

A review of existing measures of attentional biases in body image and eating disorders research

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Abstract

Cognitive theories emphasise the important role of attentional biases in the development and maintenance of body image issues and eating pathology. A wealth of research has been conducted to examine attentional biases toward body-related information among individuals with eating pathology. However, there is considerable variability in the methods that have been used to measure attention and, importantly, these methods tap into different attentional processes. Given the multifaceted nature of attention, it is important for researchers to select the right tools to test their hypotheses. This review critically evaluates the attentional measures that have been used in previous research, primarily the modified Stroop task, dot probe task, visual search task, and eyetracking. The strengths and limitations of each measure will be discussed in order to provide a guide for researchers to further investigate the attentional mechanisms underlying body image issues and eating disorders. Overall, we recommend that researchers use a combination of eyetracking technology and specific reaction-time measures that target the specific attentional mechanism of interest.

Key words: attentional bias, body image, dot probe, eyetracking, Stroop, visual search

What is already known about this topic

- Attentional biases figure prominently in cognitive models of body image and eating disorders.
- There is considerable variability in the methods used to measure attention.
- Each of these methods measures a different attentional process and thus addresses a different research question.

What this topic adds

- This review provides a guiding framework to inform researchers' selection of attentional measures appropriate for their research questions.
- Dot probe tasks and visual search tasks are valuable because they allow researchers to differentiate between specific attention mechanisms.
- Eyetracking provides a more observable measure of attention, and could be particularly useful in conjunction with other methods (e.g., the dot probe task).

INTRODUCTION

In recent years, research in the field of body image and eating disorders has increasingly used cognitive models to understand the information processing mechanisms underlying body image issues and clinical eating disorders. In line with cognitive theories of emotional disorders (Beck, 1967, 1985; Beck & Clark, 1988; Beck & Emery, 1985), cognitive

models of eating disorders emphasise the important role of information processing biases (such as biases in attention, memory, judgement, and interpretation) underlying the aetiology and maintenance of body image disturbance and maladaptive eating behaviours (Vitousek & Hollon, 1990; Williamson, White, York-Crowe, & Stewart, 2004). Attentional bias, in particular, has generated the greatest amount of research in this field. Specifically, cognitive models of eating disorders posit that individuals with eating pathology preferentially attend to information that is relevant to their concerns (i.e., schema-relevant information), such as body-related information, and that this attentional bias drives and maintains pathological eating behaviours (Vitousek & Hollon, 1990; Williamson et al., 2004). Although there are various types of disorder-related information (e.g., appearance-

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Received 19 September 2016. Accepted for publication 27 February 2017.

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eating-, food-, and mood-related stimuli) that may be relevant to cognitive models of eating pathology, this article will focus specifically on attentional biases to body-related stimuli (e.g., body-related words and images of body shapes).

A large amount of research has indicated that individuals with eating pathology and body image concerns show attentional biases toward schema-relevant information, but there is also considerable variability in the methods that have been used to measure attention. Importantly, each of these methods measures a slightly different attentional process (such as attentional maintenance, orientation, and disengagement) and tests a different research question pertaining to the attentional postulation of cognitive models. This variability in methods and the fact that they measure different facets of attention can potentially cause confusion in this area of research. There is a lack of guiding framework to inform researchers' selection of attentional measures that are most appropriate for their research questions. Given that attentional processes form such an integral part of cognitive models of eating disorders, a comprehensive methodological review of existing methods to inform future empirical research on attentional biases is warranted. The present review aims to provide such a framework to assist researchers in selecting the right tools to assess the aspects of attention that are of most relevance to the clinical presentation of body image issues and eating disorders. Future research that uses more targeted measures to examine the role of attention in disordered eating and body image will help to drive advances in theory and treatment of such clinical presentations.

Researchers in the field of body image and eating disorders have generally assessed attentional biases in two ways. The first approach, used in most studies, is to examine whether individuals with eating pathology preferentially attend to concern-related information over concern-unrelated information. Studies following this approach have employed a variety of cognitive tasks, such as the modified Stroop task, the dot probe task, and the visual search task. The second approach is more concerned with the specific attentional pattern observed among individuals with eating pathology when they look at images of their own bodies and of other people's bodies. Studies following this approach have typically employed eyetracking techniques to record individuals' gaze patterns. The purpose of the present review is to critically evaluate the strengths and limitations of the various approaches to assessing attentional biases related to body-related information, rather than to provide a systematic review of the research on attentional biases (for reviews summarising the findings of work on attentional biases, see Aspen, Darcy, & Lock, 2013; Dobson & Dozois, 2004; Faunce, 2002; Johansson, Ghaderi, & Andersson, 2005; Lee & Shafran, 2004). The primary methods reviewed include the modified Stroop task, dot probe

task, visual search task, and eyetracking. For each method, the evidence for attentional biases in both clinical and non-clinical populations will be briefly reviewed, followed by a discussion of the strengths and limitations of that measure. Finally, we conclude with some recommendations for future research. Our hope is that this review will provide a guide for researchers seeking to further investigate attentional mechanisms underlying body image issues and eating disorders, just as Thompson (2004) provided a guide for researchers on body image measurement.

Modified Stroop task

The earliest paradigm used to measure attentional bias in the body image and eating disorders literature was based on the Stroop Colour-Naming task (Stroop, 1935), which measures the speed with which participants name the ink colours of words presented to them. Using modified versions of the Stroop task that contain disorder-relevant words, studies have found delayed colour-naming latencies for disorder-relevant words compared to control words in individuals with spider phobia (Watts, McKenna, Sharrock, & Trezise, 1986), social phobia (Mattia, Heimberg, & Hope, 1993), post-traumatic stress disorder (McNally, Amir, & Lipke, 1996; Thrasher, Dalgleish, & Yule, 1994), and depression (Gotlib & McCann, 1984). This delayed colour-naming latency for disorder-relevant words is referred to as the *Stroop interference effect*, and is thought to reflect an attentional bias toward the disorder-relevant words (Williams, Mathews, & MacLeod, 1996). That is, the increased attention to the disorder-relevant word content is believed to interfere with the processing of the ink colour, thereby leading to longer colour-naming latencies.

Most of the studies that examined attentional bias toward body-related information in individuals with eating disorders have used the modified Stroop task (for reviews, see Dobson & Dozois, 2004; Faunce, 2002; Lee & Shafran, 2004). Given that the focus of this review is on cognitive biases toward body-related information, we discuss studies that used weight (e.g., 'heavy', 'scales'), shape (e.g., 'plump', 'bulky'), and body-part words (e.g., 'waist', 'stomach'), but do not include studies that used food- or eating-related words (e.g., 'cake', 'diet'). The only exception is when food- or eating-related words are presented with weight/shape/body-part words in a mixed 'disorder-relevant' category.

Clinical samples

Studies have consistently shown a greater Stroop interference effect for body-related words in individuals with bulimia nervosa (BN) compared to healthy controls (Ben-Tovim & Walker, 1991; Ben-Tovim, Walker, Fok, & Yap, 1989; Cooper, Anastasiades, & Fairburn, 1992; Cooper &

Fairburn, 1992; Cooper & Todd, 1997; Davidson & Wright, 2002; Fairburn, Cooper, Cooper, McKenna, & Anastasiades, 1991; Formea & Burns, 1996; Jones-Chesters, Monsell, & Cooper, 1998; Lovell, Williams, & Hill, 1997; Perpiñá, Hemsley, Treasure, & De Silva, 1993). Note, however, that some of these studies presented a mixture of target words together, including body-, eating-, and food-related words (Cooper & Fairburn, 1992; Cooper et al., 1992; Fairburn et al., 1991; Formea & Burns, 1996), making it difficult to ascertain which specific schema-relevant information (i.e., body, eating, or food) was responsible for driving the interference effects.

Most of the studies on individuals with anorexia nervosa (AN) have found that they show greater Stroop interference effects toward fat-related words (e.g., 'plump') than do healthy control individuals (Ben-Tovim & Walker, 1991; Cooper & Fairburn, 1992; Cooper & Todd, 1997; Green, McKenna, & de Silva, 1994; Green, Wakeling, Elliman, & Rogers, 1998; Jones-Chesters et al., 1998). Interestingly, the Stroop interference effect toward weight, shape, and body-part words has even been found in those who have recovered from AN (Lovell et al., 1997). Only one study (Sackville, Schotte, Touyz, Griffiths, & Beumont, 1998) included thin-related words and found that individuals with AN also showed the Stroop interference effect for these words compared to control participants, but the authors did not specify whether the colour-naming latencies differed between the thin-related words and neutral words for the clinical participants. Dobson and Dozois (2004) suggested that individuals with BN tend to exhibit consistent Stroop interference effects toward a wider range of stimuli (including food-, eating-, and body-related), whereas the effects tend to be limited to body-related information for individuals with AN.

Non-clinical analogue samples

The evidence for Stroop interference effects toward body-related information in non-clinical analogue samples tends to be mixed. A few studies have found that certain subgroups of the non-clinical population, such as restrained eaters (Green & Rogers, 1993; Perpiñá et al., 1993) and dieters with current or previous eating disorder symptomatology (Cooper & Fairburn, 1992), also show Stroop interference effects toward fat-related words (e.g., 'chubby') and body-part words (e.g., 'stomach'). It should be noted that two of these studies (Cooper & Fairburn, 1992; Perpiñá et al., 1993) included participants with eating disorder symptoms and, therefore, it is possible that the Stroop interference effects were driven by eating disorder symptomatology rather than by non-clinical dietary restraint. Some studies have found that this interference effect emerges, or is enhanced, in restrained eaters after they are given a high-

calorie preload to consume before completing the Stroop task, presumably because the preload activates the relevant self-schema (Mahamedi & Heatherton, 1993; Ogden & Greville, 1993). Labarge, Cash, and Brown's (1998) study further suggests that the Stroop interference effect is greatest when the appearance schemas of non-clinical individuals are primed (by being weighed in front of a mirror) prior to the Stroop task. Other studies, however, have failed to find any interference effects toward thin-related words (Sackville et al., 1998), fat-related words (Jansen, Huygens, & Tenney, 1998; Sackville et al., 1998), and body-part words (Huon & Brown, 1996; Jansen et al., 1998) in restrained eaters. Meta-analytic reviews have found either trivial to modest Stroop interference effects for dieting and food-restricting individuals (Dobson & Dozois, 2004), or small Stroop interference effects that did not differ between dieting individuals and control individuals (Johansson et al., 2005).

Summary, strengths, and limitations

Despite some inconsistencies in findings, there is evidence in the literature to indicate that individuals with eating disorders show a Stroop interference effect for words related to their concerns. The evidence is mixed for non-clinical samples, with the most consistent Stroop interference effects emerging when non-clinical individuals are primed by a preload or by being weighed in front of a mirror, presumably because their body-related schema is activated. One advantage of the Stroop task is that it is robust and relatively simple to administer (Mogg & Bradley, 1998), resulting in its wide usage in research on attentional biases. The fact that the modified Stroop task has been widely used in research on a range of psychological disorders also allows for comparisons to be made about attentional biases across different clinical groups, such as with depression. Moreover, the extensive research on the Stroop paradigm has yielded valuable insights and led to the formulation of various models to understand the mechanisms that drive the Stroop interference effect, which can also be applied to understanding attentional biases (Williams et al., 1996).

There are also a number of limitations of the modified Stroop task as a measure of attentional bias. The modified Stroop task offers a measure of attentional bias based on individuals' response latencies, but does not provide information about the actual underlying attentional processes and does not differentiate between different attentional processes (e.g., attentional orientation, maintenance, disengagement). For example, some researchers have suggested that the Stroop interference effect could actually reflect attentional avoidance, with individuals directing their attention away from the schema-related stimuli, rather than attentional preoccupation with the words (de Ruiter &

Brosschot, 1994; Dobson & Dozois, 2004; Rieger et al., 1998). Other researchers have argued that reaction-time measures of attention are limited in that they provide only a single snapshot of the attentional process that may be occurring in the moment that participants make their responses (Armstrong & Olatunji, 2012; Mogg & Bradley, 1998). Armstrong and Olatunji (2012) further argued that there is a distal relationship between the responses required during the reaction time tasks (i.e., verbal colour-naming in the Stroop task) and participants' attention to the stimuli.

Another limitation of the modified Stroop task is that the use of word stimuli limits the ecological validity of the findings. Only one study has used figure drawings of female body shapes in a version of the Stroop task (Walker, Ben-Tovim, Paddick, & McNamara, 1995), and the findings showed that participants with eating disorders were slower to colour-name the female figures than the control stimuli (balls) compared to the control participants. Overall, then, despite the robustness of the Stroop interference effect, this task provides only inferred and ambiguous evidence for an attentional bias, and the specific attentional processes underlying the effect are unclear.

Dot probe task

Given the limitations of the modified Stroop task, some researchers have used the dot probe task (MacLeod, Mathews, & Tata, 1986) to assess whether individuals with eating disorders exhibit an attentional bias toward body-related information. In the dot probe task, participants are presented with pairs of stimuli (e.g., a body-related word and a neutral word), which are subsequently replaced by a probe that appears in the location of one of the stimuli. Participants are asked to respond to the probe as quickly as possible. In this task, the location of the probe can be manipulated such that the probe appears in the previous location of a body-related word on some trials, and in that of a neutral word on other trials. A faster response to a probe that appears in the same location as a body-related word indicates that attention was directed toward the body-related word, whereas a slower response to that probe would suggest that attention was directed away from the word. Thus, the dot probe task allows for the differentiation between vigilance toward and avoidance of body-related stimuli, and is therefore considered as a better (or at least more specific) measure of attentional bias than the modified Stroop task.

Clinical samples

The first study to use a dot probe task to examine attentional bias in individuals with eating disorders found that participants with eating disorders were slower to respond to probes that appeared in the location of thin-related words

(e.g., 'thin') compared to control participants (Rieger et al., 1998). Moreover, participants with eating disorders showed a non-significant trend of responding faster to probes that appeared in the location of fat-related words (e.g., 'fat'). Rieger et al. (1998) concluded that individuals with eating disorders direct their attention *away* from thin-related words, but tend to direct attention *toward* fat-related words. Using a pictorial version of the dot probe task, Shafran, Lee, Cooper, Palmer, and Fairburn (2007) found similar patterns of attentional vigilance toward fat-related pictures (e.g., large thighs) and pictures relating to weight (e.g., scales) in participants with eating disorders compared to healthy control participants. However, contrary to the previous study, Shafran et al. (2007) did not find attentional avoidance of thin-related pictures (e.g., slim figures) in participants with eating disorders compared to healthy controls. The discrepant findings between the two studies could be due to methodological differences in the type of stimuli used (words vs photographs) and stimulus presentation duration (500 vs 1,000 ms).

Non-clinical analogue samples

In contrast to the literature on clinical samples, studies using the dot probe paradigm in non-clinical analogue samples have tended to find no attentional bias for body-related information. For example, there were no differences between restrained and unrestrained eaters (Boon, Vogelzang, & Jansen, 2000; Rieger et al., 1998), between individuals with high and low shape concerns (Shafran et al., 2007), or between individuals scoring high and low on symptoms of body dissatisfaction and drive for thinness (Placanica, Faunce, & Soames-Job, 2002), in their reaction times to probes appearing in the same location as body-related stimuli. Interestingly, Glauert, Rhodes, Fink, and Grammer (2010) found that all individuals responded faster to probes appearing in the location of a picture of a thin body than that of a fat body, regardless of the extent of their body dissatisfaction or internalisation of the thin-ideal, suggesting that most people preferentially attend to thin-related information over fat-related information. However, it should be noted that, in this study, thin body pictures were presented in a pair with fat body pictures rather than in target-neutral pairs as in other studies, which may have exaggerated the effect. In a study that used the dot probe task in conjunction with an eyetracker (Gao et al., 2011), participants with weight dissatisfaction were marginally faster to respond to probes that replaced fat-related words than were control participants. This finding was corroborated by the eyetracking results (described later). There were no differences in reaction time to probes that replaced thin-related words between the weight-dissatisfied group and the control group, which is in line with Shafran et al.'s

(2007) findings on individuals with eating disorders. Overall, there is little evidence from studies using the dot probe task to support an attentional bias among non-clinical individuals.

Summary, strengths, and limitations

Fewer studies have examined attentional bias using the dot probe task compared to the modified Stroop task, and there are also inconsistencies in findings across studies. Overall, research using the dot probe task provided evidence to support an attentional bias in individuals with eating disorders, with individuals directing attention toward fat-related information and perhaps away from thin-related information. In non-clinical samples, however, there is little evidence of attentional biases either toward or away from body-related stimuli.

The dot probe task provides a more specific test of attentional bias than does the modified Stroop task because it allows for attentional vigilance to be differentiated from avoidance. Moreover, the dot probe task overcomes the issue of limited ecological validity of the modified Stroop task because pictorial stimuli can be used (e.g., Shafran et al., 2007). One major strength of the dot probe task is that it allows for the time course of attention to be examined by varying the exposure duration of the stimulus pairs, as is often done in anxiety research. This function of the dot probe task is particularly useful given that anxiety research suggests that the nature of attentional bias may change over time, from initial vigilance to subsequent avoidance (i.e., the vigilance-avoidance hypothesis; Mogg, Bradley, Miles, & Dixon, 2004). For example, researchers studying anxiety have presented stimulus pairs for 500 ms to measure initial vigilance, and 1,500 ms to capture subsequent avoidance (Mogg et al., 2004). Similar approaches could be used to better understand the dynamics of attentional biases toward body-related information. However, one issue with using the dot probe task to examine the time course of attention is that a range of presentation durations would need to be specifically tested in order for researchers to examine individuals' attentional process at intermediate time points (e.g., presentation durations ranging between 500 and 1,500 ms).

Despite its advantages over the modified Stroop task, and the fact that it provides a method of capturing the time course of attention, a common limitation of the dot probe task is that it still relies on individuals' response latencies and keypresses to draw inferences about attentional bias. Therefore, the issues related to reaction-time measures discussed in the Stroop section also apply (Armstrong & Olatunji, 2012). The dot probe task is also limited in its ability to distinguish between other potential attentional processes that may be responsible for individuals' performance on the

task. Specifically, a faster response to probes that replace a target word is a non-specific indicator of the attentional process at play, and can actually reflect a variety of distinct attentional mechanisms. For example, faster response times could indicate that participants sustained attention on the stimulus throughout its presentation (i.e., never disengaged attention) or that they had actually disengaged attention over the course of stimulus presentation but re-engaged prior to stimulus offset (Gao et al., 2011). A related issue that researchers in the area of anxiety have identified is that even a short presentation duration of 500 ms (which is typically used) potentially allows for multiple shifts of attention between items in the stimulus pair, thereby raising questions about the validity of the dot probe task as a measure of initial attention orientation (Bradley, Mogg, & Millar, 2000; Fox, Russo, & Dutton, 2002; Mogg & Bradley, 1998). For example, an individual may have initially oriented to the neutral stimulus and then shifted attention to the target stimulus within the presentation duration of 500 ms. This would lead to a facilitated response to the probe that subsequently replaces the target stimulus and falsely indicate that initial attention was oriented to the target stimulus, even though a shift of attention had occurred within the presentation duration.

A final point about this task is that traditional dot probe tasks also do not differentiate between vigilance (facilitated detection) and difficulty with disengaging attention from body-related stimuli, both of which can result in a faster response to probes following body-related stimuli (Koster, Crombez, Verschuere, & De Houwer, 2004; Shafran et al., 2007) but for different reasons. This limitation can be overcome by comparing individuals' reaction times on neutral trials (i.e., two neutral stimuli) with reaction times on target trials (i.e., one target stimulus and one neutral stimulus; Kemps & Tiggemann, 2009; Koster et al., 2004). Specifically, a faster response to probes that replace a target word on target trials compared to probes that replace a neutral word on neutral trials would indicate attentional vigilance. Difficulty with disengaging attention from disorder-relevant stimuli would be reflected by a slower response to probes that replace a neutral word on target trials than on neutral trials, as a result of the extra time needed to shift attention from the location of the target word to the location of the neutral word.

Visual search task

Two studies (Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010; Smeets, Roefs, van Furth, & Jansen, 2008) have attempted to uncover the specific processes that underlie the attentional bias of individuals with eating disorders by using an odd-one-out visual search paradigm (Hansen & Hansen, 1988). In this task, participants are presented with

matrices of words, and are asked to indicate whether the matrices contain words of the same category or whether they contain an odd-one-out target word from a different category. The matrices either include an odd-one-out target word that was schema-relevant (i.e., a body-related word or a high-calorie food) or neutral (e.g., musical instruments) against a background of neutral distracter words from a different category (e.g., countries), or include a neutral target word against a background of schema-relevant distracter words. Smeets et al. (2008) proposed that attentional biases underlying eating disorders could be divided into two main processes: speeded detection and increased distraction. Speeded detection of body-related information is indicated when an individual is faster at detecting a body-related target word than a neutral target word against a background of neutral distracter words (from a different category to the target). Increased distraction (also referred to as slowed disengagement by Hollitt et al., 2010) is indicated when an individual is slower to detect a neutral target word against a background of body-related distracter words than against a background of neutral distracter words from a different category.

Clinical samples

Using this visual search task, Smeets et al. (2008) found that individuals with AN and BN showed speeded detection of, but not increased distraction by, body-related information compared with control participants.

Non-clinical analogue samples

There is only one study (Smeets et al., 2011) that has used the visual search task to examine individuals' attentional patterns toward body-related information, and that study involved a body-checking priming manipulation. Participants in that study who had higher body dissatisfaction, as a result of being primed to body-check, showed speeded detection of body-related words compared to those in control conditions. A second visual search study involving a sample of restrained eaters included only food-related words. Hollitt et al. (2010) found that restrained eaters showed speeded detection of high-calorie food words (e.g., 'chocolate') but not slowed disengagement from such words. These findings suggest that, although restrained eaters have heightened vigilance toward high-calorie food-related information, this attention is not sustained.

Summary, strengths, and limitations

Research using the visual search task demonstrated that individuals with eating disorders have heightened initial vigilance toward body-related information, but they have no difficulty disengaging attention from this information. The same heightened initial vigilance toward body-related

information has also been found among individuals who have elevated body dissatisfaction as a result of a body-checking priming manipulation. Moreover, there is evidence to suggest that restrained eaters show heightened initial vigilance toward food-related information.

The visual search task provides a more refined analysis of attentional bias toward body-related information, but there are still aspects of the attentional processes that remain unclear. In this task, the relative speed with which individuals detect a neutral target word against a background of disorder-relevant distracter words is used to indicate the extent to which they were distracted by (or had difficulty disengaging attention from) the disorder-relevant words. As discussed earlier in relation to the dot probe task, a similar issue with this measure is that it can also reflect two distinct attentional patterns. Specifically, an individual may be slower to detect the neutral target word because of their sustained attention on the disorder-relevant distracter words, or because they are exhibiting a cyclic pattern of attentional disengagement and re-engagement toward the disorder-relevant distracter words. Indeed, other researchers have similarly suggested that, given the mean response latencies in the studies that used the visual search task were approximately 4 s, the process of attentional engagement, disengagement, and re-engagement toward disorder-relevant stimuli could have occurred several times prior to the execution of a response (Gao et al., 2013). Both sustained attention and the cyclic pattern can contribute to increased distraction, but the latter would perhaps be a stronger indicator of the extent of individuals' difficulty with disengaging attention given the extra effort exhibited to re-engage attention. It is important to differentiate between these two processes because anxiety researchers have suggested that a cyclic pattern of attention toward threat-related stimuli can interfere with habituation to threat, thereby maintaining anxiety in the long-term (Mogg & Bradley, 1998). Similarly, a cyclic pattern of attention toward body-related information might maintain body image concerns in the long-term.

Eyetracking techniques

The cognitive tasks described thus far have inferred attentional bias from the latencies of individuals' response to body-related information, but they have not assessed the actual amount of attention that individuals allocate to the body-related stimuli. In contrast to these reaction-time methods, eyetracking techniques offer a continuous measure that allows researchers to directly examine eyegaze parameters such as the proportion of time that individuals spend looking at the stimulus, the speed with which individuals orient to the stimulus following its onset, as well as the frequency of fixations (i.e., the number of discrete

looks) exhibited when presented with the stimulus. These eye movements are thought to be guided by selective attention (Kowler, 1995; Mogg, Millar, & Bradley, 2000) in that individuals tend to look more often and for longer at stimuli that attract their attention (Jonides, 1981; Klein, Kingstone, & Pontefract, 1995). Thus, eyetracking provides a relatively unambiguous measure of attentional allocation and is therefore a valuable complement to studies that used cognitive tasks. Eyetracking studies in the field of body image and eating disorders research have typically examined individuals' gaze patterns when they view images of their own bodies and the bodies of others.

Clinical samples

Existing eyetracking studies have indicated that, when individuals with eating disorders view images of themselves, they spend more time looking at body regions that they are most dissatisfied with, such as their thighs (von Wietersheim et al., 2012), or abdomen and legs (Freeman et al., 1991). In contrast, when these individuals view images of other people, they do not show the same preferential attention toward the dissatisfied body regions (von Wietersheim et al., 2012). However, one study involving adolescents found that, although participants with eating disorders directed more attention toward the abdomen, hips, buttocks, and upper leg regions (which are body regions typically considered as unattractive), the healthy control participants also demonstrated similar attentional patterns (Horndasch et al., 2012).

Other eyetracking studies have examined how individuals with eating disorders allocate attention when there is competition between images of themselves and images of other people (that is, one cannot simultaneously look at both images and so must direct attention to one or the other). Blechert, Ansorge, and Tuschen-Caffier (2010) presented participants with images of themselves and of another person concurrently in a dot probe task, and found that participants with AN exhibited shorter saccade latencies (i.e., shorter latency between the image onset and the execution of a saccade) toward images of themselves than toward images of another person. Participants with BN showed a non-significant trend in the opposite direction (i.e., shorter saccades toward images of another person). Thus, the findings suggest that individuals with AN, but not those with BN, show preferential attention toward body-related information that is self-relevant. In another study, Blechert, Nickert, Caffier, and Tuschen-Caffier (2009) simultaneously presented participants with an image of themselves and six other people (three with low body mass index (BMI) and three with high BMI) and examined the length of eyegaze to these images. Participants with BN spent a longer time looking at the bodies with low BMI,

and a shorter time looking at the bodies with high BMI, than did control participants. There were no differences in looking time at images of themselves between participants with BN and healthy controls, which further supports the idea that individuals with BN do not exhibit preferential attention toward self-relevant body information.

Non-clinical analogue samples

Studies using eyetracking techniques have tended to find similar attentional patterns between clinical and non-clinical samples. For example, Jansen, Nederkoorn, and Mulken (2005) found that individuals with subclinical eating disorder psychopathology (e.g., dietary restraint, concerns about eating, shape, and weight) also tended to direct more attention toward self-identified unattractive parts of their own bodies than toward self-identified attractive parts. However, when viewing images of other people's bodies, these participants tended to direct more attention toward the attractive parts than toward the unattractive parts. The opposite pattern of results was found for control participants. Furthermore, the attentional bias was related to individuals' perception of their own bodies (Roefs et al., 2008). Specifically, Roefs et al. (2008) found that participants with a higher BMI and a more negative perception of their own bodies tended to direct more attention toward perceived unattractive parts of their own bodies but toward perceived attractive parts of others' bodies. Participants with a lower BMI or those who have a more positive perception of their own bodies showed the opposite pattern of attention. Thus, the pattern of eyegaze toward images of themselves among non-clinical samples replicates that of individuals with clinical eating disorders.

The evidence in relation to individuals' gaze patterns when viewing images of other people is somewhat mixed. Some studies have found that individuals with high drive for thinness (Janelle, Hausenblas, Fallon, & Gardner, 2003) and high body dissatisfaction (Janelle, Hausenblas, Ellis, Coombes, & Duley, 2009) tended to direct attention away from the body regions of other people that are typically associated with dissatisfaction. Another study, however, found that participants with a higher drive for thinness allocate more attention to the body regions typically associated with dissatisfaction, such as the waist, hips, and legs, when viewing images of males and females (Hewig et al., 2008). Moreover, the study by Janelle et al. (2009) also found that individuals with high body dissatisfaction paid more attention to the leg region of a thin model, which is contrary to the earlier study (Janelle et al., 2003) that found reduced attention to that region. Eyetracking studies have also found that individuals' pattern of attention on specific body regions also change over time. Janelle et al. (2009) showed that individuals with high body dissatisfaction tended to

fixate longer on the chest and leg regions than did individuals with low body dissatisfaction but only *late* in the 5-s presentation periods (at roughly the 4-s mark). The authors suggested that this attentional maintenance at later time periods indicate that individuals with high body dissatisfaction may have difficulty disengaging their attention from these regions once the regions are fixated upon. This study highlights the usefulness of eyetracking techniques in capturing changes in attentional patterns over time.

In addition to studies examining the body regions that individuals with eating pathology tend to focus on, three studies have used eyetracking techniques to corroborate the findings from research using cognitive tasks (Gao et al., 2011, 2014; Jiang & Vartanian, 2012). Gao et al. (2011) found that individuals with weight dissatisfaction showed speeded detection of both thin- and fat-related words compared to control participants. This eyetracking result corroborates the dot probe finding that the weight-dissatisfied participants were somewhat faster to detect probes following fat-related words (described earlier in this review). However, speeded detection of thin-related words among weight-dissatisfied participants was also indicated in the eyetracking data, which is in contrast to the dot probe finding of no group differences in reaction time to probes replacing thin-related words. Moreover, the eyetracking results showed that individuals with weight dissatisfaction spent less time looking at (i.e., shorter fixation durations on) thin-related words (but not fat-related words) than did control participants, which was also not reflected in their dot probe performance. In contrast to these findings, however, another study using pictorial stimuli found that individuals with weight dissatisfaction, relative to control individuals, showed *longer* fixations on and were *slower* to detect both thin and overweight body images (Gao et al., 2014). Further adding to the inconsistency in findings, Jiang and Vartanian (2012) found no differences between restrained and unrestrained eaters in their fixation duration on both thin and overweight images; both groups showed longer fixations on thin and overweight images compared to control images. The absence of attentional differences between groups led to the authors' suggestion that the Stroop interference effects found among non-clinical samples in previous studies may not actually reflect differences in the actual amount of attention allocated to the body-related stimuli, but may instead reflect differences in how individuals with and without body image concerns process body-related information.

Summary, strengths, and limitations

The evidence from eyetracking studies suggests that individuals with eating disorders and non-clinical individuals share similar patterns of attentional allocation when viewing images of themselves and of other people. Both clinical

(Freeman et al., 1991; von Wietersheim et al., 2012) and non-clinical individuals (Jansen et al., 2005; Roefs et al., 2008) tend to preferentially attend to regions of their own bodies that are typically considered to be unattractive or that they are most dissatisfied with. Although there are some inconsistencies in the findings that have emerged across studies regarding the pattern of eyegaze toward images of other people, the evidence generally indicates that both clinical and non-clinical groups tend to focus attention away from unattractive body regions when viewing images of others (Janelle et al., 2003, 2009; Jansen et al., 2005; Roefs et al., 2008).

Studies assessing preferential attention to body-related information compared to other competing information, which may be a more direct test of the attentional postulate of cognitive theories (Vitousek & Hollon, 1990; Williamson et al., 2004), have yielded mixed results regarding the attentional patterns of non-clinical samples. The mixed findings across those three eyetracking studies suggests that the visual attentional patterns toward body-related information among non-clinical individuals may be more nuanced than hypothesised in cognitive theories. That is, whether (and the type of) biases in visual attention are observed appears to depend on the type of stimuli or task used, and the sample of individuals tested.

An advantage that eyetracking studies have over studies that used cognitive tasks is that, aside from a few exceptions, the majority of the cognitive tasks involved word stimuli. Body image concerns are more often related to visual stimuli than words (written or auditory) in the real world. Although word-based stimuli can provide some insights about the type of cognitive concepts that individuals are preoccupied with (e.g., fat-related information), they do not capture the types of stimuli that are likely to play an important role in an individual's body image in their everyday lives. For example, media images of thin models and the body shapes of other individuals in social contexts are some types of body-related information that individual frequently encounter in the real world, and exposure to these visual images can negatively impact body satisfaction in people's everyday lives (e.g., Fardouly, Pinkus, & Vartanian, 2017). Eyetracking techniques also offer a more continuous measure of attention, and can therefore better assess the patterns underlying prolonged or sustained attentional processing (e.g., continuous disengagement and re-engagement of attention) than can cognitive tasks that measure participants' response latencies at a single time point. Indeed, Gao et al.'s (2011) study demonstrated that eyetracking may be better able to detect further attentional differences between non-clinical individuals and healthy controls that could not otherwise be captured using the dot probe task. This evidence further reinforces the value of eyetracking techniques as an important complement to cognitive tasks in

examining attention. Moreover, given that eyetracking techniques allow for virtually continuous recording of attention, they are a better tool for examining the time course of attention (Gao et al., 2014; Janelle et al., 2009) compared to the dot probe task. That is, eyetracking techniques overcome the limitation of dot probe tasks that various intermediate time points between a specific duration of interest have to be specifically measured in order to capture the full time course of the attentional pattern.

Another major advantage of eyetracking techniques is that a wide range of eyegaze indices can be measured or derived from eyetracking data to capture different mechanisms of attention. For example, in the anxiety and depression literature, attentional vigilance has typically been captured using the frequency and latency of initial fixations (i.e., the frequency of and speed with which initial fixations are captured by the target stimuli), or by examining fixation duration in an early time period (e.g., first 500 ms of viewing period; Armstrong & Olatunji, 2012). Attentional maintenance has been measured by duration of initial fixation, total fixation duration over the entire viewing period (more common in the depression literature), or by examining fixation duration in later time periods of viewing (e.g., between 1,000 and 2,000 ms; Armstrong & Olatunji, 2012). Finally, attentional avoidance is reflected in the location and duration of fixations, and the changes in fixations as a function of time. For example, attentional avoidance can manifest in briefer initial fixations on the target stimuli and an orientation away from the target stimuli (Garner, Mogg, & Bradley, 2006). The use of eyetracking in the body image and eating disorders literature is less extensive compared to the anxiety and depression literatures, and the majority of the existing eyetracking studies only examine individuals' visual scanning patterns. Although examining visual scanning patterns can provide some insights into the type of stimuli that individuals preferentially allocate attention to, it does not provide insight into the attentional mechanisms that underlie the bias (e.g., whether it is a bias in attentional orientation, maintenance, or disengagement). Among the eyetracking studies that have examined these attentional mechanisms, similar eyegaze parameters to anxiety and depression studies were used. Specifically, the frequency and latency of initial fixations have been used to indicate attentional vigilance (Gao et al., 2011, 2014), and first fixation duration (Gao et al., 2011, 2014) and total fixation duration (Gao et al., 2011; Giel et al., 2011; Jiang & Vartanian, 2012) have both been used as a measure of attentional maintenance.

Evidently, there is some variability in terms of the specific eyegaze index that is used to indicate the same attentional mechanism (i.e., there is variability in the operational definition of the attentional mechanism), depending on the type of task used and the area of literature we turn to. For example, the duration of initial fixation is used to indicate

attentional maintenance in anxiety research, whereas the total fixation duration is used in depression research. Furthermore, attentional vigilance is more often measured by direction and frequency of initial fixation in a free viewing task, but by latency of fixation (i.e., speeded detection) in a visual search task (Armstrong & Olatunji, 2012). Thus, researchers need to consider the type of task that is used and which aspect of the attentional process is most important to their research question (e.g., whether initial attentional maintenance or prolonged attentional maintenance overall has more implications for body image issues) in order to choose the most appropriate eyegaze parameters for the study.

Another issue that has been raised in eyetracking research is that the eyegaze parameters used in existing research (e.g., fixation duration) index overt attention but fail to account for covert attention (i.e., shifts in attentional focus that occur without re-orienting of gaze or other overt eye movements). Overt eye movements are typically guided and preceded by covert orienting of attention (Klein et al., 1995; Kowler, 1995), although they may not always correspond (Bradley et al., 2000). Some researchers in the field of body image and eating disorders have attempted to overcome this issue by measuring saccades and saccade latencies (Blechert et al., 2010; Gao et al., 2014), whereas other researchers in the field of anxiety have argued for eyetracking techniques to be used in conjunction with cognitive tasks, such as the dot probe task, to better capture both overt and covert attentional processes (e.g., Bradley et al., 2000). Thus, although eyetracking techniques overcome some major limitations of cognitive tasks by offering a more directly observable and continuous measure of attention, researchers who choose to use such techniques need to carefully consider which attentional mechanism is of interest to them (in order to select the most appropriate eyegaze parameter) and whether covert attention is central to their research question.

Other methods

The methods reviewed thus far compose the majority of the experimental research that has been conducted on attentional bias in the field of body image and eating disorders. This next section summarises the other available methods that have also been used, although less extensively, in research on individuals with eating pathology.

Dichotic listening task

A method that is considered to be a more naturalistic measure of attentional bias compared to some of the other cognitive tasks described above is the dichotic listening task (Osorio, Cohen, Escobar, Salkowski-Bartlett, & Compton, 2003). The dichotic listening task is a perceptual measure in

which participants are simultaneously presented with different prose passages in each ear, and are instructed to attend to and repeat aloud (shadow) only one of the passages. Participants typically have difficulty detecting words in the unattended passage unless the words are particularly salient or have personal significance (Burgess, Jones, Robertson, Radcliffe, & Emerson, 1981). In an early study by Schotte, McNally, and Turner (1990), individuals with BN and healthy controls were presented with the word 'fat' and a control word 'pick' in the attended and unattended passage, and participants were asked to shadow the attended passage and also to press a button whenever they detected the target words (i.e., 'fat' or 'pick') in either the attended or unattended passage. Participants' skin conductance response was also measured during this task. Schotte et al. (1990) found that participants with BN detected the word 'fat' more often than the control word in the unattended passage, but there was no such difference for the attended passage. The study also found that participants with BN showed greater skin-conductance responses toward the word 'fat' than toward the control word. Thus, the authors concluded that individuals with eating disorders may have greater perceptual sensitivity and physiological reactivity toward body-related information. Similarly, the dichotic listening task has also provided evidence in support of an attentional bias among non-clinical analogue samples. Li, Jackson, and Chen (2011) found that individuals with high weight dissatisfaction made more errors in shadowing the attended passage when fat- and thin-related words were presented in the unattended passage, compared to individuals with low weight dissatisfaction. A limitation of the dichotic listening task is that it uses only auditory stimuli and, therefore, the findings do not provide insight into how people attend to visual stimuli which, as mentioned earlier, may have more real-world implications.

Lexical decision task

Cassin, von Ranson, and Whiteford (2008) adopted a lexical decision test (LDT) to measure attentional bias in individuals with high thin-ideal internalisation. The LDT involves presenting participants with a word or non-word on the screen, and participants are required to determine as quickly as possible whether the presented item is a word or a non-word. Contrary to the modified Stroop task, a faster response to body-related words in the LDT is indicative of vigilance, whereas a slower response to body-related words would suggest avoidance. The underlying assumption is that a body self-schema should facilitate individuals' recognition of schema-consistent words. Moreover, Cassin et al. (2008) exposed all participants to images of swimsuit models or neutral images (cars) prior to the LDT in order to activate participants' body self-schema. The authors argued that the

absence of an attentional bias found in non-clinical analogue populations in previous studies may be due to the fact that the individuals' body self-schemas were not activated prior to attentional assessment. The findings of this study showed that women with high thin-ideal internalisation did not show vigilance toward body-related words (including thin- and fat-related words), but did show vigilance toward words relating to attractiveness (e.g., 'pretty'). One issue with using the LDT is that performance on the task may reflect the ease with which individuals process body-related words, rather than measuring the actual attentional process that individuals exhibit toward the body-related words (e.g., attentional orientation and maintenance). Indeed, the LDT has been used in other studies as a measure of processing biases underlying body image concerns (Barlett, Smith, & Harris, 2006). Thus, this task is not comparable to the other methods described in this review, which were specifically designed to capture how individuals attend to body-related information. Finally, as with most of the cognitive tasks described in this review, the LDT is limited to using only word stimuli, which reduces the ecological validity of the findings.

Spatial cueing task

A limitation of all of the methods reviewed so far is the lack of specificity in measuring attentional disengagement. As a result, some researchers have turned to the spatial cueing paradigm to capture this process (e.g., Fox et al., 2002; Gao et al., 2013). In a spatial cueing task, participants are presented with a cue word on either the left or right side of the screen, followed by a target that either appears in the same (i.e., valid trials) or opposite (i.e., invalid trials) location as the cue word, and participants are asked to respond to the location of the target. Participants typically respond faster on valid trials than on invalid trials when the time interval between the onset of the cue word and the onset of the target (referred to as the cue-target stimulus onset asynchrony; SOA) is short, presumably because participants' attention is allocated to the cue word. As the SOA increases, however, participants tend to respond slower on valid trials than on invalid trials. This performance decrement for longer SOAs on valid trials than on invalid trials is referred to as the inhibition of return (IOR) effect, and is thought to reflect a process whereby individuals' visual attention is inhibited from returning to a location that has already been searched (i.e., allowing individuals to disengage attention away from an old location) in order to prioritise attention to a new location (Posner & Cohen, 1984). The size of the IOR effects is thought to reflect individuals' capacity to disengage attention from the cue word. Research in the field of anxiety has shown that the magnitude of the IOR effect is reduced when emotionally salient stimuli (e.g., angry facial

expressions) were used as cues compared to neutral stimuli (Fox et al., 2002). Using this paradigm, Gao et al. (2013) showed that individuals with high weight dissatisfaction demonstrated difficulties with attentional disengagement from both thin and overweight body pictures. Although the spatial cueing task may provide a more targeted measure of attentional disengagement, a limitation of this measure is that it does not capture any other attentional mechanisms (e.g., initial attention orientation or attentional maintenance), and thus provides an incomplete picture of the attentional biases toward body-related stimuli.

DISCUSSION

Attention is not a unitary mechanism and it encompasses a variety of distinct components, including (but not limited to) attentional maintenance, orientation, disengagement, and even repeated cycles of engagement, disengagement, and re-engagement. This multifaceted nature of attention, in conjunction with the variability in the methods that have been used in previous literature, makes the selection of a method that is most appropriate for the research question of interest a complex task. Thus, this review sought to provide an integrated evaluation of the strengths and limitations of existing methods of measuring attentional bias in research on body image and eating disorders, to serve as a guide for researchers interested in investigating the attentional mechanisms underlying these issues.

Summary and implications of methodology

The modified Stroop task is the most widely used method for assessing attentional bias in the field of body image and eating disorders research. The Stroop interference effect has traditionally been used to reflect attentional maintenance, but can also indicate attentional avoidance. The dot probe task and visual search task both have advantages over the modified Stroop task in that they can differentiate between specific attentional mechanisms. The dot probe task allows for a distinction to be made between attentional maintenance and avoidance. The visual search task is further able to differentiate between and capture vigilance (i.e., the speed with which individuals' attention is drawn to disorder-relevant stimuli), and difficulty with attentional disengagement (i.e., the extent to which disorder-relevant information continuously captures individuals' attention). Given that each of these reaction-time measures capture different aspects of attention, the attentional measure that researchers choose should depend on the specific attentional mechanism that is relevant to their research question.

As highlighted throughout the review, all reaction-time measures of attention are limited in their ability to capture the dynamic process of attention over time (Armstrong &

Olatunji, 2012), given that they only provide a single snapshot of the attentional process at the time of response execution (i.e., key presses in the dot probe task and visual search task, and colour-naming in the Stroop task). The dot probe task can be used to capture changes in attention over time, but only if a wide range of presentation durations are specifically tested. Moreover, other researchers have argued that the distal relationship between a reaction-time response and individuals' attention to the stimuli means that these tasks are susceptible to other confounding processes that can mediate a response (Armstrong & Olatunji, 2012; Pe, Vandekerckhove, & Kuppens, 2013). For example, a slow response time could be brought about by slowed processing speed, encoding, or response execution, and not necessarily due to biased attentional processes. A statistical solution to this limitation of reaction-time variables in accounting for the complexity of the processes underlying a response is to use a diffusion model (Pe et al., 2013; Ratcliff, 1978) or a linear ballistic accumulator model (Brown & Heathcote, 2008) to analyse the reaction-time data. These models examine rates of evidence accumulation, response caution, and time taken for non-decision processes to capture and isolate the complex processes that underlie a response decision.

As an alternative, we recommend that researchers supplement reaction-time measures with eyetracking technology, which provides a continuous measure of overt visual attention. In this way, cognitive indices of attentional bias (such as speeded detection on the visual search task) can be corroborated by eyegaze indices (such as time of first fixation). By combining eyetracking with specific reaction-time measures, researchers can obtain both cognitive and overt visual indications of biased attentional mechanisms, and further uncover the nature of these attentional mechanisms. For example, speeded detection of target stimuli indicated on a cognitive task could be due to the fact that fewer fixations are needed to reach the target stimuli, or it could be due to a shorter dwell time on non-target distracters. One caveat is that researchers need to consider all the different eyegaze parameters that are thought to tap into the same attentional mechanism, in order to select the most appropriate parameter to test their hypotheses.

Implications for the cognitive model and future directions

Cognitive theories of eating disorders (Vitousek & Hollon, 1990; Williamson et al., 2004) posit that individuals with eating pathology will preferentially attend to information that is related to their body self-schemas, such as body-related information. However, the exact nature of this attentional bias is unclear. Researchers in other fields such

as anxiety and depression have highlighted that it is more important to examine which specific aspects of the attentional process are systematically biased, rather than simply determining whether or not a disorder is associated with 'an attentional bias' (e.g., Armstrong & Olatunji, 2012; Mogg & Bradley, 1998). The importance of identifying and differentiating between specific attentional mechanisms that are thought to be biased lies in the idea that different biased attentional mechanisms could have specific implications for treatment. For example, in anxiety, an unstable cyclic pattern of attentional engagement, disengagement, and re-engagement is thought to interfere with an individuals' habituation to threat, potentially because it allows only brief exposure to threat (Mogg & Bradley, 1998; Rachman, 1998). In response to this unstable cyclic pattern of attention, attention bias modification interventions that focus on reducing the repeated shifts of attention away and toward the threat stimuli to achieve a more stable pattern of sustained attention may be useful, in order to allow habituation to the threat stimuli to occur. Models of anxiety also highlight the important role that biases in initial attentional orientation has in the aetiology and maintenance of anxiety (Mathews & MacLeod, 1994). To target this biased attentional mechanism, attention retraining would instead focus on training individuals to stop orienting to threat and adopt an avoidant attentional style (Mogg & Bradley, 1998). The different treatment implications associated with specific attentional mechanisms suggest that existing cognitive models of eating disorders need to be expanded to incorporate different aspects of attention. Specifically, the postulation regarding preferential attentional allocation towards schema-related information needs to be refined to be more specific about the actual attentional mechanism that is thought to be biased. Refining existing cognitive models will contribute to a better understanding of the development and maintenance of body dissatisfaction and eating disorders, and inform more targeted interventions. Thus, it may be useful for future research to compare individuals' performance on different attentional measures to differentiate the specific aspect of attention that is systematically biased in the context of body-related information.

The present review focused on studies that examined individuals' attention towards body-related information only. Other research has demonstrated that individuals with eating pathology also show attentional bias to food (Brooks, Prince, Stahl, Campbell, & Treasure, 2011), emotional stimuli (e.g., angry faces; Harrison, Sullivan, Tchanturia, & Treasure, 2010), self-directed ego threats (e.g., 'failure'; McManus, Waller, & Chadwick, 1996; Waller, Watkins, Shuck, & McManus, 1996), and other threat stimuli (e.g., 'powerless', 'blood'; McManus et al., 1996). It is important for future research to use different attentional measures to clarify the biased attentional processes that individuals

with eating disorders exhibit towards other types of information in order to further refine existing cognitive models.

In the body image and eating disorders literature, studies have differentiated between specific biases of speeded detection and increased distraction (Hollitt et al., 2010; Smeets et al., 2008), attentional maintenance (Gao et al., 2011, 2014), and difficulty with attentional disengagement (Gao et al., 2013). Further examinations of the specific biased attentional mechanisms underlying eating pathology could potentially add to cognitive theories (Vitousek & Hollon, 1990; Williamson et al., 2004) and inform more targeted treatment. Moreover, measures of attention have often been used post-intervention to assess the effect of treatment on attentional biases (e.g., Green et al., 1998; Lovell et al., 1997). Given the multifaceted nature of attention, it may be worthwhile for future research to examine the effect of treatment using a variety of attentional measures. Thus, it is important for researchers to consider which specific attentional mechanism is of interest to them or is most appropriate for the research question that is being asked, and to select the most appropriate measure of attention accordingly. It may be that using a combination of eyetracking and cognitive tasks provides a more comprehensive picture of the attentional processes at play. Selecting the right measures of attention will help to move the field forward by disentangling the different biased attentional mechanisms that may be driving body image issues and eating disorders.

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