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Short Communication

Eye movement evidence for defocused attention in dysphoria — A perceptual span analysis

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ABSTRACT

The defocused attention hypothesis (von Hecker and Meiser, 2005) assumes that negative mood broadens attention, whereas the analytical rumination hypothesis (Andrews and Thompson, 2009) suggests a narrowing of the attentional focus with depression. We tested these conflicting hypotheses by directly measuring the perceptual span in groups of dysphoric and control subjects, using eye tracking. In the moving window paradigm, information outside of a variable-width gaze-contingent window was masked during reading of sentences. In measures of sentence reading time and mean fixation duration, dysphoric subjects were more pronouncedly affected than controls by a reduced window size. This difference supports the defocused attention hypothesis and seems hard to reconcile with a narrowing of attentional focus.

1. Introduction

Classical views on the influence of mood on information processing claim that negative affective states are associated with a narrowing of attention, a more systematic and analytical style of information processing, in which greater attention is paid to details, and the tendency to focus on one single thought or activity – most often negative and self-relevant – (e.g. Edwards and Weary, 1993; Gasper and Clore, 2002; Yost and Weary, 1996; review in: Andrews and Thomson, 2009). Some authors see a possible adaptive function of emotional states in general, and depressed mood in particular. According to these approaches, negative mood and depression itself is an adaptive mechanism that has evolved to face complex problems. Its assumed function is to minimize disruption and to sustain a subsequent analysis of those problems, thereby reducing the desire to engage in other activities that could be potentially be distracting from the perspective of the current problem. This approach to information processing in depression has been labeled as the analytical rumination theory (AR, Andrews and Thomson, 2009).

In contrast, there is also evidence to show that depressed individuals may sometimes attend to task-irrelevant information (von Hecker and Meiser, 2005), as they also often find it difficult to inhibit such information (Hertel, 1997, 1998; Hertel and Rude, 1991; Joormann, 2010). Such a defocused mode of attention is sometimes regarded as reflecting an adaptive mechanism which allows for seeking new opportunities or ways of problem solving, even if these may appear irrelevant or perceptually peripheral at the time. For example, according to the functional theory of emotion, experiencing sadness may be associated with a "do nothing and/or search for new plan" state which promotes an open, unselective and low-effort mode of attention (Oatley and Johnson-Laird, 1987) which then allows to perceive and process a greater variety of stimuli. If depressed mood is associated with defocused attention (DA), then one should be able to elicit even superior cognitive performance in the depressed as compared to nondepressed people when asking them about irrelevant aspects of a task that is being processed.

To examine this prediction with respect to memory performance, von Hecker and Meiser (2005) used a source monitoring paradigm that allows for separating various components of memory performance, relating to relevant and irrelevant aspects of the materials learnt. In their study participants had to learn 64 nouns that were presented individually on a computer screen, on either the left or the right side of the screen, and each surrounded by either a red or green frame. Participants were told that they later would be asked to recognize these 64 words as "old" when randomly presented amongst 64 distractors. Participants were also instructed to remember the location of each word for later identification. Importantly, participants were not told about remembering the frame color. In the test stage, however, participants were not only queried about old/new decisions for each presented test word and, if participants responded "old," about the side on which that word had been presented on the screen, but they were asked, additionally, what the color of its frame had been. This way, for each word they had

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classified as "old," participants attempted to recall one source dimension that had been relevant (location), and one that had been irrelevant (frame color) at the time of encoding.

Results showed that nondepressed participants' memory for frame color (irrelevant contextual information) was virtually nil. The depressed group, on the other hand, showed above-chance memory for this irrelevant stimulus feature. A possible mechanism underling better performance in the depressed group on tasks such as this may be connected with a different characteristic of the perceptual processes in the latter group. Maybe depressed people scan the environment in a way that results in perceiving a wider range of stimuli within the visual field, but do it rather superficially, as if searching for "something" new, that is, without any particular purpose — and without paying much attention to details. Hence, a less effective attentional filter could cause, e.g., more intrusions by irrelevant material into working memory. In any case, this approach is opposite to the traditional view holding that cognition in depressed mood is often operating in a local rather than global mode (e.g. Gasper and Clore, 2002).

To test the hypothesis about a wider scope of attention as a characteristic feature of mildly depressed people we directly measured the perceptual span during reading, using eye tracking. We were specifically interested in investigating defocused attention during reading. Using a moving window paradigm (McConkie and Rayner, 1975; Rayner, 1998) we assessed the size of the perceptual span, which in turn informed us about how dysphoric people acquire information during reading tasks.

1.1. Perceptual span

Useful information during reading is probed from a limited region around the fovea and the term *perceptual span* is used to denote this region. Perceptual span is defined as the width of the window of characters which one is able to attend to at each fixation during text reading (Rayner, 1975; Rayner et al., 1981; Bullimore and Bailey, 1995). In contrast to *visual span*, not all of the characters need to be identifiable within the perceptual span, but their characteristics (word length, spacing) influence planning and execution of the next eye movement. The perceptual span is asymmetric (Pollatsek et al., 1981), and as the decline in visual acuity away from the fovea is roughly symmetrical, the existence of asymmetry shows that the perceptual span is determined by attentional, in addition to structural, factors. Moreover, this asymmetry is functional as the area covered by the perceptual span is wider on the right side of the fovea for people whose reading direction is left to right, and wider on the left side for people whose reading direction is right to left (Pollatsek et al., 1981). Additionally, Miellet et al.(2009)showed that the perceptual span in reading is governed mainly by attentional factors. The size of the perceptual span (in characters) is typically smaller in languages such as Chinese with greater information content per character (1 character to the left, 3 characters to the right for readers of Chinese, compared to 3–4 characters to the left and 14–15 characters to the right for readers of English), but is roughly equal in terms of information conveyed, again suggesting that it is also limited by cognitive factors (Inhoff and Liu, 1998). Finally, the perceptual span can be dynamically modulated according to local processing difficulty. For example, the span gets smaller when more difficult words are processed (Henderson and Ferreira, 1990) or when visual search is performed under conditions with high attentional demands (Pomplun et al., 2001).

1.2. Moving window paradigm

The technique most commonly used to assess the perceptual span is the moving window paradigm as devised by McConkie and Rayner (1975), in which a region around a fixation point is designated as a "window" through which one can see the presented text or picture. As the eyes move, the display is modified so that all material within the window is seen normally whereas all material outside the window is masked. During reading participants can freely move their eyes, but the amount of useful information available on each fixation is thus controlled by the experimental program. The moving window technique is gaze-contingent, meaning that each time the eyes move, a new region of text is exposed, while the previously fixated region is masked. In our experiment, window size was defined in terms of characters, and characters as well as inter-word spaces outside of the window were filled with a mask (see Fig. 1 for details).

The logic underlying the moving window technique is that behavioral indicators related to eye movement, such as sentence reading time (longer), fixation duration (longer), and number of fixations (more), indicate the degree of processing difficulty. When the window is as large as, or larger than, the region from which the reader can obtain information, then there should be no difference with regards to the above indices between the moving-window and a normal, unmasked control condition (Rayner, 1998). The aim of the present study was to test conflicting predictions of the DA and AR theories about cognitive functioning of depressed individuals on this basic, perceptual/attentional level. Predictions of the DA theory concerning perceptual span size are quite straightforward: Attention in depressed individuals works in a defocused mode, allowing for gathering of information from a wider area in comparison to healthy controls. Consequently, in terms of reading times and fixations, depressed individuals should find the reading task more difficult than nondepressed individuals when spontaneous reading is constrained by the moving window; and particularly so when the size of that window is narrow.

In contrast, AR theory claims that depressed or dysphoric people are characterized by more systematic information processing, implying more focused attention. If this were true we should observe no differences between dysphoric and control participants, or a narrower perceptual span in the group with depressive symptoms. In terms of reading times and fixations, dysphoric individuals should find the reading task *less* difficult than individuals from the control group when spontaneous reading is constrained by the moving window, especially when the window is narrow.

2. Method

2.1. Subjects

60 healthy university students (32 women, 28 men, 18–29 years old) took part in a reading experiment employing the moving window paradigm, after giving informed consent. Participants were assigned to two groups, control and dysphoric students, according to their scores on the Beck Depression Inventory (BDI, Beck, 1967). Target groups were selected from the initial, larger sample (over 100 participants) according to the following criteria: Nondepressed group — 1 to 5 points in BDI-I, dysphoric group — above 10 points (these criteria were previously used in, e.g., Hertel and Rude, 1991; Edwards and Weary, 1993; von Hecker and Sedek, 1999). Characteristics of each group are presented in Table 1. Groups did not differ in age, but in indicators of depression (besides BDI-I we measured

xxxxxxxxxxxxxxxxxxxxpa*radixxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (1)

xxxxxxxxxxxxxxxxxxxxpa*radigm there are xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (2)

In the moving window pa*radigm there are different window size conditions. (3)

Fig. 1. In the moving window paradigm, only the gaze-centered part of a scene or sentence is displayed, whereas the remainder is masked — as illustrated by this example of the small (1), large (2) and no window (3) conditions. The current fixation position is marked with "*".