant distress faces may be compromised by depression, this association is not consistently reported. In an independent sample of women assessed during their third trimester of pregnancy, Rutherford et al. [45] did not observe the same association between the P300 elicited by distress infant faces and self-reported levels of depression that had previously been found [44]. Furthermore, only a weak association was reported between a behavioral measure of attentional bias to infant distress faces and depression symptoms in a sample of recent, primiparous, women [27]. However, given few studies of attentional

processes during pregnancy, the significant variations in paradigms, and variation in levels of depression symptoms (from subclinical to clinical levels), further work is needed with well-replicated paradigms that have yielded reliable associations between attentional biases to negative affect and depression symptoms in non-parent samples.

Attention bias modification training (ABMT) and depression

Given the centrality of attention biases to the etiology of depression and anxiety disorders, and the importance of the attentional processing of infant cues for detrimental effects of maternal depression on offspring, targeting attention biases seems a critical goal for interventions. Initial research suggests that attentional processing of infant stimuli develop during pregnancy [40, 46], and given the association between prenatal attentional bias to infant cues and later postpartum bonding, attentional processes may be a critical aspect of maternal sensitivity [39]. It therefore seems important to establish whether attentional processing of these cues during pregnancy can be improved. In one of the first studies to examine this question, Pearson and colleagues [47] demonstrated that between 9 and 12 sessions of a CBT program during pregnancy improved attentional biases towards infant distress faces in depressed women as compared to depressed women in treatment as usual. After treatment, the depressed mothers in CBT, and a comparison group of non-depressed mothers, evidenced comparable levels of attentional biases towards infant distress faces. Although valuable in demonstrating that therapeutic approaches targeting depression can change attentional biases toward infant cues, CBT is limited by the need for regular visits with a mental health professional that may pose an important barrier to treatment for women taking care of a newborn.

Recent studies on attention biases in depression and anxiety disorder, however, suggest a more time- and cost-effective way of changing attentional processing through attention bias modification training (ABMT). ABMT was first used in anxiety disorders and consists of a computer-based attention training protocol designed to implicitly affect biased attentional patterns. In recent years, an extensive body of research on attentional bias modification has accumulated (for recent reviews see [48] or [49]). A common feature of all ABMT procedures is that they manipulate attention allocation towards or away from salient stimuli when they compete for attention with neutral stimuli [50]. Thus, ABMT procedures can be used to decrease an existing bias that favors the processing of disorder-related over neutral material but it can also be used to increase attentional processing of salient material such as infant distress cues. In a recent study, ABMT was used, for example, to train attention towards healthy food pictures and the training affected subsequent eating behavior [51]. Likewise, Field and Eastwood [52] showed that training attention towards alcohol-related cues increased the amount of alcohol consumed in heavy social drinkers. In a study examining pediatric anxiety disorder, Waters and colleagues [53] increased attention towards happy faces in children with anxiety disorders and found significant reduction of anxiety symptoms in the training group. In the context of depression, studies have shown that training attention towards positive stimuli improves mood and decreases depressive symptoms [54, 55], further evidencing the broad reach and clinical utility of ABMT to shaping attentional biases.

Most ABMT research has employed the dot probe task [50]. In this task, two stimuli are simultaneously presented on both sides of a computer monitor screen. The valence of the stimuli is manipulated. Next, a neutral probe appears at the location previously occupied by one of the two stimuli. Participants are asked to indicate as

quickly and as accurately as possible whether the probe was on the left or right of the screen. To train attention towards salient stimuli (such as positive pictures or infant cues), the target consistently replaces the salient stimulus during the training phase. Although other studies have used spatial cueing tasks or visual search tasks for the training [56, 57], the mechanism of the training is identical. Studies suggest that ABMT has considerable clinical potential in that training efficiently leads to clinical improvement with little time investment and at minimal cost [58]. Meta-analyses provide evidence of the effectiveness of the training (e.g., [49]) and ABM can be easily disseminated. Indeed, web applications have been used increasingly with great initial support for the effectiveness of this approach ([55]).

The use of ABMT has also been tested in depression. For example, Wells and Beevers [59] found that four sessions of ABMT led to reduced attention to negative stimuli in depressed college students. Similarly, Yang et al., [60] found that attentional biases towards negative stimuli decreased after eight sessions of ABMT. In a recent study, LeMoult et al. [54] found that attentional biased could be modified in a high-risk sample. Likewise, Yang et al. [60] reported improvement in depressive and anxiety symptoms in depressed adolescents undergoing ABMT. Interestingly, Vazquez, Blanco [61] developed a task based on eye-tracking assessment of attention biases and found that depressed participants could be trained to disengage their attention from negative material (see also [55]). Browning, Holmes [62] not only showed that they could reduce attentional biases in depression but also that their training was associated with a decrease in recurrence risk. Importantly, a recent study shows that ABMT treatments for depression can be successfully delivered via the internet [63]. An internet-based ABMT training that can be completed at home in a flexible manner could provide a great treatment option for mothers with infants who may be reluctant to set up weekly appointments to see a therapist or to take antidepressant medication during pregnancy or the postpartum period if they are nursing. ABMT may also present an important adjunct to usual care speeding up recovery and bringing more patients into remission [55]. Importantly, given the flexibility of the ABMT approach, ABMT could be used to train attention towards increased processing of infant distress cues to target reduced maternal sensitivity and improve parenting behavior in depressed women. At the same time, ABMT could target improved disengagement from negative non-infant stimuli and foster engagement with positive (infant and non-infant) stimuli to decrease overall depressive symptoms.

SUMMARY AND CONCLUSION

The studies reviewed suggest that during pregnancy and the postpartum period, women evidence a reliable attentional bias toward infant distress cues. Concurrently, research suggests that prenatal and postpartum depression symptoms may attenuate this attentional bias toward infant distress – although more research is needed to understand the context under which this association is routinely reported. Nevertheless, given that attentional bias to infant distress may predict postpartum bonding, research and intervention approaches should be geared toward studying attentional processes in prenatal and postpartum maternal samples. Noting that many women do not engage in services during pregnancy and the postpartum period, intervention approaches that are accessible and modify attention biases and improve depressive symptoms are needed. ABMT can be easily administered through web-based platforms which do not require attendance in research or clinical settings. At-home interventions may be

especially beneficial for recent mothers given the demands associated with early caregiving and the difficulties engaging in outpatient services during the initial months postpartum.

REFERENCES

1. Le Strat, Y., C. Dubertret, and B. Le Foll, Prevalence and correlates of major depressive episode in pregnant and postpartum women in the United States. J Affect Disord, 2011. 135(1): p. 128-138.

2. Viguera, A.C., et al., Episodes of mood disorders in 2,252 pregnancies and postpartum periods. Am J Psychiatry, 2011. 168(11): p. 1179-1185.

3. Underwood, L., et al., A review of longitudinal studies on antenatal and postnatal depression. Arch Womens Ment Health, 2016. 19(5): p. 711-720.

4. Smith, M.V., et al., Screening for and detection of depression, panic disorder, and PTSD in public-sector obstetric clinics. Psychiatr Serv, 2004. 55(4): p. 407-414.

5. Marcus, S.M., et al., Depressive symptoms among pregnant women screened in obstetrics settings. J Womens Health, 2003. 12(4): p. 373-380.

6. Grigoriadis, S., et al., The impact of maternal depression during pregnancy on perinatal outcomes: a systematic review and meta-analysis. J Clin Psychiatry, 2013. 74(4): p. e321-41.

7. Bonari, L., et al., Perinatal risks of untreated depression during pregnancy. Can J Psychiatry, 2004. 49(11): p. 726-735.

8. Zuckerman, B., et al., Maternal depressive symptoms during pregnancy, and newborn irritability. J Dev Behav Pediatr, 1990. 11(4): p. 190-194.

9. Lundy, B.L., et al., Prenatal depression effects on neonates. Infant Behavior and Development, 1999. 22(1): p. 119-129.

10. Deave, T., et al., The impact of maternal depression in pregnancy on early child development. BJOG, 2008. 115(8): p. 1043-1051.

11. Chaudron, L.H., Complex challenges in treating depression during pregnancy. Am J Psychiatry, 2013. 170(1): p. 12-20.

12. Cuijpers, P., et al., A meta-analysis of cognitive-behavioural therapy for adult depression, alone and in comparison with other treatments. Can J Psychiatry, 2013. 58(7): p. 376-385.

13. Hollon, S.D., et al., Prevention of relapse following cognitive therapy vs medications in moderate to severe depression. Arch Gen psychiatry, 2005. 62(4): p. 417-422.

14. Mayes, L., et al., The Neural and Psychological Dynamics of Adults' Transition to Parenthood. Zero Three, 2012. 33(2): p. 83-84.

15. Logan, D.M., et al., How do memory and attention change with pregnancy and childbirth? A controlled longitudinal examination of neuropsychological functioning in pregnant and postpartum women. J Clin Exp Neuropsychol, 2014. 36(5): p. 528-539.

16. Crawley, R., S. Grant, and K. Hinshaw, Cognitive changes in pregnancy: Mild decline or societal stereotype? Applied cognitive psychology, 2008. 22(8): p. 1142-1162.

17. Christensen, H., L.S. Leach, and A. Mackinnon, Cognition in pregnancy and motherhood: prospective cohort study. Br J Psychiatry, 2010. 196(2): p. 126-132.

18. Stark, M.A., Directed Attention in Normal and High-Risk Pregnancy. J Obstet Gynecol Neonatal Nurs, 2006. 35(2): p. 241-249.

19. Kim, P., et al., Early postpartum parental preoccupation and positive parenting thoughts: Relationship with parent–infant interaction. Infant Ment Health J, 2013. 34(2): p. 104-116.

20. Winnicott, D.W., Primary maternal preoccupation. Through paediatrics to psycho-analysis. 1956 [1975], New York: Brunner/Mazel.

21. Rutherford, H. and L.C. Mayes, Primary maternal preoccupation: Using neuroimaging techniques to explore the parental brain. Psyche, 2011(65): p. 973-988.

22. Gollan, J.K., et al., Changes in attentional processing and affective reactivity in pregnancy and postpartum. Neuroscience & Neuroeconomicss, 2014(3) p.99-109.

23. Lorenz, K., Die angeborenen Formen mo̎glicher Erfahrung [The innate forms of potential experience]. Zeitschrift fur Tierpsychologie, 1943. 5: p. 233-519.

24. Glocker, M., et al., Baby schema modulates the brain reward system in nulliparous women. Proc Natl Acad Sci U S A, 2009. 106(22): p. 9115-9119.

25. Swain, J.E., The human parental brain: In vivo neuroimaging. Progress in Neuro-Psychopharmacology and Biological Psychiatry, 2011. 35(5): p. 1242-1254.

26. Thompson-Booth, C., et al., I Can't Take My Eyes Off of You: Attentional Allocation to Infant, Child, Adolescent and Adult Faces in Mothers and Non-Mothers. PLoS ONE, 2014. 9(10): p. e109362.

27. Thompson-Booth, C., et al., Here's looking at you, kid: attention to infant emotional faces in mothers and non-mothers. Dev Sci, 2014. 17(1): p. 35-46.

28. Ferrey, A.E., et al., Motivated Attention and Reward in Parenting. Parenting, 2016. 16(4): p. 284-301.

29. Bar-Haim, Y., et al., Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. Psychol Bull, 2007. 133 (1): p. 1-24.

30. Armstrong, T. and B.O. Olatunji, Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. Clin Psychol Rev, 2012. 32(8): p. 704-723.

31. Mathews, A. and C. MacLeod, Induced processing biases have causal effects on anxiety. Cognition & Emotion, 2002. 16(3): p. 331-354.

32. Beck, A.T., Cognitive therapy and the emotional disorders. 1976: Penguin.

33. Gotlib, I.H. and J. Joormann, Cognition and depression: current status and future directions. Annu Rev clin psychol, 2010. 6: p. 285-312.

34. Peckham, A.D., R.K. McHugh, and M.W. Otto, A meta-analysis of the magnitude of biased attention in depression. Depress anxiety, 2010. 27(12): p. 1135-1142.

35. Disner, S.G., J.D. Shumake, and C.G. Beevers, Self-referential schemas and attentional bias predict severity and naturalistic course of depression symptoms. Cogn Emot, 2017. 31(4): p. 632-644.

36. Mogg, K. and B.P. Bradley, Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. Cognition and Emotion, 1999. 13(6): p. 713-740.

37. Joormann, J. and W.M. Vanderlind, Emotion regulation in depression: The role of biased cognition and reduced cognitive control. Clinical Psychological Science, 2014. 2(4): p. 402-421.

38. Joormann, J., L. Talbot, and I.H. Gotlib, Biased processing of emotional information in girls at risk for depression. J Abnorm psychol, 2007. 116(1): p. 135.

39. Pearson, R., S. Lightman, and J. Evans, Attentional processing of infant emotion during late pregnancy and mother–infant relations after birth. Arch Women's Ment Health, 2011. 14(1): p. 23-31.

40. Pearson, R., et al., Depressive symptoms in early pregnancy disrupt attentional processing of infant emotion. Psychol Med, 2010. 40(4): p. 621-31.

41. Maupin, A., et al., The application of electroencephalography to investigate the neural basis of parenting. Parent Sci Pract, 2015. 15(1): p. 9-23.

42. Bick, J., et al., Foster mother–infant bonding: Associations between foster mothers' oxytocin production, electrophysiological brain activity, feelings of commitment, and caregiving quality. Child Dev, 2013. 84(3): p. 826-840.

43. Grasso, D.J., et al., ERP correlates of attention allocation in mothers processing faces of their children. Biol Psychol, 2009. 81(2): p. 95-102.

44. Rutherford, H., K.M. Graber, and L.C. Mayes, Depression symptomatology and the neural correlates of infant face and cry perception during pregnancy. Soc Neurosci, 2016. 11(4): p. 467-474.

45. Rutherford HJV, et al., Anxiety and neural responses to infant and adult faces during pregnancy. Biol Psychol, 2017. 125: p. 115-120.

46. Numan, M., Motivational systems and the neural circuitry of maternal behavior in the rat. Dev Psychobiol, 2007. 49(1): p. 12-21.

47. Pearson, R., et al., The normalisation of disrupted attentional processing of infant distress in depressed pregnant women following Cognitive Behavioural Therapy. J Affect Disord, 2013. 145(2): p. 208-213.

48. Mogoaşe, C., D. David, and E.H. Koster, Clinical efficacy of attentional bias modification procedures: An updated meta-analysis. J Clin Psychol, 2014. 70(12): p. 1133-1157.

49. Linetzky, M., et al., Quantitative evaluation of the clinical efficacy of attention bias modification treatment for anxiety disorders. Depress Anxiety, 2015. 32(6): p. 383-391.

50. MacLeod, C., et al., Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. J Abnorm psychol, 2002. 111(1): p. 107-123.

51. Kakoschke, N., E. Kemps, and M. Tiggemann, Attentional bias modification encourages healthy eating. Eat Behav, 2014. 15(1): p. 120-124.

52. Field, M. and B. Eastwood, Experimental manipulation of attentional bias increases the motivation to drink alcohol. Psychopharmacology, 2005. 183(3): p. 350-357.

53. Waters, A., et al., Attention training towards positive stimuli in clinically anxious children. Dev Cogn Neurosci, 2013. 4: p. 77-84.

54. LeMoult, J., et al., Attentional bias training in girls at risk for depression. J Child Psychol Psychiatry, 2016. 57(11): p. 1326-1333.

55. Ferrari, G.R., et al., Investigating the (cost-) effectiveness of attention bias modification (ABM) for outpatients with major depressive disorder (MDD): a randomized controlled trial protocol. BMC psychiatry, 2016. 16(1): p. 370.

56. Waters, A., et al., A preliminary evaluation of a home-based, computer-delivered attention training treatment for anxious children living in regional communities. Journal of Experimental Psychopathology, 2016. 7(3): p. 511-527.

57. Bar-Haim, Y., I. Morag, and S. Glickman, Training anxious children to disengage attention from threat: a randomized controlled trial. J Child Psychol Psychiatry, 2011. 52(8): p. 861-869.

58. Amir, N., et al., Attention modification program in individuals with generalized anxiety disorder. J abnorm psychol, 2009. 118(1): p. 28-33.

59. Wells, T.T. and C.G. Beevers, Biased attention and dysphoria: Manipulating selective attention reduces subsequent depressive symptoms. Cognition & Emotion, 2010. 24(4): p. 719-728.

60. Yang, W., et al., Attention bias modification treatment for adolescents with major depression: a randomized controlled trial. J Am Acad Child Adolesc Psychiatry, 2016. 55(3): p. 208-218. e2.

61. Vazquez, C., et al., Attentional bias modification in depression through gaze contingencies and regulatory control using a new eye-tracking intervention paradigm: study protocol for a placebo-controlled trial. BMC psychiatry, 2016. 16(1): p. 439.

62. Browning, M., et al., Using attentional bias modification as a cognitive vaccine against depression. Biol psychiatry, 2012. 72(7): p. 572-579.

63. Arnberg, F.K., et al., Internet-delivered psychological treatments for mood and anxiety disorders: a systematic review of their efficacy, safety, and cost-effectiveness. PLoS One, 2014. 9(5): p. e98118.