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The Influence of Emotional Valence in Backward Masking: Evidence For Early Appraisal

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Abstract

Three experiments are presented that examine the influence of Emotional Valence and Familiarity of visually presented lexical stimuli on low-level visual processing. The results provide support for the idea that an early process of automatic appraisal acts to preferentially direct attentional resources to Negative or Novel stimuli. The results are discussed with respect to evolutionary considerations.

Introduction

A number of recent studies have demonstrated that emotion can influence relatively automatic cognitive and perceptual processes in several ways. For example, Pratto & John (1991) showed that undesirable trait words captured processing capacity away from a primary task more effectively than did desirable trait words. In their study they used a modified version of the Stroop task (1935); subjects were asked to name the color of ink in which positive and negative trait adjectives were printed. Subjects responses were slower with negative adjectives than they were with positive adjectives. The authors attributed this effect to a process that they called *Automatic Vigilance*. This process evaluates stimuli on a positive-negative dimension and directs attention preferentially to negative or aversive stimuli.

Niedenthal & Setterlund (1994) demonstrated an emotion-perception congruity effect that is also consistent with claims that affective state can influence cognitive or perceptual processing. In their studies, subjects first underwent an emotion induction procedure, and then were asked to make lexical decisions to words that were either positive (Cheer, Joy) or negative (Weep, Despair) in their affective tone. The finding was that words that were consistent with an induced emotion were verified more quickly than words that were inconsistent with the induced state. In a similar study, Halberstadt, Niedenthal, & Kushner (1995) demonstrated a mood-consistency effect when the task was to disambiguate auditorially presented homographs in which one member of the pair was either Happy (rose-rows) or Sad (die-dye). Subjects underwent a mood induction procedure, either happy or sad, and then were presented auditorially with the list of homographs. Their task was simply to print what they heard. Subjects in the positive and negative induced mood condition did not differ in the proportion of happy resolutions (selection of one or the other spellings) of the homographs, but subjects in the negative mood condition selected a higher proportion of negative alternatives than did subjects in the positive condition. This result is consistent with a number of other findings suggesting that the effect of negative emotion, whether in terms of presented stimuli or affective state, is more pronounced than that of positive emotion (cf. Frijda, 1988; Schwarz, 1990). The results of these three studies suggest that mood can influence perceptual and cognitive processes. Finally, in recent years, Zajonc and others have collected data that speaks to the current issue in an oblique way (Kunst-Wilson, W., & Zajonc, R., 1980; Zajonc, 1984) Their conclusion, based on the findings of a large number of studies, is that affective reactions can occur at levels of stimulus intensity and exposure duration that seem to preclude the possibility of prior cognitive appraisal, this proposal is known as *Affective Primacy*.

Why should emotion influence low level processes? It's reasonable to assume that the ecological utility of directing attention to negative events as quickly as possible is high. Negative events or stimuli call for behavioral change, while positive events favor maintaining the status quo. This state of affairs is exemplified in the gambler's aphorism "Win stay, lose switch". There are two distinct ways that the attentional processing called for by negative and positive events might differ. First, negative events might simply call for more or faster processing with the "aim" of discovering as quickly as possible the potentiality of a particular stimulus or situation, a strictly quantitative change. It is also possible that a more analytic or focused style of attention might be called for by negative stimuli because of the value of identifying the exact attribute or attributes that creates the aversive state associated with them. Easterbrook (1959) presents data in support of this possibility. This account of attentional demand depends more on qualitative than quantitative changes in attention, but obviously might involve both if heightening focal attention has some cost associated with it. These studies address a venerable question about the relationship between emotion and perceptual or cognitive processes, "Which comes first, emotional or cognitive evaluation?"

It's not clear that a simple answer to that question is likely to be reached, perhaps because of the difficulty of defining the terms emotion and cognition, or because the claim that one process or the other is always first is overstrong. A reasonable conclusion is that emotional evaluation, of at least a general type, can take place very early and influence the results of subsequent processing. Of the studies we reviewed, Pratto & John's (1991) lends the greatest support to the idea that the direction of attentional resources to negative stimuli is automatic. Color naming, however, is a task that seems to depend on a relatively high degree of processing. And although there is some debate regarding the locus of interferencein the Stroop task (1935) a great deal of evidence suggests that the slowing that is typically observed results largely from competition at the level of response selection or output (Keele, 1972; MacLeod, 1991). Response selection is relatively late in the stage of cognitive events. In the present paper we present data from several experiments that demonstrate an automatic effect of negative and positive emotion words at a much earlier stage through a novel application of the backward masking procedure.

Capacity Demands of the Mask

Ohnesorge & Theios (1996) showed that visual recognition under backward masking is sensitive to the processing demands of the masking stimulus. In those studies, which were directed at the question of how a backward mask affects target recognition, subjects were asked to identify words that were in turn masked by other words. Characteristics of the masking words such as printed word frequency (familiarity) and repetition (recency) were manipulated and shown to affect the ability of subjects to identify a briefly presented target word. We assumed that with greater familiarity, i.e. higher printed frequency, the demand for whatever processing resources are necessary for word recognition is reduced. This assumption is supported by a large number of studies that employ a broad range of data collection techniques from the duration of eye-fixations during reading (Henderson, J., & Ferreira, F., 1990) to lexical decisions under dual task conditions (Herdman, C.M. 1992). We further assumed that repetition of a lexical stimulus is another way to manipulate its demand for processing resources that is distinct from its overall frequency of occurrence. This conclusion is supported by a large body of research findings (Theios & Walter, 1973; Scarborough, Cortese, & Scarborough, 1977; Forster & Davis 1984). Together, these manipulations affect a relatively stable index of processing demand (frequency)and a transient influence (repetition). In Experiment One Low Frequency masking words were more effective than High Frequency. In Experiment Two we factorially combined Frequency and Repetition. The findings of interest in that study were 1.) A replication of the Frequency effect, 2.) demonstration of an analogous effect with repetition, 3.) No interaction betwen the factors. Our conclusion was that backward masking appeared to influence target recognition through siphoning off sufficient resources to support recognition of the mask, with target recognition dependent on the remainder. We characterized this as a Capacity Sharing model of masking.

In the present research we simply invert the logic of those studies and assume that the task of word recognition under backward masking can be used to probe for effects of emotion on perception. Of course this strategy requires that we hold constant, or manipulate, factors such as the word frequency or repetition of our positive and negative masking words. By manipulating the emotional valence (e.g. Positive vs. Negative) of words that are used as masks and looking for differential target recognition performance we can ask the question: "Do negative and positive emotion words make equal demands for attentional/processing resources?" Any difference that occurs under masking by Positive and Negative emotion words provides support for the notion that emotional meaning is evaluated, or at least exerts an influence, very early in perceptual processing. The exact locus of this effect may be difficult to establish with complete precision, but it seems reasonable to assume that it would be at a far earlier stage than the interfering effectsof negative trait adjectives demonstrated by Pratto & John (1991) in response competition. There is, of course, a theoretical reason to predict that words referringto negative or threatening events should be more effective at capturing attention resources than stimuli that refer to positive or non-threatening events. That reason is the asymmetry between a subject's appropriate response to the two situations. A consideration of survival fitness or evolutionary pressure suggests that there is a strong pressure to evaluate negative events as soon as possible, whether to respond through decisive action or withdrawing from potential harm. In contrast, it can be argued that positive events evoke no such heightened attentional processing, as there is little pressure for behavioral change. It is this differential demand for processing capacity between negative and positive events that ought to lead to the allocation of greater attentional resources to negative stimuli, and as a result, more effective masking.

Experiment One

Subjects

27 subjects participated in return for course credit. All subjects had normal or corrected vision.

Design

The Emotional Valence of the masking words with two levels (Positive, Negative) was manipulated within subjects.

Stimuli

The masking stimuli were sets of Positive and Negative Emotion words selected through a pilot study (n = 50) in which subjects rated a set of candidate words on a nine-point Negative-Positive emotion dimension. The individual items within the sets were closely matched on frequency (Means for Positive and Negative = 94 & 98 respectively), Number of letters (Means for Positive and Negative = 4.4 & 4.3 respectively), and number of syllables (Means for Positive and Negative = 1.18 & 1.13 respectively). In each case, the inevitable small differences were in the direction of reducing the processing demand of the negative set. There were 40 words in each of the valenced sets, and 80 Neutral word filler items. The target stimuli were a set of 216 pairs of low frequency words that differed in a single letter (e.g. DINE, DIME). The location, within the words, of the substituted letter was varied to preclude strategic attention to a single location. On each trial one of the pair was randomly selected and presented as the target; the other word then became the foil in the response phase.

Apparatus

The experiment was designed and conducted using the software program PsyScope (Cohen, MacWhinney, Flatt & Provost, 1993). A Power Macintosh 7200 controlled the display sequence and collected the data.

Procedure

Subjects initiated each trial of the experiment by pressing the spacebar. Each trial was as follows. First a fixation cross was presented for 300 milliseconds. Following a 300 ms blank interval the target word was presented for 13.3 ms,. After a 40 ms interstimulus interval (ISI) the masking stimulus was presented for 26.6 ms. A further 300 ms. interval passed and then subjects were presented with the choice alternatives. Each choice alternative was a pair of low frequency words. One had just been presented as the target and the other served as a foil. The subjects indicated which of the pair they believed they had seen by pressing keys that corresponded to the positions of the two stimuli on the monitor; "z" for left, and "/" for right. The experimental session comprised a practice block of 25 trials followed by 160 experimental trials: 40 each under masking by Positive and Negative Emotion words, and 80 filler trials with Emotionally Neutral words. Feedback, in the form of tones, was provided following each trial of the practice and experimental blocks.

Result

Each subject's percentage of correct target recognitions was calculated for the Positive and Negative conditions. The average percent correct under masking by Negative words was 62 percent Vs 67 percent for the Positive masks. A paired samples T-test revealed that the Negative emotion words were more effective masks than the Positive emotion words, $T(26) = 2.7$, $p < .05$. In other words, target recognition performancewas poorer when the mask was a Negative Emotion word. Conversion of the T statistic to a point biserial correlation coefficient revealed that Emotional Valence produced a medium sized effect, $r_{pb} = .46$.
The means can be seen in figure 1.

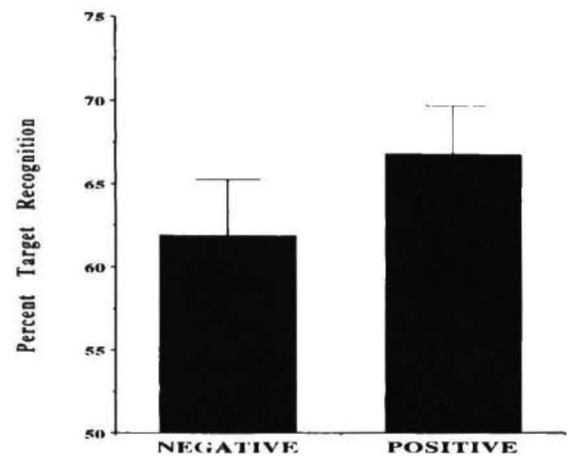

Figure 1; Target recognition under masking by Negative and Positive Emotion Words.

Discussion

This result strengthens and extends the conclusion reached on the basis of emotion congruency effects (Halberstadt, Niedenthal, & Kushner, 1995; Niedenthal & Setterlund, 1994) and the demonstration of automatic vigilance (Pratto & John, 1991). There is very little chance that bias or strategic influence plays a role in our finding that emotional valence can influence the task of word recognition. The fact that negative emotion words are more effective as masks than positive words supports the conclusion that they demand more attentional or processing resources. Given that subject's success in target recognition depends on their ability to ignore or inhibit the mask, we conclude that our results speak strongly in favor of *automatic vigilance* as suggested by Pratto & John (1991). Further, our use of a 2afc design and tight stimulus control motivate the conclusion that the emotion valence of our lexical stimuli is affecting target recognition performance via perceptual sensitivity, as there is little opportunity for bias to influence subject's selection in the choice phase. Subjects simply cannot identify the target as well when a Negative Emotion mask's higher demand has limited the available capacity. One question raised by this finding is whether the Emotional Valence effect is coextensive with the Familiarity effectexplored by Ohnesorge & Theios (1996). The same argument can be applied to each situation. There is greater ecological utility in attending to potentially threatening events, whether due to the ambiguity inherent in novelty or the specific threat of a Negative stimulus, than in attending to their more benign counterparts. Our next study explores the relation between Familiarity and Emotional Valence with regards to the *Automatic Vigilance* hypothesis.

Experiment Two

In our previous experiments (Ohnesorge & Theios, 1996) we investigated differential demands for processing resources through manipulations of familiarity, indexed via the printed word frequency of the masking stimuli, and recency, indexed via mask repetition. Those studies showed that manipulations of frequency and recency of the mask exerted separate and independent influences on target recognition. In Experiment Two we explore a factorial combination of mask frequency and emotional valence to ask the question Do familiarity and emotional valence make separate and independent contributions to masking? Several issues can be addressed through this study. For example, it is possible that negative emotion and novelty (unfamiliar or low frequency words) are not distinguished in the early evaluation process. This would predict that separate effects of Frequency and Valence would not manifest together. Assuming that these effects do occur in conjunction, we can assess their independence through the presence or absence of an interaction.

Subjects
The subjects were 60 undergraduates who participated in return for course credit. Each had normal or corrected vision.

Design
There were two within subjects variables with two levels each: Frequency of the masking words (High, Low) and Emotional Valence of the masking words (Positive, Negative).

Stimuli
The stimuli were collected by asking subjects (n = 50) to rate 216 candidate words for emotional valence negative items were those that received ratings < 4 and Positive > 6 on our nine point scale. We then sorted them into categories based on the third index of the Kucera & Francis (1967) corpus (i.e. number of samples containing the item). High Frequency items were defined as $\geq$ 50 samples, and Low Frequency $\leq$ 25 samples. In addition we controlled for number of letters and syllables to closely equate the spatial and featural properties of the various sets.

Apparatus
The experiment was designed and conducted using the software program PsyScope (Cohen, MacWhinney, Flatt & Provost, 1993). A Power Macintosh 7200 controlled the display sequence and collected the data.

Procedure
The subjects were seated 300 mm from the computer monitor. After receiving instructions they completed 20 practice trials and then 216 experimental trials. The sequence of events was as follows. Subjects pressed the spacebar to initiate each trial. A fixation cross was presented for 300 ms, followed by the target word which remained on the screen for 13 ms. Following a 40 ms blank interval the mask was presented for 27 ms. After a 300 ms interval the choice alternatives (target and foil) were presented until subjects indicated their choice. Feedback was presented on each trial.

Results
Mean target recognition percentage for each condition was computed for each subject and submitted to an ANOVA. The main effect of Valence was significant, $F(1,59) = 6.0$, $p < .05$. The measure of effect size epsilon revealed a medium sized effect, $\varepsilon = .28$. The main effectof Frequency was also significant, $F(1,59) = 12.3$, $p < .05$. Epsilon again revealed a medium sized effect, $\varepsilon = .40$. The interaction of Valence and Frequency was not significant, $F(1,59) = .168$. The means of the subjects analysis can be viewed in figure 2.

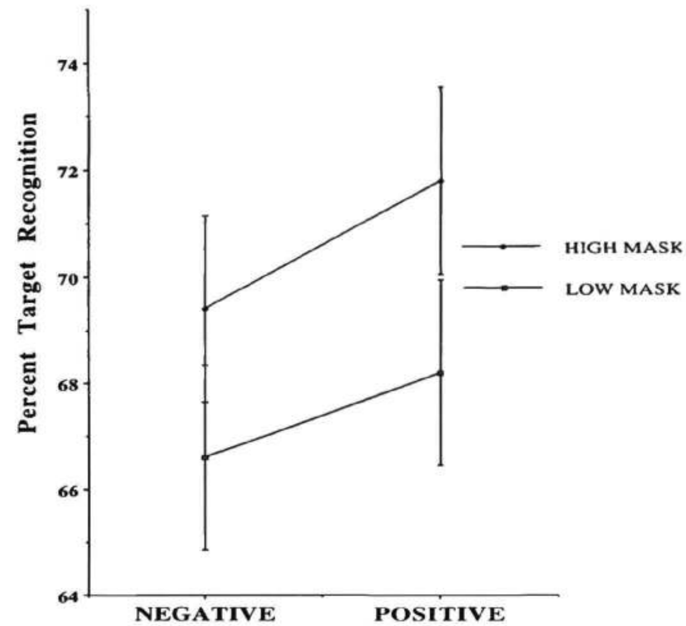

Figure 2: The independent influences of Emotional Valence and Frequency of the masking word on Target recognition.

Discussion
The results of Experiment Two show that familiarity and valence make separate and independent contributions to the backward masking effect. This precludes the possibility that Frequency (familiarity) and Emotional Valence are treated equivalently by the automatic appraisal process. The lack of an interaction between these factors suggests that the allocation of attention, at least with respect to these dimensions, is automatic and not graded by consideration of other present stimulus attributes, i.e. it is not strategic. Further data relevant to the examination of these related questions would result from a joint manipulation of Repetition and Valence, the subject of Experiment Three.

Experiment Three

Subjects
The subjects were 31 undergraduates who participated in return for course credit. Each had normal or corrected vision.

Design

There were two within subjects variables with two levels each: Emotional Valence (Positive, Negative) and Repetition condition (Repeated, Non-Repeated).

Stimuli

The stimuli were collected by asking subjects (n = 50) to rate 216 candidate words for emotional valence negative items were those that received ratings < 4 and Positive > 6 on our nine point scale. We controlled the featural level similarity of our Positive and Negative sets and the similarity of each masking set to the choice alternative set very carefully. We assessed our degree of control by counting the frequency of occurrence of each letter (A-Z) at each of the 5 possible positions for our masking sets and the 4 positions in our choice alternative set and conducting an overall correlational analysis on the resultant frequencies. Our control was very good, r (averaged across positions) for the Positive and Negative sets was .85. More importantly, the Positive and Negative masking sets were equally similar to the choice alternative set, r = .73 and .74 respectively.

Apparatus

The experiment was designed and conducted using the software program PsyScope (Cohen, MacWhinney, Flatt & Provost, 1993). A Power Macintosh 7600 controlled the display sequence and collected the data.

Procedure

The subjects were seated 300 mm from the computer monitor. After receiving instructions they completed 25 practice trials and then 160 experimental trials. The sequence of events was as follows. Subjects pressed the spacebar to initiate each trial. A fixation cross was presented for 300 ms, followed by a preview word that remained on the screen for 1 second. A 1 second refractory period was allowed to pass and then the target-mask-choice sequence analogous to Experiments One and Two occurred. For Repeated Trials the Preview stimulus was the mask that would appear later in the sequence of events, for Novel trials the Preview stimulus was a Neutral Valence word that did not appear again in the sequence of events. Feedback was presented on each trial.

Results

Mean target recognition percentage for each condition was computed for each subject and submitted to an ANOVA. The main effect of Valence was significant, $F(1,30) = 9.5$, $p < .05$. The measure of effect size epsilon revealed a large sized effect, $\varepsilon = .47$. The main effect of Frequency was also significant, $F(1,30) = 21.3$, $p < .05$. Epsilon again revealed a large sized effect, $\varepsilon = .63$. The interaction of Valence and Frequency was not significant, $F(1,30) = .216$. The means can be viewed in figure 3.

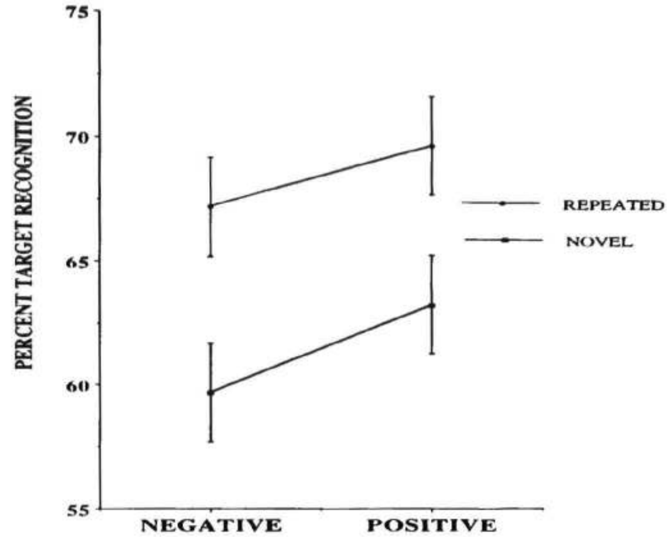

Figure 3: The effects of Emotional Valence and Repetition of the masking stimulus are independent.

Discussion

The three experiments we present support several conclusions about the automatic allocation of visual attention to negative or aversive stimuli. First, we show that this effect occurs in the low level perceptual task of word identification. There is good reason to believe that the masking effect must occur prior to lexical access (of the target word) and thus reveals an earlier influence of emotion on perceptual or cognitive processes than has been demonstrated before. Identifying the locus of this effect would be of some interest, as would discovering the extent of the appraisal process. However, the answers to these questions are not easy to deliver. We believe that the effect is occurring very early in the word recognition process, that it is automatic, and that the extent of processing is not great. Opinions about the locus and automaticity of this effect are not easy to test directly, so our conclusions rest largely on inferences that are supported by our selection of method and tight stimulus control. For example, the use of a two-alternative forced-choice response task greatly reduces the bias potentially present in data collected with free report, supporting the inference that the effect is happening at a relatively early stage of cognitive processing. This is because the recognition task required of subjects depends only on their ability to select the target word from a pair of presented stimuli. Similarly, the fact that we observe large effects of mask frequency on target identification in this cognitively undemanding task suggests that the effect is occurring prior to lexical access or during the process of activating the representations that support word recognition. The time that passes between target presentation and choice is less than one-half second, too little to make differential forgetting a compelling alternative explanation. Finally, the effectmust be automatic because it appears so early in the cascade of perceptual events.

An issue of further interest is the question of just how extensive an analysis supports the differential allocation of attentional resources. This is an important question, but at this time we have no data that directly addresses this issue. Given that it is carried out preconsciously it seems that the analysis could not be extensive. Further, the results of Experiments Two and Three lend no support to the idea that the analysis is very detailed. This is because there was no interaction between Emotional Valence and the variables manipulated in those studies. If Emotional Valence had interacted with either Frequency (Experiment Two) or Repetition (Experiment Three) it would be reasonable to consider the possibility that a more detailed analysis had been carried out, and that processing resources can be allocated in a context sensitive manner. To illustrate with Emotional Valence and Repetition, if the Repetition effect were smaller for Negative than for Positive words it would suggest the Automatic Vigilance mechanism can distinguish between Affective tone and Familiarity, and differentially allocate attentional resources on that basis. From a survival standpoint it would be reasonable to assume that a Repeated Positive stimulus presents no threat whatsoever, while a Repeated Negative continues to exert a large demand for processing capacity. A similar argument holds with respect to Frequency and Emotional Valence. As it stands, with no interaction between these variables, the most conservative conclusion is that the allocation of attention or processing capacity reflects a low level process that depends on an automatic response to a broad definition of potential threat rather than a strategic or logical analysis of stimulus properties.

One obvious danger of arguing for the ecological utility of automatically directing attention to one stimulus type or the other is the potential circularity of the argument. If attributions of capacity demand rely solely on the pattern of target recognition results this could be a relatively vapid exercise as sufficient power is guaranteed to result in a statistically significant differencebetween two levels of any variable whatsoever. The large body of data on the differential impact of Novel and Familiar (stimuli and Positive and Negative stimuli (Easterbrook, 1959; Pratto & John, 1991; Taylor, 1991) provide, if not a warrant, at least probable cause for the investigation of these factors. The finding of medium to large effectsizes in several distinct manipulations, across different experiments, with different stimulus sets shows that the automatic allocation of processing resources to novel or negative stimuli is a robust effect that manifests under a variety of circumstances.

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