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The Role of Emotion Perception and Experience on Laterality

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

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in

Psychology

by

Vanessa Maria Miller

June 2011

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Dedication

I dedicate my dissertation to my father, Richard Allen Miller, who almost made it to see me through to the end. He has been a true source of inspiration in my life. I'm just sorry that you are not able to see this.

ABSTRACT OF THE DISSERTATION

The Role of Emotion Perception and Experience on Laterality

by

Vanessa Maria Miller

Doctor of Philosophy, Graduate Program in Psychology
University of California, Riverside, June 2011
Dr. Christine Chiarello, Chairperson

Language research has moved from the left hemisphere (LH) processing all language, to a differential processing across hemispheres. Davidson (1995) suggests the right hemisphere (RH) is specialized for experiencing negative emotions, while the LH is specialized for experiencing positive emotions. However, when readers' perceive emotion, the RH processes emotion regardless of valence. Examining laterality of perception versus experience of emotions has not been thoroughly tested using cognitive paradigms. Experience was examined using positive, negative, and neutral moods induced via pictures from the International Affective Picture Inventory. We predicted a LH advantage for positive or neutral mood induction and a RH advantage when negative mood was induced. Perception of emotions was tested using valence judgments. Predictions were a RH advantage for natural and man-made target words preceded by positive and negative central words and a LH advantage for targets preceded by neutral central words. An overall LH advantage for the semantic decision task was found. The valence of the central word did have an effect on accuracy and reaction time of the subsequent semantic decision words. Although there was no effect of visual field for the

negative mood induction condition, there was a trend toward a significant interaction between mood and visual field. A LH advantage was found for accuracy of the semantic decision task for the positive mood induction, which partially supports experimental predictions. This experiment examined the effect of valence on hemispheric asymmetry. Arousal level was controlled for in order to have a non-confounded measure of valence. Given experimental findings, arousal level may be an important variable when examining valence.

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The Role of Perception and Experience on Laterality

Studying hemispheric processing of emotion is important because emotional language is one deeper facet in the exploration of laterality of language. Research into the laterality of language has moved from the idea that the left hemisphere (LH) processes all language to a differential processing of language across the left and right hemispheres. Emotion is something that is dealt with and encountered in everyday life and understanding the structure-function relationship behind emotion is vital to understanding subsequent behavior, particularly in populations with brain injury and clinical psychopathology.

Hemispheric perception of emotion has traditionally been explored via pictures or images (Bryden & Ley, 1983). Research has demonstrated the left hemisphere's superiority for the recognition of words and strings of letters (Bryden & Ley, 1983). Current research into the lexical channel of emotion has yielded a divide as to the right and left cerebral hemisphere's role in processing emotional language. Research into the lexical channel of emotional communication suggests that the RH may be specialized for recognizing negative emotions, while the LH may be specialized for recognizing positive emotions (Davidson, 1995). Some studies exploring the lexical channel of emotional communication have demonstrated support for this Valence Hypothesis (Davidson, 1995; Borod et al. 1998). Other studies, however, have shown support for the Right Hemisphere Hypothesis, which states that the RH is specialized for the processing of emotion, regardless of valence (i.e., whether emotion words are positive or negative) (Borod et al., 1998).

Davidson (1995), however, proposes a convergence between these two theories, such that a differential hemispheric advantage occurs as a result of emotional experience rather than the perception of emotion. Without the experience of emotion, according to Davidson (1995), the RH is the primary processor of emotional information. Perception of emotion refers to the recognition that a word or sentence is emotional in nature or contains emotional information (i.e. is of positive or negative valence). However, perceiving an emotion implies that one does not feel the particular emotion conveyed (i.e. one does not feel positive or negative) but rather recognizes that an emotion is described. Davidson's idea that the RH is primarily a perceptual emotion processor has emerged from studies using EEG with both clinical and non-clinical populations.

According to Davidson (1995), emotional experience shifts the RH asymmetry for all emotion to a differential asymmetry, resulting in a LH advantage for positive emotion and a RH advantage for negative emotion. It may be that the cognitive decision process employed during emotional perception is different from emotional experience. According to Davidson (1995), experience is a less distant evaluative process, which results in a differential split across the left and right hemispheres. Perhaps experience involves more than the evaluative process at work during emotional perception. Paradigms testing emotional experience do so by means of mood induction, either naturally occurring or lab created (via emotional pictures or words). The subsequent sections will review the evidence for lateralization of emotion experience and emotion perception.

Emotion Experience

Ramon, Doron, & Faust (2007) using a mood induction technique found support for differential hemispheric asymmetry depending upon the valence of the mood induced before participants completed a lateralized categorization task. The mood induction condition consisted of participants being asked to think of a time in their life that was highly positive, highly negative, or neutral and to write a description of that event. Following this, participants were asked to complete a lateralized categorization task. Participants were presented with a central word that defined a category (i.e. fruit). Following this, a lateralized target word appeared that was an example of a typical (i.e. apple) or a-typical (i.e. tomato) member of the centrally presented category. Results from their experiment showed that when participants were first induced with a negative or neutral mood, reaction times were faster for categorizing typical than a-typical words in both the left and right hemispheres. However, reaction times were equally fast for categorizing typical and a-typical words only in the LH, when first induced with a positive mood. Thus, this experiment demonstrates a LH advantage when experiencing a positive mood. However, the left and right hemispheres had an equal advantage after experiencing a negative and neutral mood. Neither the RH or valence hypotheses are fully supported by the Ramon et al. findings. Therefore, a different categorization task, one in which participants make single category judgments of natural or manmade items may be a good alternative task to examine Davidson's hypothesis.

Gruzelier and Phelan (1991) conducted a study in which they used a naturally occurring mood induction technique. Their study used a within subjects experimental design, in which the same group of medical students underwent a lateralized consonant-vowel discrimination trigram task. Participants were tested under a negative (stressful) condition, 1-2 days prior to an upcoming medical exam and then tested again four weeks later under a neutral (non-stressful) condition, in which the participant had no upcoming medical exam. The condition order of testing was counterbalanced. The lateralized trigram task consisted of a three-letter presentation in which participants were required to lift their finger from a button if they thought they saw a vowel presented in the trigram. Results from this study demonstrated a RH advantage for vowel discrimination for the medical students in the negative (stressful) condition and a LH advantage for vowel discrimination for medical students in the neutral (non-stressful) condition (Gruzelier and Phelan, 1991). Results from this study do support Davidson's idea that the experience of emotion is the basis for the valence hypothesis. However, this study is limited in that only negative and neutral conditions were compared, while a positive condition was not included. However, under the Gruzelier and Phelan (1991) paradigm, not having an upcoming medical exam may be considered by some medical students as a positive and if so, would be in support of the valence hypothesis. However, including a positive condition, like 1-2 days after passing a medical exam would be an important addition to the current study.

Results from these prior experience studies are mixed as to whether emotion experience produces a shift in laterality, as Davidson claims. The type of mood induction (emotion experience) and the lateralized task varied in the aforementioned studies. Therefore it is difficult to know whether the mood induction or lateralization task itself or a combination of the two contributed to these experimental results. I will now review the evidence for emotion perception, in which support for a RH advantage for emotion perception is mixed.

Emotion Perception

Some investigators (Borod, 1986) have proposed a more general role for the RH in processing all emotions. However, the data on which these claims are based are largely studies of perception of emotional information (i.e. facial expressions). According to Davidson (1995), perception of emotion refers to the recognition that a stimulus is emotional in nature or contains emotional information. Yet, in perceiving an emotion, one does not feel the particular emotion conveyed but rather recognizes that an emotion is present. Borod et al. (1998) explored emotional perception in a study that used an identification and discrimination paradigm in participants with left and right hemisphere injury and a non-injured control group. The identification paradigm was used to assess the ability to recognize and categorize an emotion (i.e. perception), consisting of both a word and sentence identification task. In the word identification task, participants were shown a three-word vertical cluster, such as “putrid, slime, stench” and were asked whether the cluster represented the same emotion as say “disgust.” In the sentence identification task, participants saw a seven-word sentence and indicated whether an emotion like “anger” was represented by the sentence “He felt the urge to hit someone.” The discrimination paradigm, on the other hand, was used to assess the ability to perceive stimulus characteristics (Borod et al., 1998). For the discrimination task, participants saw two printed words and had to decide whether the two words were indicative of the same or different emotion. In both the identification and discrimination paradigms, words and sentences were presented in the center of an 8.5 x 11 in. piece of paper, not lateralized to either the right or left hemisphere. Results from the identification paradigm found that participants with RH injury were less accurate in their judgments of both positive and negative valence as compared to participants with LH injury and the non-injured control group. This supports RH dominance in processing emotional stimuli. However, in the discrimination paradigm, there were no significant performance differences between the right and left hemisphere injured participants. This lack of significance does not provide support for either the RH or valence hypothesis. Overall, results from the identification task provide support for the RH's role in perception of emotion.

It is important when examining emotion perception that paradigms be used that assess whether the presented emotion stimulus is being perceived as emotional. Traditional lexical decision experiments, which require participants to make a word versus non-word response are unable to assess emotion perception. For example, Strauss (1982) and Evitar and Zaidel (1991) investigated the left and right hemisphere's role in perception of emotional and non-emotional words during a lateralized lexical decision task. Participants in both these studies made a yes/no lexical decision as to whether they saw a word or non-word on each trial. Findings showed that accuracy was greater and reaction times were faster for both positive and negative words when presented to the LH, typical of lexical decision paradigms. The Strauss (1982) and Evitar and Zaidel

(1991) studies highlight the importance of using a paradigm that tests whether participants are actually perceiving the valence of a presented emotion word.

These studies demonstrate the importance of designing experiments that can measure perception, that is whether participants are actually perceiving the presented word as emotional. Some studies have incorporated non-valenced lateralized tasks with emotion perception and experience. For example, Alfano & Cimino (2007) used a central presentation of positive, negative or neutral single word followed by a lateralized 3-consonant trigram task. Participants were required to report aloud the letters from the trigram and then report aloud the valence of the central word. Results from this study showed a LH advantage for reporting consonant trigrams when preceded by positive and neutral words and a RH advantage for reporting consonant trigrams when preceded by negative words. Thus, Alfano & Cimino (2007) demonstrated laterality effects for meaningless stimuli depending upon the valence of the reported central word. Although the Alfano & Cimino (2007) paradigm was not designed to examine emotional perception or experience, results from this study do support this differential hemispheric advantage, which according to Davidson (1995) should follow from emotional experience. Though participants were required to report aloud the centralized emotion word, a judgment regarding the emotion presented (i.e. whether the word presented was positive or negative) was not made. Therefore, this raises the question as to whether results would demonstrate the same laterality differences if participants were required to make a valence judgment regarding the central word instead of simply reporting it. Given that

Alfano & Cimino (2007) found laterality differences based upon valence of the reported word, this questions Davidson's idea of emotional experience.

Van Strien & Morpurgo (1992) also conducted a study similar to Alfano & Cimino (2007). In their study, a single word was centrally presented that was either of a positive or negative valence, which was followed by a lateralized presentation of a three consonant trigram. Participants were required to first report aloud the letter of the trigram and then report aloud the central word. Results from this study showed a non-significant trend for a LH advantage for reporting consonant trigrams when preceded by a positive word. A significant RH advantage was found for reporting consonant trigrams when preceded by a negative word. The Van Strien & Morpurgo (1992) study did not use a neutral word condition, which may be an important baseline to compare the positive and negative conditions to. Stimuli used in the central word presentation were not words from the Affective Norms for English Words (ANEW) but rather were words that were devised and normed for the experiment.

Results from the Alfano & Cimino (2007) and Van Strien & Morpurgo (1992) studies bring into question Davidson's idea that emotional experience is required to produce differential valence effects by left and right hemisphere. Can it be that reporting a single emotional word taps into emotional experience? If not, what is occurring to result in this differential hemispheric advantage? What is needed is an experiment that incorporates emotional experience (via mood induction) and emotional perception (via valence decisions) prior to a lateralized task. Additionally, would a lateralized task that involves words rather than letters result in findings similar to those found by Alfano &

Cimino (2007) and Van Strien & Morpurgo (1992)? It would be better to generalize results from a task that has meaning like a semantic decision task rather than from a trigram task. Using a task like the semantic decision in which participants are required to categorize a word based on its meaning (i.e. naturally occurring thing or manmade thing) is more similar to everyday encounters with language where verbal stimuli are processed for meaning.

Thus far I have examined the dichotomy of emotion experience and emotion perception. Though these are two important distinctions in the literature on which the valence and RH Hypotheses are based, Davidson has further examined the valence hypothesis within the anterior and posterior regions of the left and right cerebral hemispheres. Davidson emphasizes the importance of testing people's baseline affective state either in isolation or prior to inducing a mood. The following section will examine the literature on this.

EEG, Affect, & Biologic Substrates

Davidson (1992) suggests that resting anterior asymmetry can serve as a measure of a person's baseline affect. This baseline affect differs from the asymmetry observed when affect is manipulated experimentally. Experimentally induced positive and negative affect adds to the person's already existing baseline level of affect often resulting in more pronounced differences in asymmetry (Davidson, 1988). According to Davidson (1988), the presence of for example, right frontal activation is not itself sufficient to index the presence of a negative affective state (Davidson, 1988). Right frontal activation may be necessary though not sufficient for the experience of negative emotion (Davidson, 1988).

The presence of right frontal activation may, however, be indicative of a vulnerability for negative affect, given an appropriate emotion elicitor (Davidson, 1988). Therefore, experimental manipulation of positive or negative affect may be important for assessing asymmetry patterns. Clinical populations, examined by Davidson, may present with a pre-existing level of affect, which combined with experimental manipulation of affect may result in differing asymmetry patterns than the pre-existing level of affect present in a non-clinical (i.e. normal) population. Therefore, a cleaner manipulation of experimentally manipulated affect may result when inducing mood in a non-clinical population.

Based upon data from EEG measures of regional hemispheric activation, Davidson (1992) has theorized that left anterior brain activation is associated with the experience of approach-related emotions, like happiness. The principal measure extracted from the EEG in Davidson’s (1992) studies is the alpha band, representing activity between 8 and 13 Hz. These measures of band power are computed from the output of a Fast Fourier Transform (FFT), which decomposes brain activity into its underlying sine wave components (Davidson, 1992). Deficient activation in the left anterior region is associated with emotion-related phenomena reflective of approach-related deficits, like sadness and despair (Davidson, 1992). Normal right anterior brain activation has been shown to be associated with the experience of withdrawal-related emotions, like fear, anxiety, and disgust. Davidson (1992) has proposed that anterior activation asymmetry functions as a diathesis, which predisposes an individual to respond with predominately positive or negative affect, given an appropriate emotion elicitor. According to Davidson

(1992), in the absence of a specific elicitor, differences in affective symptomatology among individuals with different patterns of anterior asymmetry or asymmetry of anterior brain lesions would not be expected. In a normal population, however, baseline anterior asymmetry predicts reactivity to an affective challenge but is unrelated to measures of an individual's current, unprovoked emotional state (Davidson, 1992).

According to Davidson (1995), the perception of emotion and the experience of emotion present with differing biologic substrates. The functional significance of cerebral asymmetry differs in the anterior and posterior cortical regions (Davidson, 1988). Asymmetries in the anterior regions are associated with affective processing, while asymmetries in posterior regions are more related to cognitive processing (Davidson, 1988). According to Davidson (1998), it is important to extend research beyond the hemispheric level to a more regional approach. However, Davidson's use of EEG does not necessarily allow for more precise localization. Though EEG activation can be recorded over anterior and posterior regions, given the nature of the EEG technique, this doesn't necessarily allow for more precise localization beyond the hemispheric level and may not even be localizable to the hemispheres.

Davidson's EEG studies have found that task performance is highly correlated with asymmetry during a resting baseline, such that anterior asymmetries during resting baselines are stable over time. However, measuring EEG resting baselines may not be a direct measure of either emotional perception or experience. In one study, Davidson (1995) found baseline anterior asymmetry to be related to measures of dispositional mood. Participants in this study were administered the Positive and Negative Affect

Schedule (PANAS) after undergoing baseline EEG measures. Participants who were found to have LH baseline activation also reported more positive affect on the PANAS. Participants who were found to have RH baseline activation reported more negative affect on the PANAS.

In another EEG study by Schaffer, Davidson, and Saron (1983), a group of high and stable scorers on the Beck Depression Inventory (BDI) were compared with a group of low and stable scorers on the BDI on resting frontal asymmetry. Results from this study found that depressed subjects had less LH frontal activation compared with non-depressed subjects. Findings further showed that remitted depressives, like acute depressives had significantly less LH frontal activation compared with healthy controls, which indicates that the decreased left anterior activation, which is characteristic of depression, remains even when depression is remitted. Results also found that healthy controls (non-depressed individuals) had significantly greater LH frontal activation, as compared to the depressed and remitted depressed subjects. Therefore, according to Schaffer et al. (1983), it is the experience of depression (or negative emotion) that leads to a RH advantage. According to Schaffer et al. (1983), the fact that remitted depressives had significantly less left activation compared with healthy controls lends further support to the role that the LH plays in experiencing positive emotion.

In another study, Davidson, Ekman, Saron, Senulis, & Friesen (1990) measured EEG with non-clinical participants, while they watched two approach-related positive emotion and two withdrawal-related negative emotion film clips. Results from this study showed a greater pattern of right-sided activation during disgust compared with happiness in anterior electrodes. Results also showed a greater pattern of left-sided anterior activation for happiness (Davidson et al. 1990). Thus, results from this EEG study suggest that in this group of non-clinical participants, differential hemispheric specialization exists as a function of valence for left and right anterior brain regions. The film clips in this study may be a type of mood induction, which given results shown in this experiment, would support Davidson's emotional experience idea for differential hemispheric specialization.

In another study, conducted by Sobotka, Davidson, & Senulis (1992), a significant valence by hemisphere interaction was found but this time in the right frontal brain region. In this study, reward and punishment contingencies were manipulated in the context of a video-game-like task using a normal participant population. Participants could either win or lose money while playing the game. Participants were told that the money they had at the end of the game was theirs to keep. Results of this experiment showed greater right frontal activation during punishment trials as compared with reward trials. The fact that participants in this study would keep the money at the end of the study may be an example of participants experiencing an emotion rather than perceiving emotion.

Results from this study and the film clip study demonstrate that the measurement of emotional experience is not limited to one technique. While a dichotomy between experience and perception of emotions and the techniques used to measure each pervade the literature, some studies have tried to incorporate both experience and perception. The following section reviews these few studies.

Emotion Perception & Experience Combined

Although some studies have used paradigms testing emotional perception, emotional experience, or a combination of the two, some studies have constructed paradigms combining emotion experience or perception with a valence-neutral task. Both Gruzelier and Phelan (1991) and Ramon et al. (2007) examined emotion experience on a valence-neutral task, while Alfano & Cimino (2007) tested the effect of central emotion words on a lateralized valence-neutral consonant trigram task.

Atchley, Stringer, Mathias, Ilardi, & Minatrea (2007), used a paradigm that incorporates both emotional perception and experience into the same experiment. However, the use of clinically depressed participants in this study does question whether depressed mood is the same as negative mood induced in a normal population. In their study, Atchley et al. (2007) investigated the role the left and right hemispheres play in emotional word processing, while in a naturally occurring mood state of currently depressed, remitted depressed, and never-depressed participants. Participants in this study were undergraduates screened for depression via the Beck Depression Inventory and the Structured Clinical Interview for DSM Disorders (SCID-I). Participants were required in the experiment to make valence judgments of single lateralized words from the Affective Norms for English Words (ANEW) (i.e., the task required perception of emotion). Results from this study found differences in valence processing only when words were presented to the RH. Currently depressed and remitted depressed participants were more accurate in valence judgments of negative words. Never depressed participants were more accurate in valence judgments of positive words. A RH advantage was found for both positive and negative valence judgments in the never depressed group. This finding lends support to the idea that the RH hypothesis applies more to perception of emotional information.

However, these results do not necessarily lend support to the valence hypothesis applying more to the experience of emotion. The persistent negative mood characteristic of depressed and remitted depressed people is likely different from the negative mood induced in a normal population. The RH advantage in this clinical population may be influenced by co-occurring cognitive impairments, which in a normal population are not present. Though Atchley et al. (2007) included a never depressed group, this group may not be the same as a positive emotion experience group.

Outline of the Current Study

The current study aimed to explore this combination of emotional perception and experience in a single experiment by using the same lateralized task but varying the mood induction technique to include positive, negative, and neutral mood induction. Using a mood induction technique instead of a clinical group provides a cleaner experimental manipulation of mood that is free of pre-existing biases present in a clinical population. The current experiment included a lateralized semantic decision judgment task (i.e. naturally occurring or man-made item) to investigate the effect of mood (emotion experience) and emotion perception on performance in a valence-neutral, but meaning relevant lateralized task. Previous research suggests that emotion word processing can affect performance on a valence-neutral task, producing variations in lateralized performance (Gruzelier and Phelan, 1991; Ramon et al. 2007).

The current three-session experiment investigated whether hemispheric laterality may in fact be shifted via emotional experience or emotion perception. In the emotion perception condition, a semantic judgment (i.e. judging whether a lateralized word falls into one of two categories, naturally occurring or man-made item) was preceded by a valence judgment (i.e. judging whether linguistic stimuli represent positive, negative, or neutral valence). In the emotional experience condition, this valence judgment was replaced by a consonant judgment (i.e. judging whether 2, 3, 4 or more consonants were present in the centrally presented word), where no attention to valence was required. In this condition, laterality shifts as a result of the experience of emotion were examined by use of mood induction. The current study used cognitive methods for examining emotional perception and experience. A verification of mood state via the Positive and Negative Affect Schedule (PANAS) and an examination of laterality in a non-clinical normal population was included in the current experiment. Examining laterality of perception versus experience in a non-clinical population aimed to alleviate potential confounds that may be present when using a clinical population. For example, cognitive bias (due to depression), pre-existing emotional mood state (due to clinical disorder) or brain injury (which may impair hemispheric processing) are potential confounds that likely will not be present in a non-clinical (normal) population. The current experiment pre-screened participants for depression using the Beck Depression Inventory to ensure participants were free of a pre-existing mood disorder.

Experimental procedures were similar for both the perception and experience conditions (see Figures 1 and 2). Experimental procedures began with all participants undergoing a 10-minute mood induction, which involved viewing a slideshow of either positive, negative, or neutral valence pictures from the IAPS. Participants underwent one valence (mood induction) condition per day for three days. The positive and negative mood induction conditions represented the emotional experience manipulation. Emotional perception was tested following the neutral induction condition.

Following this mood induction period, participants underwent the laterality experiment. At the beginning of each trial, participants saw a central word (positive, negative, or neutral valence). Following presentation of the central valence word, participants viewed a lateralized word representing a member of a semantic category (i.e. naturally occurring or man-made item). All participants were required to make a button press response immediately following presentation of the lateralized word as to whether this word was a naturally occurring (i.e. bird) or manmade item (i.e. door). Following this button press response, participants in the positive and negative mood induction vocally reported the number of consonants present in the central word (i.e., 2, 3, 4 or more). Participants in the neutral mood condition were required to make a vocal response reporting the valence of the central word (i.e. positive, negative, or neutral), to further test emotion perception. Report of the number of consonants was a filler task for the emotion experience conditions, to make the task procedure comparable across the perception and experience manipulations. A preliminary experiment (described below) was conducted to verify that the consonant and valence decisions did not differently affect accuracy or reaction time of performance on the semantic decision task.

Lateralized target words were neutral in valence and unrelated to the central valence word. There was no semantic relationship between the central valence word and lateralized semantic target because the current experiment was not intended to be a semantic priming paradigm. Rather, the current experiment was designed to explore the effect of a cognitive judgment of emotion on subsequent procesing of unrelated stimuli, similar to the Alfano and Cimino (2007) paradigm.

The same valence words were centrally presented in both the perception and experience conditions in order to examine whether the cognitive decision of a valence judgment is the important component for the RH perceptual advantage (according to the RH hypothesis). Predictions were that the cognitive decision of a valence judgment would be important for obtaining the RH advantage for both positive and negative valence. Accuracy and reaction times to the lateralized semantic decisions were the dependent variables.

Predictions for the current experiment were based on Davidson's theory, such that under the emotional perception condition (i.e. a neutral mood induction), a RH advantage for semantic decision would be seen, as evidenced by greater accuracy and faster reaction times, when lateralized targets were preceded by either positive or negative words. A LH advantage was expected when targets were preceded by neutral words. For the emotional experience condition, predictions were that a positive and neutral mood induction would result in a LH advantage for the semantic decision task, while a negative mood induction would result in a RH advantage for the semantic decision task. Since these predictions are based on Davidson's theory, if results from the current experiment are found not to support predictions, then this brings into question Davidson's conceptualization of the right and left hemispheres role in emotion experience and perception.

Preliminary Experiment

Prior to Experiment 2, a control experiment was conducted to examine the effect of a cognitive valence judgment compared to a task that did not require a judgment of valence of a centrally presented word. Participants in the control experiment underwent the neutral mood induction condition but, in separate sessions, made valence and consonant judgments about the centrally presented valence word. This examination is important because Experiment 2 is not a completely crossed design. Participants in the neutral mood induction were required to a make valence judgment of the central but were required to make a consonant judgment of the central word while in a positive or negative mood. Therefore, it was important to compare accuracy and reaction time of consonant and valence judgments within the same mood condition to make sure these tasks did not differ significantly within one mood condition before separating them across three mood conditions. This control experiment was designed to make sure that no effect on laterality of consonant decisions occurred when following a neutral mood induction. Experiment 1 also examined whether exposure to a valence word shifts laterality. Alfano and Cimino (2007) and Van Strien & Morpurgo (1992) found that merely reporting a valence word results in a differential hemisphere advantage.

Predictions for the valence judgment condition were that a RH advantage would be found for the semantic decision task when preceded by either a positive or negative central word. A LH advantage was expected when the semantic decision was preceded by a neutral central word. Predictions for the consonant judgment condition were that there would be no significant differences in accuracy or reaction time for the semantic decision task when judging between 2, 3, or 4 number of consonants for the central word. Lastly, no significant differences were predicted in accuracy for the central task among the valence and consonant judgment conditions.

Experiment 1

Method

Participants

A total of 42 undergraduate college students (21 males and 21 females) between the ages of 18 and 35 participated in the control study. All participants were native English speakers, as assessed by a language history questionnaire. Participants were pre-screened for depression, using the Beck Depression Inventory (BDI). A total of 6 participants with a BDI score of 10-63 (mild-severe depression) were excluded from the study and replaced. All participants were predominately right-handed. Handedness was assessed by a five-item questionnaire, which yielded an index from +1.00 (extreme right-handedness) to -1.00 (extreme left-handedness) (Bryden, 1982). All participants were required to have an index of at least +0.30. Mean handedness score for participants was +0.94. Participants were also administered a standard eye exam to test for visual acuity.

All participants were required to have normal or corrected to normal vision. Participants were given course credit for their participation.

Stimulus Materials

Stimulus selection for the mood induction procedure was chosen from the International Affective Picture Inventory (IAPS) (Lang, Bradley, & Cuthbert, 2005). IAPS and Affective Norms for English Words (ANEW) have been developed to provide a set of normative emotional stimuli for experimental investigations of emotion and arousal. The goal has been to develop a large set of standardized, emotionally-evocative, internationally-accessible, color photographs that includes content across a wide range of semantic categories. The IAPS and ANEW are distributed by the NIMH Center for Emotion and Attention (CSEA) at the University of Florida. The Affective Norms for English Words (ANEW) provide a set of normative emotional ratings for a large number of words in the English language. This set of verbal materials has been rated in terms of pleasure, arousal, and dominance to complement the existing International Affective Picture System (IAPS, Lang, Bradley, & Cuthbert, 1999). Stimuli from the IAPS and ANEW were selected according to normed ratings for each valence, where a rating of 1 is highly negative, a rating of 5 is neutral, and a rating of 9 is highly positive.

A total of 30 neutral pictures from the IAPS were used in the mood induction (see Table 1 for means, standard deviations, and ranges for valence and arousal ratings). Criteria used to select IAPS pictures were valence and arousal ratings that were as neutral as possible. Pictures were selected accordingly using the 1-9 valence and arousal rating scale.

A total of 192 ANEW words were used in the centrally presented valence word condition (64 positive, 64 negative, 64 neutral) (see Table 2 for means, standard deviations, and ranges for valence and arousal ratings). Criteria used to select ANEW words were valence ratings that were highly negative, highly positive, or neutral. Arousal level for positive, negative, and neutral ANEW words was chosen to be as neutral as possible. Those words that had high valence ratings with high (or low) arousal ratings were not selected. Words were selected accordingly using the 1-9 valence and arousal rating scale.

Stimuli selection for the laterally presented semantic decision words were nouns chosen from the Handbook of Semantic Word Norms (Toglia & Battig, 1978). A total of 192 words were used in the lateralized semantic decision task (96 naturally-occurring items, 96 man-made items) (see Table 3 for means, standard deviations, and ranges for word length and frequency). Items were chosen from the Toglia & Battig (1978) Handbook of Semantic Word Norms according to whether they had high imageability and concreteness ratings. The researcher then selected and grouped them into the categories of naturally occurring or man-made. Word length for lateralized words was restricted to a minimun of 3 letters and a maximum of 6 letters. Word frequency ratings for each lateralized word were taken from the on-line MRC Psycholinguistic Database (MRC, 1987).

Each centrally presented valence word was paired with a lateralized semantic item. Pairings were determined by the experimenter so as to have no semantic relationship (to be unrelated). The current experiment was not intended to be a priming experiment, therefore, having no relationship between the central valence word and the laterlaized semantic word was important. A total of 20 participants completed a paper-and-pencil version of the norming to verify pair relatedness. Each participant saw the same word pairing but the order in which the word pairs were presented was randomized for each participant. The following instructions were included on the top of the rating sheet: Please rate the extent to which you think the following word pairs are related. Using the following 1-5 rating scale, where a rating of 1 = strongly unrelated and a rating of 5 = strongly related. Circle the number rating for each word pair. A total of 576 unrelated item pairs were normed. A total of 100 semantically-related filler trials were also normed. Filler trials were positive, negative, and neutral words paired with naturally-occurring or manmade words. Filler trials were semantically related and were included so participants could distribute their relatedness ratings along the 1-5 rating scale. The mean ratings were then calculated for each word pair. For the unrelated word pairs, those that received a mean rating above a 2.5 were re-paired and renormed. Mean relatedness for final word pairs was 1.0.

The 576 unrelated item pairs were then divded into three experimental lists, each consisting of 192 word pairs. Each experimental list consisted of the same central valence word but the lateralized semantic decision word was not repeated across lists. Each experimental list contained two versions (i.e. List 1A and List 1B), in order to counterbalance items across visual fields.

Apparatus

All stimuli were presented to participants using Psyscope 1.2.5 PPC (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants placed their heads in a headrest 60 cm away from the computer screen in order to stabilize distance from the screen. A Macintosh G4 computer with 17-inch monitor and standard keyboard was used. A button-box was used to record participant semantic decision judgment responses. A microphone was used to record latency of participant vocal valence judgment responses and number of consonant judgment responses.

Procedures

Participants were tested individually over 2 days. The first experimental session lasted approximately 1 hour. Once in the lab, participants immediately filled out the informed consent, language history, handedness, and Beck Depression Inventory forms in order to assess whether participants would qualify for the study. Following these forms, partcipants were administered a standard eye chart exam, in order to test for visual acuity.

Participants were then taken to an individual experimental testing room and were seated in front of a computer monitor. The experimenter then explained that for the first part of the experiment, they were going to sit through a 5-minute slide show of neutral pictures. Participants were instructed that it was important to pay attention to the entire slideshow and that they would receive a recognition test at the end of the experiment. A recognition test was not actually administered to participants but this was done in order to ensure that participants would pay attention to the entire slideshow. After giving the instructions, the experimenter then left the room and the slideshow began. Participants were watched through a one-way mirror during this time in order to make sure participants were watching the picture slideshow. The pictures presented within each block (15 pictures per experimental block, 1 experimental block per day) were independently randomized for each participant. Each picture was shown for 600 ms, followed by a blank screen for 600 ms. The purpose of the blank picture was to allow participants time to process the picture they just viewed and to limit the number of pictures presented.

Following this induction period, the experimenter went into the instructions for the divided visual field (DVF) portion of experiment. Before beginning the experiment, participants completed three practice blocks. The first practice block consisted of 20 laterally presented words. This was done to allow for participants to get acquainted with the lateral semantic decision task. The following two practice blocks consisted of 10 word pairings, a centrally presented valence word followed by a laterally presented semantic decision word. These three practice blocks were followed by the actual DVF experimental trials. The final experimental stimuli consisted of 192 central words and 192 lateral words, for a total of 384 trials. Experimental trials were divided into four blocks: each block had 48 word pairings, consisting of a central valence word trial followed by a lateral semantic decision trial.

Central and lateralized words were shown in black uppercase letters in Helvetica font on a white background. Each trial began with a central red fixation cross for 500 ms. Next, a valence word was centrally presented for 2500 ms, slightly above the central fixation cross. Each central word was followed by a 500 ms flickering central cross sequence. This flickering cross sequence first appeared as a black cross for 150 ms, followed by a red cross for 50 ms, then a black cross for 300 ms which prepared them for the following lateralized target word, presented to either the right or left visual field. The central fixation point was flashed in order to get participants to focus on the center of the screen so that the subsequent word pairs would stimulate the intended visual field. Participants were instructed to focus their eye gaze on the central cross. Next, a semantic decision target word was presented for 150 ms, with an eccentricity of 1.96 ° from the innermost edge of the stimulus to the center of the fixation cross. The horizontal visual angle was 2.57° and the vertical visual angle was 0.50°. Following the lateralized presentation, a central fixation cross and flickering cross sequence appeared for 500 ms, in which participants made a natural or man-made semantic button press response. Using their right hand, participants were instructed to press the 'natural' (green) key or the 'manmade' (yellow) key to register their semantic decision responses. The response mapping was counterbalanced across participants. Following this response, another central fixation cross and flickering cross sequence appeared for 500 ms. This cross and flicker sequence was followed by a message, 'Respond,' which prompted participants to make a valence or consonant response to the preceding central word. Participants made a valence response one session and a consonant response the other session, the order of which was counterbalanced across participants. Participants were allowed 4000 ms to respond. The next trial began 2000 ms after a response was made, or the timeout interval had elapsed. The experimenter listened on headphones to the participant's vocal response and typed in the vocal response. Participants were given rest breaks between each of the four experimental blocks.

The second experimental session lasted approximately 45 minutes. All experimental procedures were the same except participants did not have to fill out qualification paperwork prior to the mood induction phase. Once in the lab, participants in their second session went immediately into the testing room to begin the 5-minute neutral mood induction. Once participants completed the experimental testing session, they were given a debriefing form to read. The experimenter then answered any questions the participant may have had regarding the experiment.

Central task order was counterbalanced across participants, such that half the participants completed the valence judgment during the first session and the consonant judgment the second session, while the other participants completed the consonant judgment for the first session and the valence judgment the second session.

Results

Accuracy of Central Word Responses

The first set of analyses examined accuracy of participants' vocal response to the central word. Vocal responses consisted of positive, negative, or neutral in the valence judgment condition. Vocal responses consisted of 2, 3, or 4 in the consonant judgment condition. Reaction time to the central word was not analyzed because these responses were delayed until after the semantic decision response. Analysis of the central word task was not testing a specific experimental prediction, but was performed to examine possible differences between the valence and consonant judgment conditions. Visual field was also included in the central word task analysis to test whether the lateralized semantic decision judgment affected the later vocal response to the central word. Analyses first examined accuracy of the central word response separately for the valence and consonant judgment.

For the valence judgment condition, a 3 (positive, negative, neutral valence of the central word) x 2 (RVF, LVF) repeated measures ANOVA was performed. A main effect of valence was found $F(1, 41) = 38.19$, $p = .0001$. Post-hoc pair wise Tukey contrasts indicated that participants were less accurate at making a valence judgment when the central word was positive (81.9%) compared to neutral (92.7%), $p < .0001$ or negative (94.9%), $p < .0001$. Negative valence was not significantly different from neutral valence. No other main effects or interactions were significant. This suggests that participants did not consider some of the positive words to be positive. An item analysis on the central valence word was performed. Five positive items [car, bed, dog, star, beach] had the lowest accuracy (mean percent correct: 11.9%, 16.7%, 33.3%, 42.9%, 50.0%, respectively). These five items were then dropped and a 3 (positive, negative, neutral valence of the central word) x 2 (RVF, LVF) repeated measures ANOVA was performed. A main effect of valence was found $F(1, 41) = 16.21$, $p = .0001$. Participants were again found to be less accurate at making a valence judgment when the central word was positive (86.4%) compared to neutral (92.9%), $p < .0001$ or negative (95.1%), $p < .0001$. No other main effects or interactions were significant. The item-analysis indicates that the main effect of valence was due to a general property of the positive words and not a few anomalous words. When the five positive items with lowest accuracy were dropped, a general effect for all positive items was still found.

For the consonant judgment condition, a 3 (2, 3, 4 consonant of the central word) x 2 (RVF, LVF) repeated measures ANOVA was performed. No main effects or interactions were significant. An item analysis on the central valence word was also performed. Only one item [loyal, mean accuracy 57.1%] was found to have low accuracy. These results show that accuracy did not vary across variations in the number of consonants in the central word.

A task comparison between the valence and consonant judgment conditions was performed next. The central words in the consonant task were re-examined using the valence of word instead of the number of consonants. This was done in order to determine whether merely seeing a valence word, regardless of task, would affect accuracy of vocal responses, or whether the effect of seeing a valence word would differ across tasks. A 3 (positive, negative, neutral central word) x 2 (RVF, LVF) x 2 (valence, consonant task) repeated measures ANOVA was performed. A main effect of valence was found $F(1, 41) = 32.84$, $p = .0001$. Participants were less accurate when the central word was positive (86.0%), compared to neutral (92.1%) or negative (92.9%), regardless of making a valence or consonant judgment. Post-hoc pair wise Tukey contrasts found positive valence trials were significantly less accurate than both negative and neutral valence trials, $p < .0001$. Negative and neutral valence did not differ. No other main effects or interactions were significant. Gender differences were also examined for accuracy of the central word. No main effects or interactions were significant.

To summarize, results demonstrated that making a valence or consonant judgment does not differently affect accuracy of central word responses. Rather the valence of the central word itself, and not the vocal judgment made to the central word is what determines accuracy for central words. In both judgment conditions, accuracy was lowest for positive central words. In addition, although the central word response was made after the lateralized semantic decision judgment, the visual field for semantic decision items had no effect on accuracy of the central word response.

Accuracy and Reaction Time for Semantic Decision

The next set of analyses examined experimental predictions for accuracy and reaction time for semantic decision responses (natural vs. man-made) separately for each central task. Means and standard deviations for accuracy and reaction time can be found in Tables 4 (Valence Judgment Condition) & 5 (Consonant Judgment Condition).

1. Valence Judgment Task

A 3 (positive, negative, neutral central word) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) repeated measures ANOVA for accuracy of semantic decision responses was performed (see Table 4). A main effect of semantic decision judgment was found to be significant $F(1, 41) = 10.05$, $p = .0028$. Participants were most accurate at making semantic decisions when the lateralized word was a man-made (91.1%) item relative to a natural (85.3%) item. No other main effects were found to be significant. An interaction between the valence of the central word and the semantic decision judgment was found to be significant $F(1, 41) = 3.95$, $p = .0229$. For man-made items, there was no effect of valence, $p > .05$. Analysis for natural items found a main effect of valence, $F(1, 41) = 3.94$, $p = .0231$. Participants were less accurate at making semantic decision judgments for natural items when the natural items were preceded by a negative central word (87.4%) compared to positive (88.4%) or neutral words (88.8%). However, post-hoc Tukey tests for natural items showed none of the valence conditions to be significantly different from each other. No other interactions were significant. Contrary to experimental predictions, no effect of valence on visual field was observed. These results indicate that for the semantic decision judgment, participants were less accurate at making judgments of natural items compared to man-made items. Further, the results demonstrate that valence only had an impact on judgments of natural items, which may be due to a ceiling effect in the man-made items (see Table 4).

A similar repeated measures ANOVA for semantic decision was performed. A main effect of visual field was found to be significant $F(1, 41) = 5.52$, $p = .0236$. Participants were faster in the RVF/LH (1185 ms) than in the LVF/RH (1217 ms). No other main effects or interactions were significant. Hence, the valence judgment for the central word had no effect on the laterality effect for semantic decision latencies.

2. Consonant Judgment Task

A 3 (2, 3, 4 central word) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) repeated measures ANOVA for accuracy of semantic decision responses was performed. A main effect of semantic decision judgment was found to be significant $F(1, 41) = 5.92$, $p = .0193$. Participants were most accurate at making semantic decision judgments when the lateralized word was a man-made (90.3%) item relative to a natural item (86.0%). No other main effects or interactions were significant.

A similar repeated measures ANOVA for reaction time of semantic decision responses was performed. No main effects or interactions were significant.

3. Accuracy and Reaction Time for Semantic Decision within Valence and Consonant Judgment Combined

Analyses next examined the semantic decision judgment (natural vs. man-made) for accuracy and reaction time considering the valence of the central word, for each judgment task. A 3 (positive, negative, neutral central word) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) x 2 (valence, consonant judgment task) repeated measures ANOVA was performed for accuracy. A main effect of visual field was found to be significant $F(1, 41) = 4.79$, $p = .0345$. Participants were less accurate for semantic decision judgments when those words were presented to the LVF/RH (87.2%) as compared to the RVF/LH (89.3%). A main effect of semantic decision judgment was found to be significant $F(1, 41) = 10.76$, $p = .0021$. Participants were less accurate at making judgments when the lateralized word was a natural (85.7%) item relative to a man-made (90.0%) item. A main effect of valence was found to be significant $F(1, 41) = 3.84$, $p = .0255$. Participants were less accurate at the semantic decision task when the lateralized word was preceded by a negative word (87.4%) compared to either positive (88.6%) or neutral (88.8%), but conservative post-hoc tests showed none of the valence conditions to be significantly different from each other. An interaction between the valence of the central word and the semantic decision judgment was found to be significant $F(1, 41) = 5.26$, $p = .0071$ (see Table 6). An analysis examining the valence of the central word separating man-made and natural items was performed. For man-made items, no valence effects were obtained. Analysis for natural items found a main effect of valence, F (1, 41) = 7.79, p = .0008. Participants were less accurate at making semantic decision judgments for natural items when preceded by a negative (83.6%) central word, p = 0.0139 compared to a positive (86.5%), p = 0.1682 or neutral (86.79%), p = 0.1683 word. In addition, post-hoc pair wise Tukey contrasts indicated that when the central word was negative, participants were less accurate at making semantic decision judgments for natural (83.1%) than for man-made (91.2%) items, p = .0139. Natural items were not significantly different from man-made items when preceded by either positive or neutral central words. An interaction with task was not found, indicating the valence effect is not due to a cognitive decision about the valence of the central word.

A similar analysis was performed for reaction time. A main effect of visual field was found to be significant F (1, 41) = 4.75, p = .0351. Participants were faster for semantic decision responses when those words were presented to the RVF/LH (1172 ms) compared to the LVF/RH (1199 ms). No other main effects or interactions were significant.

Finally, we examined gender differences for the semantic decision judgment (natural vs. man-made) for accuracy and reaction time collapsed across the valence and consonant tasks. For accuracy, a main effect of sex was found to be significant F (1, 41) = 9.06, p = .0044. Male (91.2%) participants were more accurate at the semantic decision task than female (85.2%) participants. No other main effects or interactions were significant. For reaction time, no main effects or interactions were significant.

Discussion

The current preliminary experiment was necessary as a control in order to make sure that accuracy of vocal judgments to the central word in the valence & consonant judgment conditions did not differ. In the subsequent 3-session experiment, participants in the emotion experience condition will make a vocal consonant judgment, while participants in the emotion perception condition will make a vocal valence judgment. Results from this preliminary experiment demonstrate that accuracy for the central word response did not differ between the valence and consonant judgments. When judging the number of consonants, accuracy did not significantly differ between judgments of 2, 3, or 4 consonants. Accuracy of vocal responses to the central word was lowest when the central word was positive, regardless of whether the judgment was to identify the valence or count the number of consonants. The item valence results may be due to participants not perceiving some of the positive words as positive but rather perceiving them as more similar to neutral when making valence decisions. However, this explanation can only be applied to the valence judgment condition. It may be necessary to examine whether participants perceived the valence of the central word in the consonant judgment condition. This could be tested by asking participants to report for one-third of the trials the valence of the central word, following report of the number of consonants in the central word. Another possibility is that there may be something about the positive valence words that makes them harder to process. When selecting the experimental stimuli, positive, negative, and neutral valence words were equated for mean ratings of valence, arousal, word length, frequency, imageability, concreteness, number of consonants and vowels. However, there could still be some unidentified difference between the valence words that makes positive words harder to read or report, such as part of speech, age of acquisition, or syllable structure.

Since results from this preliminary experiment found no differences in accuracy for the central word task between the valence and consonant conditions, results from the 3-session experiment may be attributed to other factors (like mood induction) rather than to differences between the two vocal tasks.

This preliminary experiment was further interested in contrasting the decision of the emotion word (in the valence judgment condition) with merely seeing the emotion word but not making a valence judgment about it (in the consonant judgment condition) in order to see whether presentation of a valence word without the cognitive judgment of valence would have an effect on semantic decision laterality. For both the valence and consonant judgment tasks, participants were faster in the RVF/LH compared to the LVF/RH for the semantic decision task. Results also demonstrated that for both the valence and consonant judgment tasks, accuracy was lower for semantic decision judgments of natural items when preceded by a negative valence word. Valence of the central word did not affect accuracy of the semantic decision judgments of man-made items. Therefore, these results demonstrate that judging the valence of a word (valence judgment) and merely seeing a valence word (consonant judgment) has similar effects on the semantic decision judgment. However, this effect was only found for natural items when preceded by negative words. Thus, the comprehension of naturally occurring items is particularly influenced by prior negative valence words. According to Davidson, Ekman, Saron, Senulis, & Friesen (1990), negative affect persists longer than positive or neutral affect. Therefore, the effect of the negative central word likely persisted and may have interfered with the semantic decision task. But for the positive and neutral words, the effect might have dissipated by the time of the semantic decision judgment. I will defer further discussion of this finding pending the results of Experiment 2.

The current experiment found that participants had more difficulty judging natural items than man-made items. Prior research on such category specificity with patients who have a brain injury examined the possibility of different associations among natural and man-made items. This prior research has shown that people with brain injury usually have more difficulty judging natural items compared to man-made items (Devlin et al. 2002). The current experiment found that non-brain injured people have increased difficulty with judging natural as compared to man-made items. Thus, the fact that both brain-injured and non-brain injured populations demonstrated an increased impairment with natural items indicates that natural items are inherently more difficult than man-made items. One of the major ideas proposed is that the distinction is not between living and non-living things but rather is a sensory-functional distinction (Farah & McClelland, 1991). Selective deficits in the knowledge of living and non-living things may reflect a differential weighting of information from different sensorimotor channels with living things being distinguished more by their sensory attributes and non-living things more by their functional attributes (Farah & McClelland, 1991). Category specific effects tend to arise when the demands on the semantic system are increased (Devlin, Russell, Davis, Price, Moss, Fadili, & Tyler, 2002). It may be that processing the valence stimuli coupled with the natural and man-made words in the current experiments (a dual task situation) resulted in increased demands on the semantic system. Additionally, man-made items have fewer shared properties but tend to have strong form-function correlations that make them relatively robust (Devlin et al. 2002), which may explain why the natural items were more susceptible to valence effects.

For both valence and consonant judgment tasks, accuracy for the semantic decision task was higher in the RVF/LH as compared to the LVF/RH. According to Van Strien & Heijt (1995), the LH enhances positive emotion, while at the same time inhibiting negative emotion. The RH, on the other hand, enhances negative emotion, particularly those related to defensive avoidance and threat. Yet, the current experiment did not find the LH and RH to be differentially affected on the semantic decision judgment by valence of the central word. The fact that the LH was found to have an unvarying advantage for the semantic decision task may in fact be due to the nature of the task itself. Prior experiments like Van Strien & Heijt (1995) and Alfano & Cimino (2008), used more simple tasks to test laterality. They used presentation of 3-letter trigrams in which participants are required to decide whether one of the 3-letters presented matched the other two. In both the Van Strien & Heijt (1995) and Alfano & Cimino (2008) experiments, a valence word (positive, negative, neutral) was presented centrally prior to the trigram task. Participants first reported aloud to the experimenter their response to the trigram task followed by a report of the central word. The experimenter recorded the accuracy of participant responses to both of these tasks. Reaction times were not measured. Findings from these two experiments demonstrated that accuracy was higher for the trigram task when first preceded by a positive or negative central word compared to a neutral word. Valence by visual field differences were found such that accuracy was greater in the RVF/LH when first presented with a positive or neutral valence word, while accuracy was greater in the LVF/RH when first presented with a negative valence word.

Both the semantic decision and the vocal judgment tasks used in the current experiment were different than those tasks used by Van Strien & Heijt (1995) and Alfano & Cimino (2008). The current experiment differed from these prior studies in four ways. Firstly, the current experiment lateralized presentation of an entire word instead of three individual letters. Second, the current experiment required a semantic decision judgment of the lateralized word rather than a vowel discrimination task. Thirdly, the vocal response in the Van Strien & Heijt (1995) and Alfano & Cimino (2008) experiments required participants to report the word presented, whereas the current experiments required either a judgment of valence or number of consonants of the presented word. Lastly, only accuracy was measured in these prior experiments, while both accuracy and reaction time were assessed in the current experiments. The finding of a valence by visual field interaction in these prior studies may be attributable to the valence judgment being coupled with trigram task presentation. For the trigram task, one can quickly decide which letter is different from the others. Yet the semantic decision task is not as simple and requires reading and categorization of the word. Therefore, by the time a categorization is made, the effect of the valence of prior word presented may have dissipated. However, measures of reaction time for the trigram task would allow a direct comparison of processing time between the trigram and semantic decision tasks. Since reaction time measures are unavailable for these prior trigram studies, attributing differing results due to a processing time difference between the trigram and semantic decision tasks is speculative at this point.

Predictions for this preliminary experiment were that the cognitive decision of a valence judgment would affect laterality of a semantic decision judgment. This cognitive decision was predicted to be important for obtaining the RH advantage for both positive and negative valence. Specifically, a RH advantage for semantic decision was predicted, as evidenced by greater accuracy and faster reaction times, when lateralized targets were preceded by valence decisions about either positive or negative words. A LH advantage was predicted when targets were preceded by neutral words. These predictions were specific to the valence judgment condition. The consonant judgment itself (i.e. 2, 3, or 4) was not expected to affect laterality. Results from this experiment do not support experimental predictions of a RH advantage for positive and negative valence. Overall, only RVF/LH advantages were obtained. Further, a RH advantage for emotion perception as defined by the cognitive judgment of valence was not found within the current experimental paradigm. Experiment 2 will determine whether these findings are replicated or whether a RH advantage for emotion perception will be demonstrated.

Experiment 2

Experiment 2 investigated hemispheric laterality shifts on the semantic decision task via emotion perception and emotion experience. In Experiment 1, the consonant and valence judgment tasks were compared using only a neutral mood induction. For

Experiment 2, the consonant judgment task was examined using positive and negative mood induction, while the valence judgment task (emotion perception) was implemented in just the neutral mood induction. The same semantic judgment (natural or man-made) used in Experiment 1 was also used as a measure of hemispheric laterality.

Method

Participants

A total of 50 undergraduate college students (26 males and 24 females who did not participate in the control study) between the ages of 18 and 35 participated in the experience versus perception study. Assessment for language history, Beck Depression Inventory, handedness, and vision was the same as in Experiment 1. A total of 16 potential participants with a BDI score of 10-63 (mild-severe depression) were excluded from the study and replaced. Mean handedness score for participants was +0.92. Participants were given course credit for their participation or compensated $30.

Stimulus Materials

The same ANEW and IAPS stimuli from Experiment 1 were used in Experiment 2. Positive and negative pictures in addition to the neutral pictures from Experiment 1, were used in Experiment 2. A total of 90 pictures from the IAPS were used in the mood induction (30 positive, 30 negative, 30 neutral) (see Table 1 for means, standard deviations, and ranges for valence and arousal ratings). The same 3 experimental lists from Experiment 1 were used in Experiment 2.

The Positive and Negative Affect Schedule (PANAS) (Waston, Clark, & Tellegen, 1988) was administered after the end of each experimental mood induction procedure in order to verify that the intended mood (positive and negative) was induced. The PANAS was also administered at the end of the neutral mood induction in order to document participants' naturally occurring mood state. The PANAS is a 20-item inventory (10-items measuring positive affect and 10-items measuring negative affect). The current experiment used 'The Moment' time instructions when administering the PANAS (e.g. 'you feel this way right now, that is at the present moment'). The PANAS was scored according to a 1-5 scale (1 = not at all; 3 = moderate; 5 = extremely). There were separate measures for positive and negative affect, where a total score of 10 indicates no affect, a score of 20 = little or no affect, 30 = moderate affect, 40 = high affect, and 50 = extreme affect. A total PANAS score of 35 and above was used as the criteria for verification of mood induction.

Apparatus

Same as in Experiment 1.

Procedures

Participants were tested individually over 3 days. The first experimental session lasted approximately 1 hour and 10 minutes. Once in the lab, participants immediately filled out the informed consent, language history, handedness, and Beck Depression Inventory forms in order to assess whether participants would qualify for the study. Following these forms, partcipants were administered a standard eye chart exam, in order to test for visual acuity.

Participants were then taken to an individual experimental testing room and were seated in front of a computer monitor. The experimenter then explained that for the first part of the experiment, they were going to sit through a 10-minute slide show of pictures (positive, negative, or neutral depending on the counterbalancing). The order of the positive, negative, and neutral sessions was counterbalanced across participants with 6 possible orders. Participants were instructed that it was important to pay attention to the entire slideshow and that they would receive a recognition test at the end of the experiment. A recognition test was not actually administered to participants but this was told to participants in order to ensure they would pay attention to the entire slideshow. After giving the instructions, the experimenter then left the room and the slideshow began. Participants were watched through a one-way mirror during this time in order to make sure participants were watching the picture slideshow. The pictures presented within each block (30 pictures per experimental block, 1 experimental block per day) were independently randomized for each participant. Each picture was shown for 600 ms, followed by a blank screen for 600 ms. The purpose of the blank picture was to allow participants time to process the picture they just viewed and to limit the number of pictures presented.

Following this induction period, the experimenter returned to the experiment room to administer the PANAS. Participants were instructed to rate the different feelings and emotions using the 1-5 scale according to how they were feeling right now in the present moment. The experimenter then left the room to allow participants time to complete the PANAS and to set up for the next part of the experiment. Once the PANAS was completed, the experimenter gave the instructions for the divided visual field (DVF) portion of experiment. Before beginning the experiment, participants completed three practice blocks. The first practice block consisted of 20 laterally presented words. This was done to allow participants to get acquainted with the lateral semantic decision task. The following two practice blocks consisted of 10 word pairings, a centrally presented valence word followed by a laterally presented semantic decision word. These three practice blocks were followed by the actual DVF experimental trials. The final experimental stimuli consisted of 192 central words and 192 lateral words, for a total of 384 trials. Experimental trials were divided into four blocks: each block had 48 word pairings, consisting of a central valence word trial followed by a lateral semantic decision trial. The rest of the experimental procedures were the same as in Experiment 1. However, at the end of each experimental testing session, participants were shown a brief 1-minute humorous video. The purpose of this video was so that participants would leave the lab feeling positive and not focused on the pictures presented during the mood induction phase.

The second and third experimental session lasted approximately 55 minutes. All experimental procedures were the same except participants did not have to fill out qualification paperwork prior to the mood induction phase. Once in the lab, participants in their second and third session went immediately into the testing room to begin the 10-minute mood induction. Once participants completed their final experimental testing session they were given a debriefing form to read. The experimenter then answered any questions the participant may have had regarding the experiment.

Each participant received one mood condition per day. Participants in the neutral mood condition made a vocal valence response to the central word. Participants in the positive or negative mood condition made a vocal consonant response to the central word.

Results

Accuracy of Central Word Responses

The first set of analyses followed the same statistical procedure as Experiment 1. All of the analyses reported for Experiment 2 were also conducted for N = 48 participants (24 males, 24 females for complete counterbalancing). All of the statistical results were the same, therefore the results reported below used the entire sample.

1. Valence Judgment Task (Neutral Mood Induction)

A 3 (positive, negative, neutral valence of the central word) x 2 (RVF, LVF) repeated measures ANOVA was performed. A main effect of valence was found $F(2, 48) = 34.02$, $p = .0001$. Post-hoc pair wise Tukey contrasts indicated that participants were less accurate at making a valence judgment when the central word was positive (83.2%) compared to neutral (92.8%), $p < .0001$ or negative (95.3%), $p < .0001$; which was also observed in Experiment 1. Negative valence was not significantly different from neutral valence. A main effect of semantic decision visual field was not found to be significant.

An interaction between the valence of the central word and visual field was found to be significant $F(2, 48) = 4.35$, $p = .0155$ (see Table 7). An analysis examining visual field separating valence of the central word was performed. For negative and neutral valence, a main effect of visual field was not found to be significant, which may be due to a ceiling effect. For positive valence, there was a main effect of visual field, $F(1, 49) = 3.84$, $p = .0557$. Participants were less accurate in the LVF/RH (82.2%) compared to the

RVF/LH (84.7%). This valence by visual field interaction was due to the influence of the intervening visual field task on the central word vocal response and not due to an effect of the central word on visual field performance.

2. Consonant Judgment Task (Positive and Negative Mood Induction)

A 3 (2, 3, 4 consonant of the central word) x 2 (positive, negative mood induction) x 2 (RVF, LVF) repeated measures ANOVA was performed. A main effect of consonant was found $F(2, 48) = 8.84$, $p = .0003$. Post-hoc pair wise Tukey contrasts indicated that participants were less accurate at making a consonant judgment when the central word was had three consonants (90.9%) compared to four (92.3%), $p < .0005$ or two (93.1%), $p < .0005$. No other main effects or interactions were significant. Analyses found no effect of mood on the central consonant task.

<u>Positive and Negative Affect Schedule (PANAS) Analysis</u>

A one-way ANOVA was performed on the within subjects variable of mood and the dependent variable of the PANAS. This analysis was performed to verify that the mood induction procedure via the IAPS did induce positive or negative mood and that no mood was induced for the neutral induction phase. Separate one-way ANOVA's were performed on the total PANAS score, positive PANAS score, and negative PANAS score. Based on published norms, a total score of 35 indicates that positive or negative mood was induced (Waston, Clark, & Tellegen, 1988), while scores below 35 would indicate that no mood was induced. A main effect of mood was found $F(2, 48) = 23.18$, $p = .0001$ for analysis on the total PANAS score. Neutral mood induction (29.8%) was significantly different from both negative (36.0%), $p < .0001$ and positive (37.7%),

$p < .0001$ mood. These results indicate that the IAPS was effective at inducing positive and negative mood in the positive and negative mood conditions, respectively. These findings also demonstrate that mood was not induced in the neutral mood condition, as intended. The PANAS consists of 10 items that endorse negative mood and 10 items that endorse positive mood. For analysis on the positive PANAS score, a main effect of mood was found $F(2, 48) = 38.72$, $p = .0001$. Positive (26.6%) mood was significantly different from both neutral (18.6%) and negative (18.7%), indicating that a positive mood was induced. For analysis on the negative PANAS score, a main effect of mood was found $F(2, 48) = 42.39$, $p = .0001$. Negative (17.3%) mood was significantly different from both neutral (11.2%) and positive (11.1%), indicating that a negative mood was induced.

<u>Accuracy and Reaction Time for Semantic Decision</u>

The next set of analyses examined experimental predictions for accuracy and reaction time for semantic decision responses (natural vs. man-made) separately for each central task and mood condition. Means and standard deviations for accuracy and reaction time can be found in Table 8 (Valence Judgment Condition).

1. Valence Judgment Task (Neutral Mood Induction)

A 3 (positive, negative, neutral central word) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) repeated measures ANOVA for accuracy of semantic decision responses was performed. A main effect of semantic decision judgment was found to be significant $F(1, 49) = 21.63$, $p = .0001$. Participants were most accurate at making semantic decisions when the lateralized word was a man-made (91.1%) item relative to a natural (83.8%) item. No other main effects or interactions were found to be significant. Contrary to experimental predictions, there was no effect of the valence judgment on semantic decision visual field.

A similar repeated measures ANOVA for reaction time of semantic decision responses was performed. No main effects were found to be significant. However, an interaction between valence judgment for the central word and the semantic decision judgment was found to be significant $F(2, 48) = 3.47$, $p = .0351$. An analysis examining the valence judgment for the central word separating man-made and natural items was performed. For natural items, there was no effect of valence judgment, $p > .05$. For man-made items, a main effect of valence judgment was observed, $F(2, 48) = 3.33$, $p = .0398$. This finding was opposite to that found in Experiment 1. Participants were slower at making semantic decision judgments for man-made items when the man-made items were preceded by a neutral central word compared to positive or negative words (refer to Table 9). However, post-hoc pair wise Tukey contrasts for man-made items showed none of the valence judgment conditions to be significantly different from each other. No other main effects or interactions were significant.

2. Consonant Judgment Task (Positive and Negative Mood Induction)

A 2 (positive, negative mood) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) repeated measures ANOVA for accuracy of semantic decision responses was performed. A main effect of semantic decision judgment was found to be significant $F(1, 49) = 32.39$, $p = .0001$. Participants were most accurate at making semantic decision judgments when the lateralized word was a man-made (89.6%) item relative to natural items (83.7%). A main effect of visual field was found to be significant

F (1, 49) = 12.25, p = .0010. Participants were more accurate in the RVF/LH (88.4%) than the LVF/RH (84.9%). No other main effects or interactions were significant. However, there was a trend toward a significant interaction between mood and visual field F (1, 49) = 2.80, p = .1008. Analysis examining visual field separating positive and negative mood was performed. For the negative mood condition no effect of visual field was found [RVF/LH = 87.4%; LVF/RH = 85.4%], p = 0.20. However, for the positive mood condition a main effect of visual field was found to be significant F (1, 49) = 18.57, p = .0001. Accuracy was greater in the RVF/LH (89.3%) than in the LVF/RH (84.3%). This trend does provide support for experimental predictions that emotion experience shifts laterality from a RH advantage to a differential split dependent upon valence. However, this finding was not significant, suggesting that negative mood may reduce the LH advantage found for positive mood. Analyses examining mood separating left and right visual field was performed. A main effect of mood was not found for either the LVF/RH or the RVF/LH.

A similar repeated measures ANOVA for reaction time of semantic decision responses was performed. A main effect of visual field was found to be significant F (1, 49) = 9.66, p = .0031. Participants were faster in the RVF/LH (1232 ms) than the LVF/RH (1269 ms). No other main effects were found to be significant. A significant interaction between mood and semantic decision was found F (1, 49) = 4.01, p = .0507. An analysis examining semantic decision separating positive and negative mood was performed. For the positive mood condition no effect of semantic decision was found. However, for the negative mood condition a main effect of semantic decision was found to be significant $F(1, 49) = 3.99$, $p = .0513$. Reaction time was faster for natural items (1241 ms) than for man-made items (1262 ms). No other main effects or interactions were found to be significant.

Accuracy and Reaction Time for Semantic Decision (Combining all 3 Mood Conditions)

The next set of analyses examined experimental predictions for accuracy and reaction time for semantic decision responses (natural vs. man-made) combining across central tasks (valence and consonant judgment) in order to examine the effect of central word valence on the semantic decision task.

For accuracy, a 3 (positive, negative, neutral mood) x 3 (positive, negative, neutral central word) x 2 (natural, man-made response to the lateralized word) x 2 (RVF, LVF) repeated measures ANOVA for accuracy of semantic decision responses was performed. A main effect of central word valence was found to be significant $F(2, 48) = 18.98$, $p = .0001$. Post-hoc pair wise Tukey contrasts indicated that participants were less accurate at making a semantic decision following a negative (85.3%) central word compared to neutral (86.8%) or positive (88.2%) central word. Negative valence was significantly different from positive valence, $p < .0001$. Neutral valence was not significantly different from positive or negative valence. These effects were obtained regardless of judging the valence or number of consonants of the central word. A main effect of semantic decision judgment was found to be significant $F(1, 49) = 35.28$, $p = .0001$. Participants were most accurate at making semantic decisions when the lateralized word was a man-made (89.8%) item relative to a natural (83.7%) item. A main effect of visual field was found to be significant $F(1, 49) = 16.56$, $p = .0002$. Participants were more accurate in the RVF/LH (88.3%) than the LVF/RH (85.2%). No other main effects or interactions were found to be significant.

A similar repeated measures ANOVA for reaction time of semantic decision responses was performed. A main effect of valence of the central word was found to be significant $F(2, 48) = 3.81$, $p = .0254$. However, post-hoc pair wise Tukey contrasts showed none of the valence judgment conditions to be significantly different from each other. A main effect of visual field was found to be significant $F(1, 49) = 13.49$, $p = .0006$. Participants were faster in the RVF/LH (1245 ms) than the LVF/RH (1276 ms). An interaction between mood and central word valence was found to be significant $F(4, 46) = 4.02$, $p = .0037$. An analysis separating positive, negative, and neutral mood was performed. For the negative mood condition, a main effect of valence of the central word was found to be significant $F(1, 49) = 3.67$, $p = .0289$. Participants were faster at making semantic decisions when first preceded by a neutral (1240 ms) compared to positive (1253 ms) or negative (1272 ms) central word, regardless of judging the valence or number of consonants of the central word. However, post-hoc pair wise Tukey contrasts showed none of the valence conditions to be significantly different from each other. For the positive mood condition, a main effect of valence of the central word was found to be significant $F(2, 48) = 6.78$, $p = .0017$. Participants were faster at making semantic decisions when first preceded by a neutral (1237 ms) compared to positive (1240 ms) or negative (1282 ms) central word, regardless of judging the valence or number of consonants of the central word. Yet, post-hoc pair wise Tukey contrasts showed none of the valence conditions to be significantly different from each other. For the neutral mood condition, a main effect of valence was not found to be significant. These findings suggest that any type of mood (positive or negative) slows semantic decision responses following negative words. Therefore, a valenced mood makes the negative words harder to process, reducing the speed with which they are responded to.

Discussion

The aim of this 3-session experiment was to further investigate emotion perception and emotion experience in the left and right hemispheres. The current study was the first to combine emotion perception and emotion experience within the same experimental paradigm. Emotion perception was investigated and defined as requiring a cognitive judgment of the valence of the stimulus word presented. Predictions were that under the emotional perception condition (i.e. a neutral mood induction), a RH advantage for semantic decision would be seen, as evidenced by greater accuracy and faster reaction times, when lateralized targets were preceded by either positive or negative words. A LH advantage was expected when targets were preceded by neutral words.

Results from Experiment 2 were similar to Experiment 1 and indicated that, contrary to experimental predictions, the valence judgment did not interact with visual field. Lack of support for experimental predictions may be due to a hemispheric activation effect. Prior studies looking at hemispheric asymmetries in cognition have led to the hypothesis that selective hemispheric activation may facilitate the application of cognitive mechanisms associated with that hemisphere (Ramon, Doron, & Faust, 2007). The current study controlled for arousal level across valence word stimuli. Positive, negative, and neutral words were chosen based on a low to medium level of arousal.

According to the hemispheric activation effect, arousal level must be relatively high for differences in hemispheric asymmetry to become apparent (Ramon et al. 2007). Since arousal level was not high for the current stimuli, the cognitive mechanism of emotion perception via the valence judgment may not have resulted in a differential hemispheric asymmetry.

Results for the emotion perception condition indicated that participants were more accurate at the semantic decision task when the lateralized word was man-made as opposed to natural. This same result was also found in Experiment 1. Natural items may have been more prone to a subjective interpretation as to whether such items were naturally occurring. For example, ‘flower,’ ‘grass,’ and ‘goat’ are all naturally occurring things but may also be cultivated by humans, whereas an item such as ‘purse’ can only be man-made. Prior research on category specificity has shown that people with brain injury are more impaired at making judgments of natural items than man-made items (Devlin et at. 2002). In the current experiment with a non-brain injured population, participants were more impaired with their judgments of natural as opposed to man-made items. Together these findings from both the injured and non-injured populations suggest that natural items are inherently more difficult to process and discriminate in a categorization task. According to Damasio (1990), nonliving items tend to evoke kinesthetic and motoric representations that are not elicited by living things. As such, when faced with a nonliving object, a sense of how the object feels or the actions required to manipulate it is activated. This activation of how an object feels and the manipulation of such an object is less salient for living objects (Damasio, 1990). Therefore, according to this idea, man-made items are easier too recognize because they activate additional forms of representations. Experiment 2 found that accuracy was lower for man-made items when first preceded by a neutral central word. This implies that accuracy is improved for man-made words when preceded by a positive or negative emotion word. This result was different from Experiment 1, which found that accuracy was lower for natural items when first preceded by a negative central word. These differences in results for valence by semantic decision between Experiments 1 and 2 suggest that the results are not replicable.

For the emotional experience condition, predictions were that a positive mood induction would result in a LH advantage for the semantic decision task, while a negative mood induction would result in a RH advantage for this task. Participants were faster and more accurate in the RVF/LH for the semantic decision task, but contrary to experimental predictions, mood induction did not interact with visual field. A non-significant trend was found in the expected direction with a LH advantage only in the positive mood condition. A LVF/RH advantage was not found for the semantic decision task for the negative mood induction condition. Rather, no visual field difference was found here. The negative mood instead eliminated the standard RVF/LH advantage. The fact that the typical LH advantage for words was eliminated provides some limited support for the predicted hypothesis.

Analysis of the PANAS scale demonstrated that positive and negative mood was induced via the IAPS. Since induction of mood was successful, lack of strong support for experimental predictions was probably not due to effectiveness of the mood induction technique. What is likely is that the mood induction did not have a long lasting effect.

Once participants answered questions to the PANAS and began the semantic decision task, the effectiveness of the mood induction may have dissipated. Prior research has shown that mood induction is more effective and long lasting when the mood is induced by means of personal saliency, such as by a personal narrative or story (i.e. an experience that the person has went through) (Atchley, Stringer, Mathias, Ilardi, & Minatrea, 2007). Although the IAPS is an effective method of inducing mood, it is not a personally emotionally salient form of mood induction. Future studies should use the same experimental paradigm using personal narrative as the mood induction technique instead of pictures from the IAPS.

Since the mood induction was successful, lack of support for experimental predictions may also be due what Murphy & Zajonc (1993) refer to as dilution. According to Murphy & Zajonc (1993), when later information presented is congruent with affect in polarity, summation occurs. Yet, when subsequent information is inconsistent with the initial affective reaction, dilution occurs. In the current experiments, the semantic decision words were neutral in valence, which according to Murphy & Zajonc (1993), would be inconsistent with the affect of the previously presented valence word and IAPS picture stimuli. This inconsistency likely resulted in a dilution of the influence of affect, resulting in the RVF/LH superiority at the semantic decision task. In order to test this idea of dilution and summation, the semantic decision words used in the current experiment would need to be replaced with natural and man-made items that are of positive and negative valence.

General Discussion

The current study set out to separately examine emotion perception and emotion experience using the same experimental paradigm. The current experiment aimed to specify emotion perception as requiring a cognitive judgment of valence, which has not previously been proposed. According to Davidson's Valence Hypothesis (1995), the RH has an advantage for the perception of emotion, regardless of valence. Whereas, a differential hemisphere advantage depending upon valence occurs for the experience of emotion, such that a LH advantage occurs for positive valence and a right hemisphere advantage occurs for negative valence. The current experiment proposed that a cognitive judgment of valence was an important component for obtaining the RH advantage for emotion perception.

Previous research has examined perception of emotion as the recognition that a word or sentence is emotional in nature or contains emotional information (i.e. is of positive or negative valence) (Cicero, Borod, Santschi, Erhan, Obler, Agosti, Welkowitz, & Grunwald, 1991). Prior laterality studies have not considered the cognitive judgment of valence of an emotion word as an important component to emotion perception. Therefore, I postulated that the cognitive judgment of valence would be a critical aspect in obtaining a RH advantage for both positive and negative valence words for emotion perception. A LH advantage was expected when targets were preceded by neutral words. Emotion experience was predicted to be the necessary component for obtaining a differential hemisphere advantage for positive and negative valence. Predictions for the emotion experience condition were that a positive and neutral mood induction would result in a

LH advantage for the semantic decision task, while a negative mood induction would result in a RH advantage for the semantic decision task.

Experiment 1 was conducted in order to examine whether the valence and consonant judgment conditions were comparable in accuracy. This examination was performed only with a neutral mood induction. In Experiment 2, only the consonant judgment condition was performed with the positive and negative mood conditions. The valence judgment condition in Experiment 2 was performed with the neutral mood induction.

Experiment 1 found that there were no differences between the valence and consonant judgment conditions using a neutral mood. For both Experiments 1 and 2, results demonstrated that participants were more impaired at processing centrally presented positive words. Results from both experiments found an overall LH advantage for the semantic decision task. However, the valence of the central word did have an effect on accuracy and reaction time of the subsequent semantic decision words. Specifically, natural items were slower to process when first preceded by a negative valence word. However, this finding was only found in Experiment 1. While for Experiment 2, man-made items were processed faster when first preceded by either positive or negative valence.

Although there was no effect of visual field for the negative mood induction condition, Experiment 2 results did show a trend toward a significant interaction between mood and visual field. A LH advantage was found for accuracy of the semantic decision task for the positive mood induction, which supports experimental predictions. However, no VF advantage was found for negative mood induction. Prior research indicates that for a verbal task, a RVF/LH advantage is nearly always found (Beeman & Chiarello, 1998). Therefore, failure to find a LH advantage for the negative mood may indicate either a reduction in LH, or an increase in RH, performance. This does provide support that mood (emotion experience) has an effect on laterality change in the expected direction, in support of experimental predictions and Davidson's theory.

Other aspects of the current findings do not necessarily lend support to Davidson's ideas. Davidson (1995) has suggested that this differential hemispheric asymmetry depending upon valence occurs only for the anterior and not posterior regions of the brain. The current experiment used a divided visual field method, which is unable to differentiate anterior from posterior regions. Therefore, results may be different if using a methodology, such as EEG or fMRI, which would allow for examination of anterior and posterior regions of the hemispheres.

What we do know from current experimental findings is that judging the valence of the central word did not result in a RH advantage as predicted for the emotion perception condition. Nor did we observe a significant mood by visual field interaction for negative mood in the RH, as predicted. These findings do not necessarily indicate that the distinction between emotion perception and experience should be tossed out, but rather should be further delved into. Other factors besides valence may be contributing to the differential hemisphere shift for emotion experience and a RH advantage for emotion perception. One such factor is arousal level. The current studies utilized standardized stimuli from the ANEW and IAPS in order to separate valence and arousal. Many prior lateralization studies have confounded valence and arousal within their experimental stimuli. For example, Alfano & Cimino (2008) selected their own stimuli, in which they did not control for arousal or intensity, which were likely confounded with ratings of valence. Results from their study did demonstrate valence by visual field effects. Alfano and Cimino demonstrated a LH advantage for the lateralized trigram task when the task was first preceded by positive and neutral words. A RH advantage was found for the trigram task when first preceded by negative words. When separating valence and arousal via stimuli controlled for arousal, results from the current experiments found no valence by visual field effects. This implies that Alfano & Cimino's results are not due to valence, as they claim, but are likely due to some other effect of the stimuli, like arousal or likely a combination of valence and arousal. Though arousal may likely be a contributing factor, according to Strauss and Allen (2008), studies utilizing non-standardized word lists may be affected by variance in emotional intensity, valence, and categorization associated with the individual words, making results difficult to compare.

Negative stimuli tend to have higher valence and arousal ratings than positive stimuli (Bradley & Lang, 1999). Valence and arousal ratings tend to follow a similar pattern, such that as arousal ratings go up, so do valence ratings. In the current studies, IAPS and ANEW stimuli were chosen based upon high positive and negative valence consisting of a relatively neutral level of arousal. Neutral stimuli were chosen based on neutral valence and arousal ratings. In controlling for arousal level, valence ratings for positive and negative stimuli were higher than average but not at their highest. Strauss and Allen (2008) suggest that a mixture of high and medium arousal stimuli is most effective for obtaining hemispheric differences by valence. The current study controlled for arousal level in order to have a non-confounded measure of valence. However, given findings from the current two experiments, arousal level may be an important variable when examining valence. Without strong arousal, it may be difficult to obtain differential hemisphere effects by valence. For example, Holtgraves and Felton (2010) found that participants were faster at recognizing high and low arousal positive words when presented to the RVF/LH during a lexical decision task. A LVF/RH advantage was found only for highly arousing negative words, but not for low arousing negative words. Results from the Holtgraves and Felton experiment indicate that hemispheric asymmetries for positive and negative words were more pronounced for high-arousal emotion words than for low arousal emotion words. Therefore, a lack of support for experimental predictions in the current studies may be due to using word and picture stimuli that were not highly arousing. Future studies will need to implement both high and low arousal positive and negative stimuli to examine hemisphere asymmetries for both emotion perception and experience. For without the arousal component, the current experiment found the typical LH advantage for linguistic stimuli in most conditions.

Another explanation as to why experimental predictions were not strongly supported may the affective primacy hypothesis (Murphy & Zajonc, 1993). According to this hypothesis, affect is processed early in the information processing chain, such that information consistent with affect may be sustained, while information not consistent with affect is diluted (Murphy & Zajonc, 1993). Stimuli used in the semantic decision task in the current two experiments were neutral in valence. The central word and the pictures from the mood induction were positive, negative, or neutral in valence. Perhaps by the time participants had to make their response to the lateralized semantic judgment, the affect of the valence word and pictures was diluted. This would be consistent with the RVF/LH advantage found for the semantic decision task across most valence conditions for both the emotion perception and experience conditions as well as the combined task analyses for Experiment 2 results.

Limitations

One limitation to current experimental findings is that the IAPS and ANEW stimuli were all neutral in arousal level. Prior research has shown that arousal level may be an important component for obtaining visual field differences (Garavan et al. 2001; Holtgraves & Felton, 2010). Therefore, future studies should use stimuli that are both low and high in arousal level in addition to varying the level of positive and negative valence.

Another limitation to the current design is the use of the semantic decision lateralized task. Alfano & Cimino (2008) found valence by visual field differences using a lateralized vowel discrimination trigram task. Though they did not control for arousal level, which may be a contributing factor to their results, future studies should use a task like lexical decision with the current IAPS and ANEW stimuli. A lexical decision task would allow for access to word meaning (which does not occur in the letter trigram task) without the deeper categorization that is required in the semantic decision task.

Emotion perception results from the current experiment may have been influenced by the experimental instructions. Stone, Nisenson, Eliassen, & Gazzaniga, (1996) found a LH advantage when more explicit instructions were given, whereas a RH advantage was found when using less explicit instructions for a task requiring participants to judge whether two facial expressions represented the same or different emotion. Though this finding was based on a case study with one split-brain patient, results may be relevant to the current set of experiments. For Stone et al., in the less explicit instruction condition, the participant was told to decide whether two people were making the same emotional expression or a different emotional expression. In the more explicit instruction condition, the same instructions were given but additional instructions were added, "if they both look happy, answer 'same'; if one looks sad and the other looks happy, answer 'different'." Alhough this study was examining matching facial expressions with emotion words, the difference in laterality found when instructions changed may imply that the cognitive aspect plays a role in emotion perception. The instructions used in the current set of experiments for the emotion perception condition were, "you are to judge the valence of the central word presented. Whether the word presented is positive, negative, or neutral. A word like happy would be positive, a word like misery would be negative, and a word like door would be neutral." Maybe giving examples of words and their valence was very specific and explicit. Perhaps removing the examples from the instructions would be less explicit and result in a RH advantage for emotion perception.

A further limitation to the current study is the divided visual field technique. The DVF technique only allows extrapolation of emotion perception and experience processing at the hemisphere level. This technique is limited in that further sub-structures of the brain cannot be identified. Use of fMRI would allow further exploration beyond the hemisphere level.

Conclusions

Overall, results from the current study lend support to the idea that emotion, cognition, and the brain is a great deal more complex than can sometimes be accounted for by existing theories. It appears that many factors such as arousal and the type of non-valence linguistic stimuli used influence hemispheric processing of emotion. What the findings from the current study suggest is that while the Valence Hypothesis may be applicable at the anterior regional level as found by Davidson, it may not generalize to the hemisphere level as a whole.

Findings from the current study suggest that emotion perception at the single word level is a linguistic process, tapping into the left hemisphere's advantage for such processing. Many of these prior studies on emotion perception have examined emotion perception using faces, for which the RH is more specialized. In addition, studies that have combined emotion perception and experience have done so by examining clinical populations, those with depression or anxiety or designs that rely heavily on mood induction techniques.

Researchers like Alfano & Cimino (2008) and Van Strien & Morpurgo (1992) have found laterality differences varied by valence when using a lateralized task comprised of a 3-letter trigram. These findings indicate that the type of stimuli used to test laterality may be an important factor when examining emotion perception. For example, a 3-letter trigram stimulus set is not subject to the same effect of category specificity that natural and man-made stimuli are.

The current experiment found that judging the valence of a word (valence judgment) and merely seeing a valence word (consonant judgment) had similar effects on the semantic decision judgment. Yet, the valence of the central word had a differing effect depending on the semantic decision category. Experiment 1 found that comprehension of naturally occurring items was impaired when preceded by negative valence words. Whereas, in Experiment 2 positive and negative valence aided in the processing of man-made items. These findings indicate that category specificity are not only applicable to natural and man-made items but that the valence of the stimuli presented prior to a semantic decision judgment may be a contributing factor to the differential advantage the left and right hemisphere has when processing natural and ma-made stimuli.

The current study in conjunction with prior research on emotion perception and experience point to the idea that emotion and lateralization should not be examined solely by valence. It appears that valence does not fully account for lateralization of emotion but rather valence coupled with other factors such as arousal and the experimental stimuli results in differing effects. The current study was important in that the design allowed for a parceling out of arousal and valence. One of the major things learned from this study is that valence alone doesn't have as great of an effect on laterality as predicted. Whether perceiving or experiencing emotion, valence alone doesn't appear to solely effect hemispheric processing. However, valence did prove to have a differential effect on the semantic decision, regardless of the hemisphere presented, which was not predicted. This implies that valence should not only be examined at the hemisphere level but should also be examined in conjunction with various categories of linguistic stimuli.

Assessing the biologic substrates of emotion is a complex endeavor. Emotion depends on a highly interconnected system in the brain. This interconnectedness makes it difficult to localize brain regions with specific aspects of emotion. This drive to understand the particularities of each emotion component leads to a priori assumptions which bias towards localization-type models and theories (Uttal, 2002). Though it is important to examine all aspects of the emotion system, like underlying substructures such as the amygdala or the cingulate gyrus, and to utilize methodologies that test hemispheric lateralization, one must keep in mind the interconnectedness of the emotion network.

The current results suggest that we need to tweak experimental designs in order to examine all possible concerns surrounding experimental stimuli, design, theories, and predictions. For example, the current experimental design should be carried out again but this time in addition to varying valence, incorporate high and low arousal word and picture stimuli. Another study should use the same word and picture from the current experiments but change the lateralized semantic decision task to a lateralized lexical decision task. Doing this would allow examination of mood and valence without having the category specificity effects that arise when using natural and man-made stimuli. Doing this would provide further examination into whether emotion perception and experience are really separable processes.

The current study contributes to the idea that emotion perception and experience are two separable processes but what makes these two separate is not simply valence. The current study in conjunction with prior literature suggests that laterality differences that exist within emotion perception and experience are a factor of valence and arousal. The current study points to the importance of examining brain regions that are more specific than at the hemisphere level, such as anterior and posterior regions of the hemispheres and underlying sub-structures, such as the amygdala.

References

Aftanas, L. I., Varlamov, A. A., Pavlov, S.V., Makhnev, V.P., & Reva, N.V. (2001). Affective picture processing: event-related synchronization within individually defined human theta band is modulated by valence dimension. *Neuroscience Letters, 303*, 115-118.

Aftanas, L. I., Varlamov, A. A (2007). Effects of Alexithymia on the activity of the anterior and posterior areas of the cortex of the right hemisphere in positive and negative emotional activation. *Neuroscience and Behavorial Physiology, 37,* 67-73.

Alfano, K.M. & Cimino, C.R. (2008). Alteration of Expected Hemispheric Asymmetries: Valence and Arousal Effects in Neuropsychological Models of Emotion. *Brain and Cognition, 66*, 213-220.

American Psychiatric Association, 2000. Diagnostic and Statistical Manual, 4th ed. Revised. American Psychiatric Association, Washington, DC.

Atchley, R. A., Stringer, R., Mathias, E., Ilardi, S.S., & Minatrea, A.D. (2007). The right hemisphere's contribution to emotional word processing in currently depressed, remitted depressed, and never-depressed individuals. *Journal of Neurolinguistics, 20*, 145-160.

Bechara, A., Tranel, D., Damasio, H., Adolphs, R., Rockland, C., & Damasio, A.R. (1995). Double dissociation of conditioning and declarative knowledge relative to the amygdala and hippocampus in humans. *Science, 269*, 1115-1118.

Beeman, M.J. & Chiarello, C. (1998). Complementary right and left hemisphere language comprehension. *Current Directions in Psychological Science, 7*, 2-8.

Belzer, K. D., & Schneier, F.R. (2006). Tools for Assessing Generalized Anxiety Disorder. *Psychiatric Times, 23* (3), 26-27.

Borod, J.C., Andelman, F., Obler, L.K., Tweedy, J.R., Welkowitz, J. (1992). Right hemisphere specialization for the identification of emotional words and sentences: evidence from stroke patients. *Neuropsychologia, 9 (1),* 827-844.

Borod, J.C., Bloom, R.L., Brickman, A. M., Nakhutina, L., Curko, E. A. (2002). Emotional processing deficits in Individuals with unilateral brain damage. *Applied Neuropsychology 9, (1)* 23-26.

Borod, J.C., Bloom, R.L., & Santschi-Haywood, C. (1998). Right hemisphere language comprehension: perspectives from cognitive neuroscience. New Jersey: Lawrence Erlbaum Associates.

Bowers, D., Bauer, R.M., Coslett, H., & Heilman, K.M. (1985). *Processing of Faces by Patients with Unilateral Hemisphere Lesions. Brain and Cognition, 4,* 258-272.

Bowers, D., Blonder, L.X., Feinberg, T., & Heilman, K.M. (1991). Differential Impact of Right and Left Hemisphere Lesions on Facial Emotion and Object Imagery. *Brain, 114*, 2593-2609.

Bradley, M.M., & Lang, P.J. (1999). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings.* Technical report C-1, Gainesville, FL. The Center for Research in Psychophysiology, University of

Florida.

Britton, J.C., Taylor, S.F., Sudheimer, K.D., & Liberzon, I. (2006). Facial expressions and complex IAPS pictures: Common and differential networks. *NeuroImage, 31*, 906-919.

Bryden, M. P. (1982) Laterality: Functional asymmetry in the normal brain. New York: Academic Press.

Cannon, W.B. (1927). The James-Lange Theory of Emotions: A Critical Examination and an Alternative Theory. *American Journal of Psychology, 39*, 106-124.

Cicero, B. A., Borod, J. C., Santschi, C., Erhan, H. M., Obler, L. K., Agosti, R. M., Welkowitz, J., Grunwald, I. S. (1991). Emotional versus nonemotional lexical perception in patients with right and left brain damage. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 12 (4),* 255-264.

Clore, G.L., Ortony, A., & Foss, M.A. (1987). The Psychological Foundations of the Affective Lexicon. *Journal of personality and social psychology, 53* (4), 751-766.

Cohen, J., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: An interactive graphic system for designing and controlling experiments in the psychology laboratory using Macintosh computers. *Behavioral Research Methods, Instruments, & Computers, 25,* 257-271.

Connelly, M., Denney, D. R. (2007). Regulation of emotions during experimental stress in alexithymia. *Journal of Psychosomatic Research, 62,* 649-656.

Damasio, A. (1994). Descartes' Error: Emotion, Reason, and the Human Brain. Penguin Books: New York.

Damasio, A. (2003). Looking for Spinoza: Joy, Sorrow, and the Feeling Brain. Harcourt Books: Orlando.

Damasio, A. (1999). The Feeling of What Happens: Body and Emotion In The Making of Consciousness. Harcourt Books: New York.

Davidson, R. J. (1992). Anterior Cerebral Asymmetry and the Nature of *Emotion. Brain and Cognition, 20*, 125-151.

Davidson, R. J. (1995). Cerebral Asymmetry, Emotion, and Affective style. In R.J. Davidson & K, Hugdahl (Eds.), *Brain Asymmetry* (pp.361-387) Cambridge, MA: MIT Press.

Davidson, R. J. (1988). EEG Measures of Cerebral Asymmetry: Conceptual and Methodological Issues. *International Journal of Neuroscience, 39*, 71-89.

Davidson, R. J., Ekman, P., Saron, C.D., Senulis, J.A., & Friesen, W.V. (1990). Approach-Withdrawal and Cerebral Asymmetry: Emotional Expression and Brain Physiology I. *Journal of personality and social psychology, 58* (2), 330-341.

Davitz, Joel R. (1969). Comments on the Structure of Emotional Meaning. In Davitz, J.R. (Eds.), *The Language of Emotion* (pp. 127-150) New York & London: Academic Press.

Devlin, J.T., Russell, R,P., Davis, M.H., Price, C.J., Moss, H.E., Fadili, M.J., & Tyler, L.K. (2002). Is there an anatomical basis for category-specificity? Semantic memory studies in PET and fMRI. *Neuropsychologia, 40*, 54-75.

Eviatar, Z., & Zaidel, E. (1991). The effects of word length and emotionality on hemispheric contributions to lexical decision. *Neuropsychologia, 29,* 415-428.

Farah, M.J. & McClelland, J.L. (1991). A computational model of semantic memory impairment: Modality specificity and emergent category specificity. *Journal of Experimental Psychology, 120 (4)*, 339-357.

Frijda, N.H. & Sundararajan, L. (2007). Emotion Refinement A Theory Inspired by Chinese Poetics. *Perspectives on Psychological Science, 2* (3), 227-241.

Garavan, H., Pendergrass, J.C., Ross, T.J., Stein, E.A., & Risinger, R.C. (2001). Amygdala response to both positively and negatively valenced stimuli. *Neuroreport, 12* (12), 2779-2783.

Gross, J.J., John, O.P., & Richards, J.M. (2000). The Dissociation of Emotion Expression From Emotion Experience: A Personality Perspective. *Personality and Social Psychology Bulletin, 26* (6), 712-726.

Havas, D.A., Glenburg, A.M., Gutowski, K.A., Lucarelli, M.J., & Davidson, R.J. (2010). Cosmetic Use of Botulinum Toxin-A Affects Processing of Emotional Language. *Psychological Science, XX(X),* 1-6.

Hellerstein, D.J., Batchelder, S.T., Lee, A., & Borisovskaya, M. (2002). Rating dysthymia: an assessment of the construct and content validity of the Cornell Dysthymia Rating Scale. *Journal of Affective Disorders, 71*, 85-96.

Holtgraves, T. & Felton, A. (2010). Hemispheric asymmetry in the processing of negative and positive words: A divided visual field study. *Cognition and Emotion.* First published on: 07 July 2010 (iFirst). DOI: 10.1080/02699931.2010.493758.

Hughlings-Jackson, J. (1915). On the Nature of the Duality of the Brain. *Brain, 38*, 80-103.

James, W. (1884). What is an emotion? *Mind, 9*, 188-205.

Kensinger, E.A. & Corkin, S. (2004). Two routes to emotion memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences, 101* (9), 3310-3315.

Kimura, Y., Yoshino, A., Takahashi, Y., & Nomura, S. (2004). Interhemispheric difference in emotional response without awareness. *Physiology & Behavior, 82*, 727-731.

Lane, R.D., Sechrest, L., Piedel, R., Shapiro, D.E., & Kasniak, A.W. (2000). Pervasive Emotion Recognition Deficit Common to Alexithymia and the Repressive Coping Style. *Psychosomatic Medicine, 62*, 492-501.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual.* Technical Report A-6. University of Florida, Gainesville, FL.

Meyer, A.M. & Federmeier, K.D. (2007). The effects of context, meaning frequency, and associative strength on semantic selection: Distinct contributions from each cerebral hemisphere. *Brain Research, 1183*, 91-108.

Mikels, J.A., Fredrickson, B.L., Larkin, G.R., Lindberg, C.M., Maglio, S.J., & Reuter-Lorenz, P.A. (2005). Emotional category data on images from the International Affective Picture System. *Behavior Research Methods, 37(4)*, 626-630.

MRC Psycholinguistic Database: Machine Usable Dictionary. Version 2.00 Informatics Division Science and Engineering Research Council Rutherford Appleton Laboratory Chilton, Didcot, Oxon, OX11 0QX Michael Wilson 1 April 1987. http://www.psy.uwa.edu.au/MRCDataBase/uwa_mrc.htm

Muller, M.M., Keil, A., Gruber, T., & Elbert, T. (1999). Processing of affective pictures modulates right-hemispheric gamma band EEG activity. *Clinical Neurophysiology, 110*, 1913-1920.

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

Onoda, K., Okamoto, Y., Toki, S., Ueda, K., Shishida, K., Kinoshita, A., Yoshimura, S., Yamashita, H., & Yamawaki, S. (2007). Anterior cingulate cortex modulates preparatory activation during certain anticipation of negative picture. *Neuropsychologia*: Accepted Manuscript.

Orsillo, S.M., Batten, S.V., Plumb, J.C., Luterek, J.A., & Roessner, B.M. (2004). An Experimental Study of Emotional Responding in Women with Posttraumatic Stress Disorder Related to Interpersonal Violence. *Journal of Traumatic Stress, 17* (3), 241-248.

Panksepp, J. (2007). Neurologizing the Psychology of Affects How Appraisal-Based Constructivism and Basic Emotion Theory Can Coexist. *Perspectives on Psychological Science, 2* (3), 281-296.

Ramon, D., Doron, Y., & Faust, M. (2007). Categorization and affect: Evidence for intra-hemispheric interactions. *Brain and Cognition, 63*, 296-303.

Riberio, R.L., Teixeira-Silva, F., Pompeia, S., & Bueno, O.F.A. (2007). IAPS includes photographs that elicit low-arousal physiological responses in healthy volunteers. *Physiology & Behavior, 91*, 671-675.

Schachter, S. (1994). The interaction of cognitive and physiological determinants of emotional states. In Ph. H. Leiderman & D. Shapiro (Eds.), *Psychobiological approaches to social behavior* (pp. 138-173). Stanford: Stanford Univ. Press.

Scherer, K.R. (1993). Neuroscience Projections to Current Debates in Emotion Psychology. *Cognition and Emotion, 7(1)*, 1-41.

Smith, S.D. & Bulman-Fleming, B. (2005). An examination of the right-hemisphere hypothesis of the lateralization of emotion. *Brain and Cognition, 57,* 210-213.

Sobotka, S., Davidson, R.J., & Senulis, J. (1992). Anterior Brain Electrical Asymmetries in Response to Reward and Punishment. *Electroencephalography and Clinical Neurophysiology, 83*, 236-247.

Spalleta, G., Ripa, A., Bria, P., Caltagirone, C., Robinson, R. G. (2006). Response of Emotional Unawareness After Stroke to Antidepressant Treatment. *American Journal of Geriatric Psychiatry, 14*, 220-227.

Stone, V.E., Nisenson, L., Eliassen, J.C., & Gazzaniga, M.S. (1996). Left hemisphere representations of emotional facial expressions. *Neuropschologia, 34(1),* 23-29.

Strauss, E. (1983). Perception of emotional words. *Neuropsychologia, 21 (1),* 99-103.

Strauss, G.P. & Allen, D.N. (2008). Emotional intensity and categorisation ratings for emotional and nonemotional words. *Cognition and emotion, 22 (1),* 114-133.

Sutton, S.K., Davidson, R.J. (1997). Prefrontal brain asymmetry: a biological substrate of the behavioral approach and inhibition systems. *Psychological Science, 8, (3),* 204-210.

Toglia, M.P. and Battig, W.F. (1978). Handbook of SEMANTIC WORD NORMS. Lawrence Erlbaum Associates: Hillsdale.

Uttal, W.R. (2002). Functional Brain Mapping-What Is It Good For? Plenty, but Not Everything! (Reply to Malcom J. Avison). *Brain and Mind, 3,* 375-379.

Van Strien, J. W. & Heijt, R. (1995). Altered Visual Field Asymmetries for Letter Naming and Letter Matching as a Result of Concurrent Presentation of Threatening and Nonthreatening Words. *Brain and Cognition, 29*, 187-203.

Van Strien, J. W. & Morpurgo, M. (1992). Opposite Hemispheric Activations as a Result of Emotionally Threatening and Non-Threatening Words. *Neuropsychologia, 30* (*9*), 845-848.

Velten, E. (1968). A Laboratory Task for Induction of Mood States. *Behavior Research & Therapy, 6*, 473-482.

Waston, D., Clark, L.A., & Tellegen, A. (1988). Development and

Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Zaidel, E. (1983). Disconnection syndrome as a model for laterality effects in the normal brain. In J.B. Hellige (Ed.). *Cerebral hemisphere asymmetry: Methods, theory, and application* (pp. 95-151). New York: Praeger.

Table 1

IAPS Mean (SD) and Range for Valence and Arousal

	Mean Valence (*SD*) Range	Mean Arousal (*SD*) Range
Positive	7.56 (1.50) 6.62 – 8.34	5.01 (2.33) 3.30 – 6.47
Negative	2.70 (1.57) 1.79 – 4.04	5.03 (2.19) 4.53 – 5.95
Neutral	4.96 (1.24) 4.45 – 5.35	3.00 (1.90) 1.72 – 4.08

Note. Ratings are on a 1 – 9 Likert Scale.

Table 2

Central Words (ANEW) Mean (SD) and Range for Valence and Arousal

	Mean Valence (*SD*) Range	Mean Arousal (*SD*) Range
Positive	7.74 (1.46) 7.26 – 8.72	5.41 (2.59) 2.95 – 7.36
Negative	2.22 (1.49) 1.25 – 3.19	5.46 (2.52) 2.83 – 8.17
Neutral	5.32 (1.40) 4.11 – 6.02	3.82 (2.12) 2.95 – 4.86

Note. Ratings are on a 1 – 9 Likert Scale.

Table 3

Semantic Decision Words Mean (SD) and Range for Word Length and Frequency

	Word Length Mean (SD) Range		Word Frequency Mean (SD) Range	
	Natural	Man-Made	Natural	Man-Made
List 1	4.71 (1.02) 3 – 6	4.81 (0.94) 3 – 6	31.60 (38.79) 0 – 787	31.20 (33.96) 2 – 591
List 2/3	4.79 (1.0) 3 – 6	4.83 (0.98) 3 – 6	32.66 (89.46) 0 – 787	31.36 (74.66) 2 – 591

Table 4

Experiment 1

Mean Percent Correct and Reaction Time (in milliseconds) and (Standard Deviations) for Semantic Judgment in Valence Judgment Condition

	Percent Correct		Reaction Time	
	Natural	Man-Made	Natural	Man-Made
Positive				
LVF/RH	85.44 (15.66)	88.80 (11.85)	1207 (224)	1230 (249)
RVF/LH	86.89 (14.31)	92.42 (7.54)	1195 (258)	1173 (207)
Negative				
LVF/RH	83.64 (12.13)	90.99 (9.48)	1207 (234)	1236 (231)
RVF/LH	82.59 (17.12)	92.58 (8.10)	1177 (221)	1207 (237)
Neutral				
LVF/RH	86.14 (11.08)	89.47 (12.14)	1189 (238)	1232 (240)
RVF/LH	87.06 (16.39)	92.44 (7.90)	1172 (219)	1189 (238)

Table 5

Experiment 1

Mean Percent Correct and Reaction Time (in milliseconds) and (Standard Deviations) for Semantic Judgment in Consonant Judgment Condition

	Percent Correct		Reaction Time	
	Natural	Man-Made	Natural	Man-Made
Positive				
LVF/RH	83.38 (16.34)	90.54 (8.71)	1193 (220)	1202 (256)
RVF/LH	85.72 (16.74)	91.07 (10.29)	1164 (216)	1195 (252)
Negative				
LVF/RH	83.43 (18.68)	89.72 (8.83)	1157 (218)	1179 (226)
RVF/LH	88.54 (13.85)	91.15 (10.82)	1160 (240)	1155 (237)
Neutral				
LVF/RH	86.13 (13.90)	89.70 (9.03)	1188 (244)	1211 (262)
RVF/LH	88.94 (14.14)	89.84 (11.80)	1160 (208)	1195 (275)

Table 6

Experiment 1

Mean Percent Correct and Reaction Time (in milliseconds) and (Standard Deviations) for Semantic Judgment in Valence & Consonant Judgment Conditions Collapsed Over Task

	Percent Correct		Reaction Time	
	Natural	Man-Made	Natural	Man-Made
Positive	86.54 (14.45)	90.58 (10.56)	1184 (245)	1186 (236)
Negative	83.62 (15.52)	91.17 (9.16)	1193 (230)	1199 (247)
Neutral	86.79 (15.37)	90.88 (9.87)	1158 (219)	1193 (236)

Table 7

Experiment 2

Mean Percent Correct and (Standard Deviations) for Central Task in Valence Judgment Condition

	Percent Correct
Positive	
LVF/RH	81.75 (13.31)
RVF/LH	84.69 (9.00)
Negative	
LVF/RH	95.5 (4.47)
RVF/LH	95.11 (5.41)
Neutral	
LVF/RH	93.38 (6.79)
RVF/LH	92.19 (8.29)

Table 8

Experiment 2

Mean Percent Correct and Reaction Time (in milliseconds) and (Standard Deviations) for Semantic Judgment in Valence Judgment Condition

	Percent Correct		Reaction Time	
	Natural	Man-Made	Natural	Man-Made
Positive				
LVF/RH	83.23 (15.33)	89.04 (11.54)	1287 (399)	1302 (375)
RVF/LH	85.88 (12.74)	92.37 (8.11)	1272 (348)	1269 (328)
Negative				
LVF/RH	82.40 (13.18)	88.80 (10.75)	1262 (343)	1287 (309)
RVF/LH	83.58 (12.16)	89.81 (9.76)	1258 (356)	1238 (277)
Neutral				
LVF/RH	81.71 (15.36)	89.84 (8.74)	1259 (324)	1315 (309)
RVF/LH	86.08 (12.53)	90.70 (8.02)	1239 (334)	1300 (347)

Table 9

Experiment 2

Mean Reaction Time (in milliseconds) and (Standard Deviations) for the Semantic Decision Judgment in Valence Task Condition

	Reaction Time	
	Natural	Man-Made
Positive	1279 (372)	1286 (351)
Negative	1260 (348)	1262 (293)
Neutral	1249 (328)	1308 (327)

Figure Caption

Figure 1. Experimental Procedures for Emotion Experience Condition

Emotion Experience Conditions

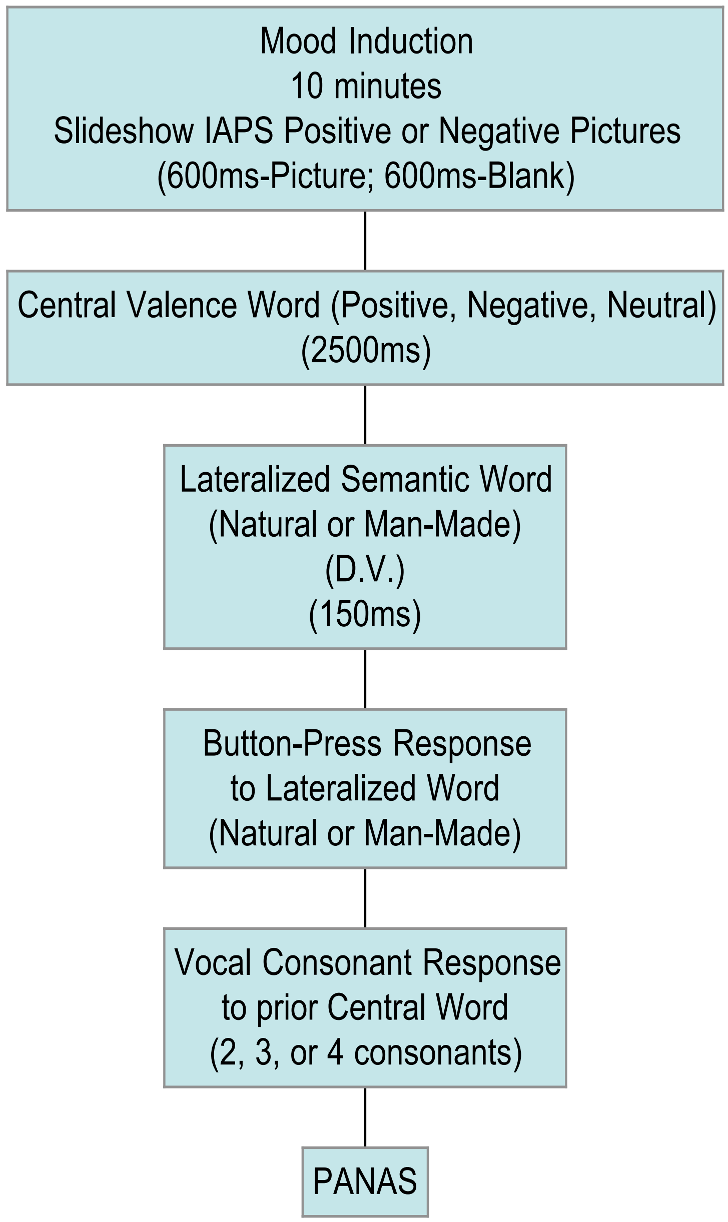

Figure Caption

Figure 2. Experimental Procedures for Emotion Perception Condition

Emotion Perception Condition