REPEATED PRESENTATION OF SUBOPTIMAL STIMULI AND SUBSEQUENT "AFFECTIVE" RESPONSES

by

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ABSTRACT

A priming paradigm was employed to examine the veridicality of an independent affective and cognitive processing system (Zajonc 1980). This assertion was tested by comparing participants physiological reactions to neutral and affective priming stimuli. Cardiovascular reactivity was recorded while participants (N=36) watched a computer monitor that presented stimuli of brief duration of exposure (suboptimal). At suboptimal exposures, only affective primes produced significant shifts in the participants physiological activity. One interpretation of these results is that participants' manifested an affective reaction to emotional primes without the benefit of conscious recognition (Kunst-Wilson & Zajonc 1980). The results are interpreted in light of neurological (Le Doux 1986) and behavioral evidence (Roediger 1990) to suggest support of interdependence of affect and cognition. This study showed that a physiological-affective priming paradigm has utility for examining the interdependence of affect and cognition.

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Most of all I would like to thank my wife for putting up with my sorry ass these past few years, if possible, I would of left me long ago.

Chapter One

Repeated presentation of suboptimal stimuli and subsequent affective responses

The affective priming hypothesis, asserts that affective reactions can be elicited with minimal stimulus input and "virtually" no cognitive processing (Zajonc 1980). This hypothesis challenges the notion that cognitive and affective processes are neurologically interdependent (Le Doux 1992a). This thesis describes research that examines the legitimacy of a claim of independent cognitive and affective processing. It also shows how various stimuli can elicit physiological reactions that may or may not be interpreted as support for independent cognitive and affective processing system.

To set the stage for the present study the following three avenues of investigation are reviewed, 1) the mere exposure effect (Zajonc 1968), 2) the non-conscious affective priming effect (Kunst-Wilson & Zajonc; Zajonc 1984; Zajonc 1980), and 3) physiological measures (Tranel & Damasio 1988; Zajonc 1968).

Mere Exposure Effect

With the publication of Zajonc's (1968) paper " the attitudinal effects of mere exposure" the mere exposure effect became a topic of conversation in mainstream psychology. Zajonc defined the exposure effect as the observation that " mere repeated exposure of the individual to a stimulus is a sufficient condition for the enhancement of his attitude toward it. By 'mere exposure, is meant a condition which just makes the given stimulus accessible to the individual's perception" (p.1). Thus, Zajonc suggested that simple unreinforced repeated exposures lead to liking for a stimulus. In a series of subsequent experiments, Zajonc then went on to demonstrate the power of the mere exposure effect for affective experiences.

In Zajonc's (1968) first experiment, participants were exposed to series of nonsense words at frequencies ranging from 0 to 25. They then rated each stimulus word for "goodness" of "meaning" (i.e. the extent to which the word connotes "good" vs."bad" affect) on a seven-point scale. Zajonc found a positive relationship between number of exposures and the average goodness rating for a word. He then replicated this experiment using a similar procedure but different stimuli: Chinese ideographs were substituted for the nonsense words used in Experiment 1. The results of Experiment 2 were consistent with the findings of Zajonc's first study; again, rated goodness of meaning was positively related to frequency of exposure.

Zajonc's (1968) third experiment investigated the extent to which typical exposure effects could be obtained with socially relevant stimuli. In this experiment, subjects were shown a series of faces (photographs of students taken from a college year book) at different exposure frequencies, after which they were asked to make liking ratings of each stimulus person on a seven point scale. A significant, positive relationship between frequency of exposure (25 presentations was the maximum number of presentations in this study) and mean liking rating of the stimuli was found.

Stimuli presentation for the above experiments occurred at optimal levels of exposure, meaning the participants could clearly see the stimulus and therefore were aware of it. However, a related phenomenon, the affective priming effect, has consistently been found even when the participant has claimed that he or she was unaware that a stimulus had been presented. Stimuli in these experiments are presented at suboptimal levels of exposure. That is, the stimulus is either presented at a level so degraded that the participant cannot recognize the stimulus or, alternatively, presented so fast that he or she cannot see the stimulus. Manipulating the image, size and focus of a stimulus constitutes suboptimal presentation of a stimulus in a degraded state (Kunst-Wilson & Zajonc 1980). The standard duration for suboptimal presentation of a stimulus is anywhere from four to five milliseconds (Kunst-Wilson & Zajonc 1980).

Nonconscious Affective Priming

Change in preferences for stimuli as result of repeated suboptimal exposures to those stimuli is known as the nonconscious affective primacy effect.

One example of the nonconscious affective primacy effect is found in research performed by Kunst-Wilson and Zajonc (1980). In this experiment, similar to the mere exposure experiments (1968), stimuli were presented repeatedly. However, instead of presenting the stimuli at optimal levels of exposure, stimuli were presented at varying levels of degradation by manipulation of the images' size and focus. The clear finding was a direct increase in participants' preference for an object after repeated exposures to that object. Interestingly, the effect was also obtained even when the exposures were so degraded that the person was not aware that anything at all had been presented. They were unable to describe why they did or did not like the stimuli they were previously exposed to. That familiarity does not appear to be involved in these effects is shown by the fact that liking scores depended almost entirely on the person's objective experiences with the object rather than on their perceptions of familiarity with the object (Moreland & Zajonc 1977; Matlin 1971). It is also of some interest that Bornstein (1987) reported stronger exposure effects with suboptimal presentations than with optimal presentations.

The clearest instance of non-conscious affective priming is found in experiments in which stimuli presentation occurs with short duration. In this type of experiment (Zajonc 1980), a photograph of a smiling face is presented at very short intervals, say 4 milliseconds, just before another neutral and unrelated stimulus (a Chinese ideograph) is shown for 1 second. Results consistently show that participants' stated preference for the neutral stimulus is influenced by whether or not that stimulus is preceded by a smile or an angry expression. It is important to note that this same procedure involving the optimal presentation of the same affective prime produces no result (Kitayama 1991; Niedenthal 1990).

One way of interpreting these results is to allow for the possibility that total affective discriminations can be made virtually without awareness, whereas cognitive discriminations require greater access to stimulus information (Kunst- Wilson & Zajonc 1980; Murphy 1990; Zajonc 1980). Indeed, the affective primacy hypothesis (and its assumption of independent affective and cognitive processing) hinges on the conjecture that the simple affective qualities of stimuli, such as good versus bad or positive versus negative, can be processed more readily than their non-affective attributes.

Physiological Evidence

Physiological evidence is often provided (Murphy 1990; Zajonc 1980) as converging support for the assumption that cognitive and affective processing systems are independent. Zajonc (1968), for example tested the hypothesis that repeated presentation of a word would lead to a decrease in galvanic skin response (GSR) fluctuations that result from stimulus exposures. Fifteen nonsense words were presented at optimal levels of exposure with a frequency between one to twenty five times. Zajonc found a negative relationship between exposure frequency and mean GSR change in response to the final stimulus presentation, suggesting that repeated unreinforced exposure to a word result in a decreased autonomic arousal following later stimulus presentations.

Supplementary research is provided by Tranel and Damasio (1988). In a study of four patients with face agnosia, Tranel and Damasio focused on the use of GSR and self-report measures in response to familiar and unfamiliar faces. Results showed a strong dissociation between the indices. Participants generated more frequent and significantly larger amplitude skin conduction responses to familiar faces than to unfamiliar ones but were unable to give discriminatory verbal ratings to familiar faces versus unfamiliar faces. In other words, skin conductance revealed that face agnostic patients responded to familiar faces although according to their self-reports they did not appear to perceive them. In a subsequent study Tranel, Damasio, and Damasio (1995) tested whether nine patients with ventromedial frontal damage could discriminate familiar faces (family) they had exposure to prior to brain damage from familiar faces (psychologists) they had exposure to following the damage. Patients were also asked to rate each face for familiarity. Participants with bilateral frontal damage recognized the identity of familiar faces, yet failed to generate discriminatory skin conductance to those same familiar faces. The findings showed electro-dermal activity to facial stimuli that patients could not recognize and for which a sense of familiarity was non-existent.

Zajonc and colleagues (Kunst- Wilson & Zajonc 1980; Murphy 1990; Zajonc 1980,1984) have suggested that physiological responses comparable to those found in the above studies can be equated with emotion. This assumption, that physiological responses are synonymous with affect, will be explored later in this paper.

In sum, collectively, mere exposure, affective priming, and physiological evidence are cited (Kitayama 1991; Kunst-Wilson & Zajonc 1980; Murphy 1990; Niedenthal 1990; Zajonc 1980; Zola-Morgan, Sqiure, Avarez-Royo, & Clower 1991) as support for separate cognitive and affective processing systems. However this evidence alone is insufficient to convince all theorists that an independent cognitive-affective processing system exists.

The Independent Affective-Cognitive Processing Debate

For theorists advocating a non-conscious process of emotion, emotion is often separated from cognition. Zajonc (1984) argued that affective influences should resist attribution interventions because the affective system responsible for preferences is separate from the cognitive system responsible for inferences. He suggested that early affective processes are automatic and therefore inaccessible to higher-order interventions. As a result, preliminary affective responses are not represented as conscious feelings but are diffuse and can "spill over" from one stimulus to another. In contrast non-conscious cognition is always context specific and must be about something.

Theorists such as, Ledoux (1989, 1986), and Shwarz and Clore (1987) who argue that non-conscious states of emotion are really subjective states of awareness oppose the idea of a separate affective system. In other words emotions are conscious states. In their feelings-as-information model Schwarz and Clore (1987) declare that judgments are based on perceptible feeling. Feelings are the central component of emotion and feelings are by definition, conscious. Like Schwarz and Clore, Ledoux (1986, 1989) asserts that non-conscious emotions do not exist. However, Ledoux does indicate that conscious emotional states are products of unconscious processes. He further suggests that processes that are themselves not permeable to consciousness are responsible for separating the substances of consciousness. Given the controversy surrounding the nature of non-conscious affect it is apparent that the question of non-conscious affect is as yet unresolved.

Overview of Present Study

The present thesis describes an experiment that further explores the question of non-conscious affect. The major objective of this experiment is to determine if awareness of our mental or implicit representation is necessary to produce physiological responses and recognition of those expressions. By including a physiological measure for detection of non-conscious affect, it was possible to circumvent the traditional method of asking for stimulus preference (Zajonc 1980) and instead assess directly implicit responses to stimuli. Additionally, the present study addresses whether facial affect type may produce differing levels of physiological arousal. Exploring this was made feasible through the use of physiological measures, in this instance, hemodynamic activity assessed by impedance cardiography (Sherwood, Allen, Fahrenberg, Kelsey, Lovallo, & Van Doornen 1990).

Another objective was to determine if repeated suboptimal presentation of facial expressions of emotion would result in increasing the threshold for detection of that emotion. In addition, it is quite possible that some facial expressions (e.g. anger)will result in greater physiological arousal than other facial expressions (e.g. disgust). Use of repeated presentation and impedance cardiography would help facilitate detection of participant's differential response to facial expressions.

In sum, the study examined the following predictions: (1) If Zajonc's (1984) affective priming hypothesis has merit then there will be a dissociation between physiological and conscious reports. Subjects exposed to the sub-optimal presentation of emotional stimuli will be unable to consciously report those stimuli. However, they will generate more frequent and significantly changed heart rate responses to facial expressions of emotion, than too neutral facial expressions. (2) Some emotions will be easier to label than others. Happiness and anger for example, will be easier to label than disgust (Prkachin & Prkachin 1994). (3) Some emotions will be easily confounded. In particular, it is predicted that fear is likely to be mistaken for surprise and disgust for anger (Prkachin in preparation). (4) Finally, some emotions will be easier to detect than others at sub-optimal levels of exposure. Happy expressions, for instance, may have a higher probability of being detected (Ladavas, Umilta, Ricci-Bitti 1980) at sub-optimal exposures than any other emotion. However, detectability does not necessarily translate into greater physiological response. What expression will result in the greatest physiological response is also a question of this research, although no explicit predictions can be made from the available literature.

CHAPTER TWO

Method

Participants

Thirty-six introductory psychology students (18 men and 18 women) participated in the following experiment for supplementary course credit. Participants were equally distributed across three between group conditions (12 participants per condition). The between group variable was the affective priming conditions of anger, disgust and happiness. A within group condition included exposure to optimal and suboptimal primes.

Apparatus and Materials

Using conductance electrodes and a BoMed Cardiodynamic Data Processing System the impedance ECG derived signals of heart rate, were saved to disk for later analysis of heart rate variability. Electrode placement was preceded with the washing of upper and lower thoracic regions with isopropyl rubbing alcohol. Redeux, a form of saline paste was then applied to facilitate conduction. Neck electrodes were attached first, with one half of a dual electrode attached at the intersection at the base of the neck and the other half of the electrode attached directly above. This procedure was repeated for the other side of the neck. A similar procedure followed for attachment of lower thoracic electrodes. Electrodes were attached bilaterally to either side of the thorax with the upper half of a dual electrode attached parallel to the xiphoid process and the other half attached just below.

For assessment purposes, participants completed a modified version of Lindsay & Johnson's (1989) source monitoring test (described more completely in procedure section) and Izard's (1972) Differential Emotion Scale (DES). The source-monitoring test assesses participants' ability to accurately memorize the representation of an event (see Appendix A). The DES, consists of a series of affect words (e.g., elated, tense) presented along with a four point likert scale, which participants used to self rate the emotions they were experiencing following stimulus presentation. At the end of each DES, a question was included asking participants to recall the stimuli they were exposed to in the preceding phase (see Appendix B).

Participants were seated in a comfortable chair approximately 50 cm away from a 1 color TRL computer monitor. Mel 2 computer programming language and a 133 MHz Pentium processor facilitated presentation of stimulus photographs. Photographs advanced automatically according to preprogrammed modules designed with Mel 2 software. In total, participants viewed ninety presentations depicting facial expressions chosen from Ekman and Friesen's (1976) Pictures of Facial Affect. Photographs included one male and one female face expressing the emotions, sadness, happiness, anger, surprise, disgust, fear and the expressionless face of neutral. The expressions happiness, disgust and anger were selected as affective primes during one of two suboptimal phases. By "suboptimal" I mean that the stimuli were presented for an abbreviated time thus preventing their complete processing. The expression 'neutral' functioned as a control stimulus during one of two suboptimal phases. Stimulus faces were 175 X 225 pixels X 75 resolution.

In phase one, participants viewed one face (either male or female) and 4 of 7 possible expressions at optimal level (10,000 milliseconds for each face). By "optimal" I mean that the stimuli were presented for a sufficient duration to be processed fully. They viewed each of these expressions 5 times for a total of 20 presentations. In phase two, a "suboptimal" condition, they viewed the same person as in phase 1 depicting one expression, not seen in phase 1, 25 times at 5 milliseconds per face. In phase three, another suboptimal condition, participants viewed the same face as in phase 1 and 2, and one expression not seen in phases 1 and 2 the same number of times and duration as in phase 2. In the fourth and final phase, an “optimal” condition, participants viewed the same face and expressions as in previous phases plus the additional expression of fear, which functioned as a foil. Each of the expressions was viewed three times for a total of 21 presentations. Expressions were presented for 14,000 milliseconds each, allowing participants time to provide verbal answers for the source monitoring test. See Figure 1 where each of the phases is presented graphically. The expressions are presented in cartoon form.

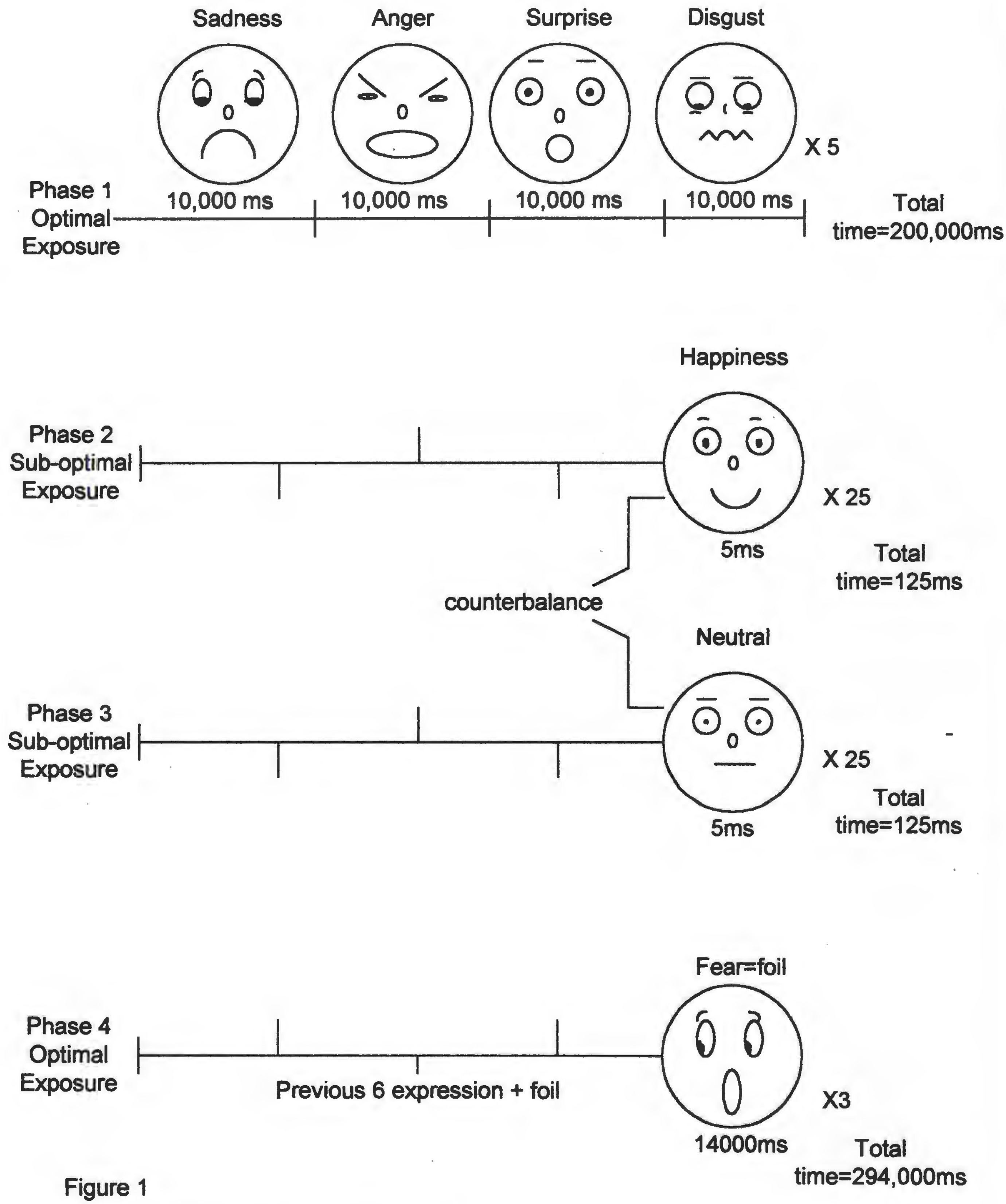

Figure 1

Stimulus presentation for phases 1-4

Procedure

Informed consent was obtained from each participant prior to the experimental session. Following agreement to participate, the impedance electrodes were attached. Participants were then instructed to rest quietly for an acclimatization period of 5 minutes.

The experiment consisted of four phases, an explicit exposure phase, a neutral phase, an implicit exposure phase and a final test phase. These ran consecutively and participants performed the same task in each. Participants were not told the distinctions between the four phases. A five-minute rest period was included between phases one, two and three. Following the completion of each phase, participants completed the DES. During the fourth and final phase participants answered the modified version of Lindsay & Johnson's (1989) source monitoring test.

Following completion of informed consent, participants were told that their task was to observe 20 photos of facial expressions. Participants were advised that each facial expression would be in view for a full 10 seconds and that they should look at it for the whole period as they would be queried at the end of the task regarding the expressions they had seen. A fixation point was projected for 2000 ms at the center of the screen, immediately prior to each of the facial expressions. Participants were exposed to a random order of facial expressions. In total, participants viewed four of seven possible facial expressions at optimal exposure.

For phases two and three, counterbalancing was performed by randomly assigning participants to either a target priming condition in which participants were exposed to an emotional facial expression (affective stimuli) or a neutral priming condition in which they were exposed to a neutral expression (neutral stimuli). For brevity, explanation of phases two and three assumes exposure too neutral stimuli first followed by target (see figure 2), but the reader should keep in mind that these phases were counterbalanced across participants.

The stimulus for the second phase of the experiment consisted of a neutral facial expression. Neutral expressions are included as a control measure. These expressions were not observed in phase one. Neutral expressions were presented to participants repeatedly and at sub-optimal levels of exposure. Each neutral expression was presented for 5 milliseconds, followed immediately by the blank backward mask. Stimuli were presented to the left visual field as research (Borod 1992; Davidson 1992; Gardner, Brownell, Wapner & Michelow 1983) indicates that the right hemisphere is dominant with respect to processing of emotional responses. To ensure that participants attended to the screen during sub-optimal exposure, a fixation point was projected for 1000 ms at the center of the screen immediately prior to target presentation. Participants viewed in total 25 presentations.

Stimuli for the third phase of the experiment were the target facial expressions of emotion. Target facial expressions, were not observed by participants in phase 1. For example participants exposed to the facial expressions of sadness, surprise, happiness, and disgust in phase 1 viewed the anger expressions in phase 3. Target expressions were presented to participants repeatedly and at sub-optimal exposures. Each target expression was presented for 5 ms, followed immediately by the backward mask. As in the second phase, the stimuli were presented to the left visual field to maximize potential physiological reaction. To ensure that participants attended to the screen during sub-optimal exposure a fixation point was projected for 1000 ms at the center of the screen immediately prior to the target presentation. Participants viewed in total 25 presentations.

In phase 4, participants were exposed to both the optimal (phase 1) expressions and the sub-optimal (phase 2 and 3) facial expressions but they were all presented at optimal fourteen-second duration. Following presentation of each face participants were asked to identify expression type. All participants were informed that each facial expression would be in view for a full fourteen seconds and that they should look at it for the whole period, then make their response, even if they recognized the expression before the period was concluded. A record was kept of each participant's ability to identify the individual expressions of emotion. Participants were also asked to the source of each expression (e.g. where and if they had previously seen the expression) and to indicate how confident they were (on a scale of 0-100) that they had seen the expression where they said they had seen it. See Figures 1 & 2 for further clarification of procedure.

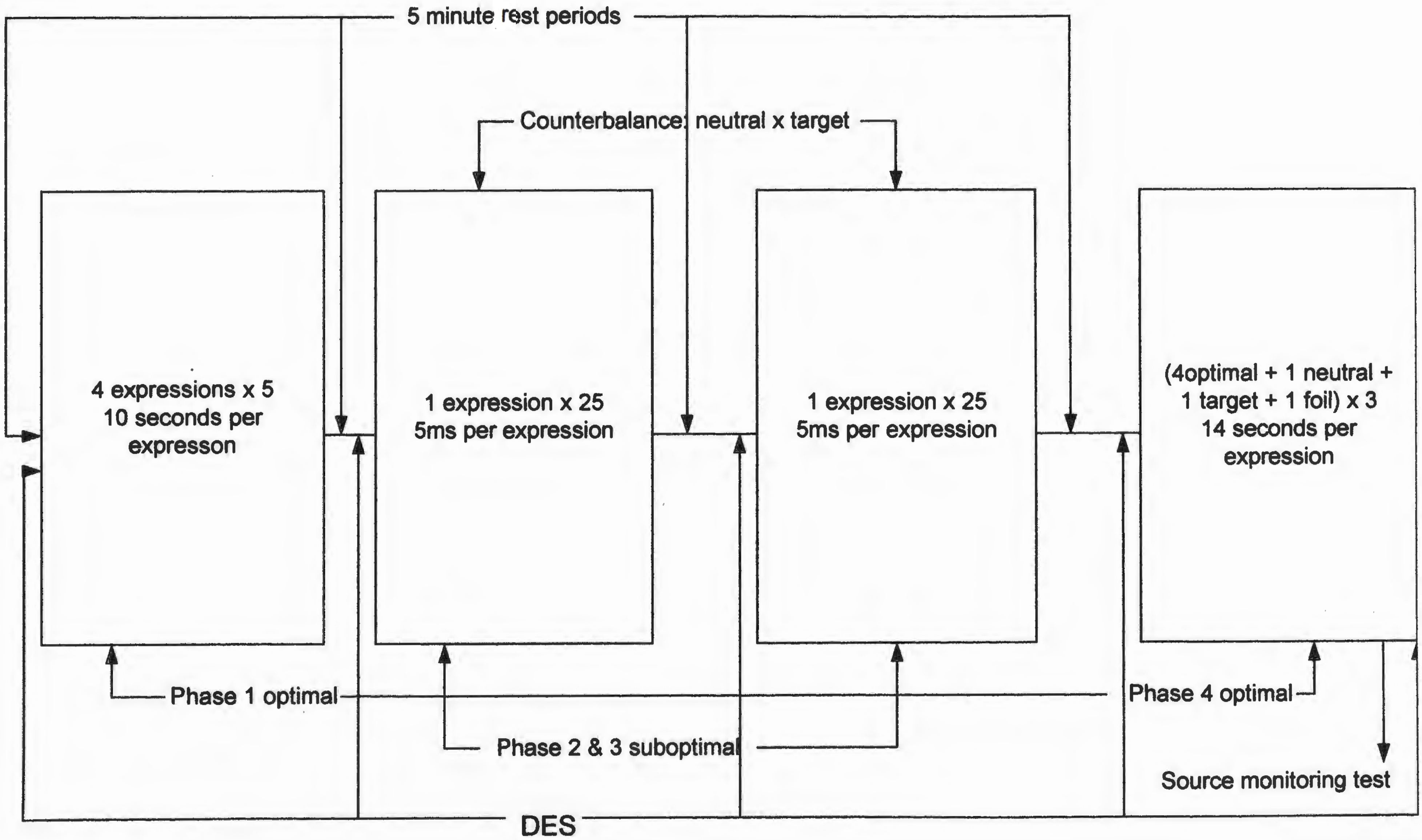

Figure 2

Presentation of optimal and suboptimal stimuli across a four stage procedure

CHAPTER THREE

Results

The analyses of the results of this experiment are limited to the exploration of the responses to the suboptimal stimuli. Investigation of the responses to the optimal stimuli is unnecessary to address the hypotheses raised in the introduction. Differences in physiological responses to optimal presentation of comparable stimuli have been explored by others (Bornstein 1987; Cabeza, Burton, & Kelly 1997; Schweinberger, Pfuetze, & Sommer 1995) and are not relevant to issues addressed in this report.

In order to determine whether participants were affected physiologically during the different stimulus conditions, it was necessary to select an index that would logically reflect physiological perturbations produced by stimuli. It is well known that heart-rate decelerates during exposure to stimuli that evoke attention (Schwartz 1971). Ordinarily such responses can be evaluated by comparing heart rate levels before and after exposure to a given stimulus, and heart rate change (deceleration) is taken as an indication of the "registration" of the stimulus. Heart rate change is usually measured over an epoch of several seconds. In the present case, stimuli were exceptionally brief and operated in rapid succession. Moreover, it was not possible to link stimulus presentation to the heart-rate time series in order to determine precisely when heart rate changes occurred. It was reasoned, however, that if the briefly presented stimuli were being "registered" at the physiological level, then it would be expected that the participants would show a series of decelerations and recoveries of heart rate over the phase of the experiment. If stimuli were not being registered, or not to the same extent, then such a series of decelerations and recoveries would not occur. Consequently, it would be possible to detect the registration of stimuli at the physiological level by measuring the variability of the heart rate during the relevant phases of the experiment. See Figure 3 for an example of heart rate variability. Given the duration of photo stimuli presentation (5ms) we were unable to assess visceral activity for independent stimuli. Standard deviations were therefore extracted from across the spectrum of participants' heart rate response for all physiological data sets.

In preliminary analyses heart rate variability was examined across gender and counterbalance order. No differences were found for gender and counterbalance conditions. Subsequent analyses therefore ignored subject gender and counterbalancing as a factor.

A 3 X 2 analysis of variance (ANOVA) was performed comparing physiological response across affective priming conditions (neutral vs target) and the between subject exposure conditions (anger vs disgust vs happy). The results (see Figure 4 & 5) revealed a significant main effect for affective priming conditions, $F(1, 33) = 18.61$, $p = .000$. A paired t-test revealed that when participants were exposed to target affective primes their heart rate variability was significantly higher than when exposed to neutral target primes. The mean heart rate variability for target primes was 1.68 heart rate SD units, in contrast with a mean of .34 for neutral primes, $t(35) = 4.36$, $p = .000$. The between group difference in the preceding analysis was nonsignificant. Participants' differential physiological response to target and neutral primes provides tentative support for the notion that feature detection may be occurring without conscious recognition. Explicit support for this assumption is possible by examining the relationship between the affective priming conditions and the free recall of those conditions, which was the purpose of the following analysis.

A 3 X 2 ANOVA was performed comparing participant free recall of affective primes (neutral and target) across between subject exposure conditions (happy vs. anger vs. disgust). The results revealed a significant affective prime X group interaction, $F (2, 33) = 20.92$, $p = .000$. Although no participant exposed to the suboptimal neutral condition reported being aware of the primes, differential reports of awareness occurred depending on the target prime, participants were exposed to, as evident in Figure 6. In order to treat the data as conservatively as possible, a Scheffe pairwise comparison was selected for post hoc analysis. The Scheffe pairwise comparison revealed that happy faces were consciously recollected significantly more than that of either angry or disgusted faces. The mean recall for happy faces following suboptimal presentation was 83%. In contrast the mean recall for anger and disgust faces were 17% and .00% respectively. No group differences were found for recall of neutral expressions. As for the affective prime condition only happy facial stimuli ($M=. 83$) were recalled significantly more than that of neutral facial stimuli ($M = .00$), $t (11) = 7.42$, $p = 000$. The same pattern emerged for participants given the source-monitoring test. There was an affective prime X emotion interaction $F (2, 33) = 16.41$, $p = .000$ with only participants exposed to happy expressions meeting the threshold of accurate designation $t (11) = 4.91$, $p=000$. In short, participants exposed to suboptimal exposures had some sense of conscious recollection but only for happy facial photo stimuli.

Given participants' capacity for recalling happy face stimuli, a 2 X 2 ANOVA was performed comparing physiological response across affective priming conditions (neutral vs. target) and the between-subject exposure conditions of anger and disgust. This was done in order to determine whether the results of the initial analyses might have been affected primarily by the processing of happy facial expressions. The results revealed a significant main effect for affective priming conditions, $F(1, 22) = 15.90$, $p = .001$. A paired t-test revealed that when participants were exposed to target affective primes, their physiological response was significantly higher than when exposed to neutral target primes. The mean physiological response for target primes was 1.60 heart rate in beats per minute, in contrast with a mean of .10 for neutral primes, $t(23) = 3.96$, $p = .001$ (see Figures 7 & 8). Results for recall of neutral and target primes (anger vs. disgust) replicated those reported previously for free recall. Moreover, even though participants were informed of the presence of the degraded primes, they nevertheless still maintained that they were not aware of them.

Finally, there were no significant differences in the participants' report of affective mental states corresponding with anger and happiness, as measured on Izard's (1972) DES. However, a trend was seen in the data, which supports the notion that observing other individuals' emotional expressions could influence a person's own mood. Although the trend was slightly higher for happy than for a neutral stimulus, this was not the case for anger or disgust as compared to the neutral stimulus. The opposite pattern of results emerged when the affective state of irritation was examined as reported with exposure to anger. Participants exposed to happy expressions reported irritation and anger substantially less than participants exposed to anger and disgust expressions. For the pattern of results see Table 1. It important to note that the affective state disgust was not adequately represented on the DES scale. Therefore, the emotion disgust was excluded from analysis and hence is not included in Table 1 as a factor for participants' change in emotional response.

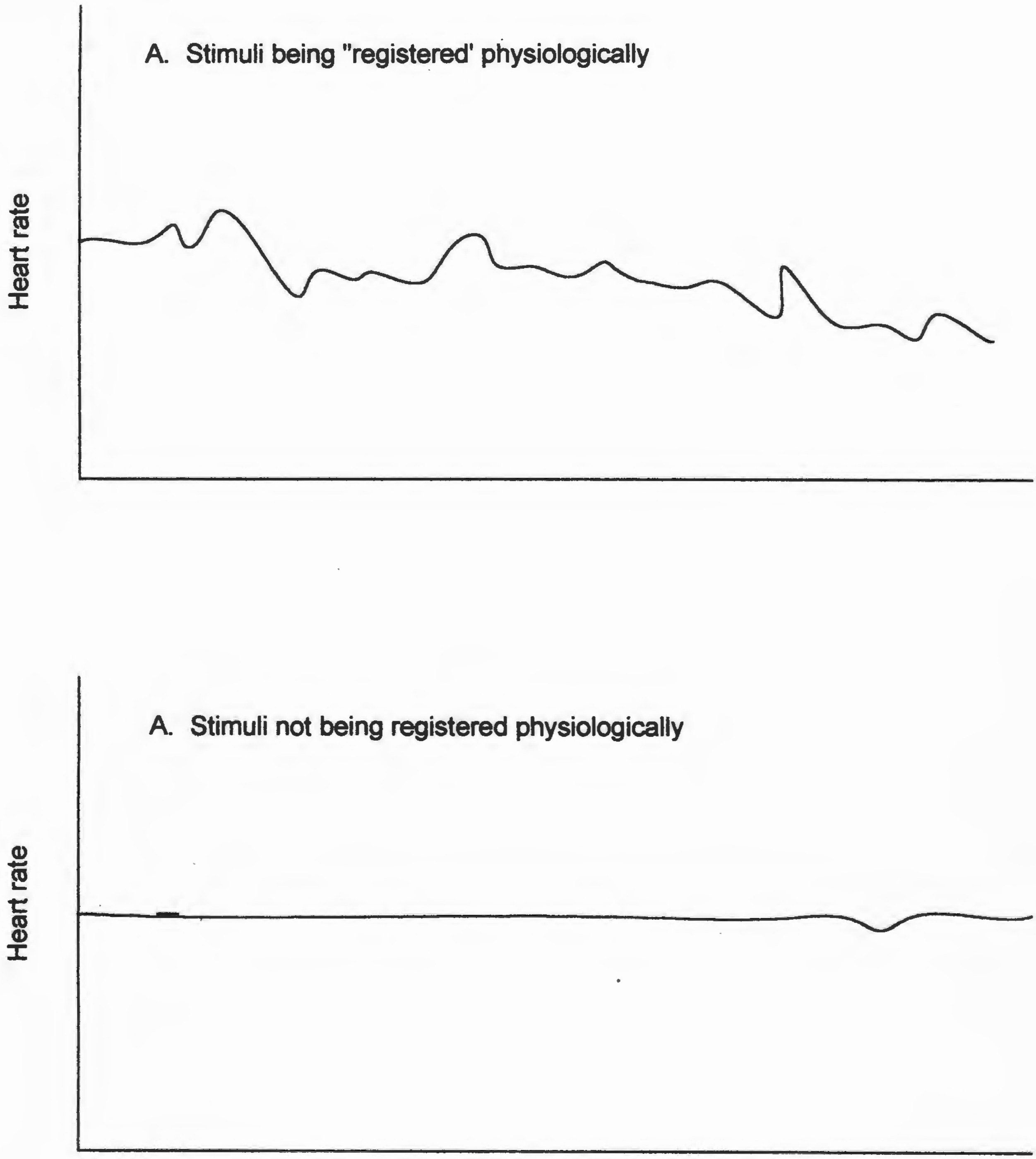

Figure 3

Differential physiological registration of stimuli.

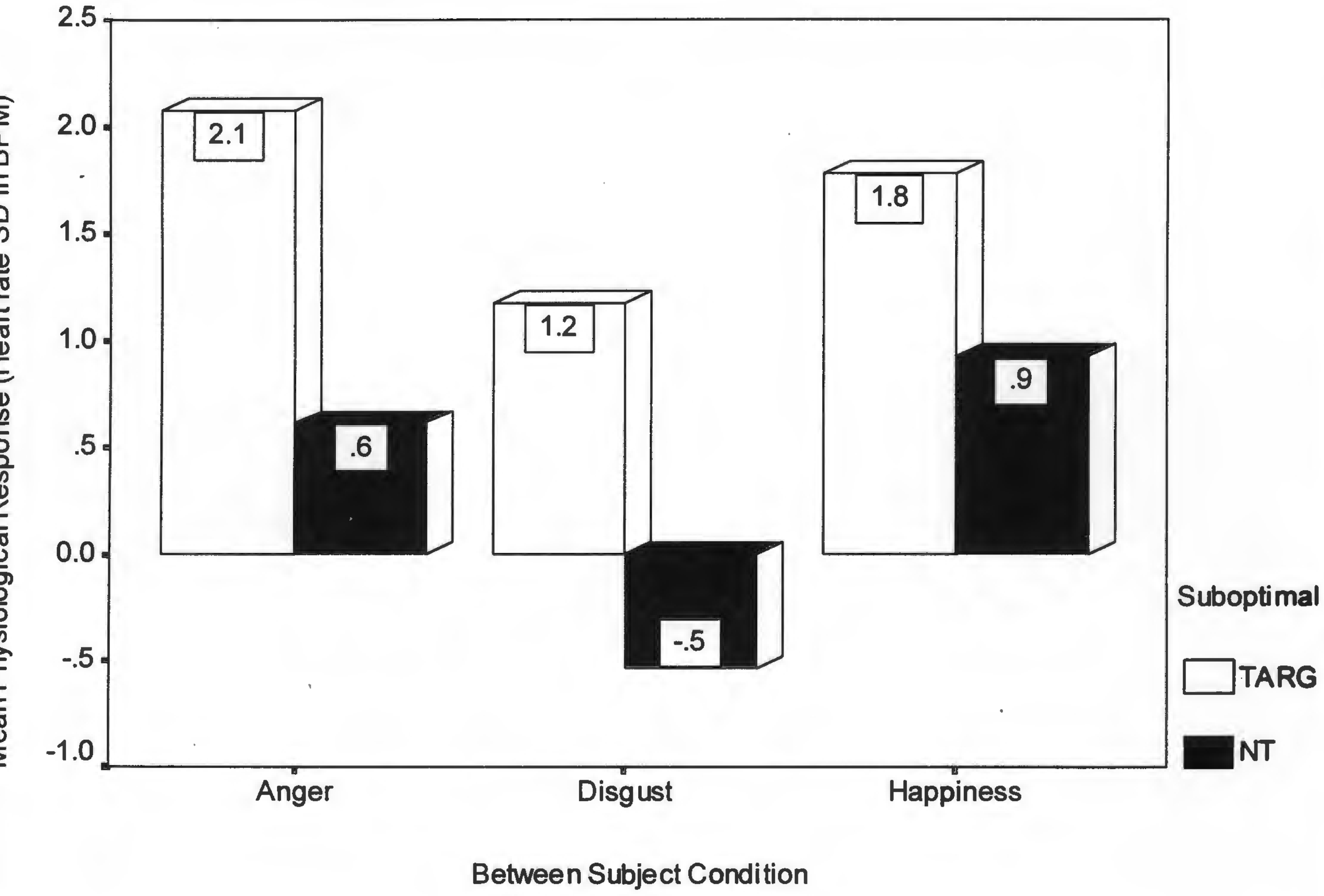

Figure 4

Physiological responses across the target and neutral conditions among the three groups.

Anger, Disgust, and Happy Facial Stimuli (5ms repeated Presentations)

Neutral Facial Stimuli (5ms repeated Presentations)

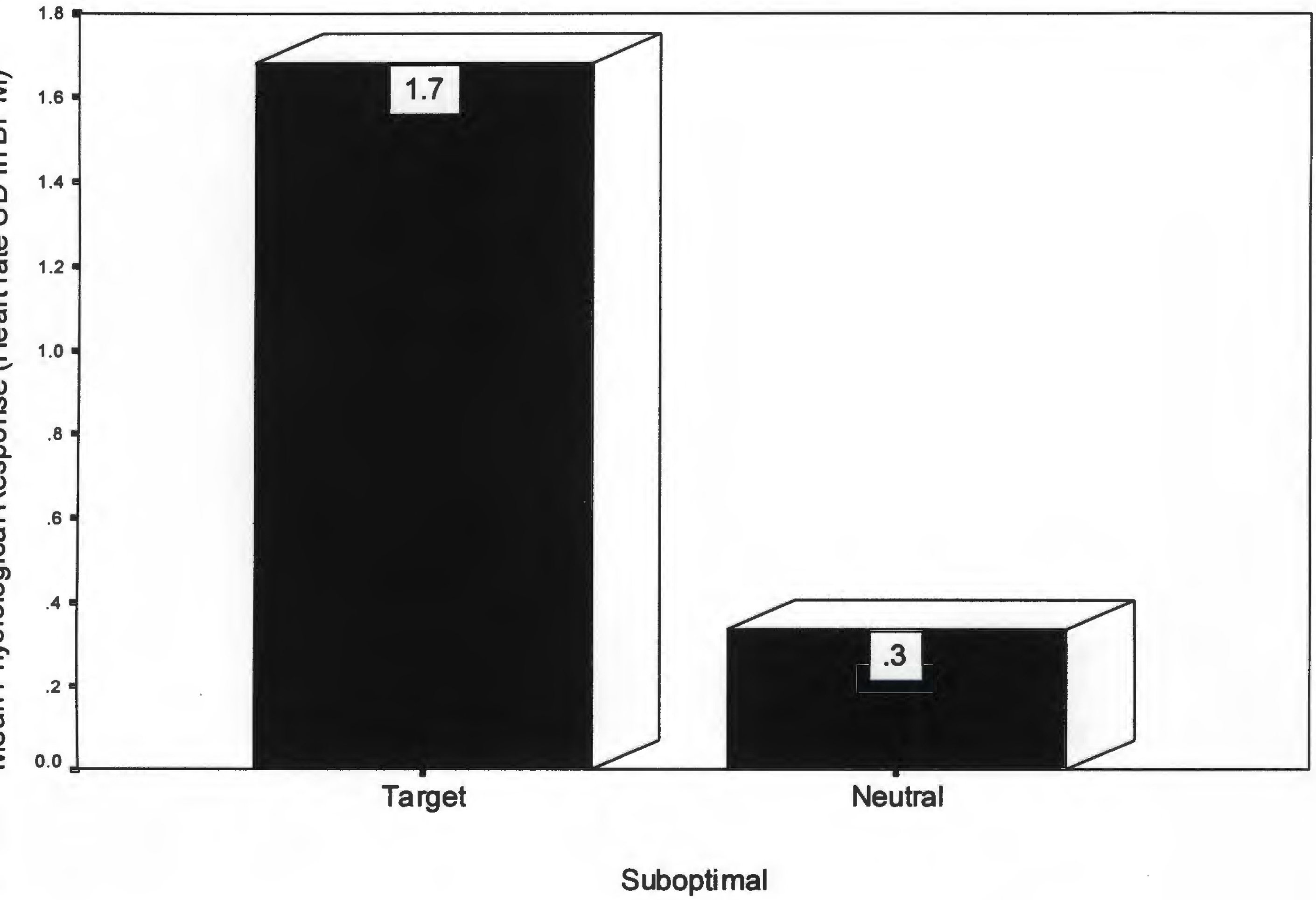

Figure 5

Main effect for within subject condition of neutral (neutral expression) vs. target (anger, disgust, and happy).

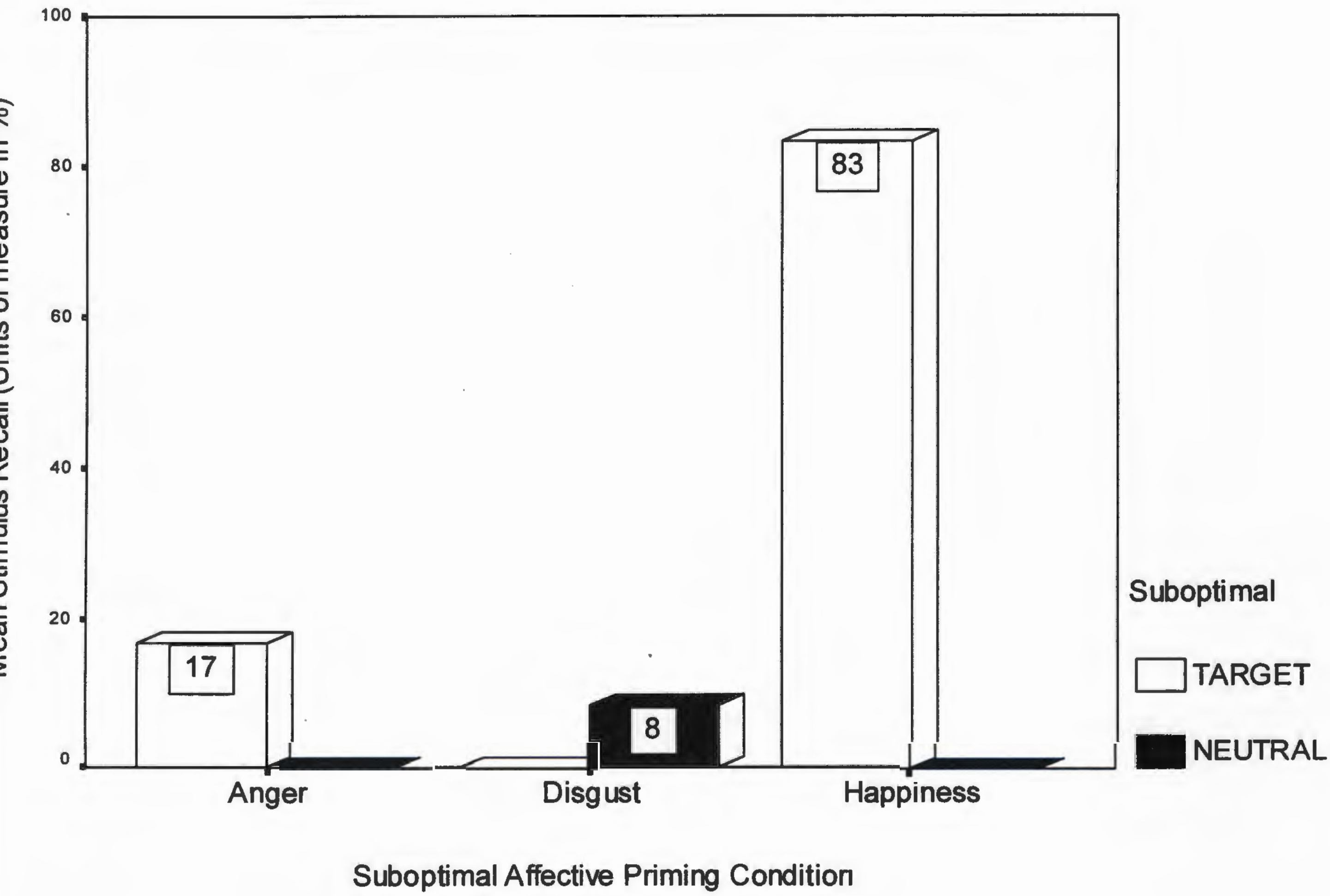

Figure 6

Interaction for free recall of affective primes (neutral and target) across the three between subject conditions.

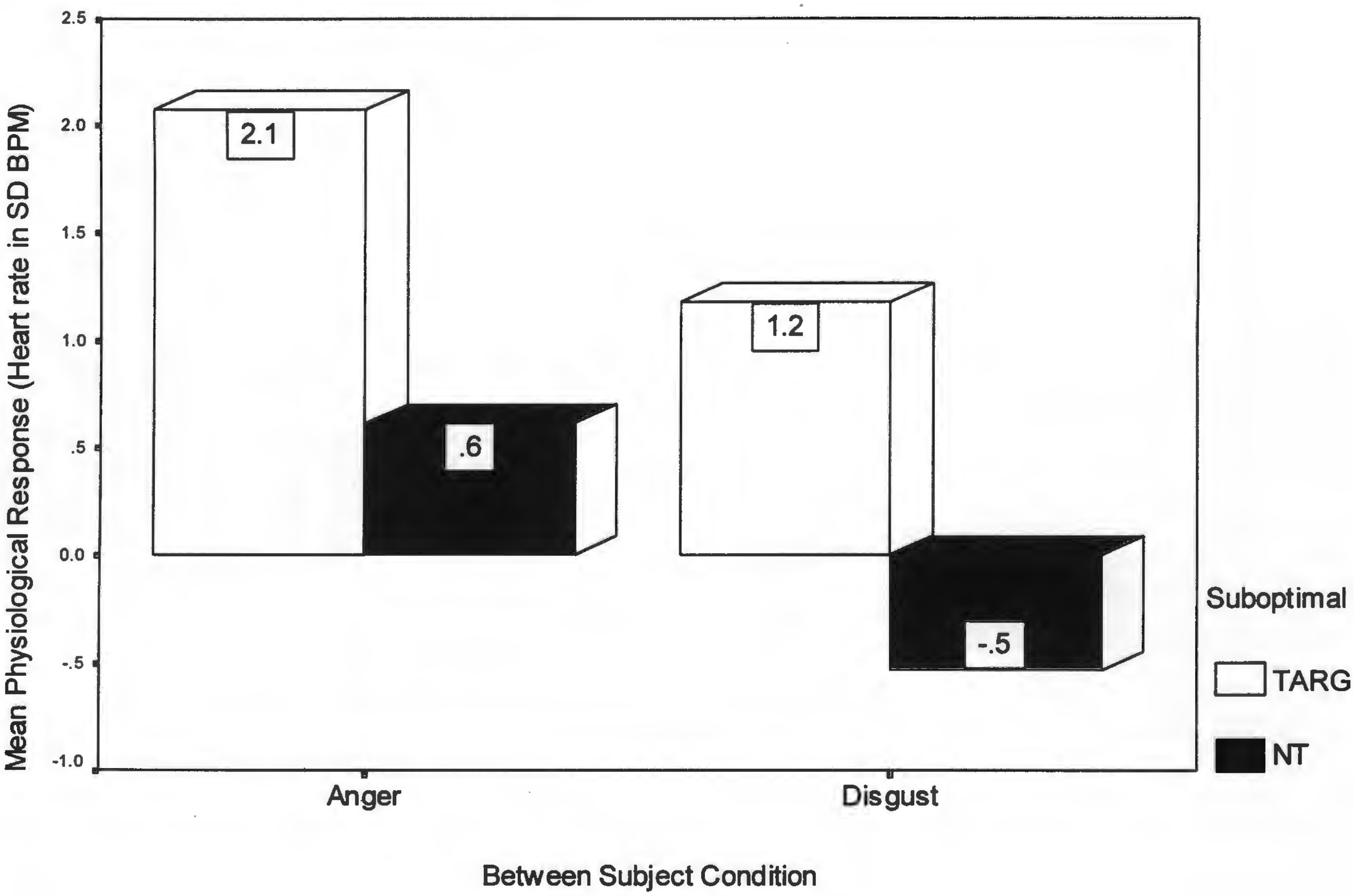

Figure 7

Physiological responses across the within subject conditions (target and neutral) by group.

Anger and Disgust Facial Stimuli

(5 ms repeated presentations)

Neutral Facial Stimuli

(5 ms repeated presentations)

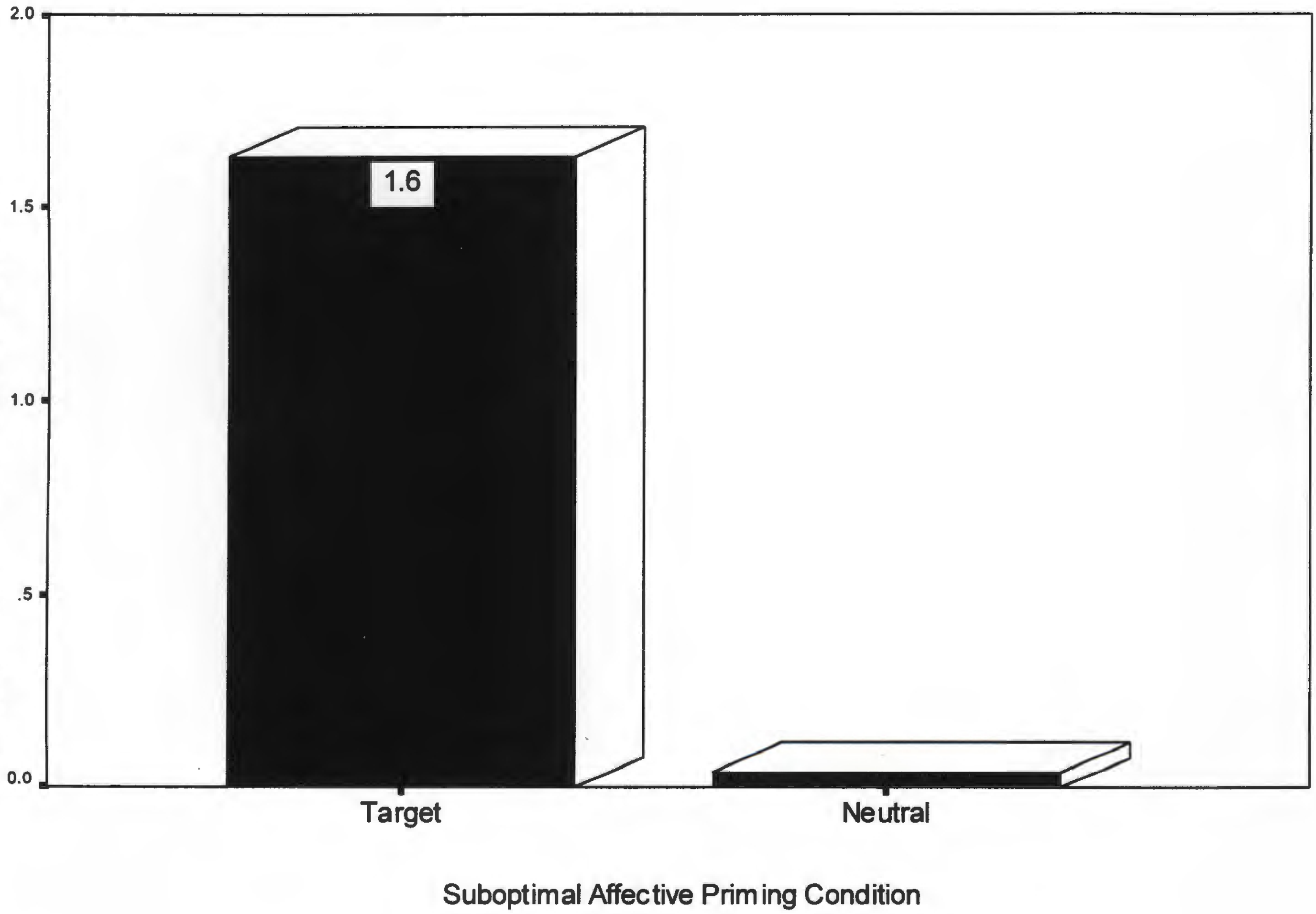

Figure 8

Main effect for within subject condition of neutral (neutral expression) vs. target (anger and disgust)

Table 1

Mean change in participants' probability of reporting affective states (DES).

Group	Exposure conditions	Reported affect: Happiness	Reported affect: Anger
Anger	Neutral	8%	8%
	Anger	8%	10%
Disgust	Neutral	13%	8%
	Disgust	13%	9%
Happiness	Neutral	11%	5%
	Happy	14%	3%

Note. Affective states of anger, irritation, and mad were collapsed to form the single emotional state of anger.

CHAPTER 4

Discussion

To summarize our experiment, suboptimal affective target primes (in the form of the facial expressions of anger; happiness; disgust) presented for 5 ms to the right hemisphere, generated significant shifts in participants' physiological responses compared to neutral expressions presented for the same duration and at the same location. In addition, participants exposed to anger and disgust facial expressions failed to designate and report those expressions on subsequent source monitoring and free recall test measures. In contrast, participants exposed to happy expressions accurately designated and reported the expression on subsequent source monitoring and free recall tests. Finally, there were no significant differences in the participants' reports of affective mental states during any phase of the study, as measured on Izard's (1972) DES. A trend was seen in the data, which supports the notion that observing other individuals' emotional expressions could influence a person's own mood. Irritation was often reported with exposure to an anger expression and less often to happy faces.

The salient finding in this investigation, was that exposure to affective primes elicited more variability in physiological responses than exposure to neutral stimuli. Those responses occurred largely without participant awareness that an emotional expression had been presented (with the exception of happiness). The most parsimonious explanation for the results is provided by the affective priming hypothesis (Zajonc 1980).

The affective priming hypothesis asserts that positive and negative affective reactions can be evoked with minimal stimulus input and "virtually" no cognitive processing. In short, cognition and affect are independent processes that perform discrete operations on the same stimulus information.

The findings are consistent with independent cognition and affect model if we can accept the validity of the following assertions: 1) visceral responses are equated with affective states and only affective states, 2) neurological architecture supports an independent cognition and affect paradigm, and 3) behavioral research supports an independent cognition and affect model. The remainder of this paper will explore evidence both consistent and inconsistent with cognitive-affective independence.

Visceral Response and Affective States

The relationship between visceral response and affective state is difficult to explain without reference to the context in which it occurs. As this relationship is strongly associated with neuroanatomy, the majority of the debate regarding this assertion will be addressed concurrently with neuroanatomical evidence. Any remaining questions about this relationship will be discussed in the conclusion.

Neuroanatomical Evidence

Support for the assumption that cognitive and affective processes are independent (Zajonc 1980, 1984) is found in the form of recent neuroanatomical discoveries. For example, separation of affective processes on the one hand and recognition and categorization of faces on the other is suggested in cases of prosopagnosia (PA). Many prosopagnosics are completely incapable of making even the most basic categorizations of faces, such as race, age, and gender, (Pallis 1955), although they retain their ability to make appropriate affective responses to distinct facial expressions (Ellis 1986). In fact, PA patients who suffer bilateral cerebral lesions are characterized by their inability to recognize the faces of the persons with whom they are familiar. Interestingly, several studies have demonstrated that PA patients display elevated skin conductance (GSR) when presented with faces of persons they had previously known but could not recognize (Bauer 1984; Tranel & Damasio 1985). Some theorists (Kunst-Wilson & Zajonc 1980) suggest that, as with the mere exposure phenomenon (Zajonc 1968), prosopagnosics manifest a positive reaction to familiarity without the benefit of conscious recollection. These theorists therefore equate the physiological skin conductance response with affect.

Interpretation of the PA results is provided by Bauer (1984) who has proposed a model involving at least two anatomically and functionally distinct pathways. He has concluded that the prosopagnosics' bilateral lesions selectively impair the ventral visuolimbic pathway (implicated in object recognition) while sparing the dorsal visuolimbic connections. These spared visuolimbic connections allow for a preliminary or pre-attentive analysis of the emotional significance of the visual stimulus. In other words, prosopagnosics seem to retain their preferences while losing their ability to discriminate (Zajonc 1980).

For additional support, researchers (Kitayama 1991; Kunst-Wilson & Zajonc 1980; Murphy 1990; Niedenthal 1990) advocating the separation of affective and cognitive processes often cite research performed by Zola-Morgan, Squire, Alvarez-Royo, and Clower (1991). These researchers conducted tests of emotional reaction and memory function on four groups of monkeys: intact monkeys, monkeys whose amygdala had been removed, monkeys whose hippocampus had been removed (LeDeoux, 1987), and monkeys whose amygdala and hippocampus had been removed. Monkeys with amygdalectomies performed well on memory tasks but lost their emotional reactions to emotion-inducing stimuli. In contrast, damage to the hippocampal formation resulted in memory deficits while leaving the emotional processes intact. Monkeys with lesions in both the hippocampus and the amygdala lost both their emotional reactivity and their ability to retain newly learned discriminations.

There is a final line of converging neuroanatomical research cited as support for affective-cognitive independence (Zajonc, 1984, 1989). Le Doux and colleagues (Iwata, Ledoux, Meely, Arneric, & Reis 1986; Iwata, Chida, & Le Doux 1987; Le Doux, Iwata, Cicchetti, & Reis 1988) found a direct pathway between the thalamus and the amygdala that is just one synapse long. The direct access from the thalamus to amygdala allows the amygdala to respond faster to some stimuli than to other. As the hippocampus is separated from the thalamus by several synapses, according to Le Doux et al, the response in the amygdala can occur as much as 40 ms faster. This neuroanatomical architecture would apparently allow us to like an object even without knowing what that object is.

I would be remiss in not pointing out that the evidence as presented is anything but definitive support for neurological separation of cognitive and affective states. The supposition that the physiological skin conductance response can be equated with an affective state is speculative at best. Any number of factors may influence the outcome of a physiological response. In the present, for instance, it is possible to equate cardiographic perturbations with affect. However, these responses may be as much cognitive as they are affective. Cognitive research, for example, has repeatedly shown that cognitive processing can occur at a nonconscious level of awareness (Johnson, Hashtroudi & Lindsay 1993; Loftus 1979a, 1979b, 1981; McClosky & Zaragoza 1985a, 1993; Roediger 1990; Tulving & Schacter 1990). Similar to procedures in this experiment, implicit memory (Roediger 1990), repetition priming (Tulving & Schacter 1990), and misinformation effect (Loftus 1978a) procedures demonstrate that participants can perform cognitive tasks and not be aware on subsequent testing that they had performed that task. It is likely, given this cognitive research, that both the present procedure and those previously mentioned (e.g. skin conductance studies) rely heavily on participants' cognitive processes. Furthermore, it is equally likely that this processing plays a role in the subsequent physiological response. We might argue then for a cognitive-affective interaction in the production of procedurally driven physiological responses.

Evidence for a cognitive-affective interaction is also found in the form of recent neuroanatomical discoveries. Research (Le Doux 1986, 1987; Amaral, Price, Pitkanen, and Carmichael 1992) has shown that the amygdala receives inputs from areas in the thalamus, the association cortex, the perirhinal cortex, and the hippocampus. Animal studies have implicated each of these inputs to the amygdala in different aspects of fear processing (Le Doux 1992a). Thalamic to amygdala projections are important in processing the emotional significance of simple sensory features as opposed to complex objects. The association cortex to amygdala connection is important for processing the emotional significance involved in the recognition of objects. The perirhinal cortexes to the hippocampus connections and subsequent cortex and amygdala projections are important in the emotional processing of complex representations, such as the memory for context (Kim & Fanselow 1992). See Figure 9 for amygdala projections to and from cortical systems.

It is apparent that the cognitive prerequisites for fear processing can operate on several levels and can be minimal, extensive or both. Le Doux (1996) suggests that thalamic sensory processing areas are the "gateway" to the neocortex, where object representations are constructed from incoming sensory signals. Furthermore, thalamic areas are a "gateway" to the amygdala, where emotional significance can be attached to sensory signals. Functionally then, the amygdala can be activated by the thalamus at about the same time the cortex can be activated by the thalamus. Consequently, object recognition and emotional representation can proceed in parallel. This neuroanatomical architecture would apparently allow us to like or fear something without knowing what it is. However, this means that the representations that activate the emotional system can be based on incomplete information rather than on clear and complete perceptions. This may account for a person having an emotional response without a cognitive characterization for that response. For example, sense or moods that can accompany a complex sensory event such as the change in season yet have no apparent evidential representation. In other words, one's mood such as sadness could be a response to a single component (leaves falling) of a complex stimulus event (the season), but the individual is not capable of identifying this relationship. This kind of architecture may be particularly useful for initiating a response to a threatening situation. Of course this kind of architecture may also lead to emotional errors. However, emotional responses that are inappropriately initiated by the thalamic sensory inputs to the amygdala can be modified by cortical inputs, which provide multiple levels of representation to activate the amygdala (Amaral et al 1992).

In addition, Amaral et al (1992) have noted that the amygdala projects back to neocortical systems (see Figure 9). Processing in the amygdala can thus influence many cognitive processes organized at the many cortical levels, and at subcortical levels which include the hippocampus. Projections to the cortex from the amygdala may serve as pathways through which emotional processing can influence cognitive processing (Rolls 1990). The amygdala also projects to the brainstem (Takeuchi, Mclean & Hopkins 1982) and the forebrain (Price & Amaral 1981). Both the brainstem level and the forebrain cortex play a role in cortical arousal.

In summarizing the cognitive-affective neurological relationship, there appears to be a demonstrable two-way interaction between emotion and cognition (Le Doux 1989; Amaral et al 1992). Bi-directional connections appear to exist between the neocortex and the amygdala that permit upstream emotion related input from the amygdala to modulate cortical activity and downstream cognitive input from the cortex to modulate the amygdalas' emotional information processing (Ledoux 1989).

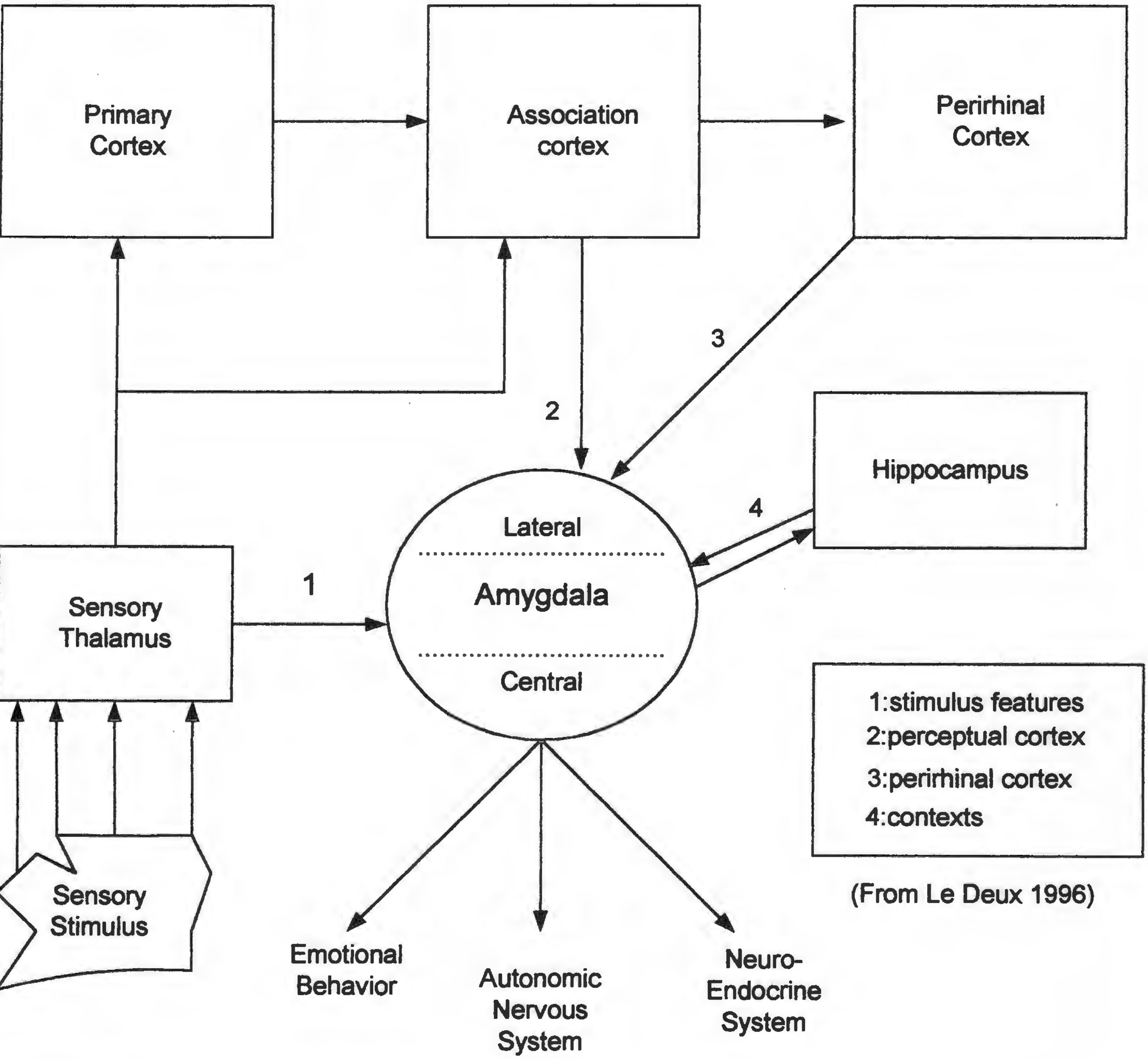

Figure 9

Amygdala projections to and from cortical systems.

Behavioral Evidence

Behavioral research supporting affective-cognitive independence has largely been generated by Zajonc's (1980) affective priming procedure, a procedure in which participants by virtue of repeated exposures, develop affective preferences for previously novel Chinese ideographs. In this procedure a priming stimulus with some emotional connotation such as a picture of a smiling or angry face is presented briefly (4 milliseconds) and is then followed by a masking stimulus. The masking stimulus displaces the prime from consciousness essentially by blanking it out. Shortly afterward, a target stimulus (a Chinese ideograph) is presented for several seconds (optimal exposure) and is consciously perceived. Later when given a forced choice recognition test, participants are unable to distinquish the priming stimulus from a new stimulus they had never seen. Yet despite this lack of overt recognition, when asked which of the two ideographs they liked better, subjects consistently preferred the one primed by the happy face.

A number of criticisms have been leveled at experiments reporting priming effects obtained for stimuli presented at suboptimal levels. For the most part, these critics doubt that there actually is a total absence of conscious detection or identification (Holender 1986; Purcell, Stewart, & Stanovitch 1983). In his experiment, Zajonc (1984) used a forced choice test of awareness to determine whether primes remained outside participants' conscious awareness. For this test, participants were exposed to two faces, one the suboptimal prime (either a happy or an angry expression), and the alternative, a foil that has never been seen before. Participants were then asked which of the two faces was the prime. Typical results showed that participants were unable to select the prime (happy or angry) from the incorrect alternative at a level greater than chance.

The results in the present study are inconsistent with those reported above. In the present study, participants were asked to freely recall stimulus presentations. As noted, participants recalled the expression "happy" at a level significantly above that of chance, whereas recall for angry and disgust faces was not above chance.

One possible explanation for differences in the recollection of affective primes corresponds with the test procedure used by Zajonc (1984) compared to the test procedure used in the present experiment. As indicated, Zajonc used a forced choice test of awareness. The rationale underlying a forced choice test is that if the subject truly cannot detect the prime, he or she should do no better than chance at recognizing it. However, a potential problem with the forced choice test is the introduction of an unnecessary artifact. Instead of having participants recollect one prime, the veridical prime, they are place in a position whereby they must consider a fabricated item. The introduction of this artifact may result in interference with the conscious recollection of the veridical prime. That is, participants may have some vague sense of familiarity regarding the prime, but that familiarity was suppressed or interfered with by the artifact. Therefore participants exposed to the forced choice test may have at some level been aware of the prime, however that awareness may have been masked.

Indeed, this is essentially what was found in this study, using the free recall procedure. With a free recall procedure no additional artifact is introduced. Participants are merely asked to recall the expression(s) they saw previously. In this experiment, nine out of twelve participants recalled the expression "happy". The majority of these participants attributed the ability to recall the expression to some 'vague sense' ('I just sensed that the expression was happy') that accompanied the recollection. Only a few participants indicated physical features ('a flash of white') as the primary reason for recollection. Since the present study did not include a forced choice comparison group to directly compare our methods with those of Zajonc (1984), veridicality of familiarity interference notion is, at this point, a question that cannot be answered. Since the emotional expression of happiness produces physiological changes with awareness while angry and disgust produce physiological changes without awareness it can be concluded that there is a differential effect of the emotions on awareness or the memory of what has been seen. The differential effect of the three emotional expressions on memory clearly suggests that the free recall method is more successful than the forced choice method. This finding also leads to some potentially interesting comparisons between the two methods that should be conducted in the future.

Another explanation for differences in recall of affective priming stimuli correlates with duration of stimulus presentation. For the typical affective priming procedure, suboptimal stimulus presentation (Zajonc 1980, 1984) occurs over 4 ms durations . This falls one ms short of the 5 ms duration in which affective primes were presented in the present study. It is conceivable that the additional 1 ms in the present experiment resulted in participants meeting a level of detection above that of threshold. However, this does not explain their inability to recall the negative affective primes of angry and disgust.

The reason for the apparently increased saliency of happy faces over those of anger and disgust is best explained by the following observations. It has been repeatedly observed that happy faces are recognized more accurately than any other facial expression (Ekman, Friesen, Ellsworth 1982; Kirouac & Dore 1983; Ladavas, Umilta, Ricci-Bitti 1980). Several researchers have suggested that the origin of this happy face advantage is a result of hemispheric differences in recognizing facial expressions, although they tend to disagree as to the content of those differences.

For example, while Suberi and McKeever (1977) claimed right hemispheric dominance in recognizing all facial expressions, Reuter-Lorenz and Davidson (1981), suggested that the dominance of the two hemispheres should depend on the polarity (positive vs. negative) of the facial expressions. Reuter-Lorenz and Davidson maintained that whereas the positive expression of happiness was recognized predominantly by the left hemisphere, the negative expressions of anger and disgust were recognized predominantly by the right hemisphere. Furthermore, Stalans and Wedding (1985) obtained faster reaction times (RTs) in the right visual field with all facial expressions, which would support the idea of a left hemispheric advantage. Finally, Hirschman and Safer (1982) found no asymmetry in the recognition of facial expressions.

In regard to the present experiment, both negative and positive affective primes were presented to the left visual field (right hemisphere). In the typical affective priming procedure stimuli are presented to the center of the visual field. One could effectively argue for a right hemispheric advantage in the present experiment. However, a right hemispheric advantage is reported to occur for negative affective primes only, primes for which participants in the present experiment had no conscious recollection. Thus, the obtained patterns of results in this experiment are opposite to those which would have been predicted assuming a right hemispheric advantage. Therefore it can be concluded that right hemispheric advantage is not an adequate explanation of the recall of the positive affective prime "happy" in the present study.

It is interesting to note that as stimuli were presented to the right hemisphere alone, the present study cannot provide conclusive evidence regarding hemispheric differences in evaluation of emotional polarity. However, the present findings are inconsistent with the hypothesis of a right hemispheric preference for recognition of negative facial expressions. As indicated previously, participants in this experiment were, at some level, cognizant of the positive expression of happiness, but were not cognizant of the negative expressions of anger and disgust. It should be emphasized that this latter conclusion is only tentative as the stimuli were presented at suboptimal levels of exposure.

Finally, in some respects the present findings parallel those found by Murphy (1990). Murphy examined participants' ability to discriminate among six specific facial expressions (Ekman 1972) at suboptimal levels of exposure. Participants were only able to differentiate among emotions that differed in pleasurable polarity. Happiness could be distinguished at a better than chance level from the negative emotions fear, disgust, sadness and anger. No reliable differences were observed among the four negative emotions.

Null Findings and Explanations

The absence of consciously reported feelings (DES) as a result of the priming manipulation is a null finding. One possible explanation is that affect produced by subliminal facial primes is rudimentary and possibly unconscious (Zajonc 1994). Another explanation for participants' absence of consciously reported feeling is that pictures of emotional facial expressions were insufficient to trigger emotional feelings.

The absence of differences in the physiological data for participants exposed to either happiness, anger, or disgust conditions is also a null finding. Accepting a null finding requires that the study gave a reasonable chance for the variable to be manifest. As there were only twelve participants per condition, this null finding may very well reflect a power deficiency. Increasing the number of participants might resolve this deficiency and reveal a putative difference in physiological responding to different emotional expressions.

Conclusion

In conclusion, the present study provides suggestive, but inconclusive support for an independent affect and cognitive model. Neurological and behavioral studies provide both consistent and inconsistent evidence for differential affective and cognitive systems and states. The debate primarily centers on whether neuroanatomical and behavioral evidence supports distinct and separate systems (Zajonce 1980), or, alternatively, that cognitive and affective systems are interdependent (Ledoux 1992a)

With respect to the present results, support for an independent cognitive and affective model is contingent on the following 1) physiological activity is a synonymous representation of affect and 2) affect produced by suboptimal facial primes is unconscious. Under these conditions, absence of consciously reported feelings emerging with an affective physiological response is tantamount to a disassociative relationship between cognition and affect. However, a physiological unconscious representation of affect necessitates that physiology can be equated with affect and that affect can then be equated with that unconscious representation. As discussed previously, this is a theoretical question with no current resolution.

The present research raises other important theoretical questions. For instance, what are the implications of affective stimuli for memory? How might the present results be integrated with current work on indirect memory (Merikle & Reingold 1991), implicit memory (Roediger 1990), repetition priming (Tulving & Schacter 1990), and the misinformation effect (Loftus 1978a). The common feature of these extensive lines of research on memory is that subtle tests, similar to those in this study, reveal memories of which the participant may not be aware. If participants show a physiological response to a stimulus of which they may not be aware, can that response be considered a more subtle indicator of memory (Merikle & Reingold 1991), a distinct process, namely affect (Zajonc 1994), or could this response reflect an interactive process between cognition and affect? Apparently the present research could be interpreted with any one of these theoretical frameworks in mind. However, it is the author's opinion that the interactive interpretation is the most reasonable for the following two reasons. One, the procedure and those described elsewhere (Zajonc 1980, 1997) requires both cognitive and affective input for the acquisition of stimuli. Secondly, neuroanatomical research (Ledoux 1992) supports an interactive interpretation.

It is also necessary to explore whether affective stimuli other than faces (which may have very unique properties), result in a different pattern of results. For example, would presenting photos of a snake suboptimally change physiological activity as well as conscious reports of feeling.

Future research in this domain will, it is hoped, lead to a more systematic understanding of the dynamics of the interactions between physiology, affect and cognition. Above all, the methods presented here, namely, the comparisons between the effects of suboptimal primes on physiology and subsequent recall might stimulate future exploration of the degree to which cognition and affect operate interdependently to modify physiology.

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APPENDIX A

SOURCE MONITORING TEST

Memory Test

On the page that follows, please write down the name of the facial expression (e.g what type of emotion is expressed) presented on the computer monitor before you and indicate (by checkmark) where you seen that expression in the designated columns. In addition we would like you to indicate (in column provided) on a scale of 0-100 (0 being not confident at all, 100 being absolutely certain) how confident you are that your choice of designation was the correct one. You have 14 seconds to make your decisions so please work quickly as possible.

Name FacialExpression Type	Saw Expression During Slow Presentation	Saw Expression During Fast Presentation 1	Saw Expression During Fast Presentation 2	Never Saw Expression	Confidence Rating 0-100
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					

Name FacialExpression Type	Saw Expression During Slow Presentation	Saw Expression During Fast Presentation 1	Saw Expression During Fast Presentation 2	Never Saw Expression	Confidence Rating 0-100
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					

APPENDIX B

DIFFERENTIAL EMOTIONAL SCALE

EMOTIONS SCALE

A number of words that describe different emotions or feelings are listed on the following page.

Read each statement and then circle the appropriate number to the right of the emotion word to indicate the extent to which it describes the way you felt <u>during the performance of the preceding task</u>.

There are no right or wrong answers. Do not spend too much time on any one emotion word, but give the answer that seems to <u>best describe your feelings</u> as you recall them.

Note: Mod. = Moderately
Consid. = Considerably

Phase__________ **Id:**____________

		Not at All	Slightly	Mod.	Consid.	Very Strongly
1.	Attentive	0	1	2	3	4
2.	Joyful	0	1	2	3	4
3.	Surprised	0	1	2	3	4
4.	Sad	0	1	2	3	4
5.	Irritated	0	1	2	3	4
6.	Guilty	0	1	2	3	4
7.	Bashful	0	1	2	3	4
8.	Afraid	0	1	2	3	4
9.	Sluggish	0	1	2	3	4
10.	Concentrating	0	1	2	3	4
11.	Enthusiastic	0	1	2	3	4
12.	Amazed	0	1	2	3	4
13.	Scornful	0	1	2	3	4
14.	Shy	0	1	2	3	4

		Not at all	Slightly	Mod.	Consid.		Very Strongly
15.	Scared	0		1	2	3	4
16.	Fatigued	0		1	2	3	4
17.	Delighted	0		1	2	3	4
18.	Startled	0		1	2	3	4
19.	Angry	0		1	2	3	4
20.	Fearful	0		1	2	3	4
21.	Happy	0		1	2	3	4
22.	Mad	0		1	2	3	4
23.	Frightened	0		1	2	3	4
24.	Excited	0		1	2	3	4
25.	Jittery	0		1	2	3	4

What expression(s) did you see?

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