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Depression-related Impairments in Prospective Memory

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Time-based prospective memory, the ability to carry out a future intention at a specified time, was found to be impaired in a community sample of clinically depressed adults, relative to a nondepressed sample. Nondepressed participants monitored the time more frequently and, in the final block of the task, accelerated time-monitoring as the target time for the prospective memory response approached. These results are consistent with previous findings of depression-related impairments in retrospective memory tasks that require controlled, self-initiated processing.

INTRODUCTION

This study examined performance on a prospective memory task, in which depressed and nondepressed participants were instructed to remember to carry out an intention in the future. An everyday example of such a task is remembering to phone at a particular time to make an appointment. Although several studies have investigated the relationship between prospective memory and ageing (e.g. Einstein & McDaniel, 1990; Maylor, 1993) and anxiety (e.g. Cockburn & Smith, 1994), we are unaware of similar studies concerning depression.

Prospective memory challenges are ubiquitous in everyday life, and the practical import of frequent failures is likely to be significant for

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people who are also experiencing affective and other cognitive difficulties. The theoretical importance of such failures is also substantial, given the evidence for certain kinds of cognitive impairments in depression (see Gotlib, Roberts, & Gilboa, 1996). Performance on time-based prospective task appears to rely on controlled, self-initiated processes (cf. Craik, 1986), and controlled, self-initiated processes are implicated in depression-related deficits on retrospective memory tasks (e.g. Hertel & Hardin, 1990).

Several lines of evidence suggest that depression "affects" performance to the degree that the memory task under study requires self-initiated processes or cognitive control. Tests of free recall, which require relatively greater use of controlled retrieval processes than do recognition tests, are generally more sensitive to depression-related impairments (e.g. Roy-Byrne, Weingartner, Bierer, Thompson, & Post, 1986), but even recognition tests can reveal impairments. By using Jacoby's (1991) process dissociation procedure, Hertel and Milan (1994) obtained independent estimates of two components of recognition—an automatic component (familiarity) and a controlled component (recollection)—and found that depressed affect in college students was associated with disruptions only in the controlled component. Similar deficits have been found in the controlled component of performance on fragment-completion tests (Hertel, 1998). Moreover, our previous research suggests that depressive impairments in free recall can be remediated by alterations in task structure that reduce reliance on self-initiated processes. Hertel and Rude (1991a,b) showed that depressed participants performed as well as nondepressed participants on an unexpected recall test when the learning task required them to focus attention on to-be-remembered words.

Our main purpose in this initial investigation of prospective memory in depression was to determine whether depressed participants would exhibit impairments on a prospective task that is maximally demanding of self-initiated processing. According to Einstein and McDaniel (1990), time-based prospective memory tasks, which require that the subject remember to take an action at a particular clock time independent of any event-related cue, demand the greatest degree of self-initiated processing. Einstein, McDaniel, Richardson, Guynn, and Cunfer (1995) compared the performance of young and elderly participants on a time-based prospective task and on an event-based task during which cues were provided. Their finding that older participants were impaired only on the time-based task is consistent with Craik's (1986) analysis of age-related differences in self-initiation during cognitive tasks. To attempt an initial demonstration of similar difficulties in depression, therefore, we used the time-based task developed by Einstein et al. (1995).

METHOD

Participants

The final sample consisted of 20 depressed and 20 nondepressed participants. Three of the depressed participants were psychiatric inpatients in a public mental health hospital; they were diagnosed with major depression (nonpsychotic). The remaining 17 depressed participants and all of the nondepressed participants were recruited from the community using flyers and newspaper advertisements. Groups were matched approximately on age, educational attainment, ethnicity, and gender.

All participants underwent a Structured Clinical Interview (SCID), which yields diagnoses based on DSM-III-R criteria (Spitzer, Williams, & Gibbon, 1987). Two of the authors conducted the interviews after receiving training from a clinical researcher (PhD), experienced in the use of the SCID. Diagnostic agreement, based on ratings by the clinical trainer of 10 audiotaped interviews, was satisfactory (kappa = .83). The SCID was used to exclude participants from either group if they had a history of psychosis, obsessive-compulsive disorder, bipolar disorder, or if they had a current substance-abuse disorder. Substance abuse was considered absent with at least 6 months of abstinence. Participants were included in the depressed group if they met diagnostic criteria for current major depression and in the nondepressed group if they clearly failed to meet diagnostic criteria for any of the affective disorders. Parts of the SCID were conducted by telephone so as to minimise the number of ineligible individuals scheduled; interviews were completed at the end of the session.

Materials

The Beck Depression Inventory (BDI; Beck & Steer, 1987), a widely used self-report inventory, was included to determine the level of depressive symptoms in study participants (see Kendall, Hollon, Beck, Hammen, & Ingram, 1987). We also administered the following subtests from the Wechsler Memory Scale-Revised (WMS-R), a clinical diagnostic test for appraising major dimensions of memory functions: Mental Control, Figural Memory, Digit Span, and the immediate and delayed versions of Logical Memory, Visual Paired Associates, Verbal Paired Associates, and Visual Reproduction.

The computer program for the main set of tasks included an adapted version of the vocabulary test from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; adapted by Einstein et al., 1995). The adapted WAIS-R vocabulary test consisted of the last (most difficult) 25 words of the WAIS-R. Instructions informed participants that we were interested in examining their familiarity with certain words. Each word was presented in the middle of the screen for 20sec each. Participants were instructed to write down the definition of each word, making the definition "to the point, but not leaving out anything important to the definition", and were instructed not to return to any previous definitions once the word had left the screen.

In the set of computerised tasks, a test of general knowledge was used as a foreground task during which measures of prospective memory were taken (Einstein et al., 1995). It consisted of 127 multiple-choice questions (e.g. "How many US states start with the letter T?"). On each trial the question appeared at the top of the screen with four alternatives listed below. After 6sec, the prompt "Your Choice" appeared on the screen for an additional 3sec while the question and alternatives remained displayed. Four adjacent response keys were marked with yellow labels A, B, C, and D. With the offset of the display, a 3sec feedback segment indicated whether the last answer was correct, gave the letter of the correct answer, and showed the cumulative percentage correct.

Procedure

Each participant was individually tested in one 2-hour session. Approximately half of each sample performed the computerised tasks first and then the WMS subtests. After a general orientation to the experimental situation, participants were asked to remove their watches for the session. Participants who began with the computerised tasks (9 nondepressed and 11 depressed participants) were next seated in front of the computer and given instructions for both the general knowledge and prospective memory tasks. Regarding the latter task, they were told that we were "interested in how well you can remember to do something in the future" and instructed to press the F8 key every 5min during the general knowledge test. (F8 key presses did not result in any display of feedback and did not alter the progression of the computerised task.) Participants were told that whenever they wanted to know the time they could press the F1 key to display the current time in minutes and seconds. The F1 key produced a digital display toward the bottom of the screen that did not obscure or alter the progression of the foreground (general knowledge) task. Following these instructions, they received a 6-item practice task for the general knowledge test during which the prospective memory task was not performed. After the practice task, the program advanced to the adapted version of the WAIS-R vocabulary test. Questions were solicited and answered before the general knowledge test was initiated. After the task, participants were queried, first with an open-ended and then with two multiple-choice probes, to determine whether any failures in prospective memory were due to forgetting of instructions. Next, the WMS subtests were administered. (Participants in the alternative order of testing performed the WMS subtests before instructions for the computerised tasks were delivered.) Finally, all participants underwent the remaining portions of the SCID clinical interview, completed the BDI, and were debriefed and paid $20.

RESULTS

In all analyses described, group (depressed vs. nondepressed) and administration order (WMS first or computerised tasks first) served as between-subject factors. A significance level of .05 was used for all statistical tests. Outcomes that produced P-values less than .10 are described; otherwise nonsignificant effects on each measure are not reported.

Characteristics of the Sample. One depressed and one nondepressed participant were replaced because they inaccurately reported the prospective memory instructions at the end of the session. The former forgot how to check the time, and the latter reported having been instructed to hit the F8 key every 8min (instead of the correct 5min interval).

Educational levels of the depressed and nondepressed groups, respectively, were as follows: 7 and 8 participants had at least 4-year college degrees; 11 and 11 had up to 4 years of college, and 2 and 1 had high school degrees or less. The majority of participants in both groups described their race as White, but 2 depressed and 3 nondepressed participants were self-described as Hispanic, 2 depressed and 3 nondepressed as Black, and 1 in each group as other. The mean age in years was 30 in the depressed group and 31 in the nondepressed group. Seven of the depressed and two of the nondepressed participants reported taking antidepressant medications at the time of the study. In all cases, these were either selective serotonin re-uptake inhibitors (SSRIs) or tricyclic antidepressants—drugs that either do not appear to impact cognitive functioning or for which cognitive effects disappear within 2–3 weeks of beginning the medication (see the review by Amado-Boccara, Gougoulis, Poirier-Littre, Galinowski, & Loo, 1995).[1]

Clinically Relevant Measures. The mean BDI score was 24.8 in the depressed group and 5.2 in the nondepressed group [$F(1,36) = 58.26$, $MS_e = 65.82$, $P < .001$]. Nondepressed participants exhibited a marginally

[1] We analysed the data with and without the inclusion of medicated participants and found the same pattern of results each way. However, results based on the full sample are reported here because removing medicated participants unbalances the design with regard to orderings of the general knowledge task, the order in which the WMS and computerised tasks were presented, and demographic variables that were matched across groups.

significant advantage over depressed participants on the vocabulary test [$F(1,36) = 3.81$, $MS_e = 102.49$, $P < .06$]. The respective means were 37.6 and 31.5 (out of 50 possible points). Last, a multivariate analysis of variance on the scores from the WMS subtests revealed no significant differences between the two groups (Wilk's lambda = .68).

General Knowledge Test. Although the main purpose of the knowledge questions was to occupy participants during the prospective memory task, performance on this test was also of interest. Knowledge scores were computed separately for six nearly equal sections of the task, corresponding roughly to the periods of time preceding each of the six prospective memory target times (21 questions in each of the first five sections, and 22 questions in the sixth section). ANOVA included a within-subjects factor for section number and indicated that the nondepressed participants performed significantly better than did the depressed [$F(1,36) = 6.47$, $MS_e = 26.87$, $P < 02$]. The mean score was 61.9 in the depressed group and 72.0 in the nondepressed group.

Prospective Memory Task. Prospective memory scores were computed, as reported by Einstein et al. (1995), by assigning a score from 1 to 6 on each of the six targeted times, depending upon whether the response occurred between 0 and ± 15sec of the targeted time (6), 16 and 30sec (5), 31 and 45sec (4), 46 and 60sec (3), over 60sec (2), or not at all (1). ANOVA with targeted time as a within-subjects factor, revealed the predicted impairment for depressed participants [$F(1,36) = 5.27$, $MS_e = 14.59$, $P < .03$].[2] The mean score was 3.5 in the depressed group and 4.7 in the nondepressed group.

Time Monitoring. The number of F1 key presses within each of the five 1min intervals preceding each of the six targeted times was tallied. Table 1 presents the means. An ANOVA with interval (1st– 5th minute) and block (preceding the 1st–6th targeted times) as within-subject factors revealed a significant main effect for group [$F(1,36) = 8.40$, $MS_e = 15.45$, $P < .01$]; depressed participants monitored the time less frequently. The main effect for block was also significant [$F(5,180) = 5.10$, $MS_e = 0.69$, $P < .001$]; time-monitoring tended to increase over blocks. The number of checks also depended on interval [$F(4,144) = 24.99$, $MS_e = 1.84$, $P < .001$].

[2] We also used a second scoring method used by Einstein et al. (1995). Each response (F8 key press) on the prospective task was counted as correct if it occurred within 15sec prior to the target time or within 60sec after the target time. ANOVA on these dichotomous scores yielded virtually identical results to those calculated by the interval method [$F(1,36) = 4.24$, $MS_e = 0.63$, $P <.05$].

TABLE 1
Mean Number of Time Checks

	Interval 1	*2*	*3*	*4*	*5*	*Total*
Nondepressed						
Block 1	0.95	0.55	0.70	2.00	0.70	4.90
Block 2	0.75	0.85	0.85	2.05	1.05	5.55
Block 3	0.65	1.00	1.30	2.15	0.85	5.95
Block 4	0.90	1.40	1.30	1.90	0.95	6.45
Block 5	0.65	1.15	1.55	2.45	1.00	6.80
Block 6	0.85	1.25	1.60	3.00	1.20	7.90
Average	0.79	1.03	1.22	2.26	0.96	6.26
Depressed						
Block 1	0.45	0.35	0.55	0.90	0.55	2.75
Block 2	0.35	0.40	0.55	0.85	0.85	2.65
Block 3	0.30	0.40	0.35	1.20	0.40	2.65
Block 4	0.40	0.40	0.50	1.20	0.55	3.05
Block 5	0.40	0.50	0.55	1.50	0.25	3.20
Block 6	0.55	0.65	0.80	0.95	0.55	3.50
Average	0.41	0.45	0.55	1.10	0.52	2.97

The ANOVA also revealed a significant interaction between group and interval [$F(4,144) = 2.76$, $MS_e = 1.84$, $P < .04$]. The pattern of means suggests that nondepressed participants monitored more often as the targeted time approached. This tendency seemed to become more pronounced in the latter blocks of the task, as suggested by a marginally significant three-way interaction among group, interval, and block [$F(20,720) = 1.58$, $MS_e = 0.56$, $P < .06$].

In order to understand this apparent trend, we created "time-monitoring acceleration" indices by subtracting the frequency of time-monitoring during the second (1min) interval in each block from the frequency of time-checking during the fourth (1min) interval of the same block.[3] ANOVA on this measure included a within-subjects factor for block number. It revealed a significant group-by-block interaction [$F(5,180) = 2.61$, $MS_e = 1.39$, $P < .03$]. Separate ANOVAs of time-monitoring acceleration in each block showed significant group difference on the last block alone [$F(1,36) = 5.85$, $MS_e = 3.59$, $P < .03$].

[3] The 1st and 5th intervals seem to be the more logical intervals to compare but those results would be misleading: Participants who responded prior to the target time would be expected to stop time-monitoring in that block; and for participants who responded after the target time, time-monitoring immediately before the response would occur during the first interval of the subsequent block.

Correlations among Time-Monitoring and Prospective Memory. The average prospective memory score across blocks was correlated with the average number of time-monitoring responses across blocks: The greater the frequency with which participants monitored the time, the better was their prospective memory performance [$r(18) = .81$] for the depressed and [$r(18) = .53$] for the nondepressed groups (Ps $< .01$). The correlation between time-monitoring acceleration and prospective memory performance was $r(18) = .53$ ($P < .01$)] for depressed and [$r(18) = .29$ ($P > .1$] for non-depressed participants.

DISCUSSION

The present study extends previous findings of depression-related impairments in memory by revealing significantly lower performance on a time-based prospective memory task. This is the first demonstration of impairments in "remembering to remember" among depressed persons. The current findings are consistent with the pattern observed in work on retrospective memory, wherein tasks that rely heavily upon self-initiated processing tend to show depression-related impairments.

Depressed participants did not monitor the time as frequently during the task and did not exhibit the same time-monitoring pattern as their nondepressed counterparts. In the final block of the task nondepressed participants showed steeper acceleration of time-monitoring prior to the target time than did the depressed participants, a pattern that is parallel to the one shown by Einstein et al. (1995) for young versus old subjects. The fact that the final block of the test was the one in which this group difference was significant suggests that nondepressed participants may have experienced more learning across trials.

Several anomalies in the present results deserve comment. First, given that depressed and nondepressed participants were matched on education, we were surprised by the group difference on the general knowledge test and by the marginally reliable group difference on the adapted WAIS vocabulary test. Knowledge measures are thought to be relatively insensitive to conditions such as depression. In considering the possibility that the ability levels of the groups differed, however, peculiarities in the vocabulary and general knowledge tests also must be taken into account. First, for the sake of conforming to the procedures of Einstein et al. (1995), the standard WAIS procedure of using interviewer probes to query ambiguous responses was not employed in this study. Participants who failed spontaneously to provide full and detailed answers (a behaviour that might reflect reduced initiative) may have been at a particular disadvantage on the adapted version of the vocabulary test. Second, the general knowledge test may have tapped the ability to process quickly and efficiently to a greater degree than is immediately apparent. Several items are challenging only because of the time constraint of 9sec for reading and responding to the question. For example, one question is, "The price of apples is 2 for 31 cents. What is the price of one dozen?"

It is also somewhat surprising that performance on the WMS tests failed to differ according to group. The WMS was chosen because it is standardised and because several of the subtests have shown depression-related differences in prior studies. But it is worth noting that the literature on these clinical measures of retrospective memory in depression is not without inconsistencies (see reviews by Burt, Zembar, & Niederehe, 1995; Hartledge, Alloy, Vasquez, & Dykman, 1993).

In conclusion, the present study represents an initial foray into a domain of depressive functioning that carries important theoretical and practical implications. However, it will be important for future research to examine depression-related performance on prospective tasks that vary in the degree of external support in order to more clearly establish the role of self-initiated processing in prospective-memory deficits. In addition, it will be important for future work to determine whether the deficits we observed are specific to depression or more generally characterise affective disorders.

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