The influence of emotive visual stimulation and anxiety on attention biases and memory

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Abstract

Literacy: Many studies have been showing that anxious individuals display attention biases including preferential engagement, difficulty in disengagement, or attention avoidance. Research in patients suggests that pathological anxiety may specifically impair *spatial* short-term and long-term episodic memory. Recently, many authors have emphasized the role of aversive stimulation on attention, working memory and anxiety. **Purpose:** The present study investigated the influence of anxiety on memory and attention, to contribute to our understanding of the anxiety effects on cognitive function. **Methods:** 130 students were included in this study (57 male and 73 female). **Procedure:** Each subject completed the State-Trait Anxiety Inventory (STAI). After this measure, only 41 participants with the highest (n=21) and the lowest (n=20) levels of anxiety complete the Trail Making Test A-B, Attentive Matrices Test, Babcock Story Recall Test and Short-Term Visual Memory Test. **Results:** Less anxious participants showed best memory capacity and less attention biases than more anxious participants.

Keywords: anxiety; attention; emotive stimulation; memory.

Introduction

Some authors have argued that anxiety impairs the ability to think and concentrate, suggesting that the interaction between emotion and cognition may elucidate the debilitating nature of pathological anxiety (Vytal et al., 2012). Some of the prominent cognitive problems associated with anxiety are correlate to impaired attention mechanisms. Anxious people complain of being easily distracted and have difficulty concentrating. Population-based studies have reported impairments in executive function and episodic memory across various anxiety disorders (Airaksinen, Larsson and Forsell, 2005). The precise impact of anxiety on cognition is, however, unclear. In general, anxiety sensitizes sensory cortical systems to innocuous environmental stimuli. More conclusive evidence that anxiety enhances sensory- perceptual processing comes from studies that include intrinsically salient stimuli. Facial displays of emotion have been heavily-used in this regard (Haxby et al., 2000; Phillips et al., 2003). Clinical populations shows comparable biases toward aversive relative to appetitive face across behavioral and neural dimensions (Blair et al., 2008; Roy et al., 2008), as do individuals with increased dispositional anxiety (Cools et al., 2005; Telzer et al., 2008). A wealth of research demonstrates that anxious individuals display an attention bias towards threatening sources of information, and this effect is less consistent or typically not observed in non-anxious individuals (Bar-Haim et al., 2007; Mogg and Bradley, 1998). However, more recent studies have demonstrated qualitatively different types of biases, including preferential engagement, difficulty in disengagement, or attention avoidance (Cisler and Koster, 2010; Sheppes et al., 2013). There is substantial evidence that biases are not inflexible, but are, in fact, very plastic and strongly influenced by environmental stressors (Bar-Haim et al., 2010; Wald et al., 2013). The attention control theory posits that anxiety disrupts two central executive functions related to attention control: inhibition and shifting. Inhibition refers to the ability to inhibit or regulate dominant or automatic responses. Shifting refers to the adaptive ability to shift attention between tasks depending on context. Eysenck and colleagues (2007) discuss these functions in terms of top-down and bottom-up processing. Anxiety impairs inhibition in that anxiety weakens the degree to which inhibitory mechanisms can regulate

automatic responses; that is, anxiety weakens top-down regulatory control. Research using the spatial cueing task has invariably demonstrated difficulty in disengagement among anxious individuals (Amir et. al., 2003; Fox et. al., 2001; Van Damme et al., 2006); moreover, research using the visual search task has almost invariably demonstrated difficulty in disengagement among anxious individuals (Lipp and Waters, 2007; Rinck et al., 2005). With regard to memory, anxiety has a selective effect that is dependent on the modality (spatial or verbal), difficulty, and task type (working memory or long-term memory). Research in patients suggests that pathological anxiety may specifically impair *spatial* short-term memory performance; patients with different anxiety disorders show deficits in spatial working memory, but not verbal working memory performance or verbal working memory capacity (Kizilbash et al. , 2002; Boldrini et al., 2005). In contrast, dispositional anxiety is frequently associated with reduced working memory capacity but not performance, as captured by digit span measures or increased reaction time on verbal and spatial short-term memory tasks (Derakshan and Eysenck, 1998; Richards et al., 2000). Some works showed that, in contrast with certain short-term memory tasks, patients with anxiety disorders are not impaired in long-term memory (Kizilbash et al., 2002; Boldrini et al., 2005). However, some studies on anxiety patients showed impairment in long- term episodic memory (Asmundson et al., 1994; Airaksinen et al., 2005). Different emotional reactions can be induced by the presentation of visual stimuli with affective content. Emotional stimuli are processed and linked with cognitive functions, such as attention and memory. Stimuli with emotional content are best recovered in tests of recall and recognition than stimuli without emotional content. The same is true for attention (La-Bar and Phelps, 1998; Ochsner, 2000; Kensinger and Corkin, 2003). Recently, the influence of aversive stimulation on attention, working memory and anxiety was verified by Giron and Martins (2010). This study was conducted with 366 participants of both sexes. Two DVD films, one containing aversive stimuli and one containing neutral stimuli, were administrating. After viewing the DVD, anxiety, working memory, and attention were assessed. Concomitant with the increase in anxiety were deficits in working memory and deficits in selective attention in the group that was exposed to the aversive scenes. No gender differences were observed. These results suggests that aversive visual stimuli increase anxiety and decrease attention and working memory performance. Considering the current evidence of the relationship between cognition and the processing of emotional stimuli, the present study investigated the influence of anxiety on memory and attention, to contribute to our understanding of the anxiety effects on cognitive function. In particular, the goals of the present study were to determine whether (1) the level of anxiety is a predictor of attention biases and interfere with two central executive functions related to attention control: inhibition and shifting; (2) subjects with different level of anxiety shows different capacity of immediate memory and recall; (3) visual stimulation through movies with emotional content influences the immediate visual memory in more anxious subjects. The assumption was that the more anxious subjects have poor memory performance after watching movies with emotional contents.

Materials and Methods

Participants

Data were collected from a sample of 130 participants of both sexes. All subjects were assessed for trait anxiety (State-Trait Anxiety Inventory). Subjects with an average level of anxiety (n=90) were excluded from successive analysis. The remaining participants were 41 (28 women and 13 men), aged 19 to 40 years (M=23.8, SD=3.83), divided into two groups. In group 1 were included 20 participants, aged from 19 to 32 years old (M=22.9, SD=2.77), with trait-anxiety scores below 46 (Less-anxious: M=36.8, SD=2). In group 2 were included 21 participants, aged from 19 to 40 years old (M=24.7, SD=4.52), with trait- anxiety scores above 46 (More-anxious: M=48, SD=2.87). A significant difference was found in these two groups $t(39)$=-14.4, p=<.001. The sample was counterbalanced for gender and age.

Instruments

The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch and Lushene, 1970). The STAI presents anxiety scales divided into state-trait, rendering the class of anxiety identifiable (i.e., situational [provoked or momentary] or trait [more permanent]). The STAI also presents standards for these two factors, as well as for the entire scale (single factor with 20 items; Cronbach a = .79) and enables distinctions between men and women (Giron and De Almeida, 2010).

The Trial Making Test (TMT, A-B; Reitan, 1958) is a widely used paper and pencil task that evaluates the executive functions, dual-task attention, cognitive flexibility and working memory. The TMT consists of two parts: on TMT Part A subjects have to connect numbers from 1 to 25, which are randomly spread over a sheet of paper, in ascending numerical order. On part B, participants are asked to connect randomly spread numbers (from 1 to 13) and letters (from A to L) in alternating numeric and alphabetical order (1-A-2-B-3-C-…-13-L). In case of an error the examiner draws the attention of the participant to the error, so that the participant completes the task without errors (at the expense of additional time). TMT performance was calculated taking the time needed to perform TMT-B minus time needed for TMT-A. This delta TMT value ‘‘removes’’ eventual bias due to differences in upper extremity motor speed, simple sequencing, visual scanning, and psychomotor functioning. The Attentive Matrices Test (Spinnler and Tognoni, 1987).

Three identical arrays of 130 digits, disposed on 13 lines of 10 items each, which are presented in succession. The task of the subject is to try to identify, and barrage with a pencil, the stimuli target, among all the other distracters.

The Babcock Story Recall Test (Babcock, 1930) was used to examine verbal recall. The subjects were asked to immediately recall a story just read to them, then after the story was read to them again, recall it 10 min later. Scoring was based on 21 memory units, with allowances for immediate recall and penalties for missing information. Scores can range 0–21.

The Short-Term Visual Memory Test**.** Four DVD movies, one including neutral content (a men while sweeping), one about generosity (a selfless act of a child), one showing the fighting between university students and police (adverse) and another showing a child dancing (funny), were used for both groups. A pilot study was carried out with 38 independent students of both sexes to examine the emotional valence of the content of the 4 visual stimulation. The content of the movies was suitable for what was proposed, considering that the movie with adverse content (visual stimulation with unpleasant emotions) was identified correctly as adverse by the 100% of the participants, the neutral movie was identified as "normal" by the 92% of participants, the movie about generosity was related to the some ethic topic and the funny movie was rated as "funny" by 93% of participants (with classifications on rating-scale). The duration of each visual stimulation was 60 ss. The Visual Memory Test is composed of 7 item-questions regarding details of the movies (28 items). This test evaluates short- term visual memory.

Procedure

The application was taken in a public university. According to schedules provided by teachers, the tests were applied at the beginning of the classes or, sometimes, at the end of these. Following the heterogeneous elements of this study, the tests were diversified by selecting different courses and, in each one of them, applied in their own classrooms. The students present in the class were invited to participate. After they agreed, they completed a demographic questionnaire and signed a consent form. Each subject completed the state-anxiety scale of the STAI, and was tested individually. After this measure, only 41 participants with the highest and the lowest levels of anxiety complete the other four tasks (Trail Making Test A-B, Attentive Matrices Test, Babcock Story Recall Test and Short-Term Visual Memory Test). To assess the visual short-term memory, four movies were shown to the participants. After, participants answered questions regarding the details of the movies.

Results

Anxiety measures

Table 1 shows the mean STAI scores for both groups. Independent t-tests revealed that the groups differed significantly on state-trait-anxiety levels, t(39)= -14.4, p=<.001.

Tab.1 Means and standard deviations of anxiety measures.

	Anxiety levels	
Groups	*M*	*SD*
Group 1 Less-Anxious	36,85	2,01
Group 2 More-Anxious	48,05	2,87

Trail Making Test

We examined the time of execution of the Trail Making Test (Part A, Part B and B-A Score) in more anxious/less anxious groups of subjects. The third phase was calculate by subtracting the Part A Score from the Part B Score. A 2(Group: More-Anxious, Less Anxious) x 3(TMT parts: A, B, B-A) ANOVA with repeated measures revealed a significant effect of the variable "TMT Parts" F(2, 78)=413.49, p=<.0001. Also, the interaction Groups x TMT Part was significant F(2,78)=3.08, p=.05. This last analysis suggesting that results of TMT for More Anxiety Group were different from those for Less Anxiety Group. In particular, on the average, the More Anxious Group and Less Anxious Group did not differ in TMT-A execution F(1,39)=2.52, p=.12. Instead, the two groups shows significant difference in the execution of TMT-B, F(1,39)=12.8, p=.001, and in Part B-A comparison, F(1,39)=8.48, p=.006.

Attentive matrices Test

The attentive matrices test allows for the assessment of two performance measures: speed (response times) and accuracy (number of counting errors). Two ANOVA with repeated measure on speed and accuracy were conducted. A 2(Groups: More Anxious, Less Anxious) x 3(Matrices 1,2,3) ANOVA with repeated measure on the last factors, using the accuracy as dependent variable, showed a significant effect of the Phases F(2,78)=7856.4, p=.<0001. Also, the variable between subject "Groups" show a significant effect F(1,39)=60.04, p=<.0001. Furthermore, the interaction Phases of Attentive Matrices x Groups show an effect F(2,78)=4.49, p=.001. This data indicate that scores of more anxious subject were lower than less anxious participants in all conditions, and decreased for more complex task. After, reaction time in Attentive Matrices Tasks were analyzed. A 2(Group: More Anxious, Less Anxious) x 3(Matrices 1,2,3)

ANOVA with repeated measure on the last factors, using the reaction times as dependent variable, showed a significant effect of variable "Phases" F(2,78)=38.3, p=<.0001. Moreover, the result were different for more anxious and less anxious participant F(1,39)=13.84, p=.001. Finally, a main effect of the interaction Groups x Phases was found F(2,78)=13.29, p<=.001. This interaction evidence that non-anxious subject were faster in the first task of attentive matrices and their performance decreased in successive phases. Instead, more anxious subject performance was lower in all phases.

Memory performance

The impact of anxiety on cognitive function was investigate used the Babcock Story Recall Test. Data were analyzed by a 2(Group: More Anxious, Less Anxious) x 2(Phases: immediate recall, delayed recall) ANOVA with repeated measures, using the second factor as between subject variable. A main effect of Phases (immediate vs. delayed recall) was found F(1,39)=7, p=<.01. This data indicate a high performance in immediate recall compared to delayed recall task for both groups. Also the variable Groups show a significant effect F(1, 39)=46.58, p=<.0001. Indeed, both mnestic index were lower in more anxiety subjects compared to non-anxious participant.

Movies Vision and Memory parameter

The hypothesis was that stimulation through movies with emotional content influences the immediate visual memory in anxious subjects. A 2(Group: More Anxious, Less Anxious) x 4(category of movie: neutral, generosity, adverse, funny) ANOVA with repeated measure on the last factor show a main effect of Groups F(1,39)=38.01, p=<.0001. Also the variable Category present a significant effect F(3,117)=4.59, p=<.004. Finally, the interaction Groups x Category of Movies was significant F(3, 117)=3.25, p=<.02. This data suggested that after vision of movies with emotive contents, the performance of more anxious subject was poor compared to less anxious participants.

Discussion and Conclusions

Anxiety is known to play an important role in the functions of memory and attention (i. e. Bar-Haim et al., 2007; Mogg and Bradley, 1998; Kizilbash et al., 2002; Boldrini et al., 2005). The present findings support the assumption that anxiety and emotion stimulation influences attention and memory. Indeed, mental function performance is directly linked to the different levels of anxiety experienced and the strategies adopted by each individual to deal with this function (Gable, Reis and Elliot, 2000; Leen-Feldner et al., 2007). The comparison between two groups of subjects with different levels of anxiety, respectively more anxious and less anxious, evidence that less anxious participants showed best memory capacity and less attention biases, than more anxious participant. Also, the group with high level of anxiety showed a limitation in various attention and mnestic performance, both accuracy of responses and reaction time speed. Overall results show low concentration, slower reaction and execution time and lower accuracy in more anxious subject, performed attention task as the Attentive Matrices Test by Spinnler and Tognoni (1987) or Trail Making Test by Reitan (1958). Furthermore, these subjects were less able in Babcock Story Recall Test (1930), both immediate and delayed recall tasks. Moreover, less anxious participant were more skilled in Visual memory Test. Their performance was better in all visual stimulations conditions, even after viewing movies with high level of emotional contents (as the aggressive and funny movies). In particular, the performance of anxious subjects in Trail Making test was lower compared to less anxious participant, only in the second phase of test. Instead, in the first phase no significant difference was found. This data can be interpreted as due to different task demands. Indeed, the second part of this test requires a great cognitive load on selective attention and working memory, that impairs the more anxious subjects performance. Even in Attentive matrices test, performances of anxious subject were lower than less anxious participants in all conditions, and decreased for more complex task (third matrices). Both speed (response times) and accuracy (number of counting errors) less anxious group of subject show a better result. An interesting data was that less anxious subject were faster in the first task of attentive matrices and their performance decreased in successive phases, instead more anxious subject performance was lower in all phases. According with others evidence, this data confirm that anxiety influence many attention biases towards threatening sources of information, engagement and disangagement of attention (Cisler and Koster, 2010; Sheppes et al., 2013; Bar-Haim et al., 2007; Mogg and Bradley, 1998; Williams et al., 1996). With regard to memory, anxiety has a selective effect that is dependent on modality (spatial or verbal), difficulty, and task type (working memory or long-term memory). In this study, performances of more anxious/less anxious subjects in memory tests showed different pattern of execution, with a high performance in immediate recall compared to delayed recall task for both groups. However, both mnestic index were lower in more anxiety subjects compared to less anxious participant. This evidence confirm that more anxious persons show impairment in long-term episodic memory (Lucas et al., 1991; Asmundson et al., 1994; Cohen et al., 1996; Airaksinen et al., 2005). However, further analysis should be performed to estimate the impact of anxiety on short term verbal memory. The role of visual stimulation was explored in this study toward a visual memory test, after the vision of movies with emotive or neutral contents. Precedent evidences shows that visual stimuli with emotional contents are best recovered in tests of recall and recognition than stimuli without emotional content (La-Bar and Phelps, 1998; Ochsner, 2000; Kensinger and Corkin,

2003). In our study we assessed the visual memory using movies with ecological situations. In fact, precedent studies investigated the role of visual aversive or hedonic stimulation using stylized drawing and simple images without contextual index. Numerous lines of research have shown that contextual information can strongly modulate the perception of emotions. Studies investigating the role of contextual information in the processing of facial expressions often argue that facial expressions are rarely seen in isolation. However many studies that have directly addressed this issue have presented participants with pictures of facial expressions along with vignettes describing an emotional situation (Carroll and Russell, 1996). Related work has also demonstrated that an identical facial expression was perceived differently depending on the accompanying body expression (Aviezer et al., 2008). In our study we manipulated the contents of visual stimulation using a rationale similar to Giron and Martins (2010), using two movies with emotive contents and two neutral movies. Our hypothesis was that visual stimulation through movies with emotional content influences the immediate visual memory in more anxious subjects. Overall, results indicate that performance in visual memory were lower in anxious participants. Furthermore, after vision of movies with emotive contents, the performance of more anxious subjects was even lower compared to less anxious participants. In particular, consisting with our hypothesis, this assessment confirm the influence of visual stimulation towards movies with emotive contents on anxiety and memory performance. This data are coherent with an ample research to suggest that emotional arousal and the physiological responses that can accompany it (e.g., increase in glucocorticoids, epinephrine, and norepinephrine) facilitate encoding and memory consolidation processes by the release of hormones in the brainstem and baso-lateral amygdala (Roozendaal et al., 2009). Hippocampal connections with the amygdala are thought to mediate this memory enhancement (Roozendaal et al., 2006). However, a meta-analytic review of studies examining the effects of stress and stress hormones on memory found the opposite effect—that declarative long-term memory is impaired by stress (Sauro et al., 2003). In our study the visual memory task performance was impaired in more anxious subjects, suggesting an in influence of dispositional anxiety on attention and, indirectly on visual memory. The present work confirm the initial hypothesis about the impact of anxiety on cognitive functioning, specifying that this influence is very strong in relation to visual stimulation through emotive stimuli. Future research should also examine the influence of other emotion regulation strategies and their impact on various cognitive function non explored in this study, as the executive function and attention to exogenous stimuli in emotive visual stimulation conditions.

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