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LATERALITY OF THE PERCEPTION OF COMPUTER PRESENTED WRITTEN SEXUAL WORDS BY RIGHT-HANDED MALES AND FEMALES

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The right hemisphere of males has been shown to possess a greater capacity for accurate perception of emotional non-verbal material (pictures) than the left hemisphere. The same is true for females, but with a smaller difference between the two hemispheres. Some previous research has partially confirmed these relationships using tachistoscopic presentation of emotional words. The present study, using briefly exposed computer-presented sexual words, compared perception accuracy with respect to a sexuality rating of clearly sexual and clearly non-sexual words, in the right versus the left visual field, and with males versus females. As with previous research using verbal stimuli, the sexual ratings were more accurately perceived by both males and females in the right than the left visual field, but the disparity between sexual and non-sexual word perception accuracy was not in the direction expected if the emotionality of the words (their sexual content) favored left visual field perception accuracy, and if this special right hemisphere capacity was not as great in females as in males.

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Randall W. Stewart

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INTRODUCTION

Overview

Since the observations of Geshwind and Kaplin (1962) concerning the disconnection syndrome resulting from destruction of the corpus callosum following an infarct of the anterior cerebral artery and the careful analyses of human split brain patients by Gazzaniga (1970), considerable speculation has been generated concerning the role that each cerebral hemisphere might play in the causation of behavior. The right hemisphere (RH) has been described as the more analytical, more musical, more emotional etc., while the left hemisphere (LH) has been considered to be the locus of language ability and fine motor control.

The results from the behavior of brain-injured patients has been supplemented by those from neuropsychological research with intact humans, taking advantage of the fact that input to each hemisphere is uniquely related to crossed sensory input. The study of hemispheric specialization using such crossed sensory input comprises the subfield called laterality, which by now constitutes a large part of human neuropsychology. There are several textbooks completely devoted to this area, with the one by Bryden (1982) possibly the best known.

With respect to the visual system, the right visual field (RVF) of both eyes is processed by the LH (left hemisphere) and the left visual field (LVF) of both eyes is processed by the RH (right hemisphere) Carlson (1986). By controlling a subject's head and eye movements it is thus possible to present visual stimuli in such a way that they result in initial input to either hemisphere alone. Hemispheric sharing by means of connections through the corpus callosum occurs under ordinary stimulation, but with very brief tachistoscopic stimuli (between 100 and 200 milliseconds) subjects report only a sort of general impression of the stimulus, which seems to be a function of the initial hemispheric input (Bryden, 1982). By comparing the accuracy with which each field processes various kinds of information it is possible to determine the extent of hemispheric specialization and hemispheric sharing via the corpus callosum. (The somatosensory system is also almost completely crossed and there are a number of crossed connections in the auditory system, but most of the research has involved tachistoscopic visual stimuli.)

In a general sense, research involving visual field differences with intact subjects has supported the clinical findings with brain injured patients. Language stimuli have been more accurately processed in the LH and spatial and emotional stimuli in the RH (Kolb and Whishaw, 1990). In addition, a number of interactions between the gender of the subject and the nature and degree of hemispheric specialization have been found. For example, from tachistoscopic studies it appears that the right hemisphere specialization for processing emotional and spatial input is seen most clearly in right handed males, with females and left handed males being more equal in hemispheric involvement, or even showing some left hemisphere specialization for such stimuli.

The research articles reviewed in the next section begin with a review article covering the last three decades of relations between perceptual characteristics of the visual stimuli (retinal eccentricity, stimulus luminance, etc.) and laterality. A moderate portion of laterality research consists in efforts to find environmental/historical (as opposed to basic neurological) explanations for differential field effects, or in other words, to be sure that experimental findings are truly due to neurological specialization. A sampling of this literature is the second topic of this review. The third topic concerns laterality as a function of relatively simple stimulus and task variables. Next are sample studies in which laterality is examined with respect to more complex features of stimulus words, such as imagery, abstractness/concreteness, and syntactic features. The last topic of the review, which is most directly relevant to the present research, concerns research on relations between emotional variables and laterality. Within each general topic, the articles are presented in chronological order. This review is not meant to be exhaustive, but rather to present articles illustrating the various topics researched, some of the methods used, and a sample of findings.

Review of Relevant Research

Perceptual Stimulus Characteristics

Christman (1989) reviewed a total of 79 visual laterality experiments from the last three decades with respect to the interaction of perceptual variables—retinal eccentricity, stimulus size, luminance, contrast, blurring/degradation and exposure duration—with laterality. Forty-five of the experiments showed significant interactions that were in the direction predicted by the visual spatial frequency hypothesis, 25 showed no interactions and 9 showed interactions opposite to the hypothesis' predictions. Visual spatial frequency refers roughly to the fineness of the discrimination that is required. Consider the task of discriminating a square grid from a solid square of the same size. A grid with high spatial frequency would have very fine lines spaced very close together. One with low spatial frequency would be composed of wider lines spaced further apart. The visual spatial frequency hypothesis is to the effect that changes in perceptual variables that decrease the availability of higher visual frequencies (increases in eccentricity, size, and blur/degradation, along with decreases in luminance and exposure duration) should produce greater relative impairment of left hemisphere

(LH) performance than in the right hemisphere (RH). It appears that the predictions of the hypothesis hold out best when the primary focus of the task is at an intermediate perceptual level (below complex cognitive and linguistic levels and above simple sensory levels of processing). Christman suggests that

> spatial frequency differences between the hemispheres (a) are not present at early sensory levels, (b) arise at intermediate processing stages where sensory codes are translated into more abstract perceptual codes upon which cognitive mechanisms operate, and (c) may be overridden by the influence of other strongly lateralized process (e.g., word identification) page 254.

This possibly implies, for the present research, that minor failures to equate stimuli for retinal eccentricity, size, blur/degradation, etc. will be overridden by the influence of the lateralized processes of main concern, namely verbal and emotional content.

Possible Non Neurological Explanations of Laterality Effects

The first three studies occurred considerably prior to the work of Geshwind and Kaplan (1962) and that of Gazzaniga (1970), and was directed at brain equipotentiality theory rather than hemispherical specialization, but they are relevant to the present issues nevertheless.

Mishkin and Forgays (1952) studied tachistoscopic English and Yiddish word recognition as a function of retinal locus. In one of several experiments they demonstrated a relationship between visual field superiority and the direction of early and well learned reading habits (left to right or the reverse) Thus demonstrating that specialized lateralization may be somewhat weak. Native Jewish speakers (readers) recognized tachistoscopically presented Yiddish words better in the LVF than in the RVF, and native English speakers (readers) recognized English words better in the RVF. For the authors this evidence is incompatible with a strong equipotentiality brain function interpretation, and more recently it is supportive of the importance of early learned reading habits as contrasted with basic neurological specialization for VF superiority.

Forgays (1953) studied the relation of right field superiority of word recognition to grade level (school grades 2 through 10 and the first 3 years of college). Three- or four-letter common English words selected from an elementary reader were presented tachistoscopically to 144 subjects. Cross hairs in the center of the exposure field were used as a fixation point. Each educational grade-level group consisted of 12 subjects, six male and six female. Clear RVF superiority only emerged after grade 6, implying to the author that this differential effectiveness is the result of selective retinal training related to reading English text.

Orbach (1953) studied retinal locus as a factor in the recognition of visually perceived words. Thirty-two readers of English and Jewish (Hebrew) were subjects. It was found that the recognition of English words was significantly superior in the RVF (LH). Hebrew word recognition varied according to which of the two languages was learned first. In other words, if English was learned first the Hebrew words were more readily recognized in the RVF and if Hebrew was learned first the Hebrew words were more readily recognized in the LVF. This with the two previous studies is evidence for an environmental basis for RVF/LVF differential sensitivity to word recognition.

Differential recognition of tachistoscopically presented English and Hebrew words in the right and left visual fields was studied by Barton, Goodglass and Shai (1965). Subjects were 20 Israeli. Ten were native English speaking students. The criteria for selection of the Israeli subjects were that Hebrew was the first reading language, it was the most fluent language and they were fluent in English. All subjects were right-handed males. The subjects were asked to identify words presented monocularly. The researchers found that the RVF (LH) was superior for both eyes, irrespective of the normal direction of reading (right to left, or left to right) of the native language.

Orbach(1967) studied the differential recognition of Hebrew and English words in right and left visual fields as a function of cerebral dominance and reading habits. Native Hebrew readers were exposed tachistoscopically to English and Hebrew words. The subjects were native Hebrew readers. He found that English was better recognized in the RVF though right-handers showed a greater recognition differential than left-handers. There were no significant differences between right- and left-handers in the recognition of Hebrew words. Right handers did, however, recognize more Hebrew words in the RVF and left-handers identified more Hebrew words in the LVF. Orbach contends that directional scanning, selective attention, cerebral dominance and structural factors all influenced the right-left recognition differential.

Visual field differences in reaction times to Hebrew letter identification was studied by Carmon, Nachshon, Isseroff and Kleiner (1972). They conducted three separate experiments to test the hypothesis that the typical RVF shorter reaction times to verbal stimuli may be determined by the direction of reading associated with the stimuli. Verbal reaction times were obtained for Hebrew letters (Hebrew words are normally read from right to left) presented tachistoscopically, and reaction times to these stimuli were shorter in the RVF by a significant margin. These results strongly imply that the laterality effect is not due to the direction of reading associated with the stimuli.

Orenstein and Meighan (1976) replicated the Ellis and Shepard (1974) study reported below, however, they categorized and matched pairs of high frequency and medium-low frequency concrete words. Each pair of words appeared twice during the experiment in reversed order to the visual fields. Subjects were seven female and five males who were volunteers from college classes. Due to the unbalanced groups the whole-word errors for each subject (as a function of visual field, type of word and the word frequency) were converted to percentages. They were all right-handed. Following a 150 millisecond presentation, subjects were asked to report in any order the words seen. If unable to report words they were asked to identify as many letters as possible. Their results are in contrast to those of Ellis and Shepard, that is, words presented in the LVF were more easily recognized than words presented in the RVF. They report that these findings are independent of frequency and concreteness.

Jonides (1979) used two letter classification to study the effects of lateral asymmetries in perceptual processing that may be sensitive to subtle changes in task demands. In his first and second experiments he demonstrated that subjects respond more quickly and more accurately to visual classifications that are readily identifiable when they are presented in the RVF rather than the in LVF. When stimuli that are not as easily identifiable are presented in the LVF they show a performance advantage. He also concluded that if readily identifiable stimuli are mixed with stimuli that are more difficult to identify it results in a LVF advantage for both the difficult and the easy classification trials. In his third experiment he demonstrated that the hemispheric superiority effect for letter classification depends upon the context in which that classification is being performed. When the word stimulus is embedded in the context of a difficult classification, the LVF is superior. When the stimulus is embedded in the context of an easy classification, the RVF is superior. It seems that it is not the actual difficulty, but the expected difficulty of the task that determines the visual field superiority. Although not contradicting the notion of hemispherical asymmetries this line of research shows an interaction with a complex cognitive variable.

Tomlinson-Keasey, Brewer and Huffman (1983) investigated the possibility that the RVF advantage, found in most studies of hemispheric specialization, results from words in that visual field having an advantage due to the first letter of the word being located closest to the fixation point. Male and female right-handed volunteers from an introductory psychology course were used in the study. The stimuli consisted of 72 four letter words, 36 high frequency and 36 low frequency. Subjects were presented 36 stimulus pairs. Each bilateral presentation was 100 milliseconds in duration. Subjects were encouraged to report letters in the event they could not identify the words. The four conditions differed in terms of the closeness of the first letters of the words to the fixation point. Condition 1 was the standard placement, with the RVF word's first letter closer to the fixation point than that of the LVF. In Condition 2 the LVF word was displaced to the right so that its first letter was as close to the fixation point as that of the RVF word. In Condition 3 the RVF word was displaced to the left so that the last letters of the two words were equidistant from the fixation point, and in Condition 4 the four-letter words were presented vertically. In all four conditions half of the words were high frequency and half low frequency, with the notion that the first letter will provide less useful information with the low frequency words. Separate field by frequency ANOVAs were carried out for each of the four conditions. A critical result was that in Condition 1, the standard condition for most such studies, the word perception was the usual one, with RVF showing clearly greater accuracy, but first letter perception in LVF and RVF were equal. In other words, even though first letter perception is favored in the RVF (because the first letter is closer to the fixation point) first letter perception was just as good in the LVF, showing that there is a robust RVF over LVF superiority in word perception. As expected high frequency words were more accurately perceived than low frequency words, but the interpretation of the frequency with the field and condition variables was quite complex. The results for

Condition 4 showed no RVF advantage, but the authors interpret this as due to the extreme difficulty of this task, and thus the result of a floor effect.

The possibility that hemispherical asymmetries are largely a function of learned scanning habits rather than innate hemispherical specializations was investigated by Webb, Fisher-Ingram and Hope (1983), who conducted two studies to examine perception of briefly (100 milliseconds) presented strings of 5 letters. In the first study they used 20 subjects and presented horizontal 5-letter strings in the left, central and right visual fields and vertical 5-letter vertical strings presented in the lower, central and upper visual fields. For both horizontal and vertical strings there was the within-string advantage expected on the basis of left-to-right scanning for horizontal, and top-to-bottom for vertical strings items. There was the typical RVF over LVF advantage in accuracy of report for horizontal strings, but no equivalent lower over upper visual-field advantage for vertical strings. In the second study, 24 subjects were presented with vertical strings in the RVF and LVF, and in the upper and lower visual fields; and with horizontal strings in the RVF and LVF. They found the same RVF over LVF advantage for horizontal strings but not for vertical strings. In the comparison of between strings, no advantage for lower over upper visual fields was found. The failure to find the typical RVF advantage for the vertical strings presented to the right and left of the fixation point leaves the issue of scanning habits as a complete explanation for hemispherical asymmetries unresolved.

Bryden, Mondor, Loken, Ingleton and Bergstrom (1990) investigated the possibility that some of the RVF over LVF effect may be due to the information in the initial or terminal parts of the words selected in various studies, because most words have more information in the beginning than in the ending of the word. The investigators used equal numbers of words with most of the information at the beginning and with most information at the end. Three experiments were conducted. They differed in procedural detail, but were similar in that half of the words viewed unilaterally by the university undergraduates had most information at the beginning and half had most information at the end of the word. The word list was also divided into four groups: high frequency/high imagery, high frequency/low imagery, low frequency/high imagery and low frequency/low imagery. Words presented in the RVF were more accurately categorized than those presented in the LVF. Words with more information at the beginning and words with more information at the ending were identified equally well in both visual fields. Therefore, no evidence was obtained for the contention that the usual RVF advantage was due to the locus of information in the words.

Lubow, Tsal, Mirkin and Mazliah (1994) conducted three experiments using tachistoscopic circular displays of English and/or Hebrew letters that were equidistant from a fixation point. The subjects reported the letters that they had seen as a result of a 50 ms single field tachistoscopic presentation. From the three experiments they determined that subjects initiate their reports of English letters from the upper left quadrant and Hebrew letters from the upper right quadrant of the display. They also report that subjects' subsequent letter reports come mostly from the same quadrant as the initial presentation. The orientation is on the area of first presentation regardless of the native language of the subject. The direction of reporting was mainly a function of the position of the first response and not the display letter language that engaged that response, nor the language displayed in adjacent letters. Together the three experiments strongly imply that RVF superiority for verbal stimuli may be the result of a particular set of stimulus conditions and response criteria, such as reaction time and correct recognition, rather than innate cerebral specialization.

Although several non neurological interpretations have been studied, in general the RVF (LH) neurological specialization interpretation remains strongly supported by most of the evidence.

Laterality and Relatively Simple Stimulus and Task Variables

These studies represent an extension of differential visual field (hemisphere) effects to a variety of phenomena related to stimuli and task characteristics of a more structural level, or at least a level not involving the "meaning" of the words.

Cohen (1973) studied hemispheric differences in reaction time to judge a series of items as same or different (one item differing from the others) primarily as a function of the number of items in the series. There was an increase in reaction times as a function of increasing the number of letters projected to the RVF (LH) . A similar increase in the number of letters projected to the LVF (RH) did not result in any increases in the reaction times, i.e., four letter reaction times were the same as two letter reaction times. The conclusion was that the LH processed the set serially while the RH processed it holistically or in parallel.

Discrimination of word and word approximations tachistoscopically presented to the left and RVFs was studied by Axelrod, Haryadi and Leiber (1977). Subjects were asked to orally report letter strings forming words, pronounceable high approximations to words and unpronounceable low approximations to words. There was the same RVF superiority obtained with high approximations as with words. Letter scores from partially correct strings, demonstrating RVF superiority, did not vary with string type. It was concluded that the LH is differentially specialized for processing words as units and that requiring oral report makes pronounceable strings processable as word-like units. It was also concluded that the LH is not specialized for processing sub-word fragments.

Segalowitz and Stewart (1979) studied LH (RVF) and RH (LVF) lateralization in such a way as to distinguish between stimulus properties and the processing strategy required for the judgment. They state that different processing styles or biases for the two cerebral hemispheres often confound stimulus qualities with task requirements. With a letter-matching task they avoided this problem by using the same stimuli for two task strategies that require different hemispheres to process. Subjects (30 female and 30 male) were required to judge letter pairs (one letter centrally and one peripherally) as same or different. Stimulus pairs were physically similar (e.g. AA), same in name (Aa), or different physically and in name (Ar). Pooling genders, the reaction times for name judgments showed a considerable RVF advantage, but not the reaction times for the physically different judgments. Females contributed more to the effect than did males. On the basis of some details of the results the researchers proposed that the male/female differences could be due to females using a single strategy while the males may have used different strategies to process the information.

Berrini, Sala, Spinnler, Sterzi and Vallar (1982) explored the possibility of hemisphere asymmetries in tasks requiring verbal and spatial recognition and whether recognition depended on the receiving or input hemisphere for matching. Right- and left-handed males and females were given the task of discriminating whether stimuli were consonant letter pairs and diagrams (vertically arranged in a column) or black five point stars drawn inside various squares of matrices. They found that the LH was more accurate in letter recognition and in the recognition of verbal diagrams than spatial diagrams while the RH was more accurate in recognizing spatial diagrams.

Birkett (1981) studied hemispheric asymmetries for the classification of upright and inverted letter pairs by handedness and gender differences. Same or different stimuli were presented to the LVF and RVF tachistoscopically and subjects responded to matching stimuli by depressing a telegraph key. He found that this rotation effect (longer reaction times to the inverted letters) was larger in the RH compared to the LH for males and for right handers but, larger in the LH than in the RH for females and for left handers of both genders. The author's conclusions were that his findings were not consistent with the current views on hemispheric asymmetry. Also, the inclusion of inverted letters may change the entire task, implying that what the laterality tasks involve must be determined precisely in information processing terms .

Chermak and Borneman (1983) studied visual field differences for the perception of consonant vowel syllables tachistoscopically presented to the RVF and LVF. They found that subjects demonstrated a LVF (RH) advantage for the bilateral mode of presentation. Their results suggest that presentations may be processed spatially or acoustically (phonetically) but probably not linguistically. They attribute this to the base of knowledge which suggests the functional differences between the cerebral hemispheres--the RH is responsible for spatial and acoustic characteristics and the LH has a greater capacity for linguistic analysis.

Hellige and Michimata (1989) studied the visual laterality for letter comparison. They used twenty right-handed men and twenty right-handed women in their study. The task was to discriminate pairs of uppercase letters as same or different. The letter pairs were presented to the RVF or LVF or to both fields simultaneously. Laterality effects were not influenced by moderate blurring of the letters. In the RVF, reaction times were faster for same pairs than for different pairs. That effect was absent on LVF presentations, which suggests a qualitative difference in the mode of processing for the two unilateral trial types. The indications from results on the bilateral trials were identical to that obtained on RVF trials. The authors believe that on bilateral trials, the subjects utilized the mode of processing characteristic of RVF trials.

Brysbaert and D'Ydewalle (1990) were primarily concerned with the reliability (test-retest) of tachistoscopic presentations of verbal stimuli for assessing cerebral dominance. They used 14 male volunteer subjects; three were the researcher and two of his assistants. Half were right-handed and half were left handed. Stimuli consisted of 100 four-letter and 100 five-letter words. The presentations were controlled by a computer programmed to present a random sample from the four-or five-letter words to the left or right of the fixation point. Series of four and five letter words were alternated. The stimulus presentations had a duration of 140 milliseconds. The naming latency was recorded with the use of a voice trigger connected to the computer. The variables investigated were handedness, visual field, word length and series (the procedure was carried out 5 times over a period of 4 hours distributed over two or three days). In a way, series (for providing reliability data) was the main variable of interest. Both an accuracy and a latency (reaction time) dependent variable were studied. The researchers found several significant main effects and interactions, but the main conclusion concerns the relatively high test-retest correlations over the 5 series, but the failure of the first test scores to correlate with the later ones. The researchers suggest that there were different processes and strategies used in the latter series compared to the first series. There is also a familiarization effect that influences the accuracy in identifying stimulus words. In general, these data imply that researchers in this area should use a large number of stimuli with each subject, and should have more than a single session.

Iaccino (1990) experimented with letter matching according to the subjects' gender, handedness, field-side of presentation and the instructions given. Subjects were required to recall either the letters or respective letter positions within 4 x 4 matrices flashed to the RVF or LVF. Furthermore, subjects received instructions prior to each trial cueing them as to the field in which the matrix would be positioned, (i.e., left, right or neither). His research indicated that right-handed men showed the predicted RVF advantage for letters while only left-handed subjects showed a LVF advantage for letter positions. The researcher believed that instructions contributed to the observed gender difference with letters. He suggested that right-handers exclusively possessed this asymmetrical organization. He also concluded that not all subjects process tachistoscopic information in the same manner. Right-handers bring their asymmetrical "blueprint" into the laboratory. He goes on to say that males use a specific attentional set for certain kinds of materials, while left-handers and women introduce some other component (which he did not identify) into the task.

Kim (1994) investigated three different stimulus types including words presented tachistoscopically. He concluded that some subjects initially display a left sensory field advantage and others a right sensory field advantage. As a result of being exposed to the trials, over time the mean asymmetry score of those subjects who start with a left sensory field advantage decreases, while the mean asymmetry score of those subjects who start with a right sensory field advantage increases. A

> "time-reversed control" analysis of laterality data show that the differential trends do not reflect a factor associated with the specific direction of time passage as would be predicted in the case of increasing stimulus familiarization. Regression of asymmetry scores toward the mean, or its equivalent, imperfect reliability of asymmetry scores, may be significantly attributable to short-term fluctuations in subjects' hemispheric arousal asymmetries (page 339).

<u>The Effects of More Complex Features of Stimulus Words</u>

Ellis and Shepard (1974) studied the recognition of abstract and concrete words presented in the LVF and RVF. Subjects were six right-handed men and six right-handed women selected from students and members of the general public. Subjects were tachistoscopically presented abstract (i.e., verbs) and concrete words (i.e., nouns) in balanced pairs (an abstract word paired with a concrete word) to both visual fields for a total of 20 trials. They were asked to identify the words or as many letters from the words as they could. The researchers concluded that both kinds of words were recognized more accurately in the RVF than in the LVF, and concrete words were more accurately recognized than abstract words. A major finding, however, was the interaction of word type with field, with concrete words better recognized than abstract words when they fell in the LVF, but the two types recognized equally well when they fell in the RVF. They discussed the popular notion that words going to the RH are transferred to be analyzed by the LH. These results support with normal subjects Gazzaniga's (1970) observations that some split brain patients could recognize some "noun-object" words with only their RH.

Marshall and Holmes (1974) studied gender, handedness and differential hemispheric specialization for components of word perception. They compared Fields by Frequency by Syntax by Sex by Handedness. A total of 144 subjects were used: 24 right-handed men and 24 right-handed women without familial left-handedness; and 24 right-handed men and 24 right-handed women with familial left-handedness; 24 left-handed men and 24 left-handed women with familial left-handedness. No mention of how the subjects were selected was noted in the article. Subjects were required to view 20 concrete nouns and 20 verbs all containing three letters. There were two arbitrarily selected frequency ranges (high and low). Words from each frequency category were paired together (high + low) and presented once in each visual field (each pair was presented once then reversed and shown again at a later time). They found that the LH is the primary mediator of the noun facilitation effect, while the right has the word-frequency advantage. They found no differences between handedness groups, however, they found significant differences in gender, males are more accurate than females in RVF presentations.

Hines (1976) studied the recognition of words in the LVF and RVF. He divided words into groups of verbs, abstract nouns and concrete nouns and presented combinations of words to both visual fields. All words used in the experimental trials were four letter. Familiar verbs, abstract nouns and concrete nouns all had an occurrence in general reading material of a least 100 per million. Unfamiliar verbs averaged an occurrence of 9.5 per million; the unfamiliar abstract nouns an occurrence of 15.75, and the unfamiliar concrete nouns an occurrence of 14.75. The researchers found that the familiar abstract nouns had a greater RVF superiority than the familiar concrete nouns. They found no difference in asymmetry for the unfamiliar abstract and concrete nouns. Greater RVF superiority for familiar abstract nouns was found for unilateral and bilateral presentations, with a fixation point at the center using a single digit as a focal point. Hines believed asymmetry for familiar concrete nouns was due to recognition of these words by both the right and LHs.

Hines (1977) repeated the previous (Hines, 1976) study of differences in tachistoscopic recognition between abstract and concrete words as a function of visual field and frequency but with a larger group of words, and with three levels of concreteness and three levels of frequency. Thirty-five right-handed subjects were used, all at least high school graduates. Thirty high frequency, thirty medium frequency and thirty low frequency words were used. The thirty words at each frequency level consisted of 10 words rated as highly concrete, 10 words as moderately concrete, and 10 as highly abstract. A fixation cross plus a center digit at fixation was presented for 900 milliseconds, followed by the stimulus card with the words for 40 milliseconds, then a blank white field. Hines found that overall recognition showed a positive correlation with the degree of concreteness. For high and moderate frequency words there was a RVF superiority, with an inverse correlation with degree of concreteness. Within the LVF the concrete words were better recognized than the moderately concrete or the abstract words. These data support the notion that some concrete words are being recognized by the RH.

Visual half-field word recognition as a function of syntactic class and imagery was investigated by Day (1979). Subjects were shown vertically oriented strings of letters in the LVF and RVF. They were asked to discriminate words from non-words. They found a significant RVF (LH) advantage for low imagery nouns and adjectives. The researcher concluded that RH word recognition is related to both imagery and syntactic class. There was an advantage with speed of response recognizing letter strings representing low imagery nouns, low imagery adjectives and both high and low imagery verbs, however, not for letter strings representing high imagery nouns and adjectives. The findings are consistent with findings in previous studies to the effect that the RH in the intact brain is capable of processing some high imagery nouns. The same is true in regard to RH processing of adjectives. Verbs appear to be processed predominantly by the LH regardless of their rated imagery. Therefore, the limits on the RH's receptive vocabulary in the intact brain may be a function of both word imagery and syntactic class.

Moscovitch and Klein (1980) were concerned with the effect of an interfering centrally presented stimulus (either a face, a word or a nonsense form) on visual field asymmetries of the perception of words and faces. Their study is derived from a consideration of different information-processing models of hemispheric organization, different theories of attention, and capacity limitations in information processing. For the purposes of the present review it may suffice to say that when comparing perception of faces with words they found that males and females were able to identify correctly faces presented in the LVF (RH) more often than the RVF (LH). They also found that the RVF (LH) had an advantage for the correct identification of words and that faces were identified correctly more often when the interfering stimulus was a word rather than as face or a nonsense shape, and the opposite results obtained when the peripheral stimuli were words.

Eight right-handed female undergraduate students showed faster reaction times in the RVF (LH) compared to eight right-handed male undergraduate students who showed a tendency, although not significant, toward a LVF (RH) superiority in complex semantic processing tasks (Hatta, Ohnishi, and Ogura 1982). Subjects were presented Katakana (Japanese) words that represent objects or animals in either large or small print and asked to discriminate whether the size of print was commensurate with the size of the object the word named. Subjects were asked to press the "Yes" button if the relationship of the physical size and the relationship of the real life size of the word pair was appropriate and to press the "No" button when the relationship was inappropriate. It was proposed that males process such stimuli with an imagery code and females with a symbolic and verbal code.

Left visual field (RH) superiority by men and women for matching low detail faces was demonstrated by Freeman and Ellis (1984). They also found that high information faces were better handled than low information faces when falling in the

RVF (LH) and that dissimilar pairs of faces were more accurately judged than similar pairs.

Jackman (1985) points out that most studies of laterality interactions with word part of speech imagery have assessed statistical significance (typically using ANOVA) with the word variables considered as a fixed effects, and subjects as a random effect. This permits generalization to another sample of subjects drawn from the same population of subjects, but only to another experiment using exactly the same words. It would be more appropriate to treat the word variables as a random effects, related to a random sample of words, and use a quasi-F test which if significant would permit generalization to another sample of words drawn from the same populations (of high and low imagery, for example). His first experiment used a group of college students to rate words with respect to imagery (a 7-point scale) and part of speech (how often used as a noun and as a verb). Frequency of word use was obtained from the Kucera and Francis, 1967, data set and the other word variables were equated for frequency of use. Experiments 2, 3, and 4 used samples of these words to investigate the relation of these word features to laterality. In the second experiment 50 right-handed male students were used to study possible laterality effects of imagery and part of speech. In the third experiment, identical with the second except for different subjects and different words, 50 subjects took part, 20 females and five males in the LVF group, and 13 females and 12 males in the RVF group. For Experiment 2, an F analysis that considered words (imagery, part of speech) as fixed effects showed significant main effects for imagery and a significant imagery by visual field interaction (larger imagery effects in the LVF). When considered as random variables, an F' analysis, no effects of word variables were found. For Experiment 3, the F analysis resulted in a significant main effect for imagery, but no significant interaction with visual field; and a significant main effect for part of speech and a significant interaction with visual field. Using an F' analysis there were no significant main effects of imagery and part of speech and no significant interactions with visual field. Combining the data from the two experiments and treating words as a fixed effect, a significant main effect of imagery and a significant interaction of part of speech with visual field were found. With words as a random effect, only the main effect of imagery and the interaction of part of speech with visual field were significant. Experiment 4 was concerned solely with word frequency and visual field, with the result that both the effect of frequency, and the interaction of frequency with visual field (greater frequency effect in the RVF) were significant using an F' analysis. In general, Jackman uses his results to question the general validity of previous studies with words considered as fixed effects.

Previous work had suggested a RH (LVF) superiority for Japanese subjects with respect to idiographic (as contrasted with phonetic) symbols, which seems reasonable in terms of other evidence for RH superiority with respect to nonverbal spatial stimuli. However, an opposite effect had been found for Chinese subjects with similar stimuli. In a related study Zhang and Yang (1986) asked Japanese and Chinese subjects to recognize idiographic as well as phonetic characters in their native languages as well as English words, presented to either RVF or LVF. A RVF (LH) superiority was found for all stimuli, contradicting some of the previous research results. These results are explained partially in terms of differences between the visual spatial frequency characteristics (as described in the review by Christman, above) of the present experiment favoring LH (RVF) recognition effects and previous research favoring RH effects. The strong vocal behavior occurring even to ideographic symbols in experienced users may also be relevant to the performance of Zhang and Yang's Japanese subjects who had lived in China for some time and were moderately experienced users of the Chinese ideographic stimuli. In general the Zhang and Yang research supports the general results consisting of RVF (LH) superiority for verbal stimuli, whether they are ideographic or phonic.

Emotional Variables and Laterality

Rizzolatti, Umilta, and Berlucchi (1971) found stimulus dependent hemispheric differences in males. The subjects had faster reaction times for discriminating letters in the RVF (LH) than in the LVF (RH) and a faster reaction time for recognizing "positive" or "negative" faces in the LVF (RH) than in the RVF (LH). The experimenters also reported that reaction times did not vary as a result of responding with either the right- or left-hand (responses required pressing a key) and that errors of commission and omission did not show any significance relative to the side of stimulus presentation and the hand used to respond.

The main purpose of the next study was to verify that the RH was capable of some reading ability if emotional words were involved, however the way the data was collected makes it quite relevant to the general issue of laterality with respect to visual stimulus presentation. Graves, Landis and Goodglass (1981) researched gender differences for visual recognition (as words) of emotional and non-emotional tachistoscopically presented words. They cite clinical and experimental evidence that indicates the RH has a better capacity for reacting to emotional non-verbal stimuli. They wanted to test the hypothesis that this capacity would generalize to written verbal stimuli. A set of 12 emotional words were selected by asking 36 people who did not participate in the actual perceptual study to rate a set of 50 four-letter words. Both males and female selected the stimuli from a list of 50 four-letter words. The word list did not include any slang, obscene or taboo words. The 12 most frequently selected words comprised the stimuli for the presentations. Twelve non-emotional four-letter words were matched to the emotional words by the frequency of use in the English language. Twenty-four nonsense words were made by rearranging the letters of the words used as presentations. All nonsense words were pronounceable. Twelve male and twelve female right-handed subjects between the ages of 19 and 30 participated in the experiment proper. Each word appeared in both visual fields. Half of the presentations contained two nonsense words and half contained one word and one nonsense word. Exposures were for 150 milliseconds. Subjects were required to press four separate keys with their index and middle fingers of both hands at the beginning of the trials. The subjects then raised the middle fingers of both hands when they recognized an English word. In that way the reaction times could be recorded. Emotional words were better reported in the RVF. The scores for emotional words in the LVF were also significantly higher than scores for the non-emotional words. The emotional-non emotional words in the RVF did not significantly differ. The emotional word advantage was larger in the LVF for males compared to females, however, the advantage was larger in the RVF for females compared to males. The researchers believe their results demonstrate that if emotional words are recognized better in the LVF it must be the RH that is recognizing them. The results also demonstrated that there is a significant effect in males of the emotional content in the LVF, however, not in the RVF. This lends to the notion that there are two different processing systems, one in each hemisphere.

Male and female college students were involved in a study by Shearer and Tucker (1981). The students viewed color slides of sexual (individuals and heterosexual couples either posing seductively or involved in depictions of intercourse) or aversive (morgue corpses, child abuse victims, starving children, snakes, rats, etc.) content. They were given the instructions either to facilitate ("turn on") or to inhibit ("turn off") any emotional arousal, but no specific instructions were given as to the method subjects were to use to accomplish this. By this procedure the experimenters were able to determine what methods students used to facilitate or inhibit stimuli (the so called "creative ability") and categorized these written descriptions as analytical-verbal or global and imaginal. Relative hemispheric activation was assessed using auditory attentional bias probes. Subjects were presented with a tone to either ear and asked to determine which side the presentation was on. There seemed to be a "contralateral shift in attention during relative dominance of one hemisphere and upon the contralateral-ipsilateral input competition in the auditory neural system" (p. 88). In this way the researchers also compared facilitation and inhibition strategies by subjects. The researchers found that analytic and verbal thinking were used more frequently to inhibit arousal whereas global and imaginal cognition were most often used to facilitate emotion. They also found greater arousal when subjects were asked to facilitate either sexual or aversive arousal compared to inhibiting such arousal. As a result the aversive stimuli had a greater right hemispheric activation effect for perception during the "turn on" than the "turn off," however, the sexual stimuli had no effect on hemispheric asymmetry during either response condition.

Safer (1981) investigated the processing of emotional facial expressions by males and females while using different perceptual strategies--half of the subjects were told to empathize and half were told to label the facial expression. Subjects were presented with a picture of a face (with an emotional expression) in the center of the visual field for eight seconds. Half of the subjects (12 male and 12 female) were then presented with a second facial emotion in the RVF or the LVF for 150 ms and the other half were presented the second face for 50 ms. They were then asked to judge whether the second face had the same emotional expression as the first or a different one. Males were more accurate when the second face was in the LVF than in the RVF. Females showed no visual field asymmetries, but they were more accurate than males when the second face was shown in the RVF. Both males and females given the instruction to empathize showed a LVF superiority in recognizing the emotional expressions, but with the label instructions the accuracy in the two visual fields didn't differ. In a second experiment the subjects were simply asked to say whether the second picture of a face was the same picture as the first--not the same emotion. Both males and females were more accurate when the second face appeared in the LVF, and there were no gender differences in the degree of asymmetry. It was concluded from the two experiments that

> gender, hemisphere, and perceptual strategy differences exist in access to verbal and imagery codes for decoding emotional expressions. Females have privileged access to left hemispheric verbal codes for emotion and this access underlies the gender difference in hemisphere specialization in recognizing emotional expressions (p. 86).

Strauss (1983), using a somewhat smaller sample attempted to replicate the Graves et al. study, and did find a greater superiority for emotional over non emotional words in the LVF, but it was not statistically significant. In an additional study she used a set of emotional stimulus words that was more balanced than the almost exclusively negative set of emotional words used by Graves et al. The results of this experiment showed an overall greater accuracy for words presented in the RVF, and an overall advantage for positive words, which she interpreted as due to the fact that the negative words were less common.

Hirshkowitz, Karacan, Thornby, and Ware (1984) found temporal lobe electroencephalograph (EEG) asymmetries during sleep related penile erections in right handed young adult males. Greater right than left hemispheric wide band integrated EEG amplitude attenuations were found with maximum tumescence during REM sleep, but were not found in parietal lobe recordings. This suggested higher right hemispheric temporal lobe activation during nocturnal penile tumescence, and that central nervous system electrophysiological changes occur predictably in relation to nocturnal penile tumescence activity.

An electroencephalographic study involving correlation of penile tumescence with temporal and occipital EEG amplitude integrated over 5 second epochs was done by Cohen, Rosen, and Goldstein (1985). Using both auditory and visual sexual stimulation they found a pattern of right temporal lobe activation in association with maximum penile tumescence in normal men. Sexually dysfunctional men appeared to show the right temporal activation to auditory stimuli but to a lesser degree with visual stimuli. They interpret their results as being consistent with the body of literature on cerebral asymmetry.

Unaware of the Graves et al. study, Wierenga (unpublished, 1986) set out to study perceptual defense using split visual field presentations of emotionally laden stimuli (photographs from an atlas of emergency room surgery) and "neutral" stimuli (travel posters). With the subject concentrating on a small fixation light, paired stimuli were presented simultaneously to both the RVF and the LVF. The subjects were then asked to rate the presentation as negative or positive using a five point scale. She found a large effect in that the stimuli presented to the LVF and hence projected to the RH governed the evaluation of the emotional content. Thus, while she found no evidence of a lateralized perceptual defense effect, she gave strong confirmation to the results of Graves et al. (1981).

In three experiments Marcin (1991) studied lateralization of emotional words that differed in emotional intensity (high, moderate, low) and in valence (positive, neutral, negative). The goal was to determine the extent to which previous laterality effects, especially those of Graves et al. described above, are controlled in part by the intensity and the valence of the emotional words, and not just by their emotionality. A large number of words were rated by male and female college students as to their imagery (low imagery to high imagery on a 7-point scale) so that this variable could be equated for with the different sets of words. Different students rated the words as to their affect (extremely negative through neutral to extremely positive, on a 7-point scale with 1 being extremely negative and 4 being neutral). Fifteen words were selected for each of the 7 groups (high negative, moderate negative, etc.). The groups were also equated for general word frequency. From the words, a set of pronounceable non words were constructed. The stimuli were presented for 150 ms, unilaterally in the first and second experiment, and bilaterally in the third. The subjects pushed one button on a panel if they saw a word, and a different button if the saw a non word. The dependent variables were the accuracy and reaction time of each response. Of the many main effects and interactions that could be examined in Experiment 1, only one was significant. The highly positive words were more accurately identified in the RVF than in the LVF. A smaller, and not statistically significant opposite effect with respect to the highly negative words was also seen--highly negative words were more accurately processed in the LVF than in the RVF.

Experiment 2 was an unsuccessful attempt to generate a stronger RH effect for negative words by producing a generally negative condition during the experiment--threatening to deliver a shock during the experiment. The threat manipulation appeared only to make the subjects generally less accurate in their word vs. non word judgments. Experiment 3 was identical to Experiment 1 except that the stimuli were presented bilaterally. The main result of this analysis was a very clear RVF superiority with respect to both the accuracy and the reaction times (shorter latencies) for words in general, and for males a greater accuracy of processing emotional words in the LVF

(RH) than non emotional words. A few other interactions were statistically significant but small and not easily interpreted.

Waldinger and Van Strien (1995) studied selective hemispheric activation and repression of negative, neutral and positive conditions. The task for the subjects was to identify three letter combinations tachistoscopically presented after viewing a word that was either neutral, positive or negative in its meaning. Subjects were divided into two groups according to their score (high or low) on the Defense Mechanism Inventory repression index (REP). The researchers found that with both positive and negative emotional word conditions, the high-REP group exhibited significant performance enhancements in the RVF. They hypothesized that this activation of the LH indicates that repression is a function of this hemisphere. In the negative word condition, the high-REP group exhibited a decrease in performance in the LVF, while the low-REP group tended to show a performance decrease in the RVF. In the high-REP subjects the RH is inhibited during the negative condition. Apparently in the low-REP subjects the LH is inhibited.

Summary

In view of the many complex and interacting variables found to be related to laterality, and in view of a reasonable number of contradictory findings it is not possible at the present time to summarize the results presented above in any simple way. It is fairly clear that efforts to ascribe differential visual field effects to non-neurological variables have not been successful. On the other hand, the details of the actual stimulus features that produce laterality effects, that are differentially related to different LH and RH functions, are still under very active investigation. With respect to emotional variables, the original RH superiority in processing of emotional input for males has been found in number of studies, and also the less noticeable asymmetry in this respect for females, but the interaction of these effects with word frequency, concreteness, parts of speech, and a number other important variables seems far from clear at the present time.

Purpose of the Present Study

The present study concerns hemispheric asymmetries in the perception by men and women of split-field computer-presented sexual and neutral stimuli in the form of words presented to either of the visual fields. There is some evidence concerning gender-by-hemisphere interactions with respect to emotional (but not sexual) nonverbal stimuli, with emotional (but not sexual) verbal stimuli , and with nonverbal sexual stimuli (pictures of sexual behavior), with males more RH dominant than females with all three kinds of stimuli, but at present there are no data regarding sexual verbal stimuli (words). Emotional words are interesting stimuli because the linguistic nature of the stimuli would favor LH specialization, but the emotionality might favor RH specialization. Sexual words are of further interest because other laterality studies with emotional words have used words that were primarily negative in implication (fear, hate, corpse), or positive emotional words that were rather bland compared with the negative ones (hope, truth, sunset) and sexual words for many adult subjects would seem to differ considerably in being neither negative nor bland.

Because of the verbal nature of the stimuli it is reasonable to suppose that both males and females will be more accurate when the words are seen in the RVF (right visual field) going to the LH than when they are seen in the LVF (left visual field). However, for the males the sexual/emotional nature of the stimuli should result in some shift toward LVF, RH superiority for the sexual as compared with neutral words. Females will be expected to show no such shift, or perhaps a smaller one.

METHOD

Subjects

The subjects were 10 right-handed males (36 to 53 years in age, average 44) and 10 right-handed females (26 to 45 years in age, average 33). Some were recruited from the general population in and around Kalamazoo, Michigan; and some were coworkers, or acquaintances of the researcher. None had any knowledge of the research topic until they were briefed for the research sessions. All but two of the male subjects (who were professional tradesmen) had a Bachelors degree or higher. A handedness questionnaire (Annett, 1970) was completed by prospective candidates. Only subjects who answered all items on the questionnaire as right-handed were included in the current study.

Subjects identified themselves by name by signing the informed consent form. After the informed consent was signed subjects' names were not associated with their responses to the presentations of the research. From that point on subjects were identified as male or female and by an assigned number, e.g., M#1 (male subject one). Subjects who volunteered and completed all 60 presentations in condition 1 (C1) and condition 2 (C2), which took approximately 45 minutes, were counted as subjects. Subjects were volunteers and were not paid for their participation.

Setting

The experiment took place in a small room at Western Michigan University (North Hall room # 250) and in the researcher's office located off the campus of

Western Michigan University. Each subject signed a consent form prior to participating in the research.

Apparatus

An Apple PowerMac and an Apple IIci were the computers used for stimulus presentations and data collection. The screens were of identical size. The commercial computer program Flash Words was used in the research. Information about the computer program Flash Words (Cool Spring Software, P. O. Box 130, Woodsboro, Maryland 21798, phone number (301) 845-8719 or e-mail: Coolspring@aol.com or http://users.aol.com/CoolSpring/CSpring.html) used in the present study is available by the researcher for inspection upon request. Although this apparatus is not an actual tachistoscope, but rather a computer arranged form of brief half-field visual presentations, these presentations will be referred to as tachistoscopic in the remainder of this document.

Stimulus Words

Words used for the stimuli in the current study were obtained from male and female psychology graduate students at Western Michigan University who listed the 20 words with the most clearly sexual meanings they could think of. The subjects used to determine the stimulus words did not participate in any other aspects of the research. The 20 most common sexual words from those lists were used as the sexual words in the research. The same subjects also listed words that they considered void of sexual meaning (neutral). The 20 most common neutral words from those lists were used as the neutral words in the research. The 20 sexual words were: breast, clitoris, cock, cum, cunt, dick, fuck, fucker, horny, kiss, lust, passion, pecker, penis, pussy, sex, sexual, sexy, tits, and vagina. The 20 neutral words were: apple, book, car, cat, chair, cold, desk, dog, door, fan, floor, house, light, pen, pencil, road, shoe, stove, table, and tree. Subjects who completed the word survey were asked to identify themselves as male or female and by their age.

Procedure

The experiment consisted of two parts. In Condition 1 (C1) individual subjects were presented with 20 paired combinations of words, one sexual and one neutral, in a fixed random order. Each subject viewed the presentations in the same order. The words were not randomized for each subject because of the complexity of setting-up multiple sets of evenly spaced words in the computer program. In Condition 2 (C2) one word was presented at a time in either the right visual field (RVF) or left visual field (LVF) in a fixed random order, and as with C1, each subject viewed the presentations in the same order. The sexual and neutral words were those selected as described above.

The paired and individual words were presented on a computer screen for 200 milliseconds, a duration sufficient to allow subjects to perceive the stimuli being presented without being able to visually focus on the word(s), and the duration is a rough average of those used in other similar studies. The endings of words in the left visual field (LVF) and the beginnings of words in the right visual field (RVF) were approximately 2 degrees from the fixation point. Subjects were asked to focus in the center of a small circle in the center of the computer screen. A variable interval ranging from 2 to 20 seconds elapsed between each stimulus presentation to avoid the subjects anticipating the presentations.

In C1 (Condition 1) the word combinations were of two categories: (1) sexual/neutral, in which the LVF (left visual field) was presented with sexual words and the RVF (right visual field) with neutral words; and (2) neutral/sexual, in which the LVF was presented with a neutral word and the RVF with a sexual word. In this condition there were 20 paired presentations of the stimuli. A prompt appeared on the computer screen that asked for a response rating. Subjects vocally rated each presentation on a scale of 1 to 5, with 1 for neutral and 5 for most sexual, and with 2, 3, and 4 as intermediate levels of sexual meaning. The researcher entered the response of the subject by using the computer keyboard. A tape recording of the subject's vocal responses was also made to permit a reliability check on the researcher's keyboard entries.

After the subject vocalized the rating, a second prompt appeared asking how confident the subject was in the rating (not at all, somewhat, or very). Again, the researcher entered the responses of the subjects using the computer keyboard. This prompt is a part of the commercial program, and could not be altered. The confidence ratings were somewhat correlated with the value of the rating, with 1 and 5 generally being rated with high confidence, and the intermediate values, as would be expected with less confidence, but no use was made of these ratings in the analysis of the data.

After the confidence ratings, a third prompt appeared on the computer screen asking whether the response was correct or incorrect. The program is a commercial one that was designed for a neuropsychologist to use while interviewing a client, and the program could not be altered to eliminate this feature. A mouse click on a "correct" or "incorrect" button on the screen had to be made for the program to progress to the next stimuli. For the purposes of this study the "correct" button was always selected. Subjects were made aware of this irrelevant feature of the procedure prior to the study (see instructions to subjects below). A final screen prompt told the researcher to run another session, until all 20 presentations in C1 and all 40 presentations in C2 were completed.

Before viewing the presentations in C1 subjects were given the following instructions:

> The research you are participating in is divided into two parts. In Condition 1 a series of paired words will be presented very briefly on the computer screen, one word in the right visual field and one in the left visual fielThe research you are participating in is divided into two parts. In Conditiond. You must fixate your focus in the small circle placed in the center of the computer screen at all times during the presentations. After each presentation you will be prompted by the computer to rate whether the presentations are neutral or sexual in nature on a scale of one to five, one being neutral and five being most sexual. The computer will then prompt you for the confidence of your response. The confidence levels are none, somewhat, and very. Finally, a prompt will appear that asks if the response is correct or incorrect. This prompt cannot be edited out of the commercial program, therefore, for the purposes of this study all responses will be entered as correct, whether your responses are correct or not.
>
> Remember, you are to give your first impression of the combination of both words briefly presented on the screen. You must fixate your gaze at the center of the computer screen in the small circle dot at all times during the presentations.
>
> You are required to give quick verbal responses without thought. In other words, you must quickly give your first impression. Again, remember to fixate on the center of the small circle at the center of the computer screen. You will be reminded of this throughout the session. Remember, you are not obligated to participate in this study and may withdraw at anytime without penalty. Do you have any questions so far?
>
> You will be presented with a practice session of eight presentations of neutral word combinations similar to what will appear in Conditions 1 and 2 to allow you to learn what to expect during the experimental presentations. The words presented in the practice session are not used in the presentations during the two experimental conditions.

In the bilateral presentation mode of C1, the rating as to sexuality would provide information as to the visual field that was being affected, because the sexual stimuli were only in one visual field. For example, if the subject rated the presentation as a 5, 4, 3, or 2 when the sexual word was in the RVF, but gave a rating of 1 when the sexual word was in the LVF, this implies that the RVF (and the LH) was processing the sexuality of the stimuli and the LVF (RH) was not.

In C2, one word was presented at a time in either the RVF or LVF. The words used in C2 were the same words used in C1, however, they appeared in the opposite visual field (VF) from their location in C1. Words in C2 were also presented in a fixed random sequence with half presented to the LVF and half to the RVF comprising four conditions: (1) sexual/blank, where a sexual word was presented in the LVF and a blank computer screen was in the RVF; (2) blank/sexual, where a blank computer screen was in the LVF and a sexual word was presented in the RVF; (3) neutral/blank, where a neutral word was presented in the LVF and a blank computer screen was in the RVF; and (4) blank/neutral, where a blank computer screen was in the LVF and a neutral word was presented in the RVF. Subjects rated each presentation on a scale of 1 to 5, 5 being the most sexual, 1 being neutral, and 2, 3, and 4 as sexual gradients in between.

Before beginning C2 the following instructions were read:

> In Condition 2 you will be viewing one word at a time in either the right or left visual field. These words will appear in a random fashion. As in Condition 1 you must immediately rate the presentation as sexual or neutral.
>
> Remember you must fixate your gaze in the center of the small circle in the center of the computer screen at all times during the presentations. You will be reminded of this several times during the session. Again, you are not obligated to participate in this study and you may withdraw at anytime without penalty.

In the unilateral presentation mode of C2, the extent to which each visual field was affected by the sexuality of the word was simply a function of the sexuality of the ratings when the sexual words were in that visual field.

Dependent Variable

The subjects' ratings of the sexuality of the words on a scale from 1 to 5 was the main dependent variable in this study. (A three-value rating of the subjects' confidence in their ratings is also obtained, and the levels of confidence will be mentioned in the Discussion section of this study.)

When subjects had completed their C2 ratings they were asked to provide a non tachistoscopic rating of the words that had been used in the study. It was recognized that although the words were considered most sexual by those who contributed these words, it was quite possible that some of them might not be considered very sexual by the actual subjects who contributed the experimental data. For example, it was quite possible that for a particular subject "vagina" might be associated with a medical context, and be assigned a sexual rating value of 4 rather than 5. Subjects were given a rating sheet containing the words listed in alphabetical order, one column sexual and one column neutral, with a space next to each word provided for them to rate the sexuality, if any, on a scale of 1 to 5. These post-experimental ratings can be considered the ratings that would have been provided during tachistoscopic presentations if the subject's judgment had been completely accurate, although as mentioned in the Discussion this is a very questionable assumption, considering the different social contexts of the two kinds of ratings. In any case, these ratings were the ones referred to as expected ratings (ER) and compared with actual ratings (AR) in calculating rating accuracy.

Data Analysis

In C1 each subject contributed 10 ratings (from 1 to 5) for the 10 bilateral presentations when the sexual word was in the LVF, and another 10 ratings for the presentations when the sexual word was in the RVF. The 10 ratings for each type of presentation were summed (sums could be as high as 50 and as low as 10) and each subject's two sums were the scores used in the Rating Sums analysis, and the raw scores upon which the Yes/No analysis was based. Because there were 10 males and 10 females, each contributing a sum for each of the two kinds of presentation, the C1 analysis was based on a total of 40 such sums (20 for males and 20 for females). In the unilateral presentations of C2 each subject contributed 10 ratings for the sexual words when they were presented in the LVF, 10 when they were in the RVF, and 10 for the neutral words in the LVF and 10 when they were in the RVF. There were thus 4 rating sums for each subject, 40 for the 10 males and 40 for the 10 females, with the C2 analysis based on a total of 80 rating sums.

With respect to accuracy, there were two kinds of analyses, the Yes/No and the Expected/Actual. For C1, because there was a sexual word either in the LVF or the RVF on every presentation, a completely accurate response to the bilateral perception would have been always to provide a rating indicating some sexuality. In the Yes/No method of analysis, if the rating for a presentation was 2, 3, 4, or 5 the presentation was counted as sexual for the visual field that contained the sexual word. This method of analysis is equivalent to asking the subject if the presentation was sexual or not, to which the subject responds either "yes" or "no." A total of 10 sexual words were presented in each visual field . An accuracy percent correct score was calculated by dividing the number of ratings above 2 when the sexual word was in that visual field by 10 (which would have been perfect accuracy) and multiplying by 100. There were 20 accuracy percent values for males (10 LVF and 10 RVF) and 20 for females (10 LVF and 10 RVF), making a total of 40 dependent variable values in the C1 Yes/No analysis.

In the Expected/Actual analysis for C1, the post-experimental ratings (the expected ratings, or ER) of the sexual words were compared with the actual ratings (AR) provided during the bilateral tachistoscopic presentations. The subjects were asked to rate what they saw in terms of sexuality. Because there was always a sexual word present, either in the LVF or the RVF, this method of analysis assumes that a perfectly accurate response would have been to provide the post-experimental rating that was given for that word, irrespective of the visual field in which the word appeared. By comparing a subject's ER (expected rating) to his/her AR (actual rating) given during the tachistoscopic presentations, an accuracy value could be determined that was based on that subject's own post-experimental ratings of the sexual and neutral words. Thus, if a subject rated a sexual word as a 4 in the post-experimental rating, a completely accurate experimental rating would have been to assign that word a 4 when it was seen tachistoscopically.

To obtain a percent accuracy value, an ER/AR discrepancy (ER - AR) was divided by the ER minus 1, and multiplied by 100. This consists in judging an erroneous rating in terms of the maximum error that could have been made. The greatest discrepancy possible for a sexual word was the difference between 1 (a completely erroneous rating that consists in judging it to be neutral in sexuality) and that subject's ER for that word. For example, if a subject rated a word post-test as a 4 (the ER) and gave the word a 3 (the AR) during the tachistoscopic presentation, the difference between 3 (AR) and 4 (ER) is 1. This discrepancy was then divided by the maximum discrepancy possible in this case, a difference between 1 and 4, which is 3. This error value (1/3, or .33) was multiplied by 100, and subtracted from 100 providing an accuracy value of 67%.

The Rating Sums analysis for the unilateral presentations of C2 was similar to the Rating Sums analysis for the C1 presentations, except that each subject provided four rating sums (LVF sexual, LVF neutral, RVF sexual, RVF neutral) instead of only two; and the total data set for the C2 analyses involve 80 instead of 40 scores. The C2 Yes/No analysis was like the one for C1 except that each subject contributed four instead of only two scores. For sexual word presentations, any rating of 2 to 5 was counted a yes, and a rating of 1 counted as a no. For neutral word presentations only a rating of 1 was counted as a yes, and any other rating was counted as a no. A percent score similar to the one in C1 was thus available for each word type (sexual and neutral). Each subject contributed four such accuracy percent scores.

The Expected/Actual method of comparison for C2 was similar to that for C1 except that there were accuracy scores for the neutral word presentations as well as the sexual word presentations. For both word types the post-experimental ratings (the expected ratings or ER) of the words were compared with the actual ratings (AR) provided during the tachistoscopic unilateral presentations. Subjects were asked to rate what they saw in terms of sexuality. Perfectly accurate responses would have been to give the post-experimental ratings that had been given for the words--ratings from 2 to 5 for the sexual words, and 1 for the neutral words. By comparing a subject's ER (expected rating) with his/her AR (actual rating) (AR), an accuracy value could be determined that was based on that subject's own ratings of the sexual and neutral words.

Percent accuracy values were calculated as with the C1 Expected/Actual analysis. For neutral words the difference between the AR and ER was divided by the highest possible rating difference between the ER and 1 to correct for the highest possible difference in rating the subject could have made for the presentation of that word (the difference between 1 and 5). Note that for the ER for neutral words only one subject rated a word higher than a 1, a male who rated "cat" as a 2. Therefore, except for this one subject's rating of 2, the error calculations for neutral words always used a dividend of 4 per word. For example, if a subject rated a neutral word as 1 for his/her ER and rated the same neutral word as a 3 during the tachistoscopic presentation, the difference between the ER and AR was 2, which was divided by the highest possible difference between 1 and 5 which was 4. The error rate would be 2/4 or 50%. The accuracy rate would be 100% minus 50% which is 50%.

There was also a visual field correction for both C1 and C2 ratings. Some of the subjects in their post-experiment ratings assigned values of 4 or even 3 to some of the sexual words. If there were more such low-rated sexual words assigned to one of the visual fields than the other, the ratings during the experiment would be expected to be lower for that visual field for this reason alone. To correct for this possible imbalance with respect to visual field location of the low-rated sexual words, the ER was totaled for each word for each visual field for each subject. If there was a difference between the subject's total ERs in the two visual fields it was corrected for by taking the difference between the expected totals of the LVF and the RVF, and dividing by 2. That number of points was then added to the lower visual field AR totals and subtracted from the higher rated visual field AR totals. For example, one subject's total ERs for the sexual words in the LVF was 43 and the total ERs for the RVF was 41. The difference between the LVF and the RVF is 2. Two divided by 2 equals 1. One would be added to the lower visual field total and 1 subtracted from the higher visual field total.

Independent Variables

The primary purpose of the study was to determine the effect of visual field (left and right) in combination with the subject's gender on the sexuality ratings of the stimuli. In C1 written sexual words were paired with written neutral words, one in each of the two visual fields (left and right). In C2 sexual and neutral words were paired with blank fields, i.e., the pairings were sexual/blank, blank/sexual, neutral/blank and blank/neutral.

Experimental Design

The experimental design for C1 was a mixed within-subject (visual field--left or right), between groups (male or female) arrangement. In C2 the design was a mixed within-subject (visual field), within-subject (sexual and neutral words), between groups (male or female) arrangement. Individual data were graphed, and an analysis of variance was performed on the ratings. The two conditions were treated as two different experiments, and analyzed separately.

RESULTS

For subjects to be included in this study it was necessary that they see some words in the 200 ms bilateral and unilateral presentations. Six subjects, two males and four females, were not able to detect any stimuli presented in either condition as a word. For those subjects the sessions were terminated about half way through C2 (Condition 2) and their data were not used in this study.

Reliability of data coliection was determined by the researcher playing back the tape recordings of the sessions and writing down the subjects' responses on response sheets designed for that purpose. All data were recorded in this way and then were compared to the printed computer data records generated by the Flash Words computer program. No discrepancies were found.

Condition 1 Rating Sums Analysis

The rating sums are shown in Table 1 and Figure 1 on the next page and all main effect means for Condition 1 are shown below in Table 2 two pages over. As is apparent from the figure, and from the main-effect means there is no gender main effect, but there is a very large visual field effect (LVF vs. RVF) consisting of much higher ratings of the sexuality of what was seen when sexual words were in the RVF than in the LVF (statistically significant with $P<.001$, see Appendix F, Table 9). This is to be expected from the fact that verbal stimuli are much more accurately perceived by right handed subjects in the RVF, going to the LH (left hemisphere) than in theLVF going to the RH (right hemisphere). The interaction between gender and visual field was not statistically significant ($P>.10$), but is in the direction of the LVF/RVF discrepancy being larger for males than for females.

Table 1

Condition 1 Rating Sums

Males											
Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	30	10	14	18	12	13	33	26	31	12	19.9
RVF	50	36	34	37	36	29	36	40	28	31	35.7
Females											
Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	35	29	26	16	28	19	20	13	10	18	21.4
RVF	41	19	34	36	43	28	28	27	38	27	32.1

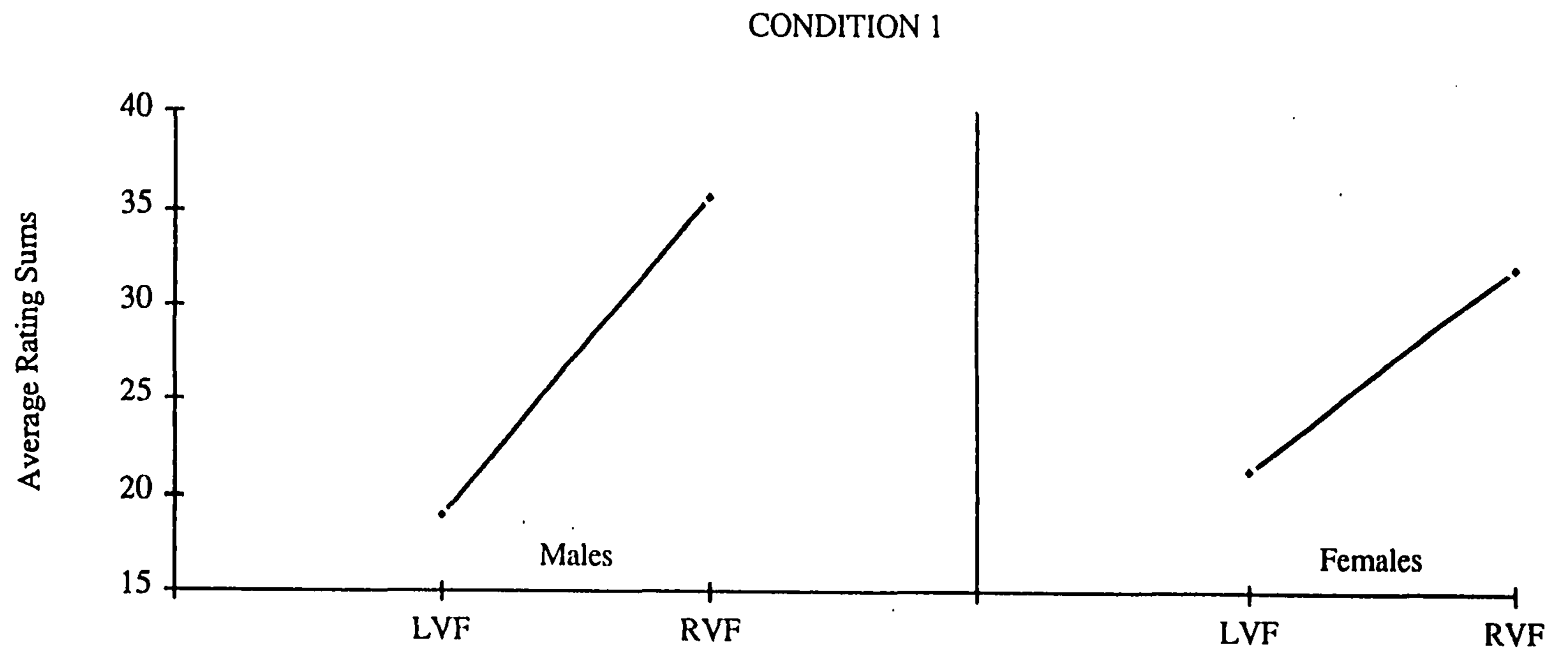

Figure 1. Condition 1 Average Rating Sums.

Table 2

Main Effect Means for Condition 1

	Males	Females	LVF	RVF
Rating Sums	27.80	26.75	20.65	33.90
Yes/No	63.5	61.0	45.0	79.5
E/A	65.3	65.7	53.8	77.2

Condition 1 Yes/No Analysis

The yes/no percent accuracy values (over the 10 words) for males and females for C1 are shown in Table 3 and Figure 2 next pages over. As can be seen in the figure and from the main-effect means (Table 2 above) there was no main effect for gender, but both males and females had higher accuracy when the sexual words were in the RVF than in the LVF ($P<.001$, see Appendix F, Table 10). Considering only the RVF, males gave higher ratings than females when the sexual words were in this visual field. In the LVF, males gave lower ratings than females when the sexual words were in this visual field, however this visual field by gender interaction was not close to statistically significant ($P>.10$, Appendix F, Table 8).

Table 3

Condition 1 Yes/No Analysis

Males

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	70	0	10	50	10	30	90	80	80	10	43%
RVF	100	80	70	90	90	80	100	90	70	70	84%

Females

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	90	60	70	20	80	30	70	10	0	40	47%
RVF	90	50	90	70	100	70	80	60	80	60	75%

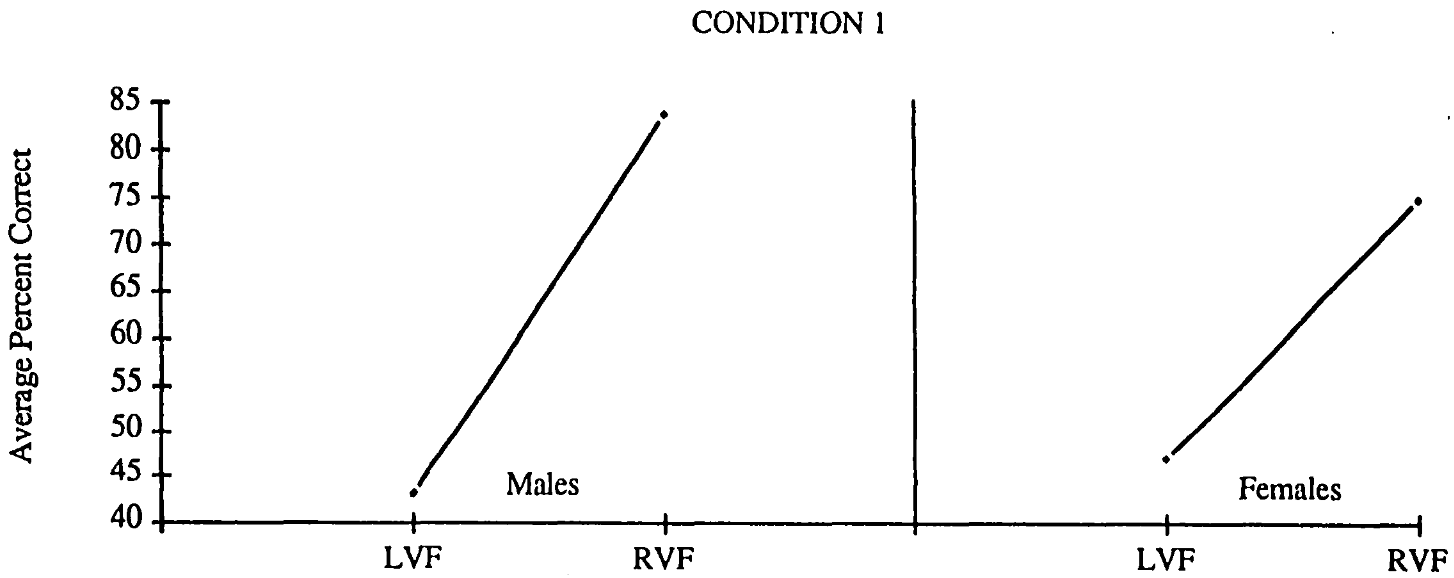

Figure 2. Condition 1 Average Percent Correct, Yes/No Analysis.

Condition 1 Expected/Actual Analysis

The data for this analysis are shown in Table 4 and Figure 3. It can be seen in Figure 3 and from the main-effect means (Table 2 above) that both males and females demonstrated higher sexual ratings when the sexual words were in the RVF than in the LVF ($P<.001$, Appendix F, Table 11). Males gave slightly higher sexual ratings in the RVF than females, and slightly lower sexual ratings when the sexual words appeared in the LVF than females, but this interaction was not close to statistical significance.

Condition 2 Rating Sums Analysis

The rating sums for males and females for C2 are shown in Table 5 and Figure 4 and all Condition 2 main-effect means are shown in Table 6. As is to be expected, there was a large difference between sexuality ratings for sexual vs. neutral words, irrespective of gender or visual field ($P<.001$, Appendix F, Table 12). There was no gender main effect and gender did not interact significantly with either word type (sexual vs. neutral) or visual field (all three F value have probabilities greater than .10, Appendix F, Table 12). There was a large visual field effect ($P<.001$, Appendix F, Table 12). This effect consisted in both male and female ratings of sexual and neutral words being higher more often in the RVF than they were in the LVF. There were no other significant effects.

Condition 2 Yes/No Analysis

Data for the "Yes/No" method of comparison are presented in Table 7 and Figure 5. It can be seen in the figure, and from the main-effect means (Table 6)

Table 4

Condition 1 Expected/Actual Analysis

Males											
Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	66	24	34	36	48	36	79	56	97	38	51%
RVF	95	74	74	74	96	65	86	78	68	83	79%
Females											
Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF	87	65	59	40	85	59	45	41	29	56	57%
RVF	80	49	69	80	86	70	64	72	93	88	75%

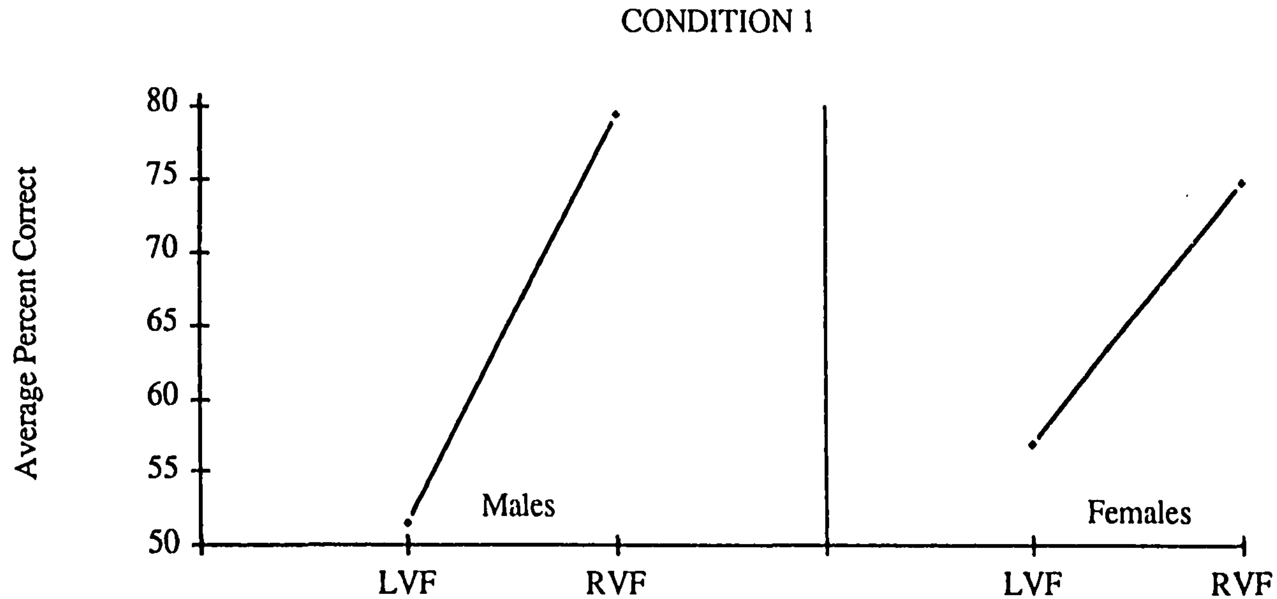

Figure 3. Condition 1 Average Percent Correct, Expected/Actual Analysis.

Table 5

Condition 2 Rating Sums

Males

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	33	31	16	27	31	37	36	24	33	33	30.1
LVF-Neutral	16	10	12	11	18	20	14	25	12	11	14.9
RVF-Sexual	50	40	37	38	29	36	31	32	19	30	34.2
RVF-Neutral	18	11	11	10	16	14	21	30	11	19	16.1

Females

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	41	29	35	33	31	32	30	21	24	24	30.0
LVF-Neutral	15	20	21	10	17	14	20	11	14	16	15.8
RVF-Sexual	43	41	35	43	33	38	37	26	29	35	36.0
RVF-Neutral	22	15	30	12	22	10	26	14	13	21	18.5

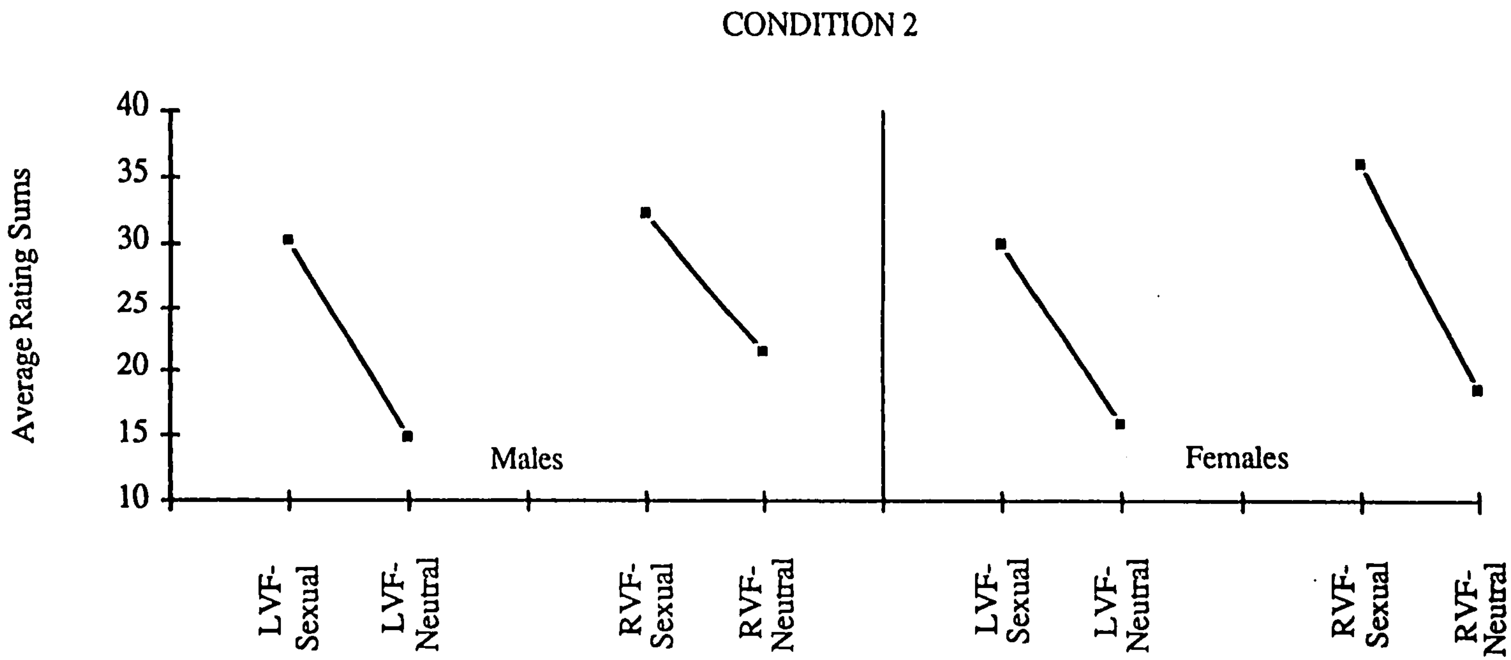

Figure 4. Condition 2 Average Rating Sums.

Table 6

Main Effect Means for Condition 2

	Males	Females	LVF	RVF	Sexual	Neutral
Rating Sums	23.8	25.1	22.7	26.2	32.6	16.3
Yes/No	74.7	72.5	72.2	75.0	80.7	66.5
E/A	72.1	71.7	69.8	73.9	59.6	84.2

that the only main effect was with respect to word type, with sexual words being rated more accurately than neutral words (P<.01, Appendix F, Table 13). The visual field by word type interaction was not statistically significant (P>.10, Appendix F, Table 13) but was close enough to be worth commenting on. This interaction consisted in the disparity between sexual and neutral word accuracy being less for the LVF than for the RVF. None of the other interactions were close to statistical significance.

Condition 2 Expected/Actual Analysis

Data for the Expected/Actual analysis are presented in Table 8 and Figure 6. It can be seen in the figure, and from the main-effect means (Table 6 above) that there was no gender main effect. The visual field main effect was not significant, (P>.10, Appendix E, Table 14) but nevertheless somewhat interesting. Accuracy in the RVF exceeded that in the LVF, but only because of the very low LVF ratings of the sexual words. There was a large word type main effect, with sexual words having much

Table 7

Condition 2 Yes/No Analysis

Males											
Subjects	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	100	70	30	50	90	80	100	80	80	80	76%
LVF-Neutral	60	100	80	90	50	60	60	30	90	90	71%
RVF-Sexual	100	100	100	70	90	100	90	80	50	70	85%
RVF-Neutral	60	90	90	100	60	80	0	40	90	60	67%

Females											
Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	90	70	100	60	90	70	90	60	50	70	75%
LVF-Neutral	70	40	40	100	60	90	40	90	80	60	67%
RVF-Sexual	90	90	90	90	100	100	90	70	70	80	87%
RVF-Neutral	40	70	10	100	40	100	20	80	90	60	61%

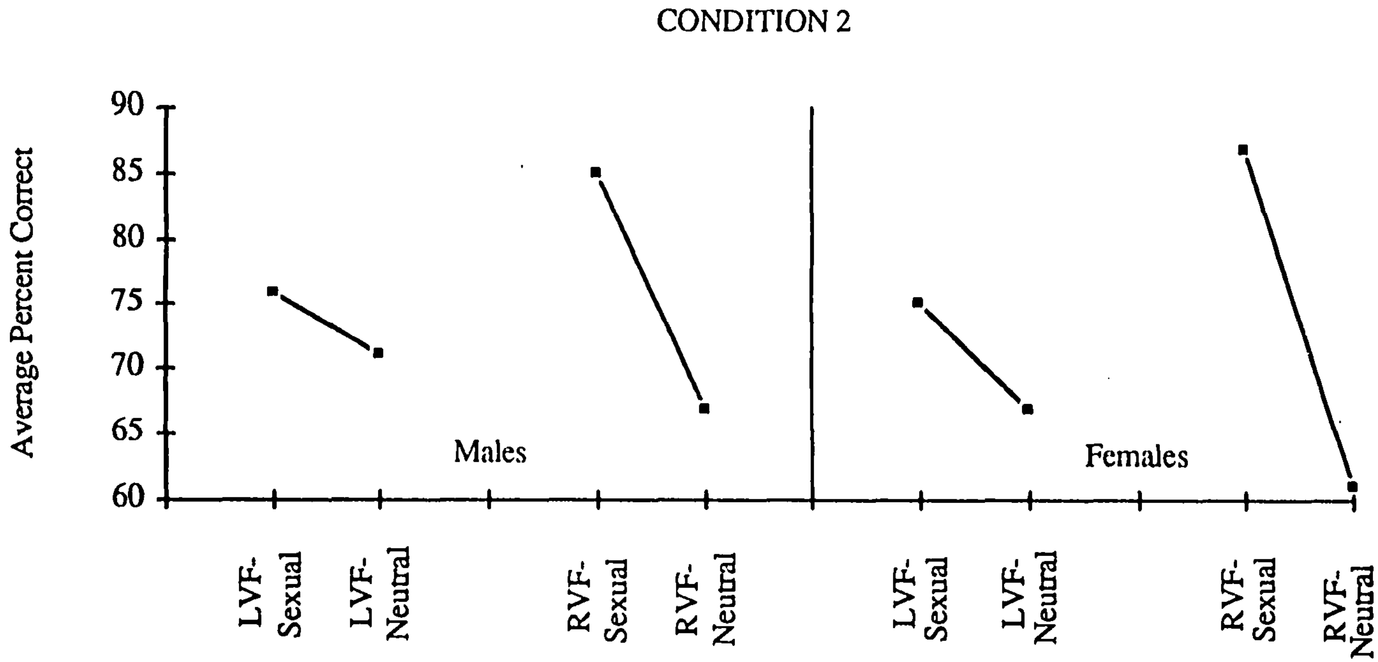

Figure 5. Condition 2 Average Percent Correct, Yes/No Analysis.

Table 8

Condition 2 Expected/Actual Analysis

Males

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	55.4	54.1	11.5	42.5	50.0	59.1	68.8	32.5	67.9	54.2	49.6%
LVF-Neutral	85.0	100	95.0	97.5	80.0	75.0	90.0	62.5	95.0	97.5	87.6%
RVF-Sexual	90.3	88.6	73.6	70.0	37.5	85.0	65.6	55.3	37.5	58.3	72.2%
RVF-Neutral	80.0	97.5	97.5	100	85.0	90.0	72.5	50.0	97.5	77.5	84.8%

Females

Subject	1	2	3	4	5	6	7	8	9	10	Average
LVF-Sexual	67.6	81.5	54.0	56.1	76.9	58.9	47.1	38.5	43.3	40.9	56.4%
LVF-Neutral	87.5	75.0	72.5	100	82.5	90.0	75.0	97.5	90.0	85.0	85.5%
RVF-Sexual	75.8	72.7	71.2	73.4	70.8	86.0	67.7	45.8	57.1	40.0	66.1%
RVF-Neutral	70.0	87.5	50.0	95.0	70.0	100	60.0	90.0	92.5	72.5	78.8%

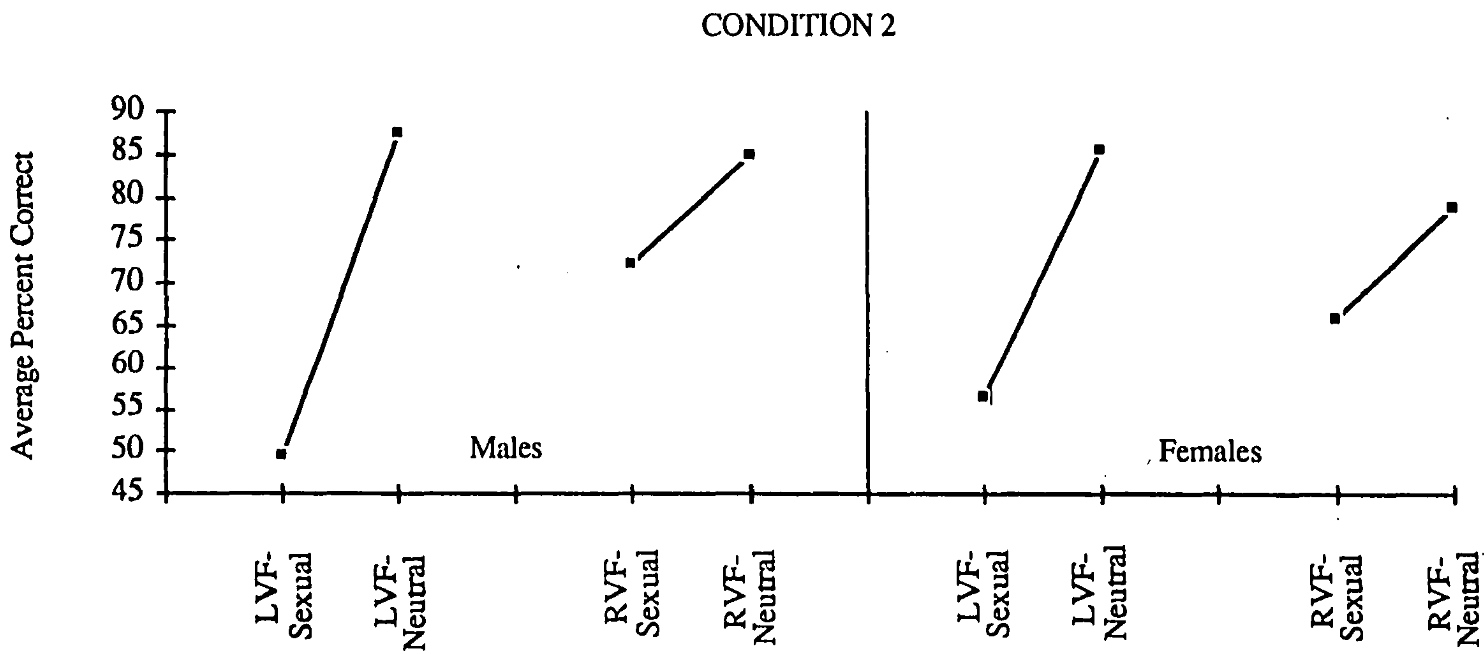

Figure 6. Condition 2 Average Percent Correct, Expected/Actual Analysis.

lower accuracy values in both visual fields, and with both genders. The gender by visual field interaction is close to significant (.05<P<.10, Appendix E, Table 14) and consists in the RVF superiority over LVF being greater for males than for females. There was a large visual field by word type interaction, (P<.001, Appendix E, Table 14) consisting in the neutral word superior accuracy over the sexual words being much greater for LVF than RVF.

DISCUSSION

The main purpose of this study was to examine male and female lateralization effects with respect to processing the sexuality of verbal stimuli consisting of common words with a strong sexual meaning. Studies addressing lateralization with respect to emotional visual stimuli have generally used pictures of emotional situations or faces with emotional expressions. The only studies of laterality with respect to emotional words are those of Graves et al. (1981), and two follow-up studies (Strauss, 1983; Marcin, 1991) based on their research. Graves et al. (see page 22 above) asked subjects to determine whether the stimulus that was presented tachistoscopically was an English word or a non word string of letters. Bilateral presentations were used, with each consisting of a word (either emotional or non emotional) in one visual field and a non word (a pronounceable but non word string of letters) in the other visual field. The results confirmed the general view of the LH (RVF) as most effective in processing verbal stimuli. Emotional words were in general more accurately reported than non emotional words (both genders and both visual fields), and most importantly, the emotional word advantage was, for males, considerably larger in the LVF, than in the RVF, but the reverse for females (see figures 1 through 5. This interaction was interpreted as confirming past findings regarding male RH specialization for emotional processing. It also supports the past general finding to the effect that females were either equal (LVF and RVF) with respect to emotional processing, or even more RVF effective.

For the present research, it was expected that the perception of sexual words would be similar to that of emotional (but non sexual) words, with a RVF advantage seen in males and females because of the verbal nature of the task. It was also thought that there might be some evidence of RH specialization for emotional processing or RH facilitation of LH processing, at least with males. In the Graves et al. study, the experimenters interpreted the gender by visual field interaction with the magnitude of emotional word advantage (the degree to which emotional word recognition accuracy exceeded that of non emotional words) as evidence of this sort. It is important to note, however, that Graves et al. did not offer any neurological or environmental explanation for the general emotional word advantage in their task, seen for both genders and in both visual fields, which makes the interpretation of their findings less clear. This issue will be mentioned in more detail below.

A first question, then, concerns the extent to which the present results fit into or contribute to the research on laterality compared to the relation between gender and laterality compared to perception of emotional verbal stimuli. However, it is important to identify some differences between the task of the present study and that of Graves et al.

In the present study an effort was made to obtain a measure of the degree of sexuality perception that was related to the independent variables, and for this reason subjects were required to rate the sexuality of what they saw on a 5-point scale. Graves et al. asked their subjects only to judge whether they saw a word or a non word string of letters. A sexuality rating would seem to be a more complex judgment, and one that is more verbal than just identifying a stimulus as a word or a non word.

The use of sexuality ratings also complicates the concept of accuracy beyond what it was in Graves et al., as can be seen from the computational complexity of the two Yes/No analyses and the two Expected/Actual analyses.

The sexuality rating also has a social feature that was absent in the Graves et al. task, namely that subjects to some extent must expose themselves to potential disapproval by the experimenter if they see a non sexual word as sexual, or if they see a sexual word as non sexual. In our sexually sensitive culture over- or under-judging something to do with sex could be seen as a mild or even a more serious character flaw, depending on one's particular subculture. Because the researcher sat close to the subject in order to operate the computer, this factor may be more relevant in the present study than in more typical tachistoscopic research. And although the scores consisted in providing only a numerical rating value (e.g. saying "4"), the subject could certainly believe that the researcher knew what word was being rated. One might expect this factor to favor more conservative sexuality ratings. When a perception was not clear, but seemed sort of like a sexual word, it might have been socially "safer" to avoid an extreme judgment. In any case, with these differences in view the three C1 and the three C2 results will be discussed in order.

The analysis of the C1 rating sums confirmed the LH (RVF) superiority in processing verbal material, for both males and females, as with the Graves et al. finding; and although not quite statistically significant the present findings also showed a greater RVF advantage for males than for females. This interaction is in line with the general view that the LH (RVF) verbal processing advantage is more clear cut in males than females. However, this interaction is not suggestive of any LVF specialization with respect to emotional processing in males, which would have predicted higher LVF sexuality scores for males than for females.

The Yes/No analysis showed the same clear superiority of the RVF for accurate processing when the sexual words appeared in that visual field, but there was only a hint at an interaction between RVF superiority and gender, although it was in the expected direction. The results of the Expected/Actual analysis were very similar to those of the Yes/No analysis.

To summarize, the bilateral C1 results, rating sums, Yes/No, and Expected/Actual all showed clear RVF superiority, but no real evidence for any gender interaction with this effect. This result is what would be expected for verbal processing in general, with no indication of any relevance of the emotional or sexual nature of the verbal stimuli. Why was there not some evidence of RH (LVF) processing, at least with males? One possibility is that sexual words do not function like the emotional stimuli used in other studies, which were typically concerned with survival or avoidance of unpleasant consequences. Another possibility is related to the task requirement that the word not only be perceived as a sexual word, but that its sexuality be rated in degree. This requirement may so enhance the verbal analytic aspects of the task as to mask any RH reaction to the presentation. It is, of course, possible that the general impression of differential hemispheric function that has resulted from previous research is seriously flawed. For every clear result there are numerous contradictory findings, suggesting that some uncontrolled variables of considerable strength have yet to be discovered. (The nature of the bilateral presentation, with words in both visual fields and only an overall perceptual impression of sexuality being obtained, precludes any comparison of sexual with neutral word perception.)

In the unilateral procedure of C2 for the rating sums, there was the expected, but not interesting, large difference between sexual ratings of sexual words and sexual ratings of neutral words. There was the same visual field effect seen in the C1 analyses, namely that the ratings of both sexual and neutral words were higher when the words appeared in the RVF than in the LVF. Higher ratings for the sexual words in the RVF may be the result of the superior processing accuracy in that visual field, but it is not clear why the superior verbal processing of the LH should result in higher ratings for the neutral words, where any rating over 1 is an error. That is, it is not clear why superior verbal processing should result in more erroneous assignments of sexual ratings (2, 3, etc.) to a neutral word which should have been rated as a 1. There were no significant interactions in this analysis, although the visual field by word type provided a hint of an interaction, but not one that is easy to interpret.

For the Condition 2 Yes/No analysis there was a statistically significant accuracy superiority for sexual words as compared with neutral words. Graves et al. found the same advantage of the emotional over the non emotional words, but did not attempt to explain it. As Marcin (1991, p. 6) points out, emotional words may have been more often associated with important events, and that association may make them more likely to be reacted to than non emotional words. Another possibility is that the sexual words occur more often in everyday language for some of the subjects than the neutral words, and word frequency has been found to be related to perception accuracy. In addition to the word type main effect, it would appear from Figure 5 that there is a noticeable interaction between visual field and word type, with accuracy superiority of sexual over neutral words being much smaller in the LVF than in the RVF. This interaction does not quite reach the .05 level of statistical significance, and the appearance in the figure is exaggerated because of the ordinate beginning at a value of 60 rather than 0. Even assuming that the effect is large enough to justify some comment, no simple explanation comes to mind for the higher neutral word accuracy in the LVF versus the lower neutral word accuracy in the RVF. This difference may be some artifact of the somewhat unusual accuracy measurement system.

The most striking result of the C2 Expected/Actual analysis is the very large word-type effect opposite to what was seen in the two preceding analyses. Sexual words, for both genders and for both visual fields, were judged much less accurately than neutral words. This strongly suggests that the concept of accuracy consisting in tachistoscopically providing the same rating that was provided in the post-experimental questionnaire is of questionable validity. In Table 5 it is clear that the sexual rating sums are averaging at least two points lower than the maximum values possible, but the neutral sums are less than one point higher than the minimum value. This would seem to be a bias in favor of larger errors for the sexual words. One can still respect a sexual aspect to a word perception with a rating as low as 2, but this would lead to a low percent accuracy if the expected value from the post-experimental ratings was a 5 or a 4, which were common values for the sexual words. On the other hand, to assign any sexuality value other than possibly a minimal rating of 2 to a word that seemed to be neutral word would be clearly departing from the first impression of neutrality.

In spite of the peculiarity of the word-type main effects, the rest of the analysis is worth comment. There was a large visual field by word-type interaction, consisting in the neutral word advantage in accuracy over sexual words being much greater in the LVF than in the RVF (see Figure 6, page 54 above). Furthermore, the accuracy for the neutral words was almost equal in the two visual fields, with the main difference being due to the much lower sexual word accuracy in the LVF than in the RVF. Whatever was responsible for the low accuracy of the sexual words was largely due to some aspect of LVF (RH) presentations. Perhaps when verbal processing is weak, as in the LVF (RH) the tendency to make conservative ratings for sexual words, as described above, is exacerbated. This result is certainly no support for the notion that the LVF (RH) specialization with regard to emotional stimuli applies to sexual words, although the effect regarding conservative judgments may be so large as to mask any possible RH superiority.

This C2 Expected/Actual analysis is the only one in the study containing a possible gender effect, which consists in an almost statistically significant gender by visual field interaction. This interaction (see Figure 6, p. 54 above) consists in the fact that when averaged across word type, there is a male RVF accuracy superiority, but with females the LVF and RVF are more equal in accuracy. This is in line with the general view of hemispheric specialization being more clear cut in males than females.

The general validity of the post-experimental ratings of the sexual words is itself problematic. The post-experimental ratings consist in the subjects providing a judgment as to the sexuality of a word, and under conditions of completely accurate perception of the word. This judgment is clearly a social act, a declaration as to the meaning of the word for the particular subject. Many intellectual and social factors may enter into such judgments, which are statements about one's sexual history, sexual sophistication, attitudes and values, etc. Even when the subject is being unselfconsciously candid, these post-experimental ratings are a very different kind of verbal behavior than the assignment of a numerical value to a stimulus that lasts only 200 ms, and is in a context where it is known that some sexual words are being presented. Also, at the time of the experimental presentations subjects had no idea that they were going to be asked to rate the same words when the experiment was over.

Summarizing the C2 results, there was no clear evidence of any gender relations to laterality in any of the methods of analysis. Two of the analyses (rating sums and Yes/No) showed higher averages for sexual than for neutral words. The first of these is trivial, and that seen in the Yes/No analysis is probably evidence for a cultural/historical rather than a neurological form of specialization. Two of the analyses, rating sums and Yes/No had weak evidence for a visual field by word type interaction; and the Expected/Actual analysis had a strong visual field by word type interaction, but these interactions seem to based on quite different aspects of the data, and no useful general conclusion can be drawn from them.

There are several implications of the present study for future research in this area. One is that the inexpensive computer-based analog to tachistoscopic presentation involving the commercial Flash Words program can obtain potentially useful data with respect to laterality. Computers that are more than adequate to run the program and to collect and analyze the data are available in almost all human service settings, and certainly in all university settings.

In retrospect, it would probably have been better to directly replicate the Graves et al. experiment using sexual words and using their task (simply judging whether a verbal stimulus was a word or not) rather than requiring sexuality ratings. This task would partially overcome the (hypothesized) reluctance to make extreme sexuality ratings because of the possible social implications of such judgments.

With respect to the sexual words which are certainly deserving of further study with respect to laterality, several kinds of additional information will be required. At the very least, some information about the frequency of occurrence of such words in written and oral language will be essential for preventing a frequency confound with other aspects of such words. Also some effective method for evaluating the actual emotional characteristics of the specific words for different individuals should be developed. Although no one would argue that the words used were not, generally speaking, sexual in content. Still, there are many unknowns with respect to such words. It was at first assumed that all would be positive in emotional valence, but it is quite possible that some were actually quite negative for some subjects because of the context of their usual usage for those individuals. For example, some of the slang words referring to male or female genitalia are clearly pejorative in many common language uses. Also, there is good reason to suppose that for many subjects terms referring to same-sex genitalia may not be erotic, or may even be somewhat anti-erotic to the degree that any form of homophobia is a part of the individual's repertoire. It might also be easier to select a sexual word because the sexual words (as are emotional words) are part of a more defined selection, while the neutral words are from a less defined selection. This may increase accuracy in the identification of such words.

Sexual or emotional words may be better compared to another more defined selection of words to see if the results of the current study are replicated.

Prior to the C1 presentations a practice session of 8 trials of bilateral and unilateral presentations was given to each subject. Several of the subjects failed to provide sexual ratings for the sexual words during the C1 experimental session until they had had several presentations, which implies that more practice sessions would be in order.

An especially interesting aspect of this area is the superiority of the recognition of emotional (also sexual) words over neutral words. This certainly deserves further study, and especially in terms of possible cultural/historical variables that may have been blended with or mistaken for neurological ones. A study in which the history with respect to some words is experimentally manipulated, and then laterality effects studied using those words, would be quite appropriate, especially from a behavioral perspective.

Appendix A

Protocol Clearance From the Human Subjects
Institutional Review Board

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899
616 387-8293

COPY

WESTERN MICHIGAN UNIVERSITY

To: Randall W. Stewart
Dr. Jack Michael

From: Richard A. Wright, Chair *Richard A. Wright*
Human Subjects Institutional Review Board

Subject: HSIRB Project # 96-08-09

Date: July 19, 1996

This is to inform you that your project entitled "Hemispheric Brain Laterality of Perception in the Right- and Left Visual Fields of Computer Presented Written Erotic Words by Male and Female College Students," has been approved under the expedited category of research. This approval is based upon your proposal as presented to the HSIRB, and you may utilize human subjects only in accord with this approved proposal.

Your project is approved for a period of one year from the above date. If you should revise any procedures relative to human subjects or materials, you must resubmit those changes for review in order to retain approval. Should any untoward incidents or unanticipated adverse reactions occur with the subjects in the process of this study, you must suspend the study and notify me immediately. The HSIRB will then determine whether or not the study may continue.

Please be reminded that all research involving human subjects must be accomplished in full accord with the policies and procedures of Western Michigan University, as well as all applicable local, state, and federal laws and regulations. Any deviation from those policies, procedures, laws or regulations may cause immediate termination of approval for this project.

Thank you for your cooperation. If you have any questions, please do not hesitate to contact me.

Project Expiration Date: July 19, 1997

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899

WESTERN MICHIGAN UNIVERSITY

Date: 27 August 1997

To: Jack Michael, Principal Investigator
Randall Stewart, Student Investigator

From: Richard Wright, Chair

Re: Extension of Approval, HSIRB Project Number 96-08-09

This letter will serve as confirmation that an extension to your research project entitled "Hemispheric Brain Laterality of Perception in the Right- and Left Visual Fields of Computer Presented Written Erotic Words by Male and Female College Students" has been granted by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now continue to implement the research as described in the original application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the continued pursuit of your research goals.

Approval Termination: 27 August 1998

Appendix B

A Classification of HandPreference
by Association Analysis

A Classification of Hand
Preference by Association Analysis*

Handedness Research Questionnaire

Subject Number____ Age_______
Sex_________

Were you one of twins or triplets at birth or were you single born?_______

Please indicate which hand you habitually use for each of the following activities by writing R for right hand and L for left hand and E for either.

Which hand do you use:

1.) to write a letter?_______

2.) To throw a ball to hit a target?_______

3.) To hold a racket in tennis, squash or badminton?_______

4.) To hold a match while striking it?_______

5.) To cut with scissors?_______

6.) To guide a thread through the eye of a needle (or guide thread through a needle?_______

7.) At the top of a broom while sweeping?_______

8.) At the top of a shovel when moving sand?_______

9.) To deal playing cards?_______

10.) To hammer a nail into wood?_______

11.) To hold a toothbrush while cleaning your teeth?_______

12.) To unscrew the lid of a jar?_______

If you use the <u>right hand for all of these actions,</u> are there any one-handed actions for which you use the <u>left hand?</u> Please list them below.

____
____
____

*Adopted from Marian Annett

Appendix C

Informed Consent

Informed Consent

I am Randall W. Stewart, a graduate student in the Department of Psychology at Western Michigan University. I am doing a study on hemispheric brain laterality and the perception differences between male and female subjects of briefly presented words with sexual and neutral meaning.

The purpose of this research is to investigate the differences in the perception of words with sexual and non-sexual meanings according to gender (i.e., hemispheric dominance). C. this research, you will be requested to participate in a session of approximately 30 to 40 minutes in duration. In the session researcher will use a computer to view brief presentations and then you will be asked to indicate your viewing impressions.

Your participation in this research will expose you to minimal risk--you may experience an increase in stress when you are asked to respond to the briefly presented stimuli, if you have trouble understanding what is asked of you and if you find the task difficult. Remember you can quit the session at any time.

In order to protect your confidentiality when the results of this research are presented publicly (when the results are presented, published or otherwise promulgated) your data will be identified only by your gender, age and subject number (in the order of your participation). There will not be a list of names matched with your responses to presentations. The informed consent you are signing is the only evidence of your participation in this study.

Your participation in this research is completely voluntary and you may withdraw at any time by telling me in person or by phoning me. You can stop at any time during the session by telling me that you do not want to continue. Please note that if you withdraw before completion of the research, I will not be able to use your data.

Should you have any questions regarding this research, please feel free to contact me at my home phone 344-4149 in the evenings. If you would like to participate in this study, please sing this form in the space provided below.

Your signature below indicates that you understand the above information and have decided to voluntarily participate.

____

(Please Print Your Name)

____

(Your Signature) (Date)

Appendix D

Post-Test Ratings of Stimulus Words

Post-Test Ratings of Stimulus Words

Rate each word on a scale of 1 through 5, 1 is neutral, 5 is most sexual and 2, 3 and 4 are varying degrees of sexual

Rating	Sexual Words
	breast
	clitoris
	cock
	cum
	cunt
	dick
	fuck
	fucker
	horny
	kiss
	lust
	passion
	pecker
	penis
	pussy
	sex
	sexual
	sexy
	tits
	vagina

Rating	Neutral Words
	apple
	book
	car
	cat
	chair
	cold
	desk
	dog
	door
	fan
	floor
	house
	light
	pen
	pencil
	road
	shoe
	stove
	table
	tree

Appendix E

ANOVA Results

Table 9

ANOVA Results for Condition 1, Sums of Ratings

Source	SS	df	MS	F	P
Between Subjects	1356	19			
Gender	11	1	11	0.01	>.10
Ss Within Genders	1345	18	75		
Within Subjects	2635	20			
Visual Field (VF)	1755	1	1755	39	<.001
VF by Gender	65	1	65	1.4	>.10
VF by Ss Within Genders	817	18	45		

Table 10

ANOVA Results for Condition 1, Yes/No Analysis

Source	SS	df	MS	F	P
Between Subjects	15847	19			
Gender	62	1	62	<1.00	>.10
Ss Within Genders	15785	18	877		
Within Subjects	19850	20			
Visual Field (VF)	11902	1	11902	29.00	<.001
VF by Gender	422	1	422	1.00	>.10
VF by Ss Within Genders	7525	18	418		

Table 11

ANOVA Results for Condition 1, Expected Versus Actual

Source	SS	df	MS	F	P
Between Subjects	5423	19			
Gender	1	1	1	<1.00	>.10
Ss Within Genders	5422	18	301		
Within Subjects	19786	20			
Visual Field (VF)	5452	1	5452	19.00	<.001
VF by Gender	207	1	207	<1.00	>.10
VF by Ss Within Genders	5127	18	285		

Table 12

ANOVA Results for Condition 2, Sums of Ratings

Source	SS	df	MS	F	P
Between Subjects	1059	19			
Gender	31	1	31	<1.00	>.10
Ss Within Genders	1028	18	57		
Within Subjects	7204	60			
Visual Field (VF)	245	1	245	8.20	<.001
Word Type (Sx/N)	5281	1	5281	177.00	<.001
Gender by VF	14	1	14	<1.00	>.10
Gender by WT	3	1	3	<1.00	>.10
VF by WT	48	1	48	1.60	>.10
Gend by VF by WT	.02	1	.02	<1.00	>.10
VF/WT by Ss Within Genders	1612	54	30		

Table 13

ANOVA Results for Condition 2, Yes/No Analysis

Source	SS	df	MS	F	P
Between Subjects	6274	19			
Gender	101	1	101	<1.00	>.10
Ss Within Genders	6622	18	368		
Within Subjects	36125	60			
Visual Field (VF)	151	1	151	<1.00	>.10
Word Type (Sx/N)	4061	1	4061	7.20	<.01
Gender by VF	1	1	1	<1.00	>.10
Gender by WT	151	1	151	<1.00	>.10
VF by WT	1201	1	1201	2.10	>.10
Gend by VF by WT	31	1	31	<1.00	>.10
VF/WT by Ss Within Genders	30527	54	565		

Table 14

ANOVA Results for Condition 2, Expected Versus Actual

Source	SS	df	MS	F	P
Between Subjects	5976	19			
Gender	3	1	3	<1.0	>.10
Ss Within Genders	5973	18	332		
Within Subjects	25118	60			
Visual Field (VF)	336	1	336	1.70	>.10
Word Type (Sx/N)	12115	1	12115	177.00	<.001
Gender by VF	14	1	14	<1.0	>.10
Gender by WT	282	1	282	1.40	>.10
VF by WT	1610	1	1610	8.2	<.01
Gend by VF by WT	13	1	13	<1.0	>.10
VF/WT by Ss Within Genders	10617	54	197		

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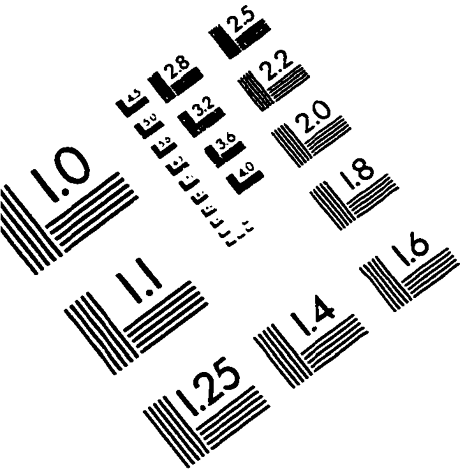
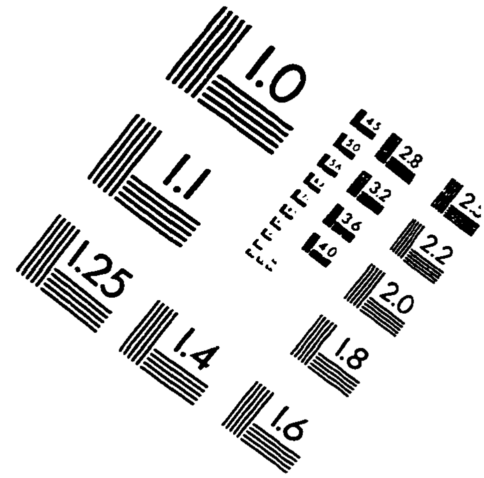
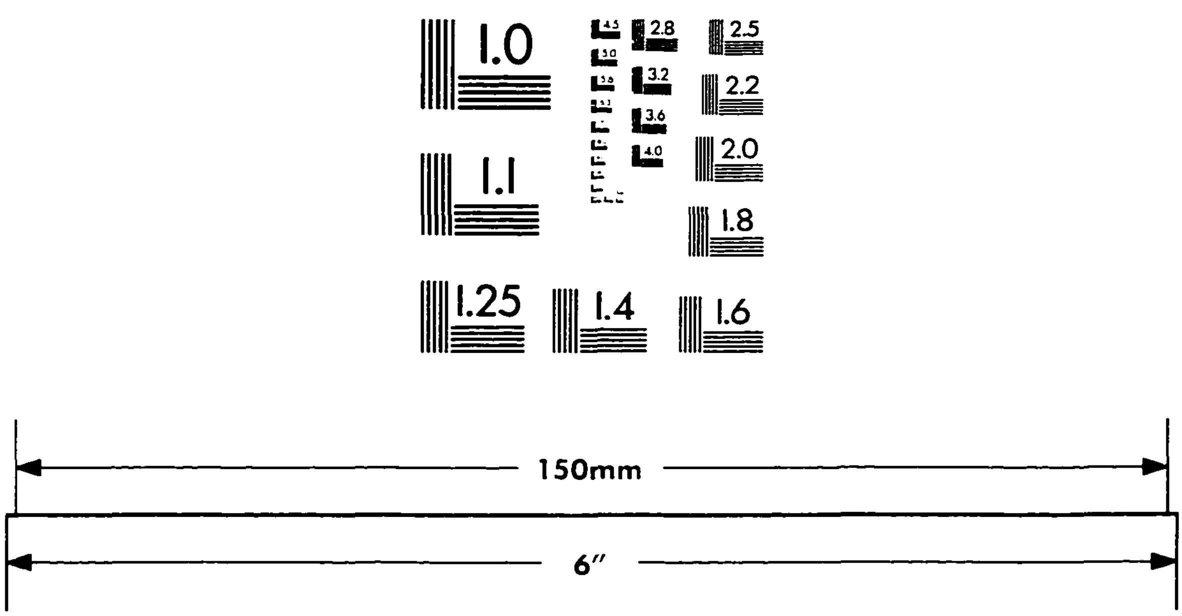
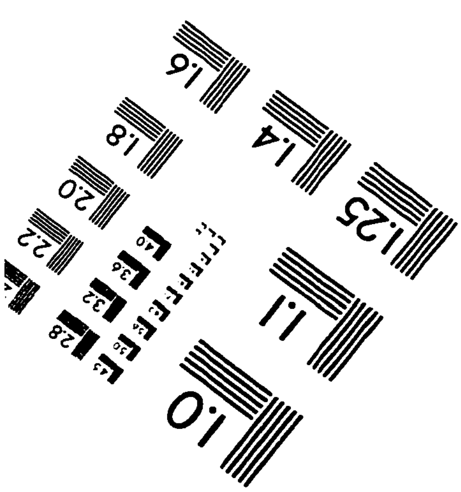
IMAGE EVALUATION TEST TARGET (QA-3)









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