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Affective bias in internal attention shifting among depressed youth

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ABSTRACT

The present study compared the performance of depressed youths and healthy controls on a modified mental counting task. The mental counting task was designed to capture processes associated with shifting the internal focus of attention by requiring participants to count random runs of words appearing on a computer screen. The words belonged to two different categories, and participants were required to maintain a count of the number of words in each category. Participants' reaction time to successfully update their counts and call for subsequent stimuli was measured. In particular, two versions of the modified counting task were developed: one incorporating neutral words and the other affective words. Overall, our findings in reaction time analysis suggest that depressed patients exhibited greater difficulty switching their internal focus of attention in the affective task when compared to healthy controls, even when controlling for their rate of accuracy. However, there was no significant difference between the groups during the neutral task. Results support the hypothesis that depression is related to impaired internal attention shifting when processing affective material.

1. Introduction

Depression is often thought to be maintained by maladaptive processing of negative information (e.g. Beck, 1976; Nolen-Hoeksema, 1991). The extent to which the affective qualities of attended information (i.e. its negativity) could influence the efficiency of attention deployment among depressed individuals has been of increasing research interest over recent years (e.g. Donaldson et al., 2007; Joormann and Gotlib, 2007; Karparova et al., 2007). In the literature, early studies employing dot-probe tasks failed to find a specific engagement or disengagement bias toward affective materials in depression (e.g. MacLeod et al., 1986; Hill and Dutton, 1989). Consequently, researchers have been interested in unraveling whether these early null findings might genuinely reflect an absence of affective attentional bias in depressive conditions, or were simply confounded by the fact that the task utilized was not sensitive enough to capture such effects. For example, some theorists posited that affective bias in attention processing would only be observed using long stimulus exposure durations so as to engage more elaborated processing (Mogg et al., 1995; Donaldson et al., 2007). However, null effects with long stimulus exposure have also been observed (Neshat-Doost et al., 2000). Faced with this mixed evidence, researchers have begun to employ alternative forms of visual probe tasks, such as the deployment-of-attention task (Karparova et al., 2007), emotional versions of the Posner task (i.e., a task during which affective cue words appeared in either the same or different location as a subsequent target word; Koster et al., 2005), and dot-probe tasks that incorporate facial stimuli (Joormann and Gotlib, 2007) to examine if effects associated with variations in the affective qualities of stimuli would robustly persist under various testing conditions.

In terms of executive control of attention shifting more generally, a large number of studies have indicated that depressed patient groups (including depressed adolescents: Wilkinson and Goodyer, 2006; adult depressed patients of various severity: Grant et al., 2001; Moritz et al., 2002; Fossati et al., 2003; as well as geriatric patients with depression: Beats et al., 1996) perform significantly worse than healthy people on a range of neuropsychological tests that assess executive set-shifting abilities. Many of these tests, however, used affectively neutral stimuli, and few have attempted to investigate the effect of affective stimuli on set-shifting processes. A study by Deveney and Deldin (2006) is one of the few to administer a modified Wisconsin Card Sorting Test (WCST) that involved affective stimuli with depressed and non-depressed samples. These authors found that depressed participants made significantly more perseverative errors as compared to their non-depressed counterparts when the stimuli were affectively negative, suggesting that the affective valence of stimuli exerted an effect on set-shifting processes.

As this brief review demonstrates, the nature of the experimental tasks adopted can be crucial in detecting affective biases in attention functioning among depressed individuals. In many of the tasks adopted, the shifting of attention focus was exogenous in nature. That is, the participants have to engage and disengage attention

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according to the spatial location (or other external stimulus attributes) of cues and targets. However, depression is often characterized by perpetuating negative thoughts and *internal* focus of attention (e.g. rumination: Nolen-Hoeksema, 1991; self-focused attention: Pyzczynski and Greenberg, 1987). As such, there is a possibility that phenomena associated with externally oriented shifting processes are somewhat different from those relevant to internal set-shifting processes. Previous studies on task switching for example suggested that switching between working memory representations (internal switching) and switching between perceptual attributes of visual stimuli (external switching) could involve distinctive cognitive components in addition to the common switching mechanism (Wager et al., 2006). Functional magnetic resonance imaging study also showed double dissociation in the cortical activation level of specific areas involved (Wager et al., 2005). As such, choosing an appropriate paradigm in examining attention-shifting phenomena associated with depression would be important. One option, as reviewed above, involves adopting standard neuropsychological tests in examining mental set-shifting abilities. However, benchmark tests such as the WCST often involve a number of complex cognitive operations in addition to set shifting (e.g., abilities to abstract and generalize contextual information, or to interpret feedback). Additionally, some of these tests rely solely on an outcome test (i.e. whether a specific given answer is right or wrong) and thus are not able to directly assess information processing speed and the ease with which a successful attention shift is made.

Considering these limitations, we have recently developed a novel modified experimental task based on a mental counting paradigm developed by Garavan (1998) and Gehring et al. (2003). In this task, participants are instructed to keep a silent count of the words appearing at the centre of the screen, one at a time. Participants are told that the words belong to one of two categories and are presented in random order, and their task is to maintain a count of the number of words in each category. In other words, participants have to maintain two mental counters simultaneously and update the relevant counter as each word item appears. The assumption is that in the case where the presented word belongs to the same category as in the previous trial participants would need to update information in a counter that is already activated and then press a button to call for next item. In contrast, if the presenting word belongs to a different category as compared to previous trial, participants would have to switch their attention focus to the other counter, update the information and then press a button to call for next item. The reaction time of these consecutive "switch" trials can then be compared with "non-switch" trials to estimate individual's internal attention-shifting ability.

Previous work in our lab has consistently found that this task is sensitive to capturing these "internal" attention switching effects across various populations (e.g. among mediators: Chambers et al., 2008; university samples: Lo et al., submitted).[1] In the present context, this task carries additional benefits of being able to test the effects of stimulus affectivity by incorporating neutral and affective words in the same empirical design. Specifically, two versions of the mental counting task were adopted in the present project: one consisting of words with neutral valence and the other consisting of affective words. Depressed outpatients and non-depressed control counterparts were recruited to perform on both versions of the task. It was hypothesized that task affectivity (i.e., whether the task involved comparing two categories of words with neutral valence, versus comparing two categories of words with differing affective qualities) would impact upon internal set shifting in depression, such that depressed individuals would exhibit greater switching difficulty when compared to healthy controls for the affective condition only.

[1] Unpublished data from our lab work have showed that the switch cost derived from the present switching paradigm was significantly associated with self-report of attention-shifting abilities (Attention Control Scale: Derryberry and Reed, 2002) on a small sample of university students ($N = 23$) in a pilot study [$r = 0.34$, $p < 0.05$]. Another pilot study on 17 depressed outpatients also found that the task showed satisfactory test–retest reliability across a 2 month period [correlation between switch cost at Time 1 and Time 2: $r = 0.501$, $p < 0.05$].

2. Method

2.1. Participants

Forty-two participants took part in this study but data from three clinically depressed participants were discarded as they achieved zero percent accuracy rates in at least one version of the mental counting task. Data from another two clinically depressed participants were also discarded as their reaction times were more than 2.5 standard deviations away from the mean. The final sample consisted of 21 depressed patients (8 males and 13 females, mean age of 19 years old) and 16 healthy non-depressed control participants (6 males and 10 females, mean age of 20 years old).

Depressed participants were recruited from outpatients admitted to the Youthscope Mood and Anxiety Clinic at ORYGEN Youth Health, Melbourne, Australia. They consisted of adolescents and young adults (age 16–24) admitted for treatment services due to diagnosed major depressive disorder (MDD). An initial clinical interview session was conducted using the Structured Clinical Interview for Axis I DSM-IV-TR Disorders (SCID: First et al., 2001). This screening procedure helped to ensure that the participants were diagnosed with MDD but had not suffered from comorbid psychotic disorders, organic brain disease or pervasive developmental disorder. Healthy control participants were first year psychology students recruited from the University of Melbourne who received participation credits for course requirement. Due to time constraints, the SCID was not administered to the control sample. However, the Centre for Epidemiological Studies-Depression Scale (CES-D) was administered and all healthy control participants scored below the clinical cut-off of 16.

Between-group comparison revealed no differences across groups in terms of age [$F < 1$] or gender distribution [$\chi^2(1) = 0.01$, $p = 0.97$]. Depressed patients had a mean Centre for Epidemiological Studies-Depression Scale (CES-D) score of 27.71 (S.D. = 14.26, range from 7 to 54) and a mean Rumination Response Scale (RRS) score of 55.71 (S.D. = 11.26, range from 28 to 73). Healthy controls had a mean CES-D score of 10.06 (S.D. = 3.13, range from 2 to 14) and a mean RRS score of 38.75 (S.D. = 11.26, range from 23 to 53). Not surprisingly, depressed patients reported significant higher CES-D scores [$F(1,36) = 23.49$, $p = 0.000$] and RRS scores [$F(1,36) = 21.99$, $p = 0.000$] as compared to healthy controls.

2.2. Materials

2.2.1. Diagnostic instrument

The Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID; First et al., 2001) was used to verify depressive diagnoses. The full version was utilized, which covered a wide spectrum of common psychiatric conditions including modules covering mood disorders, anxiety disorders, schizophrenia and psychotic disorders, substance use disorders, somatoform disorders and eating disorders.

2.2.2. Self-report questionnaires

The Centre for Epidemiological Studies-Depression Scale (CES-D: Radloff, 1977) and the Rumination Response Scale (RRS: Nolen-Hoeksema and Morrow, 1991) were administered to assess individuals' depressive symptoms and ruminative tendencies respectively.

2.2.3. Word stimuli

In the neutral version of the mental counting task, a total of 80 English words were selected. These words were general nouns belonging to either the categories of food (e.g. tomato and cheese) or household objects (e.g. television and blanket), with 40 words in each category. Word frequencies of the selected items were balanced based on the corpus by Leech et al. (2001), such that the word frequencies in food category were no different to those in household object category [$F < 1$]. The number of letters (i.e. word length) was also matched between the two semantic groups [$F < 1$]. Selected words in each group were then randomly sorted into four blocks such that there were no significant differences in word frequencies or word lengths across blocks [$Fs < 1$]. Another nine words were additionally selected as practice items.

In the affective version, a total of 80 English words were selected based on the ratings from the Affective Norms for English Words (Bradley and Lang, 1999), with 40 words in the positive descriptors category and 40 in the negative descriptors category. Words in each category were significantly different in emotional valance [$F(1,79) = 1023.002$, $p = 0.000$] but not in terms of arousal ratings [$F(1,79) = 1.749$, $p = 0.190$], word frequencies [$F < 1$] and word lengths [$F < 1$]. Specifically, positive words had a mean normative valence rating of 7.31 (ranging from 6.08 to 8.43) and negative words had a mean rating of 2.68 (ranging from 1.50 to 4.82) on a scale between 1 (unpleasant) to 9 (pleasant). As in the neutral version, selected words were sorted into four testing blocks, and items across blocks were no different in valence [$F < 1$], arousal [$F(3,79) = 1.150$, $p = 0.334$], frequency [$F(3,79) = 1.734$, $p = 0.167$] or word length [$F(3,79) = 2.319$, $p = 0.082$]. Nine additional words were chosen to act as practice items.

2.3. Procedure

In the experimental session, all participants were instructed to complete the CES-D and RRS. They were then asked to perform the two versions of the mental counting