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Temporal dynamics of selective attention in non-clinical anxiety

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ABSTRACT

For the first time, anxiety-related attentional bias was examined by considering separately its time–course and the influence of processing time. High- and low-trait-anxious undergraduates performed a color-identification task: Emotional–neutral word pairs were presented for 14 or 500 ms; color appeared at word onset or after 514 ms, at emotional word position or at the other position. Word duration (processing time) and color onset time (moment at which bias was 'tapped') were manipulated independently. Relatively fast responses when emotional word and color spatially correspond reflect attentional bias for that word. High-trait-anxious, compared to low-trait-anxious, undergraduates showed biases for physical-threat words and positive words (second half of the task). These group differences did not significantly vary as a function of duration or SOA. The findings suggest a content-specific bias for threat in non-clinical trait-anxiety, very quickly upon stimulus onset, even when only little time is available for stimulus processing. This bias does not vary over a period of 500 ms, also not when further stimulus processing is possible. It is recommended to further investigate the precise temporal characteristics of anxiety-related attentional biases.

1. Introduction

Researchers have been challenged to specify the precise nature of selective attention in anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). This work has been motivated by the notion that information processing biases, and especially attentional biases, underlie several problems in anxiety (overviews of cognitive theories on anxiety: Mathews & Mackintosh, 1998; Mogg & Bradley, 1998). The focus of this article is on the temporal characteristics of selective attention in non-clinical anxiety.

One of the main techniques used to study anxiety-related attentional bias is the dot-probe task (MacLeod, Mathews, & Tata, 1986). A stimulus pair containing one emotional and one neutral word or picture is presented, followed by a probe (e.g., dot) at a location previously occupied by one of the members of the pair. Faster responses to probes at emotional stimulus location than to probes at the other location have been taken to reflect attentional bias for the emotional stimulus: selective attention to the emotional stimulus, in preference to a simultaneously presented neutral one.

In dot-probe research, it has been common to present stimulus pairs for 500 ms. Studies employing this duration have revealed a bias for threat-relevant stimuli in clinical and non-clinical anxiety (Bar-Haim et al., 2007; Mogg & Bradley, 1998). To investigate the role of stimulus awareness and to map the time–course of attentional bias, stimulus duration has been manipulated. Five hundred-ms duration allows awareness of stimulus content; it may enable the operation of strategic processes, occurring after information entered awareness. Also with restricted stimulus awareness (e.g., 14-ms duration backward-masked) anxiety-related attentional bias has been observed (e.g., Bradley, Mogg, & Lee, 1997; Fox, 1996; Mogg, Bradley, & Hallowell, 1994; Mogg, Bradley, & Williams, 1995). Dot-probe results with 14-ms or 500-ms duration have been taken to reflect bias in initial orienting (Bradley, Mogg, Falla, & Hamilton, 1998; Mogg, Bradley, de Bono, & Painter, 1997). To investigate whether anxious people, after initial orienting, direct attention away or maintain attention on threat, stimulus duration has been increased up to 2000 ms (e.g., Bradley et al., 1998, 1997; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg et al., 1997; Mogg, Philippot, & Bradley, 2004). The course and time scale of attentional bias depends on stimulus' threat value and the anxiety group under consideration.

In nearly all dot-probe studies that manipulated stimulus duration, longer durations were paired with larger intervals between stimulus onset and probe onset (stimulus onset asynchrony; SOA). The longer the stimulus duration, the more time there is to process stimulus content. In addition, if it is assumed that attentional bias is 'tapped' at probe onset, then the larger the SOA, the later the bias is tapped in its time–course. Confounding of stimulus

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duration and SOA renders it impossible to isolate the effects of processing time and moment of tapping. Basic research into selective attention highlights the importance of considering both stimulus duration and SOA as separate temporal factors; attentional orienting has been found to depend on the combination of cue duration and cue-target SOA (Collie, Maruff, Yucel, Danckert, & Currie, 2000; Gibson & Bryant, 2005; McAuliffe & Pratt, 2005). Hence, to get a more complete view of the temporal characteristics of selective attention in anxiety, the effects of stimulus duration and SOA on attentional bias should be considered separately.

There are only few published dot-probe studies on anxiety that vary stimulus duration, while keeping stimulus-probe SOA constant (Egloff & Hock, 2003; Luecken, Tartaro, & Appelhans, 2004; Mathews, Ridgeway, & Williamson, 1996), and none that varies SOA, while keeping duration constant. Yet, this latter procedure has been used successfully to map the time–course of comparable phenomena like covert orienting (Posner & Cohen, 1984), priming (Hermans, De Houwer, & Eelen, 2001), and stimulus–response compatibility effects (Simon, Acosta, Mewaldt, & Speidel, 1976). Effects at short SOAs (<200 ms) are thought to reflect the influence of early, fast-acting cognitive processes; effects at longer SOAs the influence of strategic processes, building up as time progresses across a trial.

The present experiment is the first to study the separate effects of stimulus duration and SOA on anxiety-related attentional bias. High- and low-trait-anxious undergraduates performed a color-identification task: One emotional word (physical-threat, social-threat, or positive) and one neutral word were simultaneously presented for 14 or 500 ms; color appeared at emotional word position or at the other position, at word onset or after 514 ms.

This experiment extends dot-probe studies in two respects. In the present paradigm, attentional bias was not only tapped later in its time–course, when the words had already disappeared, but also very early, with a color-probe at word onset. Second, stimulus duration and SOA were de-confounded, making it possible to assess the effects of processing time and moment of tapping independently. It could also be examined whether anxiety-related attentional bias depends on the combination of stimulus duration and SOA.

The 514-ms SOA conditions strongly resemble conditions used in previous dot-probe studies; we expected to replicate their findings. That is, with 500-ms exposure and 514-ms SOA, the high-anxious group should show a content-specific bias for threat-relevant words, relative to the low-anxious group. With 14-ms exposure and 514-ms SOA, we had no clear hypothesis, as the few previous studies with brief, masked exposure and 500-ms SOA differed in methodology and yielded mixed results. If anything, we expected an anxiety-related bias for threat-relevant words, consistent with Mathews et al. (1996) and Luecken et al. (2004). These observations would support the notion that trait-anxiety is characterized by automatic, preferential processing of threat-relevant information (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998). Furthermore, sub-clinically anxious people may be characterized by controlling strategies, occurring after stimulus content entered awareness and counteracting initial automatic bias for threat (e.g., Fox, 1996). This would result in larger bias effects with 14-ms than with 500-ms exposure. Alternatively, it may be that high-trait-anxious people, even with 500-ms processing time, maintain attention on threat, whereas low-anxious people disengage attention from it (cf. Fox, Russo, Bowles, & Dutton, 2001). With 0-ms SOA, it could be assessed whether bias for threat is automatic also in the sense that it occurs very quickly upon stimulus presentation. It might be that anxiety is associated with processing bias for threat-relevant stimuli as soon as these stimuli appear and that, later in time, anxious people also have difficulty to disengage attention from them.

2. Method

2.1. Participants

We selected undergraduates reporting high- or low-trait-anxiety and low-social desirability. At initial screening, trait-anxiety was assessed with the Spielberger State–trait Anxiety Inventory (STAI-trait; Van der Ploeg, Defares, & Spielberger, 1980) and social desirability with the Marlowe–Crowne Social Desirability scale (SDS; Hermans, 1967). Those scoring $\geqslant$40 or $\leqslant$32 on STAI-trait and scoring $\leqslant$18 on SDS were invited. Eighteen participants scored high on STAI-trait during pre-screening, but below 40 during the experiment, or low during pre-screening, but above 32 during the experiment. They were excluded. Altogether, 24 consistently high-trait-anxious and 26 consistently low-trait-anxious undergraduates took part. All were native Dutch speakers, non-dyslexic, and with (corrected to) normal vision and color vision. They participated on informed consent basis and received €12.5. The department's Ethics Committee approved the study.

2.2. Materials

Critical stimuli consisted of 32 social-threat, 32 physical-threat, and 32 positive Dutch words, individually matched with neutral words in terms of length and frequency (Baaijen, Piepenbrock, & Gulikers, 1995). Ninety-six neutral–neutral pairs acted as fillers. The critical stimuli were drawn from published lists (e.g., MacLeod et al., 1986). Word length ranged from 3 to 10 letters. During practice trials, additional words were presented.

Affective content of all words was rated by eight staff members (three men; all Dutch) on a visual analogue scale. Physical-threat words, social-threat words, and neutral words paired with them were rated on their association with physical-threat and social-threat, respectively (from 'not at all' to 'extremely'). Valence of positive words, neutral words paired with them, and fillers was rated on a bipolar scale (from 'very negative' to 'very positive'). The mean rating difference (z-scores) between the members of physical-threat-neutral pairs was at least 1.3 (mean = 1.9), of social-threat-neutral pairs at least 1.4 (mean = 1.8), of positive-neutral pairs at least 1.4 (mean = 1.8) and of neutral–neutral pairs between −.5 and .5 (mean = .02).

Masks consisted of mirrored, upside-down upper-case consonants, numbers, and symbols. They were unique to each word, length- and color-matched with the preceding word.

Task presentation and response registration were controlled by a Dell Optiplex GX260 computer running ERTSVIPL (Berisoft Cooperation, Frankfurt, Germany).

2.3. Procedure

Participants were tested individually at a viewing distance of about 60 cm from the computer screen in a dimly lit room. They were video-monitored and could communicate with the experimenter through an intercom. They were informed that the study investigated the relationship between concentration and performance. The real purpose was explained after all participants had been tested. Each participant first performed the color-identification task and then completed the STAI-trait, STAI-state, Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and SDS.

Each trial of the color-identification task started with a white central fixation cross on a dark background. After 500 ms, a backwardly masked word pair in upper-case letters (non-proportional font, 0.5 cm high) appeared, with one word above the cross, the other below (3 cm between top upper word and bottom lower