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## Dynamic Changes in Attentional Bias in Social Anxiety

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**Date:** 2019-06-19T00:00:00+00:00

### Abstract

Attentional bias is a crucial factor in symptom maintenance among individuals with Social Anxiety Disorder (SAD), with three attentional patterns—attentional vigilance, attentional avoidance, and difficulty in attentional disengagement—having been most extensively investigated and discussed by researchers. As research has progressed, some scholars have proposed that the attentional patterns in SAD individuals are not singular or static, but rather likely shift between different modes, manifesting as a dynamic process. Currently, based on relevant research findings and theoretical hypotheses, evidence consistently indicates that attentional bias in SAD individuals tends to change dynamically with elevated anxiety levels and impaired attentional control, both in transitions from attentional vigilance to attentional avoidance and to difficulty in attentional disengagement. This perspective requires further empirical validation, and more targeted intervention approaches should be developed based on research findings.

### Full Text

#### Preamble

Dynamic Changes in Attentional Bias in Social Anxiety Jingqi Jiang, Haoyu Wang, Mingyi Qian (School of Psychology and Cognitive Science, Peking University, Beijing 100871)

### Abstract

Attentional bias represents a crucial factor in the maintenance of Social Anxiety Disorder (SAD), with three attentional patterns—vigilance, avoidance, and difficulty in disengagement—having received the most extensive research attention and discussion. As research has progressed, some investigators have proposed that the attentional mode in SAD individuals is not a singular, static pattern,

but rather likely shifts between different attentional modes, manifesting as a dynamic process. Currently, based on relevant empirical findings and theoretical assumptions, evidence consistently indicates that attentional bias in SAD individuals tends to change dynamically with increasing anxiety levels and impaired attentional control abilities, transitioning from vigilance to both avoidance and disengagement difficulties. This perspective requires further empirical verification and should inform the development of more targeted intervention approaches.

**Keywords:** social anxiety; attentional bias; vigilance; avoidance; difficulty in disengagement

## 1 Attentional Bias in Individuals with Social Anxiety

Social Anxiety Disorder (SAD) is one of the most prevalent anxiety disorders (Bandelow & Michaelis, 2015). Individuals with SAD experience persistent fear and anxiety in interpersonal situations and exhibit marked avoidance behaviors due to concerns that their actions may elicit negative evaluation, resulting in severe impairment across various functional domains (American Psychiatric Association, 2013). Numerous studies have identified that individuals with SAD demonstrate attentional biases, meaning their attentional allocation to threatening social stimuli differs from that toward neutral stimuli. This attentional characteristic, known as attentional bias, represents one of the most common features among anxious individuals (Rosso, Dillon, Pizzagalli, & Rauch, 2015).

Cognitive-behavioral models of social anxiety (Clark & Wells, 1995; Heimberg, Brozovich, & Rapee, 2010; Hofmann, 2007; Rapee & Heimberg, 1997) posit that attentional bias constitutes a key factor in maintaining social anxiety symptoms, a claim extensively supported by research. However, these models differ considerably in their theoretical assumptions. The two earliest classic models proposed that SAD involves a static attentional bias (Morrison & Heimberg, 2013), also termed a single-component attentional bias. For instance, Clark and Wells (1995) proposed an avoidance hypothesis, suggesting that individuals with SAD engage in self-focused attention during social situations, thereby inhibiting processing of external cues. Conversely, Rapee and Heimberg (1997) proposed a vigilance hypothesis, arguing that SAD individuals exhibit heightened vigilance toward threatening cues, which prevents further processing of neutral and positive stimuli.

In recent years, researchers have questioned whether vigilance or avoidance models are too limited (Fox, Zougkou, Ashwin, & Cahill, 2015; Yiend et al., 2015) and have begun proposing dynamic attentional bias hypotheses, also referred to as multi-component attentional biases. These theories suggest that attentional bias in SAD may involve different attentional stages, representing a dynamic process of multiple attentional bias components (e.g., Weierich, Treat, & Hollingworth, 2008). First, Mogg, Philippot, and Bradley (2004) proposed the “vigilance-avoidance” hypothesis, which posits that SAD individuals initially en-

ter a stage of automatic capture by social threat cues (initial hypervigilance), after which rising anxiety immediately triggers an avoidance stage to reduce anxious experiences. Second, the maintenance hypothesis, also called the difficulty in disengagement hypothesis (Amir, Elias, Klumpp, & Przeworski, 2003), suggests that SAD individuals do not show obvious vigilance in early attentional stages but rather, once attention is captured by threatening cues, cannot avoid them like typical individuals, instead maintaining attention on such cues for extended periods and experiencing difficulty disengaging.

This paper systematically reviews research findings related to four attentional bias hypotheses. Static attentional bias research is based on vigilance and avoidance hypotheses, with the dot-probe task being the primary methodology. Dynamic attentional bias research also involves two hypotheses, grounded in the “vigilance-avoidance” hypothesis and the difficulty in disengagement hypothesis, mostly requiring eye-tracking technology. This review emphasizes research methods and findings on dynamic attentional bias, integrating existing theories and empirical results under the framework of “dynamic changes in attentional bias in social anxiety.” It discusses how anxiety levels may influence changes in attentional bias, further explains potential dynamic attentional processes, and provides new research directions.

Among the studies reviewed, some samples consist of clinical populations meeting diagnostic criteria for SAD in psychiatric classification systems, referred to as SAD individuals, while others involve subclinical populations exhibiting SAD characteristics (e.g., fear of negative evaluation, social avoidance) but without formal diagnosis or not meeting diagnostic criteria, referred to as high social anxiety individuals. This paper uses the term “social anxiety group” to collectively refer to both SAD individuals and high social anxiety individuals.

## 2.1 Static Attention Bias Research Using the Dot-Probe Paradigm

Over the past three decades, the dot-probe task has been the most common paradigm for examining attentional bias toward threatening faces in SAD research. Grounded in vigilance and avoidance hypotheses, these studies investigate whether socially anxious individuals show preferences for negative faces. The dot-probe task typically includes two experimental conditions: the threat-incongruent condition, where the probe appears in the location previously occupied by the neutral stimulus when paired with a negative stimulus, and the threat-congruent condition, where the probe appears in the location previously occupied by the negative stimulus when paired with a neutral stimulus. The paradigm uses reaction time differences between these conditions (attentional bias index) as an indicator of attentional bias magnitude, with larger indices indicating greater bias (see Figure 1 [Figure 1: see original paper]) (Chen, Ehlers, Clark & Mansell, 2002; Mansell, Clark, Ehlers & Chen, 1999; Mogg, Philippot & Bradley, 2004; Schneier et al., 2016). Generally, an attentional bias index greater than zero (shorter reaction times in threat-congruent conditions) indi-

cates vigilance for negative stimuli, whereas an index less than zero indicates avoidance. Some studies also use raw reaction times as indicators of attentional bias.

**Figure 1:** Flowchart of dot-probe task under threat-congruent conditions

In terms of task characteristics, the dot-probe task examines attention in isolation, using indirect evidence (attentional bias index) to assess static attentional features (vigilance or avoidance) at specific time points (most commonly 500ms), allowing relatively sensitive detection of attentional focus in SAD individuals at particular moments. Studies using the dot-probe task to examine attentional bias have employed stimulus presentation times ranging from 17ms to 1250ms (e.g., Mogg & Bradley, 2002; Mogg et al., 2004), though most have used 500ms (e.g., Mogg et al., 2004). Research with presentation times shorter than 500ms remains relatively rare.

Mogg and Bradley (2002) used a 17ms presentation time and found that high social anxiety individuals showed significantly faster reaction times when probes appeared in the location of negative emotional faces compared to neutral faces, demonstrating vigilance for negative emotional faces. Stevens, Rist, and Gerlach (2009) found similar vigilance effects using 175ms. When stimulus presentation times exceeded 1000ms, virtually all studies failed to find attentional bias (Mogg et al., 2004; Stevens, Rist, & Gerlach, 2009).

Studies using approximately 500ms presentation times generally support the existence of attentional bias differences, though findings remain controversial regarding whether these represent vigilance or avoidance effects. Some results indicate that clinical and subclinical SAD samples show avoidance of negative emotional faces compared to healthy controls, regardless of whether individuals are in threatening social situations (Chen et al., 2002; Mansell et al., 1999). Other findings support vigilance effects (e.g., Mogg et al., 2004), while some studies suggest SAD individuals show no attentional bias (Schneier et al., 2016).

## 2.2 Summary of Static Attention Bias Research

Static attentional bias research reveals that only the dot-probe task can detect attentional bias in social anxiety groups, with bias patterns changing as stimulus presentation time increases—shifting from stable vigilance effects to an unstable transitional period (around 500ms) and finally disappearing. A recent meta-analysis examining dot-probe task results in social anxiety attention bias research found that SAD individuals show vigilance effects that decrease as stimulus presentation time lengthens (Bantin, Gerlach, & Hermann, 2016). This pattern of changing attentional bias with increasing stimulus duration suggests that attentional bias toward threatening stimuli in SAD may represent an unstable dynamic pattern. As time increases, more cognitive processes become involved in attention, masking the attentional bias.

Although the dot-probe task dominates static attentional bias research, numer-

ous findings demonstrate that stimulus presentation time influences attentional bias direction. Using static attentional bias methods to study dynamic attentional processes yields results with poor reliability and validity, a problem that remains unresolved (Kappenman, Farrens, Luck, & Proudfit, 2014). While raw reaction time values demonstrate better reliability, individual differences in response speed make attentional bias toward negative emotional faces difficult to detect (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). To address the dot-probe task's low reliability, researchers have developed new methods to compensate for this limitation. For example, Price and colleagues grouped 20 trials together, subtracting congruent-condition reaction times from incongruent-condition times and dividing by the average reaction time across all "threat-neutral" trials to correct within-subject variance and obtain better test-retest reliability (Price et al., 2015). Similarly, other researchers have attempted to improve the temporal resolution of spatial cueing tasks to achieve more stable attentional bias measures (Davis et al., 2016).

### 3 Dynamic Attention Bias

Experimental paradigms for studying dynamic attentional bias generally fall into three categories: (1) spatial cueing tasks that manipulate stimulus presentation time, (2) modified dot-probe tasks that manipulate both stimulus presentation time and initial fixation location, both attempting to differentiate attentional bias components within a single paradigm, and (3) eye-tracking-based research.

#### 3.1 Research Methods for Dynamic Attention Bias Without Eye-Tracking Technology

The spatial cueing task primarily examines the spatial distribution of attentional resources. Two rectangular frames are presented in the left and right visual fields, with participants instructed to fixate on a central point between the frames. Subsequently, a face stimulus appears randomly in one frame, cueing that location. After the face stimulus disappears, a target appears randomly in either frame, and participants must identify the target's location. Under valid conditions where the face stimulus and target location match, faster reaction times for negative emotional faces are considered vigilance effects. Under invalid conditions where they do not match, slower reaction times for negative emotional faces are considered difficulty in disengagement effects (see Figure 2 [Figure 2: see original paper]). Researchers using spatial cueing tasks to examine difficulty in disengagement from negative emotional faces in SAD individuals found that when angry faces were presented for longer than 300ms, SAD individuals showed significant difficulty in disengagement (Moriya & Tanno, 2011).

**Figure 2:** Flowchart of spatial cueing task under valid conditions

Although the dot-probe task originally only assessed static attentional bias, some researchers have manipulated the first fixation location to differentiate attentional components by dividing the task into two modules. In the vigilance

module (see Figure 3 [Figure 3: see original paper]), the first fixation always appears at the same location as the neutral face, with vigilance effect calculated as: reaction time when target and neutral face are in the same area minus reaction time when target and negative emotional face are in the same area. Larger vigilance effects indicate greater attraction to negative emotional faces. In the difficulty in disengagement module, the first fixation always appears at the same location as the negative emotional face, with disengagement effect calculated as: reaction time when target and neutral face are in the same area minus reaction time when target and negative emotional face are in the same area. Larger disengagement effects indicate longer time required to shift attention from negative emotional faces to other areas, representing greater difficulty in disengagement. One study using this paradigm found that SAD individuals' attentional bias manifested as vigilance only at 500ms stimulus presentation time, without showing difficulty in disengagement (Grafton & MacLeod, 2016).

**Figure 3:** Flowchart of vigilance module in Grafton and MacLeod (2016) study

### 3.2 Eye-Tracking-Based Research on Dynamic Attention Bias

Eye-tracking technology measures attentional patterns through indicators such as fixation points, fixation proportions, attentional shifts (saccades), and scan duration (total time visual attention remains in a specific area). The greatest advantage of eye-tracking technology lies in its ability to track changes in visual selection over time—something reaction time-based paradigms cannot achieve—making it crucial for understanding dynamic attentional bias in SAD individuals.

Eye-tracking research designs are relatively complex, employing various indicators to represent different components of attentional bias, with considerable variation across studies that lacks the consistency of traditional attention tasks and complicates comparisons between findings. Table 1 summarizes selected eye-tracking studies on dynamic attentional bias in social anxiety groups from the past decade, showing that most results support the notion that attentional bias in social anxiety is dynamic and changes significantly with stimulus presentation time.

**Table 1:** Summary of eye-tracking studies on dynamic attentional bias

Despite evidence that social anxiety groups exhibit dynamic attentional bias, no consensus exists regarding its specific manifestation. Regarding vigilance effects, if social anxiety groups show attentional vigilance toward negative emotional faces, they should demonstrate a higher probability of first fixating on negative faces (Schofield et al., 2012; Wieser et al., 2009), fixation proportions on negative faces exceeding 50% (Gamble & Rapee, 2010; Liang et al., 2017), and shorter time to first saccade to negative faces (Garner et al., 2006). However, other studies have found that social anxiety groups do not show these preferences for negative emotional faces (Fernandes et al., 2018; Lazarov et al., 2016; Liang et al., 2017).

Regarding avoidance effects, or initial fixation duration on negative emotional faces in SAD individuals, some research indicates that SAD individuals shift their gaze faster than control participants (Lange et al., 2011). Conversely, other evidence suggests that when the first fixation lands on a negative emotional face, high social anxiety individuals actually show longer initial fixation durations (Fernandes et al., 2018; Liang et al., 2017). Some findings also indicate that social anxiety level does not affect fixation duration in the first attended area (Lazarov et al., 2016). Meanwhile, researchers have found that over time, social anxiety groups show longer total fixation durations on negative emotional faces compared to low social anxiety individuals (Buckner et al., 2010; Lazarov et al., 2016; Liang et al., 2017; Schofield et al., 2012; Wieser et al., 2009), demonstrating difficulty disengaging from threatening social stimuli.

### 3.3 Summary of Dynamic Attention Bias Research

Early experimental paradigms examining dynamic attentional bias were based on classic attentional bias tasks, matching different stimulus presentation times to characterize how attentional bias changes over time. However, like static research, these approaches suffer from insufficient reliability.

Eye-tracking technology can reliably track attentional bias changes over time and has demonstrated better reliability than dot-probe tasks, particularly for longer attention durations (Waechter et al., 2014). Nevertheless, due to the lack of appropriate experimental tasks, it remains impossible to accurately separate vigilance and difficulty in disengagement components of attentional bias, preventing further investigation of how different components change and making it difficult to understand what factors influence attentional bias.

## 4 Hypothesized Dynamic Process of Attentional Bias in Individuals with Social Anxiety

Attentional bias patterns have long been a focal point in social anxiety research. Integrating findings across studies, SAD individuals' attentional bias is not a simple static pattern but changes over time. Having reviewed relevant research above, this section further discusses and analyzes this dynamic change process to advance understanding of attentional bias in SAD.

To further clarify attentional bias toward threatening social stimuli in SAD, researchers must consider different attentional systems independently. For example, some propose dividing attention into two systems: stimulus-driven exogenous attention, which is typically automatic and requires minimal attentional control resources, and goal-driven endogenous attention, which occurs later and requires attentional control regulation (e.g., Klein & Lawrence, 2012). Some researchers refer to the latter as attentional control capacity, suggesting that early vigilance/avoidance patterns in SAD represent primary attentional control mechanisms, while difficulty in disengagement reflects failed avoidance. Individuals with trait anxiety who possess better attentional control can shift attention

away from threatening stimuli more quickly, whereas those with poor attentional control show difficulty in disengagement (Derryberry & Reed, 2002).

Given that avoidance represents a primary regulatory outcome of goal-driven attention, Eysenck, Derakshan, Santos, and Calvo's (2007) attentional control theory may offer a viable framework for explaining how attentional bias changes over time in SAD. Attentional control theory posits that anxiety impairs two executive control functions: inhibition and shifting. Inhibition refers to suppressing or regulating dominant, automatic responses, while shifting refers to adaptively adjusting attention between task-relevant and task-irrelevant stimuli. Anxiety reduces inhibitory capacity, weakening top-down regulation of automatic responses and enhancing stimulus-driven attentional processes, manifested as vigilance. Simultaneously, anxiety impairs shifting capacity, reducing the ability to disengage attention from threatening stimuli and preventing task-relevant processing, ultimately resulting in difficulty disengaging from irrelevant stimuli. Because attentional control theory emphasizes how anxiety affects different attentional control components, it may provide a foundation for better understanding fluctuations in attentional bias among SAD individuals.

One study found that disengagement ability may be moderated by attentional control capacity: for individuals with weak attentional control, higher social anxiety levels correlate with poorer disengagement ability, whereas for those with strong attentional control, higher social anxiety correlates with better disengagement ability (Taylor, Cross, & Amir, 2016). Additionally, working memory capacity effectively predicts attentional control ability but is unrelated to stimulus-driven processes (Redick & Engle, 2006). Building on this empirical foundation, one study manipulated executive control capacity by varying working memory load, finding that SAD individuals under high working memory load showed significant difficulty in disengagement during later attentional stages, whereas those under low load showed significant vigilance (Judah, Grant, Lechner, & Mills, 2013).

Based on these theoretical and empirical foundations, we propose that attentional bias in SAD individuals changes dynamically with anxiety level. Most likely, when stimulus presentation times are brief, individual anxiety levels are low, and top-down attentional control is not engaged, SAD individuals show greater vigilance toward negative emotional faces. As stimulus presentation time increases and individual anxiety levels rise, constrained by attentional control capacity, attentional bias toward negative emotional faces may shift toward avoidance, and with further impairment of attentional control, ultimately manifest as difficulty in disengagement.

#### **4.1 Vigilance Effects for Negative Emotional Faces in the Early Attentional Stage of SAD Individuals**

Based on existing empirical evidence, when stimulus presentation times are brief and top-down attentional control is not engaged, SAD individuals' attentional

bias shows a relatively stable preference for threatening social stimuli. For example, eye-tracking experiments with short presentation times have demonstrated faster attention to and greater probability of capture by negative emotional faces (Liang et al., 2017; Schofield et al., 2012).

Importantly, although SAD individuals show a higher probability of initially attending to threatening social stimuli, not all high social anxiety individuals or those with SAD exhibit this attentional bias, and insufficient evidence supports a clear association between this bias and individual severity of social anxiety (e.g., Taylor et al., 2016). Despite meta-analytic support for this difference (Bantin et al., 2016), researchers must consider whether this vigilant attentional bias is specific to social anxiety.

#### **4.2 Dynamic Adjustment Process of Attentional Bias Toward Negative Emotional Faces in SAD Individuals**

Considering that eye-tracking experiments have found first saccades occur around 350ms (Garner et al., 2006), the period around 500ms and beyond represents the most complex and contradictory findings in attentional bias research, including other visual attention paradigms requiring emotion recognition. When stimulus presentation times exceed 2 seconds, no studies have found attentional bias effects, possibly because a transitional stage for dynamic adjustment of attentional bias exists between 400ms and 2000ms.

In the initial stage of this dynamic process, SAD individuals are easily captured by threatening social stimuli and experience anxiety. To regulate emotions, they quickly avoid such stimuli (Lange et al., 2011). According to attentional control theory, as anxiety levels increase, the bottom-up stimulus-driven attentional system becomes enhanced, and attention quickly shifts back to threatening social stimuli, maintaining or intensifying anxiety levels. During this stage, the attentional process in SAD individuals may involve repeated cycles of capture by and shifting away from negative emotional faces. Since dot-probe tasks assess attention at specific time points, this may explain why different studies support different attentional bias patterns.

At this point, increased or maintained anxiety levels further impair inhibitory and shifting abilities, causing attentional bias in social anxiety groups to transition to difficulty in disengagement (Buckner et al., 2010; Lazarov et al., 2016; Liang et al., 2017; Schofield et al., 2012; Wieser et al., 2009). Preliminary research indicates that shifting ability moderates the relationship between social anxiety level and difficulty in disengagement: when shifting ability is low, social anxiety slows disengagement; when shifting ability is high, social anxiety speeds disengagement (Taylor et al., 2016).

In summary, compared to healthy controls, even when SAD individuals initially show sustained vigilance/avoidance patterns toward threatening social stimuli, top-down attentional systems influenced by anxiety levels make them more susceptible to attentional capture by threatening stimuli and less able to inhibit this

capture. Consequently, they show longer total fixation durations on negative emotional faces. Conversely, greater attention to threatening stimuli maintains higher anxiety levels, further damaging attentional control capacity and creating a vicious cycle. In essence, once top-down attentional control engages in the attentional process, SAD individuals' attentional bias patterns likely undergo dynamic changes, transitioning from initial vigilance/avoidance patterns to a balanced pattern between avoidance and difficulty in disengagement.

Based on existing research and theoretical hypotheses, we propose that attentional bias in SAD individuals involves a dynamic change process. Most current research in this field suffers from insufficient reliability and validity, and most attentional paradigms cannot track dynamic features of attentional processes or adequately control potential moderating variables. Future research must improve in two key areas:

First, at the technical level of experimental design, studies must emphasize dynamic features of attentional processes. Reaction time-based attentional bias methods do not measure dynamic attentional bias; their primary advantage lies in separately examining vigilance and difficulty in disengagement. Dynamic effects are still determined by controlling different presentation times, which cannot continuously track how specific components of attentional bias change dynamically. Currently, eye-tracking technology offers the most powerful means of tracking dynamic attentional processes, recording specific manifestations of attentional changes over time. However, existing paradigms still struggle to simultaneously measure different components of attentional bias. Combining the advantages of both approaches represents the greatest challenge researchers face.

Conceptually, vigilance represents bottom-up attentional capture, while avoidance and difficulty in disengagement represent top-down attentional control. To simultaneously examine these three attentional control components, more ingenious experimental designs and new research paradigms must be developed. Currently, however, research continues using self-report scales (Attentional Control Scale; Derryberry & Reed, 2002) to measure different components of attentional control (e.g., Judah, Grant, Mills, & Lechner, 2014). The extent to which such measurements represent actual attentional abilities in social anxiety individuals during attentional processes remains questionable. Researchers should employ more direct methods that better reflect immediate attentional control capacity to measure current attentional patterns in social anxiety individuals.

Second, researchers must attend to moderating variables affecting attentional processes. The influence of trait social anxiety and state anxiety on attentional bias in SAD individuals is crucial for explaining dynamic attentional bias. According to attentional control theory, the direction of dynamic attentional bias change depends on attentional control capacity, which is influenced not only by trait anxiety but more importantly by the degree to which state anxiety impairs attentional control. Previous research on attentional bias in SAD has not monitored or controlled state anxiety, potentially contributing to contradictory

findings and unexplained issues across studies. Future research should give this sufficient attention.

Few previous studies on attentional bias in SAD have simultaneously examined the effects of trait social anxiety and state anxiety on attentional bias and their interaction. Some findings suggest complex interactions between these factors. For example, eye-tracking research found that high social anxiety individuals show vigilance-avoidance patterns toward negative emotional faces, but only when state anxiety levels are high (Garner et al., 2006). Singh and colleagues also found that high social anxiety individuals show avoidance of negative emotional faces when state anxiety is high, but vigilance when state anxiety is low (Singh et al., 2015). Some EEG studies indicate that although SAD individuals show relatively stable vigilance effects for negative emotional faces in behavioral data, their anxiety symptoms actually affect top-down control capacity, leading to increased avoidance behaviors associated with reduced late positive potential activity (MacNamara, Jackson, Fitzgerald, Hajcak, & Phan, 2019). Therefore, future research should ideally examine how trait social anxiety levels and state anxiety levels independently influence attentional bias in SAD individuals and how they contribute to symptom development and maintenance.

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*Note: Figure translations are in progress. See original paper for figures.*

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