



# Attentional control deficits in social anxiety: Investigating inhibition and shifting functions using a mixed antisaccade paradigm

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## ABSTRACT

**Background and objectives:** Attentional control has recently been assumed to play a critical role in the generation and maintenance of threat-related attentional bias and social anxiety. The present study aimed to investigate whether socially anxious (SA) individuals show impairments in attentional control functions, particularly in inhibition and shifting.

**Methods:** Forty-two SA and 41 non-anxious (NA) participants completed a mixed antisaccade task, a variant of the antisaccade task that is used to investigate inhibition as well as shifting functions.

**Results:** The results showed that, overall, SA participants had longer antisaccade latencies than NA participants, but the two groups did not differ in their antisaccade error rates. Moreover, in the single-task block, SA participants had longer latencies than NA participants for antisaccade but not prosaccade trials. In the mixed-task block, the SA participants had longer latencies than the NA participants for both task types. The two groups did not differ in their latency switch costs in the mixed-task blocks.

**Limitations:** First, this study was conducted using a non-clinical sample of undergraduate students. Second, the antisaccade task measures primarily oculomotor inhibition. Third, this study did not include the measure of state anxiety to rule out the effects of state anxiety on the present findings.

**Conclusions:** This study suggests that SA individuals demonstrate diminished efficiency of inhibition function but show no significant impairment of shifting function. However, in the mixed-task condition, SA individuals may exhibit an overall reduction in processing efficiency due to the higher task difficulty.

## 1. Introduction

Cognitive theories suggest that social anxiety results from information processing biases of socially threatening stimuli such as attentional, memory, and interpretive biases (Clark & McManus, 2002; Heinrichs & Hofmann, 2001). Increasing evidence supports the hypothesis that socially anxious (SA) individuals (i.e., individuals with social anxiety disorders or individuals with subclinical social anxiety) show attentional bias toward threatening stimuli (e.g., threatening faces) (Bantini, Stevens, Gerlach, & Hermann, 2016; Staugaard, 2010). More specifically, some studies have shown that SA individuals exhibited attentional vigilance toward threatening stimuli (Klump & Amir, 2009; Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004), while others have shown that they had difficulty in disengagement from threatening stimuli (Amir, Elias, Klump, & Przeworski, 2003; Buckner, Maner, & Schmidt, 2010; Liang, Tsai, & Hsu, 2017). In recent years, considerable attention has been focused on the mechanisms underlying attentional bias in anxiety (Cisler & Koster, 2010). On the one hand, some researchers suggest that attentional

control may moderate the relationship between social anxiety and attentional bias. For example, one study reported that SA individuals with poor self-reported attentional control ability showed more difficulty disengaging from threats than those with better self-reported attentional control ability (Taylor, Cross, & Amir, 2016). On the other hand, some researchers suggest that attentional bias for threatening stimuli may result from impaired attentional control ability (Heeren, De Raedt, Koster, & Philippot, 2013). From this perspective, SA individuals are assumed to exhibit attentional control deficits and these deficits may lead to threat-related attentional bias (Cisler & Koster, 2010). Functional neuroimaging studies have reported that SA individuals had reduced recruitment of the dorsolateral prefrontal cortex (DLPFC) and dorsal anterior cingulate cortex (DLACC), which are involved in top-down attentional control processes (Balderston et al., 2017; Blair et al., 2012). These findings lead to the important question of whether SA individuals exhibit general attentional control difficulties compared with non-anxious (NA) individuals.

Attentional control refers to the ability to efficiently and flexibly allocate attention to goal-relevant information and resist interference

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from goal-irrelevant information (Eysenck, Derakshan, Santos, & Calvo, 2007). Attentional control theory (ACT) was developed by Eysenck et al. (2007) to explain the negative effects of anxiety on cognitive performance via attentional control processes. According to ACT, the term “anxiety” is used here to refer to both individual differences in anxiety (e.g., trait anxiety or social anxiety) and state anxiety which is experimentally manipulated (e.g., via evaluative instructions). There are two major assumptions underlying ACT. The first assumption is that anxiety impairs attentional control and leads to poor performance on tasks involving two core central executive functions, inhibition and shifting (Miyake et al., 2000). Successful attentional control processes rely on a balanced interaction between a stimulus-driven attentional system and a goal-directed attentional system (Corbetta & Shulman, 2002). The stimulus-driven attentional system involved in the bottom-up control of attention was found to be primarily influenced by the salience of a stimulus. It is also involved in a threat-detection mechanism that is associated with amygdala activity (Cisler & Koster, 2010; Mogg & Bradley, 2016). The goal-directed attentional system involved in the top-down control of attention was found to be mainly influenced by an individual's current goals. ACT assumes that anxious individuals<sup>1</sup> tend to allocate greater attentional resources to detect the potential threatening stimuli in the environment, and thus, the amount of attentional resources devoted to task-relevant stimuli is reduced. Therefore, ACT proposes that anxiety impairs attentional control processes by interfering with the balance between the two attentional systems. Specifically, anxiety leads to an increased influence of the stimulus-driven attentional system and a decreased influence of the goal-directed attentional system (Eysenck et al., 2007). This assumption can be used to account for the mixed findings regarding threat-related attentional biases in SA individuals. On the one hand, some studies reported that SA individuals exhibited facilitated attention for threats (Klumpp & Amir, 2009; Stevens, Rist, & Gerlach, 2009), which has been assumed to be associated with increased stimulus-driven bottom-up processing. On the other hand, other studies showed that SA individuals demonstrated difficulty in disengaging from threats (Amir et al., 2003; Moriya & Tanno, 2011), which has been assumed to be associated with diminished goal-directed top-down attentional control (Cisler & Koster, 2010). Accordingly, ACT predicts that anxious individuals demonstrate impairments in two critical central executive functions, inhibition and shifting, which are directly involved in attentional control. The inhibition function refers to an ability to resist interference from task-irrelevant stimuli and suppress irrelevant prepotent responses when necessary. The shifting or set-shifting function refers to the capacity to flexibly switch one's attention back and forth between different tasks or response rules.

The second assumption of ACT is that anxiety adversely impacts processing efficiency more than performance effectiveness. Effectiveness refers to one's ability to make responses correctly on a task. Efficiency, by contrast, refers to the amount of cognitive resources one devotes to performing a task correctly. Decreased performance effectiveness of a task is usually indexed by lower response accuracy, while reduced processing efficiency is usually indexed by longer response latency (Ansari, Derakshan, & Richards, 2008). According to ACT, anxious individuals may try to compensate for the adverse effects of anxiety by making more efforts to achieve the task goal. Therefore, ACT predicts that anxious individuals may exhibit reduced processing efficiency but show intact performance effectiveness on tasks involving inhibition and shifting functions compared with NA individuals (Eysenck & Derakshan, 2011; Eysenck et al., 2007).

Researchers have used a variety of experimental tasks to investigate

attentional control functions in anxious individuals. For example, the Stroop task, in which participants are required to ignore the word content and report the printed ink color of each word as fast as possible (Price & Mohlman, 2007) was used to measure inhibition function, and the Wisconsin Card Sorting Test (WCST) which is a neurological test of “set-switching” was used to measure shifting function (Caselli, Reiman, Hentz, Osborne, & Alexander, 2004). However, these tasks do not provide a direct measurement of attention. Eye tracking has recently become a promising technology to provide a more direct assessment of attentional control and has been increasingly applied to investigate human cognitive processes (Ainsworth & Garner, 2013; Eckstein, Guerra-Carrillo, Miller Singley, & Bunge, 2017). The antisaccade task, an eye tracking paradigm that assesses the top-down attentional control, has been widely used in studies of a variety of psychiatry disorders (Ainsworth & Garner, 2013; Malsert et al., 2012; Rommelse, Van der Stigchel, & Sergeant, 2008). In the antisaccade task, participants are instructed to make either a prosaccade toward or an antisaccade away from a sudden onset target. When a target suddenly appears in the peripheral visual field, individuals have a natural tendency to make a reflexive prosaccade toward and fixate on it. By contrast, antisaccades require participants to inhibit a reflexive prosaccade toward the suddenly appearing target and to generate a voluntary saccade in the opposite direction. Pro- and antisaccades are often completed in separate single-task blocks of trials with either all prosaccades or all antisaccades during a typical antisaccade task. The antisaccade task provides two measures to evaluate participants' attentional inhibition ability. The error rates of antisaccade trials are used to index performance effectiveness, and the latencies of correct antisaccades are used to index processing efficiency. Several studies have shown that compared with low-anxious individuals, individuals with high trait anxiety demonstrated intact performance effectiveness but impaired processing efficiency on an antisaccade task involving inhibition (Ainsworth & Garner, 2013).

Some researchers have used the mixed antisaccade task, a variant of the antisaccade task, to investigate inhibition as well as shifting functions involved in attentional control (Ansari et al., 2008; De Lissnyder, Derakshan, De Raedt, & Koster, 2011). There are two kinds of experimental blocks: single-task blocks, in which only pro- or only antisaccade trials are included, and mixed-task blocks, in which pro- and antisaccade trials are interspersed randomly. In the mixed-task blocks, participants are required to flexibly switch between pro- and antisaccade task rules. Therefore, the mixed antisaccade tasks can be used to assess both inhibition and shifting functions. Ansari et al. (2008) investigated participants' performance on a mixed antisaccade task and reported that individuals with high trait anxiety showed less efficient inhibition and shifting functions than individuals with low trait anxiety. To date, few studies have simultaneously examined inhibition and shifting functions in individuals with high social anxiety. One study of event-related potential (ERP) activity in the mixed antisaccade task by Judah, Grant, Mills, and Lechner (2013) reported that SA individuals showed impaired processing efficiency for both inhibition and shifting. Moreover, their findings suggest that self-focused attention may exaggerate these deficits. However, the mixed antisaccade task used in their study included only mixed-task blocks (pro- and antisaccade trials were interspersed randomly), not single-task blocks (only pro- or only antisaccade trials). This may result in difficulty in differentiating inhibition from shifting abilities in the task (Fox, Derakshan, & Standage, 2011). More empirical investigations are necessary to clarify whether SA individuals exhibit impairments in both inhibition and shifting functions.

The present study attempted to adopt the mixed antisaccade task to simultaneously investigate inhibition and shifting in SA individuals. The Brief Fear of Negative Evaluation scale (BFNE; Leary, 1983) was used for screening of SA and NA participants because cognitive models have postulated that fear of negative evaluation is a core feature of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997). The

<sup>1</sup> ACT (Eysenck et al., 2007) emphasizes adverse effects of anxiety on processing efficiency. The term “anxiety” in ACT is used to refer to both individual differences in anxiety (e.g., trait anxiety or social anxiety) and state anxiety. Accordingly, “anxious individuals” here is used as a generic term for both individuals with high trait anxiety (or other more specific measures such as high social anxiety) and individuals with high state anxiety.

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