

ISSUES REGARDING THE USE OF THE SEMANTIC DIFFERENTIAL SCALE  
IN STUDYING THE HEMISPHERIC LATERALITY OF AFFECT

by

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### ABSTRACT

The purpose of this research was to examine the correspondence of some components of attitude theory to a neuropsychological model which proposes a right hemisphere advantage for processing affect. Accordingly, the research employed a common measure of affective appraisal used in social psychological research, the semantic differential scale. Five studies were designed to examine hemispheric differences in the processing of affect and in the formation of affective responses during an evaluative conditioning procedure.

The first study found a left hemisphere advantage in rating the direction (positive, negative) and intensity of emotional words on a semantic differential scale, supporting and extending the conclusions of previous research which used accuracy and reaction time as dependent measures. Tachistoscopically presented negative words were rated more negatively, and positive words more positively, in the right visual field (left hemisphere) than in the left visual field (right hemisphere). Words presented to the left visual field were, nevertheless, accurately rated as positive, neutral or negative. A unique nonverbal analog of a semantic differential scale was developed for this and subsequent studies. Additionally, this scale, which was anchored by sad and happy cartoon faces instead of adjectives, was built into the tachistoscope so that subjects were not required to remove their eyes from the viewer during the study.

The second study found no significant differences between the ratings of positive and negative facial expressions presented tachistoscopically to the right and left visual

fields. This finding countered the results of most reported studies using accuracy or reaction time for measuring the processing of emotional facial expressions and suggested that scale ratings measured different processing activities than other measures. It was suggested that responding to the scale involved sufficient left hemisphere involvement to eliminate the expected right hemisphere effect, perhaps because it may require numeric processing, shown to have a left hemisphere advantage in previous studies, or because it may promote a conscious assessment and cognitive labelling.

This study also found some support for the hypothesis that mirror images of facial expressions would be rated more intensely in the right visual field than facial expressions in original orientation, owing to the presentation of the more expressive, left side of the face closer to the fovea. These results indicated that this factor should be taken into consideration in the design of laterality studies of facial expressions.

The third study developed a method to examine the laterality of evaluative conditioning, through pairing negative facial expressions with neutral expressions in lateralized presentations in a differential conditioning procedure. In addition to the development of a lateralized procedure, the use of a differential conditioning design is unique in studies of evaluative conditioning and has the advantage of permitting a more direct comparison of results with studies of physiological conditioning, where the design is commonly used. This study did not demonstrate conditioning in either hemisphere, however, likely owing to the weakness of the UCS at short exposure durations.

A stronger and novel conditioning procedure was developed, pairing abstract visual patterns with a noxious odour (puffs of butyric acid solution). In the fourth study, the procedure was tested with nonlateralized, foveal presentations at short exposure durations over different combinations of patterns and numbers of trials. Evaluative conditioning was produced successfully. Similar to the results of studies of physiological conditioning, conditioning effects were found primarily for participants who could articulate the stimulus relationships. The procedure had the advantage of producing a substantial proportion of unaware participants; these subjects showed minimal changes in affective response (in the expected direction). These results suggested that the development of verbalizable awareness interacted with the development of evaluative conditioning.

The fifth study tested the conditioning procedure developed in the fourth study with lateralized presentations of the visual patterns. The study was stopped when it became apparent that the ratings of the neutral stimuli at short exposures showed poor reliability which could increase variance and decrease the possibility of finding an effect (a problem which arose less seriously in the fourth study).

The results of these studies indicate that ratings on a semantic differential scale may be inappropriate for studies of hemispheric differences related to affect. First, ratings were found to be ineffective at capturing previously established right hemisphere effects for processing emotional facial expressions, which suggests that they may engage left hemisphere processes. Second, they were found to be difficult to use reliably with abstract visual stimuli.

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## CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

This research started out as an examination of hemispheric differences in the processing of affect and in the formation of affective responses during a conditioning procedure. It had a unique purpose which crossed disciplines, to test the fit of some components of attitude theory to a neuropsychological model for processing affect. The goals of such research are twofold, to learn more about the neuropsychological underpinnings of attitudes and to ask new questions of neuropsychological models through a consideration of social psychological theory. The push and pull of trying to fit together two different aspects of the same phenomenon can reveal a new understanding of each.

The research plan evolved from investigating hemispheric differences in making affective appraisals to testing whether one mechanism of attitude formation, evaluative conditioning, would show a right hemisphere advantage for nonverbal stimuli. Accordingly, the design was interdisciplinary in approach, combining a neuropsychological paradigm for testing visual laterality with an attitude measure, an analog of a semantic differential scale.

The following literature review describes the research which led to my expectations that right hemisphere effects would be found for some attitudinal processes and that the semantic differential scale would be useful for obtaining them. First, the review presents the evidence for a right hemisphere effect in the processing of affect, including a discussion of the kinds of tasks and responses that have produced this effect. Second, it describes the hypothesized characteristics of attitudes and relates

them to the neuropsychological model for processing affect. Third, it examines the use of the semantic differential scale in attitude research.

### Role of the Right Hemisphere in Processing Affect

Zajonc (1984) described two general classes of theory about emotion, cognitive theories which emphasize the role of cognitive processes in mediating emotional experience (for example, Schacter, 1964), and more biologically oriented theories which propose two separate but interacting systems for cognition and emotion.

A parallel for these two general theories is found in research on the neural pathways involved in emotion. From an evolutionary perspective, the functional areas for emotion are distributed across the older regions of the brain (brainstem, limbic, and paralimbic regions) as well as the more recently developed, neocortical regions of the brain. Conventional, cognitive models of emotion, which suggest that emotion occurs after detailed cognitive processing, find a functional basis in the sequence of processing that starts in the neocortical sensory areas, continues to neocortical association areas, and subsequently activates the paralimbic regions (Derryberry & Tucker, 1992). However, recent studies have also found evidence for a backward flow of information from paralimbic to neocortical areas, suggesting emotional influences on the manner in which information is represented in the neocortex (Derryberry & Tucker, 1992).

Hemispheric differences likewise point to a separation of the systems for cognition and emotion. Left hemisphere processing has been characterized as verbal, analytic,

detailed, serial, and involving logical, sequential reasoning, whereas right hemisphere processing has been characterized as nonverbal, synthetic, holistic, spatial, and involving concrete, perceptual insight. While the left hemisphere (LH) is dominant for linguistic functions in over ninety percent of right-handers (Searleman, 1977), studies of normal right-handers and patients with hemispheric lesions have shown that the right hemisphere (RH) has an advantage in processing affect as well as nonverbal, visual spatial operations. This advantage in processing affect extends to both the perception and expression of affect, however, the following discussion is primarily limited to a discussion of perception. In this regard, the right hemisphere acts as if it contains a vocabulary of nonverbal affective signals (facial expressions, prosody, and gestures) which makes it specialized for reading the nonverbal human social displays of other humans (Bowers, Bauer, & Heilman, 1993; Spence, 1992).

Clinical comparisons of patients with right and left hemisphere lesions have indicated that damage to the right but not left hemisphere can impair abilities to recognize facial expressions (for example, Cicone, Wapner, & Gardner, 1980; DeKosky, Heilman, Bowers, & Valenstein, 1980), discriminate and label affective vocal tones (Tucker, Watson, & Heilman, 1976; Weintraub & Mesulam, 1983), match type of affect to drawings of emotional situations and sentences (Cicone et al., 1980; Heilman, Scholes, & Watson, 1975), recall affective passages (Wechsler, 1973), and comprehend visually presented humorous material (Gardner, Ling, Flamm, & Silverman, 1975). Evidence for a right hemispheric advantage in emotion is usually attributed to the hemisphere without regard to site, although some evidence from lesion

and electroencephalographic (EEG) studies suggests that posterior regions of the cortex may be more important for processing affective information while anterior regions may be more important for expression (Borod, 1992; Tomarken, Davidson, & Henriques, 1990).

The majority of lateralization studies with normal right-handers have also found a right hemisphere advantage for processing emotional stimuli. In auditory lateralization studies which used a dichotic listening paradigm, left ear advantages, reflecting a right hemisphere effect, have been found for recognizing emotional vocal nonspeech sounds such as laughing and crying (Carmon & Nachshon, 1973), and identifying the affective tone of both spoken passages (for example, Ley & Bryden, 1982; Strauss & Moscovitch, 1981) and emotional tonal sequences (Bryden, Ley, & Sugarman, 1982). Many visual lateralization studies, which used a tachistoscopic paradigm, have found left visual field advantages for a variety of tasks involving facial expressions, again reflecting a right hemisphere effect. This effect was found to be independent of the broader right hemisphere superiority for processing faces (Ley & Bryden, 1979). It is influenced by the intensity of the facial expression; in a study of cartoon faces, Ley and Bryden (1979) found a left visual field advantage for more extreme positive and negative expressions but not for milder expressions.

Since the experimental studies in this dissertation involve visual laterality tasks, it is worthwhile at this point to describe the general method. The visual laterality paradigm takes advantage of the specificity of ascending nerve fibres from areas of the retinal field to the right and left visual cortex. Specifically, objects presented in the

left visual field (to the left of the centre of focus) are exposed to the right half of the retina in each eye; this area of the retina sends fibres exclusively to the right visual cortex. Correspondingly, objects presented in the right visual field are exposed to the left half of the retina and are processed exclusively by the left visual cortex. Objects presented in central focus are exposed to the fovea which send fibres to the visual cortices of both hemispheres. Consequently, presenting an object a sufficient distance to the right or left of central focus enables the experimenter to control the hemisphere to which the visual information is sent. Since the eyes move constantly from side to side, it is necessary to control the length of exposure of the object so that it is presented to the correct area of the retina. The length of exposure should be less than the length of time that it takes the eye to initiate a saccadic eye movement to move the eyes to a new fixation point, that is, approximately 180 ms (Bryden, 1982). A tachistoscopic presentation permits the controlled exposure of a stimulus for very short durations. Participants are requested to keep their eyes focused on the centre of the screen, which is usually marked by a dot. Shortly after the onset of the dot, a stimulus is flashed to the right and/or the left of the dot. Stimuli may be presented 'unilaterally', to one visual field at a time, or 'bilaterally', to both visual fields simultaneously. A critical feature of a tachistoscopic presentation is that the stimuli are degraded through brief exposure to an area of reduced visual acuity (compared to the fovea) (Bryden, 1982). A demonstrated hemispheric effect would suggest that the hemisphere which showed the advantage was better able to process the degraded stimulus information.

Reaction time and accuracy are the most common dependent variables used in studies of visual laterality. Reaction time is measured as the length of time from the onset of the stimulus to the registration of a simple motor response, such as a key press, to a processing task. It is thought to represent the interhemispheric transmission time from the hemisphere which initially visually processes the stimulus to the hemisphere specialized for the higher order processing of the information and the time required to process the information in the hemisphere (Sergent, 1983). A faster reaction time in one visual field would indicate that the corresponding hemisphere was more specialized to handle the information since less interhemispheric transfer was necessary or less time was required to process it. Similarly, greater accuracy of response would suggest more effective processing of the degraded information.

Since visual lateralization tasks are particularly relevant to the research plan, it is worthwhile to note the types of visual lateralization processing tasks which have been shown to produce an RH effect (for review, see Ley & Strauss, 1986). These included deciding whether two facial expressions were the same or different as a previously seen target face or a designated affect (for example, Hansch & Pirozzola, 1980; Ley & Bryden, 1979; Strauss & Moscovitch, 1981; Suberi & McKeever, 1977), identifying which visual field contained an emotional face (for example, Reuter-Lorenz & Davidson, 1981; Reuter-Lorenz, Givis, & Moscovitch, 1983), and identifying which of two composite expressions was more intense (for example, Campbell, 1978; Heller & Levy, 1981). Only one study was found which asked participants to evaluate facial expressions on a rating scale (Natale, Gur, & Gur, 1983); this study, which produced

mixed results, is discussed in the section, 'The Semantic Differential Scale'.

There is some question whether the valence of the emotional stimulus influences hemispheric differences in processing affect. The role of the right hemisphere in processing negative affect is well established, although in a study of schematic faces in which facial components were systematically altered, Magnussen, Sunde, and Dyrnes (1994) proposed that the left hemisphere advantage for processing negative facial expressions may be restricted to non-aggressive, sad expressions as opposed to hostile expressions. The main area of contention is the extent to which the two hemispheres differentially contribute to the processing of positive affect (Davidson, 1984). While many visual lateralization studies have shown left visual field (RH) effects for both positive and negative stimuli, other studies have suggested that the left hemisphere may be specialized to process positive affect (for review, see Davidson, 1984). For example, Reuter-Lorenz and Davidson (1981) found shorter response latencies for positive faces in the right visual field (LH) when participants had to pick the side of presentation of an emotional face during bilateral tachistoscopic presentations.

The verbal or nonverbal nature of the stimulus has been shown to influence the exhibition of hemispheric advantages in processing affective content in visual lateralization studies. While the right hemisphere has been found to have some capability for the production of emotional utterances in severe aphasics (Searleman, 1977), visual lateralization studies of normal right-handers have generally shown that emotional words are recognized better for right visual field (RVF), left hemisphere (LH) presentations than for left visual field (LVF), right hemisphere (RH)

presentations, particularly for males (Graves, Landis, & Goodglass, 1981; Strauss, 1983). This indicates that the linguistic superiority of the left hemisphere has a greater impact on the outcome of a laterality study than any processing of affect by the right hemisphere. However, Graves et al. (1981) found that in right-handed males, affective content may aid the ability of the right hemisphere, in particular, to recognize a word. Emotional words were recognized significantly better than non-emotional words, and this emotional effect was significantly stronger for left visual field presentations than for right visual field presentations. Strauss (1983) found similar results although the stronger LVF emotional effect was not statistically significant.

Although the verbal or nonverbal nature of the stimulus is perhaps the easiest way to conceptualize the processing asymmetries of the two hemispheres, Bryden (1982) pointed out that the strategy used to perform the task may be more important than the type of stimulus studied. Since verbal mediation of a task involving nonverbal stimuli may reduce or reverse any expected right hemisphere effect, left visual field (RH) advantages in tachistoscopic tasks may only be seen when holistic or nonverbal strategies become relatively more important than analytic or linguistic strategies. For example, Levy-Agresti and Sperry (1968) had noted that both hemispheres of split-brain patients were capable of performing some visual spatial tasks, but that the left hemisphere had an easier time with easily verbalizable patterns whereas the right hemisphere did better on more difficult visual discriminations. Such strategy differences have also been used to explain discrepancies in face perception studies. Sergent (1986) proposed that in face perception tasks where an analytic strategy could

be used, a left hemisphere effect was observed, whereas a right hemisphere effect was observed when a holistic, configurational strategy was more efficient.

### The Link Between Attitude Research and the Hemispheric Model for the Processing of Affect

Definition of attitude. In social psychology, the term 'attitude' is synonymous with affective response. Thurstone (1931) defined an attitude as "affect for or against a psychological object." While later researchers expanded the definition to include cognitive and behavioural correlates, Fishbein and Ajzen (1972) suggested that the term again be restricted to the evaluative dimension to indicate liking or disliking for an object. Traditionally, attitude measurement has involved locating an individual on a bipolar continuum with a neutral or zero reference point, implying that an attitude has direction and intensity that can be quantitatively measured (Heise, 1970; Osgood, Suci, & Tannenbaum, 1957).

In the simple form described above, an attitude is equivalent to affective processing and may be a function of right hemisphere processing. Notably, there are parallels between the characteristics of right hemisphere processing and the characteristics of affective judgements proposed by some social and cognitive psychologists. Zajonc (1980) proposed that affective judgements occur early in perceptual processing and involve a holistic, pre-cognitive analysis of the gross, global features of a stimulus or event, rather than a detailed identification of discriminant features. He reasoned from an evolutionary perspective that it would be vital to survival for organisms to develop

a mechanism to respond quickly to dangers in the environment. An effective mechanism for self-protection would be a rapid, automatic evaluation of stimuli relevant to an approach or avoidance response.

Pre-attentive or pre-conscious affective appraisals have also been proposed from an information processing perspective. Through the demonstration of an effect known as perceptual defense, McGinnes (1949) suggested that individuals can discriminate and emotionally respond to a stimulus before fully perceiving it. Subjects showed heightened galvanic skin responses to tachistoscopically presented socially taboo words at exposure durations below recognition threshold, and higher recognition thresholds were required for these words than neutral words (the perceptual defense effect). In a subsequent review, Erdelyi (1974) suggested that this effect and its counterpart, perceptual vigilance, were special instances of selectivity in cognitive processing, possibly in the encoding of information into short-term memory storage, purportedly the region of consciousness. More recently, Ohman proposed that affective appraisals of fear-evoking stimuli, in particular, were automatic and pre-attentive. Their functions were to prime skeletal and autonomic responses as well as activate further cognitive analysis of the event (Ohman, 1986; Ohman, Dimberg, & Esteves, 1989).

The neurofunctional relationship in affective processing may be more complex than a simple right versus left hemisphere involvement, given the distributed nature of the emotional system. For example, Derryberry and Tucker (1992) have suggested that these immediate, global, emotional reactions may not be a function of cortical processing at all but may instead be a product of independent functioning of the limbic

system, in particular the thalamus. This would reduce the likelihood that these reactions were lateralized to a particular hemisphere. However, it would be consistent that these reactions could influence cortical representations of stimuli and that a laterality effect may be exhibited which depended on the nature of the stimulus.

Attitude formation and change. Right hemisphere models of processing may also be relevant to theories of attitude change, particularly those proposing that attitude change occurs without verbalizable awareness. As with theories of emotion, existing theories of attitude formation and change differ in the extent to which affect is incorporated and linked to conscious reasoning. Some more 'mindful' models of attitude change include dissonance theory and balance theory. Dissonance theory proposes that attitude change is mediated entirely by the result of holding inconsistent cognitions about an object or event, expressed as 'cognitive dissonance' (Festinger, 1957). Balance, or 'cognitive consistency' theories base attitude change predictions on the affective relationships between individuals and objects, but construct a cognitive decision-making process to mediate changes in affect (Heider, 1958; Himmelfarb & Eagly, 1974).

Zajonc (1980) proposed a less 'mindful' model, stating that attitude formation as well as judgements could occur 'pre-cognitively.' This conclusion was based on studies of the 'mere exposure' effect, the observation that liking for a neutral stimulus could be increased through repeated exposure (Moreland & Zajonc, 1977, 1979; Zajonc, 1968). When ratings were based on long exposure durations of visual stimuli, changes in liking were found to be independently influenced by the affective response

and a cognitive factor, recognition (Moreland & Zajonc, 1977, 1979; Zajonc, 1980). The mere exposure effect was still found, however, when exposure duration was decreased to 1 ms to reduce visual recognition (Kunst-Wilson & Zajonc, 1980; Zajonc, 1980). An earlier study that used a dichotic listening technique found a similar result. Although recognition for melodies presented to the unattended ear was just above the chance level, liking was greater for previously presented melodies than for new melodies (Wilson, 1975, as cited in Zajonc, 1980). Zajonc (1980) later proposed that if evaluations occurred and changed without conscious awareness, the reason or history behind an affective response might not always be accessible to conscious thought.

Another model of attitude change which hypothesizes a similar 'mindless' or nonconscious mechanism for the development of an attitude is evaluative conditioning. Through the pairing of neutral nonsense syllables (CS) with affective words (UCS), Staats and Staats (1957) claimed to demonstrate that liking or disliking for verbal stimuli could be conditioned without participants' awareness of the stimulus contingencies in the conditioning procedure. However, their procedure was controversial and subsequently criticized for the measure of awareness used and the possible demand characteristics of the experimental situation (Insko & Oakes, 1966; Page, 1969).

When a more elaborate cover story was used to obscure the nature of the study, and more explicit post-experimental questionnaires were used to assess awareness, only participants who were aware of the stimulus contingencies in the conditioning procedure, and in some cases, the purpose of the study as well, showed the expected

attitude changes (Insko & Oakes, 1966; Page, 1969). Staats (1969) in turn suggested that the post-experimental questionnaires used by his critics were so explicit that they elicited awareness while being filled out. Reduced to arguments about methodology, research in the area slowed.

During this period, a considerable amount of research was being carried out on the conditioning of physiological responses. This research tended to support the view that conditioning effects were contingent on verbalizable awareness of the CS-UCS relationship (for example, Baer & Fuhrer, 1968, 1982; Dawson & Reardon, 1973; Maltzman, 1977), or in other words, were a form of conscious 'sign learning' (Mowrer, 1947). However, this research was affected as well by methodological considerations similar to those in attitude conditioning studies. Furedy and Schiffman (1971) pointed out that the cognitive prediction held only when participants were divided into two groups of accurate versus inaccurate verbalizers of the stimulus contingencies, and that this forced dichotomy may have obscured the relationship over intermediate values of contingency awareness. As evidence, they showed that there was no correlation between physiological conditioning and a continuous measure of contingency awareness, one of the facts later used by Furedy (1991) to argue that conditioning in humans was not solely a cognitive phenomenon. Further, it is important to note that the criterion for awareness, verbalizable awareness, is one that may be applied only to humans. For other species, it is not known whether conditioning requires awareness or whether it involves other levels of awareness; clearly, conditioning in animals occurs without the ability to communicate it verbally.

The debate over cognitive mediation in attitude conditioning re-emerged in the mid 1970s with the experiments of Levey and Martin. Using pairs of briefly presented neutral and emotive pictures, Levey and Martin found that some conditioning effects were obtainable without verbalizable awareness of the stimulus contingencies (Levey & Martin, 1975; Martin & Levey, 1978). However, the studies were poorly controlled, provided incomplete description of the criterion for awareness, and produced inconsistent results, finding consistent forward conditioning for negative UCSs, but less reliable conditioning for positive UCSs and backward conditioning (in view of the model below, equally strong forward and backward conditioning would be expected).

Later, Levey and Martin developed a model of evaluative conditioning which was based on the conceptualization of affective appraisals proposed by Zajonc (Levey & Martin, 1983; Martin & Levey, 1987). They proposed that the learning of an affective response was sufficient to produce conditioning, while cognitive responses such as the development of awareness occurred later. The learning of the affective response developed automatically from the contiguity, or pairing, of the CS and UCS. The CS and UCS elicited immediate affective judgements and were stored in short term memory as an undifferentiated stimulus complex with the combined evaluative tone of both stimuli. Multiple pairings increased the intensity of the association and shift. Because the affective change resulted from the congruence of affective judgements, it should not matter whether the UCS preceded the CS (backward conditioning) or followed it (forward conditioning).

A study by Baeyens, Eelen, and van den Bergh (1990), in which neutral faces were paired with liked or disliked faces, possibly provided some support for the evaluative conditioning model, although it was arguable whether the conditioning effects they found reached statistical significance. Using both concurrent and post-experimental measures of awareness, the researchers found changes in the evaluation of the neutral faces in the few cases in which participants were unaware of the stimulus relationships. Baeyens, Hermans, and Eelen (1993) later reported that in subjects aware of the stimulus contingencies, the extent of evaluative conditioning was not sensitive to the level of the contingency. However, contrary to expectation, Hammerl and Grabitz (1993) found that backward conditioning did not occur under the same conditions that produced forward conditioning.

While some researchers have questioned whether affective responses are conditionable without awareness or even fall into the category of conditionable responses (for example, Ohman, 1986), these 'mindless models', for which there is some, admittedly limited, empirical support, are interesting in suggesting a primacy of affective processes in attitude formation. They have several proposed characteristics that would suggest right hemisphere involvement: the integral role of affect, more holistic than detailed processing, and the absence of cognitive mediation. As a result, it could be predicted that the associative learning of nonverbal stimuli such as facial expressions would be more strongly represented in the right hemisphere than the left hemisphere. At a minimum, the right hemisphere would play a critical role in processing the stimuli and appraising the affective intensity of the UCS, which would

influence the strength of the associated evaluative response of the CS. More likely, the associative process engages the right hemisphere as well, given the experimental evidence for a right hemisphere advantage for memory for emotional facial expressions (Strauss & Moscovitch, 1981).

Support for laterality differences in conditioning is evident in studies of the conditioning of physiological responses. In this type of study, a physiological response (for example, galvanic skin response) to the conditioned stimulus is measured rather than an affective appraisal on a rating scale. Physiological responses have been shown to correlate in intensity to attitude responses, but do not indicate whether the responses reflect positive or negative affect. Hugdahl and his colleagues have demonstrated laterality differences in the conditioning of electrodermal responses, such as the galvanic skin response, to visual and auditory stimuli, using shock or loud noise as the UCS. They found a left hemisphere effect for words and syllables, and a smaller right hemisphere effect for colour cues and facial expressions (Hugdahl & Brobeck, 1986; Hugdahl, Kvale, Nordby, & Overmier, 1987; Johnsen & Hugdahl, 1991, 1993; Ohman, Esteves, Para, Soares, & Hugdahl, 1988). These studies extended the general finding in laterality studies that the overall hemispheric effect depends on the verbal/nonverbal nature of the stimuli involved.

In a study examining the conditioning of electrodermal responses to emotional facial expressions, using shock as the UCS, Johnsen and Hugdahl (1993) provided evidence that the right hemisphere effect for conditioning to facial expressions was attributable to an advantage for forming associations, in addition to the storing and

retrieval of perceptual information. During the conditioning phase, different CSs were bilaterally presented to each hemisphere; during the test (extinction) phase, they were presented foveally to both hemispheres. The use of foveal presentations during the test phase controlled for the perception of facial expressions; the stronger electrodermal response to expressions presented to the right hemisphere during conditioning suggested that the advantage included associative processing. Furthermore, this study, as well as an earlier one (Johnsen & Hugdahl, 1991) showed that the conditioning effect was stronger to negative (angry) facial expressions than to positive (happy) facial expressions; although this may have been attributable to the greater saliency of pairing a negative UCS (shock) with a negative facial expression.

Hugdahl and his colleagues did not examine whether conditioning effects in either hemisphere were dependent on awareness. Independent conditioning in the right hemisphere would not necessarily imply an absence of cognitive mediation or awareness since there is time during the conditioning process for interhemispheric transfer of information. Moreover, while a lack of awareness has been hypothetically associated with pre-cognitive or affective processing, it does not necessarily imply a lack of higher-order cognitive processing. Research on subliminal processes has indicated that some processes which likely require higher-order cognitive processing may not require conscious processing. In particular, people have been shown to learn complex procedural rules automatically and without conscious awareness (Lewicki, 1986; Lewicki, Czyzyska, & Hoffman, 1987; Lewicki, Hill, & Bizot, 1988). Pertinent to associative learning, Lewicki (1986) observed that subjects were able to use pattern

cues that were learned unconsciously over many trials to predict the positioning of a target stimulus within a frame.

The question of whether awareness is required is an interesting one. If right hemisphere conditioning does not require awareness, then this would support a modular model of the brain in which the experiential history for a change in attitude might not be verbalizable (Gazzaniga, 1985; Nisbett & Wilson, 1977; Zajonc, 1980).

In summary, it is well established that the right hemisphere has a special involvement in the processing of emotional facial expressions independent of its role in processing visual spatial stimuli. This advantage has been shown to extend to the formation of associations with facial expressions as measured by a physiological response. Based on these findings, the present research plan was designed to determine whether these effects extended to a direct measure of evaluation, the semantic differential scale, described in the following section, and second, whether the formation of associations in the right hemisphere required awareness.

### The Semantic Differential Scale

The semantic differential method of attitude measurement requires a person to rate an object on one or more simple bipolar scales, anchored by evaluative adjectives such as 'good - bad' or 'pleasant - unpleasant' (Osgood, Suci, & Tannenbaum, 1957). The points of the scale may be marked by numbers, where '0' is the neutral point, or additionally, labelled with qualifiers such as 'extremely', 'slightly' or 'quite'. The scale is used to measure both the direction and intensity of the evaluation of an object.

The use of the semantic differential to measure attitude was a development of its original purpose, which was to explore the psychological dimensions of the meaning of objects (Heise, 1970; Osgood, Suci, & Tannenbaum, 1957). This involved rating objects on many bipolar scales with a broad range of adjective pairs in addition to those above, such as 'hot - cold', 'powerful - powerless', 'fast - slow', and 'clean - dirty'. Over repeated studies, factor analyses reliably produced three stable dimensions of individuals' responses, characterized as Evaluation, Potency, and Activity (EPA). The Evaluation component (good - bad) accounted for the majority of the variance in responses.

Research on the semantic differential scale frequently used several bipolar scales to measure the evaluation of an object or concept in order to increase the stability of the response. Studies of the test-retest reliability of the scale and studies of correlations with other attitude scales were usually based on factor scores, which were the averaged ratings across the set of evaluative scales. Measured in this way, the test-retest reliability tended to be high (correlation greater than .8) over intervals of several weeks (see review in Osgood, Suci, & Tannenbaum). However, neutral concepts have been found to be rated with less reliability (Heise, 1970).

The semantic differential scale, like the Likert scale, is a 'generalized scale' since the same scale can be used for different objects or concepts. This is in contrast to scales like the Thurstone and Guttman which are designed to be object specific. However, correlations between the semantic differential scale and other attitude scales tend to be good (correlations range from .6 to .8), suggesting the measurement of a

stable underlying evaluative mechanism (see review, Osgood, Suci, & Tannenbaum, 1957). However, the relationship between the semantic differential and Thurstone scales was found to be poorer for concepts which were highly salient to the participants (Heise, 1970).

Pre- and post-intervention ratings on a semantic differential scale were used in many studies of evaluative conditioning and the mere exposure effect; the resulting measurements helped to form the basis for inferences made about affective judgements and processes. For example, ratings on a single 7-point semantic differential scale were used by Staats and Staats (1957, 1958) and Page (1974) in their studies of evaluative conditioning; Insko and Oakes (1966) summed ratings across five 7-point evaluative scales [later evaluative conditioning studies used a combination of ranking and categorization (Levey & Martin, 1975; Martin & Levey, 1978)]. Similarly, Moreland and Zajonc (1977) and Zajonc (1968) used a single 7-point semantic differential scale in studies of the mere exposure effect [Kunst-Wilson and Zajonc (1980) chose a forced-choice procedure instead of a semantic differential scale].

An extensive literature review showed that attitude scales have rarely been used in neuropsychological research on hemispheric differences in processing affect. Only one visual laterality study of affect was found that used an attitude rating scale. Natale, Gur, and Gur (1983) asked subjects to rate tachistoscopically presented facial expressions on a 7-point semantic differential scale, where 1 indicated 'very sad'; 2, 'sad'; 3, 'somewhat sad'; 4, 'neutral'; 5, 'somewhat happy'; 6, 'happy'; and 7, 'very pleasant'. Participants made their ratings by moving a lever to a point on the scale.

The results of this set of studies were mixed. In one study, right-handed participants rated negative expressions as significantly more negative when presented in the left visual field (RH) than in the right visual field (LH). No effect was found for happy expressions. In the second study, no significant differences were found between ratings of chimeric faces in the two visual fields. However, stimuli presented to the left visual field were rated more accurately. It was unclear from these studies whether or not rating scales of this kind were an appropriate measure of right hemisphere affective functions.

It is important to recognize that an attitude rating has different characteristics than the tasks and dependent measures used normally in visual laterality studies of affect, and that these characteristics may impact on the production of a laterality effect. In a laterality study, the response demanded of the subject should not require processing which masks the hypothesized functional process. While the response may require input from both hemispheres, the input should be sufficiently balanced so as not to confound the experimental findings. In studies of affect, concurrent left hemisphere processes such as verbal activity may attenuate or mask a right hemisphere effect.

The amount of processing required to make a response increases the opportunity for confounding factors to intervene. For example, Sergent (1983) noted that a discrimination task, such as deciding whether two stimuli were the same, requires less processing than a task which requires identification, since identification requires a specific response that the participant has to construct. In an attitude scaling task, the participant is likewise required to construct a response, which is to quantify the

amount of liking or disliking for an object and cross-modally match the perceived affect with a visual scale rating. Furthermore, in constructing a response, participants may consciously assess factors such as experience with the object. The strategy individuals use in translating their 'feelings' about an object to a scale response and the concomitant amount of processing required will be critical to the outcome of the laterality study.

Despite these caveats, the use of scale ratings should not have a significant impact on lateralization studies of attitude change which involve calculating the difference between ratings before and after an intervention. In these studies, which include research on the mere exposure effect and evaluative conditioning, factors other than the intervention should cancel out in the calculation of the difference scores. The resulting measure should primarily reflect the change in attitude.

In the present set of studies, ratings on a semantic differential scale were used as the operational measure of affective processing instead of the more common dependent variables, accuracy and reaction time, used in visual lateralization studies. An analog of the traditional verbal semantic differential scale was constructed for these studies. Verbal anchors on the scale might be expected to engage left hemisphere linguistic processes and, by changing the balance of processing between the hemispheres, reduce or eliminate any right hemisphere effects. Consequently, a deliberate attempt was made to remove this bias by creating a nonverbal analog. In all of the following studies, participants rated affect on a 15-point or 19-point scale, anchored by sad and happy cartoon faces (none of the intermediate points of the scale were labelled). The

scale was built into the tachistoscope, and ratings were made by operating a joystick to produce a light bar that reflected the direction and the intensity of the evaluation.

Subjects were not required to read or respond verbally when making ratings.

## CHAPTER 2: RESEARCH PLAN

### A. Proposed Research

The initial research plan involved two approaches. The first approach investigated whether affective stimuli would be rated more intensely on a semantic differential scale when presented to the right hemisphere than to the left hemisphere, and second, whether any laterality effect would depend on the nature of the stimulus. Only one set of previous studies has used this approach of investigating differential left and right hemisphere affective responses to visual stimuli (Natale, Gur, & Gur, 1983). Two new studies were conducted. The first study examined ratings of affective words presented tachistoscopically to the right and left visual fields, the second examined ratings of similarly presented facial expressions. The studies are presented and discussed in Chapter 3.

The second approach attempted to differentially evaluatively condition the right and left hemispheres. While there are many published evaluative conditioning studies, no previous study has attempted to determine whether the left and right hemispheres can be differentially evaluatively conditioned. The initially planned study employed lateralized presentations of negative and neutral facial expressions.

### B. Additional Followup Research

Because the initially planned evaluative conditioning study did not produce conditioning (at least as revealed by the rating scale responses), a further study was

designed. This study attempted to produce conditioning, this time in central fixation, by pairing a stronger noxious stimulus (bad odour) with brief presentations of visual patterns. As well as piloting the new conditioning procedure, this study investigated the impact of awareness on conditioning when awareness was reduced through the use of brief exposure durations. This study succeeded in producing evaluative conditioning.

The final study was a pilot attempt to again investigate laterality effects in evaluative conditioning but using the stronger noxious stimulus.

The two studies which paired the odour with abstract, visual patterns revealed an unexpected problem in the use of semantic differential scales, the often poor reliability of scale ratings based on short stimulus exposures to abstract stimuli. Owing to this problem, the final laterality study was discontinued once the reliability problem became apparent. The evaluative conditioning studies are presented in Chapter 4.

### CHAPTER 3: STUDIES OF HEMISPHERIC DIFFERENCES IN RATINGS OF AFFECT

#### Study 1: Hemispheric Differences in Ratings of Affect for Emotional Words

The purpose of this study was to investigate hemispheric differences in ratings of the direction and intensity of affect in emotional words.

The right hemisphere has been shown to have some capability to produce language, particularly emotional utterances, and to read affective and high frequency, concrete, and imageable words (Graves et al., 1981; Strauss, 1983), and there is evidence that words are stored pictorially as well as verbally (Paivio, 1975). The study of high imagery and affectively loaded words has also been shown to effectively prime the right hemisphere and enhance subsequent performance on face recognition tasks (Bryden & Ley, 1983). The enhanced right hemisphere performance for high frequency words may be mediated in part through affect as well as imageability; Zajonc (1968) has shown that high frequency words are associated with greater liking.

Despite the capacity of the right hemisphere to process some verbal information, the verbal or nonverbal nature of a stimulus is a major factor in predicting whether a task will produce a left or right hemisphere advantage in a visual laterality study. Indeed, it is still a question whether the right hemisphere plays as important a role in processing the affective component of words as it does in processing elements of the nonverbal affective lexicon. Left hemisphere linguistic processing has been shown to

mask hypothesized right hemisphere effects in processing the affective component of words in tachistoscopic studies (Graves et al., 1981; Strauss, 1983), although affective content improved the performance of the right hemisphere. The separation of hemispheric involvement for tone (RH) and content (LH) has been noted in dichotic studies (Ley & Bryden, 1982; Strauss & Moscovitch, 1981). These findings would suggest that an overall left hemisphere effect would also be found for judging and reporting the direction and intensity of evaluations of the emotional content of words.

In this study, participants rated their subjective responses to positive, negative and neutral words.

### Hypotheses

Given the left hemisphere superiority for processing words, positive and negative words will be judged as more positive and negative, respectively, in the right visual field (left hemisphere) than in the left visual field (right hemisphere). This hypothesis would also be consistent with the hypothesis that the response used to measure the affective judgement (use of the scale) may involve complex processing, with substantial input from the left hemisphere.

## Method

### Subjects

Seventeen right-handed male students at the University of Victoria participated in the study. Their degree of right-handedness was determined by using a scale made of 28 non-right biased items developed by Healey, Liederman, and Geschwind (1986)

(Appendix A). To be included in the study, participants reported the preferred use of their right hand for 25 or more items. Participants were also screened for their ability to read four-letter words presented unilaterally at 100 ms exposures to the right and left visual fields, with corrective lenses if needed. In this test, the participant was requested to read aloud each word as it was presented; the criterion for inclusion in the study was 90% accuracy.

The mean age of participants was 22.9 years ( $SD = 4.0$  yr).

### Materials

Verbal stimuli. The stimuli comprised 22 neutral, 22 positive, and 26 negative (including three expletives) four-letter words, as well as 10 nonsense three-letter words. To facilitate recognition by the right hemisphere, neutral words were selected which were rated high in frequency (Kucera & Francis, 1967; Thorndike & Lorge, 1944), imagery, and concreteness (Paivio, Yuille, & Madigan, 1968). The selection of positive and negative words was based on 'face' emotional content and included many words used in previous studies of affective processing (Graves et al., 1981; Strauss, 1983). The nonsense words consisted of a beginning consonant, a middle vowel, and an ending consonant; several were selected from the evaluative conditioning studies of Staats and Staats (1957, 1958). The stimuli are listed in Table 1 (page 35).

The stimuli were printed in 36-point, black, Helvetica typeface press-down lettering, on four by six inch, white Gerbrands tachistoscope cards. Each card contained one word positioned on the horizontal midline, two degrees to the right or left of the centre of the card.

Apparatus and rating scale. The experimental apparatus consisted of a Gerbrands G-1130 three-field Harvard tachistoscope with timer, an Apple 2+ personal computer with joystick, and a bar graph display (rating scale). The three fields of the tachistoscope were used to present the central fixation dot, the stimuli, and the bar graph display. Reaction time was measured using an external timer card inserted into the computer which was capable of measuring up to 8.22 seconds ( $\pm 250$  us). An interface board isolated the Gerbrands timer from the computer via a relay to prevent ground loops. It also provided an input for the joystick and rerouted signals to the timer board, bar graph, and joystick.

The bar graph display consisted of two horizontal scales, one above the other. The anchors of the two scales were reversed and only one of the scales was exposed at any one time. Each scale comprised a row of 15 red light emitting diodes (LEDs) with an array of smaller yellow LEDs at either end to backlight the anchors. The anchors were transparent overlays of a sad cartoon face and a happy cartoon face. The program software enabled switching between the two scales in order to test responses in each anchor orientation. The scale was superimposed over the fixation dot after the verbal stimulus faded.

The scale was built into the third field of the tachistoscope so that participants could rate stimuli without moving their heads from the viewer. This lessened the need for eye accommodation and allowed the immediate reporting of affective responses. The participant operated the scale by moving a joystick handle to the right or left depending on the valence of the response, making greater movements for stronger

feelings of pleasantness/unpleasantness. As the handle moved, diodes lit up in a corresponding direction from the centre of the scale toward the anchor, forming a light bar. The length of the bar corresponded to the amount of movement and, consequently, the intensity of the rating. The participant registered the rating by pushing a button on the top of the joystick handle.

### Procedure

At the beginning of the session, the participant filled out a handedness questionnaire. The experimenter then introduced the study and read the instructions to the participant.

A practice session preceded the experimental ratings in order to familiarize subjects with the use of the rating scale. The practice session consisted of a total of 20 unilateral right and left visual field presentations of three-letter words which varied in affective tone. Subjects were also asked whether they objected to expletives; none reported objections (if they had objected, they would have been excused from the study).

In the experimental session, each participant rated 80 stimuli in the right and left visual fields, resulting in a total of 160 stimulus presentations. The stimuli were divided into eight blocks of 20 words. The first four blocks each contained 80 unique stimuli for presentation to either the right or left visual field. The second four blocks repeated the words in the same order but presented each word to the opposite visual field. Word order was constant across subjects.

Within each test block, one-half of the stimuli were presented to the right visual field, one-half to the left visual field. Order of field presentation was randomized so that no more than three exposures were made successively to one field. Order of affect category was also randomized with the criterion that two stimuli of the same affect type could not appear in succession. Across the blocks, one-half of the words for each affect type were initially presented to the right visual field, one-half to the left visual field.

In addition, participants were counterbalanced for the initial side of presentation of the stimuli. The stimuli presented to the right visual field first for the first group of subjects were presented to the left visual field first for the second group, and vice versa. Participants were randomly assigned to the two groups.

At the end of the experimental session, the experimenter conducted the vision test and debriefed the subject.

Instructions. The experimenter read the following instructions to the participant in preparation for the tachistoscopic presentation.

"Words differ in their capacity to arouse emotional feeling. Some words arouse a strong positive or negative response, some only a moderate response, others no feeling at all. Using the tachistoscope, the equipment in front of you, I'll be presenting a series of words to you. What I'd like you to do is to rate how pleasant or unpleasant your response to each word is."

"Each word will be presented very briefly. If you look into the tachistoscope viewer, you can see a dot at the centre of focus. After this dot has been on for a

second or so, a word will be flashed to either the right or left of the dot. Now, it's important to keep your eyes focused on the dot rather than to try to read the word. In fact, it is preferable that you do not read the word. Just focus on the dot."

"After the word disappears, a scale will appear in the viewer. This is the scale for rating your subjective responses. It is operated by this joystick. At one end of the scale will be a happy face, at the other end, a sad face. Moving the joystick in either direction will cause a line of diodes to light up. If a word generates a pleasant feeling in you, then move the joystick toward the happy face. If the word generates an unpleasant feeling, then move the joystick toward the sad face. The number of diodes that light up will reflect how strongly you feel, so make greater movements to the right or left for stronger feelings and smaller movements for lesser responses. If the word does not generate any feeling in you, then just leave the joystick centred."

"Once you have moved the joystick to make the response you want, push the button at the top of the joystick. This will register your response. Make your rating as quickly as possible, rating the initial feeling that comes to you. Feel free to use the entire range of the scale. At the same time, do not be concerned about how often you use a particular rating as long as the rating you give feels right."

"After you make a rating, the scale will disappear and the fixation dot will appear again. Fix your eyes again on the dot, another word will appear shortly. We will start off with a practice run so that you can familiarize yourself with the rating scale and procedure. Feel free to ask questions now or after the practice session. Occasionally, at the end of a block, I will ask you to switch the hand you are responding with. A

couple of times, I will also change the orientation of the scale so that the happy and sad faces are reversed. I will tell you when I am doing this. Ready to start the practice session? For this block, use your right hand. Note that when the scale appears, the 'happy face' is on the left."

Tachistoscopic presentation. Following the presentation of a centrally positioned fixation dot for 1500 ms, each stimulus was exposed for 100 ms. At the offset of the stimulus, the rating scale appeared. The scale was exposed until the participant registered a response or until 8.22 seconds elapsed, whichever came first. Either event automatically triggered the reappearance of the fixation dot.

Design. A one-factor between, 3X2X2X2 factor within subjects design was used. The four within factors were stimulus affect (positive, negative, neutral), visual field presentation (RVF, LVF), the hand used to operate the joystick (right, left), and scale anchor orientation (happy face on right, happy face on left). The two latter factors resulted in 4 conditions; each subject rated two test blocks per condition. The design was counterbalanced between subjects for initial side of presentation of the words and in such a way that every test block was rated in every condition. One constraint was placed on the design. Words rated with a particular hand and scale orientation in one visual field presentation were rated with the same hand and scale orientation in the second visual field presentation.

## Results

### Ratings of words

The mean ratings of the words for right visual field (left hemisphere) [RVF(LH)] and left visual field (right hemisphere) [LVF(RH)] presentations are presented in Table 1. Overall, words were rated in the expected directions. On a scale from 7 (happy face) to -7 (sad face), the average rating of positive words was 2.89 ( $SD = 1.50$ ) for words presented to the LVF, and 3.20 ( $SD = 1.30$ ) for words presented to the RVF. The respective mean ratings for negative words in the LVF and RVF were -2.44 ( $SD = 1.05$ ) and -3.14 ( $SD = 1.31$ ); for expletives, -1.14 ( $SD = 1.13$ ) and -1.56 ( $SD = 1.39$ ); for neutral words, 1.07 ( $SD = 0.53$ ) and 1.13 ( $SD = 0.60$ ); and nonsense words, 0.07 ( $SD = 0.47$ ) and -0.15 ( $SD = 0.43$ ).

### Visual field effects

An average score was calculated for the ratings of words in each affective category (positive, negative, neutral, nonsense, and expletive) for each subject and visual field. A two-factor within subjects MANOVA was conducted to test differences in average scores due to type of affect and field of presentation (RVF, LVF). As expected, the overall effects for field and type of affect were significant, as well as the field by type of affect interaction [field:  $F(1,14) = 6.60$ ,  $p < .05$ ; type of affect:  $F(4,56) = 75.26$ ,  $p < .000$ ; field X type of affect:  $F(4,56) = 7.28$ ,  $p < .000$ ]. An analysis of the means was subsequently carried out using paired t-tests (for a priori planned comparisons) to determine whether there was a significant difference between the LVF and RVF ratings for each affective category. Congruent with the hypothesis, more extreme

Table 1.  
Mean ratings of affective words presented to right and left visual fields in Study 1.

<u>Word</u>	<u>Ratings</u>			
	<u>LVF (RH)</u>		<u>RVF (LH)</u>	
	<u>(M)</u>	<u>(SD)</u>	<u>(M)</u>	<u>(SD)</u>
POSITIVE				
king	2.41	3.26	2.24	2.63
free	2.76	3.23	4.88	2.18
dear	2.47	3.16	2.41	2.55
baby	3.29	2.28	3.29	1.76
like	2.76	2.14	2.94	2.25
life	4.29	2.11	3.82	2.40
good	3.00	2.42	3.82	2.16
safe	2.76	2.59	2.76	1.89
play	3.82	2.13	4.06	1.75
rich	1.94	2.11	2.41	3.39
glad	3.18	2.07	3.59	2.27
hope	2.76	2.54	2.65	3.14
best	2.24	1.92	3.35	2.29
love	3.88	2.96	4.59	2.85
sexy	3.53	3.22	3.82	1.81
wise	1.94	2.08	3.06	2.41
care	2.44	2.78	2.69	1.92
kind	3.18	2.35	3.71	2.47
gold	2.94	2.88	3.47	2.15
easy	1.59	2.79	1.88	2.18
kiss	3.76	2.93	4.35	2.91
nice	2.53	2.72	2.35	2.37
NEGATIVE				
puke	-2.47	2.90	-2.94	2.41
debt	-2.12	2.76	-2.65	2.21
jail	-4.12	2.26	-3.65	2.32
cold	-1.71	1.99	-2.76	2.14
poor	-3.71	2.08	-3.59	2.15
hate	-1.65	2.57	-3.41	2.53

Table 1 continued.

<u>Word</u>	<u>Ratings</u>			
	<u>LVF (RH)</u>		<u>RVF (LH)</u>	
	<u>(M)</u>	<u>(SD)</u>	<u>(M)</u>	<u>(SD)</u>
<b>NEGATIVE</b>				
continued				
hurt	-3.65	2.57	-3.53	1.94
stab	-1.76	2.49	-3.53	1.84
rape	-4.82	3.13	-5.12	2.15
kill	-4.94	2.41	-4.53	2.60
fear	-2.06	2.28	-3.06	2.05
liar	-3.65	2.06	-3.71	2.08
exam	-1.00	2.00	-1.82	3.05
sick	-2.82	2.16	-4.00	2.24
evil	-3.76	2.75	-3.82	2.04
rude	-0.88	1.96	-2.41	2.45
dead	-2.65	2.42	-3.71	2.66
slap	-1.12	2.03	-2.88	2.09
lose	-1.41	3.04	-2.29	2.31
rage	-2.41	2.81	-3.53	2.45
ugly	-2.53	1.84	-3.00	1.97
pain	-2.18	2.90	-2.75	2.72
hell	-2.47	3.30	-2.88	2.62
<b>EXPLETIVES</b>				
shit	-1.59	1.80	-2.13	2.47
f--k	0.00	0.00	-0.35	1.50
crap	-1.82	2.13	-2.47	2.32
<b>NEUTRAL</b>				
gate	0.00	1.00	0.47	1.07
food	3.19	1.68	3.47	1.81
star	2.29	1.69	2.24	3.13
hand	0.94	1.95	0.59	1.54
lake	1.29	2.54	1.71	2.49
seat	0.65	1.73	0.29	0.69
shoe	0.65	1.00	0.82	1.07
face	2.18	1.78	2.18	2.24

Table 1 continued.

<u>Word</u>	<u>Ratings</u>			
	<u>LVF (RH)</u>		<u>RVF (LH)</u>	
	<u>(M)</u>	<u>(SD)</u>	<u>(M)</u>	<u>(SD)</u>
NEUTRAL continued				
rock	1.00	2.28	1.18	2.01
ring	2.71	3.18	2.24	2.61
camp	1.88	2.39	0.82	3.03
coat	0.06	1.85	0.82	1.98
tree	1.82	2.16	1.65	2.50
book	1.59	2.00	1.94	2.36
ship	1.06	1.78	0.88	1.17
road	-0.06	1.85	0.59	1.23
fire	-1.81	2.20	-1.18	1.98
bird	2.59	2.03	2.53	2.03
boat	0.88	1.62	1.00	2.37
door	0.29	0.85	0.00	1.22
hall	0.06	1.89	-0.65	2.12
hair	1.94	1.60	1.18	1.24
NONSENSE				
cef	1.29	2.34	0.53	1.23
xeh	-0.12	1.11	-0.12	0.49
laj	0.12	0.49	-0.24	0.97
vot	0.00	0.71	-0.06	0.24
giw	0.76	1.60	0.25	1.29
bez	0.18	0.73	-0.06	1.65
qug	-1.35	2.69	-1.41	3.81
yof	0.06	0.90	-0.24	0.75
jic	-0.06	0.25	-0.13	0.50
pid	-0.18	0.64	-0.18	1.47

---

ratings of affective words were generally found for RVF(LH) presentations than for LVF(RH) presentations. Positive words were rated as significantly more positive in the RVF(LH) ( $M = 3.18$ ) than in the LVF(RH) ( $M = 2.69$ ),  $t(14) = -2.40$ ,  $p < .05$ . Similarly, negative words were rated as significantly more negative in the RVF(LH) ( $M = -3.14$ ) than in the LVF(RH) ( $M = -2.44$ ),  $t(15) = 4.50$ ,  $p < .001$ . No significant field effects were found for expletive, neutral or nonsense words.

#### Handedness and scale orientation

A one-factor within, two-factor between subjects MANOVA was conducted to test whether the average ratings of positive, negative, neutral, nonsense, and expletive words in each visual field differed depending on the hand used to respond and the orientation of the scale anchors. No significant effects were found.

#### Reaction times

Reaction times (the interval between the onset of the rating scale and the registration of a rating) were measured for subjects' responses but were not analyzed. Some subjects had difficulty making small, precise movements of the joystick, particularly around the zero point of the scale (for neutral ratings), resulting in lengthy and variable reaction times.

### Discussion

As expected, a left hemisphere advantage was found for ratings of the pleasantness/unpleasantness of positive and negative words. This result is consistent with other studies of the affective processing of words (Graves et al., 1981; Hansch &

Pirozzola, 1980; Strauss, 1983) and shows that with respect to this hypothesis, evaluations of emotional content operate in a similar fashion to other dependent variables (reaction time, accuracy). While the left hemisphere showed a processing advantage, the results suggest that the right hemisphere was also capable of accurately assessing the valence of the emotional content, as well as deriving a measure of intensity. The lack of an effect for neutrally rated and nonsense words owed to their neutrality as well as the averaging of values above and below zero to obtain subject scores. Depending on the word, expletives were rated negatively or neutrally; although some expletives tended to show a right visual field effect, when averaged, the field effect was not significant.

Left hemisphere linguistic involvement in the processing of affective words is relevant to attitude studies which made inferences about the type of processing involved in affective appraisals of verbal stimuli. Zajonc (1980), for example, suggested that affective appraisals were immediate, holistic, and pre-cognitive; however, it is questionable whether these characteristics would apply to verbal stimuli, such as the "Turkish adjectives" used in the original research on the mere exposure effect (Zajonc, 1968). The use of verbal stimuli necessitates left hemisphere involvement and consequently, left hemisphere strategies for processing stimuli. Zajonc's (1980) model of affective appraisals does not fit neatly into a right hemisphere model of affective processing. As with physiological conditioning, the loci and types of processing will likely depend on the verbal or nonverbal nature of the specific stimulus, or, as Derryberry and Tucker (1992) suggested, also involve

paralimbic processes.

Since verbal stimuli were used in this experiment, it was not possible to assess whether the left hemisphere also had an advantage in the processes used to make scale ratings. However, the results are consistent with a left hemisphere bias.

In the next study, hemispheric differences in the ratings of facial expressions were investigated. This provided an opportunity to examine the use scale ratings when a right hemisphere effect was anticipated.

#### Study 2: Hemispheric Differences in Ratings of Affect for Facial Expressions

In this study, participants rated the pleasantness/unpleasantness of photographs of positive, negative and neutral facial expressions presented to the right and left visual fields. This study is important to the examination of the processing involved in making a scale rating. Previous studies which used similar stimuli but different response tasks reliably found a right hemisphere effect for the processing of affect (for example, Hansch & Pirozzola, 1980; Safer, 1981). If scale ratings for facial expressions reflect functional processes, then the same result would be expected in this study.

Two presentation formats were used for facial expressions presented to the right visual field (left hemisphere). The left side of the face has been shown to be more expressive than the right side for posed or voluntary expressions (for example,

Campbell, 1978). Because each side of the lower half of the face is innervated by the opposite hemisphere, this is thought to reflect greater right than left hemispheric control over emotional processing. Such functional asymmetry may create a problem for lateralized presentations in the right visual field, when compared with the left. The left side of the face is presented to the right visual field more peripherally than to the left visual field, and consequently, to an area of lower visual acuity. In the left visual field, the left side of the face is presented more toward the centre of focus.

Consequently, a facial expression presented to the right visual field may seem less intense than to the left visual field. To test for this possibility, mirror-images of the photographs were created for presentations in the right visual field; one-half of the subjects saw the mirror-images and the rest saw the facial expressions in original orientation. Since this was an issue only for right visual field presentations, mirror-images were not created for left visual field presentations (although this would have allowed a comparison between responses under the condition that both hemispheres were receiving more degraded input). The goal of the study was to reduce bias while maintaining as strong a stimulus impact as possible; the solution was to create a condition for each hemisphere which placed the strongest emotional expression closer to the centre of focus.

### Hypotheses

Given the right hemisphere advantage for processing facial expressions and affect, it is expected that positive and negative facial expressions will be judged as more positive and negative, respectively, in the left visual field (right hemisphere) than in

the right visual field (left hemisphere). If the determination of the affective judgement (use of the scale) involves complex processing, the expected right hemisphere effect may disappear and a left hemisphere effect may occur.

## Methods

### Subjects

Forty right-handed male students at the University of Victoria participated in the study. Degree of right-handedness was determined using the handedness scale described in Study 1 (the criterion for inclusion in this study was the preferred use of the right hand for 20 or more items). Participants were also screened for their visual acuity (with corrective lenses if needed) using a Snellen's eye chart appropriately sized for presentation in the tachistoscope. Participants were excluded from the study if they were unable to read fewer than one-half of the letters on the 20/20 line with either eye or if they had more than a one-line difference in acuity between the two eyes.

The mean age of participants was 22.3 years ( $SD = 3.0$ ).

### Materials

Stimuli. The stimuli comprised black and white photographs of facial expressions. Three sources of photographs were used: Ekman photographs of faces with posed happy, sad, angry, fearful, disgusted, and neutral expressions; disturbing photographs from the Szondi-test (version: Verlag Hans Huber, 1965) depicting persons with psychiatric disorders or epilepsy (used to elicit a negative response); and photographs of faces of staff and students at the University of Victoria, posed with neutral

expressions, and taken by the experimenter. All three sources included photographs of males and females. A sample of the photographs taken by the experimenter is presented in Appendix B.

The stimuli for RVF presentations were prepared in two orientations: original and mirror image. Stimuli for LVF presentations were prepared in original orientation.

The 34 mm X 22 mm photographs (contact print size) were presented on white Gerbrands tachistoscope cards. Before being pasted onto the cards, the photographs had to be peeled from the paper backing on which they were printed in order to reduce their thickness; otherwise the cards would have jammed in the tachistoscope. The paper backing was removed from each contact sheet of photographs by soaking the sheet in water, separating and peeling off the top layer, drying the layer between sheets of onion paper, and storing it flat. Each tachistoscope card contained one photograph, positioned laterally two degrees to the right or left of the centre of the card, and vertically so that the centre of the photograph lay on the horizontal midline of the card.

Apparatus and rating scale. The same apparatus was used as in Study 1. The rating scale for this study and following studies was changed from a horizontal scale to a single, vertical, 19-point red diode bar graph display with a happy cartoon face at the top end and a sad cartoon face at the bottom (the scale was presented in this orientation only). The orientation of the scale was changed to vertical to avoid the possibility of an association between the valence of the scale anchor (positive, negative) and the field of presentation, which might occur in a horizontal format in

which anchors were peripherally positioned. The participant operated the scale with forward and backward movements of the joystick handle to make positive and negative ratings, respectively.

### Procedure

At the beginning of the study, the participant filled out a handedness questionnaire and was given the visual acuity test. The experimenter then introduced the study and read aloud the instructions as the participant followed along on a separate copy.

As in Study 1, a practice session preceded the experimental ratings to familiarize subjects with the operation of the rating scale. The practice deck contained 6 positive, 6 negative, and 6 neutral facial expressions; one-half of each category was presented to each visual field. Side and order of presentation were randomized.

While the participant rated the stimuli in the practice deck, the experimenter monitored responses to check that the participant understood how to use the rating scale.

After the practice session, the participant rated the stimuli in the test deck while the experimenter stayed in the room to operate the tachistoscope. The test deck contained 116 unique stimuli, consisting of 10 positive, 44 negative, and 62 neutral facial expressions (as rated by the experimenter in free viewing). Each facial expression was presented twice, once to the RVF and once to the LVF, producing a total of 232 presentations. The entire set of 116 unique stimuli was presented once (set 1) before any stimulus was repeated in the opposite visual field (set 2).

The stimuli in the test deck were counterbalanced for initial side of presentation. Stimuli were randomly assigned for initial presentation to the RVF or LVF, with the constraint that one-half of the stimuli in each affective category were initially presented to each visual field. In addition, participants were counterbalanced for the initial side of presentation of the stimuli. The stimuli presented to the right visual field first for the first group of subjects were presented to the left visual field first for the second group, and vice versa. Participants were randomly assigned to the two groups.

In order to reduce the effect of context on ratings, two random orders were used. Within each random order, the order of field presentation was randomized such that no more than four presentations were made successively to one visual field. In each order, the two sets of presentations followed the same sequence to ensure a similar context for ratings for the two visual fields.

Two test decks were created, one for each stimulus orientation condition. In the original condition, facial expressions were presented in their original orientation to the RVF and LVF. In the mirror condition, mirror images of the facial expressions were presented to the RVF and facial expressions in original orientation were presented to the LVF.

At the end of the session, the experimenter debriefed and thanked the participant.

**Instructions.** Similar instructions were used to those in Study 1, with modifications for the type of stimulus, the different operation of the scale, and changes in procedure (Appendix C).

Tachistoscopic presentation. Following the presentation of a centrally positioned fixation dot for 2 seconds, each stimulus was exposed for 120 ms. At the offset of the stimulus, the rating scale appeared. The scale was exposed until the participant registered a response or until 8.22 seconds elapsed, whichever came first. Either event automatically triggered the reappearance of the fixation dot.

Design. A 2X2X2 between, 3X2 within subjects design was used. The two within factors were stimulus affect (positive, negative, neutral) and visual field presentation (RVF, LVF). The three between factors were stimulus orientation (original, mirror), stimulus order (order 1, order 2), and initial side of presentation (group 1, group 2). Participants were randomly assigned to the eight conditions.

## Results

### Missing Values

Owing to problems with the tachistoscope during testing, 1.84% of the stimulus presentations resulted in missing values (171 out of 9,280 presentations across subjects). Since the problem tended to occur with particular stimulus cards, 6 stimuli were removed from the analyses because they had 4 or more missing values. As a result, the analyses were based on the 110 remaining stimuli.

For the remaining 143 missing values, the cell mean for the appropriate cell condition was substituted for the missing value in the analyses.

### Mean Ratings

The remaining 110 stimuli were divided into three affective categories. On a scale from 9 (happy face) to -9 (sad face), a stimulus was categorized as negative if the mean rating across subjects was less than or equal to -2 in at least one visual field. A stimulus was categorized as positive if the mean rating was greater than or equal to 2 in at least one visual field. The remaining stimuli were categorized as neutral (the mean ratings for both visual fields fell between -2 and 2).

A mean rating was calculated for the group of stimuli in each affective category, for each subject and visual field. These mean ratings were averaged across subjects to produce overall means for affective categories by visual field (Table 2).

Table 2.

Overall mean ratings of facial expressions in each affective category for right and left visual field presentations in Study 2 (criteria for inclusion into the negative and positive categories were  $\leq -2$  and  $\geq 2$ , respectively).

<u>Visual Field</u>	<u>Facial Expression Category</u>					
	Positive ( <u>n</u> = 29)*		Negative ( <u>n</u> = 16)		Neutral ( <u>n</u> = 65)	
	( <u>M</u> )	( <u>SD</u> )	( <u>M</u> )	( <u>SD</u> )	( <u>M</u> )	( <u>SD</u> )
RVF(LH)	3.81	1.68	-2.83	1.05	-0.19	0.79
LVF(RH)	4.13	1.72	-2.71	1.19	-0.11	0.83

\* n denotes number of stimuli

### Visual Field Effects

A three factor between (orientation, stimulus order, and side of presentation), one factor within (visual field), MANOVA was used to compare the mean ratings for visual field presentations for each affective category. The laterality hypothesis was tested on the within factor, visual field. There was no significant difference between LVF and RVF ratings for any of the three affective categories (positive, negative, neutral).

In addition, none of the three independent factors, orientation, stimulus order, and side of presentation, were found to have a significant effect on the differences between LVF and RVF ratings. None of the main effects or interactions were significant.

Because it was possible that a laterality effect might exist only for more intensely rated stimuli, one subset of more positively rated stimuli and one subset of more negatively rated stimuli were created. The negative subset contained 14 facial expressions, each with a mean rating of less than or equal to -3 in one or both visual fields. The positive subset contained 12 facial expressions with mean ratings greater than or equal to 3 in one or both visual fields (see Table 3). As in the previous analysis, a mean rating for the stimuli in each affective category was calculated for each subject and visual field. The mean ratings were then subjected to the same multivariate analysis. Again, no laterality effects were found for positive or negative stimuli, and none of the main effects for the independent factors were significant. A significant orientation by side of presentation interaction was found in the analysis of negative facial expressions (overall means:  $M_{RVF} = -4.68$ ,  $M_{LVF} = -3.85$ ),

$F(1,32) = 5.43, p < .05$ ). The subjects in one of the two 'initial side of presentation' groups rated facial expressions presented in mirror format in the RVF(LH) more negatively. This resulted in a larger difference between LVF and RVF ratings for this group.

Table 3.

Overall mean ratings of facial expressions in each affective category for right and left visual field presentations in Study 2 (when criteria for inclusion into negative and positive categories were  $\leq -3$  and  $\geq 3$ , respectively).

<u>Visual Field</u>	<u>Facial Expression Category</u>			
	Positive ( <u>n</u> = 12)*		Negative ( <u>n</u> = 14)	
	( <u>M</u> )	( <u>SD</u> )	( <u>M</u> )	( <u>SD</u> )
RVF(LH)	4.44	1.96	-3.44	1.47
LVF(RH)	4.72	1.91	-3.21	1.53

\* n denotes number of stimuli

### Discussion

Contrary to expectations based on previous studies, a right hemisphere effect was not found for ratings of the pleasantness/unpleasantness of facial expressions. The average intensities of ratings for positive, negative, and neutral expressions were very similar for presentations to both visual fields. Given these findings, it would be reasonable to question whether the tachistoscopic procedure and stimulus format

contributed to the absence of an effect. This is unlikely; as noted previously, the use of photographs of posed expressions (including Ekman faces) at short exposures has been effectively used in other studies of affective processing (for example, Buchtel, Compari, De Risio, & Rota, 1978; Hansch & Pirozzola, 1980; Safer, 1981) and in studies of the conditioning of physiological responses (Johnsen & Hugdahl, 1991, 1993). Alternatively, the rating task may have required significant left hemisphere involvement, which would have masked the hypothesized right hemisphere advantage in this study and have enhanced the left hemisphere effect for rating verbal stimuli in the previous study.

Most previous studies involved discrimination tasks (deciding whether a face was the same as a verbal cue or a designated type of affect), assessments of whether affect was present, or determining which of two facial expressions was more intense. The present study is more similar to the studies conducted by Natale, Gur, and Gur (1983) which used attitude measures that required participants to quantify the amount of affect perceived. Whereas the results of Natale, Gur, and Gur were mixed, showing inconsistent support for a right hemisphere affective processing superiority, the results of the present study revealed no hemispheric differences in affective processing.

The rating task requires the participant to develop a conscious, subjective assessment of 'how much' affect is present and match this to a visual display. A cross-modal judgement of this type may require some form of numerical processing, which requires left hemisphere involvement (Borod, 1992). It may also include some verbal reflection about how a facial expression should be rated, particularly if the

participant feels that there is some correct response and wishes to be accurate. While it may have been helpful, it may not have been sufficient to use a nonverbal analog to a semantic differential scale to limit left hemisphere processing.

Spence (1992), after failing to find a right hemisphere effect for deciding whether gory visual scenes were emotional, suggested that physiological measures, which showed the expected effect, reflected the right hemisphere role in processing affect better than tasks which required cognitive labelling of evocative stimuli. Congruent with the hypothesis that right hemisphere plays a major role in processing nonverbal human social displays (Bowers, Bauer, & Heilman, 1993), Spence argued that the right hemisphere advantage in processing affect may be restricted to stimuli which portrayed symbolic affect and did not require the subject to assess their experience with the stimulus content. While the present study involved facial expressions, the instructions in the task asked participants to assess their feelings (experience) and translate them into scale ratings; such an assessment may have helped to mask a right hemisphere advantage in stimulus processing.

Given the findings of the present study and the possible mediating factors in making ratings, ratings on a semantic differential scale or analog may not be appropriate for assessing right hemisphere involvement in processing affect, although, as noted previously, they may still be effective in lateralization studies of attitude change.

As in the previous study, the finding that a scale rating on a semantic differential scale involves significant left hemisphere processing has an impact on the

interpretation of scale ratings in attitude studies of evaluative conditioning and the mere exposure effect. In particular, it raises questions about Zajonc's (1980) assertion that scale ratings in mere exposure studies exclusively reflected holistic processing when the stimuli were presented at brief exposures. Judgements may be mediated through the effort of consciously translating feelings into scale ratings. These findings do not contradict Zajonc's central proposal that individuals make immediate and holistic assessments of the affect in objects or events, or that a mere exposure effect involves an unconscious change in affect. However, it is reasonable to question whether a 'pre-cognitive' affective appraisal may be consciously quantified without cognitive mediation.

Some evidence in the study was found for differential processing of lateralized presentations of faces in mirror image and original orientation in right visual field (left hemisphere) presentations. One of the two groups of participants (but not both) who rated mirror images of negative facial expressions in the right visual field (left hemisphere) rated the images more intensely than subjects who rated them in original format. As noted previously, this effect is expected because the left side of the face is positioned more toward the centre of focus in right visual field presentations when the facial expression is presented as a mirror image than when it is presented in original format. These results suggest that this bias should be taken into consideration when designing lateralized presentations for studies examining hemispheric differences in processing facial expressions. It should be noted that, although the use of mirror images in this study contributed to the lack of right hemisphere effect for negative

ratings, it was not the major factor. Unlike other studies which presented lateralized facial expressions in original format and found a right hemisphere effect, no right hemisphere effect was found for participants in this study who saw facial expressions in original format (and one-half of the subjects who saw them in mirror image). As a result, it was still necessary to look for other factors to explain the lack of a right hemisphere effect.

This study, as well as the first one, investigated the laterality of evaluations of emotional stimuli. The evaluative conditioning studies which follow were designed to examine whether the learning of evaluative responses (attitude change) would show a laterality effect.

## CHAPTER 4: EVALUATIVE CONDITIONING STUDIES

### Study 3: Hemispheric Differences in the Evaluative Conditioning of Facial Expressions

This study was the first in a set of evaluative conditioning studies designed to determine whether the right hemisphere had an advantage for the conditioning or associative learning of affective responses to nonverbal stimuli. Specifically, it examined affective responses to facial expressions. The second goal was to investigate whether awareness of the stimulus contingencies was required to develop a conditioning effect. The brief exposure durations in the study conferred an advantage in investigating need for awareness since participants would be less likely to note the contingencies.

In order to provide optimal conditions for a right hemisphere effect, the study focused on the processing of negative affect, which has more consistently shown a right hemisphere advantage. The conditioning procedure paired negative facial expressions (UCSs) with neutral facial expressions (CSs) selected from Study 2.

The study used a differential conditioning procedure in combination with lateralized presentations. Differential conditioning is commonly used in studies of physiological conditioning. In a typical differential conditioning procedure, one or more CSs ( $CS_{\text{negative}}$ ) is paired with a noxious UCS, and in order to control for presentation effects, one or more CSs ( $CS_{\text{neutral}}$ ) is presented without the UCS. The

difference in response to the  $CS_{negative}$  and the  $CS_{neutral}$  is used as the measure of the conditioning effect. As a result, in an evaluative conditioning study, more than one outcome can be classified as differential conditioning. The normally expected outcome in a study using a negative UCS would be that the evaluation of the  $CS_{negative}$  would shift negatively in the direction of the UCS, whereas the evaluation of the  $CS_{neutral}$  would either not change at all, change positively, or if it changed negatively, shift to a lesser extent than the  $CS_{negative}$ . However, a second outcome might be that the  $CS_{neutral}$  shifted in a positive direction and the  $CS_{negative}$  did not change or shifted positively to a lesser extent than the  $CS_{neutral}$ . This second outcome would not match the criteria for evaluative conditioning used in previous studies (for example, Staats & Staats, 1957, 1958).

In this study, two unique  $CS_{negative}$  and  $CS_{neutral}$  combinations were employed. In each conditioning trial, a  $CS_{negative}$  or  $CS_{neutral}$  pair was simultaneously presented to both visual fields (bilateral presentation). Repeated bilateral presentations of the  $CS_{negatives}$  were followed by bilateral presentations of the UCSs. Similarly, neutral facial expressions followed the  $CS_{neutrals}$  in a bilateral format. Participants rated unilateral CS presentations before and after the conditioning phase.

It was not expected that the processing required to respond to the scale would have a significant impact on the expected outcomes. Measurements of conditioning consisted of difference scores, calculated as the shift in ratings from before to after the conditioning procedure. Factors other than associative learning were expected to cancel out in the difference score calculation.

### Hypotheses

The hypotheses were, first, that evaluative conditioning would occur; second, that a right hemisphere effect would be found; and third, that awareness of the stimulus relationships would not be necessary for the occurrence of conditioning in the right hemisphere. More specifically, the neutral facial expressions paired with negative facial expressions would be judged as significantly more negative after the pairings than before, and more so than neutral expressions paired with neutral faces. The negative shift in ratings and differential conditioning would be significantly greater for the CS<sub>negative</sub> presented during test presentations to the left visual field (right hemisphere) than to the right visual field (left hemisphere).

## Method

### Subjects

Fifty-five right-handed male students at the University of Victoria participated in the study. Right-handedness and visual acuity were assessed using the same methods and criteria for inclusion used in Study 2. The mean age of participants was 22.0 years ( $SD = 2.7$ ).

### Materials

Stimuli. The CSs and neutral facial expressions used in the study are presented in Appendix D. The 10 negative facial expressions which were most consistently rated as negative across visual fields in Study 2 were selected as UCSs. The selected UCSs had the following characteristics: the average rating for each visual field presentation

was less than or equal to -2.50, the average rating across visual field presentations was less than or equal to -3.00, and at least 75% of participants rated the stimulus negatively (less than or equal to -1.00) in both visual field presentations.

The 32 neutral facial expressions which were most consistently rated as neutral in Study 2 were selected to use as CSs (two for each visual field; one  $CS_{\text{negative}}$  and one  $CS_{\text{neutral}}$ ), as neutral faces to follow the  $CS_{\text{neutrals}}$  (10 presented bilaterally), or as foils in the rating tasks. These stimuli had the following characteristics: the mean ratings for both visual field presentations fell between -1.00 and +1.00, and at least 62% of the ratings in both visual fields fell between -2.00 and +2.00. The four most consistently rated and most neutral facial expressions were selected as  $CS_{\text{negatives}}$  and  $CS_{\text{neutrals}}$ .

In the conditioning phase, stimulus pairs were presented bilaterally, one member of the pair to each visual field. The stimuli were positioned on white cards, two degrees to the right and two degrees to the left of centre. The horizontal midline of each stimulus was aligned with the horizontal midline of the card.

In the rating phases which preceded and followed the conditioning procedure, each stimulus was presented unilaterally, either two degrees to the right or left of centre.

Apparatus and rating scale. The same apparatus and rating scale were used as in Study 2.

Awareness questionnaire. The awareness questionnaire consisted of 14 questions. It began with open-ended questions about the purpose of the experiment and progressed to more specific questions about the stimulus contingencies and the

participant's background knowledge of conditioning. The questionnaire is presented in Appendix E. A liberal criterion was used for awareness. Participants were considered aware for a visual field, if, when presented with the two  $CS_{negatives}$  and the two  $CS_{neutrals}$ , they could differentially select the stimulus which had been immediately followed by negative faces in the visual field (question 10). If the participant said that both the  $CS_{negative}$  and the  $CS_{neutral}$  had been followed by negative faces, then the certainty rating for the  $CS_{negative}$  had to be greater than for the  $CS_{neutral}$ .

### Procedure

At the beginning of the study, the participant filled out a handedness questionnaire and was given the visual acuity test. The experimenter introduced the study and read aloud the instructions as the participant followed along on a separate copy. The subject then completed the practice session while the experimenter monitored responses to determine whether the participant was having problems responding. The practice deck consisted of 18 unique positive, negative, and neutral facial expressions. One-half of the facial expressions were presented to each visual field.

After the practice session, the participant rated the stimuli in the pre-conditioning rating phase while the experimenter stayed in the room to operate the tachistoscope. The deck of experimental stimuli consisted of 22 unique, neutral facial expressions, unilaterally presented to the right or left visual field. The  $CS_{negatives}$  were placed in positions number 3 and 5; the  $CS_{neutrals}$  were placed in positions number 8 and 10. Each CS was presented to the same visual field as during the conditioning phase.

The order of the  $CS_{negatives}$  and  $CS_{neutrals}$  in the rating decks was counterbalanced

across subjects for visual field presentation. For 27 subjects (order 1), the  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  presented to the left visual field were rated first (positions number 3 and 8, respectively); for the remaining 28 subjects (order 2), the  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  presented to the right visual field were rated first. Participants were randomly assigned to each group.

The pre-conditioning rating phase was immediately followed by the conditioning procedure. In the conditioning phase, the  $CS_{\text{negative}}$  pairs and the  $CS_{\text{neutral}}$  pairs were each presented bilaterally an equal number of times in random order. The number of presentations depended on the trial condition (5, 10, 20, or 40 presentations). Each presentation of a  $CS_{\text{negative}}$  or a  $CS_{\text{neutral}}$  pair was followed by the bilateral presentation of a UCS or neutral facial expression, respectively. In the 5-trial and 10-trial conditions, each CS was followed by a unique UCS or neutral expression. In the 20-trial and 40-trial conditions, a set of 10 UCSs and 10 neutral expressions were repeated (once and three times, respectively).

The interval between the presentation of the CS and the UCS (or neutral facial expression) within a trial was 2 seconds, which was the length of time that the tachistoscope required to present two cards in succession. The intertrial interval was 5 seconds.

Subjects were counterbalanced for the visual field to which a particular  $CS_{\text{negative}}/CS_{\text{neutral}}$  combination was presented. Twenty-eight subjects saw one combination of  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  in the left visual field and the other combination in the right visual field (deck 1). The combinations were presented in reverse for the

remaining 27 subjects (deck 2). Participants were randomly assigned to each group.

The post-conditioning rating phase immediately followed the conditioning procedure. The same rating deck was used as for the pre-conditioning rating phase, with one change. In the post-conditioning rating phase, 6 UCS stimuli replaced 6 of the last 11 neutral faces, in order to test responses to the UCSs.

After the post-conditioning rating phase, the participant filled out the awareness questionnaire. The experimenter then debriefed and thanked the participant.

Instructions. The experimental instructions are presented in Appendix C. The instructions for the practice session and pre-conditioning rating phase were similar to those in Study 2, with minor wording changes.

Stimulus presentation. In the rating phases, the same stimulus presentation was used as in Study 2, except that the exposure duration was increased to 150 ms to increase the impact of the negative facial expressions. This exposure duration was also used for the bilateral presentations of the UCSs and CSs in the conditioning procedure.

Design. A 4X2X2 factor between, 2X2X2 factor within subjects design was used. The three within factors were visual field (RVF, LVF), type of CS ( $CS_{\text{negative}}$ ,  $CS_{\text{neutral}}$ ), and the conditioning intervention (pre- versus post-conditioning ratings). The three between factors were the number of trials (5, 10, 20, 40 presentations of the  $CS_{\text{negative}}$ ), the  $CS_{\text{negative}}/CS_{\text{neutral}}$  combinations presented to the visual fields (deck 1, deck 2), and the order of the  $CS_{\text{negatives}}$  and  $CS_{\text{neutrals}}$  in the rating phases (order 1, order 2).

## Results

### Differential conditioning

The criteria for conditioning in each visual field were, first, a significant negative shift in the rating of the  $CS_{\text{negative}}$  from before to after the conditioning procedure, and second, a significantly greater negative shift for the  $CS_{\text{negative}}$  than for the  $CS_{\text{neutral}}$  (differential conditioning). Table 4 presents the mean pre- and post-conditioning ratings for the  $CS_{\text{negatives}}$  and  $CS_{\text{neutrals}}$ , as well as the mean shift in ratings and the amount of differential conditioning (D-Cond).

Differential conditioning (D-Cond) was calculated as the difference between post- and pre-conditioning ratings for the  $CS_{\text{neutral}}$  minus the difference between post- and pre-conditioning ratings for the  $CS_{\text{negative}}$ . A positive result would indicate support for differential conditioning.

A one-factor between, two-factor within MANOVA was conducted to test the differences in ratings of the  $CS_{\text{negative}}$  due to the field of presentation, the conditioning intervention (pre- versus post-conditioning ratings), and the number of trials. The overall trial and field effects were significant, as well as the trial by field by conditioning interaction [trial:  $F(3,51) = 3.99, p < .05$ ; field:  $F(1,51) = 4.03, p = .05$ ; trial X field X conditioning intervention:  $F(3,51) = 3.08, p < .05$ ]. Examination of the means indicated a large positive shift in the RVF ratings of the  $CS_{\text{negative}}$  after the conditioning procedure in the 10-trial condition, compared to a small negative shift in LVF ratings. Further analysis of the means using paired t-tests (for a priori planned comparisons) revealed no significant negative shifts in ratings of the  $CS_{\text{negative}}$ ;



in other words, no significant negative associations were formed through the pairing of the CS<sub>negative</sub> and the UCSs, a result clearly displayed in Table 4.

A similar analysis was conducted to test the significance of differences in ratings of the CS<sub>neutral</sub>. No significant effects were found.

In order to examine differential conditioning, a one-factor between, two-factor within MANOVA was conducted to test the significance of differences in the shifts in ratings of the CSs due to field of presentation, type of CS (CS<sub>negative</sub>, CS<sub>neutral</sub>), and the number of trials. None of the main effects were significant, nor were any of the interactions which examined differential conditioning. A significant trial by field interaction was found,  $F(3,51) = 3.39, p < .05$ . Examination of the means indicated that the CS shifts (across CS type) in the LVF and RVF tended to be in the reverse direction for the different trial conditions; this was most apparent for the 5- and 10-trial conditions.

Analyses of variance were conducted to test the effects of the independent variables, order and deck, on the differences between the pre- and post-conditioning ratings of the CS<sub>negative</sub> and CS<sub>neutral</sub> and on the amount of differential conditioning in each visual field. None of the main effects or interactions were significant.

#### Post-conditioning ratings of the UCSs

Mean ratings across subjects were calculated for the three UCSs presented in the post-conditioning rating phase. The mean ratings of the UCSs in the RVF and LVF were -4.14 and -3.99, respectively.

### Awareness

Only 8 of the 55 participants in the study were aware of the stimulus contingencies for the CS<sub>negative</sub>/CS<sub>neutral</sub> in both visual fields. Thirteen subjects were aware of the stimulus contingencies in one visual field. Overall, subjects were as likely to be aware of the contingencies for the RVF as for the LVF. Aware subjects were scattered throughout the trial conditions.

Owing to the small number of aware subjects, it was not possible to repeat the analysis described above to determine whether aware subjects showed a different pattern of responding than all subjects as a group, and in particular, whether aware subjects were more likely to show conditioning in some of the trial conditions. As a second but less sensitive option, aware subjects were grouped across trials. Paired t-tests were then used to compare the pre- and post-conditioning ratings for the CS<sub>negative</sub> and the shifts in ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub>, for each visual field. No significant conditioning effects were found for subjects who were aware of the stimulus contingencies in either visual field. As a comparison, a similar analysis was conducted for all subjects (both aware and unaware). Again, no significant conditioning effects were found.

### Discussion

The lack of conditioning in both visual field presentations suggests that negative facial expressions were not strong enough UCSs to condition neutral facial expressions, particularly when both the UCSs and CSs were shown for short exposure durations.

As noted in both this and the previous study, participants did not rate the UCSs very negatively; the ratings fell into the low to mid-negative range of the scale. However, the lack of conditioning was unexpected, given that other studies have effectively used photographs of emotional visual scenes to condition negative affect to neutral stimuli (Levey & Martin, 1975; Martin & Levey, 1978), although for longer exposures.

Because increasing the number of pairings might have resulted in a declining effect due to habituation and an overly long experimental procedure, it was decided to stop using negative facial expressions as UCSs and instead find a more negative stimulus.

Post-experimental discussions with the subjects indicated that some participants were using complex strategies for rating facial expressions during the rating phases which may have operated against finding a conditioning effect. In particular, one participant mentioned that he did not rate the neutral CS<sub>negative</sub> faces more negatively after the conditioning procedure because he felt that it would be impolite to rate the neutral faces as unpleasant. In this case, the requirement that the person consciously make a directional rating interacted negatively with the experimental intervention, and a forced-choice procedure might have been more appropriate.

Unfortunately, the absence of a conditioning effect for either visual field presentation removed the opportunity to test the hypothesis that there would be a right hemisphere advantage for the conditioning of evaluative responses to facial expressions. Although the results of this study might alternatively suggest that evaluative conditioning is not possible through lateralized presentations, this explanation is unlikely given the success of Hugdahl and his colleagues in

demonstrating hemispheric advantages in the conditioning of physiological responses to verbal cues, colour cues, and facial expressions using lateralized procedures. For example, as previously noted, Johnsen and Hugdahl (1991, 1993) demonstrated a right hemisphere effect for conditioning electrodermal responses to emotional facial expressions.

The present study was designed prior to the publication of Johnsen and Hugdahl's studies and approached the issue from a different perspective. First, it directly examined evaluative responses to the CS in order to measure both the intensity and direction of the response, unlike physiological conditioning which measures only the intensity of the physiological response. Furthermore, it is unclear how the results for lateralized physiological conditioning relate to previous studies which suggested awareness was necessary for conditioning to occur. The question arose whether verbalizable awareness was required to develop associative learning in the right hemisphere. Notably, in the present study, few participants developed awareness of the stimulus contingencies. If awareness was required for evaluative conditioning, then this would be consistent with the absence of a conditioning effect. However, the results of this study were insufficient for drawing a conclusion about awareness; this would require a proper comparison of the patterns of responses of aware and unaware participants. This analysis was carried out in the following study, which was more successful in demonstrating conditioning.

#### Study 4: The Evaluative Conditioning of Visual Patterns Using a Noxious Odour

Given the apparent lack of conditioning in the previous study, a stronger evaluative conditioning procedure was devised in which the UCS was a noxious odour and the CSs were simple abstract visual patterns. Furthermore, it was decided to test the conditioning procedure with foveal presentations before proceeding to a lateralization study. The combined results of the two studies could then also be used to assess whether evaluative conditioning, unlike physiological conditioning, required that the stimulus pairs be presented to both hemispheres (if the lateralized procedure did not generate conditioning). As in the previous study, an additional goal was to investigate whether awareness of the stimulus contingencies was required to develop evaluative conditioning; the brief exposure durations conferred an advantage for investigating this by reducing the opportunity for participants to develop awareness.

Since it was desirable to provide optimal conditions for a right hemisphere effect for evaluative conditioning in the later lateralized procedure, the design incorporated several factors to enhance right hemisphere processing: a focus on negative affect, the use of simple abstract visual patterns for CSs, and the use of a noxious smell for the UCS. Abstract visual designs were substituted for neutral facial expressions as CSs in the present study because they were simpler to produce, and possibly less likely to be rated based on attractiveness, or result in socially desirable responses (for example, not rating a face negatively out of courtesy). The designs were the shapes of jigsaw puzzle pieces which were not expected to be easily verbally labelled when briefly

presented.

There were anticipated advantages for employing a noxious smell for the UCS. On first presentation, odour was found to be differentially associated with right hemisphere processing in a preliminary study of brain electrical activity mapping (Van Toller, 1988). The olfactory pathways are also associated closely with the limbic system, which is functionally involved in memory and emotion.

The UCS was the odour of the vapour of a dilute solution of butyric acid. The odour smells like rancid butter, although on first exposure, has been equated with stench or vomit. It has been ranked as very unpleasant in several studies of human smell (for example, Moncrieff, 1966) and has been found effective as a UCS for aversive conditioning to foods (Foreyt & Kennedy, 1971; Kennedy & Foreyt, 1968).

As in the previous study, a differential conditioning procedure was used. The  $CS_{\text{negative}}$  was repeatedly paired with a puff of the noxious odour, and the  $CS_{\text{neutral}}$  was repeatedly presented alone. Evaluative conditioning would be successfully demonstrated if, first, a negative shift occurred in the ratings of the pleasantness of the  $CS_{\text{negative}}$  from before to after the conditioning procedure, and second, a significantly greater negative shift was found for the  $CS_{\text{negative}}$  than for the  $CS_{\text{neutral}}$  (differential conditioning).

The conditioning parameters for the study were developed in a step-by-step fashion. Initially, the number of trials ( $CS_{\text{negative}}$  presentations) selected for the conditioning procedure was 20. When this number was not found to be effective in producing conditioning, the number of trials was increased first to 40, then to 60.

Also, the choice of CS stimuli was found to affect conditioning. Initially, one pair of CS<sub>negative</sub> and CS<sub>neutral</sub> patterns were developed for the 20-trial and 40-trial conditions. A second pair was subsequently developed for the 40-trial condition since two sets were required for the planned laterality study. When the first set performed poorly in the 40-trial and 60-trial conditions, a third set was developed for the 60-trial condition.

### Hypotheses

The visual spatial patterns paired with the noxious smell would be judged as significantly more negative after the pairings than before. A differential conditioning effect would be found; the shift in the CS<sub>negative</sub> would be significantly more negative than the shift in the CS<sub>neutral</sub>. The study also investigated whether evaluative conditioning required verbalizable awareness of the stimulus contingencies.

## Method

### Subjects

Forty-three male and 18 female students at the University of Victoria participated in the study. Left-handed students were included in addition to right-handed students. Visual acuity was tested using the method described in Study 2. The students ranged in age from 19 to 29 years; the mean age was 21.8 years (SD = 2.2). Female students participated in the 20-trial and 40-trial conditions; male students participated in all trial conditions.

## Materials

Stimuli. The UCS was a puff of vapour from a 10% solution of butyric acid. The puff of vapour was delivered by the experimenter by hand-squeezing a bulb connected to a glass tube inserted into the solution. The resulting pressure pushed the vapour through a tube which was taped to the tachistoscope and opened just below the nose level of the subject.

The CSs and foil stimuli were patterns in the shape of jigsaw puzzle pieces, measuring, on average, 25 mm by 31 mm. Each pattern was presented in black and positioned in the centre of a white card. The stimuli are presented in Appendix F.

Apparatus and rating scale. The same rating scale and apparatus were used as in Study 2.

Awareness questionnaire. The awareness questionnaire was shortened to 6 questions based on feedback from the previous study, but otherwise followed the same format (see Appendix E). Again, participants were considered aware if they could differentially select the pattern that had been paired with the odour. If a participant picked both the CS<sub>negative</sub> and the CS<sub>neutral</sub>, the rating of certainty had to be greater for the CS<sub>negative</sub> than for the CS<sub>neutral</sub>.

## Procedure

As in previous studies, the participant filled out a handedness questionnaire and was given the visual acuity test at the beginning of the study. The experimenter introduced the study, and read aloud the instructions for the practice session and pre-conditioning rating phase while the subject followed along on a separate copy.

The practice deck consisted of 10 unique shapes of puzzle pieces. During the practice session, the experimenter monitored responses to determine whether the participant was having problems responding. Since it was difficult to tell with neutral stimuli whether subjects understood the operation of the scale, four blank cards were added to the end of the practice deck in the 40 and 60-trial conditions. The subject was asked to make positive ratings for the first two cards and negative ratings for the last two cards.

After the practice session, the participant rated the stimuli in the test deck while the experimenter stayed in the room to operate the tachistoscope. In the 20 and 40-trial conditions, the deck in the pre-conditioning rating phase consisted of 10 unique shapes (different from those in the practice session). The  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  were placed in positions number 3 and 5, respectively. In the 60-trial condition, the deck was modified to include a reliability measure. After the initial deck had been presented once, the first 8 cards were repeated a second time, in the same order, to obtain a second rating for each pattern.

The pre-conditioning rating phase was immediately followed by the conditioning procedure. In the conditioning phase, the  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  were each presented for the requisite number of trials. The order of presentation was randomized for 20 presentations each of the  $CS_{\text{negative}}$  and the  $CS_{\text{neutral}}$ , with the constraint that no more than three presentations of the same stimulus were shown in succession. In the 40-trial and 60-trial conditions the deck was repeated once and twice, respectively.

A puff of odour was delivered at the same time or shortly after the presentation of the CS<sub>negative</sub> (the experimenter squeezed the bulb when the stimulus card was heard to drop in the tachistoscope). No odour was presented with the CS<sub>neutral</sub>.

In the 20-trial and 40-trial conditions, the intertrial interval (between successive presentations of CSs) was 8 seconds. In the 60-trial condition, the interval was reduced to 6 seconds to decrease the length of time required for this phase.

The post-conditioning rating phase immediately followed the conditioning procedure. The same rating decks were used as in the pre-conditioning rating phase.

The subject then filled out the awareness questionnaire. An additional questionnaire was added to the 60-trial condition, which subjects filled out before the awareness questionnaire. Subjects were requested to note any change in the pleasantness of the CS<sub>negative</sub> and CS<sub>neutral</sub>, rate the pleasantness of the odour, and indicate whether the odour retained its strength during the session. At the end of the session, the experimenter debriefed and thanked the participant.

Instructions. The experimental instructions are presented in full in Appendix C. The instructions for the practice session and pre-conditioning rating phase were similar to those in Study 3, but modified for presentations in central focus.

The experimenter gave the following instructions to introduce the presentation of the odour in the conditioning procedure.

"Now we'll move to a separate task. This time, I'll be presenting some patterns but you won't have to rate them. Just pay attention to them, we'll get back to them later. Occasionally you will smell an odour. This will come through the tube taped to

the tachistoscope. Please breathe normally. It is important that you breathe in each time you hear a card drop, and that you do not try to avoid the smell at any time during the task. Any questions?"

Stimulus presentation. The same stimulus presentation was used as in Study 2 (the patterns were presented for 150 ms during the rating phases and the conditioning phase).

Design. A 3X3 factor between, 2X2 factor within subjects design was used. The two within factors were CS type ( $CS_{negative}$ ,  $CS_{neutral}$ ) and conditioning intervention (pre- versus post-conditioning ratings). The two between factors were the number of  $CS_{negative}$  trials (20, 40, and 60 trials) and the pair of patterns used for the  $CS_{negative}$  and  $CS_{neutral}$  (set 1, set 2, set 3). Due to the step by step development of the conditioning procedure, subjects were not randomly assigned to all conditions.

## Results

### Reliability

In order to develop a reliability screen for use in later studies, a reliability measure was incorporated into the rating phases of the 60-trial condition. Eight stimuli were rated twice in each phase. For each phase, the mean absolute difference in ratings between the first and second presentation was calculated across six of the stimuli (the  $CS_{negative}$  and  $CS_{neutral}$  were excluded). The mean differences between the two presentations were 1.79 ( $SD = 0.81$ ) and 1.69 ( $SD = 1.17$ ) for the pre- and post-conditioning rating phases, respectively.

Correlations were calculated to determine the test-retest reliability of the eight stimuli (including the CSs) in the rating phases. The correlations of the six non-CS stimuli ranged from .47 to .91 in the pre-conditioning rating phase (median = .67) and .60 to .81 in the post-conditioning rating phase (median = .63). The test-retest reliabilities for the CS<sub>negative</sub> and CS<sub>neutral</sub> for each CS combination were also calculated. The correlations in the pre-conditioning phase for set 1 were .16 and .73 for the CS<sub>negative</sub> and CS<sub>neutral</sub> respectively; the corresponding values for set 2 were .79 and .86; for set 3, .64 and .28. In the post-conditioning phase, the test-retest reliability for set 1 was .75 and .89 for the CS<sub>negative</sub> and CS<sub>neutral</sub> respectively; the corresponding values for set 2 were .92 and .72; for set 3, .93 and .71.

#### Conditioning effect

The first criterion for conditioning was that the CS<sub>negative</sub> should be rated significantly more negatively after the conditioning procedure than before it. To satisfy the criterion for differential conditioning, a significantly greater negative shift should be found for the CS<sub>negative</sub> than for the CS<sub>neutral</sub>. Table 5 presents the mean pre- and post-conditioning ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub>, the mean shifts in ratings, and the amount of differential conditioning (D-Cond). In the 60-trial condition, subjects rated the CS<sub>negative</sub> and the CS<sub>neutral</sub> twice in each rating phase; the subject's final rating for each CS was calculated as the average of the two ratings.

Figure 1 shows the mean shifts in ratings for the CSs and the amount of differential conditioning for each trial condition.

Table 5.  
Conditioning results for all subjects in Study 4. Mean pre- and post-conditioning ratings and shifts in ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub> and mean differential conditioning (D-Cond).

<u>Set</u>	<u>n</u>	<u>CS<sub>negative</sub></u>			<u>CS<sub>neutral</sub></u>			<u>D-Cond</u>
<u>X Trial</u>		<u>pre</u>	<u>post</u>	<u>post-pre</u>	<u>pre</u>	<u>post</u>	<u>post-pre</u>	
<u>Set 1</u>								
20 trials	8							
<u>M</u>		-0.25	-1.37	-1.12	1.00	1.87	0.87	2.00
<u>SD</u>		(2.87)	(3.11)	(5.44)	(3.85)	(3.31)	(2.23)	(5.21)
40 trials	9							
<u>M</u>		-0.33	-1.56	-1.22	3.11	3.33	0.22	1.44
<u>SD</u>		(4.12)	(4.22)	(3.56)	(2.93)	(3.54)	(5.17)	(7.21)
60 trials	8							
<u>M</u>		0.00	0.00	0.00	0.12	1.44	1.31	1.31
<u>SD</u>		(2.05)	(2.78)	(1.25)	(3.07)	(2.48)	(2.52)	(3.21)
<u>Set 2</u>								
40 trials	11							
<u>M</u>		2.36	-0.64	-3.00	0.55	1.27	0.72	3.73
<u>SD</u>		(3.88)	(4.82)	(6.31)	(2.98)	(2.80)	(5.00)	(8.26)
60 trials	11							
<u>M</u>		2.82	-1.36	-4.18	0.73	2.18	1.45	5.64
<u>SD</u>		(3.48)	(4.94)	(5.12)	(3.93)	(3.60)	(4.22)	(4.70)
<u>Set 3</u>								
60 trials	14							
<u>M</u>		1.54	1.14	-0.39	0.68	2.36	1.68	2.07
<u>SD</u>		(2.66)	(4.93)	(4.15)	(2.85)	(3.41)	(3.40)	(6.00)

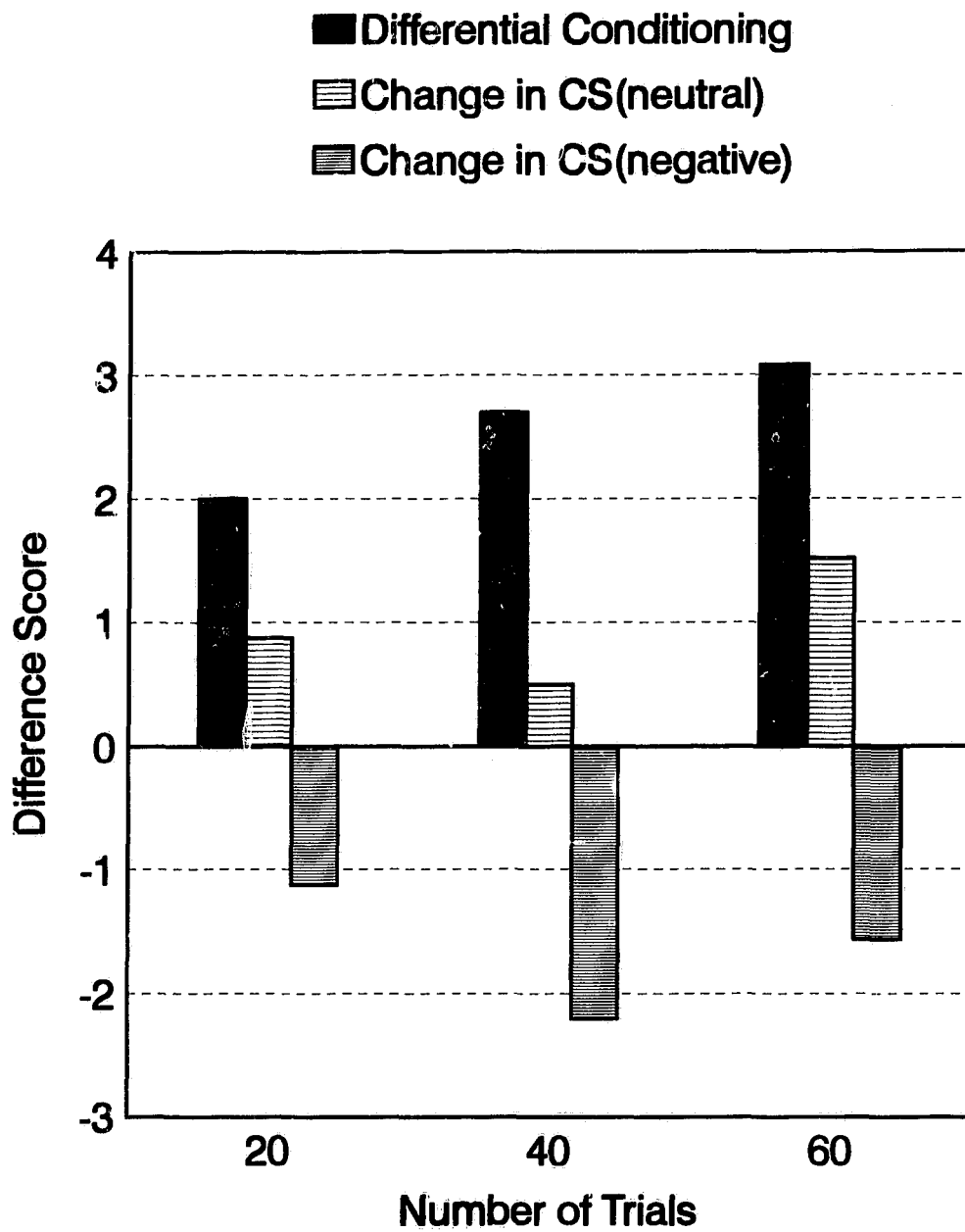


Figure 1. Conditioning by Number of Trials in Study 4

As in Study 3, differential conditioning was calculated as the difference between pre- and post-conditioning ratings for the CS<sub>neutral</sub> minus the difference between pre- and post-conditioning ratings for the CS<sub>negative</sub>. A positive result would indicate support for differential conditioning.

A one-factor between, two-factor within subjects MANOVA was conducted to test differences in the ratings of the CSs due to the type of CS (CS<sub>negative</sub>, CS<sub>neutral</sub>), the conditioning intervention (pre- versus post-conditioning ratings), and the number of trials. As expected, evidence for a negative shift in the CS<sub>negative</sub> and differential conditioning were found. The main effect for type of CS was significant,  $F(1,58) = 5.35, p < .05$ , along with the interaction of CS type by conditioning intervention,  $F(1,58) = 7.81, p < .01$ . Ratings of the pleasantness of the CS<sub>negative</sub> decreased after the conditioning procedure whereas ratings of the CS<sub>neutral</sub> increased. None of the remaining effects, including the number of trials, was significant.

A separate, similar analysis was conducted to test the effect of stimulus set (combination of CS<sub>negative</sub> and CS<sub>neutral</sub>) on ratings because a fully crossed design (trials by set) was not used. In this case, only the interaction of the type of CS by conditioning intervention was significant, as described above,  $F(1,58) = 12.40, p = .001$ . None of the remaining effects, including set, was significant.

### Awareness

Nine (14.8%) of the subjects were unaware of the stimulus contingencies. To determine whether awareness of the stimulus contingencies affected the occurrence of conditioning, the above analyses were repeated for aware participants only. The

resulting means are presented in Table 6.

When unaware subjects were removed from the analyses, greater overall conditioning was found. Again, a one-factor between, two-factor within subjects MANOVA was conducted to test differences in the ratings of the CSs due to the type of CS, the conditioning intervention, and the number of trials. The results were similar in pattern to those for all subjects, but enhanced. The effect for type of CS was significant,  $F(1,49) = 8.44, p < .01$ , along with the interaction of type of CS by the conditioning intervention,  $F(1,49) = 13.67, p = .001$ . None of the remaining effects was significant.

The analysis of set (combination of  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$ ) also found a similar, enhanced pattern of effects. The effect for type of CS was significant,  $F(1,49) = 7.78, p < .01$ , along with the interaction of type of CS by the conditioning intervention,  $F(1,49) = 22.20, p < .001$ . Again, none of the remaining effects was significant.

A cross-tabulation was done to determine whether any subjects who were classified as unaware showed evidence of differential evaluative conditioning. The results are presented in Table 7. While aware subjects were far more likely to show evidence of differential conditioning, three unaware subjects showed some evidence as well. However, the amount of differential conditioning shown by each of these three subjects was very small (less than or equal to 1.00 scale unit), and the results may have been due to chance.

Table 6.

Conditioning results for aware subjects only in Study 4. Mean pre- and post-conditioning ratings and shifts in ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub> and mean differential conditioning (D-Cond).

<u>Set</u>	<u>n</u>	<u>CS<sub>negative</sub></u>			<u>CS<sub>neutral</sub></u>			<u>D-Cond</u>
<u>X Trial</u>		<u>pre</u>	<u>post</u>	<u>post-pre</u>	<u>pre</u>	<u>post</u>	<u>post-pre</u>	
<u>Set 1</u>								
20 trials	8							
<u>M</u>		-0.25	-1.37	-1.12	1.00	1.87	0.87	2.00
<u>SD</u>		(2.87)	(3.11)	(5.44)	(3.85)	(3.31)	(2.23)	(5.21)
40 trials	7							
<u>M</u>		-1.14	-2.14	-1.00	2.71	4.86	2.14	3.14
<u>SD</u>		(4.37)	(4.45)	(3.70)	(3.15)	(2.04)	(3.76)	(6.64)
60 trials	7							
<u>M</u>		0.07	0.29	0.21	0.07	1.79	1.71	1.50
<u>SD</u>		(2.21)	(2.87)	(1.19)	(3.31)	(2.46)	(2.43)	(3.41)
<u>Set 2</u>								
40 trials	9							
<u>M</u>		2.11	-1.22	-3.33	0.11	1.44	1.33	4.67
<u>SD</u>		(4.11)	(5.09)	(7.00)	(2.89)	(3.09)	(5.29)	(8.90)
60 trials	11							
<u>M</u>		2.82	-1.36	-4.18	0.73	2.18	1.45	5.64
<u>SD</u>		(3.48)	(4.94)	(5.12)	(3.93)	(3.60)	(4.22)	(4.70)
<u>Set 3</u>								
60 trials	10							
<u>M</u>		1.25	-0.75	-2.00	0.95	3.45	2.50	4.50
<u>SD</u>		(2.54)	(3.81)	(2.51)	(3.14)	(2.33)	(3.45)	(4.78)

Table 7.  
Number of aware and unaware subjects in Study 4 who showed or did not show evidence of differential evaluative conditioning, across all experimental conditions.

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	<u>Aware</u>	<u>Unaware</u>
Showed evidence of differential conditioning	37	3*
Did not show evidence	<u>15</u>	<u>6</u>
Total	52	9

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\* Minimal conditioning was found for these subjects; see text.

#### Discussion

The results demonstrated that a noxious odour was an effective UCS for producing evaluative conditioning to briefly presented abstract visual patterns. Consistent with expectations, the formation of negative associations and differential evaluative conditioning were observed. Neutral patterns paired with the odour were subsequently rated more negatively; in contrast, patterns presented without the odour were rated more pleasantly after the conditioning procedure. The positive shift in ratings for patterns presented without the odour is consistent with Zajonc's (1968) mere exposure effect; however, the context in the present study differs from that of a mere exposure study by including the contrasting condition of presenting a similar pattern with a noxious stimulus. The positive shift was likely a response to the negative contingency, that is, an increase in liking for the stimulus because it accompanied or signalled a pleasant event, the absence of the noxious odour.

Although the pattern of means suggested that the number of trials and the  $CS_{\text{negative}}/CS_{\text{neutral}}$  combination influenced conditioning, these factors were not significant. The slightly poorer performance of one combination of  $CS_{\text{negative}}/CS_{\text{neutral}}$  (set 1) compared to the other two combinations, was probably due to the greater similarity between the two patterns in this set than in other sets. When the  $CS_{\text{neutral}}$  from this set was paired with a more distinctive  $CS_{\text{negative}}$ , more conditioning occurred.

As expected, the use of brief exposure durations reduced awareness of the stimulus contingencies and provided an opportunity to compare the results of aware and unaware subjects. The analysis suggested that awareness may mediate the conditioning effect; a greater proportion of aware than unaware subjects showed evidence of conditioning and the amount of conditioning was greater for aware subjects than all subjects as a group.

However, the awareness analysis was not entirely conclusive since three subjects who were unaware of the stimulus contingencies showed a small, though minimal amount of differential conditioning. It is unclear whether the results for these three subjects reflected genuine conditioning or chance responses; the latter is suspected because of the small size of the effect in each case. However, the possibility of a real effect should not be ruled out. Moreover, it may not be inconsistent with the suggestion that awareness mediates evaluative conditioning. Rather, it is consistent with the proposition that awareness develops along a continuum, and in the early stages, may be masked by an insensitive measure of awareness (Furedy, 1991; Furedy & Schiffman, 1971). On the other hand, the finding may reflect the opposite, that

affective changes in evaluative conditioning can precede the development of awareness. A third alternative is that both awareness and affective changes are parallel products of conditioning.

The possibility that awareness may be required for evaluative conditioning runs counter to the hypotheses proposed by Staats and Staats (1957, 1958) and more recent researchers of evaluative conditioning (Levey & Martin, 1983; Martin & Levey, 1987) but is in agreement with the findings of other researchers in the field (Insko & Oakes, 1966; Page, 1969). It also agrees with the general findings of studies which examined the conditioning of electrodermal responses (for example, Baer & Fuhrer, 1968, 1982; Dawson & Reardon, 1973; Maltzman, 1977).

Another question which arose during this study was about the reliability of scale ratings. The test-retest reliability of several of the patterns was only poor to fair. Neutral concepts, such as the puzzle shapes used in the study, tend to be rated with less reliability than emotional concepts (Heise, 1970), and reliability was probably further reduced in the study through the use of brief exposure durations. It was noted that a few subjects were very inconsistent in their ratings of the same puzzle shapes over a two-minute period, frequently rating the same stimulus as both positive and negative. Also, for a few subjects, the difference between first and second ratings of a pattern in a given phase was greater than the expected change in ratings due to the conditioning procedure. This contrasted with the accuracy for rating facial expressions and words found in Studies 1 and 2. This problem was not sufficient to eliminate the conditioning effect across subjects; however, it raised the possibility that the reliability

of rating briefly presented neutral stimuli could be an issue for some participants and, consequently, that it should be measured and used as a screening device.

Of the two factors, awareness and reliability, the latter would likely have a greater impact on studies of the lateralization of conditioning. Johnsen and Hugdahl (1991, 1993) were able to demonstrate a right hemisphere effect for conditioning electrodermal responses although this type of conditioning appears to be mediated by awareness in foveal presentations. It is not clear whether awareness was required for conditioning in the right hemisphere; if it was, the necessary processing did not mask the right hemisphere effect. The reliability issue was more serious because variability in scale ratings might mask a conditioning effect, particularly if ratings were made of lateralized presentations. It would be expected that reliability would be poorer where abstract stimulus input is more degraded, as it would be in peripheral as opposed to foveal presentations.

The question of whether evaluative conditioning in the right hemisphere occurs and requires awareness was pursued in a subsequent pilot study using a similar conditioning methodology with lateralized presentations.

Study 5: Hemispheric Differences in the Evaluative Conditioning of Visual Patterns  
with a Noxious Odour

Like Study 3, this study was designed to investigate the differential abilities of the right and left hemisphere to condition an evaluative response to a neutral stimulus. This time, the stronger UCS (noxious smell) and conditioning procedure tested in Study 4 were used to increase the likelihood of conditioning. Simple abstract visual patterns, selected from Study 4, were used as CSs. The differential conditioning procedure was modified to accommodate the lateralized presentations.

In the conditioning phase, a different  $CS_{negative}/CS_{neutral}$  combination was presented to each visual field. On the  $CS_{negative}$  trials and on the  $CS_{neutral}$  trials, the CSs were presented bilaterally so that both visual fields received input at the same time. As in the previous study, the  $CS_{negative}$  presentations were followed by a puff of the noxious odour, and the  $CS_{neutral}$  presentations were used to control for the effect of repeated presentations in the absence of the UCS.

In the 60-trial condition in the previous study, it was noted that some subjects produced highly unreliable ratings for the abstract patterns. For some subjects, the average difference in ratings between the first and second presentations of the stimuli in a given rating phase was greater than the size of the expected shift in ratings following the evaluative conditioning procedure. Since this might increase the overall variance of subjects' ratings and reduce the chance of finding hemispheric effects, a reliability screen was incorporated into this study, initially, to screen out subjects with

highly unreliable ratings. However, the reliability problems became so great that the study was stopped midway.

### Hypotheses

The hypotheses were, first, evaluative conditioning would occur; second, a right hemisphere effect would be found; and third, awareness of the stimulus relationships would not be necessary for the occurrence of conditioning in the right hemisphere. More specifically, the patterns paired with the aversive smell ( $CS_{negatives}$ ) would be judged as significantly more negative after the pairings than before, and more so than patterns not accompanied by the smell.

## Method

### Subjects

Ten right-handed male students at the University of Victoria participated in the study. Degree of right-handedness and visual acuity were assessed using the same methods and criteria described in Study 2. The students were between the ages of 19 and 30 years; the mean age based on 9 subjects was 21.8 years ( $SD = 2.3$ ) (one subject did not state his age).

Four additional male students did not complete the experimental session. Two failed the visual acuity test and two were dropped from the study when the experimenter noted that they produced highly unreliable ratings during the pre-conditioning rating phase.

## Materials

Stimuli. The UCS was a puff of vapour from a 10% solution of butyric acid, delivered in the same manner as described in Study 4.

The two CS<sub>negative</sub>/CS<sub>neutral</sub> pairs for which conditioning was demonstrated in Study 4 in the 60-trial condition (for aware subjects) were used in this study (set 2 and set 3). The same foil stimuli were used for the rating phases and practice deck (Appendix F).

In the conditioning phase, the two CS<sub>negatives</sub> and the two CS<sub>neutrals</sub> were presented bilaterally on white cards, two degrees to the right and left of the centre of the card. In each case the centre of the card was marked by a small up or down arrow to enable the experimenter to test whether the subject was focusing on the centre of the card. Ninety percent of the cards had an up arrow, 10% had a down arrow.

Two presentation formats were used in the rating phases and practice session. For the first 4 subjects, each CS or foil was presented unilaterally on the card, two degrees to the right or left of the centre of the card. In this format, the individual CSs were presented to the same visual field as during the conditioning phase. The format was changed for the remaining 6 subjects when it was noted that the reliability of ratings in the lateralized format was poor. For these subjects, each stimulus was positioned in the centre of the card (in central focus).

Apparatus and rating scale. The same rating scale and apparatus were used as in Study 2.

Awareness questionnaire. The same awareness questionnaire was used as in Study 4 (see Appendix E). Participants were considered aware for a visual field, if, when presented with the two CS<sub>negatives</sub> and the two CS<sub>neutrals</sub>, they could differentially select the pattern that had been paired with the odour in the visual field. If the participant said that both the CS<sub>negative</sub> and the CS<sub>neutral</sub> in a visual field had been paired with the odour, then the certainty rating for the CS<sub>negative</sub> had to be greater than for the CS<sub>neutral</sub>.

#### Procedure

As in previous studies, the participant filled out a handedness questionnaire and was given the visual acuity test at the beginning of the study. The experimenter introduced the study, and read aloud the instructions for the practice session and pre-conditioning rating phase while the subject followed along on a separate copy.

The practice deck consisted of 10 unique shapes of puzzle pieces, followed by four blank cards for testing whether the subject understood the scale (the subject was asked to make positive ratings for the first two cards and negative ratings for the last two cards). As noted above, the first 4 subjects rated laterally presented patterns in the practice session and pre- and post-conditioning rating phases, whereas the last 6 subjects rated the patterns in central focus.

After the practice session, the participant rated the stimuli in the test deck while the experimenter stayed in the room to operate the tachistoscope. The deck consisted of 24 cards. In order to assess reliability, 12 unique patterns were presented once and then repeated a second time. The maximum length of time between successive ratings of the same stimulus during the rating phase was less than 2 minutes. The CS<sub>negatives</sub>

for the two visual fields were placed in positions number 3 (RVF) and 5 (LVF) and repeated in positions number 15 and 17; the CS<sub>neutrals</sub> were placed in positions number 8 (RVF) and 10 (LVF), and repeated in positions 20 and 22.

An attempt was made to counterbalance subjects for the side of presentation to which a particular CS<sub>negative</sub>/CS<sub>neutral</sub> combination was shown (the study was stopped before the full design could be carried out). Seven subjects saw one combination of CS<sub>negative</sub> and CS<sub>neutral</sub> in the left visual field and the other combination in the right visual field (deck 1). The combinations were presented in reverse for the remaining three subjects (deck 2).

The pre-conditioning rating phase was immediately followed by the conditioning procedure. In the conditioning phase, the CS<sub>negative</sub> and CS<sub>neutral</sub> were each presented for 60 trials. The order of presentation was randomized for 20 presentations of both the CS<sub>negatives</sub> and the CS<sub>neutrals</sub>, with the constraint that no more than three presentations of either were shown in succession. This order was repeated twice.

A puff of odour was delivered at the same time or shortly after the presentation of the CS<sub>negatives</sub> (the experimenter squeezed the bulb when the stimulus card was heard to drop in the tachistoscope). No odour was presented with the CS<sub>neutrals</sub>. The intertrial interval was 6 seconds.

Subjects were given a task during the conditioning procedure to ensure that they focused their eyes on the centre of the screen. They were asked to raise their hand every time they saw a 'down arrow' in the centre of the card.

The post-conditioning rating phase immediately followed the conditioning procedure. The same rating decks were used as in the pre-conditioning rating phase.

The subject then filled out the awareness questionnaire. At the end of the session, the experimenter debriefed and thanked the participant.

Instructions. The experimental instructions are presented in Appendix C. The instructions were similar to those for Study 4, but modified for lateralized presentations.

Stimulus presentation. The patterns were presented for 150 ms during the rating phases and the conditioning phase.

Design. A one-factor between, 2X2X2 factor within subjects design was used. The three within factors were CS type ( $CS_{negative}$ ,  $CS_{neutral}$ ), visual field (LVF, RVF), and conditioning intervention (pre- versus post-conditioning ratings). The between factor was the  $CS_{negative}/CS_{neutral}$  combination presented to each visual field (deck 1, deck 2). Additionally, as noted above, the first 4 subjects rated lateralized presentations of the patterns whereas the remaining subjects rated the patterns in central focus.

## Results

### Reliability

For the purposes of screening, the reliability of a subject's ratings was calculated as the average absolute difference between the first and second ratings of eight non-CS repeated patterns in each rating phase. A subject was considered unreliable if the

mean difference between first and second presentations was 3.00 or greater, on a scale from 9 (happy face) to -9 (sad face).

Initially, the reliability of the subject's ratings in the pre-conditioning rating phase was intended to be a screen for inclusion in the study. As a result, two subjects were did not complete the study when the average difference between first and second presentations was noted to be large (4.50 or greater). Owing to other tasks during this part of the study, the experimenter did not consistently calculate reliability for all subjects at this time and consequently, decided to use reliability as a post hoc screen. Reliability, however, became an issue in this study, and the following results reflect the ratings of the 10 subjects who completed the experimental session.

The mean reliability ratings for the four subjects who rated the patterns in the lateralized format were 3.59 and 4.02 in the pre-and post-conditioning rating phases, respectively. The corresponding reliability ratings for the six subjects who rated the patterns in central focus were 2.69 and 2.08.

If a reliability rating of 3.00 or less is considered as 'reliable', then all 4 subjects who rated the patterns in the lateralized format produced unreliable ratings in either the pre- or post-conditioning rating phases. Three of the 6 subjects who rated the patterns in central focus produced unreliable ratings in either the pre- or post-conditioning phases (this does not include the two subjects who were dropped from the study due to unreliable ratings in the pre-conditioning rating phase).

In this study, a correlational analysis was not conducted to determine the test-retest reliability of ratings because of the low number of subjects in each format group

(lateralized format, central focus).

Visual field effects for conditioning

Table 8 presents the mean pre- and post-conditioning ratings of the CS<sub>negative</sub> and CS<sub>neutral</sub>, the shift in ratings of the CS<sub>negative</sub> and CS<sub>neutral</sub>, and the amount of differential conditioning for each visual field. Owing to the small number of subjects in this study, the results for the subjects who rated the patterns in the lateralized format and those who rated them in central focus are combined.

To examine whether conditioning occurred, a two-factor within subjects MANOVA was conducted to test the differences in ratings of the CS<sub>negative</sub> due to the field of presentation and the conditioning intervention (pre- versus post-conditioning ratings). No significant effects were found. A similar analysis conducted for the CS<sub>neutral</sub>; again, no significant effects were found.

Table 8.  
Conditioning results for all subjects in Study 5. Mean pre- and post-conditioning ratings and shifts in ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub>, and mean differential conditioning (D-Cond), for each visual field.

Subjects X Visual Field	n	CS <sub>negative</sub>			CS <sub>neutral</sub>			D-Cond
		pre	post	post-pre	pre	post	post-pre	
LVF(RH)	10							
<u>M</u>		3.25	2.60	-0.65	0.10	1.45	1.35	2.00
<u>SD</u>		(4.83)	(3.87)	(3.06)	(5.37)	(4.69)	(4.48)	(4.31)
RVF(LH)	10							
<u>M</u>		3.25	1.65	-1.60	0.70	2.55	1.85	3.45
<u>SD</u>		(4.37)	(3.26)	(4.03)	(6.29)	(4.10)	(4.64)	(6.03)

To determine whether differential conditioning occurred, a two-factor within subjects MANOVA was conducted to test the shifts in ratings of the CSs due to the field of presentation and the type of CS (CS<sub>negative</sub>, CS<sub>neutral</sub>). Although the general pattern of means shown in Table 8 was suggestive, no significant conditioning effects were found.

### Awareness

Of the 10 subjects, 4 were aware of the relationship between the CS<sub>negative</sub>/CS<sub>neutral</sub> and the odour for LVF presentations and 5 were aware for RVF presentations. Only 2 subjects were aware of the stimulus relationships for both fields. Table 9 presents the conditioning results for these subjects. Owing to the small number of subjects who were aware in each visual field, no further analysis of conditioning results was conducted.

### Discussion

This study was terminated early because of the problems experienced with the reliability of ratings. Few subjects would have been included in the study had the initial reliability screen remained in place. For many subjects, the difference between first and second ratings of a pattern in a given phase was frequently greater than the expected change in ratings due to the conditioning procedure. Ratings of lateralized patterns, positioned at the periphery of the visual field where acuity is poorer, showed greater variation than ratings of patterns in central fixation. This would be expected and suggests that lateralized presentations should be restricted to the conditioning

Table 9.

Conditioning results for subjects in Study 5 who were aware of the stimulus relationships in one or both visual fields. Mean pre- and post-conditioning ratings and shifts in ratings for the CS<sub>negative</sub> and CS<sub>neutral</sub> and mean differential conditioning (D-Cond), for each visual field.

Subjects								
X Visual		CS <sub>negative</sub>			CS <sub>neutral</sub>			D-Cond
Field	n	pre	post	post-pre	pre	post	post-pre	
Aware in								
<u>LVF(RH)</u>								
LVF	4							
<u>M</u>		1.12	0.25	-0.87	-0.50	3.00	3.50	4.37
<u>SD</u>		(3.68)	(1.56)	(4.27)	(5.24)	(2.74)	(6.55)	(5.65)
RVF	4							
<u>M</u>		3.12	0.50	-2.62	-1.50	3.12	4.62	7.25
<u>SD</u>		(4.59)	(1.41)	(3.57)	(7.01)	(4.87)	(5.09)	(8.21)
Aware in								
<u>RVF(LH)</u>								
LVF	5							
<u>M</u>		5.80	3.90	-1.90	-1.30	0.00	1.30	3.20
<u>SD</u>		(2.97)	(4.44)	(3.27)	(4.91)	(5.16)	(2.68)	(4.04)
RVF	5							
<u>M</u>		3.60	1.40	-2.20	1.90	2.30	0.40	2.60
<u>SD</u>		(3.66)	(3.72)	(4.35)	(6.87)	(5.18)	(3.86)	(2.33)

phase in this type of study. As in Study 4, reliability was probably further reduced through the use of neutral, abstract patterns in combination with brief exposure durations.

While the overall pattern of results was consistent with evaluative conditioning, significant conditioning was not found for presentations in either visual field. This

was likely due to the small number of subjects in combination with the relatively large variances in ratings. It is interesting to note that the pattern of pre- and post-conditioning ratings of the  $CS_{\text{negative}}$  and  $CS_{\text{neutral}}$  does not provide evidence for a right hemisphere effect for forming associations for visual spatial patterns during the conditioning procedure. If anything, a greater negative shift in the rating of the  $CS_{\text{negative}}$  pattern, both after the conditioning procedure and relative to the  $CS_{\text{neutral}}$ , was observed for right visual field (left hemisphere) presentations when the scores of all subjects were examined.

The sample contained too few subjects to appropriately examine the impact of awareness of the stimulus contingencies on subjects' scores. The comparison between the few aware subjects in the sample and the whole sample suggests that awareness promoted associative effects and may have influenced the hemispheric pattern observed for the whole sample.

No consistent pattern of awareness developed during the evaluative conditioning procedure. Only a few subjects were aware of the stimulus contingencies in both visual fields; others expressed differential awareness between the visual fields; that is they were more aware of the contingencies in one visual field than in the other. Too few subjects were included in this study to speculate on the impact of differential awareness on laterality effects in evaluative conditioning.

## CHAPTER 5: CONCLUSIONS

This research was designed to address two major questions. First, it examined whether ratings of the pleasantness or unpleasantness of verbal stimuli and facial expressions on a 'nonverbal' analog of a semantic differential scale would show similar laterality effects as the more traditional measures, accuracy and response time. In Study 1, as expected, a left hemisphere effect was found for assessing affective responses to emotional words, consistent with the findings of previous researchers who used accuracy and reaction time as dependent variables (Graves et al., 1981; Strauss, 1983) and extending the general finding to scale ratings. Again, the right hemisphere showed a capability for verbal processing, rating words in the correct direction. However, more intense ratings were found for presentations to the left hemisphere, although left hemisphere involvement in making scale ratings may have enhanced the overall size of the difference. Overall, these results support other work which suggests that the right hemisphere advantage in processing affect is limited to the nonverbal affective lexicon, comprising elements of social displays.

In Study 2, however, no laterality effects were found for ratings of positive and negative facial expressions presented tachistoscopically to the right and left visual fields. This finding countered the results of most reported studies using accuracy or reaction time for measuring the processing of emotional facial expressions and raised the possibility that scale ratings might measure different functional processing than these other measures.

The semantic differential scale has rarely been used to measure affective response in neuropsychological research, and when it has, with mixed results (Natale, Gur, & Gur, 1983). However, the scale has been used extensively in attitude studies to assess the direction and intensity of an evaluative response; some researchers have proposed that this type of evaluative judgement reflects an automatic, pre-cognitive, holistic response (Zajonc, 1980), sharing characteristics similar to those proposed for right hemisphere processing. The results of the present research suggest that the scale rating does not uniquely represent this type of response but instead involves substantial left hemisphere processing. Unlike discrimination tasks, a rating task requires a conscious, subjective assessment of how much affect is present. A cross-modal judgement of this type may require numerical processing, which has a left hemisphere advantage (Borod, 1992), and may include verbal reflection or an assessment of experience, which would also reduce the opportunity for finding a right hemisphere advantage (Spence, 1992). Ideally, a response in a laterality study should not predispose a strategy more directed to one hemisphere than another. Since it appears that the processing required to respond to the semantic differential scale masks the right hemisphere advantage for affect, the scale has limited usefulness to laterality studies of affect, even when a 'nonverbal' analog of the scale is used. Use of the semantic differential scale should pose less of a problem to attitude studies such as evaluative conditioning that analyze the change scores resulting from an experimental intervention because the processing used to respond to the scale should cancel out in the calculation of the change score.

In Study 2, support was found for the differential processing of facial expressions

presented in mirror image and original orientation to the left hemisphere. One group of participants gave more negative ratings to mirror images, consistent with the fact that, in mirror images presented to the right visual field, the left, more expressive side of the face was presented closer to the fovea (this occurs for images in original orientation in left visual field presentations). These results suggest that this bias should be taken into consideration when designing lateralized presentations in order to ensure that both hemispheres are receiving input of equal emotional intensity. As in this study, this could be done by presenting mirror images to the right visual field and images in original orientation to the left visual field.

The second question the research addressed was whether it was possible to condition affective responses in the right and left hemispheres separately, and if so, whether verbalizable awareness was necessary for evaluative conditioning to occur, particularly in the right hemisphere. In Study 3, a differential conditioning procedure was developed to examine the laterality of evaluative conditioning; this procedure is unique in evaluative conditioning studies but was developed to permit comparisons with the results of studies of physiological conditioning, where the procedure is commonly used.

The pairing of neutral faces with emotional facial expressions in lateralized presentations did not result in evaluative conditioning in either hemisphere, as measured by scale ratings. Notably the lack of effect was associated with little verbalizable awareness, an issue discussed further below. The lack of conditioning effect likely owed to the low strength of the UCS (for the short exposure duration)

rather than a more general inability to condition the hemispheres separately. Johnsen and Hugdahl (1991, 1993) demonstrated the conditioning of physiological responses to lateralized presentations of emotional, particularly angry faces, when a stronger UCS, shock, was employed. However, conditioning the hemispheres separately may be more difficult than producing conditioned responses in the brain as a whole and may work only in restricted circumstances. An additional and interesting difference between these studies and the present study was the use of emotional facial expressions as CSs in the former and the use of neutral facial expressions in the latter. It may be easier to produce a more negative assessment of an already negative facial expression than shift the appraisal of a neutral facial expression in lateralized presentations. Johnsen and Hugdahl (1991, 1993) found that the pairing of happy expressions with shock resulted in weak or no conditioning, possibly owing to the greater saliency of pairing a negative UCS with a negative facial expression.

In Study 4, a stronger and novel, evaluative differential conditioning procedure was developed, using a noxious odour as a UCS and abstract visual patterns as CSs, which was successful in producing conditioning with foveal presentations across various combinations of stimuli and numbers of trials. The short stimulus exposure durations reduced the opportunity for participants to become aware of the stimulus contingencies, which provided an opportunity to examine whether awareness was required for conditioning to occur. The results of the study echoed the longstanding controversy in studies of both evaluative and physiological conditioning; while it appeared that awareness of the relationship between the CS<sub>negative</sub> and the UCS

accompanied conditioning, a few participants showed a minimal conditioning effect without developing awareness. These small effects may have been due to measurement error particularly as there were questions about the reliability of ratings; however, a real effect cannot be ruled out. Both the development of awareness and affective changes may occur concurrently along continua, and influence the other.

A reliability problem arose with the use of abstract stimuli in Study 4 which was exacerbated in Study 5 when the conditioning procedure was tested in a lateralized format (this resulted in the termination of Study 5). Some subjects showed remarkably inconsistent ratings of the abstract patterns over a two-minute period. This problem occurred with foveal presentations but was worse with lateralized presentations, in which the patterns were presented peripherally to an area of the retina with poorer visual acuity. Reliability has been found to be poorer with abstract compared to salient stimuli (Heise, 1970); in this case, the effect was likely compounded by the short exposure durations. Owing to this problem, it would be preferable to use more salient stimuli in conjunction with the scale. A more productive procedure might have been to pair emotional facial expressions as CSs with the noxious UCS, as Johnsen and Hugdahl (1991, 1993) did in their studies of electrodermal conditioning.

In summary, this research contributed to a better understanding of the limitations of the semantic differential scale for laterality research in affect. It raised the question of whether an analog of a semantic differential scale could be developed which minimized left hemisphere processing in order to test for laterality effects in affective

appraisals. Second, it found that the abstract or concrete nature of a stimulus influenced the reliability of scale ratings on briefly exposed stimuli, and suggested that this should be considered when designing laterality studies involving this measure.

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## APPENDIX A: HANDEDNESS SCALE

HAND PREFERENCE QUESTIONNAIRE

Please indicate your hand preference for each of the following activities by checking the appropriate space. If you are not sure, try to physically mimic the action to make sure.

-----  
Which HAND do you use:  
-----

		<u>Right Always</u>	<u>Right Preferred</u>	<u>No Preference</u>	<u>Left Preferred</u>	<u>Left Always</u>
1	To write a letter	_____	_____	_____	_____	_____
2	To write on the blackboard	_____	_____	_____	_____	_____
3	To draw	_____	_____	_____	_____	_____
4	To throw a ball	_____	_____	_____	_____	_____
5	To hold a match while striking it	_____	_____	_____	_____	_____
6	To hammer a nail	_____	_____	_____	_____	_____
7	To brush your teeth	_____	_____	_____	_____	_____
8	To thread a needle	_____	_____	_____	_____	_____
9	To shave	_____	_____	_____	_____	_____
10	To sew	_____	_____	_____	_____	_____
11	To peel an apple	_____	_____	_____	_____	_____
12	To throw a dart	_____	_____	_____	_____	_____
13	To open a letter with a letter opener	_____	_____	_____	_____	_____

-----  
 Which HAND do you use:  
 -----

	<u>Right Always</u>	<u>Right Preferred</u>	<u>No Preference</u>	<u>Left Preferred</u>	<u>Left Always</u>
14 To use a pair of tweezers	_____	_____	_____	_____	_____
15 To wash a dish (which hand washes the dish?)	_____	_____	_____	_____	_____
16 To pour a cup of coffee	_____	_____	_____	_____	_____
17 To use a comb	_____	_____	_____	_____	_____
18 To paint a wall	_____	_____	_____	_____	_____
19 To hold a bat in baseball	_____	_____	_____	_____	_____
20 To throw a bowling ball	_____	_____	_____	_____	_____
21 To colour or paint a picture	_____	_____	_____	_____	_____
22 To pour water from a pitcher	_____	_____	_____	_____	_____
23 To point to something in the distance	_____	_____	_____	_____	_____
24 To snap your fingers	_____	_____	_____	_____	_____
25 To use a bottle opener	_____	_____	_____	_____	_____

---

Which HAND do you use:

---

	<u>Right Always</u>	<u>Right Preferred</u>	<u>No Preference</u>	<u>Left Preferred</u>	<u>Left Always</u>
26 To do a cartwheel (which hand lands first?)	_____	_____	_____	_____	_____
27 To use an eraser on a pencil	_____	_____	_____	_____	_____
28 To carry a heavy suitcase	_____	_____	_____	_____	_____

## APPENDIX B: SAMPLE OF FACIAL EXPRESSION STIMULI USED

## IN STUDY 2

Source: Photographs Taken by the Experimenter

The two printing formats for the photographs are shown: original and mirror orientations.



Original



Mirror



Original



Mirror



Original



Mirror



Original



Mirror



Original



Mirror



Original



Mirror

## APPENDIX C: INSTRUCTIONS TO PARTICIPANTS IN STUDIES 2, 3, 4, AND 5

Study 2

"The purpose of this study is to examine how the brain processes facial expressions. One way of doing this is to measure subjective or gut responses to pictures of faces when they are presented very briefly."

"Different faces and facial expressions differ in their capacity to arouse emotional feeling. Some arouse a strong pleasant or unpleasant feeling. Some arouse only moderate feeling, some no feeling at all. In this experiment, I will be presenting a series of faces to you. What I'd like you to do is to rate how pleasant or unpleasant you feel after each face is presented."

"Faces will be presented very briefly using the tachistoscope in front of you. Look into the viewer right now. Do you see the dot at the centre of the screen? What will happen is that after the dot has been exposed for a second or so, a picture of a face will be flashed to either the right or left of the dot. It is important, however, that you keep both eyes focused on the dot at all times."

"Shortly after the picture of the face disappears, a vertical scale will appear in the viewer. At the top end of the scale will be a happy face, at the bottom, a sad face. If the picture of the face has generated a pleasant feeling in you, move the handle on this joystick forward. Red lights will light up from the centre of the scale toward the happy face. If the picture of the face has generated an unpleasant feeling, move the handle backward, toward you. Red lights will light up from the centre toward the sad

face. Your rating will be the number of lights that light up, or in other words, the length of the light bar. So make greater movements for stronger feelings. Move the handle until you feel your rating is right. If the picture of the face doesn't generate any feeling in you, then leave the handle centred."

"Once you have the handle positioned where you want it, push the button on the top of the joystick handle with your thumb. This will register your rating on the computer. The button on the joystick is a bit tricky. You may hear a click even when the rating hasn't registered. So push the button hard. When your rating is registered the scale will disappear. So if you think you've made a rating and the scale hasn't disappeared, push the button again harder until it does."

"Please make each rating as quickly as possible, rating the initial feeling that comes to you. Feel free to use the entire range of the scale. At the same time, don't be concerned about how often you use a particular rating as long as the rating you make feels right."

"If you haven't made a rating after several seconds, the scale will disappear on its own. When the scale disappears, the fixation dot will reappear. Again, fix your eyes on the dot. Another face will appear shortly. Remember to keep your eyes fixed on the dot at all times."

"We'll start off with a practice session of 18 faces. Please use your right hand to move the joystick handle and your right thumb to register your ratings. Please do not push the button on the joystick except to make a rating. Do you have any questions?"

### Study 3

The instructions for the practice session and pre-conditioning rating phase were as follows.

"The purpose of this study is to examine how the brain processes facial expressions. This session has four parts. In part one, I am going to show you some pictures of faces using the tachistoscope. What I'd like you to do is to rate how pleasant or unpleasant you feel after each face is presented."

"Faces will be presented very briefly in the tachistoscope. Look into the viewer right now. Do you see the dot at the centre of the screen? What will happen is that after the dot has been on the screen for a second or so, a picture of a face will be flashed to either the right or left of the dot. It is important, however, that you do not try to look directly at it. Just look at the dot, keep both eyes focused on the dot at all times."

"When the picture of the face disappears, a vertical rating scale will appear. At the top of the scale will be a happy face, at the bottom, a sad face. If the picture of the face has generated a pleasant feeling in you, move the handle on the joystick forward, away from you. Red lights will light up from the centre of the scale toward the happy face. If the picture of the face has generated an unpleasant feeling, move the handle toward you, lights will light up toward the sad face.

Make greater movements for stronger feelings, your rating will be the length of the light bar. If the picture of the face doesn't generate any feeling in you, then leave the handle centred."

"Once you have the handle positioned where you want it, push the button on the top of the joystick handle with your thumb. This will register your rating on the computer. The button on the joystick is a bit tricky. You may hear a click even when the rating hasn't registered. So push the button hard. When your rating is registered the scale will disappear. So if you think you've made a rating and the scale hasn't disappeared, push the button again harder until it does."

"Please make each rating as quickly as possible, rating the initial feeling that comes to you. Feel free to use the entire range of the scale. At the same time, don't be concerned about how often you use a particular rating."

"If you haven't made a rating after several seconds, the scale will disappear on its own. The dot will reappear, followed by another face."

"We'll start with a practice session to familiarize you with the scale. Please use your right hand to move the joystick handle and your right thumb to register your ratings. Please do not push the button on the joystick except to make a rating. Do you have any questions?"

The experimenter gave the following instructions to introduce the conditioning procedure.

"Now we will move to a separate task. This time, I will be presenting some faces but you will not have to rate them. In this task, it is important that you keep your eyes directed toward the centre of the screen and that you do not try to look directly at the faces."

The following instructions were given for the post-conditioning rating phase.

"Now, I would like you to rate more patterns using the same procedure as before. Again, keep your eyes directed toward the centre of the screen, and rate your initial reaction for each face."

#### Study 4

The instructions for the practice session and the pre-conditioning rating phase were as follows.

"This session has four parts. In part one, I am going to show you some patterns using the tachistoscope. What I'd like you to do is to rate how pleasant or unpleasant you find each pattern."

"The patterns will be presented very briefly in the tachistoscope. Look into the viewer right now. Do you see the dot at the centre of the screen? When the dot appears, focus your eyes on it. After the dot has been on the screen for a second or so, a pattern will be flashed very briefly."

"When the pattern disappears, a vertical rating scale will appear. At the top of the scale will be a happy face, at the bottom, a sad face. If the pattern seems pleasant, move the handle on the joystick forward, away from you. Red lights will light up from the centre of the scale toward the happy face. If the pattern seems unpleasant, move the handle toward you, lights will light up toward the sad face.

Make greater movements the more pleasant or unpleasant the pattern, your rating will be the length of the light bar. In many cases, the pattern may appear neither

pleasant nor unpleasant. If so, leave the handle centred."

"Once you have the handle positioned where you want it, register your rating by pushing the button on the top of the joystick handle with your thumb. After you register your rating, the scale will disappear. The button is tricky. You may hear a click and think your rating has registered, but it won't have unless the scale disappears. If the scale remains on, push the button again harder."

"Please make each rating as quickly as possible, rating your initial reaction. Feel free to use the entire range of the scale. At the same time, don't be concerned about how often you use a particular rating."

"If you haven't made a rating after several seconds, the scale will disappear on its own. The dot in the centre of the screen will reappear, followed by another pattern."

"We'll start with a practice session to familiarize you with the scale. There are no expected responses to the patterns, just rate your reactions. Any questions?"

The experimenter gave the following instructions to introduce the conditioning procedure.

"Now we'll move to a separate task. This time, I'll be presenting some patterns but you won't have to rate them. Just pay attention to them, we'll get back to them later. Occasionally you will smell an odour. This will come through the tube taped to the tachistoscope. Please breathe normally. It is important that you breathe in each time you hear a card drop, and that you do not try to avoid the smell at any time during the task. Any questions?"

The following instructions were given for the post-conditioning rating phase.

"Now, I'd like you to rate more patterns using the same procedure as before. For each pattern, rate your initial reaction."

### Study 5

The experimenter gave the following instructions for the practice session and the pre-conditioning rating phase.

"This session has four parts. In part one, I am going to show you some patterns using the tachistoscope. What I'd like you to do is to rate how pleasant or unpleasant you find each pattern."

"The patterns will be presented very briefly in the tachistoscope. Look into the viewer right now. Do you see the dot at the centre of the screen? When the dot appears, focus your eyes on it. After the dot has been on the screen for a second or so, a pattern will be flashed very briefly. The pattern will be to the right or left of the screen. It's important that you do not try to look directly at it - just look at the dot."

"When the pattern disappears, a vertical rating scale will appear. At the top of the scale will be a happy face, at the bottom, a sad face. If the pattern seems pleasant, move the handle on the joystick forward, away from you. Red lights will light up from the centre of the scale toward the happy face. If the pattern seems unpleasant, move the handle toward you, lights will light up toward the sad face.

Make greater movements the more pleasant or unpleasant the pattern, your rating will be the length of the light bar. In many cases, the pattern may appear neither

pleasant nor unpleasant. If so, leave the handle centred."

"Once you have the handle positioned where you want it, register your rating by pushing the button on the top of the joystick handle with your thumb. After you register your rating, the scale will disappear. The button is tricky. You may hear a click and think your rating has registered, but it won't have unless the scale disappears. If the scale remains on, push the button again harder. If pushing the button a second or third time doesn't work, hold the handle in position for a couple of seconds until the scale goes off on its own."

"Please make each rating as quickly as possible, rating your initial reaction. Feel free to use the entire range of the scale. At the same time, don't be concerned about how often you use a particular rating."

"If you haven't made a rating after several seconds, the scale will disappear on its own. The dot in the centre of the screen will reappear, followed by another pattern."

"We'll start with a practice session to familiarize you with the scale. There are no expected responses to the patterns, just rate your reactions. Any questions?"

The experimenter gave the following instructions to introduce the conditioning procedure.

"Now we'll move to a separate task. This time, I'll be presenting some patterns but you won't have to rate them. In this task, it is again important that you keep your eyes directed toward the centre of the screen and that you do not try to look directly at the patterns. When the patterns are being flashed, an 'up arrow' or 'down arrow' will mark the centre of the screen. Please raise your hand every time you see a 'down

arrow'. Occasionally you will smell an odour. This will come through the tube taped to the tachistoscope. Please breathe normally. It is important that you breathe in each time you hear a card drop or see it flashed, and that you do not try to avoid the smell at any time during the task. If you find it too unpleasant to continue, just ask me to stop. Any questions?"

The following instructions were given for the post-conditioning rating phase.

"Now, I'd like you to rate more patterns using the same procedure as before. Again, keep your eyes directed toward the centre of the screen, and for each pattern, rate your initial reaction."

APPENDIX D: FACIAL EXPRESSION STIMULI USED IN STUDY 3



CS<sub>negative</sub>



CS<sub>neutral</sub>

### Neutral Facial Expressions Used in Conditioning Phase

Source: Photographs Taken by the Experimenter

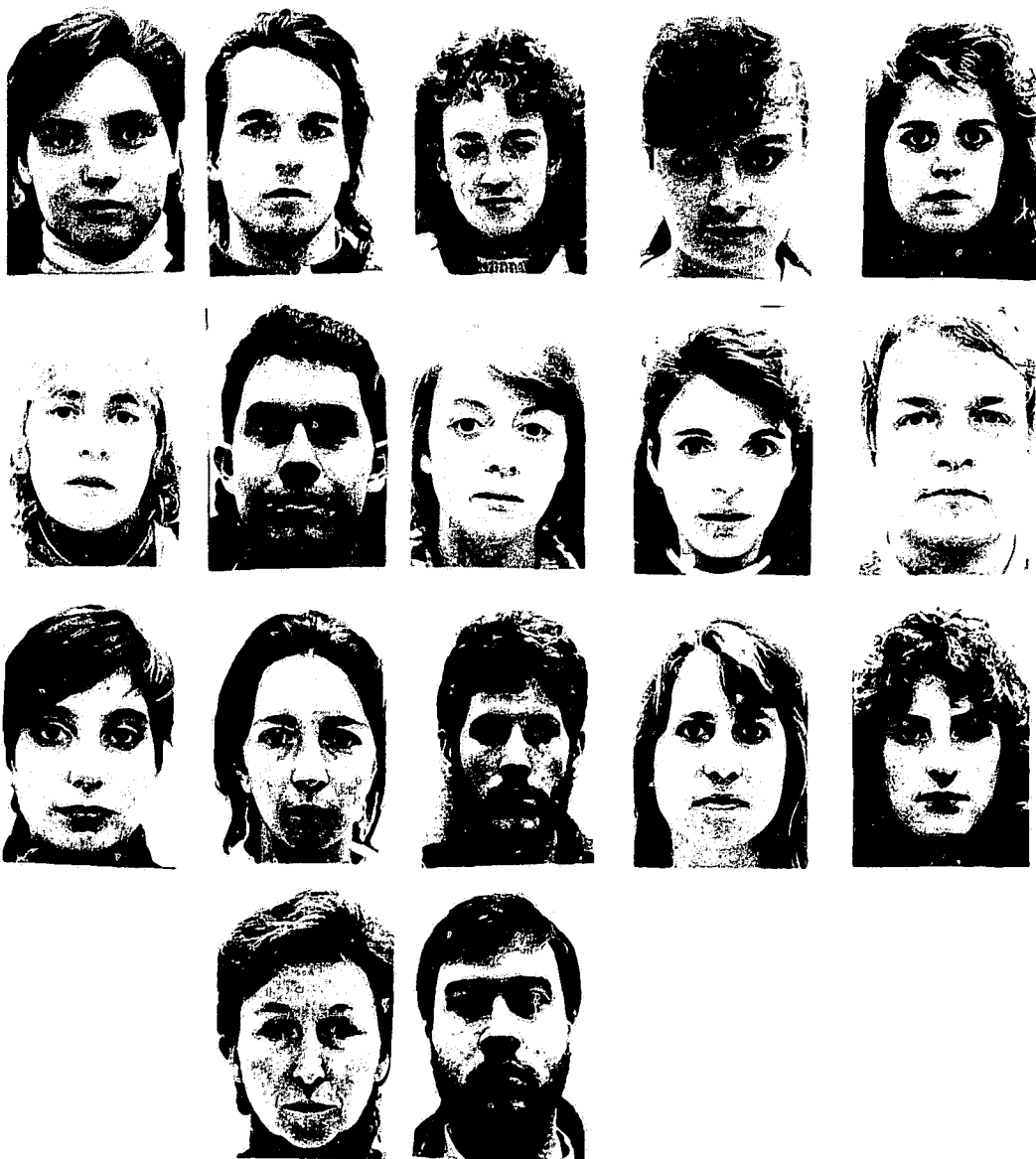
(Expressions from other sources not included)



Neutral Facial Expressions Used in Rating Phases

Source: Photographs Taken by the Experimenter

(Expressions from other sources not included)



APPENDIX E: AWARENESS QUESTIONNAIRES USED  
IN STUDIES 3, 4 AND 5

Study 3

Each question was presented on a separate page, except the last two questions, which were presented on the same page. Participants were requested to complete the questions in consecutive order, not to read ahead to later questions, and not to change the answers to previous questions.

Questions:

1. What do you think the purpose of this experiment was?
2. What were you supposed to do in this experiment?
3. At any time, did you notice any relationships between the pictures of faces?
4. If you noticed some relationships, were you aware of them during the experiment, or is it something you thought of while filling out these questions?
5. If you noticed some relationships during the experiment, when was it you first noticed them?
  - (a) during the first rating task
  - (b) during the non-rating task
  - (c) during the second rating task
6. What did you think the purpose of the ratings was at the time you were making them, if anything?
7. On what basis did you make your ratings?

8. Did you think that the experimenter might have expected that you would rate certain faces in a certain way? If so, please explain.
9. If you answered yes to the previous question, did you think this:  
 during the first rating task \_\_\_\_\_  
 during the second rating task \_\_\_\_\_
10. [For this question, the experimenter placed four cards displaying the two  $CS_{\text{negative}}$  faces and the two  $CS_{\text{neutral}}$  faces in front of the participant] Which face(s) were usually immediately followed by less pleasant faces during the non-rating task? For each face that you pick, please rate how certain you are on a scale from 1 to 10 [where 10 is very certain], and indicate whether you were aware of this relationship during the second rating task.
- | <u>#</u> | <u>Certainty/Uncertainty</u> | <u>Aware during second rating task?</u> |
|----------|------------------------------|---|
|----------|------------------------------|---|
11. Did your awareness of the relationships in question 10 affect your ratings of the faces in the second rating task? If so, how?
12. Please make any other comments that you feel might help make the researcher understand your reaction to this experiment.
13. Are you taking or have you had a course in psychology? Yes / No
14. Do you know the meaning of the term conditioning? Yes / No  
 If yes, did you think about it during the experiment?

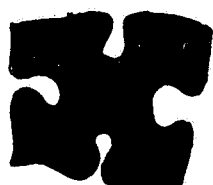
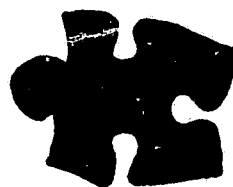
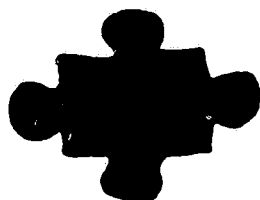
### Studies 4 and 5

The same instructions were used as for the questionnaire in Study 3.

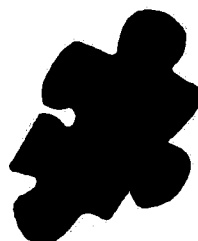
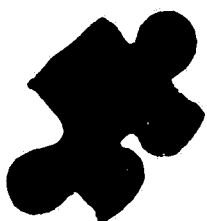
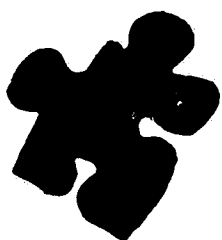
#### Questions:

1. What do you think the purpose of this experiment was?
2. At any time, did you notice any relationship(s) between the patterns and the odour? If so, what was (were) the relationships?
3. If you noticed some relationship, did you become aware:
  - (a) during the experiment?
  - (b) while you were filling out these questions?
4. If you noticed some relationship during the experiment, did you become aware:
  - (a) during the first set of ratings?
  - (b) during the time when you saw the patterns but weren't rating them?
  - (c) during the second set of ratings?
5. Did you think that the experimenter might have expected that you would rate certain patterns in a certain way? If so, please explain.
6. [The experimenter placed two stimulus cards containing the CS<sub>negative</sub> and the CS<sub>neutral</sub> in front of the participant.] Which of the patterns usually occurred at the same time as the smell? (Ask the experimenter to show you the patterns). For each pattern that you pick, please rate how certain you are on a scale from one to ten, where one is 'not at all certain' and ten is 'very certain'.

## APPENDIX F: ABSTRACT VISUAL STIMULI USED IN STUDY 4

CS<sub>negative</sub> and CS<sub>neutral</sub> CombinationsSet 1CS<sub>negative</sub>CS<sub>neutral</sub>Set 2CS<sub>negative</sub>CS<sub>neutral</sub>Set 3CS<sub>negative</sub>CS<sub>neutral</sub>

Foils in Rating Phases



**APPENDIX G: RAW DATA FOR STUDIES**

Raw Data for Study 1

<u>Variable</u>	<u>Description</u>
Subject	Subject number
Age	Subject's age
Vision	Score on vision test
Hndscore	Score on handedness questionnaire
R1 - R80	Evaluative ratings for right visual field presentations of words (words are listed in order of presentation on the following page)
L1 - L80	Evaluative ratings for left visual field presentations of words
Order	Anchor orientation by hand combination by initial field of presentation of word, as follows:

<u>Order</u>	<u>Response Hand</u>	<u>Anchor Orientation</u>
1 (Stimulus Blocks)	right (1, 2, 5, 6) left (3, 4, 7, 8)	happy face on right side (1, 3, 5, 7) sad face on right side (2, 4, 6, 8)
2 (Stimulus Blocks)	right (1, 2, 5, 6) left (3, 4, 7, 8)	happy face on right side (2, 4, 6, 8) sad face on right side (1, 3, 5, 7)
3 (Stimulus Blocks)	right (3, 4, 7, 8) left (1, 2, 5, 6)	happy face on right side (1, 3, 5, 7) sad face on right side (2, 4, 6, 8)
4 (Stimulus Blocks)	right (3, 4, 7, 8) left (1, 2, 5, 6)	happy face on right side (2, 4, 6, 8) sad face on right side (1, 3, 5, 7)

Orders 5-8 used the same response hand and anchor orientations as orders 1-4, respectively; however, the initial side of presentation of each word was in the opposite visual field.

## List of Words, in Order of Presentation:

1	king	31	vot	61	slap
2	gate	32	play	62	slap
3	puke	33	shit	63	fire
4	free	34	rich	64	kind
5	food	35	ring	65	jic
6	debt	36	giw	66	crap
7	cef	37	fear	67	bird
8	jail	38	camp	68	gold
9	dear	39	glad	69	lose
10	star	40	liar	70	boat
11	cold	41	hope	71	rage
12	hand	42	coat	72	door
13	baby	43	exam	73	ugly
14	poor	44	best	74	easy
15	lake	45	tree	75	pain
16	like	46	love	76	hall
17	like	47	sick	77	kiss
18	hate	48	bez	78	hell
19	xeh	49	sexy	79	hair
20	hurt	50	evil	80	nice
21	shoe	51	book		
22	life	52	rude		
23	stab	53	wise		
24	face	54	ship		
25	good	55	care		
26	rock	56	f--k		
27	rape	57	qug		
28	laj	58	road		
29	kill	59	dead		
30	safe	60	yof		

data list /subject 1-2 age 3-4 order 5 vision 6-7 hndscore 8-9

R1 11-12 L1 13-14 R2 15-16 L2 17-18 R3 19-20 L3 21-22 R4 23-24  
 L4 25-26 R5 27-28 L5 29-30 R6 31-32 L6 33-34 R7 35-36 L7 37-38  
 R8 39-40 L8 41-42 R9 43-44 L9 45-46 R10 47-48 L10 49-50 R11 51-52  
 L11 53-54 R12 55-56 L12 57-58 R13 59-60 L13 61-62 R14 63-64  
 L14 65-66 R15 67-68 L15 69-70 R16 71-72 L16 73-74 R17 75-76  
 L17 77-78/  
 R18 1-2 L18 3-4 R19 5-6 L19 7-8 R20 9-10 L20 11-12 R21 13-14  
 L21 15-16 R22 17-18 L22 19-20 R23 21-22 L23 23-24 R24 25-26  
 L24 27-28 R25 29-30 L25 31-32 R26 33-34 L26 35-36 R27 37-38  
 L27 39-40 R28 41-42 L28 43-44 R29 45-46 L29 47-48 R30 49-50  
 L30 51-52 R31 53-54 L31 55-56 R32 57-58 L32 59-60 R33 61-62  
 L33 63-64 R34 65-66 L34 67-68 R35 69-70 L35 71-72 R36 73-74  
 L36 75-76/  
 R37 1-2 L37 3-4 R38 5-6 L38 7-8 R39 9-10 L39 11-12 R40 13-14  
 L40 15-16 R41 17-18 L41 19-20 R42 21-22 L42 23-24 R43 25-26  
 L43 27-28 R44 29-30 L44 31-32 R45 33-34 L45 35-36 R46 37-38  
 L46 39-40 R47 41-42 L47 43-44 R48 45-46 L48 47-48 R49 49-50  
 L49 51-52 R50 53-54 L50 55-56 R51 57-58 L51 59-60 R52 61-62  
 L52 63-64 R53 65-66 L53 67-68 R54 69-70 L54 71-72 R55 73-74  
 L55 75-76/  
 R56 1-2 L56 3-4 R57 5-6 L57 7-8 R58 9-10 L58 11-12 R59 13-14  
 L59 15-16 R60 17-18 L60 19-20 R61 21-22 L61 23-24 R62 25-26  
 L62 27-28 R63 29-30 L63 31-32 R64 33-34 L64 35-36 R65 37-38  
 L65 39-40 R66 41-42 L66 43-44 R67 45-46 L67 47-48 R68 49-50  
 L68 51-52 R69 53-54 L69 55-56 R70 57-58 L70 59-60 R71 61-62  
 L71 63-64 R72 65-66 L72 67-68 R73 69-70 L73 71-72 R74 73-74  
 L74 75-76/  
 R75 1-2 L75 3-4 R76 5-6 L76 7-8 R77 9-10 L77 11-12 R78 13-14  
 L78 15-16 R79 17-18 L79 19-20 R80 21-22 L80 23-24.

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end data.
```

Raw Data for Study 2

<u>Variable</u>	<u>Description</u>
Subject	Subject number
Cond	Condition (see specifications on 'if' and value labels statements)
Age	Subject's age
Leye	Score on vision test for left eye
Reye	Score on vision test for right eye
Hand	Score on handedness questionnaire
Exptr	Identity of experimenter
Rh1 - Rh116	Evaluative ratings of faces presented to left visual field (right hemisphere)
Lh1 - Lh116	Evaluative ratings of faces presented to right visual field (left hemisphere)

## data list

/subj 1-2 cond 4 age 6-7 leye 9-10 reye 12-13 hand 15-16 exptr 18

/rh1 to rh39 1-78 /rh40 to rh78 1-78 /rh79 to rh116 1-76

/lh1 to lh39 1-78 /lh40 to lh78 1-78 /lh79 to lh116 1-76.

missing value all (99).

if (value(rh4)=99 and cond=2) rh4=.75.

if (value(rh7)=99 and cond=2) rh7=-1.

if (value(rh8)=99 and cond=2) rh8=-.5.

if (value(rh9)=99 and cond=2) rh9=.75.

if (value(rh115)=99 and cond=2) rh115=2.5.

if (value(lh114)=99 and cond=2) lh114=3.5.

if (value(lh116)=99 and cond=2) lh116=-.75.

if (value(rh7)=99 and cond=1) rh7=1.25.

if (value(rh113)=99 and cond=1) rh113=-3.5.

if (value(lh114)=99 and cond=1) lh114=8.5.

if (value(lh7)=99 and cond=8) lh7=-.5.

if (value(lh37)=99 and cond=8) lh37=-2.5.

if (value(lh46)=99 and cond=8) lh46=-.5.

if (value(lh48)=99 and cond=8) lh48=.25.

if (value(lh80)=99 and cond=8) lh80=-.5.

if (value(rh7)=99 and cond=7) rh7=-5.75.

if (value(rh21)=99 and cond=7) rh21=2.

if (value(rh42)=99 and cond=7) rh42=.25.

if (value(rh43)=99 and cond=7) rh43=5.5.

if (value(rh48)=99 and cond=7) rh48=2.67.

if (value(rh69)=99 and cond=7) rh69=-2.25.

if (value(rh86)=99 and cond=7) rh86=.75.

if (value(lh10)=99 and cond=7) lh10=1.25.  
if (value(lh14)=99 and cond=7) lh14=2.25.  
if (value(lh20)=99 and cond=7) lh20=-2.5.  
if (value(lh33)=99 and cond=7) lh33=6.  
if (value(lh46)=99 and cond=7) lh46=-2.  
if (value(lh50)=99 and cond=7) lh50=3.25.  
if (value(lh55)=99 and cond=7) lh55=-.5.  
if (value(lh66)=99 and cond=7) lh66=2.25.  
if (value(lh97)=99 and cond=7) lh97=-1.25.  
if (value(lh100)=99 and cond=7) lh100=4.  
if (value(lh107)=99 and cond=7) lh107=3.5.  
if (value(rh14)=99 and cond=7) rh14=.25.  
if (value(rh15)=99 and cond=7) rh15=1.  
if (value(rh19)=99 and cond=7) rh19=-1.  
if (value(rh55)=99 and cond=7) rh55=-4.33.  
if (value(rh65)=99 and cond=7) rh65=-6.25.  
if (value(rh81)=99 and cond=7) rh81=-4.  
if (value(rh88)=99 and cond=7) rh88=4.25.  
if (value(rh106)=99 and cond=7) rh106=-1.75.  
if (value(lh3)=99 and cond=7) lh3=-2.25.  
if (value(lh12)=99 and cond=7) lh12=1.  
if (value(lh16)=99 and cond=7) lh16=-.75.  
if (value(lh28)=99 and cond=7) lh28=-.25.  
if (value(lh41)=99 and cond=7) lh41=0.  
if (value(lh47)=99 and cond=7) lh47=1.  
if (value(lh67)=99 and cond=7) lh67=-3.75.  
if (value(lh80)=99 and cond=7) lh80=1.  
if (value(lh81)=99 and cond=7) lh81=-2.25.  
if (value(rh12)=99 and cond=6) rh12=1.  
if (value(rh84)=99 and cond=6) rh84=.75.  
if (value(rh89)=99 and cond=6) rh89=4.75.  
if (value(rh97)=99 and cond=6) rh97=-.67.  
if (value(rh116)=99 and cond=6) rh116=-.5.  
if (value(lh50)=99 and cond=6) lh50=-.25.  
if (value(lh62)=99 and cond=6) lh62=-3.  
if (value(lh63)=99 and cond=6) lh63=-.67.  
if (value(lh87)=99 and cond=6) lh87=-3.33.  
if (value(lh92)=99 and cond=6) lh92=1.33.  
if (value(lh110)=99 and cond=6) lh110=-.5.  
if (value(rh10)=99 and cond=1) rh10=-.25.  
if (value(rh19)=99 and cond=1) rh19=-5.  
if (value(lh9)=99 and cond=1) lh9=0.  
if (value(lh63)=99 and cond=1) lh63=0.  
if (value(lh65)=99 and cond=1) lh65=-3.25.

if (value(rh9)=99 and cond=5) rh9=1.  
 if (value(rh42)=99 and cond=5) rh42=-.75.  
 if (value(rh64)=99 and cond=5) rh64=-1.25.  
 if (value(rh86)=99 and cond=5) rh86=1.25.  
 if (value(rh108)=99 and cond=5) rh108=-3.25.  
 if (value(lh36)=99 and cond=5) lh36=-.75.  
 if (value(lh37)=99 and cond=5) lh37=-2.75.  
 if (value(lh41)=99 and cond=5) lh41=-.5.  
 if (value(lh67)=99 and cond=5) lh67=-4.5.  
 if (value(lh71)=99 and cond=5) lh71=4.5.  
 if (value(lh73)=99 and cond=5) lh73=2.33.  
 if (value(lh87)=99 and cond=5) lh87=-3.5.  
 if (value(lh92)=99 and cond=5) lh92=2.67.  
 if (value(lh100)=99 and cond=5) lh100=2.25.  
 if (value(lh110)=99 and cond=5) lh110=0.  
 if (value(rh3)=99 and cond=8) rh3=-1.  
 if (value(rh23)=99 and cond=8) rh23=-4.5.  
 if (value(rh34)=99 and cond=8) rh34=-4.  
 if (value(rh64)=99 and cond=8) rh64=2.5.  
 if (value(lh10)=99 and cond=8) lh10=-1.  
 if (value(lh20)=99 and cond=8) lh20=-2.5.  
 if (value(lh21)=99 and cond=8) lh21=-.25.  
 if (value(lh41)=99 and cond=8) lh41=-1.75.  
 if (value(lh62)=99 and cond=8) lh62=-1.75.  
 if (value(lh79)=99 and cond=8) lh79=-1.  
 if (value(lh51)=99 and cond=2) lh51=1.25.  
 if (value(rh14)=99 and cond=8) rh14=.5.  
 if (value(rh15)=99 and cond=8) rh15=.75.  
 if (value(rh115)=99 and cond=8) rh115=4.  
 if (value(lh16)=99 and cond=8) lh16=-3.5.  
 if (value(rh64)=99 and cond=6) rh64=.75.  
 if (value(rh91)=99 and cond=6) rh91=2.25.  
 if (value(lh85)=99 and cond=6) lh85=-1.25.  
 if (value(lh100)=99 and cond=6) lh100=-.33.  
 if (value(rh2)=99 and cond=7) rh2=-5.  
 if (value(rh91)=99 and cond=7) rh91=1.75.  
 if (value(rh114)=99 and cond=7) rh114=6.25.  
 if (value(lh4)=99 and cond=7) lh4=-2.25.  
 if (value(lh8)=99 and cond=7) lh8=-4.5.  
 if (value(lh29)=99 and cond=7) lh29=5.25.  
 if (value(lh47)=99 and cond=7) lh47=1.  
 if (value(lh52)=99 and cond=7) lh52=-2.  
 if (value(lh83)=99 and cond=7) lh83=.25.  
 if (value(lh91)=99 and cond=7) lh91=2.75.

if (value(lh102)=99 and cond=7) lh102=-1.25.  
 if (value(rh29)=99 and cond=5) rh29=7.  
 if (value(rh44)=99 and cond=5) rh44=.5.  
 if (value(rh45)=99 and cond=5) rh45=2.  
 if (value(rh92)=99 and cond=5) rh92=3.25.  
 if (value(rh96)=99 and cond=5) rh96=3.  
 if (value(rh113)=99 and cond=5) rh113=-.25.  
 if (value(rh114)=99 and cond=5) rh114=3.  
 if (value(rh115)=99 and cond=5) rh115=3.33.  
 if (value(lh20)=99 and cond=5) lh20=-3.67.  
 if (value(lh32)=99 and cond=5) lh32=4.75.  
 if (value(lh46)=99 and cond=5) lh46=-1.  
 if (value(lh69)=99 and cond=5) lh69=-3.25.  
 if (value(lh80)=99 and cond=5) lh80=.75.  
 if (value(lh89)=99 and cond=5) lh89=7.33.  
 if (value(lh90)=99 and cond=5) lh90=-3.5.  
 if (value(rh98)=99 and cond=5) rh98=3.5.  
 if (value(rh101)=99 and cond=5) rh101=-1.  
 if (value(lh23)=99 and cond=5) lh23=-3.5.  
 if (value(lh38)=99 and cond=5) lh38=-.5.  
 if (value(lh42)=99 and cond=5) lh42=2.5.  
 if (value(lh51)=99 and cond=5) lh51=2.25.  
 if (value(lh107)=99 and cond=5) lh107=3.25.  
 if (value(lh109)=99 and cond=5) lh109=-.5.  
 if (value(lh116)=99 and cond=5) lh116=.75.  
 if (value(lh73)=99 and cond=4) lh73=.75.  
 if (value(rh57)=99 and cond=5) rh57=-1.25.  
 if (value(rh79)=99 and cond=5) rh79=-3.  
 if (value(rh111)=99 and cond=5) rh111=-.5.  
 if (value(rh35)=99 and cond=6) rh35=-4.5.  
 if (value(rh83)=99 and cond=6) rh83=3.  
 if (value(rh68)=99 and cond=7) rh68=0.  
 if (value(rh96)=99 and cond=7) rh96=-1.5.  
 if (value(lh98)=99 and cond=7) lh98=.75.  
 if (value(rh16)=99 and cond=6) rh16=-2.5.  
 if (value(rh17)=99 and cond=6) rh17=2.25.  
 if (value(rh29)=99 and cond=6) rh29=3.75.  
 if (value(rh74)=99 and cond=6) rh74=1.  
 if (value(lh67)=99 and cond=6) lh67=-1.  
 if (value(rh33)=99 and cond=7) rh33=6.  
 if (value(rh92)=99 and cond=7) rh92=4.25.  
 if (value(rh103)=99 and cond=7) rh103=-4.5.  
 if (cond=1 or cond=2 or cond=3 or cond=4) orient=1.  
 if (cond=5 or cond=6 or cond=7 or cond=8) orient=2.

```

if (cond=1 or cond=2 or cond=5 or cond=6) order=1.
if (cond=3 or cond=4 or cond=7 or cond=8) order=2.
if (cond=1 or cond=3 or cond=5 or cond=7) group=1.
if (cond=2 or cond=4 or cond=6 or cond=8) group=2.
value labels orient 1 'original' 2 'mirror'.
begin data.
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0-6-3 0
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7-1-1-1-1-1-2-1
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4-2-2-2-3-4-3-1
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299
02 1 22 1 12 28 1
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0-3-3 1 0
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0-3
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03 8 20 -2 -2 26 2
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4 9
05 7 23 -8 -8 15 1

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7-3 2  
end data.

Raw Data for Study 3

<u>Variable</u>	<u>Description</u>
Subject	Subject number
Age	Subject's age
Hand	Score on handedness questionnaire
Reye	Score on vision test for right eye
Leye	Score on vision test for left eye
Cond	Condition (see specifications in 'if' statements below. Trial conditions are as follows: trial (1) = 5 trials, trial (2) = 10 trials, trial (3) = 20 trials, trial (4) = 40 trials)
Negtrial	Number of completed trials of CS <sub>negative</sub> and UCS
Neutrial	Number of completed trials of CS <sub>neutral</sub> and neutral face
Csprh1	Pre-conditioning rating for CS <sub>negative</sub> presented to right hemisphere
Csplh1	Pre-conditioning rating for CS <sub>negative</sub> presented to left hemisphere
Csmrh1	Pre-conditioning rating for CS <sub>neutral</sub> presented to right hemisphere
Csmhl1	Pre-conditioning rating for CS <sub>neutral</sub> presented to left hemisphere
Csprh2	Post-conditioning rating for CS <sub>negative</sub> presented to right hemisphere
Csplh2	Post-conditioning rating for CS <sub>negative</sub> presented to left hemisphere
Csmrh2	Post-conditioning rating for CS <sub>neutral</sub> presented to right hemisphere
Csmhl2	Post-conditioning rating for CS <sub>neutral</sub> presented to left hemisphere
Pre1 - Pre9	Pre-conditioning ratings for foils in order of position (pre11 - pre22 not entered)
Post1 - Post22	Post-conditioning ratings for foils and UCS stimuli in order of position (UCS stimuli were in positions numbered 12, 14, 15, 18, 20, 21)

## data list

/subj 1-3 age 4-5 hand 6-7 reye 8-10 leye 11-13 cond 15-16 negtrial 17-18  
 neutrial 19-20 csprh1 22-23  
 csplh1 24-25 csmrh1 26-27 csmhl1 28-29 csprh2 30-31 csplh2 32-33  
 csmrh2 34-35 csmhl2 36-37  
 /pre1 1-2 pre2 3-4 pre4 5-6 pre6 7-8 pre7 9-10 pre9 11-12 post1 14-15  
 post2 16-17 post4 18-19 post6 20-21 post7 22-23 post9 24-25 post11 26-27  
 post12 28-29 post13 30-31 post14 32-33 post15 34-35 post16 36-37  
 post17 38-39 post18 40-41 post19 42-43 post20 44-45 post21 46-47  
 post22 48-49.

missing value all (99).

if (cond=12 or cond=22 or cond=32 or cond=42) trial=1.  
 if (cond=1 or cond=2 or cond=3 or cond=4) trial=2.  
 if (cond=5 or cond=6 or cond=7 or cond=8) trial=3.  
 if (cond=52 or cond=62 or cond=72 or cond=82) trial=4.  
 if (cond=1 or cond=2 or cond=5 or cond=6 or cond=12 or cond=22 or cond=52 or  
 cond=62) deck=1.  
 if (cond=3 or cond=4 or cond=7 or cond=8 or cond=32 or cond=42 or cond=72 or  
 cond=82) deck=2.  
 if (cond=1 or cond=3 or cond=5 or cond=7 or cond=12 or cond=32 or cond=52 or  
 cond=72) order=1.  
 if (cond=2 or cond=4 or cond=6 or cond=8 or cond=22 or cond=42 or cond=62 or  
 cond=82) order=2.  
 begin data.  
 0013025 0 -3 11010 0-3 3 6-5 6 5 5  
 1 2 3-7 0-7 7 2 9-4-4-3-7-4-9-6 0 0-9 5-9-8 9 6  
 0021926 -5 -7 62020 0-2 0 0 0-1 0-1  
 2 2 0 2 0-1 -1 0 1 2-1 0 1-1 0-1-2 0 1-1 1-1-2 0  
 0032126 -2 -3 41010 -2-1 0 0-2 1 0 0  
 0 1-2 1 1 0 3-3-2 0 2 1 1 0-1-2-3 1 0-2-1-3-4 0  
 0042113 -3 -3 410 8 -2-2-1-2-5-3 0 0  
 3 0-2 2 1 0 5 0-2 5 0 5 2 0-2 0-5-2-4 0 0 0-8 3  
 0052023 -3 -3 41010 0-2 1-1 0-3-4-3  
 -2-6-4 0 1 0 1-3-5 2 3-1-2-9-1-9-6 1-1-9 3-9-9 2  
 0062326 -4 -1 72020 0-1 1 1 1-2-1-2  
 0 0 0 0 0 0 0 0 2 1 1-3 0-2-1-3 0-1 0 1 0-2 1  
 0072328 -3 -9 11010 0-2-3 0-1-3 0 0  
 0-3 0 0-3-4 0-2 0 1-2-2-4 0-5 0-4 -5-2-6-6 2  
 0081928 -2 -2 11010 1 0-2 0 1-1 0 0  
 1-2-1 2-2 0 0 -1 1 1 0-2-1 2-3-3 0 0 0 0 0-3 0  
 0091916 -1 -4 51819 0-2-1 2 0-1 2 2  
 1 1 0-1 0-2 1 3 1 0 2-1-3 0-1-2 0 3-1 2-2 0 1-1  
 0102016 -7 -7 51819 -4-1-3 2 4-9 2-5  
 3-6-4 2 3-9 2-4-5-2 3-5-4-8 6-6-6-4 1-8 2-4-7-3  
 0112026 -2 -1 82020 -1-1 1-3 0-2-2-1  
 1-1 1 3 1-3 2-2-1 1 2 0 2-3 1-3-3 1 2-2 2-1-2 2  
 0122527 -1 -1 21010 0-5 0-2 0 0 1 0  
 0 1-1 0 3-2 0-2-2-2 0 3-2-8-3-8-7 0-2-8-2-5-8 0  
 0132227 -2 -2 82020 -6-2-2 2-3-1 4-4  
 4-4 3 2-2-5 7-3 2 4 1-3-3-6 2-4-5 4-2-7 2-5-5 4  
 0142125 -9 -8 72020 0-1 0-2 0 0 0-2  
 1-2 0 0-3 0 1 1-1 1 0 0 0-3 0-2-4 1 2-3 1-2-3 2  
 0152025 -1 -9 7 -2 1 0 1-3 0 0 1  
 3-7 0-1-2 0 2-3 1-2-2 0-4 0-2 0-5 1-3 0 0 0-6 1  
 0162327 -3 -2 41010 1-7-1-4 1 0-2-4  
 0-2 0-4 0 0 -1 0 2-2 1-3 1-7-3-7-7-4 2-7-4-7-7-7  
 0172228 -1 -1 6 4-1 0 1 6 1-2 4  
 2 0 0 0 2 0 0-1-2 0 2-4-1-3 2 0-3 0 3-2 2 2 2-4  
 0182127 -8 -7 2 8 9 -1-3 1-3-5 0 3-3  
 3 1 2 2 0 1 3-4-2 1-4-8 0-9-3-9-8-3-3-4-9-9-9-1  
 0191927-11 -4 62020 2-1 1-1 0-2-2-2  
 -1 0 0-1 1 0 2 0 1-1-1 0 1-4 1-3-3-1 0-4-2-3-3-2  
 0202225 -1 0 31010 0-1 0 3 0 9 0 0  
 0 0 0 2 1-1 0-1-1 5-2-2-1 1 0 0-3 2 1-4 0-4-3 0  
 0212825 -2 -1 31010 0 2 2 2 0 1 2 2  
 1 2 1 0 2 2 1 0 2 2 1 1 2-4 2-7 0 2 2-8 3-9-3 3  
 0222025 -2 -1 41010 1-4 1 1 0-1-2-1

2 2-1 0 1 3 0 1-1 0 0-1 1-7 2-9-5 0 0-9-2-9-8 2  
 0232724 -8 -6 120505 -2-1-2 4 0-3 2-2  
 -4-9 0 0-8-2 2-8-1 2 3 2-3-8 6-8-4-2-5-8 3-8 3  
 0242128 0 -8 723839 4 0-6 2-1 0-1 0  
 4 4 5 4 2 5 2-1 2 0 2 0 3 2-2 3-3 3-1 4-2 3-3-1  
 0252023 -3 -1 524040 3-3 1 2-2-3-2-1  
 2 0-1 0 2 1 3-2 2 1 3 0 2-7-1-7-4 2 3-5 1-7-8 0  
 0262325 -4 -3 420505 -4 0-2 0 0-4 0-2  
 -3-4-3 1-3 1 -3-4 0 2-4 1 0-3 2 0 2 3 3-2-2-3-3 4  
 0272423-20 -4 320505 -1 0-3-1 0-2 2 0  
 0-3 1-2-1 1 1-2 2-1-2 1 1-2 0-3-3 1 0-2-1-1-3 2  
 0282425 -3 -8 220505 1 1 2 2 0-1 0-1  
 1 1 3 3 3 3 3 1 3 3 1 2 2 0-2 0-2 1 2 0 0 0 0  
 0292027 -2 -7 82 0 3-1-2 1 2 1 0  
 0 0-2 0 0 0 1 0 0 0 1 1 2-3 0-5-2 0 2 -3-2 0  
 0302125 -3 -8 62 3 3 2 1 3 2 4 2  
 2 1 3 2 2-3 -3 2 3 4 2 1 6-1 3-2 1 2 4-2 2 0 2 1  
 0312425 -3 -3 320405 0 0 0-1-2 2-1 1  
 1 0 0 3 1 3 5-1 0 4 1 1 2-9 2-7-8 3 2-6 3-4-4 3  
 0322127 -2 -3 220504 -1 0-2 3 0 0-2-1  
 0 0 0 1-1 0 0 0 0-1 2 2-1 0-1 0-3-1-1-1 2 0-3 1  
 0331926 -4 -5 72 3 3 5 0 1 1 0 3  
 -5 1 3 0 0 6 0 1 0 0 0-4 9 0 9 5 2 0 9 4 5 9 0  
 0342025 -1 -1 52 0 0 0-1 0 1 0 0  
 0 0 1-1 0 0 1 0 2 3 0 0-1-2 1-3-2 1-1-3 0-6-1 2  
 0352125 2 6 42 -2-4-2-1 3-2-2 0  
 0 0-2 5 0 0 2 3 2 4 1-1-1-6 1-8-7 2-1-8 2-7-8 2  
 0362128 -3 -9 823938 2 2 0 0 1 1-3-1  
 2 2 0 1 2-1 2-1-2 3 0-2 0-4-2-3-2 1 1-6 -3-2 2  
 0372426 8 8 12 5 5 -2-2-2-4-3-3-3-8  
 4 2-1 2 0-2 9 5-3 5 3-3 2-8 4-8-9 9 2-8 6-4-8 8  
 0381927 -5 -4 62 1-5-4-5 7 1-2-3  
 3-5-5-2-7-3 -3-9 4-3-5 4-8-7 3-9-9 4 3 1-9-9 3  
 0392525 -2 -2 723438 -2 1 1 0-3-1 1-2  
 1-2 0 3 2 0 -2-1 2 1-1-4-3-2-1-7 -6-9 1-1-7-6  
 0402914 -8 -8 523839 2 3 0 2 2 2 3 2  
 4-4 4 1 4-3 2 0 4 4 2-2-1 0 1 0 0 2 0 2-1-1 2  
 0412027 -1 -4 42 5 5 -6 0-9 0 0-4 0 9  
 0-5-5 2 2-8 -9-3 4-4-2-6-9 5-9-6-9-3-9 6-9-9 4  
 0421927 -3 -2 32 5 5 0-1 0 5-4 4 3 4  
 0-3 1 4 2 3 4-5-3 4-2 3-2-7 4-9-9 2 5-9 5-9-9 5  
 0431919 -2 -3 12 5 5 -3-2-2-1-3-1-1-1  
 2 1 1 1-2-4 2-3-2-199-1 0-7 0-7-5 0 0-5 1-7-6 0  
 0442027 -1 -2 22 5 5 0-1-3 1 2 0-2 1  
 2 1 2-299 0 -2 1 099 0-1 0 0 4-7-3 0-2-7 2-9-4-1  
 0452428 -2 0 623835 3-2 3 1 2-6 3 2  
 1 0 0 3 1 4 5 0 3 1 2 3 1-7 0-7-9 0 0-7 5-8-7 3  
 0462026 -3 -2 823938 -1-2-2 0 0-1 0 0  
 -2-1-1 1 1 0 1-1-2 1-1-1 1-5-2-5-8 2 0-8-2-9-6-1  
 0472425 -2 -1 2 -1-2 2-3 0-2 0 2  
 -1 0 099 1-1 3-1 1 3 4-3 2-4 3-4-8-2-2-9 2-4-8 4  
 0482226 -5 -4 31010 -4-5-2-3 2-3-3 2  
 4-2-1 4-3 2 9-2-3 4-5 0-1-9 3-9-7 5-3-9 0-9-7 0  
 0491925 -3 -9 82019 0-5-2-3 0-5-5 0  
 4 0-4 1 0 0 0-6 0 4-3 0 0-9 3-9-3 0 0-999-9-4 1  
 0502226 -1 -3 52020 0 0 0-1 0 0-1 2  
 99-2-1-1 0 0 3-1-1 2 0-2-1 0 1 1-2 0 099 1-2-2 0  
 0512128 -3 -1 52020 2 4-2-6-1-1-3-7  
 0 2 1 0-1-1 1-3 2-1-5-2-8 1-2 1-5-1-5-399-3-6 1  
 0522025 -2 -2 62020 1-4 1-1 2 1 2 0  
 1 1-2 6-1 1 3 0 2 5 0 2-3-9 2-9-9 1 199 2-9-9 2  
 0532823 -1 -1 623739 0-1-2-4-1-1 0-4

-4 0 0 2-1-2 2-1 0 3 1-1-3-5 2-5-6 1 0-7 2-6-2 2  
0542227 -1 -4 52 0 1 0-3-1-2 2-3  
3 0 1 6-1 0 4 1 9 6 4-3-7-9 1-9-6 599-9 2-8-6 6  
0552527 -5 -2 72 -1-1 0-1 1 1 0 1  
2 0 0 0-2 0 0-1 0 2 0 0-1-2 1 0-1 2 099 1-1-199  
end data.

Raw Data for Study 4

<u>Variable</u>	<u>Description</u>
Subject	Subject number
Trials	Number of conditioning trials
Set	Combination of CS <sub>negative</sub> /CS <sub>neutral</sub>
Age	Subject's age
Hand	Handedness (see specification on value labels statement)
Leye	Score on vision test for left eye
Reye	Score on vision test for right eye
Sex	Sex of subject
Tpre1 - Tpre18	Pre-conditioning ratings for visual patterns. Position numbers for CS <sub>negative</sub> and CS <sub>neutral</sub> were 3 and 5, respectively.
Tpost1 - Tpost18	Post-conditioning ratings for visual patterns. Position numbers for CS <sub>negative</sub> and CS <sub>neutral</sub> were 3 and 5, respectively.
Change1	Did the subject notice a change in the pleasantness of the CS <sub>negative</sub> ? (see specification on value labels statement)
Affect1	If yes to above question, did the stimulus become more pleasant or unpleasant? (see specification on value labels statement)
Amt1	How much did the pleasantness of the stimulus change? (see specification on value labels statement)
Change2	Did the subject notice a change in the pleasantness of the CS <sub>neutral</sub> ? (see specification on value labels statement)
Affect2	If yes to above question, did the stimulus become more pleasant or unpleasant? (see specification on value labels statement)
Amt2	How much did the pleasantness of the stimulus change? (see specification on value labels statement)
Avoid	Did the subject avoid any of the conditioning trials? (see specification on value labels statement)
Advamt	Number of trials avoided (see specification on value labels statement)
Dodour	Did the subject detect a change in the strength of the odour from the beginning to the end of the conditioning phase? (see specification on value labels statement)
Strength	If yes to above question, did the odour become weaker or stronger? (see specification on value labels statement)
Detect	Ability to detect odour at end of conditioning phase (see specification on value labels statement)
Aware	Awareness of stimulus contingencies (see specification on value labels statement)

```

data list /subject 1-2 trials 3-4 set 5 age 6-7 hand 8 leye 9-11 reye 12-14
sex 15(A) tpre1 16-17 tpre2 18-19 tpre3 20-21 tpre4 22-23
tpre5 24-25 tpre6 26-27 tpre7 28-29 tpre8 30-31 tpre9 32-33
tpre10 34-35 tpre11 36-37 tpre12 38-39 tpre13 40-41 tpre14 42-43
tpre15 44-45 tpre16 46-47 tpre17 48-49 tpre18 50-51 tpost1 52-53
tpost2 54-55 tpost3 56-57 tpost4 58-59 tpost5 60-61 tpost6 62-63
tpost7 64-65 tpost8 66-67 tpost9 68-69 tpost10 70-71 tpost11 72-73
tpost12 74-75 tpost13 76-77 tpost14 78-79 /tpost15 1-2 tpost16 3-4
tpost17 5-6 tpost18 7-8
change1 10 affect1 11 amt1 12 change2 13
affect2 14 amt2 15 odour 16-17 avoid 18 advamt 19 dodour 20
strength 21 detect 22 aware 23.
value labels hand 1 'right' 2 'left' /
change1 1 'yes' 2 'no' /
affect1 1 'pleasant' 2 'unpleasant' /
amt1 1 'a little' 2 'some' 3 'a lot' /
change2 1 'yes' 2 'no' /
affect2 1 'pleasant' 2 'unpleasant' /
amt2 1 'a little' 2 'some' 3 'a lot' /
avoid 1 'yes' 2 'no' /
advamt 1 '1-10' 2 '>10' /
dodour 1 'yes' 2 'no' /
strength 1 'weaker' 2 'stronger' /
detect 1 'yes' 2 'no' /
aware 1 'yes' 2 'no'.
if (subject ge 32)
relypre=(abs(tpre11-tpre1) + abs(tpre12-tpre2) + abs(tpre14-tpre4) +
abs(tpre16-tpre6) + abs(tpre17-tpre7) + abs(tpre18-tpre8))/6.
if (subject ge 32)
relypost=(abs(tpost11-tpost1) + abs(tpost12-tpost2) +
abs(tpost14-tpost4) + abs(tpost16-tpost6) +
abs(tpost17-tpost7) + abs(tpost18-tpost8))/6.
if (subject=37) tpost13=0.
if (subject=37) tpost15=3.
if (subject ge 32) tcsnegd=(tpost3+tpost13)/2-(tpre3+tpre13)/2.
if (subject le 31) tcsnegd=(tpost3-tpre3).
if (subject ge 32) tcsneutd=(tpost5+tpost15)/2-(tpre5+tpre15)/2.
if (subject le 31) tcsneutd=(tpost5-tpre5).
compute tdiffcnd=tcsneutd-tcsnegd.
if (subject ge 32) csppre=(tpre3+tpre13)/2.
if (subject le 31) csppre=tpre3.
if (subject ge 32) csppost=(tpost3+tpost13)/2.
if (subject le 31) csppost=tpost3.
if (subject ge 32) csmpre=(tpre5+tpre15)/2.

```





52603221 -2 -3M-1-3-4-1 4 3-3-3 7 4-1 0 0-4 7 3-2-1-2-2-3 0 5 2-6 0 2  
 2-3-2-2-2  
 5 4 0 0 2 121-1112 1  
 53603211 -4 -7M 6-7 9 5-6 8-3 7 0-6 6-6 5 6 0 5 4 4-4-6 7 7-6 9 6 5-5-5  
 5 3 5 5  
 -6 4 5-4 1222 -3111122  
 54603191 -4 -4M-6-6 2 3 4-5-9-6 2 5-7-9 0 3-2 1-4-4-6-9 9 0-3 5-3 3 1  
 3-3-9 9 3  
 2 4 0-2 111113 02 1122  
 55603221 -2 -5M 4 0 0-3 0 0-3 0 0 0 3 0 0 0 0 0 1 0 0 0 0-1 0 0 0 0 0 3  
 0 0-1 0  
 0 0 0 0 2 2 2112 2  
 56603201 -4 -4M 9 5 2-1-7 3-5 3-6-6 9 3 7-2-5 1 3 3 5 9 1 3 3 5-4-7 5 9  
 9 9 5 2  
 3 2-3-6 113121-12 12 1  
 57603201 -2 -3M 4 9-1 1 0 3 5 3 4 3 3 3 3 4 3 3 3 9 8 9 0 4-3-3 1-2 5  
 7 8 9-3  
 6-2 0 1 112112-22 2 2  
 58603191 -2 -4M 3 0 0 1-2 3 0 0-2 1 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0  
 2 0 0 0  
 0 0 0 0 2 2 02 2 1  
 59603221 -5 -3M 0 1-1 1-3-2-2-4 2-1 1-3 2-4 4-3 1-4-3 1-7 1 5 0-1 2 0 0  
 1 0-8 2  
 3 0-3 0 112123-41112 1  
 60603191 -4 -1M-5 9 7-3 6-5 7-2 1 4-2 7 5 5-3-5 6-4-3 5 5 6 8-7 5-1 1  
 7-2 6 5-2  
 9-7 5 0 2 122-12 12 1  
 61603221 -2 -4M 1 1 1 0 1 1 1 1 1 0 0 1 1 0 0 0 1 0 1 1 1 1 1 1 1 1 1  
 1 0 1 1  
 1 1 1 1 2 2 -12 2 1  
 62603251 -7 -7M 9-4 0-2-1-1 4 0 0 9 9-6 0 0 0-1 1 0 9-4-7 4 0-1 3 0 0 9  
 9-1-2 1  
 9 0 9-1 2 121-12 1111  
 63603191 -4 -2M 2 3 3 1 3 2 4 2 3 3 5 6 3 1 4 3 1 1 3 4 1 2 3 2 4 3 2 5  
 3 5 2 2  
 3 2 2 1 2 121-22 12 1  
 64602211 6 -3M 5 2 0 1 0 2 2 0-1 2 3-1 1-3-1 2 2-2 9 3-1 3 3-2 2 3 4 5  
 4 4 0 3  
 4 4 3 3 111122-22 12 1  
 end data.

Raw Data for Study 5

<u>Variable</u>	<u>Description</u>
Subject	Subject number
Age	Subject's age
Cspprerh	Average rating of CS <sub>negative</sub> presented to right hemisphere in pre-conditioning rating phase (average of Cspre5 and Cspre17)
Csppstrh	Average rating of CS <sub>negative</sub> presented to right hemisphere in post-conditioning rating phase (average of Cspst5 and Cspst17)
Csmprerh	Average rating of CS <sub>neutral</sub> presented to right hemisphere in pre-conditioning rating phase (average of Cspre10 and Cspre22)
Csmpstrh	Average rating of CS <sub>neutral</sub> presented to right hemisphere in post-conditioning rating phase (average of Cspst10 and Cspst22)
Cspprelh	Average rating of CS <sub>negative</sub> presented to left hemisphere in pre-conditioning rating phase (average of Cspre3 and Cspre15)
Csppstlh	Average rating of CS <sub>negative</sub> presented to left hemisphere in post-conditioning rating phase (average of Cspst3 and Cspst15)
Csmprerh	Average rating of CS <sub>neutral</sub> presented to left hemisphere in pre-conditioning rating phase (average of Cspre8 and Cspre20)
Csmpstlh	Average rating of CS <sub>neutral</sub> presented to left hemisphere in post-conditioning rating phase (average of Cspst8 and Cspst20)
Relypre	Mean difference between first and second ratings of 8 foils in pre-conditioning rating phase
Relypost	Mean difference between first and second ratings of 8 foils in post-conditioning rating phase
Aware	Awareness of stimulus contingencies (1 = aware for left hemisphere presentations only; 2 = aware for right hemisphere presentations only; 3 = aware for presentations to both hemispheres)
Format	Presentation of stimuli during rating phases (1 = unilateral; 2 = central focus)
Cspre1 - Cspre24	Ratings of CSs and foils during pre-conditioning rating phase (see above for designations of CSs)
Cspst1 - Cspst24	Ratings of CSs and foils during post-conditioning rating phase (see above for designations of CSs)

data list /subject 1-2 age 3-4 cspprerh 5-8 csppstrh 9-12 csmprerh 13-16  
 csmpstrh 17-20 cspprelh 21-24 csppstlh 25-28 csmprerh 29-32  
 csmpstlh 33-36 relypre 37-40 relypost 41-44 aware 45 format 46  
 /cspre1 1-2 cspre2 3-4 cspre3 5-6 cspre4 7-8 cspre5 9-10  
 cspre6 11-12 cspre7 13-14 cspre8 15-16 cspre9 17-18 cspre10 19-20  
 cspre11 21-22 cspre12 23-24 cspre13 25-26 cspre14 27-28  
 cspre15 29-30 cspre16 31-32 cspre17 33-34 cspre18 35-36

cspre19 37-38 cspre20 39-40 cspre21 41-42 cspre22 43-44  
 cspre23 45-46 cspre24 47-48  
 /cspst1 1-2 cspst2 3-4 cspst3 5-6 cspst4 7-8 cspst5 9-10  
 cspst6 11-12 cspst7 13-14 cspst8 15-16 cspst9 17-18 cspst10 19-20  
 cspst11 21-22 cspst12 23-24 cspst13 25-26 cspst14 27-28  
 cspst15 29-30 cspst16 31-32 cspst17 33-34 cspst18 35-36  
 cspst19 37-38 cspst20 39-40 cspst21 41-42 cspst22 43-44  
 cspst23 45-46 cspst24 47-48.

compute cspdrh=cspstrh-csprrh.  
 compute cspdlh=cspstlh-csprrh.  
 compute csmdrh=cspstrh-csprrh.  
 compute csmdlh=cspstlh-csprrh.  
 compute dcondrh=csmdrh-cspdrh.  
 compute dcondlh=csmdlh-cspdlh.  
 if (aware=1 or aware=3) awarelh=1.  
 if (aware=2 or aware=3) awarerh=1.  
 begin data.

0119 6.5 6.5-4.0-4.0 7.0 7.5 8.5 7.53.623.6211  
 -2-4 5 9 6 6 3 9-4-4-3-3 4-2 9 6 7 5-4 8-8-4-5-4  
 -4-6 8 7 7 4-4 6-6-5-4 4-3-4 7 5 6 9 3 9-8-3-4-6  
 0221 7.0 9.0-5.5-5.5-0.5 0.0-3.0 0.52.375.2511  
 2 4-2 2 5-4 2-3 2-7 6-6 6 6 1 5 9-3 4-3 6-4 6-3  
 -3 3-4 6 9 0 3 4 5-2 7 3-4-5 4 5 9-8-6-5 4-9 5-9  
 03 9.0 5.5 6.5 7.5 7.0-2.5 4.5-1.04.252.8711  
 4 0 5-4 9-4-5 0 0 9-6-3-4 9 9-8 9 0 0 9 0 4-4-5  
 4 5-4 1 7 6 1-3 0 6-6 1 1 9 1 6 4 9-2 1 1 9-9 0  
 0421 1.0-0.5-4.0 2.0 4.5 1.5 7.0 8.04.124.3731  
 6-2 4 5-5-3 4 5-5-4 5 4-4-4 5-4 7-3-4 9-3-4 6 3  
 -3-3-2-7 5 3 5 9 3-1 3 6 4-5 4 5-6 6 5 7 7 5-4 6  
 0527 1.5 2.5 6.5 3.5-1.0-1.5 1.5 3.04.121.8722  
 2 2 0 2 0 0 2-1-2 6 5 5 4 3-2-2 3-5 5 4 0 7 0-6  
 5 5-3 3 3-6 4 3-1 3 3 4 8 1 0 0 2-4 4 3 0 4 1 4  
 0622 9.0 5.5 9.0 6.0 8.5 7.0 9.0 6.50.370.5002  
 9 9 9 9 9 8 9 9 9 9 9 9 7 9 8 9 9 9 9 9 9 9 9  
 6 7 7 6 5 6 6 6 7 6 6 6 7 6 6 6 6 7 6 6 7 6  
 0720 5.5-1.0 0.5 0.0 0.0 0.5-7.5-3.55.122.2532  
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 9 7 9-4-4-7 7-7-9-7 2 9 8-9 9-5-3-4 3-7-9-3 3 6  
 7 9-5-6-9 4 6 4-7 6 8 6-9 9 7-9 9-7-6 6-6 7 6 9  
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 1023 0.5 1.5-0.5 2.5 1.0 2.0-1.5 1.52.621.8702  
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 3-3 2-1 1 0 1 2 1 2 1 0 1-1 2 1 2 1-1 1 1 3 0 2  
 end data.

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