HAPPY DISTRACTION: POSITIVE AFFECT BROADENS ATTENTION TO IRRELEVANT INFORMATION

by

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Abstract

The present study investigated the claim that positive mood broadens the scope of attention to include irrelevant information, and if so, whether this loosening of attentional control has longer term cognitive consequences. In Experiment 1, participants in an induced happy mood were more influenced by distracting information that interfered with responses in the global-local task, particularly when this information was global in nature. Experiment 2 demonstrated that, when previously irrelevant information became solutions on a subsequent task, implicit memory for this distraction was positively correlated with naturally-occurring positive mood. This study corroborates findings that individuals in a happy mood are more affected by distracting irrelevant information. Furthermore, this widened scope of attention can facilitate performance on a subsequent task, a finding with implications for the relationship between positive mood and creativity.
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# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Experiment 1</td>
<td>7</td>
</tr>
<tr>
<td>2.1. Method</td>
<td>9</td>
</tr>
<tr>
<td>2.1.1. Participants</td>
<td>9</td>
</tr>
<tr>
<td>2.1.2. Materials</td>
<td>9</td>
</tr>
<tr>
<td>2.1.3. Procedure</td>
<td>11</td>
</tr>
<tr>
<td>2.2. Results</td>
<td>12</td>
</tr>
<tr>
<td>2.2.1. Global-Local</td>
<td>12</td>
</tr>
<tr>
<td>2.2.2. Arrow Flanker</td>
<td>15</td>
</tr>
<tr>
<td>2.2.3. Mood Manipulation Check</td>
<td>17</td>
</tr>
<tr>
<td>2.3. Discussion</td>
<td>17</td>
</tr>
<tr>
<td>3. Experiment 2</td>
<td>19</td>
</tr>
<tr>
<td>3.1. Method</td>
<td>20</td>
</tr>
<tr>
<td>3.1.1. Participants</td>
<td>20</td>
</tr>
<tr>
<td>3.1.2. Materials</td>
<td>20</td>
</tr>
<tr>
<td>3.1.3. Procedure</td>
<td>21</td>
</tr>
<tr>
<td>3.2. Results</td>
<td>22</td>
</tr>
<tr>
<td>3.3. Discussion</td>
<td>24</td>
</tr>
<tr>
<td>4. General Discussion</td>
<td>25</td>
</tr>
<tr>
<td>5. References</td>
<td>30</td>
</tr>
</tbody>
</table>
List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Example of the type of stimulus display used in the global-local comparison task</td>
<td>3</td>
</tr>
<tr>
<td>2. Examples of stimuli from the global-local classification task</td>
<td>8</td>
</tr>
<tr>
<td>3. Global-local mean (+SE) RTs for neutral and happy groups, according to stimulus type and response conditions</td>
<td>13</td>
</tr>
<tr>
<td>4. Global-local mean (+SE) costs and benefits of distraction across mood groups</td>
<td>15</td>
</tr>
<tr>
<td>5. Arrow Flanker mean (+SE) RTs according to group and trial type</td>
<td>16</td>
</tr>
<tr>
<td>6. Arrow flanker mean (+SE) costs and benefits of distraction across mood groups</td>
<td>17</td>
</tr>
<tr>
<td>7. Correlation between pleasantness of mood rating and priming for distraction across participants</td>
<td>24</td>
</tr>
</tbody>
</table>
Happy Distraction: Positive Affect Broadens Attention to Irrelevant Information

Emotional states are a powerful influence on cognition and behaviour. Signals from different emotional states are associated with divergent courses of action, whether a feeling of terror implies the need to escape from a threat, excitement signifies that one should be on the lookout for something rewarding, or contentment denotes a desire to maintain one’s current state. On a general level, emotional states can bias information processing by setting processing priorities according to the demands of a given situation (Gray, 2004). That is, emotional states may serve as cues to prioritize certain cognitive abilities over others. For example, a long experimental tradition in psychology suggests that stressful, high arousal states cause a narrowing of cognition, or “tunnel vision”: attention focuses limited processing resources on a narrow range of information. In particular, visual attention may concentrate on central rather than peripheral information, and object perception may emphasize local rather than global form (Derryberry & Tucker, 1994; Easterbrook, 1959). One example of this effect is weapon focus, the idea that a victim who is robbed at gunpoint remembers details about the weapon but not the assailant’s face (e.g. Maass & Kohnken, 1989). This narrowing of attention is not unique to anxiety among negative emotional states; it may also be caused by feelings of failure (Derryberry & Tucker, 1994).

Bolstered by interest within the burgeoning field of positive psychology, questions about positive affect’s influence on cognition have stimulated recent experimental curiosity. One consistent finding is that positive mood fosters creative and flexible thinking. For example, participants in a happy mood gave more unusual associations to common, neutral words (Isen, Johnson, Mertz, & Robinson, 1985), produced more words in a creative uses fluency task (Phillips, Bull, Adams, & Fraser, 2002), and were more likely to solve Duncker’s (1945) candle task (Isen, Daubman, & Nowicki, 1987). In addition, on the remote
associates task (RAT; Mednick, Mednick, & Mednick, 1964), individuals in positive-induced moods were able to find more associations between semantically distant words than control participants (Isen et al., 1987; Rowe, Hirsh, & Anderson, 2007). These findings suggest that positive mood may enhance the creative process by improving the ability to relate and integrate disparate information (Isen, 1999). Spreading activation to weak and remote associations caused by positive mood may also play a role in intuition. Participants in a positive mood made more accurate intuitive judgments about whether three words were weakly associated with a common concept, even when they did not consciously retrieve the solution (Bolte, Goschke, & Kuhl, 2003). Even high arousal positive states, including elation and mania, have been associated with the flexible, inclusive thinking that facilitates creativity. For example, relative to other psychiatric illnesses, manic patients have a more overinclusive conceptual style, similar to that seen in creative writers (Andreasen & Powers, 1975).

A number of theoretical accounts suggest that these consequences of positive mood are related to a widened scope of cognition and attention (Derryberry & Tucker, 1994). According to the broaden-and-build theory (Fredrickson, 2001), positive emotions broaden individuals’ thought-action repertoires by stimulating the urge to explore, create, and savour current experiences. The affect-as-information hypothesis (Clore et al., 2001) also associates positive mood with a widened scope of processing. According to this framework, positive affect stimulates cognitive processing that is top-down, integrative, and global in focus. In support of the widened scope of attention suggested by these theories, studies of object perception suggest that happy individuals are more likely to see the “forest” than they are to see the “trees”. In one measure contrasting local and global processing, participants judge
which of two comparison figures, one matching in global configuration and the other in local components, more closely resembles a standard figure (Kimchi & Palmer, 1982; see Figure 1 for an example). Using this paradigm, participants in induced positive moods showed a greater global bias compared to those in a negative mood (Fredrickson & Branigan, 2005; Gasper & Clore, 2002).

![Comparison figures](image)

**Figure 1**: Example of the type of stimulus display used in the global-local comparison task (Kimchi & Palmer, 1982): participants are asked to judge which of the two comparison figures (1b and 1c) is more similar to the top standard figure (1a).

It follows from the research reviewed above that emotional state influences the ability to allocate attention. More specifically, emotional state affects the distribution of attentional resources, analogous to widening the scope of the proverbial “spotlight” (Posner, Snyder, & Davidson, 1980) or “zoom lens” of attention (Eriksen & Yeh, 1985) to encompass a larger range of information. A consequence of this broadening may be a lack of attentional selectivity; as attention is widened in scope, more irrelevant information may be picked up from the environment. Thus, as suggested by Rowe and colleagues (2007), positive mood may broaden attention by relaxing inhibitory control processes that filter out irrelevant
information. When efficient, inhibitory mechanisms limit early selection to goal-relevant information, thereby preventing goal-irrelevant information from entering the contents of working memory (Hasher & Zacks, 1988; Hasher, Zacks & May, 1999). In this way, positive mood may diminish inhibitory processes that otherwise function to narrow the scope of information processing.

Indeed, studies of visual selective attention have demonstrated that individuals in positive moods are more affected by distracting, goal-irrelevant information. In the Eriksen flanker task (Eriksen & Eriksen, 1974), participants respond to a central target that is surrounded by distracting flankers. When these flankers are incompatible with the response to the target, slowed responding is taken as evidence for greater processing of the irrelevant peripheral information. When this task was administered to participants in induced mood states, positive mood resulted in greater flanker interference compared to sad and neutral moods, suggesting broadened attention to irrelevant information (Rowe et al., 2007). Positive facial expressions also increase interference from peripheral information. The compatibility of flanker faces had a greater influence on responses to target faces displaying positive emotion compared to negative or neutral facial expressions (Fenske & Eastwood, 2003). A study using eye tracking to assess attentional breadth found that participants in a positive mood had longer fixations to peripheral images and made more frequent saccades, although only for positively-valenced stimuli (Wadlinger & Isaacowitz, 2006). In addition, positive mood may relax inhibitory mechanisms that suppress task-irrelevant activation. Induced-positive mood caused task-switching impairments on a version of the Stroop task, suggesting that diffuse activation consistent with a widened scope of attention may make it more difficult to suppress the task that is no longer current (Phillips et al., 2002).
Thus, information about one’s emotional state may serve as a situational cue to constrict or loosen inhibitory control processes that limit what information accesses the scope of attention. This effect may result in greater distraction from task-irrelevant information, thus harming goal-directed performance. Conversely, this broadened attentional scope may also facilitate performance, particularly on tasks requiring creative responses, by increasing access to a wider range of material. Since the distinction between relevant and irrelevant information is rarely straightforward or obvious in everyday life, a vast amount of information may be pertinent. The ability to connect seemingly disparate ideas is an important element of creativity, and a wider breadth of attention means that a larger pool of associations is available to combine in novel and unusual ways (Kasof, 1997).

Widened attentional scope can also be beneficial if previously irrelevant information suddenly becomes relevant (Healey, Campbell, & Hasher, 2008). Indeed, there are experimental demonstrations of loosened inhibitory control facilitating performance on subsequent tasks. In particular, aging and synchrony effects (i.e., testing participants at a nonoptimal time of day) cause reductions in inhibitory control, with the consequence that more distracting information accesses the focus of attention (Hasher & Zacks, 1988; Hasher, Lustig, & Zacks, 2007; Hasher et al., 1999). In one study, older and younger adults read stories with interspersed distracting words, and subsequently completed a version of the RAT in which some of the distractors could be used as solutions (Kim, Hasher, & Zacks, 2007). Older adults showed a significant benefit from exposure to the distractors for the problem-solving task; in comparison, younger adults’ performance did not vary with exposure to distraction. Distractors related to the solution also enhanced problem-solving performance in
older adults and individuals tested at off-peak times when it was presented concurrently with the RAT (May, 1999).

Similarly, reduced inhibitory control facilitated implicit memory in older adults in a study that tested word fragment completion (Rowe, Valderrama, Hasher, & Lenartowicz, 2006). Participants performed similarity judgments on a series of pictures, some of which were superimposed with words or letter strings. They were instructed to focus attention on the pictures and ignore the distracting words. On a subsequent word fragment completion task, some word fragments could be completed using the original distracting words. Particularly at their nonoptimal time of day, older adults showed increased priming for the distracting words; that is, they used more of the original words to complete the fragments relative to their baseline performance.

This research indicates that, with the loosening of inhibitory control, more distracting information enters the focus of attention, and furthermore, that this information may remain accessible for future use. This sustained activation of information that is no longer relevant parallels the finding in the positive mood literature, in which sustained semantic access to a wider range of information facilitated performance on creative tasks, like the RAT (Isen et al., 1987; Rowe et al., 2007).

There were two main goals of the present study. Firstly, following Rowe and colleagues’ (2007) example, we aimed to demonstrate an increased susceptibility to distraction in happy individuals, using different tasks (Experiment 1). Secondly, we wished to determine whether happier individuals are able to benefit from this distractibility by using previously-irrelevant information to facilitate performance on a subsequent task (Experiment 2). To increase the generalizability of our findings, we used different procedures to establish
or measure existing moods: Experiment 1 induced positive and neutral moods in participants, and Experiment 2 measured the pleasantness ratings for naturally-occurring moods.

2. Experiment 1

Experiment 1 was designed to conceptually replicate earlier findings of increased susceptibility to distraction among individuals in an induced positive emotional state (Rowe et al., 2007), now using the global-local task (Navon, 1977) and an arrow version of the flanker task (Eriksen & Eriksen, 1974). Participants were assigned to either a happy or neutral mood comparison group, and watched a set of positive or neutral film clips that were designed to induce the respective emotional state.

Previous studies (e.g., Fredrickson & Branigan, 2005; Gasper, 2004; Gasper & Clore, 2002) have investigated global bias in different emotional states using a similarity judgment task, which compares biases in global and local selections (Kimchi & Palmer, 1982; see Figure 1). Instead, we used Navon’s (1977) original classification task, which allowed us to compare attention to global configuration versus local details in the presence or absence of conflicting information. In this global-local classification task, participants are instructed to respond to either the global or local level of a hybrid stimulus, and must identify which of two letters (“H” or “S”) is presented at that level (see Figure 2). The letter(s) comprising the irrelevant level may be congruent, incongruent, or neutral with the level relevant to the response.
2a. Congruent stimulus  
2b. Incongruent stimulus

2c. Neutral stimulus, for which participants respond to local letter  
2d. Neutral stimulus, for which participants responded to the global letter

Figure 2: Examples of stimuli from the global-local classification task.

We predicted that, similar to findings of a greater global bias in comparison judgment tasks (Fredrickson & Branigan, 2005; Gasper & Clore, 2002), individuals induced to be happy would show a greater global precedence effect, that is, faster responses to the global, rather than local level of the stimulus (Kimchi, 1992; Yovel, Rivelle, & Mineka, 2005). Furthermore, if happy individuals are more influenced by distraction, they should show greater overall interference from the irrelevant level compared to the neutral group, that is, slower reaction times (RTs) on trials when the global and local aspects of the stimulus conflict. If this susceptibility to distraction is related to a more global focus of processing, participants in the happy condition should experience more interference from the global level of the stimulus when responding to the local details (“global interference”; Kimchi, 1992).
The second task, arrow flanker, requires responses to a central arrow in the presence or absence of flanking arrows. The flankers either are congruent or incongruent with the direction of the central arrow, or are neutral letters, unrelated to the response. Interference from distraction is measured as slowed RT, or cost, in the presence of incongruent compared to neutral flanking information. We predicted that individuals in the happy condition would experience increased interference from incongruent flankers compared to those in the neutral mood condition, consistent with previous findings in happy individuals using letter flankers (Rowe et al., 2007).

2.1. Method

2.1.1. Participants

Forty-four undergraduate students (21 male, 23 female), from the University of Toronto participated in this experiment for course credit or monetary compensation. The mean age was 20.2 years (SD = 2.49; range = 17-25 years), and the mean years of education was 14.1 years (SD = 2.04; range = 12-19 years). Twenty-two subjects were randomly assigned to the happy mood condition, and 22 to the neutral mood condition. All participants were tested at their optimal time of day (after 12 p.m.), as determined by their score on the Horne-Ostberg Morningness-Eveningness Questionnaire (MEQ; Horne & Ostberg, 1976).

2.1.2. Materials

Two film clips, each 8-9 minutes in length, were used to induce neutral or positive mood. Participants in the neutral condition watched clips from Egypt educational films, and those in the happy condition watched clips from the films “In America” and “Four Weddings and a Funeral”. In pilot testing, participants watched one set of clips and immediately completed mood ratings, which were summed to form a bipolar happiness measure. The pilot
study confirmed that this mood manipulation was effective: comparable participants who watched the happy clip \((n = 10)\) reported a happier mood \((M = 4.01, SD = 0.66)\) compared to those who watched the neutral clip \((n = 16, M = 3.32, SD = 0.57)\), \(t(24) = 2.85, p < .001\).

Mood was measured using a modified version of the Positive and Negative Affect Schedule (PANAS; Feldman-Barrett & Russell, 1998). The PANAS consists of 20 adjectives describing feelings and emotions, forming scales for Positive Affect (interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, active) and Negative Affect (distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, afraid). We included ten additional adjectives, which provided a bipolar happiness measure, calculated as the sum of ratings for happy adjectives (happy, content, joyful, cheerful) and the sum of reverse-scored ratings for sad adjectives (depressed, unhappy, sad). Participants rated their current experience of each word on a five-point Likert scale from “not at all” to “extremely”.

Stimuli for the global-local task were compound letters (“H” or “S”) or geometric shapes (rectangles or triangles) made up of smaller letters or shapes. Three types of stimuli were presented: congruent (local letters match the global letter), incongruent (local letters conflict with the global letter), and neutral (either a large shape consisting of small letters, or a large letter made up of small shapes; see Figure 2 for examples of stimuli).

Stimuli for the arrow flanker task included arrows pointing either to the left (<) or right (>). In each trial, the focal arrow was presented alone or with flanking arrows or x’s. The flanking information was either congruent (flanking arrows pointed in the same direction, e.g., > > > > > > > >), incongruent (flanking arrows pointed in the opposite direction, e.g., << << << << << <<), or neutral (e.g., x x x x x). The focal arrow was always presented in the middle of the flanking information. On single trials, the arrow was presented alone.
2.1.3. Procedure

Prior to the mood-induction, participants completed a three minute relaxation exercise with the goal of minimizing individual differences in baseline emotional state and arousal level. Next, they watched either the happy or neutral film clip. Participants were instructed that they would be asked about their impressions of the film at a later time in the study.

Participants then completed the global-local task. The task began with 12 practice trials, followed by four experimental blocks of 48 trials each, ordered global, local, local, global. Each block contained an equal number of congruent, incongruent, and neutral trials, which were presented in a fixed, random order. Before each block, participants were instructed to respond to either the global or local level of the stimulus by pressing a key corresponding to either “H” or “S”. Once the participant made a key press to begin each block, a fixation point appeared for 1000 ms, followed by the presentation of the hybrid stimulus. The stimulus remained on the screen until the participant made a response.

Between tasks, participants viewed a one minute excerpt from their group’s respective film clip; the excerpt was chosen to be the most happy or neutral part of the clip. Following this short mood booster, participants completed the arrow flanker task. Each trial of this task began with the presentation of an arrow at either the top or bottom of an otherwise blank, white screen. The arrow remained on the screen until the participant made a response by pressing a key corresponding to either “<” or “>”, followed by an interstimulus interval (ISI) of 1000 ms. The task began with 40 practice trials that required responses to a single arrow, and 28 practice trials that required responses to the arrow in the presence of congruent, incongruent, or neutral flankers. Participants then completed 72 experimental trials, which included 18 of each condition (congruent, incongruent, neutral, or single). The
trials were presented in a fixed random order, with no more than three consecutive iterations of the same type of trial or response.

At the conclusion of the study, approximately 25 minutes following the initial mood manipulation, participants filled out the mood questionnaire. They were then questioned to determine whether they were aware of any connection between the films and experimental tasks. Afterwards, they were debriefed and filled out the MEQ, Shipley, and demographic questionnaires. As a reinstatement treatment at the end of the experiment, all participants listened to music previously shown to elicit a happy mood (Rowe et al., 2007).

2.2. Results

2.2.1. Global-local

We analyzed median RTs for correct responses, following removal of error trials. Data from one participant in the happy condition and one in the neutral condition who were statistical outliers were removed from the analysis for this task (RTs were more than 3 SDs from the group mean). The mean error rates for the remaining participants were 3.3% ($SD = 3.8\%$) in the neutral condition and 1.8% ($SD = 1.8\%$) in the happy condition, which did not significantly differ, $t(40) = 1.59, \text{ns}$.

Figure 3 illustrates RTs for neutral and happy groups according to stimulus type and response condition. One aspect of the global precedence effect is faster responses to the global compared to the local level in the absence of any interfering information (Navon, 1977; Yovel, Revelle, & Mineka, 2005). That is, responses should be faster to a neutral stimulus that requires a global response (e.g., Figure 2d) compared to a neutral stimulus that requires a local response (e.g., Figure 2c). We conducted a 2 (Mood Group: happy, neutral) $\times$ 2 (Processing Level: global, local) analysis of variance on the median RTs on neutral trials.
As is typical, there was a main effect of processing level; participants responded faster overall to neutral global trials ($M = 552, SD = 79.5$) than neutral local trials ($M = 578, SD = 71.4$), $F(1, 40) = 12.37, MSE = 1069.064, p < .01$. The main effect of condition was not significant, $F < 1$, indicating that there was no difference in overall RTs between the happy and neutral groups. Based on previous findings of a global bias in happy individuals (Fredrickson & Branigan, 2005; Gasper & Clore, 2002), we expected that individuals in the happy condition would show a stronger global precedence effect. However, the Mood Group × Processing Level interaction was not significant, $F < 1$, suggesting that the global precedence effect did not differ across mood groups.

![Figure 3](image)

*Figure 3*: Global-local mean (+SE) RTs for (a) neutral, and (b) happy groups, according to stimulus type (congruent, neutral, incongruent) and response conditions (local, global).

Distraction effects were calculated as the difference in reaction time between incongruent and neutral trials (cost). We first examined the overall cost across both local and global trials. Individuals in the happy condition ($M = 74.7, SD = 39.8$) were more affected by the irrelevant processing level than those in the neutral condition ($M = 45.9, SD = 29.5$), $t(40) = 2.66, p < .05$. The global interference effect is the cost of distraction from an incongruent
global letter when responding to the local level of the stimulus; that is, the cost of distraction when responding to the local level. The happy group demonstrated greater global interference \( (M = 106.2, SD = 62.7) \) compared to the neutral group \( (M = 67.1, SD = 35.9) \), \( t(40) = 2.48, p < .05 \). We also compared group differences in the local interference effect, or the cost of distraction from incongruent small letters when responding to the global configuration. There was no difference in local interference between the happy \( (M = 40.1, SD = 62.8) \) and neutral \( (M = 24.6, SD = 44.5) \) mood groups, \( t(41) = 0.92, ns \).

Another consequence of increased distraction is faster response times when the distracting feature of the stimulus matches the response, that is, the difference between congruent and neutral trials (benefit). There was no difference between happy and neutral groups for overall benefit across both local and global trials, \( t(41) = 0.25, ns \), or for benefit from irrelevant global information on local trials, \( t(41) = 1.28, ns \). There was some suggestion that the happy group \( (M = -4.8, SD = 31.6) \) differentially benefited from irrelevant local information on global trials compared to the neutral group \( (M = 14.5, SD = 39.5) \); this difference approached significance, \( t(41) = 1.74, p = .089 \). Costs and benefits of distraction, organized by level of the distracting information, are displayed in Figure 4.
2.2.2. Arrow Flanker

As for the global-local task, we removed error trials and analyzed median RTs for correct responses only. Data from two participants in the neutral condition and one participant in the happy condition whose RTs were more than 3 SDs from the group mean were removed from the analysis. The mean error rates for the remaining participants in the neutral and happy groups were 2.0% ($SD = 2.7$) and 2.5% ($SD = 2.8$), respectively, which did not differ, $t(39) = .662, ns$.

Figure 5 illustrates the response times for each group according to type of stimulus. Once again, there were no differences in neutral RT between groups, $t(39) = 1.72, ns$. 

Figure 4: Global-local mean (+SE) costs and benefits of distraction: (a) global interference, or effect of irrelevant global information when responding to the local level, and (b) local interference, or effect of irrelevant local information when responding to the global level.
To determine the cost of distracting flanking information, we calculated the difference between RTs on incongruent and neutral trials (see Figure 6). The cost of distraction did not differ significantly between mood groups, $t(39) = 1.24$, $ns$, with the happy group ($M = 171$, $SD = 181$) no more slowed by the incongruent information than the neutral group ($M = 114$, $SD = 104$). To determine the benefit of congruent flankers, we calculated the difference between RTs on congruent and neutral trials. The benefit from distraction did not differ between the happy ($M = -27$, $SD = 31$) and neutral groups ($M = -38$, $SD = 38$), $t(39) = 1.01$, $ns$.  

Figure 5: Arrow Flanker mean (+SE) RTs according to group (neutral, happy) and trial type (congruent, neutral, incongruent).
2.2.3. Mood Manipulation Check

We compared mood ratings completed at the end of the task between the two groups. In contrast to the data from the pilot study, there was no difference between the happy and neutral conditions for either the PANAS Positive Affect scale \((M_s = 3.51 \text{ and } 3.77\) respectively), \(t(42) = .248, ns\), or our bipolar mood measure \((M_s = 2.84 \text{ and } 2.78)\), \(t(42) = 1.364, ns\). It is possible that this measure failed because it was given too long after the induction procedure.

2.3. Discussion

In this study, we attempted to induce positive and neutral moods to determine the impact of mood on the breadth of attention. Relative to a neutral mood group, individuals in an induced happy mood were more affected by distracting information on the global-local task, especially by the global information while doing the fine-grained task. This result is consistent with the idea that positive mood is associated with a heightened susceptibility to distraction, as previously demonstrated using a different task (Rowe et al., 2007).
Importantly, the difference in interference was not driven by group differences in overall RTs. We found mixed results regarding the global precedence effect: individuals in the happy condition were more affected by global level distraction compared to the neutral condition. However, while individuals in both the neutral and happy conditions responded faster to the global aspect of the stimulus, the magnitude of this effect did not differ among mood groups. This lends at least partial support to the idea that positive mood is associated with a more global bias in processing (Fredrickson & Branigan, 2005; Gasper & Clore, 2002); by using a different measure of attention to global versus local properties of a stimulus, our results suggest that this global bias occurs more specifically when the to-be-ignored global property interferes with responses to local details.

We did not find a parallel susceptibility to distraction among happy compared to neutral individuals for the arrow flanker task, despite the similarity of this task to the Eriksen flanker task used by Rowe and colleagues (2007). Since our tasks were completed in a fixed order, with the arrow flanker task later in the experiment, it is possible that the effects of the manipulation dissipated in the time required to complete the experimental tasks (Frost & Green, 1982; Isen, Clark, & Schwartz, 1976). Therefore, the influence of mood on cognitive processing may have been less evident once participants performed the arrow flanker task.

Although pilot data validated the mood manipulation, mood ratings in the current study did not yield differences between the happy and neutral mood groups. Participants gave their ratings following the experimental tasks, approximately 25 minutes after the mood manipulation. We administered the mood check at this time in order to minimize awareness of the purpose of the films and their connection with the cognitive tasks, as well as to avoid experimenter demand effects (Martin, 1990). In addition, requiring people to focus on how
they currently feel may have made individuals artificially more aware of their affect than they would naturally be (Isen, 1999). This awareness could potentially have caused participants to correct their behaviour for the effects of mood (e.g., McFarland, White, & Newth, 2003), thereby diminishing the effectiveness of the mood induction. However, in measuring mood 25 minutes after the induction, the transient nature of the mood induction may have meant that group differences in emotional state had diminished by the time of the mood measure.

3. Experiment 2

If happy people are more influenced by distraction, as suggested by some of the results of Experiment 1, would the distracting information that accesses the focus of attention be available for future use? Experiment 2 was conducted to test the hypothesis that individuals in a positive mood may show longer term consequences of increased distractibility. That is, not only does more irrelevant information reach the contents of working memory in individuals in a positive mood, but they may also have sustained access to this information.

To test this idea, we adapted the procedure used by Rowe and colleagues (2006), in which participants first performed a task with a series of pictures that are superimposed with to-be-ignored words or letter strings. After a filled interval, participants completed word fragments, some of which could be solved with the irrelevant words from the first task. Priming for the distracting information was taken as the proportion of fragments that were solved using the to-be-ignored words relative to baseline completion rates. If positive mood is associated with sustained activation of distracting information, then happy individuals should be more likely to use this information on the later task. Specifically, we hypothesized
that individuals who rate their naturally-occurring mood more positively would use more of
the previously distracting information to solve word fragments, compared to those in a more negative mood.

3.1. Method

3.1.1. Participants

Thirty-nine undergraduate students from the University of Toronto participated in the experiment. Three participants were replaced: one reported consciously looking at the words that subjects were instructed to ignore, and two participants were replaced due to technical difficulties. The remaining sample consisted of 36 participants (9 males, 27 females; \( M \) age = 19.67, \( SD \) = 2.28). The mean years of education was 13.51 years (\( SD = 2.15 \)). Subjects participated for course credit or received monetary compensation. Participants were tested at a central time of day (after 12 p.m.), and had a range of optimal circadian cycles, as determined by their score on the MEQ (Horne & Ostberg, 1976). All participants were native English speakers, or had learned English prior to the age of six.

3.1.2. Materials

Fifty-five line drawings, derived from Snodgrass and Vanderwart (1980), comprised the target pictures for the one-back task. Fifty of these drawings were superimposed with either random letter strings (\( n = 30 \)), filler words (\( n = 10 \)), or target words (\( n = 10 \)). The two lists of 10 target words were selected based on word-fragment completion norms collected previously at the University of Toronto (Ikier, 2005). The words were an average of six letters long, and the fragments had a completion rate of 0.11 among younger adults from the norming sample. In the word-fragment completion task used to test implicit memory for the distracting words, 30 total word fragments were used: 10 target words seen in the study
phase, 10 control words from the alternate list not seen in the study phase, and 10 filler fragments. All target and control fragments could be solved using multiple English words, but only one solution was presented in the experiment. Filler fragments all had high completion rates 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 & 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. Scores can be calculated on either pleasant-unpleasant or arousal-calm dimensions. For the pleasant-unpleasant scale, negative items (i.e., jittery, sad, fed up, grouchy, tired, drowsy, gloomy, nervous) were reverse scored and added to the sum of ratings for positive items (i.e., content, loving, peppy, happy, caring, lively, calm, active). Possible scores range from 16 (extremely unpleasant) to 112 (extremely pleasant).

3.1.3. Procedure

The experiment included a study phase, a filler task and a test phase, adapted from Rowe and colleagues (2006). During the study phase, participants viewed a sequence of 55 line drawings each presented in the centre of the computer screen for 1000 ms, with an ISI of 500 ms. In this one-back picture 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 was 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 version of the Corsi Block Test, a measure of spatial working memory (Corsi, 1972). This filler task lasted between 8 and 10 minutes, 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 3000 ms. They 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, 10 were filler word fragments, and 10 fragments were from the target list not seen by the participant. Solution rates from these 10 fragments served as baseline completion rates. 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 experiment, 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, so that any aware participants could be removed from the data analysis.

Following completion of the tasks, participants filled out the BMIS, MEQ, and Shipley vocabulary scales, and were debriefed about the purpose of the experiment.

3.2. Results

No participant reported any awareness of the connection between study and test phases. Accuracy was high for the picture task during the study phase: the mean error rate
was 2.2% ($SD = 5.4\%$). Priming scores for each participant were calculated as the difference between the proportion of correctly solved target fragments and the baseline completion for each list. Participants showed a mean priming level of 9\% ($SD = 13\%$) across lists. Participants solved a mean of 8.78 ($SD = 2.22$) of the 20 control fragments that they had not seen earlier in the experiment. Mean vocabulary score was 29.7 ($SD = 3.3$) out of 40, and participants had an average of 66.2\% correct ($SD = 18.3\%$) on the spatial working memory task.

Consistent with the predicted relation between positive emotional state and memory for distractors, there was a significant correlation between pleasant-unpleasant mood rating and priming ($r = .40, p < .05$; Figure 7). Thus, individual differences in mood accounted for 16\% of the variance in memory for distraction. The relation between positive mood and memory for distractors was not due to increased arousal; there was no relation between the arousal-calm scale and priming ($r = -.01, ns$).

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 performance on the task. Indeed, there was no relation between pleasantness of mood and number of the 20 control fragments (10 fillers, 10 control list fragments) that were completed with a plausible solution ($r = .00, ns$). The partial correlation between pleasant-unpleasant mood and priming remained significant while controlling for control fragment completion ($r = .40, p < .05$). Mood was also unrelated to spatial working memory performance ($r = .03, ns$), and vocabulary score ($r = .30, ns$).
3.3. Discussion

In this experiment, we tested whether positive mood was associated with the ability to use previously distracting information when it becomes relevant on a subsequent task. Indeed, pleasantness of mood was significantly correlated with priming for the distracting information. Furthermore, memory for distraction was unrelated to arousal. We also ruled out the possibility that positive mood was related to performance on the word fragment completion task itself; solution rates for control fragments were not associated with mood ratings. In addition, individual differences in memory for distraction were specifically related to pleasantness of mood, but not to either spatial working memory score or vocabulary. These results demonstrate an additional example of the potentially beneficial effects of distraction, this time in happy individuals. Positive emotional states may not only facilitate creativity by providing a wider scope of semantic access (Rowe et al., 2007), but also by
increasing the amount of incidental information extracted from the environment that may become valuable later on.

It is important to note that, since we computed correlations, the causal direction is not evident. It is possible that the effect acts in the alternate direction: people who have more relaxed inhibitory control feel happier, whereas successful inhibition results in a more negative mood. There is some evidence that inhibition can have negative emotional consequences: for example, subjects gave more negative affective ratings to stimuli that they had ignored on a previous task compared to previously attended or novel targets (Raymond, Fenske, & Tavassoli, 2003). However, considering that the results of Experiment 1 indicate that positive mood resulted in greater distractibility, it is likely that emotional state resulted in a wider scope of attention, with more distraction accessing the contents of working memory.

4. General Discussion

The results of Experiment 1 indicate that, compared to those in a neutral mood, individuals in an experimentally-induced positive mood were more susceptible to distracting information, particularly when it was global in nature. Furthermore, in Experiment 2, this distractibility had longer-term consequences: naturally-occurring pleasant mood was associated with greater use of previously irrelevant information on a later task. These results are consistent with the hypothesis that positive emotional state relaxes inhibitory control, resulting in a widened scope of attention (Rowe et al., 2007).

In the current study, we found increased susceptibility to distraction among individuals in both induced and naturally-occurring positive moods. The use of diverse measures of emotional state increases the generalizability of our findings to include both
transient, mild positive affect to longer-term states in daily life with no direct cause. It also
echoes methods used by other researchers in the positive emotion literature: for example, a
more global scope of attention has been associated with positive mood that is both induced
(Fredrickson & Branigan, 2005; Gasper & Clore, 2002) and naturally-occurring (Basso,
Scheffit, Ris, & Dember, 1996).

In Experiment 1, we found mixed evidence for the hypothesis that individuals in a
happy state have a more global attentional focus: this effect was specific to interference from
the global level, and not related to faster responses to the global level. To our knowledge, this
is the first study to examine local and global interference across different mood states. A
related line of research focuses on manipulating motivational rather than affective state to
compare approach and avoidance behaviour, or more specifically, actions related to acquiring
reward versus evading punishment. These studies suggest that approach behaviour, like
happy mood, prompts a focus on global form, whereas avoidance engenders local focus
(Derryberry & Reed, 1998; Derryberry & Tucker, 1994). In one study that used a similar
global-local RT measure, but which only included neutral stimuli (not allowing a measure of
interference), approach and neutral control groups had faster response times to global targets
compared to an avoidance group (Förster, Friedman, Özelsel, & Denzler, 2006). However,
paralleling our results, approach and neutral groups did not differ from each other. To the
extent that motivational state has similar effects on attention as affective state, it is possible
that including a third, negative mood induction group would have yielded group differences
in RT to local versus global targets.

At the same time, the relation between motivational and affective state is complex
and not completely understood. For example, induced positive emotional states that are high
in approach motivation (i.e., viewing a desirable dessert) elicit a less global attentional focus compared to low-approach positive affect (Gable & Harmon-Jones, 2008). Our study was concerned with affective valence, that is, the pleasantness or unpleasantness of mood that is not associated with a particular object. Since craving a desired object implies focusing on the goal object while ignoring goal-irrelevant stimuli, it is consistent with our hypothesis that approach behaviour directed at a particular object exerts effects on attention independently of affective state.

In Experiment 2, we found evidence of improved implicit memory for distraction in happy mood, reproducing an effect demonstrated in older adults and individuals tested at their nonoptimal time of day using the same task (Rowe et al., 2006). Aging and asynchrony effects are hypothesized to impair goal-driven attentional control that suppresses irrelevant information (Hasher & Zacks, 1988; Hasher et al., 1999, 2007). It is unclear whether happy individuals are less able to exert this effortful attentional control, or if a more passive broadening of attention allows them to incorporate more information from the environment. Another potential consequence of these results relates to emotional state and age. Older adults report a more positive mood, a finding that has been replicated across many studies (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Gross et al., 1997; Mroczek & Kolarz, 1998; Thomas & Hasher, 2006). Coupled with the aforementioned evidence that older adults are also more influenced by distracting information, it is possible that older adults’ positive mood contributes to this susceptibility to distraction. However, it is also conceivable that positive mood differentially interacts with distractibility in older adults. As the results of the current study are specific to younger adults, future investigation is needed to determine whether the same relation between positive mood and distractibility holds in older adults.
Increased distractibility with a positive emotional state contrasts with the observation that younger adults are typically very adept at ignoring irrelevant information. In the extreme example of inattentional blindness, younger adults neglect to notice unattended information even if it is presented at the centre of the visual field (Mack & Rock, 1998). In a neuroimaging study with a similar procedure to the one-back study task we used in Experiment 2, younger adults’ neural activity did not differentiate between the words and letter strings that they were instructed to ignore (Rees, Russell, Frith, & Driver, 1999). This was taken as evidence that younger adults do not process the unattended, irrelevant information. Similarly, Rowe and colleagues (2006) found that younger adults at an optimal time of day showed no implicit memory for irrelevant words. However, there is variability in distractibility among younger adults, and we have demonstrated that differences in emotional state are one source of this variability. Younger adults are also more likely to attend to irrelevant information at a nonoptimal time in their circadian cycle: when tested in the morning, evening-type younger adults showed an equivalent memory for distraction as the mean 9% priming for the same words in our study. Our sample included younger adults with a range of circadian cycles and who were tested at a central time (after 12 p.m.). Thus, one can conclude that a range of factors impact the effectiveness of attentional regulation in younger adults, with emotional state as a powerful influence.

The conclusion that happy mood increases distractibility is consistent with the idea that positive mood broadens attention (Derryberry & Tucker, 1994; Fredrickson, 2001). According to Fredrickson’s (2001) broaden-and-build theory, this broadening of cognition and behaviour promotes actions that have long-term benefits for the individual. 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 a wider breadth of 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). This interaction between emotional state, attention, and goal-directed behaviour fits with the proposal that emotion and attention are principal systems of prioritization in the brain (Fenske & Raymond, 2006). Specifically, emotional responses help to distinguish between beneficial and harmful aspects of the environment, while selective attention allocates processing to relevant information and suppress irrelevant information.

This study also ties findings that positive mood fosters creativity with evidence demonstrating the benefits of distractibility. Reduced inhibitory control, and therefore a widened scope of attention, may mediate the relation between positive mood and creativity. Indeed, creative and divergent thinking have been linked to reductions in the ability to screen out previously irrelevant information (Carson, Peterson, & Higgins, 2005). 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. Generative, creative thinking should be best when one is free to assimilate a wide range of information from the environment, and the present study shows that a happy, content mood means just that.
5. References


