Happiness by association: Breadth of free association influences affective states

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A B S T R A C T

Several studies have demonstrated that affective states influence the number of associations formed between remotely related concepts. Someone in a neutral or negative affective state might draw the association between cold and hot, whereas someone in a positive affective state might spontaneously form the more distant association between cold and sneeze. Could the reverse be true, that generating increasingly broad or narrow associations will put someone in a more or less positive affective state? We test this possibility by using verbal free association tasks, and asking whether the breadth of semantic associativity between cue words and generated responses might predict resulting affective states. Two experiments show that generating broader associations, regardless of their valence, changes affect; specifically, broader associations lowered negative affect and marginally increased positive affect over time. These findings carry implications for theories positing interactions between brain areas mediating associative processing and affect, and may hold promise for enhancing affect in clinical contexts.

1. Introduction

Our emotional states can wield a powerful influence over our mental processes. Several studies have demonstrated a relationship between affective state and the nature and scope of connections we draw between concepts in memory. Specifically, increases in positive affect lead to broad, associative processing, whereas decreases in positive affect lead to more constrained thought. For instance, inducing positive affect in laboratory settings promotes relational processing (Storbeck & Clore, 2005), creativity (Mednick, Mednick, & Jung, 1964), and the production of broadly related words in free association tasks (Isen, Johnson, Mertz, & Robinson, 1985). Conversely, inducing sadness leads to item-specific processing (Storbeck & Clore, 2005), and depressed individuals show restricted contextual processing and narrow ruminative thinking (Msetfi, Murphy, Simpson, & Kornbrot, 2005). Various evolutionary and functional perspectives have been proposed to account for such effects; it is generally thought that negative affect narrows the scope of mental processing in an attempt to evaluate potential threats, and positive affect broadens its scope and iteratively builds upon positive affective states (Baddeley, 1972; Fredrickson, 2004).

Bar (2009) proposed that the opposite relationship may also exist, namely that broad, progressive associative processing might encourage positive affect. Notably, this hypothesis highlights the overlapping brain networks implicated in both associative processing and affective
experience (Shenhav, Barrett, & Bar, in press), and suggests that dysregulation in these networks might underlie some symptoms accompanying mood disorders like depression. For instance, the ability to draw associations between items (or between items and contexts) relies upon neural structures in the medial temporal lobes (MTL), including the hippocampus and parahippocampal cortex (Eichenbaum, 2000; Rolls, 1996). These associative MTL brain regions have been implicated in mood disorders such as depression; putative reductions in hippocampal grey-matter volume have been observed in major depression (e.g., Bremner et al., 2000), whereas successful antidepressant treatments have been shown to increase neurogenesis in the dentate gyrus (DG) of the hippocampus (Malberg, Eisch, Nestler, & Duman, 2000). Further, induced genetic DG neurogenesis in mouse models can improve contextual learning and promote anti-depressant-like behaviors (Sahay et al., 2011). However, the precise link between affect and associations remains unclear, and direct evidence for a bi-directional relationship remains largely unexplored.

Some indirect behavioral evidence supports the view that associative processing might influence affect; specifically, a narrowing of conceptual scope is related to increased negative affect. For instance, healthy individuals tasked to ruminate on restricted topics and events tend to develop negative affective states (Segerstrom, Tsao, Alden, & Craske, 2000), and the degree of rumination predicts the depressive symptoms accompanying several clinical disorders (Nolen-Hoeksema, 2000). Though this work provides some indirect evidence for narrowed processing increasing negative affect, truly reciprocal relationships between affective states and associative processing would also predict affective enhancement as a result of promoting broad associative processing.

To examine this possibility, we conducted two experiments. In the first, participants completed a free association task and we measured the semantic breadth of their generated word relative to each cue. We predicted that participants who produced increasingly broad associations over the course of the experimental session would report higher levels of positive affect at the end of the session. The practice phase presented five example trials, and affect less positive (\(t = .09; p > .05\)).

2. Experiment 1

2.1. Method

Forty-eight Tufts University undergraduates (28 female; \(M_{\text{age}} = 20\)) participated for monetary compensation. In order to help equate baseline affective state across participants prior to beginning the free association task, participants first viewed one of two 5-min neutrally-valenced (as determined via pilot ratings; \(N = 12\)) films. Each participant then completed a brief practice phase, and then completed the experimental phase.

The practice phase presented five example trials, and the experimental phase presented participants with a total of 175 trials separated into five 35-trial blocks. During each trial, a single cue word appeared in the center of the screen above an empty textbox, and participants were asked to “type the first word that comes to mind.” Cues were chosen by extracting a pool of neutral (\(M \pm 1SD\)) valence and arousal words from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) database; and then using the Medical Research Council (MRC; Coltheart, 1981) psycholinguistic database to restrict the cues to only nouns, adjectives and verbs that were 3–6 characters in length, 1–3 syllables, and of moderate imageability, frequency and familiarity (e.g., barn, coach, dream, supply).

Following each block of 35 trials we administered the Positive and Negative Affect Schedule-Short Form (PANAS-SF), which involves rating 10 adjectives on a 1–5 scale to indicate feelings at that moment. We separately assessed positive and negative affect by averaging the affect-specific PANAS-SF adjectives.

2.2. Experiment 1: Results

We computed associative strength between each generated word and its cue using the Latent Semantic Analysis document-to-document approach (LSA: Landauer, Foltz, & Laham, 1998), which mathematically quantifies meaning similarity of words by analyzing large bodies of text. In LSA, higher associative strengths indicate narrower associations (e.g., RACE \(\rightarrow\) win, \(LSA = 0.65\)) and lower associative strengths indicate broader associations (e.g., RACE \(\rightarrow\) rat, \(LSA = 0.02\)). Generated words that did not appear in the LSA database were excluded from analyses (1.3% of all responses). Valence of generated words was gathered from the ANEW database; for words not included in the database, further ratings were collected from an independent set of raters (\(N = 10\)) using Bradley and Lang’s (1999) 9-point self-assessment manikin (SAM) procedure.

On average, participants generated words varying widely in LSA-based associativity to provided cues (\(M = .15, SD = .04; range .02–.53\)). In general, from blocks 1 to 5, associations tended to become narrower (\(M_{\text{block}5-\text{block}1} = .03; range −.09 to .12\), and affect less positive (\(M_{\text{block}5-\text{block}1} = −.046; range −1.4 to 0.4\)).

We conducted two multiple regressions (see Fig. 1a and b), one assessing change in positive affect and the other change in negative affect (block 5–block 1) as dependent measures. Each model included three predictors: (1) change in breadth of generated associates over that period (block 5–block 1), (2) baseline positive or negative affect (respectively), and (3) change in average valence of words generated (block 5–block 1). The first model, examining positive affect, produced an \(R\) value of .34; of the three predictors, only the difference in breadth of generated associates reached significance, \(\beta = −.295, t(44) = 2.08, p < .05\) (baseline affect, \(\beta = −.14\); valence of generated words, \(\beta = .086\)). The second model, examining negative affect, produced an \(R\) value of .37; breadth of generated associates reached marginal significance, \(\beta = .25, t(44) = 1.69, p = .09\).
(baseline affect, $\beta = -0.193$; valence of generated words, $\beta = 0.01$). Two robust regressions (using Huber weighting) intended to reduce the influence of outlier data points replicated this pattern ($t = -2.02, t = 1.75$, respectively).

### 2.3. Experiment 1: Discussion

Our first experiment aimed to assess whether changes in breadth of processing during a free association task would result in alterations in subjective affect. Overall, generating increasingly broad associates over the course of the five experimental blocks led to decreased negative affect and marginally increased positive affect. Critically, these effects could not be explained by differences in baseline affect or as a result of the generated associates themselves being more positive or negative. However, the present experiment did not explicitly manipulate the breadth of associative processing, and thus we cannot rule out the possibility that the observed effects might be attributable to individual propensities towards generating broad associations or adopting positive affective states. Our second experiment provides a more powerful test of our hypothesis by experimentally manipulating whether participants would be associating broadly or narrowly at a given point in the experiment.

### 3. Experiment 2: Introduction

In this experiment, cue words were selected from the set used in Experiment 1 based on their tendency to elicit (a) a greater number of unique responses, and responses that were generally remotely associated with the cue word (i.e., broad), or (b) fewer unique responses, and responses that were generally closely related to the cue word (i.e., narrow). If generating broad associations supports positive affect, then participants should show increased positive affective states following the generation of broad versus narrow associations.

#### 3.1. Experiment 2: Methods

Forty-eight participants volunteered for this study (31 female; $M_{\text{age}} = 20.1$). Two sets of cue words were selected from Experiment 1 data, using the 50 words that, on average, elicited the broadest associations (e.g., card, school, wonder; $M_{\text{LSA}} = 0.08, SD_{\text{LSA}} = 0.11$) and greater unique responses across participants ($M = 42\%$ unique, $SD = 11.7\%$), and 50 that elicited the narrowest associations (e.g., answer, male, silver; $M_{\text{LSA}} = 0.34, SD_{\text{LSA}} = 0.28$) and fewer unique responses ($M = 32.5\%$ unique, $SD = 13.9\%$) (all $p$’s < .01). The two sets of cue words were equated in mean cue valence ($M_{\text{broad}} = 5.67, M_{\text{narrow}} = 5.94, p > .05$) and produced associates with equated mean valence in Experiment 1 ($M_{\text{broad}} = 5.71, M_{\text{narrow}} = 5.69, p > .05$). Each participant completed a brief practice session and then two blocks of 50 free association trials, one designed to elicit broad and one narrow associations (in counterbalanced order across participants). Prior to each block participants viewed one of the two neutral videos. Prior to and following each block participants completed the PANAS-SF.
A 10-min break was placed between the two blocks. All other methods matched those of Experiment 1.

3.2. Experiment 2: Results

3.2.1. Manipulation checks

On average, participants generated words varying widely in LSA-based associativity to provided cues ($M_{narrow} = .37, SD_{narrow} = .08; M_{broad} = .09, SD_{broad} = .03$); this pattern was present in all 48 participants. Furthermore, across participants there were fewer unique words generated in response to the narrow versus broad cues, $t(47) = 5.93, p < .01, d = .86$ ($M_{narrow} = 28\%$ unique, $SD_{narrow} = 9.8\%$; $M_{broad} = 38\%$ unique, $SD_{broad} = 10.7\%$); this pattern was present in 40 of the 48 participants. Thus, the broad context generally elicited a wider range of responses that were more distantly associated with the cues. Finally, using ANEW norms complemented with data from an independent set of rater ($N = 10$), the valence of generated words was similar across the two conditions ($M_{broad} = 4.89, SD_{broad} = .45; M_{narrow} = 5.16, SD_{narrow} = .44$).

3.2.2. Affective changes

As in Experiment 1, affect became generally less positive across the experimental session ($M_{post-pre} = -0.40$; range $-2.2$ to $0.8$). Two simple-effects ANOVAs showed that participants developed more positive affect (comparing post–pre) following the generation of broad versus narrow associates, $F(1, 47) = 15.52, p < .01, n^2 = .25$ (see Fig. 2, Panel A), and marginally lower negative affect following the generation of broad versus narrow associates, $F(1, 47) = 3.03, p = .09, n^2 = .06$ (see Fig. 2, Panel B). These effects did not vary as a function of block order ($p_{min} = .25$).

We also conducted one-way $t$-tests to assess whether mean affect changes varied from zero, which revealed decreased negative affect in the broad condition (net positive), $t(47) = 2.59, p = .01$, and decreased positive affect in the narrow condition (net negative), $t(47) = 3.52, p < .01$. The other two conditions did not differ from zero ($p_{min} = .23$).

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4. Discussion

Decades of research have demonstrated a unidirectional link between induced positive affective states and increased processing breadth in tasks eliciting global/relational processing, creativity, and distal semantic associations (Gasper & Clore, 2002; Isen et al., 1985; Mednick et al., 1964; Storbeck & Clore, 2005). We tested the reverse prediction, namely that associative processing could influence affective state. Experiment 1 showed that individuals who tended to generate increasingly broad associations to a provided cue were more likely to show decreases in negative affect and marginal increases in positive affect over the course of the experiment. Conversely, those who generated increasingly narrow associations showed the opposite. Experiment 2 replicated this pattern by actively manipulating the breadth of associative processing across experimental blocks. Specifically, though we note that overall affect decreased throughout the experimental session, generating broad associations supported overall positive affect by marginally increasing positive affect ratings and significantly decreasing negative affect ratings. Generating narrow associations, however, significantly decreased positive affect ratings.

Csikszentmihalyi (1990) proposed that positive affect, creativity and insightful thinking can be enhanced when individuals become highly motivationally engaged in a task. As part of this process, it is proposed that during these intense periods of engagement thinking progresses across contexts, a concept he referred to as flow. A recent experimental test of whether mental progression influences affect showed some evidence of mild affect enhancement when participants read word lists that progressed across contextual barriers (Mason & Bar, 2011). This work complements earlier findings demonstrating reduced affect resulting from rumination or repetitiveness (Pronin & Jacobs, 2008; Segerstrom et al., 2000). However, it does not provide direct evidence that self-generating broad versus narrow associations will increase positive affect.

We provide unique evidence that spontaneously producing broader associations to a verbal cue can decrease negative affect and provide a mild boost to positive affect, resulting in net increases to positive affect. Of course, this interpretation rests strongly on theories positing that affective valence exists along a bipolar continuum ranging from negative to positive (e.g., Lang, Greenwald, Bradley, & Hamm, 1993); as such, decreases in negative affect are indicative of positive affect increases. We note, however,

Table 1

<table>
<thead>
<tr>
<th>Cue word</th>
<th>Generated word (freq., LSA)</th>
<th>Generated word (freq., LSA)</th>
<th>Generated word (freq., LSA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow: answer</td>
<td>Question (31, .84)</td>
<td>Call (4, .14)</td>
<td>Response (2, .10)</td>
</tr>
<tr>
<td>Narrow: male</td>
<td>Female (30, .96)</td>
<td>Man (7, .00)</td>
<td>Boy (2, .00)</td>
</tr>
<tr>
<td>Narrow: silver</td>
<td>Gold (27, .87)</td>
<td>Dollar (5, .41)</td>
<td>Shiny (2, .38)</td>
</tr>
<tr>
<td>Broad: card</td>
<td>Game (7, .02)</td>
<td>Birthday (5, .13)</td>
<td>Deck (3, .07)</td>
</tr>
<tr>
<td>Broad: school</td>
<td>Bus (8, .20)</td>
<td>House (4, .04)</td>
<td>Work (3, .01)</td>
</tr>
<tr>
<td>Broad: wonder</td>
<td>Woman (6, .06)</td>
<td>Think (4, .24)</td>
<td>Bread (4, .04)</td>
</tr>
</tbody>
</table>
that there is some evidence that individual emotional states such as happiness or sadness may be independent psychological states reliant upon separable neurocognitive mechanisms (Barrett, 2006); under these theories, emotional states carry important motivational characteristics (e.g., approach, avoidance) that drive cognition and behavior. In Bar’s (2009) hypothesis, he proposes that increased associative processing might facilitate more predictions about future events, thereby reducing uncertainty and related anxiety. Along these lines, Kagan (1972) proposed that resolving uncertainty is a primary human motive with benefits to adaptive outcomes. Indeed lower tolerance or readiness for uncertainty has been associated with several mood disorders such as generalized anxiety (Holaway, Heimberg, & Coles, 2006), and panic disorder (Dugas, Marchand, & Ladouceur, 2005). Higher uncertainty also leads to more negative interpretations of ambiguous information (Heydayati, Dugas, Buhr, & Francis, 2003), and increased estimations of aversive events (Sarinoopoulos et al., 2010). Increasing the breadth of associative processing may reduce feelings of uncertainty – and related negative affect – by providing more predictions about the future, perhaps guided by motivational states reinforcing approach-oriented behavior (Förster, Friedman, Özelsel, & Denzler, 2006).

The dopaminergic reward system is also sensitive to predictive advance information about uncertain outcomes; midbrain dopamine neurons may signal the value of information about subsequent events, serving to motivate the exploration and learning of the surrounding environment (Bromberg-Martin & Hikosaka, 2009). Similarly, generating new and/or broader associations could provide the information necessary to make predictions within varied contexts (Bar, 2007), thereby attenuating uncertainty, and perhaps also triggering the release of midbrain dopamine. Offering evidence for this prediction, an intriguing study by Shohamy and Wagner (2008) showed that drawing associations between separate episodes (i.e., generalizing knowledge across prior events) is correlated with activation in both hippocampus and midbrain dopamine regions. In this sense, the act of making novel associations in itself may be rewarding.

In his original article, Bar (2009) proposed testable predictions regarding the potential therapeutic value of developing experimental methods for broadening the scope of associative processing. Over time, he proposed that a therapeutic promotion of associative processing might result in long-term therapeutic value of clinical relevance, we find it promising that promoting broad associative processing resulted in increasingly positive affect among healthy individuals. Notably, the observed affect changes did not require generating more positive or less negative associations, but instead were dependent upon the semantic breadth of the associations. Future work will examine the transient and prolonged affective influences of processing breadth in the healthy and clinically depressed.

In sum, we provide evidence that encouraging broad versus narrow associative processing results in relatively positive affective states during a brief experimental session. These results speak to theorized relationships between associative processing and affect, and further suggest therapeutic practices to promote processing breadth and, potentially, mood.

Acknowledgements

We thank Moshe Bar for helpful feedback on an earlier version of this manuscript, and Eiran Vadim Harel for helpful comments regarding this research.

References


Note that whereas some suggest that the relationship between approach-related positive affect and increases in global processing is “one of the most robust and widely confirmed findings in the affect literature” (Isen, 2002, p. 57), others suggest that the relationship is more complex than previously thought and guided by the strength of the approach motivations associated with the positive mood state (Gable & Harmon-Jones, 2010).
annual convention of the association for advancement of behaviour therapy, Boston, MA.


