

Note: These proofs may contain color figures. Those figures may print black and white in the final printed book if a color print product has not been planned. The color figures will appear in color in all electronic versions of this book.

AUTHOR QUERY FORM

 ELSEVIER	Book: Reilly-1631088 Chapter: CH015	Please e-mail your responses and any corrections to: E-mail: omer.m@elsevier.com
---	--	--

Dear Author,

Any queries or remarks that have arisen during the processing of your manuscript are listed below and are highlighted by flags in the proof. (AU indicates author queries; ED indicates editor queries; and TS/TY indicates typesetter queries.) Please check your proof carefully and answer all AU queries. Mark all corrections and query answers at the appropriate place in the proof using on-screen annotation in the PDF file. For a written tutorial on how to annotate PDFs, click https://www.elsevier.com/_data/assets/pdf_file/0004/475249/Annotating-PDFs-Adobe-Reader-9-X-or-XI.pdf. A video tutorial is also available at <http://www.screencast.com/t/9OIDFhigE9a>. Alternatively, you may compile them in a separate list and tick off below to indicate that you have answered the query.

Please return your input as instructed by the project manager.

Missing references: References listed below were noted in the text but are missing from the reference list. Please make the reference list complete or remove the references from the text.	
Location in Article	Query / remark

No Query

The origins of disordered eating and childhood food neophobia: Applying an anxiety perspective

15

c0015

Frances A. Maratos and Emma E. Sharpe

Department of Psychology, College of Life and Natural Sciences, University of Derby

s0010 15.1 Introduction

p0010 Anxiety is a complex state of psychological distress that manifests as a result of cognitive, affective, physiological, and behavioral responses to threatening thoughts, situations, or objects (Barlow, 2004). Those diagnosed with anxiety disorders are subject to excessively intense, frequent, and enduring concern, worry, and/or fear that something terrible might happen. This can be “free-floating”, such as in the case of generalized anxiety disorder, or initiated in response to a specific stressor, such as in the case of phobia. A commonly accepted premise is that such marked threat responses have developed as a consequence of our evolution, given that fear, and its associated physiological trademarks (e.g., raised blood pressure, heart rate, and noradrenalin release), is adaptive in situations where rapid responding is necessary (e.g., Lang et al., 2000). For example, the rapid processing of a predator—be it a wolf, snake, bear, or nonaffiliated human—and consequent selection of an appropriate response (be it fight, flight, or freeze) facilitates survival and gene pool continuation. Thus, rapid cognitive processing and behavioral responding to particular *visual* situations and/or objects can be adaptive, as they aid coordination of responses to immediate well-being threats. However, for those diagnosed with anxiety disorders, such responses are observed even in the absence of threat. That is, a plethora of research now demonstrates that anxious individuals display hypersensitivity in recognizing, processing, and responding to specific visual cues, be they representative of threat or otherwise (see Barry et al., 2015, for a review).

p0015 Importantly, while a number of ubiquitous factors can give rise to fear and anxiety disorders, a common tenant is that processes of visual attention influence potential vulnerability to, and the maintenance of, such disorders. Here parallels can be drawn with food neophobia, as a common tenet of childhood food neophobia is that it too is a predominant of the visual domain (e.g., Brown and Harris, 2012; Cashdan, 1998; Dovey et al., 2008). Thus for a comprehensive understanding of food neophobia (and disordered eating more generally), the application of knowledge from the study of anxiety disorders may prove extremely useful. This includes the disentanglement of various components of visual attention and how processes associated with these components differ in individuals as a function of anxiety. Considering this, in this chapter, we first provide an overview of processes/

components of visual attention in light of what has been garnered in respect to anxiety, followed by an exploration of how such theory is relevant within the context of adult and child (disordered) eating. Finally, we will briefly review whether emerging treatments for anxiety disorders, which focus on the retraining of visual attention, might also be applicable in the treatment of disordered eating and childhood food neophobia.

s0015 **15.2 Main components of visual attentional bias**

p0020 The idea that visual processing may be comprised of distinct stages was first suggested by [Posner and Peterson \(1990\)](#) who identified two separable, but interrelated, networks within the brain concerned with orienting, detecting, and alerting. Since this early research, and not dissimilar to Posner and Peterson, a growing body of literature has revealed that visual attentional biases involve processes of “shift, engage, and disengage”. That is, to attend to something, we first need to “shift” our visual attention to that object/location (be this covertly or via overt eye movement) in order to then be able to process or “engage” with the located stimuli, after which we need to be able to orient our attention elsewhere, or rather “disengage”, from the current visual stimuli. However, in the case of those with anxiety vulnerability, individuals often show differences in how quickly or easily these processes of engagement and disengagement are manifest as well as, on occasion, “avoidance” of certain stimuli, as overviewed below.

s0020 **15.2.1 Anxiety and facilitated engagement**

p0025 It is now well accepted that the capacity of visual attention is limited. In other words, we cannot pay attention to everything in our visual environment simultaneously. Typically attention operates as a “zoom lens”, with limited visual information processed at any one time. The question is, however, what processes dictate what is and what is not more readily captured for further visual processing?

p0030 The most common answer to this question is threat. Several models of attentional processing propose that preattentive ([Öhman, 1996](#); [Mogg and Bradley, 1998](#); [Bar-Haim et al. 2007](#)) and/or automatic ([Ledoux, 1998](#); [Beck and Clark, 1997](#), [Williams et al., 1998](#)) brain processes have evolved to enable rapid and facilitated engagement of stimuli that may pose a threat to our survival. Thus, phylogenetic threats are subject to facilitated engagement, with much behavioral research demonstrating quicker orientation and detection (i.e., facilitated engagement) of such threats as compared to non-threatening stimuli (see [Yiend, 2010](#), for review). This is supported by neuroimaging studies, demonstrating rapid activation of brain regions associated with processes of facilitated orientation/engagement when threat stimuli are viewed (e.g., [Luo et al., 2007](#); [Maratos et al. 2009](#); [2012](#)).

p0035 In the case of those with vulnerability to anxiety, however, a number of prominent models highlight that such threat detection processes are activated *too rapidly*

or *too easily* in those with higher trait anxiety (e.g., Beck and Clark, 1997, Mogg and Bradley, 1998). To expand, for those with vulnerability towards anxiety, stimuli that are ambiguous or mildly threatening also receive facilitated engagement. This can be thought of in terms of “thresholds”. High anxious individuals have a lowered threshold in terms of what stimuli in the environment will capture their attention (see Fig. 15.1, Box A). In accord with this, several studies have now demonstrated that high anxious individuals, as compared to low anxious individuals, respond more quickly to information appearing in the location of mildly threatening stimuli (e.g., Koster et al., 2005; Richards et al., 2014). Moreover, Kelly et al. (2016) have demonstrated that high anxious children display facilitated engagement of ambiguous (i.e., neutral) faces as compared to low anxious children. Additionally,

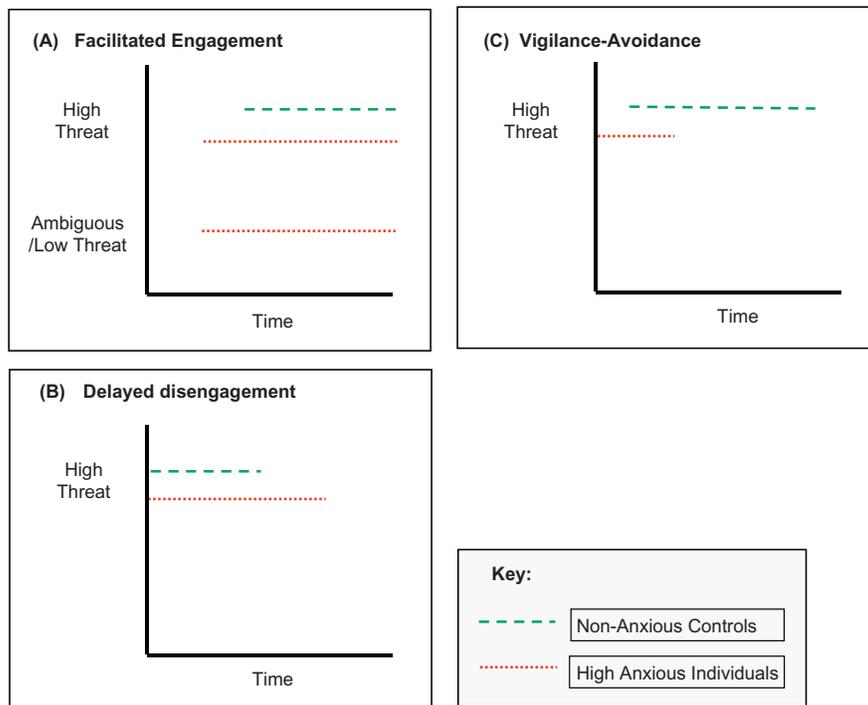


Figure 15.1 (A) The threshold for threat detection is lower for anxious individuals as compared to non-anxious controls, thus anxious individuals typically demonstrate more rapid orienting toward threatening stimuli (top lines) as well as facilitated engagement of mildly threatening or ambiguous stimuli (bottom line). (B) For anxious individuals, elaborate effortful processing and/or inhibition of motor responses can lead to the observation of delayed disengagement, as compared to healthy controls, when viewing high threat stimuli. (C) Anxious individuals, as compared to controls, often also show a pattern of vigilance-avoidance of relevant salient/threatening stimuli, i.e., rapid facilitated engagement of salient stimuli followed by rapid attentional shifts away (i.e., avoidance) from such stimuli.

neuroimaging studies reveal heightened brain activity in regions associated with processes of facilitated orientation/engagement when anxious individuals view feared or mildly threatening stimuli, as compared with non-anxious individuals (e.g., [Straube et al., 2009](#); [Heitmann et al., 2017](#)).

p0040 To briefly sum, whereas it is widely accepted that evolution of the human brain has enabled all individuals to rapidly orient to salient stimuli (and especially that which is threatening) in order to enable efficient processing of potentially survival-related stimuli, it is recognized that for anxious individuals, such brain processes are activated too easily. That is, the threshold for such threat detection is lowered and hence anxious individuals demonstrate more rapid orienting towards, and consequently facilitated processing of, threatening as well as mildly threatening or ambiguous stimuli, as compared to non-anxious individuals.

s0025 **15.2.2 Anxiety and delayed disengagement**

p0045 A second aspect of visual attention is the ability to rapidly switch attention from one location (in space or time) to another. To expand, to enable efficient processing of an environment, an individual also needs to be able to reallocate attention away from a stimulus that has captured attention. This process is known as disengagement, with “dwell” time a measure of how long it takes an individual to orientate attention away from a stimulus that has captured attention (i.e., reorientate/shift attention).

p0050 In relation to disengagement and dwell time, much research demonstrates that for all individuals, threatening stimuli are associated with increased attentional processing. This often leads to increased dwell time and hence slowed disengagement (see [Fox et al., 2002](#); [Most et al., 2005](#); but cf. [Maratos, 2011](#)). Thus, emotional stimuli, especially threat-related stimuli, are associated with increased processing (i.e., delayed disengagement), as well as prioritized attentional capture (i.e., facilitated engagement). However, in the case of those with vulnerability to anxiety, it is argued that once a stimulus has captured attention, elaborate, effortful processing can lead to prolonged engagement (see [Fig. 15.1, Box B](#)) and/or “threat slowing”. Threat slowing is the inhibition of motor responses as a consequence of freezing and/or motoric processing costs associated with cognitive prioritization of the threat stimuli ([Mogg et al., 2008](#)). In accordance with the former, research has consistently demonstrated that anxious individuals show increased dwell time, or a deficit in disengaging attention away from, threatening stimuli as compared to non-anxious individuals. For example, as compared to controls, anxious individuals are slower to find a neutral stimulus when threatening stimuli are presented (e.g., [Gerdes et al., 2008](#)), take longer to reorientate attention away from the location of a (previously shown) threatening face (e.g., [Cisler and Olatnuji, 2010](#)), and demonstrate persistent engagement with a threatening stimulus at the expense of processing further potentially relevant task information (e.g., [Buckner et al., 2010](#)).

p0055 Thus, whereas all individuals typically show greater or more in-depth processing of threat stimuli as compared to non-threat stimuli, in anxious individuals these processes cause processing deficits and/or motor inhibition. This consequently leads to observations of greater increases in dwell time/processes of disengagement.

s0030 **15.2.3 Anxiety and attentional avoidance**

p0060 A third process of visual attention often associated with anxiety is attentional avoidance. Here, individuals avoid elaborate processing of the threat-related or feared stimuli, which enables them to avoid direct overt visual processing of such stimuli. Thus, anxious individuals strategically/covertly avoid allocating attention to particular stimuli they perceive as potentially negative or threatening (see Fig. 15.1, Box C).

p0065 Of importance, avoidance of threat-related stimuli has been suggested to be a key factor in the maintenance of anxiety disorders, as the reduced processing of the feared stimuli leads to limited habituation towards the said stimuli (e.g., Mogg et al., 2004). For example, in social anxiety, avoidance of social cues (e.g., faces) will lead to limited processing of the actual expression and potentially incorrect interpretation of the emotion conveyed, exacerbating the anxiety. However, support for attentional avoidance (also encompassed within the “vigilance-avoidance” hypothesis; see for example, Derakshan, et al., 2007) is mixed. That is, whereas a number of studies demonstrate anxious individuals avoid processing, or overt eye movements towards threat-related stimuli at long stimulus presentations following brief initial early orienting (e.g., Armstrong and Olatunji, 2012), this research is not equivocal. For example, Amir et al. (2003) have demonstrated prolonged interaction with threat-related stimuli rather than a vigilant-avoidant attentional processing style (but see Evans et al., 2016, for a recent explanation of such equivocal findings).

p0070 In summary, and taken as a whole, the above literature evidences that when it comes to anxiety, anxious individuals demonstrate differences in processes of engagement, disengagement, and avoidance as compared to non-anxious individuals. This is especially apparent when the target of attentional processing is threat-related or related to the individual’s personal fear or phobia. While we have not considered in detail the various methods used to reach these conclusions (typically reaction time, correct detection, and/or eye-tracking paradigms), nor the mediating factors that can potentially influence findings (e.g., task demands and attentional control), it is evident that anxious individuals often show (1) facilitated, or heightened, processing of certain stimuli; (2) problems disengaging attention from such stimuli; and/or (3) avoidance of such stimuli when presented for prolonged periods. Of relevance, and as will become clear in the next two sections, emerging research with those displaying disordered eating, or a tendency towards disordered eating, demonstrates parallels between such processes of visual attention in both populations, that is, those with vulnerability to anxiety and those with vulnerability to eating disorders/neophobia.

s0035 **15.3 Anxiety theory applied to disordered eating in adults**

p0075 As evidenced above, there is a wealth of research to support the notion that high levels of anxiety are associated with attentional biases towards and away from social/emotional information (for reviews, see Cisler and Koster, 2010; Becker and

Rinck, 2004; Matthews and Mackintosh, 1998; Mogg and Bradley, 1998; or Williams et al., 1998). Of importance, there is also substantial evidence to suggest that visual attentional biases in the processing of threatening information are implicated in the development of adult disordered eating (e.g., Campayo and Sanchez, 2005; McManus et al., 1996). Disordered eating is a term used to refer to those individuals who exhibit pathological eating patterns and behaviors, primarily those with anorexia nervosa and bulimia nervosa. However, this definition is also thought to encompass the entire spectrum of eating-related psychopathology, from the less severe risk factors/indicators in the general population (e.g., body dissatisfaction, a drive for thinness, bulimic tendencies) to those of clinical significance (e.g., anorexia nervosa, bulimia nervosa, binge-eating disorder) (e.g., Ridout et al., 2010; Ridout et al., 2012; Sharpe et al., 2016). While anxiety and disordered eating represent different expressions of psychopathology, they do share similar characteristics and may frequently co-occur. Notable traits of both disorders include low self-esteem, fear of rejection, and elevated levels of depression (Bydlowski et al., 2005; Gilboa-Schechtman et al., 2006). Furthermore, there is evidence to suggest that individuals with anxiety and disordered eating display similar preferences for visual information (threatening or otherwise) (e.g., Barry et al., 2015; McManus et al., 1996). Therefore, it is also feasible that the same visual biases associated with the onset and maintenance of anxiety may contribute to the development and maintenance of pathological eating attitudes and behaviors.

p0080 As discussed in Section 15.2.1, individuals with anxiety frequently demonstrate facilitated engagement of disorder-relevant information (see also Becker and Rinck, 2004). Comparably, similar patterns of attentional orienting and facilitated engagement have been displayed within the context of eating disorders. This has been demonstrated using a variety of tasks designed to measure selective attention (such as the Stroop task and visual probe paradigm). These tasks often present both threatening and neutral stimuli simultaneously, and the individual is required to select one and ignore the other. More often than not, individuals with eating disorders will favor the threat-related stimuli over neutral information (e.g., Cardi et al., 2012; Kanakam et al., 2013; McManus et al., 1996). For example, McManus et al. (1996) utilized the Stroop task (Stroop, 1935) to investigate facilitated engagement towards words depicting threat in individuals with eating disorders. Importantly, findings revealed an overall facilitated engagement/orientation towards threat in eating disorder patients relative to the healthy comparison group. Of note, work employing variations of the Stroop task have substantiated these findings. Specifically, Harrison et al. (2010) used an adapted pictorial Stroop task to assess bias toward emotional facial stimuli. In line with previous research, eating disorder patients displayed longer color naming latencies in comparison to controls when presented with colored social stimuli (faces). Evidence of facilitated engagement was particularly apparent when viewing angry faces relative to neutral, supporting the notion of enhanced engagement towards information that is perceived as particularly threatening or aversive. Crucially, visual preferences for threat-related information have significant implications for the individuals concerned. To expand, selective attention towards angry emotional expressions

could lead to misunderstandings during social interactions, possibly affecting interpersonal functioning or undermining the formation of social bonds (see [Fairburn and Harrison, 2003](#); [Jackson et al., 2005](#); [McClinton and Evans, 2001](#)). This could then lead to isolation, loneliness, and the subsequent withdrawal from social settings. Of relevance, research has frequently associated disordered eating with social maladjustment, reduced emotional support from friends/family members, and a much higher frequency of negative interactions with others ([Grissett and Norvell, 1992](#); [Jackson et al., 2005](#)). Therefore, visual attentional biases towards negative social or emotional information may exacerbate eating disorder symptoms and subsequently prevent recovery from the disorder.

p0085 In addition to enhanced orientation/engagement, anxious individuals take significantly longer to disengage from threat in comparison to neutral stimuli (see Section 15.2.2). This same pattern of responding is evident in those with high levels of disordered eating. For example, research conducted by [Wilson and Wallis \(2013\)](#), using a modified Stroop task, revealed that those with high levels of self-reported dietary restraint were particularly slow to disengage from words depicting interpersonal threat as compared to neutral words. Thus across both disorders of anxiety and eating, the presence of anxiety-provoking or fear-related stimuli may interfere with the ability to rapidly disengage from threat. Again, this pattern of attentional allocation may have important consequences for understanding disordered eating. Specifically, the tendency to dwell on threat-related information acts to maintain cognitive resources on the stressor, which subsequently increases anxiety levels and encourages disordered eating (such as binge eating or dietary restraint) in an effort to gain relief ([Fox et al., 2001](#)).

p0090 Avoidance, the final component of visual attention and of key potential importance in maintaining anxiety biases, is also evident in individuals who report high levels of eating-related psychopathology. Findings from studies examining attentional processing in those with clinical eating disorders reveal a clear avoidance response when presented with stimuli associated with threat ([Cardi et al., 2015](#); [Davies et al., 2010](#); [Quinton, 2004](#); [Mountford et al., 2004](#)). For example, [Quinton \(2004\)](#) investigated the avoidance of emotional information in both eating disorder patients and healthy controls using an information-processing task in which neutral or socially relevant threat words were presented among a series of distractors. Findings revealed that threat words were identified more slowly than neutral ones, demonstrating cognitive avoidance of threatening information in individuals who exhibit symptoms of disordered eating. Furthermore, [Davies et al. \(2010\)](#) presented a series of film clips to eating disorder patients and controls in order to assess attentional avoidance. Film clips were chosen to increase the ecological validity of the study, as they provide a more realistic account of emotional experience within a social setting. Findings demonstrated that in comparison to controls, eating disorder patients were more likely to look away when shown negative film clips. Again, this provides support for the link between eating-related psychopathology and emotional avoidance.

p0095 Interestingly, the avoidance of threat-related information is also evident within non-clinical populations. “Non-clinical” refers to those individuals who display dysfunctional attitudes and behaviors relating to eating but do not meet the criteria for

a diagnosis of a clinical eating disorder according to the [DSM-5 \(2013\)](#). Here, recent findings utilizing eye-tracking technology have revealed a significant association between self-reported eating-related psychopathology and the avoidance of angry facial expressions ([Sharpe et al., 2016](#)). In this research, females viewed a series of face pairs (happy or angry paired with neutral), while their allocation of attention was continuously monitored using eye-tracking methodology. Those with high levels of disordered eating demonstrated biased attention away from emotional faces during later, strategic processing (interpreted as avoidance) in comparison to those with lower levels. These findings are consistent with earlier work demonstrating an avoidance of positive and negative words in participants with non-clinical levels of disordered eating ([Seddon and Waller, 2000](#)). Clearly, these findings support an association between emotional avoidance and disordered eating. Additionally, these findings are not dissimilar from those observed in individuals with social anxiety; here too avoidance of facial emotion is observed (e.g., [Mansell et al., 1999](#); [Armstrong and Olatunji, 2012](#)). Thus, it is possible that heightened anxiety in social settings, coupled with a tendency to avoid facial displays of emotion, may represent a possible risk factor for eating disorders or, at the very least, predict vulnerability by disrupting normal social functioning. This, as suggested above, could potentially lead to social maladjustment issues exacerbating eating disorder symptoms and/or impeding recovery from the specific disorder.

p0100 From the above brief review of current eating disorder literature, it is evident that those with disordered eating, as compared to healthy controls, display different emotion processing biases, particularly for threat. Here, parallels are clearly evident between the anxiety literature and the disordered eating literature and hence, undoubtedly, visual attentional biases could play a key role in adult disordered eating. Crucially, however, attentional processing biases in those with disordered eating are further observed for different classes of stimuli, not just those representative of social threats. That is, differential attentional processing biases in those with disordered patterns of eating are also related to images of food, body shape, and body size (e.g., [Aspen et al., 2013](#); [Jansen et al., 2005](#); [Werthmann et al., 2015](#)).

p0105 A study carried out by [Jansen et al. \(2005\)](#), for example, demonstrated increased prioritization of “ugly” body parts in eating disorder patients. Relative to controls, individuals with eating disorders directed attention towards their self-identified “ugly” body part as compared to a self-identified “beautiful” body part. Additionally, in relation to food-specific stimuli, in research conducted by [Smeets et al. \(2008\)](#), facilitated engagement towards high-energy food words in eating disorder patients was observed relative to healthy individuals. Furthermore, recent research comparing obese individuals with and without binge eating behaviors has revealed significant differences in the way their attention towards food is allocated ([Deluchi et al., 2017](#)). Specifically, obese individuals who binge-eat displayed a greater attentional bias towards unhealthy food images compared to those who do not engage in episodes of binge eating. Difficulty disengaging from food-related stimuli was also evident in those categorized as binge eaters. Importantly, these initial findings might suggest that a difficulty disengaging from unhealthy food items represents a particular “trait” of binge eating behavior in severely obese

individuals. Thus these studies demonstrate a heightened allocation of attention to either disliked body parts or (high-energy prohibited) food stimuli in individuals with disordered eating attitudes and behaviors. Again here, parallels can be drawn between findings from the anxiety literature and the disordered eating literature. However, specific to disordered eating, it is possible that selective attention towards unhealthy food or disliked body parts is related to these stimuli being appraised as salient and/or threatening and thus prioritized. In this way, dysfunctional cognitions and beliefs associated with the eating disorder maintain attention on food and body-related information that may, in turn, reinforce eating disorder-related behavior.

p0110 In sum, the above literature demonstrates a number of similarities between visual attentional processes identified in both vulnerability to anxiety and vulnerability to eating disorders. Of note, concerning disordered eating, findings from studies such as those cited above highlight differences between healthy controls and those with eating psychopathology when viewing social, emotional, and potential disorder-related stimuli in processes of engagement, disengagement, and vigilance/avoidance. This selective attention towards what can be considered fearful, threat-related, or aversive information emphasizes the importance of threat prioritization in both individuals with a vulnerability to anxiety and those displaying unhealthy attitudes and behaviors relating to eating in both clinical and non-clinical domains. As with anxiety disorders, the development of such differing attentional biases (as compared to non-disordered controls) may act as a precursor to, and a maintaining factor in, the disordered behavior and subsequently inhibit processes of recovery from the disordered eating pattern.

s0040 **15.4 A model of childhood eating from an anxiety perspective**

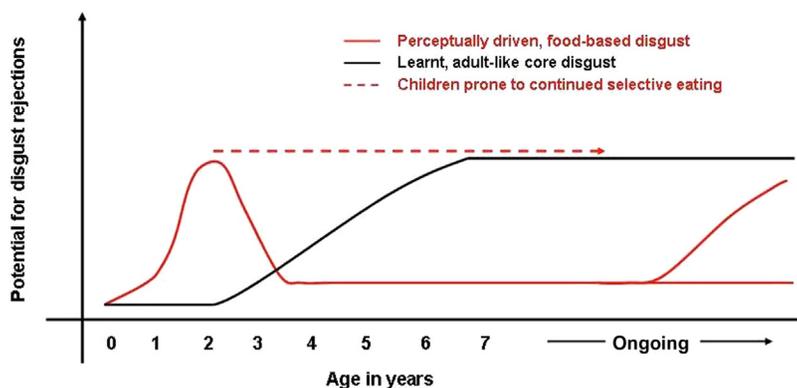
p0115 It is clear from a consideration of the literature thus far presented that visual attentional biases are one of the factors associated with the maintenance, if not the etiology, of both disordered eating and anxiety psychopathologies. To date, however, much of the research examining the role of visual attentional biases in disordered eating has been conducted with adult populations, with less known with respect to the role visual attentional biases play in disordered eating in childhood. If visual attentional biases *are* observed in patterns of disordered eating in childhood, then it is likely that such biases may contribute to the onset, as well as the maintenance, of disordered eating *per se*.

p0120 Of relevance here, two factors associated with restricted dietary intake and restricted dietary variety in childhood are “picky/fussy eating” and “food neophobia”. Whereas controversy exists as to the exact distinction and/or overlap of these two components of food rejection, according to [Dovey and colleagues \(2008\)](#) picky/fussy eating is the rejection of a large proportion of familiar (as well as novel) foods. Food neophobia, in comparison, is recognized as an inherent

evolutionary adaptive personality trait where foods that are novel or unknown to the child are rejected on sight. Consistent with this definition, and the idea that food neophobia may reflect an enduring disposition, is research demonstrating that food neophobia is associated with trait anxiety in both adults and children (Pliner and Hobden, 1992; Galloway et al., 2003; but see also Farrow and Coulthard, 2012). Moreover, food neophobia has been shown to be less susceptible to environmental influence. That is, in recent research conducted by Smith et al. (2017), while both picky/fussy eating and food neophobia showed considerable heritability at 16 months, the influence of environmental factors on the expression of related disordered eating behaviors was found to be greater for picky/fussy eating than food neophobia. In other words, the home and familial environment played a more important role in shaping fussy eating in early life (in the 1,500+ twin cohort) than they did in food neophobia. This disparate influence of the role of the environment in food neophobia as compared with picky/fussy eating accords well with the idea that food neophobia is largely a predominant of the visual domain.

p0125 Indeed, it has been suggested that food neophobia developed as a survival mechanism to enable children to avoid ingestion of potentially hazardous/noxious substances. Here it is reasoned that a young child will naturally reject potential food sources that they have had no prior experience with to avoid the risk of poisoning (e.g., Cashdan, 1998; Cooke et al., 2003). Thus, in food neophobia, rejection does not occur following tasting but is a consequence of visual processing—that is, food is rejected, or accepted, entirely based upon “what it looks like” (see Wadhera and Capaldi-Phillips, 2014 for a recent review). Consistent with this, a number of studies have now demonstrated that familiarity with food types influences their subsequent acceptance or rejection in childhood (e.g., Mustonen et al. 2012; Heath et al., 2014; Coulthard et al., 2016). For example, Mustonen et al. (2012) observed that in 8- to 11- year-old children, food neophobia predicts the number of foods tried, with low neophobic children familiar with a larger number of foods than high neophobic children. Additionally, Coulthard et al. (2016) observed that 7- to 11- year-old children rated a familiar vegetable as more positive than a novel vegetable across a number of sensory domains. Importantly, they further observed a clear dimensional shift in the sensory domains used to rate the novel vegetable. That is, while the older children were more likely to rate the novel vegetable as “smelling strange” (an olfactory domain response), the younger children were more likely to rate the novel vegetable as “looking strange” (a visual domain response), thus again highlighting the role of visual processing mechanisms in early childhood eating behaviors.

p0130 Of relevance, Brown and Harris (2012) have put forward a model of perceptually driven eating behavior in infancy through to mid-childhood. In this model (see Fig. 15.2), Brown and Harris argue that neophobic eating is driven by disgust. In early childhood, similar to others (e.g., Cashdan, 1998; Cooke et al., 2003; Dovey et al., 2008; Heath et al., 2011), they suggest it is the perceptual attributes of food stimuli that drive food neophobic responses. They propose that the onset of disgust is simultaneous with food neophobia, but whereas perceptually driven rejection of food peaks at 2 years of age, rejection of foods based on cognitive understanding of disgust is only just emerging at this age. In terms of cognition, at this age, they



f0015 **Figure 15.2** Graphical representation of learnt, adult-like core disgust and the proposal for the development of a perceptually driven, food-based disgust (Brown and Harris, 2012).

posit that the primary basis and/or development of food rejection/disgust is “fear of contamination”. What then follows is a transition of food neophobia from the rejection of foods based on perceptual attributes to the rejection of foods based on full cognitive understanding of disgust/contagion. The latter occurring by around 7 years of age. Importantly, they suggest that one factor underlying a continuation of food neophobia into mid/later childhood is increased anxiety/fear towards food during the onset of normal developmental neophobia (at age 2/3). This then leads to an increased focus on the perceptual features of the food perpetuating the neophobia and/or picky/fussing eating. Somewhat consistent with this is research demonstrating that food neophobia is associated with physiological responses indicative of fear (Raudenbush and Capiola, 2012).

p0135 To sum, the main premise of the above literature is that food neophobia, similar to clinical disorders, and especially the anxieties, may not only reflect evolutionary survival mechanisms (and therefore be linked to specific genotypes), but that visual perceptual biases may be a key factor in food neophobia etiology as well as maintenance. If this is the case, and given that high food neophobia is a factor associated with continued disordered eating (including continued picky/fussy eating in later childhood; see Lafraire et al., 2016; Taylor, Wernimont et al., 2015), it is perhaps surprising that limited empirical research has been conducted in this area. That is, the role of perceptual attentional biases in food preferences has, until recently, received minimal investigation. However, if food preferences are related to familiarity and neophobia, and neophobia originates from perceptually driven processes, then it seems logical that perceptual attentional biases may be implicated in childhood food preferences.

p0140 Recently, Maratos and Staples (2015) have explored this hypothesis by investigating attentional biases toward familiar and unfamiliar foods in a child population ranging in picky/fussy eating and food neophobia. Using visual probe methodology, Maratos and Staples presented 8- to 11- year-old children with familiar and unfamiliar fruits and vegetables, where the children had to respond to a probe replacing

either the familiar or unfamiliar food of a paired stimulus set. Results revealed that while all children demonstrated facilitated engagement of the novel/unfamiliar food stuffs (e.g., star fruit, bitter melon, and chow-chow), these biases were heightened in those children displaying high food neophobia. An additional finding of this research was that the more unwilling a child was to try the pictured food per se, the greater their bias to look toward the unfamiliar fruits and vegetables. Thus [Maratos and Staples \(2015\)](#) concluded that the same perceptual cognitive mechanisms suggested to underlie phobic and anxiety disorders (i.e., automated or facilitated visual attentional biases) may also underlie the development and/or maintenance of food neophobia in children. Additionally, they suggested that the less willing a child is to try a food, potentially the more “fearful” or “disgusting” they find it, which in turn leads to a natural heightened vigilance towards (or facilitated engagement of) such foods. This again accords with findings from the anxiety literature and the idea that food neophobia represents a fear response ([Raudenbush and Capiola, 2012](#)).

p0145 Of note while there appears to be no further studies directly investigating the relationship between visual attentional biases and food neophobia, in a number of fairly recent research studies the role of repeated visual exposure on consequent preference and/or eating behaviors has been studied. For example, [Houston-Price and colleagues](#) have explored whether repeated exposure to picture books containing familiar (e.g., strawberries and sweetcorn) and unfamiliar (e.g., radishes and lychees) foods influence toddlers subsequent preferences. The studies demonstrated that following 2–3 weeks of story reading, toddlers were more likely to display a visual viewing preference towards the food stimuli presented in the books ([Houston-Price et al., 2009a](#)), as well as approach (touch and/or taste) the unfamiliar foods ([Houston-Price et al., 2009a](#)). In a subsequent study, [Heath et al. \(2014\)](#) explored whether the effects of picture book exposure could reflect familiarity with the pictured foods and/or initial liking of the pictured food. Most strikingly, [Heath et al.](#) demonstrated that following the intervention, toddlers consumed more of the unfamiliar vegetable presented in the picture book than that of a matched control familiar vegetable; hence demonstrating that repeated visual exposure was key and not preference/familiarity predispositions.

p0150 Concerning older children, while minimal literature on food neophobia or picky/fussy eating and visual attentional biases has been published with this population, [Folkvord et al. \(2015\)](#) have demonstrated that visual food advertising increases subsequent food intake. In this research, 7- to 11- year-old children played an advergame that promoted energy-dense snacks (candy) or non-food pictures (toys). Following the game, those children exposed to the food cues ate more of the advertised snacks than those exposed to the toys, especially those who demonstrated facilitated attention (i.e., faster orienting) toward the food cues as well as delayed disengagement (i.e., increased gaze duration) from the food cues. Additionally, using eye-tracking methodology, [Schmidt et al. \(2016\)](#) have demonstrated that adolescents with binge-eating disorder show both facilitated attention of, and delayed disengagement from, food cues as compared to sex, age, body mass index (BMI), and socioeconomic status–matched controls. Finally, [Werthmann et al. \(2015\)](#) provide preliminary evidence that attentional bias toward food as compared to non-food stimuli in older children (average age 12 years), predicts weight gain in obese children post 6 months. Thus

the research of [Folkvord et al., 2015](#); [Schmidt et al. 2016](#), and [Werthmann et al. 2015](#), in addition to that of [Maratos and Staples \(2015\)](#), again evidences the role of visual attention when considering eating and/or disordered eating behaviors in childhood. Crucially, such studies highlight how individual differences in visual attentional biases can play a key role in the (disordered) eating behaviors observed.

p0155 Taken as a whole, it is evident that one factor influencing disordered eating in childhood is visual attention. While empirical evidence is still somewhat lacking, it is clear that processes of visual attention associated with anxiety vulnerability may also be related to disordered eating and food neophobia in children. Certainly, the above research highlights that processes of facilitated engagement and/or prolonged disengagement are related to eating preferences and behaviors in childhood, and that repeated visual exposure to food stimuli can subsequently influence eating preferences. Given this, it may be the case that an emerging therapy proving successful in the treatment of anxiety disorders may also prove useful in the treatment of eating disorders. This specific treatment involves the retraining of visual attentional biases. Its application to eating disorders is reviewed in the penultimate section of this chapter (Section 15.5), before a number of concluding remarks are offered.

s0045 **15.5 Disordered eating and food neophobia—applying an anxiety disorder approach**

p0160 Despite anxiety disorders displaying complex etiologies ([Hudson and Rapee, 2004](#); [Newman et al., 2013](#)), given visual attentional biases influence potential vulnerability to, and the maintenance of, such disorders, one emerging method of treating anxiety disorders proving particularly useful is attentional bias modification (ABM). ABM is based on research and theory, such as that presented above, highlighting that cognitive biases (and especially visual information processing biases), play a central role in the etiology and maintenance of anxiety disorders (see [Mogg and Bradley, 2016](#), and [MacLeod and Clarke, 2015](#), for reviews). It involves adapting the most frequently applied experimental paradigms utilized in identifying information processing biases (and most often visual probe tasks), to train anxious individuals to attend to neutral, as opposed to threatening, stimuli. Hence in such (visual probe) training, a target would more frequently replace a neutral stimulus (e.g., neutral face) as compared to a threatening stimulus (e.g., angry face), given changing the orientation of attention should work to reduce processes associated with anxiety symptomology. That is, training should attenuate heightened processing of specific (threat-related) stimuli. A simplified schematic of ABM protocols put forward by [Bar-Haim \(2010\)](#) is depicted in [Fig. 15.3](#).

p0165 Thus far, ABM has been shown to effectively diminish both threat-related attentional biases and anxiety symptoms in adults with high trait anxiety, generalized anxiety disorder, and social phobia (e.g., [Hakamata et al., 2010](#); [Hallion and Ruscio, 2011](#); [Bar-Haim, 2010](#); [Beard et al., 2012](#); [MacLeod and Mathews, 2012](#)). Indeed, in the meta-analyses of [Hakamata et al. \(2010\)](#), of 12 controlled trials investigating the efficacy of ABM for anxiety, ABM was shown to produce

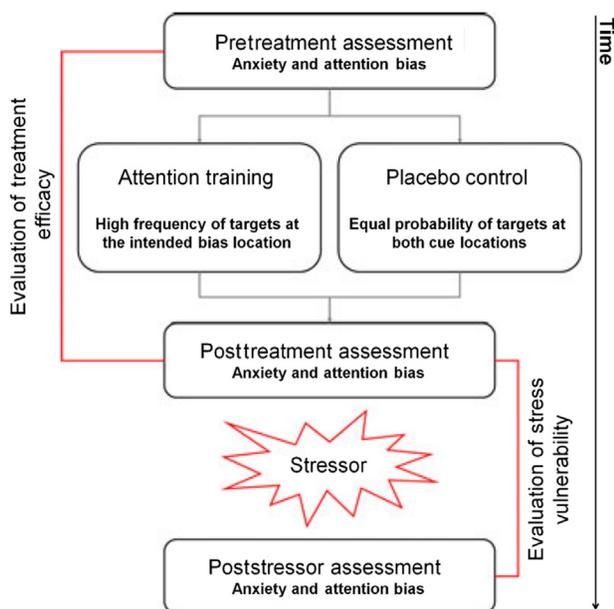


Figure 15.3 Schematic of attention bias modification (ABM) study design to evaluate treatment efficacy (Bar-Haim, 2010).

significantly greater reductions in anxiety as compared to control training, with a medium effect size observed (but cf. Mogoase et al., 2014). Additionally, as compared to traditional procedures such as Cognitive Behavioural Therapy (CBT), ABM requires relatively fewer resources (Coward and Ollendick, 2010). To expand, ABM requires less practitioner investment and less time than more traditional procedures. For example, there are multiple dissemination possibilities for ABM, as training can be administered via a computer or smartphone without the need for trained therapists (e.g., Dennis and O’Toole, 2014; Enock et al., 2014; MacLeod et al., 2007). Moreover, ABM for anxiety has been found to be effective after only a limited number of training sessions (e.g., Amir et al., 2009), with further research demonstrating long-lasting improvements. For example, Schmidt et al. (2009) observed reductions in bias towards threat-related information in anxious individuals enduring for up to 4 months post-training and Britton et al. (2015) have observed neural changes in the amygdala (a brain region implicated in threat processing) following a 4-week ABM training protocol.

Of note, while it is recognized that disordered eating in both children and adults may reflect a number of ubiquitous factors (see Lafraire et al., 2016 for a model of disordered eating in children), anxiety and disordered eating do share similar characteristics. We have highlighted above the potential role of information processing, and specifically visual attentional biases, in influencing vulnerability to, and the maintenance of, disordered eating. Considering this, and the similarities between

disordered eating and anxiety, it may be that ABM can be applied as a successful treatment or treatment adjunct for eating disorders. Certainly, as our review consistently evidences, adults high in eating-related psychopathology display significant attentional biases towards emotionally or potentially aversive food/body-related stimuli. Moreover, despite current evidence being somewhat scant, the same also appears to be true of children displaying vulnerability to disordered eating, i.e., such children demonstrate differential attentional biases toward food stimuli as compared to non-disordered controls. Thus identifying methods of modifying these biases, through the use of ABM, for example, could lead to targeted interventions for adult and childhood eating disorders (see [Renwick and colleagues, 2013a](#)).

p0175 In accord with this, [Renwick et al. \(2013b\)](#) have described how current eating disorder treatments such as CBT often encourage patients to direct their attention away from threatening or salient (emotional) cues. However, this relies on an ability to effectively exercise effortful control and divert attention away from potentially negative or anxiety-provoking stimuli—something previous research suggests is impaired in individuals with eating disorders (e.g., [Cardi, et al., 2012](#); [Harrison et al., 2010](#); [Murphy et al., 2002](#)). In contrast, as ABM targets processes that lie outside the realms of higher cognitive control, it potentially provides an opportunity to implicitly reprogram or “train” early attentional orienting in both adults and children alike. This is especially important when one considers young children lack sophisticated cognitive processing skills, with the development of such being age-dependent. Related to this, as evidence demonstrates that the emotional significance (or otherwise) of an event is encoded at the very early stages of perception (e.g., [Compton, 2003](#); [Maratos et al., 2009](#); [2012](#)), ABM can potentially target these non-conscious neural orienting/appraisal stages (see also [Britton et al., 2015](#), as cited above). Indeed if changing the orientation of attention can work to reduce eating disorder symptoms, then attention training may offer a much needed adjunct to eating disorder treatments by targeting early cognitions and stages of information processing relevant to the eating-related psychopathology.

p0180 To date, within the realm of eating behavior research, investigating the efficacy of ABM as a targeted intervention to address disordered eating is limited. However, emerging research is demonstrating that retraining attentional biases in those who are obese or overweight is beneficial. For example, [Boutelle et al. \(2016\)](#) used an ABM intervention to train attention away from food cues in overweight adults displaying binge-eating habits using a visual probe task. The ABM intervention was for 8 weeks and the follow-up at 3 months. Results revealed that the ABM was effective in decreasing weight, disordered eating symptoms, and binge eating. However, a limitation of the study was the lack of any form of control. Similar research by [Kemps et al. \(2016\)](#) has employed a control and was successful in evidencing reduced bias toward food stimuli in overweight and obese women. This stated, in the study by [Kemps et al.](#) longer-term evaluation of the impact of these retrained biases on eating behavior was lacking; although, such training has been shown to be successful in reducing consumption of chocolate in the general population ([Schumacher et al., 2016](#); see also [Turton et al., 2016](#)). Perhaps of most relevance, however, is very recent research by [Bazzaz et al. \(2017\)](#). In this study 49

obese and overweight dieters were assigned to: a 4-week ABM intervention to retrain attention to low calorie foods, a 4-week sham intervention, or a no intervention control group. Importantly, at 3-month follow-up only the ABM intervention group showed significant reductions in food-related attentional biases and BMI. Thus, [Bazzaz et al. \(2017\)](#) concluded that ABM is a promising methodology for retraining eating behaviors, with ABM promoting dieting success in dieting populations (see also [Kakoschke et al., 2017](#), for a recent review of ABM on consumption behaviors more generally).

p0185 To sum the above studies, albeit minimal in number, demonstrate that in adult populations ABM may be a useful intervention in retraining attentional biases either away from food or towards healthier foods. This subsequently has very real implications for the eating behaviors observed. Of note, while the effectiveness of ABM in clinical groups remains to be seen, research in such populations is now underway. For example, [Brockmeyer et al. \(2016\)](#) have registered a randomized controlled trial of ABM for evaluation with bulimia nervosa and binge-eating disorder individuals directed at retraining attention away from food cues. Results are eagerly awaited.

p0190 With regard to studies of eating behaviors and the retraining of attention in children/adolescents, currently very few studies exist exploring the effectiveness of such strategies. However, as discussed in Section 15.4, training attention towards novel fruits and vegetables in toddlers through the use of picture books (e.g., [Houston-Price et al., 2009a; 2009b](#)) does seem to increase acceptance of such foods when subsequently presented to the child. Hence, ABM style interventions may be a useful method for the reduction of food neophobia in children. Indeed, as neophobia is argued to be a predominant of the visual domain, early training of visual processing biases *towards* novel or unfamiliar foods in a fun gaming format may reduce the potential salience, or threat value, of such novel foods as well as hyper-vigilance to such stimuli in later childhood. In accord with this, increased variety of, and frequency of vegetables offered, in early childhood can promote subsequent and later consumption—even into adulthood (see [Dazeley and Houston-Price, 2015](#), and [Ahern et al., 2013](#), respectively). Additionally, as neophobia is often seen in picky/fussy eating, attentional training may be a useful intervention to trial in both these childhood disordered eating behaviors. That is, training attention to a variety of different types of food stuff (rather than ABM per se) may be one route to increasing dietary variety in the neophobic or fussy eating child. While research investigating this theory is still to be pursued, ABM has been used to modify over-eating in obese children ([Boutelle et al., 2014](#)). Described as a pilot study, [Boutelle et al. \(2014\)](#) assigned obese children of age 8–12 years to either a one-session ABM to train attention away from food-related words ($n = 15$) or a one-session control condition in which attention was trained equally to neutral and/or food-related words ($n = 14$). In a subsequent free eating session controlling for satiety, children assigned to the control condition demonstrated increased calorific intake, as compared to those in the ABM condition, as a proportion of calorific intake at baseline. Thus, the research of [Boutelle et al. \(2014\)](#) appears to demonstrate that

ABM can be successfully used in child cohorts to alter eating behaviors, albeit the focus was on short-term eating behaviors.

p0195 Finally, yet importantly, ABM to reduce bias towards emotional words or images in eating-related psychopathology may further be an important area for future investigation. To expand, and as overviewed in Section 15.3, attentional biases towards emotional words and images have previously been implicated in the maintenance of eating-related psychopathology in adults by creating emotional instability. Indeed, individuals with eating disorders are shown to encounter a number of difficulties processing emotional events and experiences, particularly those which are perceived as negative or threatening (e.g., [Harrison et al., 2010](#); [Svaldi et al., 2012](#)). This consequently can lead to eating disorder patients using eating disordered behavior as a means of coping or dealing with aversive emotion. For example, dietary restraint has been associated with the avoidance of negative or threatening emotional information, whereas binge/purge behaviors have been associated with the reduction of negative affect once a threatening emotional experience has occurred ([Luck et al., 2005](#)). Thus, the effects of ABM for retraining emotional biases may be an important avenue for further exploration when considering interventions for disordered eating, as disordered eating not only reflects maladaptive attentional biases to food cues but also those of emotional significance (e.g., angry faces, specific body parts). Of relevance here is a recent study by [Cardi et al. \(2015\)](#). [Cardi et al. \(2015\)](#) reasoned that if social difficulties in anorexia nervosa are underpinned by negative processing biases of social stimuli, then retraining attention toward positive social stimuli might alleviate such difficulties. Thus they recruited 28 individuals with anorexia nervosa to complete a five-session ABM training protocol involving the retraining of attention towards positive stimuli using visual probe as well as an ambiguous scenario training task. The latter involved training patients to interpret ambiguous stimuli as benign rather than threatening. Results revealed that for both tasks the training was successful in changing attentional/cognitive biases. Moreover, after the training interventions, lower levels of anxiety and higher levels of self-compassion were reported. However, if such biases and associated emotion regulation processes impact upon actual eating behaviors is a research area yet to be pursued.

p0200 To sum, in this penultimate section, we have demonstrated how the emerging treatment ABM, shown to be effective for anxiety disorders, may also be effective for disordered eating, or, at the very least, a treatment adjunct that should be trialed. While further research is needed with respect to the efficacy of ABM for disordered eating across both adult and child populations, a benefit of ABM is that it can be tailored to target specific biases, cognitions, and behaviors associated with different eating disorders or their subtypes. For example, in childhood neophobia, training attention towards unfamiliar fruits and vegetables in a fun way may prove useful, whereas in disordered eating reflecting a tendency towards obesity (or bulimia), training attention away from food stimuli per se may be more useful. Alternatively, in disordered eating where social (processing) difficulties are frequently observed, using more traditional ABM paradigms to retrain attention away from social threat may be valid. Such suggestions highlight how ABM can be adapted, and thus how ABM can

potentially offer a much needed individualized approach to disordered eating treatment able to reflect the diversity of eating disorder-related psychopathology.

s0050 **15.6 Concluding remarks**

p0205 To conclude, in this chapter we have highlighted how processes of visual attention observed in those with vulnerability to anxiety disorder may be applicable to those with vulnerability to eating disorder. In evidencing this, we have reviewed research demonstrating that in both adults and children with vulnerability to eating disorders, processes of facilitated engagement, delayed disengagement, and/or avoidance of food stimuli are observed. Additionally, we have further highlighted how in adult populations such visual attentional processing biases extend to emotional stimuli and hence potentially contribute to the social difficulties such individuals' experience, exacerbating the specific disorder. Last but not least, we have suggested that ABM and/or attentional training per se may be a valid, efficient, and effective method of treating disordered eating given: (1) its current successful utilization with anxiety disordered populations and (2) the ease with which the training can be adapted to the specific eating disorder or population in question. However, we put forward our last argument tentatively, as we also argue that more research is currently needed to establish if an anxiety disordered approach, with a specific focus on processes of visual attention, can be applied to disordered eating. Certainly, the empirical evidence for our arguments is still somewhat lacking concerning the role of visual attentional biases in childhood disordered eating, not only in relation to food stimuli per se but also in relation to emotional stimuli. For example, as far as we are aware no studies exist in children examining if social processing biases are related to eating preferences. Conversely, in the adult eating disorder literature, it would appear that more studies have examined social processing biases as opposed to food-related biases.

p0210 We would hope, therefore, that the theories and ideas we consider here, alongside the supporting evidence reviewed, inspires others to investigate if an anxiety-disordered approach is a useful framework from which to present disordered eating. Of importance, we of course do not posit that visual attentional biases are the only factor influencing disordered eating. Certainly, we recognize that all disorders potentially reflect multiple etiologies. Rather, we suggest that similar attentional processing mechanisms may underlie both vulnerability to anxiety and vulnerability to eating disorders. Considering this, we further suggest that recent attentional training paradigms found to be effective in treating anxiety disorders may consequently also be of use in treating disordered eating; or those with a vulnerability to disordered eating such as food neophobic and picky/fussy eating children. To determine this, however, we again opine that much more research is needed in this area.

References

- Ahern, S.M., Caton, S.J., Bouhhal, S., Hausner, H., Olsen, A., Nicklaus, S., et al., 2013. Eating a rainbow. Introducing vegetables in the first years of life in 3 European countries. *Appetite* 71, 48–56.
- Amir, N., Elias, J., Klumpp, H., Przeworski, A., 2003. Attentional bias to threat in social phobia: facilitated processing of threat or difficulty disengaging attention from threat? *Behav. Res. Ther.* 41 (11), 1325–1335.
- Amir, N., Beard, C., Burns, M., Bomyea, J., 2009. Attention modification program in individuals with generalized anxiety disorder. *J. Abnorm. Psychol.* 118 (1), 28–33.
- Armstrong, T., Olatunji, B.O., 2012. Eye tracking of attention in the affective disorders: a meta-analytic review and synthesis. *Clin. Psychol. Rev.* 32 (8), 704–723.
- Aspen, V., Darcy, A.M., Lock, J., 2013. A review of attention biases in women with eating disorders. *Cogn. Emotion.* 27 (5), 820–838.
- Bar-Haim, Y., 2010. Research review: attention bias modification (ABM): a novel treatment for anxiety disorders. *J. Child Psychol. Psychiatr. Allied Discip.* 51 (8), 859–870.
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., Van Ijzendoorn, M.H., 2007. Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychol. Bull.* 133 (1), 1.
- Barlow, D.H., 2004. *Anxiety and Its Disorders: The Nature and Treatment of Anxiety and Panic*. Guilford press, New York, NY.
- Barry, T., Griffith, J., Vervliet, B., Hermans, D., 2015. The role of stimulus specificity and attention in the generalization of extinction. *J. Exp. Psychopathol.* 7 (1), 143–152.
- Bazzaz, M.M., Fadardi, J.S., Parkinson, J., 2017. Efficacy of the attention control training program on reducing attentional bias in obese and overweight dieters. *Appetite* 108, 1–11.
- Beard, C., Sawyer, A.T., Hofmann, S.G., 2012. Efficacy of attention bias modification using threat and appetitive stimuli: a meta-analytic review. *Behav. Res. Ther.* 43 (4), 724–740.
- Beck, A.T., Clark, D.A., 1997. An information processing model of anxiety: automatic and strategic processes. *Behav. Res. Ther.* 35 (1), 49–58.
- Becker, E.S., Rinck, M., 2004. Sensitivity and response bias in fear of spiders. *Cogn. Emotion.* 7, 961–976.
- Boutelle, K.N., Kuckertz, J.M., Carlson, J., Amir, N., 2014. A pilot study evaluating a one-session attention modification training to decrease overeating in obese children. *Appetite* 76, 180–185.
- Boutelle, K.N., Monreal, T., Strong, D.R., Amir, N., 2016. An open trial evaluating an attention bias modification program for overweight adults who binge eat. *J. Behav. Ther. Exp. Psychiatry.* 52, 138–146.
- Britton, J.C., Suway, J.G., Clementi, M.A., Fox, N.A., Pine, D.S., Bar-Haim, Y., 2015. Neural changes with attention bias modification for anxiety: a randomized trial. *Soc. Cogn. Affective Neurosci.* 10 (7), 913–920.
- Brockmeyer, T., Schmidt, U., Friederich, H.C., 2016. The ABBA study—approach bias modification in bulimia nervosa and binge eating disorder: study protocol for a randomised controlled trial. *Trials* 17 (1), 466.
- Brown, S.D., Harris, G., 2012. A theoretical proposal for a perceptually driven, food-based disgust that can influence food acceptance during early childhood. *Int. J. Child Health Nutr.* 1 (1), 1–10.

- Buckner, J.D., Maner, J.K., Schmidt, N.B., 2010. Difficulty disengaging attention from social threat in social anxiety. *Cogn. Ther. Res.* 34 (1), 99–105.
- Bydlowski, S., Corcos, M., Jeammet, P., Paterniti, S., Berthoz, S., Laurier, C., 2005. Emotion-processing deficits in eating disorders. *Int. J. Eat. Disord.* 37 (4), 321–329.
- Campayo, M.A.R., Sanchez, F.M., 2005. Cognitive biases in an experimental task of focalised selective attention in eating disorders. *Actas Esp. Psiquiatr.* 33 (2), 71–80.
- Cardi, V., Di Matteo, R., Corfield, F., Treasure, J., 2012. Social reward and rejection sensitivity in eating disorders: an investigation of attentional bias and early experiences. *World J. Biol. Psychiatry.* 14 (8), 622–633.
- Cardi, V., Corfield, F., Leppanen, J., Rhind, C., Deriziotis, S., Hadjimichalis, A., et al., 2015. Emotional processing, recognition, empathy and evoked facial expression in eating disorders: an experimental study to map deficits in social cognition. *Public Library of Science One* 10 (8), e0133827.
- Cashdan, E., 1998. Adaptiveness of food learning and food aversions in children. *Soc. Sci. Inform.* 37 (4), 613–632.
- Cisler, J.M., Koster, E.H., 2010. Mechanisms of attentional biases towards threat in anxiety disorders: an integrative review. *Clin. Psychol. Rev.* 30 (2), 203–216.
- Cisler, J.M., Olatunji, B.O., 2010. Components of attentional biases in contamination fear: evidence for difficulty in disengagement. *Behav. Res. Ther.* 48 (1), 74–78.
- Compton, R.J., 2003. The interface between emotion and attention: a review of evidence from psychology and neuroscience. *Behav. Cogn. Neurosci. Rev.* 2 (2), 115–129.
- Cooke, L.J., Wardle, J., Gibson, E.L., 2003. Relationship between parental report of food neophobia and everyday food consumption in 2–6-year-old children. *Appetite* 41, 205–206.
- Coulthard, H., Palfreyman, Z., Morizet, D., 2016. Sensory evaluation of a novel vegetable in school age children. *Appetite* 100, 64–69.
- Cowart, M.J., Ollendick, T.H., 2010. Attentional biases in children: implications for treatment. In: Hadwin, J.A., Field, A.P. (Eds.), *Information Processing Biases and Anxiety: A Developmental Perspective*. John Wiley & Sons, Chichester, UK, pp. 297–319.
- Davies, H., Schmidt, U., Stahl, D., Tchanturia, K., 2010. Evoked facial emotional expression and emotional experience in people with anorexia nervosa. *Int. J. Eat. Disord.* 44 (6), 531–539.
- Dazeley, P., Houston-Price, C., 2015. Exposure to foods' non-taste sensory properties. A nursery intervention to increase children's willingness to try fruit and vegetables. *Appetite* 84, 1–6.
- Deluchi, M., Costa, F.S., Friedman, R., Goncalves, R., Bizarro, L., 2017. Attentional bias to unhealthy food in individuals with severe obesity and binge eating. *Appetite* 108, 471–476.
- Dennis, T.A., O'Toole, L.J., 2014. Mental health on the go effects of a gamified attention-bias modification mobile application in trait-anxious adults. *Clin. Psychol. Sci.* 2 (5), 576–590.
- Derakshan, N., Eysenck, M.W., Myers, L.B., 2007. Emotional information processing in repressors: the vigilance–avoidance theory. *Cogn. Emotion* 21 (8), 1585–1614.
- Dovey, T.M., Staples, P.A., Gibson, E.L., Halford, J.C., 2008. Food neophobia and 'picky/fussy' eating in children: a review. *Appetite* 50 (2), 181–193.
- American Psychiatric Association, 2013. *Diagnostic and Statistical Manual of Mental Disorders*. 5th Ed American Psychiatric Association, Washington, DC.
- Enock, P.M., Hifmann, S.G., McNally, R.J., 2014. Attention bias modification training via smartphone to reduce social anxiety: a randomised, controlled, multi-session experiment. *Cogn. Res. Ther.* 38, 200–216.

- Evans, T.C., Walukevich, K.A., Britton, J.C., 2016. Vigilance-avoidance and disengagement are differentially associated with fear and avoidant behaviors in social anxiety. *J. Affective Disord.* 199, 124–131.
- Fairburn, C.G., Harrison, P.J., 2003. Eating disorders. *Lancet* 361 (9355), 407–416.
- Farrow, C.V., Coulthard, H., 2012. Relationships between sensory sensitivity, anxiety and selective eating in children. *Appetite* 58 (3), 842–846.
- Folkvord, F., Anschutz, D.J., Wiers, R.W., Buijzen, M., 2015. The role of attentional bias in the effect of food advertising on actual food intake among children. *Appetite* 84, 251–258.
- Fox, E., Russo, R., Dutton, K., 2002. Attentional bias for threat: evidence for delayed disengagement from emotional faces. *Cogn. Emotion* 16 (3), 355–379.
- Fox, E., Russo, R., Bowles, R., Dutton, K., 2001. Do threatening stimuli draw or hold visual attention in subclinical anxiety? *J. Exp. Psychol.* 130 (4), 681–700.
- Galloway, A.T., Lee, Y., Birch, L.L., 2003. Predictors and consequences of food neophobia and pickiness in young girls. *J. Am. Diet. Assoc.* 103 (6), 692–698.
- Gerdes, A.B., Alpers, G.W., Pauli, P., 2008. When spiders appear suddenly: spider-phobic patients are distracted by task-irrelevant spiders. *Behav. Res. Ther.* 46 (2), 174–187.
- Gilboa-Schechtman, E., Avnon, L., Zubery, E., Jeczmierny, P., 2006. Emotional processing in eating disorders: specific impairment or general distress related deficiency? *Depression Anxiety* 23 (6), 331–339.
- Grisset, N.I., Norvell, N.K., 1992. Perceived social support, social skills, and quality of relationships in bulimic women. *J. Consul. Clin. Psychol.* 60 (2), 293–299.
- Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J.C., Fox, N.A., Leibenluft, E., et al., 2010. Attentional bias modification treatment: a meta-analysis toward the establishment of novel treatment for anxiety. *Biol. Psychiatry.* 68, 982–990.
- Hallion, L.S., Ruscio, A., 2011. A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychol. Bull.* 137, 940–958.
- Harrison, A., Sullivan, S., Tchanturia, K., Treasure, J., 2010. Emotional functioning in eating disorders: attentional bias, emotion recognition and emotion regulation. *Psychol. Med.* 40 (11), 1887–1897.
- Heath, P., Houston-Price, C., Kennedy, O.B., 2011. Increasing food familiarity without the tears. A role for visual exposure? *Appetite* 57 (3), 832–838.
- Heath, P., Houston-Price, C., Kennedy, O., 2014. Let's look at leaks! Picture books increase toddlers' willingness to look at, taste and consume unfamiliar vegetables. *Front. Psychol.* 5, 191.
- Heitmann, C.Y., Feldker, K., Neumeister, P., Brinkmann, L., Schrammen, E., Zwitserlood, P., et al., 2017. Brain activation to task-irrelevant disorder-related threat in social anxiety disorder: the impact of symptom severity. *NeuroImage* 14, 323–333.
- Houston-Price, C., Butler, L., Shiba, P., 2009a. Visual exposure impacts on toddlers' willingness to taste fruits and vegetables. *Appetite* 53 (3), 450–453.
- Houston-Price, C., Burton, E., Hickinson, R., Inett, J., Moore, E., Salmon, K., et al., 2009b. Picture book exposure elicits positive visual preferences in toddlers. *J. Exp. Child Psychol.* 104 (1), 89–104.
- Hudson, J.L., Rapee, R.M., 2004. *From Anxious Temperament to Disorder: An Etiological Model*. Guilford Press, New York, NY.
- Jackson, T., Weiss, K.E., Lunquist, J.J., Soderlind, A., 2005. Sociotropy and perceptions of interpersonal relationships as predictors of eating disturbances among college women: two prospective studies. *J. Genet. Psychol.* 166 (3), 346–360.
- Jansen, A., Nederkoorn, C., Mulken, S., 2005. Selective visual attention for ugly and beautiful body parts in eating disorders. *Behav. Res. Ther.* 43 (2), 183–196.

- Kakoschke, N., Kemps, E., Tiggemann, M., 2017. Approach bias modification training and consumption: a review of the literature. *Addict. Behav.* 64, 21–28.
- Kanakam, N., Krug, I., Raoult, C., Collier, D., Treasure, J., 2013. Social and emotional processing as a behavioural endophenotypes in eating disorders: a pilot investigation in twins. *Eur. Eat. Disord. Rev.* 21 (4), 294–307.
- Kelly, L., Maratos, F., Lipka, S., Croker, S., 2016. Attentional bias towards threatening and neutral facial expressions in high trait anxious children. *J. Exp. Psychopathol.* 7, 343–359.
- Kemps, E., Tiggemann, M., Hollitt, S., 2016. Longevity of attentional bias modification effects for food cues in overweight and obese individuals. *Psychol. Health* 31 (1), 115–129.
- Koster, E.H., Verschuere, B., Crombez, G., Van Damme, S., 2005. Time-course of attention for threatening pictures in high and low trait anxiety. *Behav. Res. Ther.* 43 (8), 1087–1098.
- Lafraire, J., Rioux, C., Giboreau, A., Picard, D., 2016. Food rejections in children: cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. *Appetite* 96, 347–357.
- Lang, P.J., Davis, M., Öhman, A., 2000. Fear and anxiety: animal models and human cognitive psychophysiology. *J. Affective Disord.* 61 (3), 137–159.
- LeDoux, J., 1998. *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. Simon and Schuster, New York, USA.
- Luck, A., Waller, G., Meyer, C., Ussher, M., Lacey, H., 2005. The role of schema processes in the eating disorders. *Cogn. Ther. Res.* 29 (6), 717–732.
- Luo, Q., Holroyd, T., Jones, M., Hendler, T., Blair, J., 2007. Neural dynamics for facial threat processing as revealed by gamma band synchronization using MEG. *NeuroImage* 34 (2), 839–847.
- MacLeod, C., Clarke, P.J., 2015. The attentional bias modification approach to anxiety intervention. *Clin. Psychol. Sci.* 3 (1), 58–78.
- MacLeod, C., Mathews, A., 2012. Cognitive bias modification approaches to anxiety. *Ann. Rev. Clin. Psychol.* 8, 189–217.
- MacLeod, C., Soong, L.Y., Rutherford, E.M., Campbell, L.W., 2007. Internet-delivered assessment and manipulation of anxiety-linked attentional bias: validation of a free-access attentional probe software package. *Behav. Res. Method* 39, 533–538.
- Mansell, W., Clark, D.M., Ehlers, A., Chen, Y.P., 1999. Social anxiety and attention away from emotional faces. *Cogn. Emotion.* 13 (6), 673–690.
- Maratos, F.A., 2011. Temporal processing of emotional stimuli: the capture and release of attention by angry faces. *Emotion* 11, 1242–1247.
- Maratos, F.A., Staples, P., 2015. Attentional biases toward familiar and unfamiliar foods in children: the role of food neophobia. *Appetite* 91, 220–225.
- Maratos, F.A., Mogg, K., Bradley, B.P., Rippon, G., Senior, C., 2009. Course threat images reveal oscillations in the amygdala: a magnetoencephalography study. *Cogn. Affective Behav. Neurosci.* 9, 133–143.
- Maratos, F.A., Rippon, G., Mogg, K., Bradley, B.P., Senior, C., 2012. Threatening faces modulate early gamma band activity in occipital cortex. *Cogn. Neurosci.* 3, 62–68.
- Mathews, A., Mackintosh, B., 1998. A cognitive model of selective processing in anxiety. *Cogn. Ther. Res.* 22 (6), 539–560.
- McClinton, J.M., Evans, I.M., 2001. The underlying psychopathology of eating disorders and social phobia: a structural equation analysis. *Eat. Behav.* 2 (3), 247–261.
- McManus, F., Waller, G., Chadwick, P., 1996. Biases in the processing of different forms of threat in bulimic and comparison women. *J. Nerv. Ment. Dis.* 184 (9), 547–554.

- Mogg, K., Bradley, B.P., 1998. A cognitive-motivational analysis of anxiety. *Behav. Res. Ther.* 36 (9), 809–848.
- Mogg, K., Bradley, B.P., 2016. Anxiety and attention to threat: cognitive mechanisms and treatment with attention bias modification. *Behav. Res. Ther.* 87, 76–108.
- Mogg, K., Bradley, B., Miles, F., Dixon, R., 2004. Brief report time course of attentional bias for threat scenes: testing the vigilance-avoidance hypothesis. *Cogn. Emotion.* 18 (5), 689–700.
- Mogg, K., Holmes, A., Garner, M., Bradley, B.P., 2008. Effects of threat cues on attentional shifting, disengagement and response slowing in anxious individuals. *Behav. Res. Ther.* 46 (5), 656–667.
- Mogoşe, C., David, D., Koster, E.H., 2014. Clinical efficacy of attentional bias modification procedures: an updated meta-analysis. *J. Clin. Psychol.* 70 (12), 1133–1157.
- Most, S.B., Chun, M.M., Widders, D.M., Zald, D.H., 2005. Attentional rubbernecking: cognitive control and personality in emotion-induced blindness. *Psychon. Bull. Rev.* 12 (4), 654–661.
- Mountford, V., Waller, G., Watson, D., Scragg, P., 2004. An experimental analysis of the role of schema compensation in anorexia nervosa. *Eating Behav.* 5 (3), 223–230.
- Murphy, R., Nutzinger, D.O., Paul, T., Leplow, B., 2002. Dissociated conditional associative learning in anorexia nervosa. *J. Clin. Exp. Neuropsychol.* 24, 176–186.
- Mustonen, S., Oerlemans, P., Tuorila, H., 2012. Familiarity with and affective responses to foods in 8–11-year-old children. The role of food neophobia and parental education. *Appetite* 58 (3), 777–780.
- Newman, M.G., Llera, S.J., Erickson, T.M., Przeworski, A., Castonguay, L.G., 2013. Worry and generalized anxiety disorder: a review and theoretical synthesis of evidence on nature, etiology, mechanisms, and treatment. *Ann. Rev. Clin. Psychol.* 9, 275–297.
- Öhman, A., 1996. Preferential preattentive processing of threat in anxiety: preparedness and attentional biases. *Curr. Controversies Anxiety Disord.* 2, 253–290.
- Pliner, P., Hobden, K., 1992. Development of a scale to measure the trait of food neophobia in humans. *Appetite* 19 (2), 105–120.
- Posner, M.I., Petersen, S.E., 1990. The attention system of the human brain. *Ann. Rev. Neurosci.* 13 (1), 25–42.
- Quinton, S., 2004. Processing of five types of ‘threat’ information in female dieters and non-dieters. *Eur. Eat. Disord. Rev.* 6 (4), 266–276.
- Raudenbush, B., Capiola, A., 2012. Physiological responses of food neophobics and food neophilics to food and non-food stimuli. *Appetite* 58 (3), 1106–1108.
- Renwick, B., Campbell, I.C., Schmidt, U., 2013a. Attention bias modification: a new approach to the treatment of eating disorders? *Int. J. Eat. Disord.* 46 (5), 496–500.
- Renwick, B., Campbell, I.C., Schmidt, U., 2013b. Review of attentional bias modification: a brain-directed treatment for eating disorders. *Eur. Eat. Disord. Rev.* 21, 464–474.
- Richards, H.J., Benson, V., Donnelly, N., Hadwin, J.A., 2014. Exploring the function of selective attention and hypervigilance for threat in anxiety. *Clin. Psychol. Rev.* 34 (1), 1–13.
- Ridout, N., Thom, C., Wallis, D., 2010. Emotion recognition and alexithymia in females with non-clinical disordered eating. *Eat. Behav.* 11 (1), 1–5.
- Ridout, N., Wallis, D.J., Autwal, Y., Sellis, J., 2012. The influence of emotional intensity on facial emotion recognition in disordered eating. *Appetite* 59 (1), 181–186.
- Schmidt, R., Lüthold, P., Kittel, R., Tetzlaff, A., Hilbert, A., 2016. Visual attentional bias for food in adolescents with binge-eating disorder. *J. Psychiatr. Res.* 80, 22–29.
- Schmidt, N.B., Richey, J., Buckner, J.D., Timpano, K.R., 2009. Attention training for generalized social anxiety disorder. *J. Abnorm. Psychol.* 118, 5–14.

- Schumacher, S.E., Kemps, E., Tiggemann, M., 2016. Bias modification training can alter approach bias and chocolate consumption. *Appetite* 96, 219–224.
- Seddon, K., Waller, G., 2000. Emotional processing and bulimic psychopathology: age as a factor among nonclinical women. *Int. J. Eat. Disord.* 28 (4), 364–369.
- Sharpe, E., Wallis, D., Ridout, N., 2016. The influence of variations in eating disorder-related symptoms on processing of emotional faces in a non-clinical female sample: an eye-tracking study. *Psychiatr. Res.* 240, 321–327.
- Smeets, E., Roefs, A., van Furth, E., Jansen, A., 2008. Attentional bias for body and food in eating disorders; increased distraction, speeded detection, or both? *Behav. Res. Ther.* 46 (2), 229–238.
- Smith, A.D., Herle, M., Fildes, A., Cooke, L., Steinsbekk, S., Llewellyn, C.H., 2017. Food fussiness and food neophobia share a common etiology in early childhood. *J. Child Psychol. Psychiatry.* 58 (2), 189–196.
- Straube, T., Schmidt, S., Weiss, T., Mentzel, H.J., Miltner, W.H., 2009. Dynamic activation of the anterior cingulate cortex during anticipatory anxiety. *NeuroImage* 44 (3), 975–981.
- Stroop, J.R., 1935. Studies of interference in serial verbal reactions. *J. Exp. Psychol.* 18 (6), 643–662.
- Svaldi, J., Gripenstroh, J., Tuschen-Caffier, B., Ehring, T., 2012. Emotion regulation deficits in eating disorders: a marker of eating pathology or general psychopathology? *Psychiatr. Res.* 197 (1-2), 103–111.
- Taylor, C.M., Wernimont, S.M., Northstone, K., Emmett, P.M., 2015. Picky/fussy eating in children: review of definitions, assessment, prevalence and dietary intakes. *Appetite* 95, 349–359.
- Turton, R., Bruidegom, K., Cardi, V., Hirsch, C.R., Treasure, J., 2016. Novel methods to help develop healthier eating habits for eating and weight disorders: a systematic review and meta-analysis. *Neurosci. Biobehav. Rev.* 61, 132–155.
- Wadhera, D., Capaldi-Phillips, E.D., 2014. A review of visual cues associated with food on food acceptance and consumption. *Eat. Behav.* 15 (1), 132–143.
- Werthmann, J., Jansen, A., Vreugdenhil, A.C., Nederkoorn, C., Schyns, G., Roefs, A., 2015. Food through the child's eye: an eye-tracking study on attentional bias for food in healthy-weight children and children with obesity. *Health Psychol.* 34 (12), 1123.
- Williams, J.M., Watts, F.N., MacLeod, C., Mathews, A., 1998. *Cognitive Psychology and Emotional Disorders*. John Wiley & Sons, Chichester, UK.
- Wilson, C., Wallis, D.J., 2013. Attentional bias and slowed disengagement from food and threat stimuli in restrained eaters using a modified Stroop task. *Cogn. Ther. Res.* 37 (1), 127–138.
- Yiend, J., 2010. The effects of emotion on attention: a review of attentional processing of emotional information. *Cogn. Emotion* 24 (1), 3–47.

Further Reading

- Giel, K.E., Friederich, H.C., Teufel, M., Hautzinger, M., Enck, P., Zipfel, S., 2011. Attentional processing of food pictures in individuals with anorexia nervosa- an eye-tracking study. *Biol. Psychiatry.* 69 (7), 661–667.

NON-PRINT ITEM

Abstract

A plethora of research now demonstrates that processes of visual attention towards certain stimuli (particularly threat) influences vulnerability to, and the maintenance of, anxiety disorders. Here parallels can be drawn with food neophobia and the eating disorder literature. As such, the application of knowledge from anxiety research may prove useful in increasing our understanding of food neophobia (and disordered eating more generally). In this chapter, we first present a review of the main components of attentional bias, before demonstrating that similar processes of visual attention (i.e. facilitated engagement, delayed disengagement and/or avoidance) are apparent within both adult and child (disordered) eating. These biases, as with anxiety disorders, could potentially exacerbate the specific eating condition. We also briefly review evidence concerning the effectiveness of attentional training in treating anxiety disorders, and suggest that such therapies may be applicable in the treatment of disordered eating/childhood food neophobia. Thus, we hope our work inspires further investigation of the usefulness of an anxiety-disordered approach when considering future research in this area.

Keywords: Anxiety disorders; eating disorders; childhood food neophobia; picky fussy eating; visual attention; attentional bias modification; disordered eating; facilitated attention; delayed disengagement; avoidance