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Affective and Non-affective Meaning in Words and Pictures

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Abstract

When people see a snake, they are likely to activate both affective information (e.g., dangerous) and non-affective information (e.g., animal). According to the Affective Primacy Hypothesis, the affective information has priority, and its activation can precede identification of the ontological category of a stimulus. Alternatively, according to the Cognitive Primacy Hypothesis, perceivers must know what they are looking at before they can make an affective judgment about it. We propose that neither hypothesis holds at all times. In two experiments, we show that the relative speed with which affective and non-affective information gets activated by words and pictures depends upon the contexts in which the stimuli are processed. These data support a view according to which words and pictures do not "have" meanings; rather, they are cues to activate patterns of stored knowledge, the specifics of which are co-determined by the item itself and the context in which it occurs.

Keywords: ad hoc cognition; affective primacy; cognitive primacy; affective priming; context; emotion; task set inertia.

Introduction

When people see a snake, they are likely to activate both affective information (e.g., snakes are dangerous) and non-affective information (e.g., snakes are animals). Which kind of information is activated first? For decades, researchers have debated the temporal priority of affective and non-affective processing. According to the Affective Primacy Hypothesis (Zajonc, 1980, 2000; Murphy & Zajonc, 1993; LeDoux, 1996), information relevant for affective responses can be activated quickly and automatically, before information about ontological kinds. Alternatively, the Cognitive Primacy Hypothesis (Lazarus, 1984; Storbeck, Robinson, & McCourt, 2006; Calvo & Nummenmaa, 2007) posits that perceivers must know what they are looking at before they can make an affective judgment about it.

The present study investigated whether one kind of information is activated faster than the other, in general, or whether the speed with which affective and non-affective[1] information gets activated varies with context. Imagine the following scenarios: If a person is hiking around in a tropical jungle and is constantly reminded of possible poisonous animals and plants in the surroundings, the affective information associated with the animals they see (e.g., safe or dangerous) might be very salient. If a person is taking a timed test for a biology class, however, and classifying animals according to their ontological categories, they might not even notice if some animals are more dangerous than the others.

We propose a context-dependent view of affective and non-affective information processing. Rather than arguing for the primacy one type of information over the other, we suggest that the relative speed with which affective and non-affective information gets activated in response to words and pictures should depend upon the contexts in which the stimuli are processed.

Affective Primacy

Three lines of empirical evidence have been used to support the Affective Primacy Hypothesis, namely, subliminal priming (Murphy & Zajonc, 1993), affective priming (Klauer & Musch, 2003), and neuropsychological evidence (LeDoux, 1996). However, as can be seen in the following, these data seem to support an affective-early theory, as opposed to an affect-precedes-non-affect theory.

Subliminal priming studies in general show that briefly presented affect-laden primes (e.g., smiling and angry faces) can influence the affective evaluation of the subsequent unseen targets (e.g., Chinese ideographs). In contrast, briefly presented non-affective primes (e.g., big and small geometric shapes) cannot influence the non-affective processing of the unseen targets (e.g., the size of the object the ideographs might represent). In the latter case, though, if the presentation duration is adjusted to allow for optimal viewing, the classic semantic priming (e.g., *doctor-nurse*) effects emerge. It is argued that affect can be activated first with minimal exposure, prior to the activation of non-affective information.

Affective priming refers to the phenomenon that positively- or negatively- valenced targets (e.g., *sunshine*) can be primed when preceded by primes with congruent valence (e.g., *love*) compared to primes with incongruent valence (e.g., *death*). Affective priming occurs even when attention is focused on another, concurrent verbal task (Calvo & Nummenmaa, 2007), suggesting the automaticity of affective evaluation (Fazio, 2001; Bargh, Chen, & Burrows, 1996). These data support the part of the claim in the Affective Primacy Hypothesis that affect can be elicited with virtually no non-affective processing.

[1] We use "non-affective" instead of "cognitive" to allow the possibility that both affective and non-affective meaning be considered aspects of cognitive processing.

Neuropsychological data also upport the immediateness of affective evaluation (LeDoux, 1996; Whalen, Rauch, Etcoff, McInerney, Lee, & Jenike, 1998). It has been shown that when it comes to processing emotional stimuli, a neural system that learns the emotional significance of these stimuli is activated. This system is a shortcut for ensuring fast reaction to potentially life-threatening stimuli. The shortcut can by-pass the neural system that allows us to identify objects, people, events, etc.

These data indeed point to a fast and early processing of affect. However, it is not clear if these data strongly support the temporal primacy of affective information. For example, the null results for non-affective dimension in the subliminal priming literature do not rule out the possibility that such information (e.g., size) can be elicited early in circumstances where the information is made salient (e.g., finding the right size lego for building something in a lego contest). Even if one non-affective dimension (e.g., size) is indeed activated late, other non-affective dimensions (e.g., color) may not be perceived late. Moreover, in those subliminal priming experiments, the affective and the non-affective processing are not put directly in competition with each other. As for evidence coming from the affective priming effect, the automaticity of affect seems similar to the automaticity of lexical-semantic (non-affective) information observed in classic Stroop tasks. So, people cannot suppress affective evaluation while doing a verbal task. People also cannot suppress lexical access of “red” even when their task is to verbally state the blue ink color of the printed word “red”. If these two kinds of information are compatible and can be both viewed as a feature in a semantic-network, then there is no need to ask which feature must be always activated first. Lastly, the shortcut for the fearful stimuli in the neural system seems valid, but such a neural circuit does not prevent parallel processing of the non-affective aspects of the emotional stimuli. Therefore, we can agree that affective processing is early, but cannot be certain about whether affective processing precedes non-affective processing.

Cognitive Primacy

Evidence supporting the Cognitive Primacy Hypothesis primarily comes from studies showing the lack of affective priming (e.g., Storbeck & Robinson, 2004). Storbeck and colleagues used prime-target pairs of positive/negative words orthogonally involving semantic dimensions of religion, animal, and texture. In one experiment, they had the participants do a lexical decision (word/nonword) task on the target words. In another experiment, they had the participants do an affective (good/bad) task. In both of the experiments, they found significant facilitation when the prime and target words were congruent along the semantic dimension, but not when the words were congruent along the affective dimension. Interestingly, the affective priming emerged when they restricted the prime-target pairs to one semantic category (e.g., animal). They concluded that when people are left with only one dimension for relating primes and targets, people rely on that dimension, even if the dimension is affective.

The problem with the lack of affective priming effect is similar to the lack of non-affective processing in subliminal priming. The null effects cannot strongly rule out the existence of either kind of priming. In addition, the fact that Storbeck & Robinson (2004) actually found affective priming when the semantic categorization was restricted to one category suggests that people are able to make use of affective information when the situation (context) requires them to.

Recently, an eye-tracking study provided strong support for the Cognitive Primacy Hypothesis. Nummenmaa, Hyönä, & Calvo (2010) presented their participants with paired pictures of emotional and neutral scenes involving humans and animals. They eye-tracked the participants’ saccades when they did an affective categorization (pleasant or unpleasant) task and a non-affective categorization (animal or human) task. They found that while the saccades for both kinds of tasks were fast, within ~220 msec, the ontological categorization always preceded the affective categorization, by ~40 msec in all their experiments. Interestingly, the item-wise affective and semantic recognition times were positively correlated and additive. They suggested that this means that affective processing is an additional stage that occurs after object identification and recognition, consistent with models in which a serial processing is assumed.

Nummenmaa et al. (2010) show that, across 7 experiments, non-affective information is consistently activated faster than affective information when participants judge complex scenes. They interpret this finding as strong evidence for the Cognitive Primacy Hypothesis, and suggest that, “[non-affective] processing of visual scenes is faster than their affective processing and…semantic categorization precedes affective evaluation” (pg. 243). We suggest that this robust result may have had much to do with the particular stimuli they used. For example, judging from the example stimuli the authors provide, the photographs might have biased participants toward processing the non-affective, ontological information first because the information relevant for determining whether a stimulus was an animal or a human was detectable from coarser-grained visual information (i.e., information with a lower spatial frequency) than the information relevant to determining the pictures’ affective content (e.g., an emotional facial expression). It is no surprise if making judgments based on fine-grained information takes longer than making judgments based on coarse-grained information. If low-level visual factors were responsible for their results, it should be possible to observe a different pattern simply by performing a similar task with different stimuli.

Context-Dependent Processing

What determines which kind of information gets activated first? We suggest that neither Affective Primacy nor

Cognitive Primacy holds at all times. Furthermore, the stimuli themselves should not fully determine the relative primacy with which affective and non-affective information gets activated, nor should the judgments that people make on the stimuli. Instead, the context in which processing occurs should be able to modulate the relative speed with which affective and non-affective information gets activated, even when the stimuli themselves and the judgments people make on them are held constant. This claim is motivated by the *Ad Hoc Cognition* framework, according to which the role that words, pictures, and other cues play in activating neurocognitive representations is inseparable from the role played by the context in which they are experienced (Casasanto & Lupyan, 2011).

Examination of the past studies supports our proposal that the processing priority of affective and non-affective information should be determined by context. First, the literature reviewed so far suggests that neither affective nor non-affective information must always be activated first. Second, corroborative evidence from electrophysiological data suggests that both affective and non-affective information can be processed at an early, overlapping time window. Some studies showed that affective processing can be early. For example, one study demonstrated that the emotional content of the visual cues can facilitate the sensory encoding of these stimuli, as revealed by a P100 component starting at ~100 msec (e.g., Schupp, Junghöfer, Weike, & Hamm, 2003). Another study using word stimuli showed that the emotional tone of words can be identified at ~80-120 msec, and can lead to differential processing (Scott, O'Donnella, Leutholda, & Sereno, 2009). Other studies showed that non-affective processing too can be early. One study showed that rapid semantic analysis of visual scenes can occur in less than 120 msec (Kirchner & Thorpe, 2006). In terms of word processing, it has been demonstrated that some lexical-semantic analysis can take place at ~100 msec (Sereno, Brewer, & O'Donnell, 2003; Hauk, Davis, Ford, Pulvermüller, & Marslen-Wilson, 2006).

In addition, affective priming literature indicates that such priming may be goal dependent. While many studies found goal-independent affective evaluation (Bargh, Chaiken, Raymond, & Hymes, 1996), one study found goal-dependent affective evaluation (Klauer & Musch, 2002). Klauer & Musch (2002) used prime-target pairs with words that can be categorized by an affective dimension and a non-affective dimension. They had one group of participants do an affective (positive/negative) task, and had another group do a non-affective task (e.g., upper-/lower- letter case, the stimulus locations on the screen, color, etc.) They found priming effects only when the priming dimension was task-relevant. Although the design of their study is not ideal due to a between-group comparison, these data are consistent with a context-dependent processing account.

The Present Study

The present paper aims at testing a context-dependent account of affective and non-affective meaning processing. To test this proposal, we had participants process the same stimuli in different contexts.

To create the different contexts, we used a "Task-Set Inertia" paradigm (Allport & Wylie, 2000). In this paradigm, there are target trials and filler trials. The target trials contain stimuli (e.g., words) with characteristics varying in two orthogonal dimensions (e.g., affective, non-affective). The filler trials contain a different kind of stimuli (e.g., scenes) that vary along the same dimensions as the target stimuli (e.g., affective, non-affective). The idea is that what the participants do for the filler trials will persist and facilitate or interfere with the execution of the response for the target trials. In other words, the filler trials serve as a context that orients the participants toward a specific dimension of the stimuli during the target trials.

In Experiment 1, we tested whether a context-dependent account holds in word meaning. We used affective (positive/negative) and non-affective (animal/human) words as the target trials, and affective (pleasant/unpleasant) and non-affective (indoor/outdoor) scenes as the filler trials. We predicted a context-congruent facilitation for the target word trials.

In Experiment 2, we tested the context-dependent processing using pictures. We swapped the target and the filler trials in Experiment 1, so that the scenes became the targets, and the words became the fillers. We also predicted a context-congruent facilitation for the target scene trials.

Experiment 1

Experiment 1 tested the context-dependence of affective and non-affective information cued by words (targets), in the context of visual scenes (distractors). We predicted a context-congruity effect: the relative speed with which affective and non-affective information could be activated in response to the target words should vary according to the type of processing (affective or non-affective) participants were required to perform on the distractor pictures.

Method

Participants Native Dutch-speaking undergraduates (N=27; mean age=22.6) at the Raboud University Nijmegen participated in this experiment for payment. Of these participants, 13 were assigned to the affective context group and 14 to the non-affective context group.

Materials and Design The stimuli consisted of 96 nouns, 24 each of 4 types: positive-valence animals (e.g., *konijntje* 'bunny', *panda* 'panda', etc.), negative-valence animals (e.g., *parasite*, 'parasite', *kakkerlak*, 'cockroach', etc.), positive-valence humans (e.g., *prinses* 'princess', *grootvader* 'grandfather' etc.), and negative-valence humans (*moordenaar* 'murderer', *pedofiel* 'pedophile', etc.).

A norming pretest was carried out to ensure the valence of the target words. 18 native Dutch speakers participated in the pretest for payment. Each participant was given 145 nouns, one word at a time, and was to rate the valence of each noun on a 9-point Self-Assessment Manikins scale

(Lang, 1980), ranged from a smiling figure at the positive end of the scale to a frowning one at the negative end. Based on the rating results, we chose 96 nouns that were clearly valenced out of the original 145, for the purpose of matching the clear-cut animal vs. human distinction. The mean valence ratings were 6.78 (SD=0.59) for the positive nouns and 2.79 (SD=0.82) for the negative nouns. The valence for the two types differed significantly, as confirmed by a two-tailed t-test (t=27.29, p=.0001).[2]

The 96 selected nouns were then divided into 2 blocks. For each session, 12 of each of the 4 types of nouns were randomly selected to be included in the first block, while the remaining 12 of each type were presented in the second block. The participants made affective judgments (Positive/Negative) for one of these blocks, and non-affective judgments (Animal/Human) for the other block. The order of the blocks was counterbalanced between participants.

To create a biasing context, we adapted the Task-Set Inertia paradigm. Randomly intermixed with the target word judgments were an equal number of filler trials. The fillers consisted of 96 photos of complex scenes, 24 each of 4 types: pleasant indoor, unpleasant indoor, pleasant outdoor, unpleasant outdoor scenes. The valence of the pictures (positive or negative) was rated by two independent coders. Inter-coder agreement was 100%. In the affective context group, the participants made affective judgments (pleasant/unpleasant) for all photos. In the non-affective context group, the participants made non-affective (indoor/outdoor) judgments for all photos. Therefore, for each participant, the biasing context was congruent with the target judgments for one block and incongruent for the other block.

Procedure

Participants sat in a comfortable chair about 90 cm from a monitor in a soundproof, dimly-lit experimental booth. Stimuli were presented on a computer monitor (resolution = 1024 x 768 pixels). In a target (word) trial, the word was presented for 300 msec, followed by a dark screen until an (affective or non-affective) judgment was made. In a filler (scene) trial, the scene was presented for 500 msec, also followed by a dark screen until an (affective or non-affective) judgment was made. Participants were instructed to press the response keys (e.g., pleasant and unpleasant) as quickly and accurately as possible. The order of the key assignments (left to right vs. right to left) was counterbalanced for both the affective and the non-affective judgments across participants. Participants responded with the index fingers of both hands. A brief practice was given at the beginning of the session, and a brief break was given between the two blocks during the session. Each session lasted approximately 15 minutes.

[2] While the present design does not require the length, the log frequency, or the arousal of words in different categories to be matched, we still matched these factors.

Results and Discussion

Accuracy The accuracy was the number of correct responses divided by the overall number in the target trials. 3 participants were excluded due to their low accuracies (<80%). 24 participants (Mean accuracy=89%, ±0.75%, range 81-93%) were included in the following analysis. Performance on the filler (scene) trials was not analyzed**.**

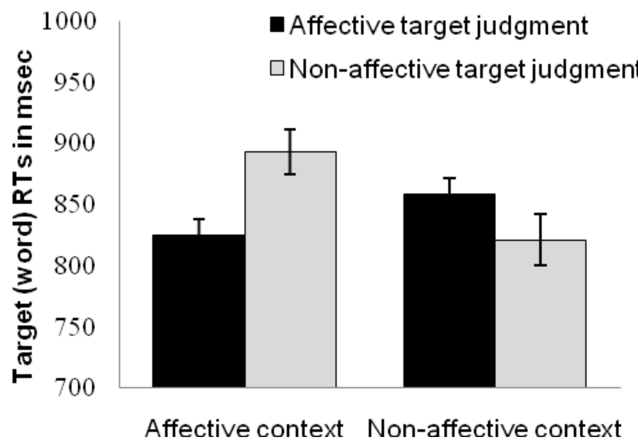

Figure 1. Reaction times for the (word) targets when participants made affective judgments (dark bars) and non-affective judgments (light bars) in the affective context group (left bars) and the non-affective context group (right bars) in Experiment 1. The error bars indicate standard errors.

Reaction Times Extreme reaction times (>5,000 msec) were excluded (0.06% of the data). The averaged reaction times by item are summarized in Figure 1.

To test the predicted effect of contextual modulation on the reaction times, we carried out a linear mixed-effects regression model of context types (affective, non-affective) x 2 judgment types (affective, non-affective). A significant interaction was found between the judgment type and the context type [F(1,2069)=21.42, *p*=.0001]. Within the affective context group (Figure 1, left bars), affective targets were judged faster than the non-affective targets [F(1,1059)=11.26, *p*=.001]. Within the non-affective context group (Figure 1, right bars), non-affective targets were judged faster than the affective targets [F(1,1039)=9.95, *p*=.002]. Within the affective judgments (Figure 1, black bars), the judgments were not significantly faster in the affective context than in the non-affective context [F(1,24)=0.64, *p*=.43]. Within the non-affective judgments (Figure 1, grey bars), the judgments were not significantly faster in the non-affective context than in the affective context [F(1,24)=1.25, *p*=.27].

As predicted, context mattered. When participants attended to the affective dimension, their affective judgments about the word targets were facilitated. When participants were oriented toward the non-affective dimension, their non-affective judgments about the word targets were facilitated. The effect of context cannot be attributed to superficial similarities between the responses during filler and target trials, since the effect was found even when responses were dissimilar (e.g., *indoor* - *human*).

Experiment 2

Experiment 2 tested whether processing pictorial stimuli is also context-dependent, using a 'mirror' version of Experiment 1. The scenes were now used as target trials, and the words, filler trials. The context-dependent account predicts an effect of congruity between the type of context and the type of target judgments, regardless of the format of the target stimuli (pictorial or verbal). Affective target judgments should be faster in the context affective filler judgments than in the context of non-affective filler judgments, and vice versa for non-affective target judgments.

Method

Participants 26 Native Dutch-speaking undergraduates (mean age=21.4) at the Raboud University Nijmegen participated payment. None of them previously took part in Experiment 1. Among these participants, 13 were assigned to the affective context group and 13 to the non-affective context group.

Materials, Design, and Procedure The materials and the procedure were the same as in Experiment 1. The design for the words and scenes was reversed, so that the scenes became the targets (judgments manipulated within-subject) and the words became the context (judgments manipulated between-subjects).

Results and Discussion

Accuracy We excluded 2 participants due to low accuracy (<80%) on the target (picture) trials. 24 participants (Mean accuracy=89%, ±0.67%, range 82-94%) were included in the analysis. Performance on the filler (word) trials was not analyzed.

Reaction Times Extreme reaction times (>5,000 msec) were excluded (0.04% of the data). The averaged reaction times by item are summarized in Figure 2. To test the predicted effect of contextual modulation on reaction times, we carried out a linear mixed-effects regression model of 2 context types (affective, non-affective) X 2 judgment types (affective, non-affective). There was a significant interaction between the judgment type and the context type [F(1,2086)=15.43, *p*=.0001], replicating Experiment 1. There was a main effect between the context types [F(1,23)=4.30, *p*=0.05], and a main effect between the judgment types [F(1,2089)=48.83, *p*=0.0001]. Within the affective context group (Figure 2, left bars), affective judgments were made faster than the non-affective judgments [F(1,1062)= 51.26, *p*=.0001]. Within the non-affective context group, affective targets were still judged faster than the non-affective targets [F(1,1031)=5.85, *p*=.02]. Within the affective judgments (Figure 2, black bars), the judgments were not significantly faster in the affective context than in the non-affective context [F(1,24)=1.07, *p*=.31]. Within the non-affective judgments (Figure 2, grey bars), the judgments were significantly faster in the non-affective context than in the affective context [F(1,24)=8.19, *p*=.009]. Therefore, the RT difference between affective and non-affective target judgments varied depending on the context.

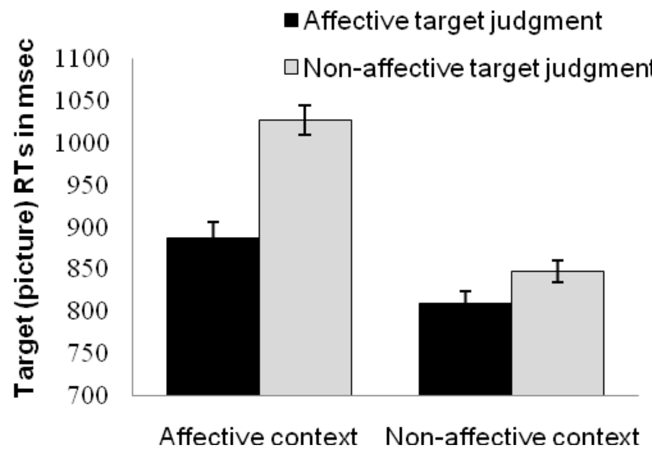

Figure 2. Reaction times for the (picture) targets when participants made affective judgments (dark bars) and non-affective judgments (light bars) in the affective context group (left bars) and the non-affective context group (right bars) in Experiment 2. The error bars indicate standard errors.

To test whether the results of the two experiments differed, we carried out a linear mixed effects regression of 2 experiments (word, picture) X 2 context types (affective, non-affective) X 2 judgment types (affective, non-affective). There was no 3-way interaction [F(1,4155)=.15, *p*=.70], suggesting no difference between when the target stimuli were words and when the target stimuli were pictures. Yet, the 2-way interactions observed in the previous analyses still hold [F(1, 4156)=36.41, *p*=.0001].This means that there was little difference between the significant effects of context types on judgment types between experiments.

General Discussion

Changes in the context can determine the relative speed with which people make affective and non-affective judgments on words and pictures. These findings challenge both the Affective Primacy and the Cognitive Primacy hypotheses. Our results support the Ad Hoc Cognition framework, according to which words and pictures activate different neurocognitive representations every time they are processed, the specifics of which are co-determined by the stimuli themselves and the contexts in which they occur (Casasanto & Lupyan, 2011; see also Elman, 2004).

Although we obtained interactions of nearly identical sizes for scenes and for words, which did not differ statistically across experiments 1 and 2, the details of the data were different descriptively. For the scene targets, the affective judgments were made faster than the non-affective judgments, no matter what the context. On one possible explanation, the representations activated in response to scenes (in this case, detailed color photographs) may be more constrained by the stimuli themselves than is the case for words. Whereas words name generic types (e.g., "puppy" can refer to any puppy) pictures depict a specific instance of a type (e.g., a photo must be of a specific puppy). Therefore, representations activated in response to photographs may be more constrained than representations activated in response to words (c.f., De Houwer & Hermans, 1994). Yet, importantly, in both experiments, representations varied as a function of cues-in-context, belying any broad generalizations about the primacy of once kind of information (affective or non-affective) over the other.

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References

Allport, A. & Wylie, G. (2000). 'Task-switching', stimulus-response bindings, and negative priming. In S. Monsell & J. S. Driver (Eds.), *Control of cognitive processes: Attention and Performance XVIII*. Cambridge: MIT press.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of Social Behavior: Direct Effects of Trait Construct and Stereotype Activation on Action. Journal of Personality and Social Psychology, 71(2), 230-244.

Calvo, M. G., & Nummenmaa, L. (2007). Processing of unattended emotional visual scences. Journal of Experimental Psychology: General, 136, 347-369.

Casasanto, D. & Lupyan, G. (2011). Ad Hoc Cognition. Manuscript submitted for publication.

De Houwer, J., & Hermans, D. (1994). Differences in the affective processing of words and pictures. Cognition & Emotion, 8(1), 1-20.

Elman, J. L. (2004). An alternative view of the mental lexicon. Trends in Cognitive Sciences, 8(7), 301-306.

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. Cognition and Emotion, 15, 115-141.

Glaser, W., & Glaser, M. O. (1989). Context effects in Stroop-like word and picture processing. Journal of Experimental Psychology: General, 118(1), 13-42.

LeDoux, J. E. (1996). The emotional brain. New York, NY: Simon & Schuster.

Lang, P. J. (1980). Behavioral treatment and bio-behavioral assessment: computer applications. In J. B. Sidowski, J. H. Johnson, & T. A. Williams (Eds.), Technology in mental health care delivery systems (pp. 119-l37). Norwood, NJ: Ablex.

Lazarus, R. (1984). On the primacy of cognition. American Psychologist, 39, 124–129.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: affective priming with optimal and suboptimal stimulus exposures. Journal of Personality and Social Psychology, 64(5), 723-739.

Nummenmaa, L., Hyönä, J., & Calvo, M. G. (2010). Semantic Categorization Precedes Affective Evaluation of Visual Scenes. Journal of Experimental Psychology: General, 139(2), 222-246.

Keller, F., Gunasekharan, S., Mayo, N., & Corley, M. (2009). Timing accuracy of Web experiments: A case study using the WebExp software package. Behavior Research Methods, 41(1), 1-12.

Klauer, K. C., & Musch, J. (2003). Affective priming: Findings and theories. In J. Musch & K. C. Klauer (Eds.), The psychology of evaluation: Affective processes in cognition and emotion (pp. 7-50). Mahwah, NJ: Erlbaum.

Scott, G. G., O'Donnell, P. J., Leuthold, H., & Sereno, S. C. (2009). Early emotion word processing: Evidence from event-related potentials. Biological Psychology, 80(1), 95-104.

Storbeck, J., & Robinson, M. D. (2004). Preferences and inferences in encoding visual objects: A systematic comparison of semantic and affective priming. Personality and Social Psychology Bulletin, 30, 81-93.

Storbeck, J., Robinson, M. D., & McCourt, M. (2006). Semantic processing precedes affect retrieval: The neurological case for cognitive primacy in visual processing. Review of General Psychology, 10, 41-55

Whalen PJ, Rauch SL, Etcoff NL, McInerney SC, Lee M, Jenike MA. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. Journal of Neuroscience, 1998; 18:411-418.

Zajonc, R. (1980). Feeling and thinking: Preferences need no inferences. American Psychologist, 35, 151-175.

Zajonc, R. (2000). Feeling and thinking: Closing the debate over the independence of affect. In J. P. Forgas (Ed.), Feeling and thinking: The role of affect in social cognition. Studies in emotion and social interaction (Vol. 2, pp. 31-58). New York: Cambridge University Press.