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Positive mood is associated with the implicit use of distraction

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Abstract

Previous research demonstrates that individuals in a positive mood are differentially distracted by irrelevant information during an ongoing task (Rowe et al. in Proc Natl Acad Sci 104:383–388, 2007). The present study investigated whether susceptibility to distraction shown by individuals in a positive mood results in greater implicit memory for that distraction. Participants performed a similarity-judgment task on pictures that were superimposed with distracting words. When these previously distracting words could be used as solutions on a delayed implicit task administered several minutes later, performance was positively correlated with pleasantness of mood. Individuals in a positive mood are more likely than others to use previously irrelevant information to facilitate performance on a subsequent implicit task, a finding with implications for the relationship between positive mood and creativity.

Keywords

Emotional states; Positive affect; Attention; Distraction; Implicit memory

Positive moods, desirable as they may be, have mixed effects on cognitive functioning. On the one hand, a number of studies show that positive moods foster creative and flexible thinking. For example, relative to neutral or negative mood controls, people in induced positive moods give more unusual associations to common words (Isen et al. 1985), show greater verbal fluency in a creative uses task (Phillips et al. 2002), and generally produce more answers in problem solving situations (Isen et al. 1987; Rowe et al. 2007). Studies of individual differences in naturalistic moods show a similar pattern of results: individuals with more positive naturally occurring moods demonstrate greater verbal fluency (Carvalho and Ready 2009) and produce more solutions in situations requiring divergent thinking (Vosburg 1998).

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There is also evidence that individuals in positive moods show disrupted performance, at least when distracting information is present (Dreisbach and Goschke 2004). Of course, processing irrelevant information can be disruptive to a task, depending on the relationship between the distraction and the task at hand. Consider the classic flanker task (Eriksen and Eriksen 1974) from the visual attention literature, in which participants respond to a central target that is surrounded by distracting flankers. People induced to be in a happy mood experience more interference from flankers than people in a sad or neutral mood (Rowe et al. 2007). Positive facial expressions used as distractors in flanker tasks also produce more interference relative to negative or neutral facial expressions (Fenske and Eastwood 2003). At the neural level, positive emotional states increase perceptual encoding of unattended peripheral information in the visual cortices (Schmitz et al. 2009). Irrelevant information in memory is also processed differently according to mood state: intentional forgetting of previously studied, but now irrelevant information is less effective in induced positive moods (Bäuml and Kuhbandner 2009). Thus, positive moods have both negative and positive consequences for behaviour, depending on the task at hand.

Consistent across these positive and negative findings in the positive mood literature is the openness of individuals to noncentral, or even completely irrelevant, information. One way to account for this pattern of behaviour is to suggest that inhibitory attentional regulation, which ordinarily downregulates attention to distraction, is less effective in positive than in other mood states (Rowe et al. 2007). This loosening of inhibitory control is associated with a broadened scope of attention, as irrelevant information is processed in addition to relevant information. In the inhibitory control literature (e.g., Hasher et al. 1999), there are recent reports that poor regulation of distraction at one point in time leaves that information accessible to influence subsequent performance. That is, individuals with poor attention regulation not only show greater impact on performance from concurrent distraction (e.g., May 1999), they also demonstrate greater sustained access to that distracting information over at least brief—10 min—intervals (Campbell et al. 2010; Kim et al. 2007; Rowe et al. 2006).

In the present study, we considered whether or not individuals in naturalistic positive moods show downstream benefits of increased distractibility, previously demonstrated in other populations with poor attention regulation. We used a task originally introduced by Rowe et al. (2006). In this procedure, participants perform similarity judgments on a series of pictures, some of which are superimposed with distracting words that they are instructed to ignore. Following a filled interval, participants solve word fragments, a subset of which can be completed using some of the distracting words from the initial task. Participants' naturally occurring mood was measured, along with several other factors that might influence performance. Our question was whether mood would be significantly associated with the degree to which distraction from one situation remains accessible to influence performance in a completely different task, performed 10 min after the original exposure to distraction. We predicted that, relative to others, individuals in a positive mood would use more of the initial irrelevant words to complete the word fragment task relative to baseline completion rates, thus demonstrating improved implicit memory for distraction.

Method

Participants

Forty-two undergraduate students from the University of Toronto participated in the study. Six participants were replaced: two reported consciously looking at the words that subjects were instructed to ignore, three were disrupted during the study due to technical difficulties, and one scored more than two SDs below the group mean on the vocabulary test and more than 2.5 SDs below the mean on the spatial working memory measure (the filler task).[1] The remaining sample consisted of 36 participants (9 males, 27 females; *M* age = 19.7, SD = 2.3). The mean years of education was 13.6 years (SD = 2.1). Subjects participated for course credit or received monetary compensation.

Materials

Fifty-five line drawings, derived from Snodgrass and Vanderwart (1980), comprised the target pictures for the similarity judgment task. Fifty of these drawings were superimposed with distracting information: 30 with random letter strings, 10 with filler words, and 10 with critical primed words. The filler words did not appear again in the experiment.

Two different lists of 10 critical words and corresponding fragments were used. The lists were counterbalanced such that each participant was exposed to one list in the similarity judgment task (the primed list) and solved fragments from both lists in the fragment completion task, with completion from the alternate list not seen in the similarity judgment task (the control list) used to calculate baseline fragment completion. The critical words were an average of six letters long, and were selected based on word-fragment completion norms collected previously at the University of Toronto (Ikier 2005). All primed and control fragments could be solved using multiple English words (e.g., _E_ON can be solved with MELON or LEMON), but only one target solution (e.g., MELON) was presented in the study. Ten easy filler fragments were also used in the fragment completion task. Filler fragments all had high completion rates (*M* = 0.74) and were easily solved, to ensure that participants felt successful during the task and to limit awareness of the connection between the study and test phases.

Mood was measured using the Brief Mood Introspection Scale (BMIS; Mayer and Gaschke 1988). The BMIS requires participants to rate the extent to which they currently feel each of 16 mood adjectives on a seven-point Likert scale. Valence and arousal scores can be calculated independently on pleasant-unpleasant and arousal-calm dimensions. For the pleasant-unpleasant scale, negative items (i.e., jittery, sad, fed up, grouchy, tired, drowsy, gloomy, nervous) were subtracted from the sum of ratings for positive items (i.e., content, loving, peppy, happy, caring, lively, calm, active). Possible scores range from −56 (extremely unpleasant) to 56 (extremely pleasant). For the arousal-calm scale, low arousal adjectives (i.e., calm, tired) were subtracted from the sum of high arousal adjectives (i.e., active, caring, fed up, gloomy, jittery, lively, loving, nervous, peppy, sad). Possible scores for this scale range from −4 (extremely calm) to 68 (extremely aroused).

[1]The removal of this participant from the data set did not change any statistical outcomes.

Procedure

During the study phase, participants viewed a sequence of 55 line drawings each presented in the centre of the computer screen for 1,000 ms, with an ISI of 500 ms. In this similarity judgment task, participants were instructed to identify whenever consecutive pictures were identical by saying the word “same” out loud; this response was recorded by the experimenter. There were a total of 10 consecutive picture pairs to be identified; the pairs were randomly placed amidst novel pictures. The sequence of pictures began and ended with buffer trials, in which nonwords were superimposed over the pictures. Nonwords, filler words, and target words were distributed proportionally over the consecutive picture pairs. Participants were instructed to ignore the superimposed letters or words.

Between the study and test phases, participants completed a computerized version of the Corsi Block Test, a measure of spatial working memory (Corsi 1972). This filler task lasted between 8 and 10 min, and was intended to minimize awareness of the connection between words used in the study and test phases.

In the test phase, participants viewed 30 word fragments, each presented on the screen for 3,000 ms. Participants were instructed to respond with the first word that came to mind; these responses were recorded by the experimenter. Of the presented fragments, 10 could be completed using the superimposed target words from the study phase (i.e., primed fragments), 10 were filler word fragments, and 10 fragments were from the control list not seen by the participant. The proportion of critical words used to solve these 10 fragments served as the baseline completion rate. In order to ensure that participants did not use explicit strategies to complete the word fragments with words that they remembered from earlier in the study, no mention of the initial task was made in the instructions. An awareness check was also conducted to ensure that deliberate retrieval was not used: following the test phase, participants were questioned to determine whether they were aware of any connection between the study and test phases.

Following completion of the tasks, participants filled out the BMIS and Shipley vocabulary scales, and were debriefed about the study’s purpose.

Results

No participant reported an awareness of the connection between study and test phases. Mean BMIS ratings were 6.9 (SD = 10.7, range = −20–24) on the pleasant/unpleasant scale, suggesting that overall moods were mildly pleasant. Mean ratings were 23.5 (SD = 6.6, range = 10–42) on the arousal/calm scale, suggesting that participants were somewhat calm. Mean vocabulary score was 29.9 (SD = 3.1), and participants had an average of 68% correct trials (SD = 16%) on the spatial working memory task. Accuracy was high for the picture task during the study phase ($M = 97.5\%$, SD = 5.5%), and did not vary as a function of mood pleasantness ($r = .21$, *ns*) or arousal ($r = .05$, ns).

Priming scores for each participant were calculated as the difference between the proportion of correctly solved primed fragments and control fragments. The baseline completion rate for control items that participants had not seen earlier in the study was 9% (SD = 10%). The completion rate for critical primed items was 17% (SD = 15%), yielding a mean of 8% (SD = 18%) priming for items that had been presented as distraction. As a measure of overall fragment task performance, we also examined the number of the 20 unprimed fragments (10 control fragments and 10 filler fragments) completed with any possible solution. Since all fragments could be solved using multiple English words, possible solutions included both the critical word and any other correct word (e.g., MELON or LEMON for the fragment _E_ON). Participants solved a mean of 44% (SD = 11%) of these 20 fragments for which no solution was primed.

Correlations between mood and performance measures are shown in Table 1. Consistent with the predicted relation between individual differences in mood state and memory for distractors, there was a significant correlation between BMIS pleasant-unpleasant mood rating and priming for the distracting information, $r = .40$, $p < .02$ (Fig. 1). Thus, individual differences in mood accounted for 16% of the variance in memory for distraction. A median split on mood showed that the half of the sample who reported more pleasant mood ratings had greater priming for distraction ($M = 14\%$, SD = 20%) compared to the half with less pleasant mood ratings ($M = 2\%$, SD = 13%), $t(34) = 2.16$, $p < .04$. The relation between positive mood and memory for distractors was not due to increased arousal; there was no relation between the BMIS arousal-calm scale and priming ($r = .19$, *ns*).

Since the mood questionnaire was administered following completion of the word fragment completion task, we conducted analyses to ensure that a more pleasant mood rating was not related to overall performance on the task. Indeed, there was no relation between pleasantness of mood and number of the 20 unprimed fragments (10 fillers, 10 control list fragments) that were completed with a plausible solution ($r = -.02$, *ns*). Mood was also unrelated to spatial working memory performance ($r = -.13$, *ns*), and vocabulary score ($r = .20$, *ns*).

Discussion

Previous work demonstrated that individuals in an induced positive mood are more affected by distracting information than are others (Rowe et al. 2007; see also Schmitz et al. 2009). Here, we demonstrated that longer-term consequences of increased distractibility are associated with individual differences in mood. Naturally occurring pleasant mood was associated with greater implicit use of previously distracting information on a later task, and unrelated to several other factors, including unprimed fragment completion, vocabulary and spatial working memory. This finding is consistent with the hypothesis that positive emotional state is associated with less effective inhibitory regulation, such that attention is broadened to include information that is irrelevant to the current task (Rowe et al. 2007).

We theorize that individuals in a pleasant mood pay more attention to irrelevant information during the study phase, and it is this distractibility at encoding that causes greater priming for the distracting words. However, we did not find a significant association between pleasant mood and performance in the study phase, likely because accuracy on the similarity judgment task was near ceiling. An alternate possibility is that mood valence is associated with retrieval: individuals in a more positive mood may be more likely to transfer previously encoded information for use on a later task. Since mood was measured after the cognitive tasks, a third possibility is that performing the tasks affected mood ratings. While positive mood was not associated with general fragment task performance, as measured by completion of unprimed fragments, the priming itself may have caused more pleasant mood ratings. Future work should establish causal links between positive mood, distractibility, and priming for distraction, using experimentally induced mood states to determine whether positive mood causes priming for distraction at encoding or retrieval.

The relation between mood and implicit memory for distraction was specific to individual differences in mood valence, and not arousal. These results are in line with other research demonstrating that valence affects performance on measures of selective attention (Dreisbach and Goschke 2004; Fenske and Eastwood 2003; Rowe et al. 2007), although some attentional measures can be influenced by an interaction of mood valence and arousal (Jefferies et al. 2008). One might have predicted that arousal would be negatively correlated with priming for distraction, based on Easterbrook’s (1959) suggestion that that a state of high emotional arousal reduces the range of cue utilization to central information at the expense of cues that are only partially relevant. Typically, university-aged adults already have a very narrow attentional scope, showing minimal priming at an optimal time of day when tested on this same paradigm (Rowe et al. 2006). In addition, a neuroimaging study found that younger adults’ neural activity did not differentiate between words and nonwords that they were instructed to ignore (Rees et al. 1999). Since younger adults are already proficient at constricting their attention, individual differences or everyday increases in emotional arousal are likely insufficient to narrow attention further.

This study ties findings that positive mood fosters creativity with evidence demonstrating the benefits of distractibility. Previous research has suggested that positive emotional states are associated with creative problem solving. This effect may be related to a wider scope of semantic access, as previously suggested by evidence that individuals in positive moods were able to find more associations between semantically distant words (Isen et al. 1987; Rowe et al. 2007) on the remote associates test (Mednick et al. 1964). An additional mechanism through which positive mood may facilitate creativity is by increasing incidental processing of extraneous information that could contribute to performance on subsequent tasks. Indeed, susceptibility to distraction facilitated remote associates test performance when distractors could be used as solutions later on (Kim et al. 2007). Also in support of this idea, creative and divergent thinking have been linked to reductions in the ability to screen out previously irrelevant information (Carson et al. 2003). If inhibitory control causes premature rejection of unusual ideas because they do not obviously fit with the current goal, excessive inhibition may be detrimental to the creative process.

The conclusion that pleasant mood is associated with benefits of distractibility is consistent with the idea that positive mood broadens cognition and behaviour, promoting actions that have long-term benefits for the individual (Fredrickson 2001). In particular, positive emotions encourage exploration, which in turn helps to build physical, intellectual, and social resources. A certain level of distractibility may confer a similar benefit: being receptive to irrelevant information, like exploring the environment, means that the individual can notice and capitalize on unexpected opportunities. With broadened attention, a larger range of information is accessed; the drawback is that distraction from less important stimuli may interfere with information relevant to the current goal. However, beyond these decrements to the achievement of a particular goal, positive emotional states may produce an openness to alternatives beyond the goal currently being pursued (Carver 2003). Exploratory and creative thinking should be best when one is free to assimilate a wide range of information from the environment, and the present study suggests that a positive mood is associated with this very type of cognition.

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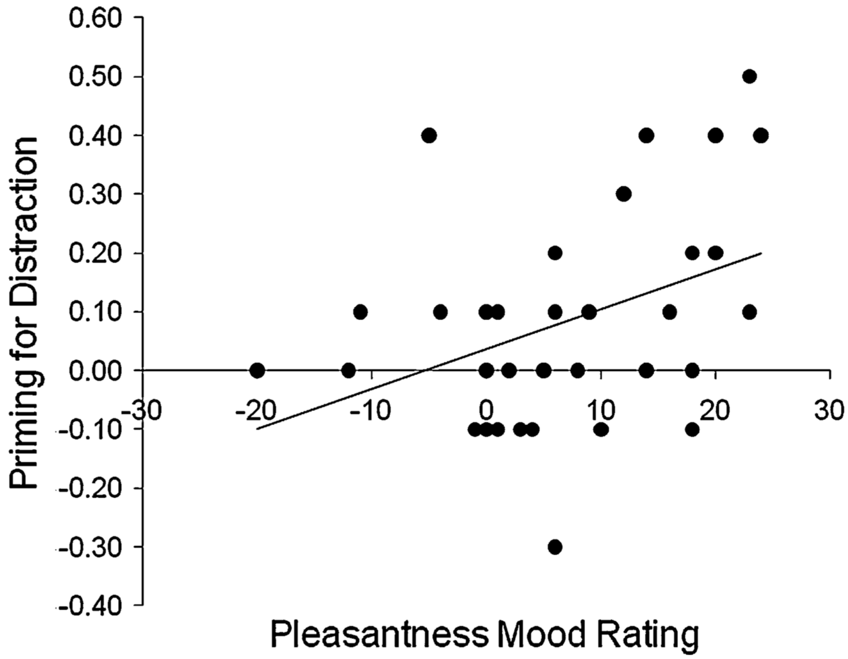

Fig. 1.

Correlation between pleasantness of mood rating and priming for distraction across participants

Table 1

Correlation matrix for mood and performance measures

	1	2	3	4	5	6
1. Pleasant/unpleasant mood rating	–					
2. Arousal/calm rating	−.12	–				
3. Spatial working memory	−.13	.19	–			
4. Vocabulary	.20	−.24	.09	–		
5. Control fragment completion	−.02	−.16	.05	.20	–	
6. Priming for distraction	.40*	.19	−.05	−.12	.10	–

* $p < .05$