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REVIEW

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Attentional bias in eating disorders: A meta-review

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Abstract

Objective: This meta-review summarizes and synthesizes the most reliable findings regarding attentional bias in eating disorders across paradigms and stimulus types and considers implications for theory and future research.

Method: Four databases were systematically searched, along with reference lists of included reviews, yielding 15 systematic reviews (four of which were also meta-analyses). The quality of each review was appraised using the AMSTAR-2.

Results: Key findings from systematic reviews are summarized, organized by paradigm and stimulus type.

Discussion: The authors synthesize evidence from the highest-quality studies. There is evidence for attentional avoidance and vigilance in eating disorders depending on stimulus properties (low vs. high-calorie food; high-body mass vs. low-body mass index photos of others) and attentional avoidance of food stimuli in those with anorexia nervosa. Sad mood induction may generate attentional bias for food in those with binge-eating disorder. There may also be attentional bias to general threat in eating disorder samples. This meta-review concludes that most systematic reviews in this field are low in quality and summarizes the main areas that could be improved upon in future reviews. Implications of this study's findings for theory and intervention research are also discussed.

Resumen

Objetivo: Esta meta-revisión resume y sintetiza los hallazgos más confiables con respecto al sesgo de atención en los trastornos de la conducta alimentaria a través de paradigmas y tipos de estímulos y considera las implicaciones para la teoría y la investigación futura.

Método: Se realizaron búsquedas sistemáticas en cuatro bases de datos, junto con listas de referencias de las revisiones incluidas, lo que arrojó 15 revisiones sistemáticas (cuatro de las cuales también fueron metanálisis). La calidad de cada revisión se evaluó mediante el AMSTAR-2.

Resultados: Se resumen los hallazgos clave de las revisiones sistemáticas, organizados por paradigma y tipo de estímulo.

Discusión: Los autores sintetizan evidencia de estudios de la más alta calidad. Existe evidencia de evitación atencional y vigilancia en los trastornos alimentarios dependiendo de las propiedades de los estímulos (alimentos bajos en caloróas frente

a alimentos ricos en calorías; fotos de otros con índice de masa corporal alto o bajo) y la evitación atencional de los estímulos alimentarios en personas con anorexia nerviosa. La inducción del estado de ánimo triste puede generar un sesgo de atención hacia la comida en personas con trastorno por atracón. También puede haber un sesgo de atención a la amenaza general en las muestras de trastornos alimentarios. Esta meta-revisión concluye que la mayoría de las revisiones sistemáticas en este campo son de baja calidad y resume las áreas principales que podrían mejorarse en revisiones futuras. También se discuten las implicaciones de los hallazgos de este estudio para la investigación de la teoría y la intervención.

KEYWORDS
anorexia nervosa, attentional bias, binge-eating disorder, bulimia nervosa, dot probe task, eating disorders, eye-tracking, meta-review, Stroop, systematic review

1 | INTRODUCTION

Cognitive theories have proposed that biases in information processing maintain problematic emotional states such as generalized anxiety (e.g., Eysenck, 2013), and there have been investigations into attentional bias across a range of presentations, including eating disorders (e.g., Dondzilo, Rieger, Palermo, Byrne, & Bell, 2017; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007). The remarkable volume of studies in this field has led to a variety of systematic reviews and meta-analyses, whose purpose is to summarize and synthesize different researchers' findings (Mulrow, 1994).

Smith, Devane, Begley, and Clarke (2011) noted that those looking for a summary of the best evidence on a particular topic may become overwhelmed as reviews become more numerous. These authors also remarked on the added challenge of variability in the quality and scope of review articles. These problems are evident in the field of attentional bias in eating disorders; for example, some reviews include articles resulting from a single database search (e.g., Aspen, Darcy, & Lock, 2013), whereas others search more comprehensively across multiple databases (e.g., Kerr-Gaffney, Harrison, & Tchanturia, 2019). Furthermore, only some reviews consider whether primary studies have taken risk of bias into account (e.g., Ralph-Nearman, Achee, Lapidus, Stewart, & Filik, 2019).

Reviews in this area vary greatly in their scope, and for understandable reasons. For one, attentional bias in eating disorders has been measured with a variety of paradigms, each purporting to measure different aspects of attention and doing so with varying degrees of reliability (to be discussed further below). Furthermore, primary studies have focused on different diagnoses and diagnostic subtypes, in order to understand particular attentional biases associated with these presentations. Researchers have also attempted to specify the particular attentional targets that may engender attentional bias in different contexts—not only words and pictorial stimuli but also, within these categories, stimuli that tap into a range of themes: emotional, food-related, and weight-related, to name a few. As a result, some reviews narrow their focus to particular diagnoses (e.g., binge-eating disorder: Kittel, Brauhardt, & Hilbert, 2015; bulimia nervosa: DeJong et al., 2013), others focus on a subset of attentional bias paradigms (e.g., the Stroop paradigm: Johansson, Ghaderi, & Andersson, 2005; the dot probe task: Renwick, Campbell, & Schmidt, 2013; the eye-tracking paradigm: Kerr-Gaffney et al., 2019) and some focus on particular stimuli (e.g., food stimuli: Giel, Teufel, Junne, Zipfel, & Schag, 2017; body-related stimuli: Jáuregui-Lobera, 2013). Finally, some reviews have drawn different conclusions about the same topic, for example, whether attentional bias is greater in those with bulimia nervosa on the modified Stroop (Brooks, Prince, Stahl, Campbell, & Treasure, 2011) or whether the evidence is unclear (Van den Eynde et al., 2011). At this juncture, the advancement of the field would benefit from an overview of the best-supported findings across diagnostic groups, paradigms, and stimuli, to inform theory about the nature of attentional bias in eating disorders, and to guide further research.

Meta-reviews are a relatively recent method of providing such an overview. A meta-review entails a systematic survey of the literature, where included articles are confined to systematic reviews and meta-analyses. This allows for a broader synthesis of evidence than would usually be possible for a single systematic review and can provide a map of the existing evidence base (McKenzie & Brennan, 2017). There are not many validated protocols for undertaking meta-reviews and there have been concerns about the rigor with which some meta-reviews have been conducted (e.g., Pieper, Buechter, Jerinic, & Eikermann, 2012). Nonetheless, there is a growing base of tools for conducting meta-reviews, including those for assessing the quality of systematic reviews and meta-analyses to inform the interpretation of their findings. The present study is a meta-review of extant reviews in the field of attentional bias in eating disorders. To begin, we will provide a brief summary of the main paradigms for assessing attentional bias that will be discussed in this review.

1.1 | Attentional bias in eating disorders

There is a variety of methods for assessing attentional bias in eating disorders, such as the visual search task (Caglar-Nazali et al., 2014)

and spatial cueing task (Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006). However, three methodologies predominate over the others in frequency to the extent that they have been the sole focus of some systematic reviews: the Stroop task, the dot-probe task, and the eye-tracking paradigm. These will now be discussed in more detail.

The traditional Stroop task (Stroop, 1935) involves participants naming the color in which a word is printed, ignoring the word itself (which describes a different color), and the speed of naming the appropriate color is calculated; a bigger latency is thought to represent bigger interference from task-irrelevant information, that is, the meaning of the word. The emotional or "modified" Stroop task (Williams, Mathews, & MacLeod, 1996) involves measuring participants' reaction times in naming the colors of emotionally salient words compared with the time taken to name the colors of neutral words. Delayed color-naming latency for emotional words again indicates Stroop task interference and processing bias in favor of emotional words. The modified Stroop does not allow for different components of attention to be investigated, such as attentional engagement versus disengagement. Furthermore, as stimuli are typically presented at long durations in a way that is consciously accessible to participants, the results cannot differentiate between attentional bias occurring at an early, automatic stage of attentional orientation as opposed to a strategically maintained attentional focus (Kerr-Gaffney et al., 2019).

In the dot probe task (MacLeod, Mathews, & Tata, 1986), participants are asked to stare at a fixation cross on the center of the screen. Two stimuli, one of which is neutral in valence and the other threatening, appear simultaneously on either side of the screen for a predetermined amount of time (studies investigating attentional bias in eating disorders might include a food-related word or picture). On some trials, a probe (usually a dot) is presented in the location of one former stimulus and participants are instructed to press a button to indicate the location of the probe as quickly as possible. Quicker reaction times to the probe replacing the threat stimulus compared with when the probe replaces the neutral stimulus are thought to reflect attentional bias to threat. This paradigm allows the particular nature of attentional bias to be deduced, by including trials with two neutral stimuli. Whereas quicker reaction times on trials where the probe replaces a threat stimulus than on neutral–neutral trials indicates facilitated engagement (vigilance) to threat, slower reaction times on trials where the probe does not replace a threat stimulus than on neutral–neutral trials indicates poorer disengagement from threat (Koster, Crombez, Verschuere, & De Houwer, 2004). Unlike the modified Stroop, this task can therefore be used to investigate different attentional components. Researchers can also vary the duration at which stimuli are presented in order to assess attentional bias at different stages of processing (e.g., Baum, Schneider, Keogh, & Lautenbacher, 2013). This relates to theories of attention, which have posited a distinction between initial, more automatic and unconscious orienting that is stimulus-driven, and more conscious and strategic attentional bias at longer durations (Ouimet, Gawronski, & Dozois, 2009).

Eye-tracking is a more recent paradigm for assessing attentional bias which, unlike the Stroop and dot probe, is a direct measure of overt attentional bias that records participants' saccades toward visual stimuli (Armstrong & Olatunji, 2012). It is argued that eye-tracking methodologies allow for more ecologically valid conclusions about attention as they can be used to study the movement of attention over a more naturalistic visual array (e.g., Kerr-Gaffney et al., 2019). By tracking attention over time rather than looking at a snapshot (e.g., as with the dot probe; Starzomska, 2017), eye-tracking also provides a much more detailed picture of the patterns of attentional avoidance and engagement with stimuli over time (e.g., Rinck & Becker, 2006), allowing for attentional bias at both automatic and strategic stages of attentional processing to be detected. For example, initial eye movements to a stimulus followed by fewer eye movements to the stimulus later on would imply automatic attention toward that stimulus followed by conscious avoidance of that stimulus. The anti-saccade task, in which participants are instructed to move their eyes away from a stimulus, can also be informative, as any inability to do this can imply attentional bias underlain by impulsivity. There is also evidence that eye-tracking is more reliable than the dot probe for assessing attentional bias to emotional stimuli, when stimuli are presented over a period of many seconds (as would usually be the case in a natural setting) rather than very briefly (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014).

1.2 | Aims of the present review

The present meta-review aims to summarize the most reliable evidence for attentional bias in eating disorders by synthesizing evidence from the highest-quality systematic reviews and meta-analyses that include these three paradigms, across a range of stimuli and diagnostic groups. Additional aims are to integrate the best-supported findings with existing conceptions of attentional bias in eating disorders, and to provide a steer for future research.

TABLE 1 Search strategy for identifying articles to include in the meta-review

Attentional bias		Eating disorder		Review
Attention Attention* bias Cognition Cognitive bias Metacognition Cognitive Neuropsychology	AND	Eating disorder* Anorexia Anorexic Binge-eating disorder Restrained eating Dieting Disordered eating Compulsive eating Dietary restraint Purging Binge eating Bulimia Bulimic	AND	Review Systematic review Meta-analysis Meta-anal* Quantitative* overview* Systematic overview* Methodologic* review* Methodologic* overview* Literature reviewMeta-review

Note: The asterisk (*) was used as a 'wildcard' method to broaden searches by including all words that start with the letters preceding the asterisk.

2 | METHODS

2.1 | Protocol

A meta-review protocol was registered at PROSPERO with the registration number CRD42018108030. Search terms included in this meta-review (Table 1) were broadened beyond what was originally recorded on PROSPERO to include more eating-disorder related terms; this was to ensure that all relevant reviews were included. The names of particular attentional bias paradigms specified on PROSPERO were removed from the final searches as terms relating to attentional bias were deemed sufficient for including relevant studies.

2.2 | Search methods

A systematic search of the four following databases took place: PsycINFO, EMBASE, SCOPUS, and MEDLINE. The terms used in each search are to be found in Table 1. There were no restrictions on publication date or geographic regions. Additionally, to maximize the identification of relevant abstracts, the same search terms were entered into Google Scholar using the Advanced Scholar Search function. Searches took place on September 30, 2020.

Article titles and keywords were screened in a first step, and relevant articles were retrieved. Duplicates were removed, and the inclusion processes were executed after that. A hand-search of reference sections included in articles ensured that all relevant studies were identified.

2.3 | Eligibility criteria

For inclusion, reviews were required to:

1. Include at least one study focused on exploring attentional biases in those meeting diagnostic criteria for an eating disorder, that is, Anorexia Nervosa, Bulimia Nervosa, Binge-Eating Disorder, Eating Disorder Not Otherwise Specified, or Other Specified Feeding and Eating Disorders. Studies were not required to draw samples from clinical settings
2. Be a systematic review or meta-analysis, including details of search strategy

Reviews were excluded when:

1. The focus was modification as opposed to measurement of attentional bias
2. Studies included in the review did not include an experimental measure of attentional bias
3. They were not written in English
4. Reviews were non-systematic (literature reviews that did not undertake a systematic search for articles)

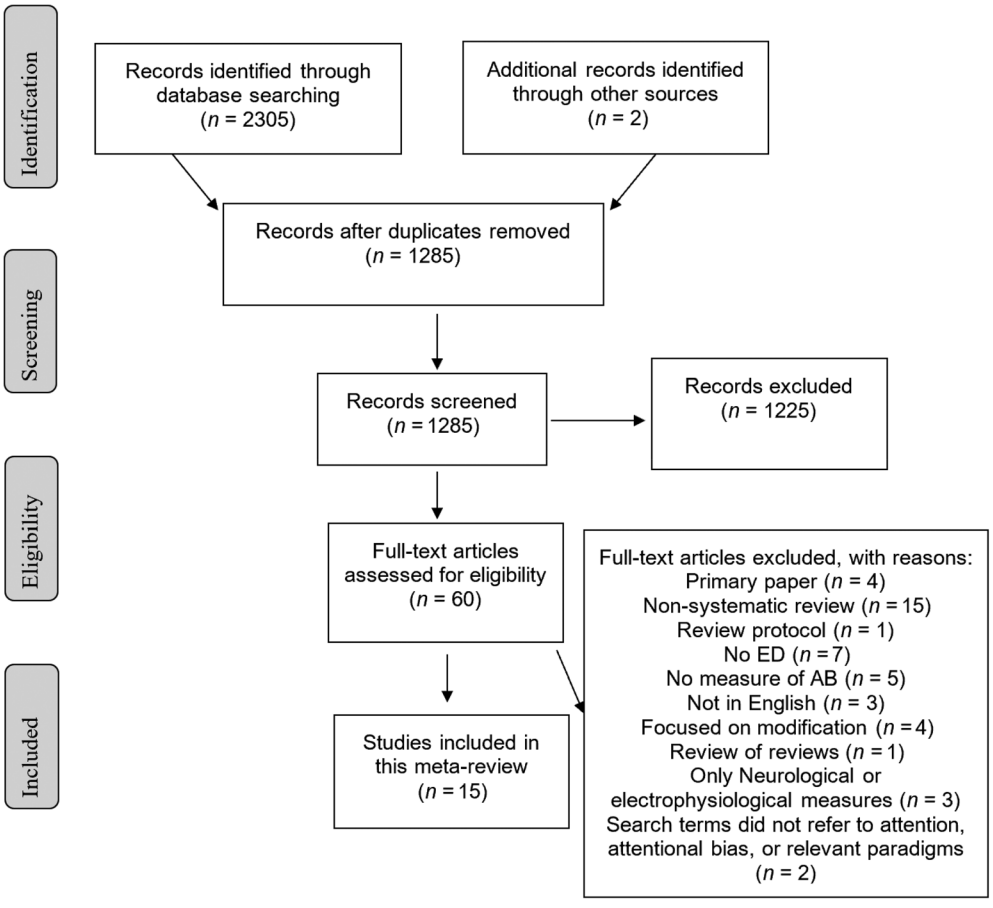

FIGURE 1 PRISMA flow diagram. AB, attentional bias; ED, eating disorder

TABLE 2 Items of the AMSTAR-2 and whether they were deemed critical or not (paraphrased from Shea et al., 2017)

Item	Critical? (Y/N)
1. The research questions and inclusion criteria for the review included the components of PICO (population, intervention, control group, outcome)	N
2. There was an explicit statement in the report that review methods were established prior to undertaking the review, and any significant deviations from the protocol were justified	N
3. The authors explained their selection of the study designs for inclusion in the review	N
4. The authors used a comprehensive literature search strategy	Y
5. The authors performed study selection in duplicate	N
6. The authors performed data extraction in duplicate	N
7. The authors provided a list of excluded studies and justified the exclusions	Y
8. The authors described included studies in adequate detail	N
9. The authors used a satisfactory technique for assessing included studies' RoB	Y
10. The authors reported on the sources of funding for included studies	N
11. If meta-analysis was performed, the authors used appropriate methods for statistically combining results	Y
12. If meta-analysis was performed, the review authors assessed the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis	N
13. The review authors accounted for RoB in individual studies when interpreting/discussing the results of the review	Y
14. The review authors discussed and provided a satisfactory explanation for any heterogeneity observed in the review's results	N
15. If a quantitative synthesis was performed, the review authors carried out an adequate investigation of publication bias (small study bias) and discussed its likely impact on the results of the review	Y
16. The review authors reported any potential sources of conflict of interest, including any funding to conduct the review	N
17. The review authors considered the impact that the sample sizes of included studies may have had on the reliability of the review's findings	Y
18. If meta-analysis was performed, the review authors assessed the potential impact of small-study-bias on the results of the meta-analysis or other evidence synthesis	Y

Abbreviation: RoB, risk of bias.

5. They were meta-reviews
6. Studies included in the review focused on electrophysiological or neurobiological measures of attentional bias

2.4 | Study selection

A two-step inclusion process was undertaken: (1) screening based on titles and abstracts; (2) screening based on full-text articles. Reference lists of reviews were also screened. Step 1 was carried out by the first author. Step 2 was carried out in duplicate by the first and third authors, in which studies were excluded at the full-text screening stage based on the predetermined criteria (see Table S1 for a list of excluded studies, with associated reasons). There was agreement on the inclusion/exclusion of 59 out of the 61 full-text articles, and the two articles where there was disagreement were chosen for inclusion in the study following discussion. All reviews remaining at this point were included in the final list of reviews. Relevant data from the included reviews were extracted in duplicate (by the first and third authors).

This meta-review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Liberati et al., 2009). Figure 1 outlines the PRISMA flow diagram of articles excluded at each stage. After rigorously applying the exclusion criteria to the full-text reading of the documents, a set of 15 publications proved to fulfill the inclusion criteria for type and content of study.

2.5 | Quality assessment

This meta-review used the AMSTAR-2 ("Assessing the Methodological Quality of Systematic Reviews" [second version]; Shea et al., 2017), originally developed for assessing the quality of reviews of healthcare interventions. It is one of the recommended tools in assessing the quality of systematic reviews in a Cochrane handbook for conducting meta-reviews, (Pollock, Fernandes, Becker, Pieper, & Hartling, 2020) and has been shown to have superior inter-rater reliability in relation to another tool for assessing review quality (Pieper, Puljak, Gonzalez Lorenzo, & Minozzi, 2018). The AMSTAR-2 advises the use of critical domains, in which raters judge which items would seriously affect the validity of conclusions of the included reviews if they were not demonstrated (see Table 2 for the items in the AMSTAR-2 that were used to appraise review quality in the present study, including those that were deemed critical/non-critical).

As Table 2 shows, eight items on the AMSTAR-2 were chosen as "critical items": 4, 7, 9, 11, 13, 15, 17, and 18. Critical items are those that are deemed most important for a review to evidence in order to ensure its validity; not meeting one of these criteria counts as a critical weakness. Non-critical items, while being indicators of review quality, are not deemed as harmful to its validity if they are not present; not meeting one of these criteria counts as a non-critical weakness. The first four items are those that the developers of the AMSTAR-2 (Shea et al., 2017) recommend as critical items. The authors of the current article agreed with the applicability of these critical items to their meta-review, as these items consider whether the review assessed risk of bias in primary studies (items 9 and 13), which determines the degree to which results can be relied upon. One of the items asks whether meta-analyses considered the possibility of publication bias, which would affect their validity (item 15), and another assesses whether meta-analyses used an appropriate method for statistically combining results to reduce any bias in their effect size estimates, also

TABLE 3 Characteristics and findings of included reviews

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
1. Aspen et al. (2013)	SR and MA	4	Gender: All women samples Ethnicity: NR Age: NR SES: NR	AN, BN, BED, ED-NOS	HC	DP ($n = 4$ included in meta-analysis)	Photographs: Eating, body shape and weight. Words relating to a thin and large physique	Critically low (C = 6; NC = 7)	• Two studies found AB toward negative body shape stimuli in ED group with medium effect sizes ($d = 0.63$; $d = 0.61$), and pooled effect size showed AB away from positive shape stimuli in ED groups ($d = -0.16$) • ED groups had an AB away from positive eating stimuli ($d = 0.83$) and toward negative eating stimuli • ED groups had differential AB in relation to photographs of the self (found in AN) vs. others (found in BN)
2. Brooks et al. (2011)	SR and MA	18	Sex:– - Stroop: All female samples - DP: NR Ethnicity: NR Age range: 21–26 SES: NR	AN, BN, ED	HC, BN(REC), AN(REC), RE	Modified Stroop ($n = 16$ included in meta-analysis), DP ($n = 2$ included in meta-analysis)	Food words. High and low-calorie food images	Moderate (C = 0; NC = 6)	• Meta-analysis of modified Stroop studies showed a statistically significant effect of higher AB to food stimuli using the modified Stroop in BN ($d = 0.43$) and AN ($d = 0.26$), compared with HC; meta-regression indicated that AN and BN groups did not differ from each other on the degree of AB toward food stimuli • A study using the DP found ED groups in general were avoidant

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									of food pictures with a medium effect size ($d = 0.50$); whereas negative, high calorie images caused avoidance ($d = 0.93$), positive, low calorie images caused attentional vigilance ($d = 0.73$)
3. DeJong et al. (2013)	SR	1	Sex: All female samples Ethnicity: NR Age: 27.5 SES: NR	BN	HC	Modified Stroop ($n = 1$)	Neutral and emotional faces	Critically low (C = 2; NC = 5)	• Those with BN showed AB toward social stimuli and more AB for angry than neutral faces (large effect size; $d = 0.8$)
4. Dobson and Dozois (2004)	SR and MA	18	Sex/gender: NR Ethnicity: NR Age: NR SES: NR	AN, BN	HC, BN(REC), AN(REC), TMJ patients	Modified Stroop ($n = 18$)	Food, body, weight, shape, and emotion words	Critically low (C = 4; NC = 8)	• Meta-analysis of modified Stroop studies showed consistently moderate effects sizes (compared with HC) only in BN (when food words and body/shape words were used), whereas in AN the only substantial (moderate) effect size was when body/weight words were presented (not food words). • Meta-analysis comparing effect sizes when food vs. body/shape words were used showed no consistent difference in the effects of using different stimuli, across different diagnostic groups.

(Continues)

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
5. Giel et al. (2011)	SR	4	Sex:– - ED groups: All female samples - HC: NR Ethnicity: NR Age: NR SES: NR	ED, AN, BN	HC	DP ($n = 4$), modified Stroop ($n = 1$)	Positive and negative eating, food, emotional stimuli	Critically low (C = 2; NC = 6)	• One study using the Stroop showed ED groups to have AB to positive eating stimuli compared with HC • Two DP studies found ED groups to have AB to positive food stimuli and away from negative food stimuli than HC
6. Giel et al. (2017)	SR	3	No demographics reported	BED	OBC, NWC, WMC	ET ($n = 2$), DP ($n = 1$)	Food-specific and neutral	Critically low (C = 3; NC = 2)	• One DP study found more early attentional engagement to high-calorie food pictures in BED than OBC • One ET study found greater total gaze duration on food pictures in BED than OBC, and the other found this to be greater in BED than OBC and NWC
7. Jáuregui-Lobera (2013)	SR	16	Sex: All female samples Ethnicity: NR Age range: 18–45 SES: NR	AN, BN, EDNOS-BN, R-AN, R-BN, AN-R	HC	Traditional Stroop ($n = 7$), modified Stroop ($n = 6$), DP ($n = 2$), ET ($n = 1$)	Thin/fat words. Body shape-related words.	Critically low (C = 4; NC = 6)	• Traditional Stroop: Six of seven studies of those with BN and AN found no statistically significant AB. • Modified Stroop: Two studies showed those with AN had AB toward "thin" and "fat" words. • DP: One study showed AN and BN groups to have AB away from words depicting a thin physique

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									• Two studies using modified Stroop found those with AN and BN had AB toward food stimuli. One ET study showed AN group to have more attentional disengagement from food pictures compared with control subjects. • One study using modified Stroop found AB for eating and weight stimuli in AN and BN and another study found BN group were more distracted by shape compared with HC • One study using DP found those with AN and BN showed AB toward rejecting faces
8. Johansson et al. (2005)	SR and MA	27	Sex/gender: NR Ethnicity: NR Age range: 14–26 (majority of studies had adult samples) SES: NR	AN, BN	HC, subclinical but over-concerned with eating and body weight	Modified Stroop ($n = 27$)	Food/eating. Body/weight. Body shape words and neutral	Critically low (C = 4; NC = 7)	• Modified Stroop inference for females with ED with medium effect size ($d = 0.48$).
9. Kerr-Gaffney et al. (2019)	SR	26	Most studies had all-female sample Ethnicity: NR Age range: 14–26 SES: NR	AN-R, AN, AN-B/P, AN-REC, AN-W/R, BN, BED	HC, OWC	ET ($n = 26$)	Food, bodies, social	Critically low (C = 3; NC = 3)	• BED group had poorer attentional inhibition to both food and non-food stimuli in comparison to HC

(Continues)

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									• Two studies together indicated less attention toward food stimuli in AN groups than in HC and AN-REC • Two studies looking at body stimuli in those with AN, BN, and BED showed more AB toward pictures of one's own body than another's body, compared with controls; one found differences that depended on the BMI of the depicted image of the other. One study found no evidence of differences in this regard between AN, BN, and HC. • AN, BN, and BED group were reported generally to spend more time looking at unattractive features of their own face than HC
10. Kittel et al. (2015)	SR	5	Sex: Authors state majority studies all-female, and remaining predominantly female samples Ethnicity: NR Age: NR SES: NR	BED	OBC, OW	Traditional Stroop ($n = 2$); ET ($n = 3$)	Food and non-food stimuli. Images: Self and control body parts	Critically low (C = 3; NC = 6)	• One study using ET found more initial fixation on food stimuli compared with non-food stimuli in BED • One study using ET found AB for food-related stimuli in BED compared with OB and NWC

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									• Two studies using the traditional Stroop task found no statistically significant difference between BED group and OBC/NWC
11. Ralph-Nearman et al. (2019)	SR	20	Sex: Authors report that most studies had all-female samples Ethnicity: NR Age: NR SES: NR	AN, BN, BED	HC, OWC, NWC	Modified Stroop (n = 11); DP (n = 2); ET (n = 7)	Food, body, and weight stimuli. Self- and other bodies.	Low (C = 1; NC = 4)	• Majority of studies found more interference on modified Stroop in ED groups than HC, with some showing specific AN interference with food/body stimuli and BN interference with body/weight stimuli • One study showed modified Stroop differences between AN and HC were weaker when stimuli were presented preconsciously; another found that block presentations of stimuli specific to one theme gave more robust effects than mixed presentation of stimuli • One dot-probe study reported AB toward photos of one's own body compared with another's body in AN compared with HC; the opposite effect was found in BN

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TABLE 3 (Continued)

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									• The second dot probe study on nonspecific ED sample reported more AB toward food and body stimuli than HC • Studies using ET indicated attentional avoidance of food in AN at a longer duration of stimulus presentation; in BN, more attention to lower-BMI than higher-BMI bodies, compared with HC; in BED, more attention to food stimuli (after a sad mood induction) compared with OWC and NWC
12. Renwick et al. (2013)	SR	9	Sex/gender: NR Ethnicity: NR Age: NR SES: NR	AN, BN, ED-NOS	HC, anxious, subclinical ED with varying levels of shape concern	DP ($n = 9$)	Food, eating weight, and shape images, self and other body images, shape, weight, emotion, and physical illness/harm words, facial images.	Critically low (C = 5; NC = 6)	• Reported findings that ED groups in general show AB toward negative and neutral weight/shape as well as eating-related stimuli. • Reported evidence of AB to depression and anxiety-related words in BN (not AN). • Reported another study indicating general AB toward threat in BN • One study found no bias to sexual abuse-related words in AN or BN

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
13. Reville, O'Connor, and Frampton (2016)	SR	4	Sex/gender: NR Ethnicity: NR Age: Authors described most studies as either adult or teenage sample (majority adult) SES: NR	AN, ED-NOS	HC, athletes	ET ($n = 2$), DP ($n = 3$)	Food, weight, and shape images, thin/fat body images, threat words	Critically low (C = 3; NC = 6)	• A study using ET showed that the AN group spent more time than healthy controls looking at thin ($d = 2.09$) and fat ($d = 1.06$) bodies • Studies within this article that looked at effects of oxytocin administration were not deemed relevant; two studies looking at DP performance without oxytocin administration found no evidence of higher AB to negative stimuli in AN (general threat stimuli in one study; eating/shape-related threat stimuli in another) compared with HC
14. Stojek et al. (2018)	SR	33	Sex:- - Stroop: All female - DP: All female - ET: NR Ethnicity: NR Age range: 14–26 SES: NR	Binge eaters: BED, BN (clinical and sub-clinical), AN-B/P	HC, subclinical/ recovered BN	Modified Stroop ($n = 24$), ET ($n = 6$), DP ($n = 1$)	Weight/shape, food, threat	Critically low (C = 2; NC = 2)	• Majority of Stroop studies with body weight/shape stimuli showed more AB relating to these stimuli in BN than controls, whereas the majority of Stroop studies with food stimuli found no difference between BN and controls

(Continues)

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									• Majority of studies using the Stroop found that more AB relating to threat in ED group (binge eaters) than controls • One study using the DP showed a BN sample to have AB toward rejecting faces, but attentional avoidance of accepting faces, and the opposite pattern in HC • ET studies consistently showed those who binge eat (BN/BED) to have poorer disengagement from food cues • ET studies showed attentional bias in those with BN that depends on BMI depicted in images of others; those with BED have poorer disengagement from images of their own bodies than HC, and in particular with regard to the "ugliest" parts of their bodies
15. Van den Eynde et al. (2011)	SR	16	Sex/gender: NR Ethnicity: NR Age range: 19.1–33.6 SES: NR	BN, BED	HC	Modified Stroop ($n = 11$), traditional Stroop ($n = 5$), DP ($n = 1$)	Body weight, shape, food, and eating stimuli	Moderate (C = 0; NC = 3)	• Traditional Stroop task showed no difference in Stroop interference between BN, BED, and HC

TABLE 3 (Continued)

Authors	Type of review [systematic review (SR)/meta-analysis (MA)]	No. relevant studies included	Demographics [sex/gender, ethnicity, mean age, and socio-economic status (SES)] of relevant studies	Clinical groups	Comparison groups	Experimental methods	Stimuli	Quality category (C = no. of critical weaknesses; NC = no. of non-critical weaknesses)	Key findings and effect sizes
									• Overall studies reported a stronger effect on the modified Stroop to food/eating stimuli in people with BN compared with HC • Authors using the modified Stroop tended to find a stronger effect on AB in BN compared with HC when body weight and shape stimuli are used instead of food stimuli • One DP study found no difference between BN and HC in AB to body stimuli • Two modified Stroop studies found more AB toward emotional threat words in those with BN than HC

Abbreviations: NR, not reported. *ED Groups*: AN, anorexia nervosa; AN-R, anorexia nervosa restricting subtype; AN-B/P, anorexia nervosa binge/purging subtype; BN, bulimia nervosa; BED, binge eating disorder; ED, eating disorder (not differentiated); EDNOS-BN, eating disorder not otherwise specified, bulimia nervosa type. *Comparison Groups*: AN-W/R, anorexia nervosa (weight-restored); AN-REC, anorexia nervosa recovered; HC, healthy controls; OB, obese individuals with binge-eating disorder; OBC, obese controls; OWC, overweight controls; NWC, normal weight controls; RE, restrained eaters; REC, recovered; TMJ, temporo-mandibular joint disorder; WMC, weight matched controls. *Attentional Bias Terminology*: AB, attentional bias; DP, dot probe; ET, eye-tracking paradigm.

deemed important (item 11). The authors also agreed that items 4 and 7 should be critical, as they relate to minimizing selection bias that could undermine the validity of the review's conclusions. Item 2 was not included as a critical domain in spite of the recommendation of Shea et al.; this would have affected our assessment of quality variability as the vast majority of reviews did not meet this criterion. Due to the prevalence of small and underpowered studies in the literature, two critical items were added to the quality rating tool to assess whether each review considered the influence of small studies on the reliability of its findings (item 17) and whether meta-analyses assessed for the impact of small-study-bias (item 18).

To assess the inter-rater reliability of the AMSTAR-2, 60% of all included reviews were quality appraised by the first and third authors. Cohen's kappa indicated substantial agreement between the two reviewers, ($\kappa = .92$, $p < .01$), and any disagreements with regard to review quality appraisal were resolved by consensus.

One of four methodological quality ratings were assigned, following the AMSTAR-2 guidance: "high" (if the review met all critical domains and failed on no more than three non-critical domains); "moderate" (if the review did not meet more than three non-critical domains but met all critical domains); "low" (if the review did not meet one critical domain); "critically low" (if the review did not meet more than one critical domain). See Table S2 for the final quality rating for each included review based on the number of critical and non-critical domains that were met.

3 | RESULTS

A total of 15 systematic reviews were included for data synthesis and quality assessment. See Table 3 for included reviews' experimental methods, findings, population characteristics, stimuli, key findings, and overall quality ratings.

3.1 | Search methods of included reviews

All reviews searched at least two databases apart from one that only searched PubMed (Aspen et al., 2013) and one that searched PubMed and supplemented this with a search on Google Scholar (Renwick et al., 2013). PsycInfo and Pubmed were the most searched databases ($n = 9$) followed by Medline ($n = 5$) and Web of Science ($n = 4$). Brooks et al. (2011) searched the most databases ($n = 8$).

3.2 | Methodological quality of included reviews

Table 3 shows that methodological quality was classified as "critically low" for 12 of the included reviews, "low" for one review, and "moderate" for two.

In terms of the non-critical items, all included reviews described their research questions in a way that covered the four key aspects of a study question (population, intervention, control group, and outcome; item 1 of the AMSTAR-2). The majority of studies did the following: described the included studies in adequate detail (item 8), discussed any heterogeneity in the results (item 14), either reported on funding (item 10) or conflicts of interest (item 16). The majority of the included studies failed to meet the following criteria: explaining their selection of study design (item 3) and performing in duplicate their study selection (item 5) and data extraction (item 6). Of the four reviews to include a meta-analysis, only one (Brooks et al., 2011) assessed the potential impact of risk of bias on their results (item 12).

As for critical domains, all reviews bar two conducted an adequate literature search (item 4). Most reviews did not provide a detailed list of their excluded studies alongside justifications (item 7). The majority of reviews did not report an assessment of the risk of bias in primary studies (item 9) and did not discuss the influence of small study samples on their results (item 17). However, the majority of reviewers attempted to account for risk of bias in their interpretation of results (item 13). All four reviews that included a meta-analysis used appropriate methods for statistical combination of results (item 11), and two performed an investigation into publication bias using plots and statistical tests (item 15). Only one review that included a meta-analysis (Brooks et al., 2011) assessed for small-study-bias (item 18).

3.3 | Overlap between reviews

The authors determined the degree of overlap between the reviews using the "corrected covered area" (CCA; Pieper, Antoine, Mathes, Neugebauer, & Eikermann, 2014). The CCA calculates the frequency of repeated inclusion of studies across different reviews, divided by the product of the number of reviews and number of studies (reduced by the total number of studies). The overlap was found to be 8.6%, which is deemed to be in the "moderate" range (i.e., between 6 and 10%; Pieper et al.) The authors concluded that the included reviews provide an acceptable degree of independent information. The total number of primary articles covered by included reviews (without duplicates) was 109.

3.4 | Summary of key findings

According to the included reviews, the modified Stroop task is the most frequently used experimental method to identify attentional bias in individuals with eating disorders, followed by the dot probe task and then the eye-tracking paradigm.

Now we will look in more detail at results obtained from the three main paradigms, with each of these headings subdivided by stimulus type. Higher quality reviews will be considered first, which include those rated "Moderate" quality (Brooks et al., 2011; Van Den Eynde et al., 2011) and the one review rated "Low" (Ralph-Nearman et al., 2019), as this review had only one critical weakness and four non-critical weaknesses.

3.4.1 | Traditional Stroop

One of the higher-quality reviews (Van den Eynde et al., 2011) reported that most studies did not find a difference between bulimia nervosa

(BN)/binge-eating disorder (BED) groups and healthy controls on the traditional Stroop task. Two of the lower-quality reviews reporting on this paradigm (Jáuregui-Lobera, 2013; Kittel et al., 2015) reported a similar lack of evidence for differences between eating disorder (ED) groups and healthy controls on this task. The partial exception is the review of Dobson and Dozois (2004), whose meta-analysis found a statistically significant deficit in color naming on the traditional Stroop among participants with BN, compared with healthy controls; nonetheless, they caution that this result may not be reliable due to a statistically significant test of heterogeneity ($Q = 17.82$). These authors' meta-analysis found no difference between participants with anorexia nervosa (AN) and healthy controls on the traditional Stroop, but again there was statistically significant evidence of heterogeneity ($Q = 16.21$).

3.4.2 | Modified Stroop

Food stimuli

The two highest quality reviews reported on the modified Stroop. Van den Eynde et al.'s (2011) narrative summary of the literature reported inconsistent findings for participants with BN, with seven studies finding more attentional bias on the modified Stroop for food words in comparison to healthy controls, and three studies finding no difference between these groups. These authors noted, however, that most of the studies in their review were underpowered and therefore less likely to detect true effects. Brooks et al. (2011) completed a meta-analysis of the findings from modified Stroop studies using food stimuli and reported a medium effect size on the modified Stroop in those with BN ($d = 0.43$) and a small effect size in those with AN ($d = 0.26$), compared with healthy controls. Most studies compared food words with neutral words, and one study compared food pictures with non-food (household-related) pictures (Stormark & Torkildsen, 2004). Their meta-regression indicated that the difference in strength of the effect between these two diagnostic groups was not statistically significant. Brooks et al. used a variety of methods for investigating small-study-bias, including funnel plots and Egger's test, reporting no evidence that any such bias was in operation.

As for the lower quality reviews, the meta-analyses of Dobson and Dozois (2004) reported a statistically significant attentional bias for food stimuli in AN and BN groups relative to healthy controls, but reported statistically significant levels of heterogeneity (AN: $Q = 16.21$; BN: $Q = 23.98$). Johansson et al.'s (2005) meta-analysis indicated that both those with AN and BN had a larger attentional bias for food words than healthy controls on the modified Stroop. Jáuregui-Lobera (2013) reported two studies showing that those with AN and BN had an attentional bias toward food stimuli. Giel, Teufel, et al. (2011) reported that females with ED (the sample consisted of a mixture of AN, BN, and eating disorder not otherwise specified [EDNOS]) showed evidence of attentional bias for food pictures compared with neutral stimuli, and compared with healthy controls. Stojek et al. (2018) reported that only 6 out of 18 studies showed attentional bias toward food stimuli in those with BN.

Body stimuli

Van den Eynde et al. (2011) reported that modified Stroop studies showed consistent attentional bias to shape/weight stimuli in those with BN (compared with healthy controls), and that this is a more consistent finding in BN groups than studies using food stimuli.

As for lower-quality reviews, Stojek et al. (2018) reported the same finding as Van den Eynde et al. (2011). Jáuregui-Lobera (2013) reported two studies using the modified Stroop in which those with AN had an attentional bias toward body-related words. Dobson and Dozois (2004) found no evidence in a meta-analysis of attentional bias for body/weight stimuli in AN compared with healthy controls, and no evidence of such attentional bias in BN; however, the authors reported statistically significant levels of heterogeneity (AN: $Q = 28.23$; BN: $Q = 24.67$). Johansson et al. (2005) conducted a meta-analysis on findings using the Stroop task and body stimuli. They found a statistically significant effect in which attentional bias was larger in women with ED than in healthy controls.

Threat stimuli

Stojek et al. (2018) reported that the majority of studies of adolescent/adult women with BN or BED have a greater attentional bias toward threat stimuli (such as angry faces or ego-related threat words) in comparison to healthy controls. The review by DeJong et al. (2013) included one of these studies (Harrison, Sullivan, Tchanturia, & Treasure, 2010), reporting that Harrison et al. found greater attentional bias for angry faces compared with neutral faces ($d = .80$) in those with BN. However, there was no justification of the sample size in the study of Harrison et al., raising the likelihood that the large effect size was due to small-study-bias. There was also no reported analysis of interaction effects prior to calculating main effects, which can inflate the Type I error rate. Van den Eynde et al. (2011) report one additional modified Stroop study not included in these other reviews, which also shows attentional bias toward emotional threat words in a BN group compared with healthy controls (Rodriguez-Campayo & Martinez-Sanchez, 2005).

3.4.3 | Dot probe

Food stimuli

Brooks et al. (2011) and Ralph-Nearman et al. (2019) reported findings from the same dot probe study (Shafran et al., 2007; Study 2); Brooks et al. gave a more elaborate description of the study in which those with ED (a group mostly comprising an EDNOS and BN sample, and with a much smaller number of individuals with AN and BED) had an attentional bias away from food pictures overall, where different picture types led to different attentional bias: there was attentional avoidance of low calorie images and attentional vigilance for high calorie images.

These review articles did not include Study 1 of Shafran et al. (2007), which had a comparison group with significant shape concerns (without a clinical diagnosis), but the lower-quality articles elaborated on the contents of this study. Aspen et al. (2013) reported that Study 1 found the same pattern of vigilance versus avoidance depending on the calorie content of food pictures, and their meta-

analysis including these two studies (along with one other: Lee & Shafran, 2008) found a statistically significant effect in which there is vigilance for high-calorie stimuli and avoidance of low-calorie stimuli in ED groups. However, it should be noted that Aspen et al. reported statistically significant heterogeneity in the data and that this reduces the reliability of their results (low-calorie stimuli: $I^2 = 87\%$; high-calorie stimuli: $I^2 = 81\%$).

Body stimuli

Renwick et al. (2013) reported articles in which attentional bias is found in ED groups toward negative and neutral weight/shape and eating-related stimuli. Jáuregui-Lobera (2013) reported a dot probe study in which those with AN and BN had an attentional bias away from words describing a thin physique (Rieger et al., 1998). Aspen et al. (2013) did not find a statistically significant attentional bias in ED groups for positive shape stimuli (e.g., words like 'thin') or negative shape stimuli (e.g., words like "fat"), based on four studies, although they noted that the positive shape stimuli comparison showed statistically significant heterogeneity ($I^2 = 72\%$) and the comparison for negative shape stimuli showed statistically non-significant heterogeneity that was nonetheless quite high ($I^2 = 57\%$).

Threat stimuli

Stojek et al. (2018) reported one study using the dot probe in a BN sample which showed attentional bias toward rejecting face stimuli, but avoidance of accepting face stimuli (Cardi, Matteo, Corfield, & Treasure, 2013). Jáuregui-Lobera (2013) also reported this study, elaborating that this attentional bias pattern was also found in AN groups. The opposite pattern was found in healthy controls.

3.4.4 | Eye-tracking studies

Food stimuli

Ralph-Nearman et al. (2019) reported an eye-tracking study in which, following a sad mood induction, overweight individuals with BED showed more attentional bias to food stimuli compared with overweight and normal-weight controls (Leehr et al., 2018). These authors also reported a study in which those with AN showed conscious attentional avoidance of food pictures compared with healthy controls (Giel, Friederich, et al., 2011).

Kerr-Gaffney et al. (2019) also reported the study of Giel, Friederich, et al. (2011), elaborating that the article reported an initial attentional orientation to food stimuli only in AN (compared with two healthy control groups: satiated/fasted), and that the AN group also looked at food for less time overall, that is, in which these early fixations were followed by later avoidance (this relates to the description in Ralph-Nearman et al. [2019] of this attentional avoidance as "conscious"). Kittel et al. (2015) reported three eye-tracking studies in which those with BED had more ongoing, conscious allocation of attention to food stimuli than obese and normal weight controls (where all three groups showed an initial attentional bias to food stimuli compared with non-food stimuli). Kerr-Gaffney et al. (2019) reported studies in which those with BED had poorer attentional inhibition to both food and non-food stimuli in comparison to healthy controls, using an anti-saccade task.

Body stimuli

Van den Eynde et al. (2011) and Ralph-Nearman et al. (2019) reported an article by Blechert, Ansorge, and Tuschen-Caffier (2010) but described it differently. The authors of the present meta-review inspected the primary article for clarification and found that it described a dot probe/eye-tracking study showing more visual attention toward photos of the self than photos of others in an AN group, and the opposite (but statistically non-significant) pattern in a BN group.

As for the lower quality reviews, Stojek et al. (2018) also reported an eye-tracking study in which those with BN were found to be poorer at disengaging from low-BMI images of others and that they intentionally avoid high-BMI images of other people (Blechert, Nickert, Caffier, & Tuschen-Caffier, 2009). This review also reported an eye-tracking study in which women with BED showed more attentional bias toward, and poorer disengagement from, images of their own bodies compared with healthy controls (Svaldi, Caffier, & Tuschen-Caffier, 2011b) and an eye-tracking study in which those with BED showed the poorest disengagement from the "ugliest" parts of their own body compared with healthy controls (Svaldi, Caffier, & Tuschen-Caffier, 2011a). Reville et al. (2016) reported an eye-tracking study in which adolescents with AN showed attentional bias toward thin bodies (Pinhas et al., 2014); however, the very large effect sizes, and no a priori power analysis to justify the sample size, indicate that this could be an artifact of small-study-bias (e.g., $d = 2.09$ for the contrast between the AN group and healthy controls on time spent looking at thin bodies).

4 | DISCUSSION

This meta-review has presented findings regarding attentional bias in eating disorders, subdivided by paradigm and stimulus type, across 15 systematic reviews/meta-analyses that vary in quality. The findings from the three reviews rated highest in quality deserve particular consideration (Brooks et al., 2011; Ralph-Nearman et al., 2019; Van den Eynde et al., 2011). We will now integrate their findings across paradigms, considering how they relate to theories of attentional bias and their implications for future research.

Brooks et al. (2011) provided evidence from a meta-analysis that those with AN and BN have attentional bias toward food compared with healthy controls (with small and medium effect sizes, respectively) when using the modified Stroop. The other review of "moderate" quality (Van den Eynde et al., 2011) reported inconsistency with regard to this finding in BN populations. Brooks et al. note that the articles on which their meta-analysis was based (many of which overlapped with the articles of Van den Eynde et al.) tended to be of small sample size, and such underpowered studies are more likely not to detect a true effect, thereby impeding replicability (Button

et al., 2013). Low-powered studies are also more susceptible to inflated estimates of effect sizes (Button et al.). As such, the findings of Brooks et al. do warrant some caution in their interpretation, although these authors did not find evidence of small-study-bias when these were investigated through statistical and graphical means. Evidence from the dot probe, as reported by Brooks et al., substantiates the existence of an attentional bias to food in ED groups but provides a more fine-grained picture, in which there may be attentional avoidance of low-calorie foods and attentional bias toward high calorie foods in ED groups (Shafran et al., 2007).

The meta-regression reported by Brooks et al. (2011) showed no evidence of a statistically significant difference between AN and BN groups on the degree of attentional bias to food stimuli (using the modified Stroop), which is the best evidence to date on this matter. We do not believe this is the final word on differences between these diagnostic groups, due to the aforementioned limitations of the modified Stroop in differentiating between components of attention and stages of attentional processing. Given the superiority of the eye-tracking paradigm over other paradigms in assessing the components of attention as they change over time, a meta-analysis comparing diagnostic groups' results using this methodology would add a welcome voice to this debate.

Ralph-Nearman et al.'s (2019) review summarized interesting findings from the eye-tracking paradigm. One of these is that individuals with AN, compared with healthy controls, appear to have a conscious attentional avoidance of food stimuli (Giel, Friederich, et al., 2011). There is no indication as to the type of food pictures presented, for example, high-calorie or low-calorie, but this finding is potentially consistent with the aforementioned dot probe study of Shafran et al. (2007) in which there is attentional avoidance of low-calorie food pictures in ED groups (although the studies are not perfectly comparable given the very low numbers of those with AN in Shafran et al.'s study). Another eye-tracking study reported by Ralph-Nearman et al. showed that overweight people with BED appear to develop attentional bias to food stimuli following a sad mood induction compared with overweight and normal weight controls (Leehr et al., 2018).

As for body stimuli, Ralph-Nearman et al. (2019) reported an eye-tracking study (Blechert et al., 2010) in which those with AN attend more to photos of themselves than of others whereas a BN group showed the opposite (albeit statistically non-significant) pattern. This review also reported findings in a BN sample of poorer disengagement from low-BMI images of others and intentional avoidance of high-BMI images (Blechert et al., 2009). As this task was associated with more body dissatisfaction in those with BN, the reviewers concluded that this pattern of visual attention may be indicative of upward social comparisons in BN groups. Further support that BN entails attentional bias to body-related stimuli is presented by Van den Eynde et al. (2011), who summarized evidence that the modified Stroop task has consistently shown bias to body-related stimuli in those with BN (compared with healthy controls). This appears to be a more consistent effect than when food and eating stimuli are used.

Whilst important findings, the ecological validity of the above studies that used body stimuli differs markedly. Blechert et al.'s (2009) simultaneous presentation of a photo of one's own body with another's body on the screen has questionable applicability to real-life situations. On the other hand, the findings of Blechert et al. (2010) of attentional bias toward high-BMI and away from low-BMI images of others among those with BN would have implications for common scenarios, such as encountering an array of individuals with higher or lower BMIs when walking down the street.

One way of conceptualizing the above findings is through the lens of appetitive and aversive (or approach/avoid) motivational systems, a distinction made in eating research (e.g., Veenstra, de Jong, Koster, & Roefs, 2010). The prevailing account of the maintenance of AN is that deliberate avoidance of food intake primarily for control of weight/shape is a key feature (Fairburn, Cooper, & Shafran, 2003), and attentional avoidance of food (as reported in an eye-tracking study by Giel, Friederich, et al., 2011) is therefore what would be expected for this group of individuals. If this is the attentional manifestation of the desire to avoid eating, it may be a maintenance factor for the illness, in which case the potential benefits of inducing attentional bias toward food might be an avenue to explore for this group of individuals (see Renwick et al., 2013). The other side of the coin, appetitive motivation, could explain Leehr et al.'s (2018) finding that a sad mood induction leads to attentional bias in overweight individuals with BED. This study is consistent with evidence for negative emotion serving as a trigger for binge episodes in BED (Leehr et al., 2015).

The picture is likely more complex when considering the interplay between appetitive and aversive motivational systems (as described by Lang, Bradley, & Cuthbert [1998] in the case of addictions); for example, a desire to eat may exist alongside a fear of food, and both motivations may apply even to the same food. It is known that attentional bias can be a result of either motivational system (see Field, Munafò, & Franken [2009] who report a meta-analysis on the relationship between attentional bias and craving in substance misuse). This might explain one of the key findings reported by Brooks et al. (2011), in which there is attentional avoidance of low-calorie foods and attentional vigilance for high-calorie foods in ED (Shafran et al., 2007); it is possible that the appetitive response to low-calorie stimuli may be defensively suppressed, but that self-control mechanisms become overwhelmed in the face of high-calorie (very appealing) stimuli. The implications for research are that, when food stimuli are used, their calorie content should be a consideration. A more fine-tuned analysis of attentional bias to food stimuli—and the extent to which this reflects appetitive or defensive motivation—might entail generating individualized stimuli based on participants' self-reported desired/feared foods.

The most ecologically applicable findings with regard to body stimuli, in which those with BN attend more to low-BMI versus high-BMI pictures of others (Blechert et al., 2010), appear consistent with Vitousek and Hollon's (1990) cognitive model of eating disorders. This model posits that people with EDs develop schemas that encode information relating to weight and the implications of one's weight for one's self-concept; the resulting overevaluation of body weight/shape gives rise to automatic biases in information processing toward

related information. Again, both approach and avoidance mechanisms appear to be at play given the existence of vigilance for and avoidance of pictures of others, depending on the BMI.

While overevaluation of body weight/shape is considered central to the development and maintenance of eating disorders (Fairburn et al., 2003), this feature of Vitousek and Hollon's (1990) theory of attentional bias has not been directly tested in clinical ED samples. Support for the link between overevaluation of weight/shape and attentional bias currently only exists for non-clinical samples, and only on the modified Stroop (Labarge, Cash, & Brown, 1998; Tabri & Palmer, 2020). As such, we can only assume that the findings of attentional bias in clinical ED samples can be attributed to the overevaluation of weight and shape in these groups. To address this gap, the theory could be tested in ED samples by looking for associations between measures of body overevaluation and attentional bias. This should be investigated using a broader range of tasks that can provide a clearer picture than the modified Stroop, such as the dot probe and eye-tracking paradigms.

Body dissatisfaction—a related concept—is known to be associated with attentional bias for body stimuli in ED groups, such as those with BN (e.g., Smith & Rieger, 2006). There is evidence that inducing attentional bias toward weight/shape information can induce body dissatisfaction even in a healthy sample (Smith and Rieger). Persistent body dissatisfaction following treatment for BN is predictive of relapse (Freeman, Beach, Davis, & Solyom, 1986). There may be value in researching the potential of attentional bias modification as a means of reducing body dissatisfaction, particularly among those with BN.

The link between attentional bias and individual differences in emotional experiences has not received much investigation to date, and a deeper exploration of these would enhance our understanding of appetitive/aversive motivations underlying attentional biases in EDs. Fear and disgust are both candidates; for example, there is evidence of disgust conditioning of food in adolescents with AN (Hildebrandt et al., 2015) and that disordered eating is associated with disgust sensitivity (Troop, Murphy, Bramon, & Treasure, 2000). Correlating individual differences in attentional bias with measures such as the Disgust Propensity and Sensitivity Scale-Revised (Van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) would be one methodological avenue to explore.

Finally, this review has summarized evidence for attentional bias to a wide range of threatening stimuli that are not directly related to food or shape/weight; this evidence has come from the modified Stroop and the dot probe tasks, applying to AN, BN, and BED groups. The existence of comorbid anxiety and processes such as worry need to be ruled out given their influence on attentional bias (e.g., Mogg, Mathews, & Eysenck, 1992; Williams, Mathews, & Hirsch, 2014), and it is not clear from reviews whether primary studies controlled for these factors. The authors of the present study were not aware of studies making direct comparisons between ED groups and clinically anxious participants, and research in this area might shed light on this question. Furthermore, there is a lack of eye-tracking studies in relation to such threatening stimuli that are not eating disorder-specific, which would be beneficial to undertake at this stage.

4.1 | Suggestions for improving study quality

A high-quality systematic review is one of the most reliable sources of evidence to guide clinical practice (Clarke, 2011). Our meta-review found critical methodological limitations in the majority of the reviews in this area. Biases can be introduced at several stages in the design, planning, conduct, and analysis of a study (Shea et al., 2017). We will now provide some brief suggestions for future research in order to address the main detractors of study quality.

None of the authors referred to having developed a protocol before commencing their review; this should be a priority focus for future reviews as it is a simple method for improving the review's transparency and giving readers confidence in the review's conclusions, as well as reducing duplication of effort (Chang & Slutsky, 2012). Conducting risk of bias analyses for primary articles is another key step in conducting systematic reviews (Shea et al., 2017), which was unfortunately absent for the majority of included reviews. Data selection and extraction was often not performed in duplicate, which can contribute to a higher prevalence of errors in systematic reviews (Gøtzsche, Hróbjartsson, Marić, & Tendal, 2007); conducting systematic reviews within a team may be one way for authors to mitigate this in future. There was also a lack of detail provided by authors with regard to excluded studies, which prevents a deeper understanding of what impact exclusion might have had on the results (Shea et al.). While not formally assessed in this meta-review as a mark of study quality, it was notable that there are varying degrees of specificity in systematic reviews with regard to diagnostic samples, which often results from overly general descriptions of samples (e.g., "ED groups"). Given differences between these diagnoses in terms of presentation as well as some of the specific findings detailed above, this is an evident limitation to systematic reviews' ability to make fine-grained assessments of attentional biases in particular groups.

The replication crisis is a continuing challenge for psychological research, caused in part by a lack of planning of a sample size matched to the estimated effect size (Maxwell, Lau, & Howard, 2015). While the authors of this meta-review have noted times when small-study-bias may be in operation, primary articles often did not report effect sizes or justify their sample sizes, making it harder to judge the impact of small-study-bias on their findings. Many systematic reviews did not consider the potential impact of small-study-bias (such as inflated effect sizes) and only one meta-review (Brooks et al., 2011) conducted tests for such effects. Despite two meta-analyses included in the present meta-review having conducted tests to investigate publication bias (funnel plots and "fail-safe *n*"), these methods rest on assumptions that can render them unreliable (e.g., Song, Hooper, & Loke, 2013). In view of these points, all meta-analyses bar Brooks et al. may be influenced by small-study-bias, and a majority of systematic reviews may have reported studies where the effects are inflated by the inclusion of studies with small sample sizes. Moreover, every review that we have included potentially suffers from publication bias. The implication is that the effects identified in this meta-review may be weaker than suggested by the included reviews.

Finally, it is important to add that the vast majority of articles included in reviews focused on females or people who identify as women, with much less attention given to males or people who identify as men. Reviews often did not report on the age of study samples, but Table 3 shows that there is a bias toward adult samples in the articles selected from included reviews. Two reviews included articles with a mean sample age spanning childhood and adulthood and made no other statement about age, one stated that most samples were adult but that some had teenage samples, and the articles extracted from four reviews had samples whose range of mean ages only included adults (18+). Reviews did not report on other demographics of their samples such as ethnicity or socio-economic status. We cannot therefore conclude how generalizable the findings summarized in this meta-review are to the population of those with eating disorders. Reviews rely on these demographics being reported in primary articles, which they are often not; primary studies should aim to report data from more diverse samples, including ethnicity, country of origin, and across sexes/genders, as this is currently a major limitation in this area of research.

4.2 | Limitations of this meta-review

While a meta-review allows for pulling together the most consistent findings from the highest quality reviews, it does not allow for the level of in-depth examination that is possible with systematic reviews. It is possible, therefore, that the present study excluded recent individual primary articles with important findings. To address this in a limited way, an effort was made to include findings from recent studies in the discussion. Due to its recent publication, there may be specific limitations of using the AMSTAR-2 (Shea et al., 2017) that are yet to be uncovered; we are aware that a protocol has been registered for a study into the reliability and validity of this tool (Gates et al., 2018). This review did not consider electrophysiological and neurobiological measures of attentional bias, and as such cannot comment on any additional insights, or potential disagreement that might arise from, articles using these methodologies. Finally, our review did not systematically search the grey literature for unpublished data, which introduces the possibility of publication bias.

5 | CONCLUSIONS

Our meta-review summarizes the highest-quality evidence on attentional bias in eating disorders relative to non-clinical groups, across stimuli and three different paradigms. One of the highest quality reviews included a meta-analysis indicating that ED groups in general do have attentional bias for food stimuli (Brooks et al., 2011) on the Stroop. A more fine-grained picture comes from a dot probe study reported by Brooks et al., which indicated that attentional bias might depend on the calorie content of food stimuli (avoidance of low-calorie vs. vigilance for high-calorie food; Shafran et al., 2007). Ralph-Nearman et al. (2019) summarized eye-tracking studies reporting that those with AN showed conscious attentional avoidance of food stimuli (Giel, Friederich, et al., 2011), and a sad mood induction can induce attentional bias to food stimuli in overweight people with BED (Leehr et al., 2018). These reviewers also reported a study in which those with BN have poorer disengagement from low-BMI depictions of others and intentional avoidance for high-BMI depictions (Blechert et al., 2009). There is also evidence for attentional bias to general threat in ED groups, although it is unclear whether this relates to comorbid anxiety.

Given the maintaining role that these attentional biases may have in eating disorders, we have suggested that attentional bias modification might be a promising avenue for intervention research. Validating the theoretical link between overevaluation of weight and shape and attentional bias (Vitousek & Hollon, 1990) is required in clinical samples. A deeper understanding of emotional correlates of attentional bias, such as disgust, might also help with developing theory in this area. Future research should focus on employing the eye-tracking paradigm and, when using food stimuli, keeping in consideration the calorific value of chosen stimulus sets. We have also suggested the possibility of tailoring stimuli to participants' self-reported desired/feared foods.

Eighty percent of included reviews were deemed to be critically low in quality, and future systematic reviews would benefit from focusing on key areas of limiting bias. These areas include pre-registering a research protocol, implementing risk of bias assessments of primary studies, justifying study exclusion, considering the impact of small studies on findings and, for meta-analyses, conducting tests of small-study-bias.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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