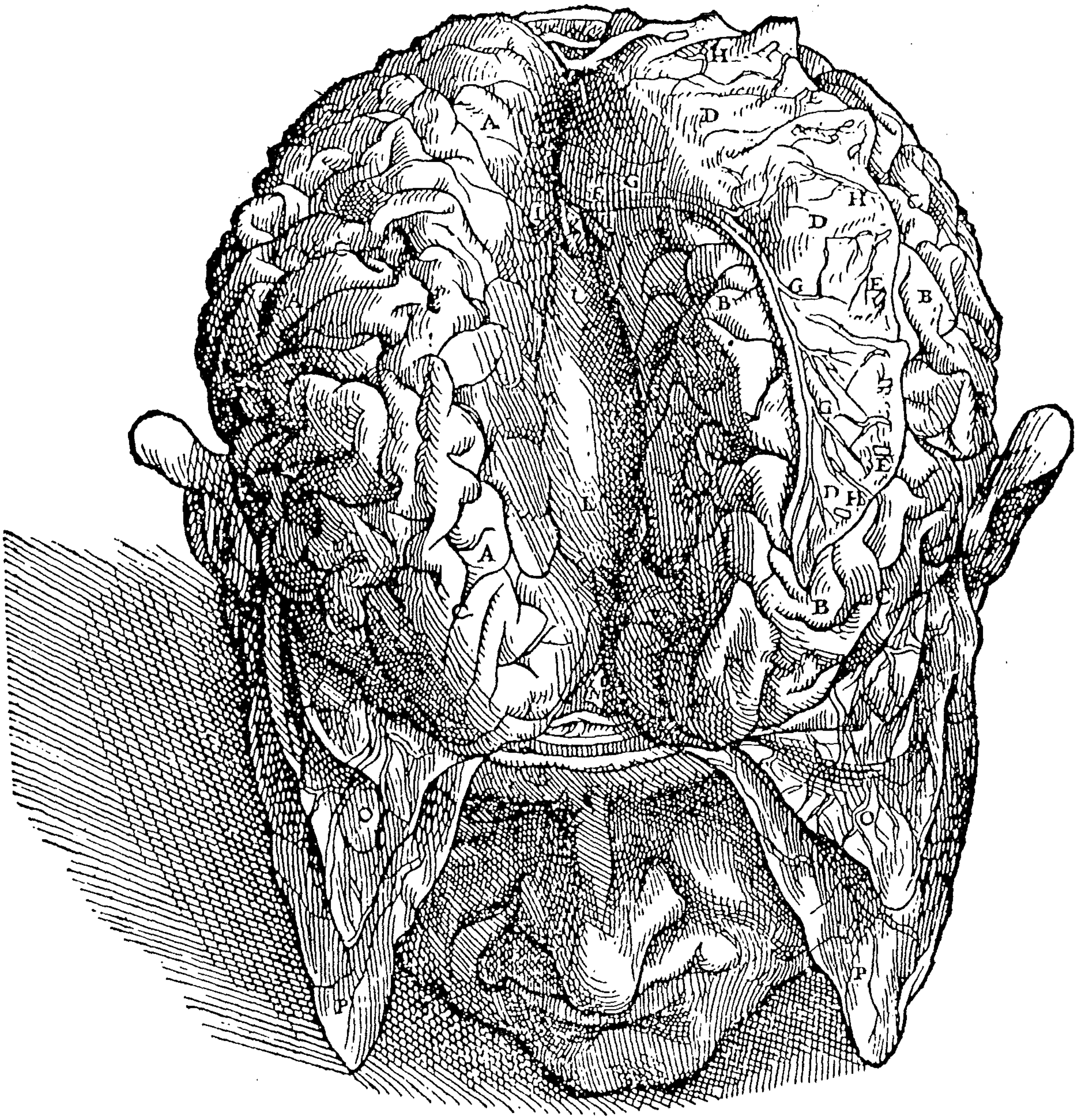
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EMOTION, MEMORY AND LATERALITY

A Thesis

submitted in partial fulfilment

of the requirements for the degree

of

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in the

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by

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1986

Dedicated

to the memory of

my mother

Grace Bartlett

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ABBREVIATIONS

CR	Cued recall
E	Experimenter
EEG	Electroencephalograph
EHI	Edinburgh Handedness Inventory
FR	Free recall
GSR	Galvanic skin response
LEA	Left ear advantage
LEMs	Lateral eye movements
LH	Left hemisphere
LQ	Laterality quotient
LVF	Left visual field
REA	Right ear advantage
RH	Right hemisphere
RT	Reaction time
RVF	Right visual field
S(s)	Subject(s)

ABSTRACT

Emotional words are often recalled more easily than neutral words. Inspection of the literature on emotional word recall led to the view that the manner of recall has special importance. In free recall (FR) more emotional than neutral words are recalled, while in cued recall (CR) both types of words are recalled equally well. A considerable body of research suggests that language is processed in the left hemisphere of the brain, and emotion is processed in the right hemisphere. It was hypothesized that in FR both sides of the brain contribute to recall, but in CR the additional verbal processing involved increases the activation of the left hemisphere and inhibits the right.

This was tested in an experiment in which subjects heard either a verbal-nonemotional or a nonverbal-emotional sound between learning a list of emotional and neutral words, and recalling them. The results showed that in FR a significant emotional word advantage obtained ($p < .002$). The effect of the nonverbal-emotional sound on emotional word recall was also significant ($p < .002$). There was no emotional word advantage or effect of sound in CR.

It was found that FR subjects with high laterality quotient (LQ), indicating a strong right hand preference on a variety of tasks, performed no differently from the CR subjects. The emotional word advantage was due to the low LQ subjects ($p < .001$). This suggested a greater contribution of the right hemisphere in these subjects. A short version of the experiment was conducted with silence between learning and free recall. No emotional word-low LQ effect obtained. It was suggested that the low LQ FR subjects in the first experiment were affected by the emotional words and sounds, which activated their right hemispheres to the extent that they biased their responses toward greater left hand preference. The results are discussed in terms of priming and strategy effects.

Neural structures involved in emotion and memory are considered and relevant cognitive and laterality literature is reviewed.

Chapter One

INTRODUCTION

The relationship between emotion and memory is a relatively new area of study. Research dealing specifically with this relationship has been carried out only in the last few years. There is a considerable amount of data from other areas of psychology where memory has been used as a measure of emotion. These include perceptual defence, impression formation and perseverative consolidation. Results from these studies are not consistent, perhaps due to different theoretical perspectives and research methods

There are two approaches to the study of emotion and memory. One focuses on the person, seeking to understand how mood affects memory, while the other focuses on the emotional content of the stimuli in order to see how this affects recall. The present study is mainly concerned with the emotional content of words, though the emotional state of the person will not be overlooked.

Indeed the effect of mood on thinking and memory is the foundation and starting point of the topic. The research in this area was advanced by Bower and his associates (Bower, 1981; Bower, Gilligan and Monteiro, 1981; Bower and Cohen, 1982). Bower's work involved testing the memory of subjects (Ss) who were in various hypnotic-induced moods. In one experiment

(Bower, 1981) Ss learned two sets of words, one list while in a happy mood and the other in a sad mood, with moods and lists counterbalanced. For free recall of the words learned the Ss were in either a happy or a sad mood. More words were recalled from the list that was learned in the same mood as recall. Control Ss learned both lists and recalled the words in one mood. Both the happy and the sad groups recalled a similar number of words.

The results of other experiments on state-dependant memory showed that Ss in a pleasant mood recalled more pleasant than unpleasant experiences from the previous week, or from child-hood events. Conversely, Ss in an unhappy mood recalled a greater number of unpleasant experiences.

Bower suggested that people more easily remember events if they are associated with strong emotional reactions because they are distinctive from other events and are often more important. However, memory for emotional events and mood-dependant memory are not the only ways in which emotion and cognition interact.

Emotionally charged words are more easily remembered than neutral words. There seems to be levels of thought and memory that are intimately concerned with connotation rather than mere meaning. The power of words has long been known and it has been used to great effect in literature. Often it is the ideas expressed by the words that are moving, but a gifted writer will use words that have associations and affective value that go well beyond the surface meaning of the text. Illustration of this can be found in <u>Great Expectations</u>, in which Dicken's choice of words conjures up images and feelings that add layers of suggestion and implication to the narrative. It is exemplified in the sparse verse of the projective poets, such as Charles Olson or Robert Creeley, in which ideas, feelings and imagery are distilled into single words. Fascination for this power of the word is at the very root of this thesis.

The course passes not through poetry, however, but through cognitive psychology, physiology and neuropsychology. It begins in the next chapter with a discussion on emotional words and their effects on memory. The discovery that the manner of recall has a significant influence on the retrieval of emotional and neutral words leads to a theory that word and connotation are processed separately and that there is a physiological basis for this dissociation, namely the two cerebral hemispheres.

In Chapter Three an attempt is made to identify the neural structures involved in emotion and in memory, with examples drawn from clinical literature. The fourth chapter is a general introduction to the research on hemispheric specialization in normal people. This is followed by a more detailed review of research on the lateralization of emotion and of memory. The specific interaction between emotion, memory and laterality is discussed in the sixth chapter, along with a rationale for testing the hypothesis, and a statment of the assumptions on which it is based.

Three preliminary studies are described in Chapter Seven. The main experiment and an auxillary experiment are reported in the next chapter, and a general discussion follows in Chapter Nine.

The final chapter contains a brief apologia and suggestions for further research.

This thesis does not aim at providing a comprehensive account of hemispheric specialization for emotion and memory. The evolutionary aspects and animal research have been omitted altogether. Furthermore, reference to the research on clinical populations has been kept to a minimum. The emphasis is on normal, intact human beings.

Chapter Two

MEMORY AND EMOTIONAL WORDS

Emotional words are sometimes recalled more easily than neutral words. Noting the inconsistent results in the literature Manning and Julian (1975) considered these were caused by the confounding effects of categorization. Emotional or taboo words are easily categorized and are therefore easy to remember, while neutral words in the various studies were not so easily categorized. To overcome this problem Manning and Julian constructed lists of words drawn from the three emotional categories of sex, bathroom and violence, and three neutral categories of reading materials, fruit and beverages. In free recall (FR), after learning these lists Ss recalled significantly more sex and bathroom words than violence or neutral words.

Another approach was taken by Strongman (1982), who tested Craik and Tulving's (1975) suggestion that a target which is congruent with its context will be better remembered than one that is incongruent. He composed sentence frames that varied in emotionality, with target words missing. The target words also varied in emotionality. To complete the sentences Ss chose from the target and another word, which was non-emotional and inappropriate in meaning. Later, in the FR condition, they were required to write down as many of the chosen words as they could remember. When the responses had been collected the Ss were shown the sentence frames as cues to recall. In the FR condition significantly more emotional than neutral words were recalled, and more emotional words were recalled from highly emotional sentence frames, compared with those from mildly emotional or neutral frames. Results from the cued recall (CR) condition were somewhat different, being superior when both the target and the frame were non-emotional.

In an extension of this study Strongman and Russell (1986) sought to overcome any confounding effects due to the more easily categorized emotional words and also to the possible order effects between free and cued recall. Subjects' performance with emotional and neutral target words and sentence frames was compared with that of others seeing only animal and neutral targets and frames. In this experiment FR only was tested. The results showed that significantly more emotional than animal words were recalled. Furthermore, significantly more emotional words were recalled when the frame was congruent than when it was neutral. For neutral words recall was superior when the <u>frame</u> was emotional.

SOME THEORIES OF EMOTION AND MEMORY

These results, together with those of Manning and Julian (1975) suggest that the emotional content of the word has special importance in remembering. Strongman (1982) favoured a theory that comes from studies on attitude and impression formation in which emotion memory is held to be independant of item memory.

Two-Structure Memory

Anderson and his associates (Anderson and Hubert, 1963; Anderson and Farkas, 1973) found that impression memory has a primacy effect, while the words used to form the impression have a recency effect on recall. The adjectives used in such experiments were seen as momentary carriers of information or meaning, which is extracted and integrated into the current attitude. The words themselves are no longer required and are stored in a different memory system.

This notion was supported by Posner and Snyder (1975). Part of their research also focused on impression formation. Subjects were presented with sentences consisting of a proper name, followed by 1-4 trait-descriptive adjectives, which were all positive in emotional tone, all negative, or a mixture of both. Following the sentence a single probe word was presented. Half of the probes matched an adjective in the sentence and the Ss were required to state whether or not the probe matched. The reaction time (RT) for 'yes' answers were much the same, regardless of emotional tone, but the 'no' answers were quite different. There was a significantly shorter RT and considerably fewer errors when the probe did not match the emotional tone of the sentence.

This result led Posner and Snyder to predict that it would take longer to search the adjective list as the number if items were increased, but more items would strengthen the impression. In a second experiment Ss were required to say whether the probe matched a word in the list or the emotional tone of the list. As predicted, increasing the number of items on the list increased the RT for word match, but decreased it for emotion match.

Posner and Snyder maintained that there are two independant memory structures. One is an item memory consisting of the adjectives, and the other is an emotion memory consisting of an abstract impression of a combination of traits. Posner (1978) further suggested that emotion raises the level of alertness and the responses are made on the basis of less complete information. While this may be so in experiments on impression formation where the strength of the impression is being measured, it may not apply in experiments on word recall, such as Manning and Julian's(1975). If it does then one could expect an appreciable number of synonyms to appear. This has not been reported.

However, the theory of a two-structure memory, together with the suggestion of arousal improving performance, is attractive. Arousal may account for the inconsistency in Manning and Julian's (1975) study where sex and bathroom words were facilitated but violence words were not. The sex and bathroom lists included the more colourful four-letter words, as well as words such as 'masturbate' that may have caused surprise. Manning abd Julian considered this a possibility since these words were better remembered on the first trial compared with the two later trials.

In both Manning and Julian's study and that of Manning and Melchiori (1974) arousal, as measured by Galvanic skin response (GSR), was higher for the easily recalled words than for violence words that had been rated by other groups of Ss as being much more emotional. Manning and Julian suggested the reason for this may be that taboo words were for social reasons not rated as upsetting, when in fact they were, and that people are so familiar with violence words that they are no longer aroused by them even though they are still cognitively disturbing.

Conditioning

There are other theories that can explain why emotional words are recalled more easily than neutral words. For example, Staats (1967) offered a theory on the emotional meaning of words. In his view words acquire their emotional meaning by Classical conditioning. Once conditioned the words can act as both positive and negative reinforcers. They can 'transfer' the responses they have come to elicit to other words or objects with which they are associated, and they can act as reinforcers in operant conditioning, shaping behaviour. While this sort of theory can explain arousal to emotional words and their greater ease of recall it fails to account for some of the cognitive complexities that are evident in the literature. One of these is the Ss' tendency to rate as highly emotional words that do not arouse them according to GSR measurement (Manning and Melchiori, 1974). Another is the differing effect that the manner of recall has on the proportion of emotional words remembered. This effect will be discussed in more detail later.

Information Processing

At the other extreme from conditioning theories is the information processing model (Bower, 1981; Bower and Cohen, 1982; Erdelyi, 1974). An example is Bower's (1981) associative network theory of memory and emotion. According to him

> An event is represented in memory by a cluster of

> descriptive propositions. These are recorded in memory by establishing new associative connections among instances of the concepts used in describing the event... The basic process of thought is activation of a proposition and its concepts... Activation presumably spreads from one concept to another by associative linkages between them. (Bower, 1981, p. 135).

Emotion nodes are activated by many stimuli. Excitation is transmitted to nodes that produce the pattern of autonomic arousal and expressive behaviour that is associated with emotion. Some emotions, such as fear and joy, are mutually inhibiting, while others can be activated together to produce a blend, such as sadness and surprise to produce disappointment.

In the case of state-dependant retrieval, words learned in a particular context may have weak connections in the network, but if the particular emotion in which the words were learned is activated as well, then activation from both context and emotion are added together to make the items more accessible to recall.

The better recall of emotional than neutral words could be explained in this theory by the activation of emotion nodes which would strengthen the associations for these words. This could account also for the strengthening of impressions by increasing the number of adjectives, as in Posner and Snyder's (1975) study, and for the better recall of neutral words in the emotional, rather than neutral frames in Strongman and Russell's (1986) study, since the target was associated, however indirectly, with an emotion node.

The information processing model is very good at explaining a wide variety of phenomena and it is also effective in generating new hypotheses. However, its potential for completness exposes it to the danger of becoming a closed system with circular cause/effect relationships. One aim of the present study is to look beyond rigid theories and attempt to synthesize data from several different systems. The information processing model is therfore not useful for this purpose.

Dual Encoding and Parallel Processing

The notion of memory having two structures or processes is not confined to research on impression formation. At least two other theorists have proposed similar models, without reference to each other's. Pavio (e.g. 1975) has suggested that there are two independant, though interconnected, cognitive systems. One encodes verbal information in memory, while the other encodes non-verbal information. Emotion is not specifically mentioned in Pavio's dual encoding hypothethis, but in Leventhal's (1970) parallel processing model emotion is crucial. According to this model there are two similtaneously active, parallel systems, one emotional and one cognitive. In the earlier model these processes had two stages, the perceptual stage, and a later action-planning or coping stage. An emotion memory was included in a later form of the model (Leventhal, 1979) which was attributed, along with other emotional processes, to the right hemisphere of the brain (Leventhal, 1982). In this last assertion Leventhal was acknowledging a large body of research supporting the view that emotion is processed primarily in the right hemisphere. This will be discussed further in the final section of the present chapter.

FREE RECALL VERSUS CUED RECALL

The better recall of emotional words over neutral words has been discussed as though it is an established fact. This is not the case, however. Inconsistencies are common in the literature. The recall of emotional and taboo words compared with neutral words was often used as a measure of perceptual defence and response suppression. It was generally predicted that taboo words would not be recalled as frequently as neutral words because the Ss either unconsciously denied seeing or hearing them, or for some reason, conscious or otherwise, would not report having seen or heard them. Another line of research used paired associate learning to measure the effects of perseverative consolidation (cf. Walker and Tarte, 1963). According to this theory the laying down of permanent memory is an active process during which there is a temporary inhibition of recall. High arousal words would increase the activity, resulting in a greater temporary inhibition against recall.

The inconsistencies among the results are probably due partly to different theoretical perspectives, but perhaps more important are the differences in research methods. These include the required method of recall.

In their introduction Manning and Julian (1975) cited several papers which illustrate the inconsistencies (Grosser and Walshe, 1966; Kleinsmith and Kaplan, 1963, 1964; Maltzman, Kantor and Langdon, 1966; Walker and Tarte, 1963; Zajonc, 1962). They believed that the results were confounded by the emotional words being readily categorized and they controlled for this in their own study. However, analysis of these papers, together with Manning and Julian's, Strongman's (1982), Strongman and Russell's (1986), and observations made by Bower (1981) suggest a further confounding effect. The results appear to be dependant on the type of recall being used.

Several of these experiments used paired-associate learning to test perseverative consolidation. The results from Kleinsmith and Kaplan (1963, 1964) and Walker and Tarte (1963) supported the theory that high arousal words would be more easily remembered in the long-term (one week), but would less likely to be recalled in the short-term (two minutes). However, FR studies have produced different results. Maltzman et al's (1966) Ss heard the words presented individually at intervals. They then wrote down as many as they could remember, either immediately or half an hour later. Under these conditions immediate recall was significantly better that delayed recall, and reliably more high than low arousal words were recalled for both intervals. In Grosser and Walsh's (1966) FR study more sex words than neutral words were recalled by male Ss. More emotional than neutral target words were recalled in the FR condition of Strongman's (1982) study, while more neutral than emotional target words were recalled in the CR condition. In Strongman and Russell's (1986) FR experiment more emotional than neutral words were recalled. Bower (1981) observed that the state-dependant learning effect is best with free recall, that it is greatly reduced in strongly cued or recognition tests.

Additional evidence is provided by a series of experiments on self-generated paired associates. Parkin, Lewinsohn and

Folkard (1982) replicated an experiment conducted by Levinger and Clark (1961, reported in Parkin et al., 1982). In these experiments Ss were first required to generate associations for each of 60 stimulus words, half of which were emotional and the other half neutral. During this phase recordings of GSR fluctuations were made. Immediately afterwards in Levinger and Clark's experiment the stimulus words were presented again and Ss were asked to recall their previous assocation for each one. Levinger and Clark found that emotional stimuli produced more forgotten associations than did neutral stimuli, and associations that produced significantly higher GSRs were more often forgotten than remembered.

Since Kleinsmith and Kaplan (1963) had obtained similar results for immediate recall, but not for delayed recall, Parkin et al. (1982) repeated Levinger and Clark's experiment, adding a delayed recall condition. In immediate recall (two minutes) their Ss recalled more neutral than emotional associations, but in the 7 day retention condition Ss recalled more emotional than neutral associations. To explain this result Parkin et al. favoured a suggestion made by Eysenck and Wilson (1973, in Parkin et al., 1982) that immediate recall facilitates information encoded at lower arousal levels, whereas for delayed recall highly arousing stimuli is advantaged.

Further replications were carried out by Rossman (1984), who tested retention intervals (2 minutes vs 7 days; and 2 minutes, 20 minutes and 24 hours. In these two experiments more associates to emotional than neutral stimuli were forgotten, regardless of the retention period.

There are additional FR experiments showing contrasting results. Farley (1969, cited by Osbourne, 1974) used the words from Walker and Tarte's (1963) paired associate study for a FR experiment and found that more high arousal words were recalled than low arousal words. Osbourne (1974) tried to account for the inconsistencies in the immediate recall condition results within the arousal theory of perseverative consolidation. He conducted an experiment using FR. None of his predictions was supported because more high than low arousal words were recalled ($p < .001$). As an explanation Osbourne suggested that emotional arousal produced by words can affect retention without necessarily producing an increase in cortical arousal sufficient to inhibit memory.

There is, therefore, a considerable body of research in which inconsistencies can be explained in terms of the type of recall employed. In both free and cued recall, when the retention interval is half an hour or longer, emotional words are recalled more easily than neutral words. However, for immediate or nearly immediate recall emotional words have an advantage over neutral words only if recall is free. When cued recall is employed, as in paired associate experiments, there is no such advantage.

If this is so then two inconsistencies remain among the papers cited by Manning and Julian (1975). One is the female Ss' higher score of neutral words (e.g. 'helpful,' 'logical,' 'wealthy') in Grosser and Walsh's (1966) FR study. The words that these young women at a summer school in the mid 1960s had most difficulty in recalling were 'penis,' 'erection' and 'masturbate,' words that may have been unpleasant for them to say out loud, which they were required to do. The other difficulty is Zajonc's (1962) paired associate learning experiment in which pairs of emotional words were learned faster and with fewer errors than pairs of neutral words. One possible explanation is that in Zajonc's experiment the paired associates were presented repeatedly until the S could respond correctly to each stimulis for three consecutive trials, whereas in the other paired associate experiments only one presentation of the pairs was made.

A PHYSIOLOGICAL BASIS FOR THE TWO-STRUCTURE MEMORY?

Earlier it was mentioned that emotion is processed primarily in the right hemisphere (RH) of the brain. This notion, though still rather contentious, has gained considerable support in the research on laterality in both clinical and normal populations. For example, Geschwind (1979) observed that a patient with a disorder of the RH can usually understand the meaning of what is said, but may often not recognise that it is spoken in an angry or humorous way. In a dichotic listening experiment Ley and Bryden (1982) found that their normal Ss were more accurate at recognising the meaning of short sentences heard in their right ears (LH), whereas the emotional tone the sentences were spoken in were recognised more accurately when heard by their left ears (RH).

Work on hemispheric specialization, or hemispheric asymmetry, began last century with the study of brain-damaged patients, with observations of their behaviour and capabilities which were later compared with postmortem examinations of their brains. It gained impetus in the 1960s with the study of commissurotomized patients in which the corpus callosum, connecting the two sides of the cerebral cortex, was sectioned to control seizures. In these patients it is possible to communicate separately with each side of the brain to discover its special functions. While investigation continues in these fields the present emphasis of psychological research is on the integrated, intact brain of the normal person.

A large body of research now exists to support the view that in most normal right-handed people emotion is perceived, processed and possibly remembered by the right hemisphere, and language is perceived, processed and committed to memory by the left hemisphere. It is suggested here that the separate components of the two-structure memory are associated with the separate functions of the two hemispheres. Words are processed by the LH, while any emotional content of the words is processed by the RH, each hemisphere being capable of contributing to recall.

The hypothesis is that in free recall both hemispheres contribute to the response, which results in an advantage for emotional words, while in cued recall, the special language processing required for word search and word match allows the left hemisphere to dominate, removing the advantage for emotional words.

Chapter Three

EMOTION, MEMORY AND THE BRAIN

The brain is studied on several different levels. These range from brain processes within the framework of some theoretical construct such as the information processing model, through various groupings of structures according to position or function, individual structures, to cells and neurochemistry. Each level has its own discipline, its own methods and its own theories. Often experts of one level show little interest in the work of others working at different levels, or their respective theories have mutually exclusive elements that may give rise to controversy.

For present purposes the brain will be considered at the level of functional areas with an emphasis on structures and their interconnections that are involved in emotion and memory.

EMOTION AND THE BRAIN

There has been a great deal of research done emotion and the brain but it has produced very little firm evidence concerning the brain structures and processes involved in human emotions. The bulk of the research has been carried out on animals, with the most frequently used methods being the observation of behaviour following ablation, the making of lesions, or during stimulation by electrical or chemical means. The finding of some parallels in human behaviour under similar conditions has led to extensive interspecies extrapolation. As a result it is the more primitive emotions such as fear and anger, that humans share with animals, that have been studied. Evolutionary orientated theorists regard these basic emotions as the foundations from which complex human emotions have developed (e.g. Panksepp, 1982).

From both animal studies and human clinical studies certain brain structures are known to be involved in emotion. These include the reticular formation of the spinal cord and brainstem; some major structures in the diencephalon, such as the hypothalamus and the thalamus; the various cortical and sub-cortical structures of the limbic system, such as the amygdala, the hippocampus, the cingulate cortex, the septum and the mammillary bodies; and the neocortex of the frontal and temporal lobes. All these structures have been found to produce changes in emotional behaviour if removed, damaged or stimulated. Some of these changes are specific to particular areas, but the overlap of function within structures makes mapping of functions <u>on</u> structures unreliable. Furthermore, changes produced in one species need not be evident in other species under the same conditions. As Strongman (1978) points out, at best it can only be said that the structures are implicated in emotion.

The relevance of this area of research to the emotions of the normal human adult remains to be seen. However, here is a brief description of the structures, their interconnections and a sample of the vast number of experiments that have been conducted.

The most important structure appears to be the hypothalamus. This is a small area situated about the third ventrical deep within the brain. It has a number of very important functions, such as the control of body temperature, water balance and food intake, as well as control of the autonomic nervous system. The hypothalamus has many complex interconnections with other structures in the brain. Of particular interest here are afferent pathways from the reticular formation, the hippocampus, the amygdala, the cingulate cortex and the frontal association cortex. Some efferent pathways pass to the cingulate cortex via the anterior nucleus of the thalamus; the reticular formation and the autonomic neurons in the spinal cord. As well as having neural connection it also exerts hormonal influence over the pituitary gland, which controls the endocrine system. Both the autonomic nervous system and the endocrine system are responsibe for the physical reactions and feelings associated with emotion.

In human clinical studies massive sympathetic discharge and emotional expression has been produced by electrical stimulation of the hypothalamus (Grinker and Serota, 1938, in Boddy, 1978), while similar stimulation has produced sympathetic and parasympathetic discharge without the subjective experience of emotion (White, 1940, Ibid.).

The reticular formation is situated in the brainstem and the spinal cord. This structure facilitates cortical reception of sensory information. It may be responsible for selective attention (Jacobson, 1972).

The thalamus is a large twin-lobed structure situated at the upper end of the brainstem. Among its functions is the relay of sensory information and motivational impulses between cortical and subcortical structures.

The interconnected structures of the limbic system have a central role in emotion. They include the amygdala, the hippocampus and the cingulate gyrus. Other structures included in the system by various authors are the mammillary bodies of the hypothalamus, the septum, and the anterior nucleus of the thalamus. The neural connections between these structures and other cortical and subcortical structures are very complex. Emotional functions of the structures of the limbic system are poorly understood and can only be speculated upon. Bilateral amygdalectomy has been found to reduce aggression in humans (Moyer, 1971, in Boddy, 1978), while stimulation has produced rage and assaultive behaviour (Ervin, Mark and Stevens, 1969, ibid.). Stimulation of the hippocampus has also produced aggressive behaviour in humans (Sweet, Ervin and Mark, 1969, ibid.), and in cats cholinergic stimulation of the hippocampus has produced irritable aggression (Maclean and Delgardo, 1953, ibid.). However, removal of the cingulate gyrus has reduced aggression in humans (Tow and Whitty, 1953, ibid.), but increased irritable aggression in cats (Kennard, 1950, ibid.).

Neocortical areas in the frontal and temporal lobes are also involved in emotion. The frontal lobes have connections with the cingulate cortex, the hypothalamus and the thalamus. The frontal cortex is so closely related to the limbic system that Nauta (1971) considered it may be viewed as the major neocortical representation of the limbic system. In humans, leucotomy, a surgical procedure in which the connections between the frontal lobes and the limbic system are severed, was used to moderate the behaviour of emotionally volatile patients. According to Marcus (1972) patients who have had prefrontal lobectomies (i.e. ablation) do not appear to be aware of the consequences of their actions, which suggests that the area has an inhibitory function.

Functions of the temporal lobe cortex are difficult to ascertain. In the bulk of experiments it is not clear the extent to which the effects apply to the neocortex or to the underlying structures, which include the hippocampus and the amygdala. Human studies deal almost exclusively with clinical cases. In a review of many studies on patients suffering from temporal lobe epilepsy, Bear (1979) classified a number of characteristics of interictal (between-seizure) behaviour. These include a deepening of all emotions; increases in elation, sadness, anger, aggression and hypersexual or hyposexual behaviour. From the results of these studies and from his own research Bear suggested that temporal lobe seizures progressively modify the function of the limbic system so that previously neutral stimuli are enhanced by emotional colour.

LATERALIZATION OF EMOTION: CLINICAL EVIDENCE

The clinical literature abounds in studies indicating that emotion is lateralized. For example, Gainotti (1972) administered a battery of tests to brain damaged patients, 80 with LH damage and 80 with RH damage. He found that those with LH damage were characterized by a catastrophic or anxious-depressive mood, while those with RH damage were more likely to be indifferent, to minimize or deny their defects, or have a tendency to joke. The anxiety reactions, swearing and bursts of tears observed in the LH patients Gainotti considered were secondary to the language difficulties.

As an explanation of these differing emotional reactions Gainotti cited an hypothesis proposed by Hecaen and Angelergues (1963, a French paper, part of which is summarized in English by Gainotti, 1972). On the strength of their studies on visual agnosia Hecaen and Angelergues concluded that sensory data undergo a complex conceptual elaboration mediated by language in the LH, but in the RH "they are processed in a more primitive way, so that they retain their immediateness and rich affective value" (Gainotti, 1972, p. 53, emphasis his).

Cicone, Wapner and Gardner (1980) tested patients with unilateral brain damage on their ability to match emotional facial expressions, group together drawings of situations similar in emotional tone, and to match short descriptive phrases to the situations. Patients with LH damage had difficulties with the verbal task, but RH patients performed poorly on all the tasks. Furthermore, the RH patients were much more likely to engage in misinterpretations and confabulatory relating of stimuli. Cicone et al. also considered that the emotional problems in the LH patients were secondary to the language difficulties. However, among the RH patients the difficulty in understanding emotional situations and the structural relations between the emotions was general.

In an experiment conducted by Kolb and Taylor (1981) patients with LH lesions were shown to have an impairment of their ability to apply verbal labels to emotional facial expressions. Patients with RH damage were impaired in their ability to match emotional expressions depicted in different photographs. In addition, RH patients with frontal, but not with temporal lobe damage, talk excessively, which fits into a pattern of impulsiveness and rule-breaking behaviour that characterized these patients. Kolb and Taylor believed the site, as well as the side of the lesion should be considered.

The site of the lesion was considered in a recent study by Robinson, Kubos, Starr, Rao and Price (1984). They found that the severity of depression significantly in patients with left anterior lesions, as opposed to any other site. Patients with right posterior lesions than those with right anterior lesions, who were unduly cheerful and apathetic.

In contrast to the lesion studies Bear's (1979) study on sufferers of temporal lobe epilepsy produced evidence of a different sort. Bear compared self-report statments made by the Ss with the statements of raters (long-time friend, relative or professional). The right temporals' self descriptions contained more elation than negative emotions, while the left temporals' self descriptions contained more anger than positive emotions. In the raters' descriptions the right temporals were emotive and the left temporals ideative. The right temporals under-reported disapproved tendencies, such as depression, suicidal feelings, explosive temper, peevish anger to irritation and inappropriate dependance. They over-reported self worth, the ability to see the meaning to suffering, exceptional personal etiquette, prompt attention to obligations and minimal sexual demands. The left temporals' reports were the reverse of those of the right temporals'. It would appear that temporal lobe epilepsy has the opposite effect to lesions in that it seems to exaggerate hemispheric processes.

Most of the clinical laterality studies have been carried out on commissurotomy patients in whom the corpus callosum has been sectioned to prevent violent seizures from spreading throughout the brain. While much can be learned from these 'split brain' patients the findings should be interpreted with caution. Not only do these patients have a long history of epilepsy, but the marvelous potential of the brain to adapt to tissue loss and damage, and to regenerate lost functions in other cortical locations raises the possibility that they are qualitatively as well as quantiatively different from normal people. This of course applies to all clinical findings. For this reason the main body of the present study will concentrate on research on normal subjects.

MEMORY AND THE BRAIN

As with the research on emotion and the brain the neural mechanisms of memory are studied mainly in animals, using similar methods of ablation, lesion and stimulation. Research on humans is largely restricted to clinical populations. Because learning and memory obviously involve very subtle changes much of the research has been on the level of neurochemistry and neuronal activity. A vast amount of research has been conducted in an effort to discover the physiological processes involved in learning and the localities of specific memory storage. However, as in the study of emotion, the results are inconclusive, with certain structures being implicated in memory without their necessity or sufficiency being established.

Furthermore, it is difficult to interpret many results. For example, if a S fails to recall previously learned information is the fault in the encoding or in the retrieval, or both? Such a question is critical to the present study since it is concerned with recall rather than learning. Another related problem occurs in ablation and lesion studies. If information is forgotten after damage is incurred does this mean that the memory trace is destroyed, or that the processes involved in recall have been disrupted? This question is especially important when considering the emotion and memory functions of structures in the temporal lobes. A third problem is the inappropriate nature of animal studies to research on word recall.

Given the principles of Classical conditioning it is hardly surprising that the structures implicated in emotion have been studied in relation to memory. However, this approach has tended to concentrate on conditioning experiments using cats, rats and rabbits, and even invertibrates. In humans Classical conditioning is obviously involved in the learning and memory of some words, but most words bear no relation to the primary states and processes that are the basis of conditioning.

The structures involved in emotion that are also studied in relation to memory are those in which amnesia results from their damage or removal. Different types of amnesia are associated with different structures. For instance, in Wernicke-Korsakoff disease, which results from a severe thiamin deficiency, damage occurs to the area around the third ventrical, including the dorsomedial nucleus of the thalamus (Adams,1969) which has afferent fibres from the hypothalamus and the amygdala, and two-way connections with the prefrontal cortex (Carlson, 1981). Wernicke-Korsakoff disease has a particular set of symptoms, according to Adams. These include both anteriorgrade and retrograde amnesia, though the patient is alert, with normal ability to think and solve problems, and to use language and imagination.

The structure that is most likely to be responsible for much of the processing and storage of information is what Penfield (1975) calls the uncommitted cortex, those parts that at birth are not committed to any particular function as are the sensory and motor areas. In humans this accounts for the bulk of the cerebral cortex. A great deal is known about some of the processes that take place in the uncommitted or association cortex, such as those in the interconnected areas of the LH that are involved in language, but those associated with memory are still very vague.

While the temporal lobes are closely involved in memory the precise nature of the relationship is a matter for conjecture. They have functions that may be involved in the processes of encoding and recall, without being the site of memory storage. Penfield (1975), who has used electrical stimulation on the brains of epilepsy patients prior to surgery, has found that in certain areas of the temporal lobes stimulation produces vivid memories in the patient. Stimulation of these areas, which he calls the interpretive cortex, reveals two mechanisms. One sends neuronal signals that interpret the relationship of the individual to his environment producing signals, such as 'familiar' or 'frightening' in consciousness. The other mechanism is capable of bringing back a slice of past experience. If this is so then perhaps it is in the interpretive areas of the temporal lobes that the complex interaction between emotion and memory takes place.

The extent of the interaction may be subject to individual variation. In a recent study of electrical stimulation of the medial temporal lobe of psychomotor epileptics Halgren, Walter, Cherlow and Crandall (1978) found that the type of mental phenomenon evoked was not closely related to anatomical site as are somatosensory responses. There was considerable variability among the patients, with the type of mental phenomenon reported being more related to the patient's personality than to site. For example, those patients reporting fear scored higher on the 'psychoesthenia' subscale of the MMPI than did other patients.

A great deal of research done on memory has focused on the hippocampus. However, the problem of separating the functions of the hippocampus from those of the neocortex are as real here as in the study of emotion.

Removal of the medial areas of both temporal lobes, including the neocortex and parts of the hippocampus and amygdala, produced permanent anteriograde amnesia in one patient (Milner, 1966, 1970). In this patient early memories and language were intact, his social behaviour and emotional responses were appropriate, and his short-term memory was normal, yet he was quite unable to transfer new information into long-term memory.

Patients with unilateral removal of the temporal lobes have shown modality-specific memory loss (Corsi, 1972, reported in Milner, 1974). Left temporals, in whom the language areas have been retained, showed impairment on a verbal memory task, compared with right temporals and normal subjects. The greater the damage to the hippocampus the greater the impairment. In a spatial memory task left temporals performed as well as normals, but right temporals showed considerable impairment. With the right temporals it was the amount of cerebral cortex removed that determined the intensity of the impairment, rather than the amount of hippocampus. Hippocampal lesions in rats produced disruption in working memory (Olton, Becker and Handelman, 1979) which seems to be at odds with the human studies. One theorist at least refutes the idea that the hippocampus is the critical structure for memory in the temporal lobes. Horel (1978, 1979) maitains that it is in the temporal stem, the white matter of the temporal lobes, that lesions disrupt memory. Removal of all or part of the hippocampus also causes damage to the temporal stem. If this is so then this would account for the greater impairment with larger loss of cortex in the right temporal patients in Corsi's study (Milner, 1974). The human right temporal lobe has been found to contain considerably more white matter than does the left temporal lobe (Gur, Packer, Hunger-buhler, Reivich, Obrist, Amarnek and Sacheim, 1980).

Whatever the involvement of the temporal lobes in memory it seems likely that their function is not actually storage. Squire (1978) noted that in different types of retrograde amnesia, including that suffered by the patient studied by Milner, mentioned above, and by patients receiving E.C.T., the memory loss is restricted to the immediate pretreatment period (in some cases several years), while memories prior to this period remain intact. Other researchers (e.g. Milner, 1970; Risse, Rubens and Jordan, 1984) believe, on the basis of lesion studies, that short-term memory and long-term memory are two independant processes.

An important point that should be made here is that in practically all the studies mentioned in this section the subjects have suffered from temporal lobe epilepsy. Bear's (1979) review of the research on patients with this complaint revealed considerable cognitive and emotional disturbances that may be strengthened over time. Since surgery was in most cases a last resort the probability of these disturbances is high. How far the findings can be applied to normal people remains to be seen.

The frontal lobes of the cerebral cortex are also associated with both emotion and memory. This area seems to be more concerned with the voluntary or conscious control of emotion, and with planning and judgement than with memory. However, people with frontal lobes removed or damaged have great difficulty in appreciating the temporal order of events and this can affect their memory in a specific way. According to Milner (1974) patients with frontal lobe lesions perform normally on many verbal and non-verbal tasks, but they have trouble discrimination a more recently presented stimulus from one presented earlier. Comparisons between patients with left unilateral lobectomy and those with right lobectomy reveal a hemispheric specialization effect. Left frontals performed well on a non-verbal recency discrimination task, but did poorly on a similar verbal task. Right frontals' performance was the opposite, comparing well with normals on the verbal task, but showing a marked deficit on the nonverbal task. Patients with frontal lesions had no trouble recognizing previously presented stimuli but those with temporal lobe lesion did, depending on the type of stimuli and the side of the lesion. For example, in left temporals recognition of verbal stimuli was impaired. Furthermore, people with temporal lobe lesions performed almost as well as normal people on the recency discrimination task.

Finally, Risse, Rubens and Jordan (1984) studied the performance on a verbal learning task (9 verbs from 3 categories) of right-handed aphasic patients after ischaemic infarction of the LH. The site and extent of the lesion was determined by CT scan. Patients with lesions of the inferior frontal lobe and/or basal ganglia were severely impaired in both acquisition and long-term retention of the word list compared with patients with posterior temporoparietal lesions, and normal controls. The posterior group, however, were impaired in short-term memory, compared with the anterior group and the normals. This suggested to them that not only are short-term and long-term systems separate, but that neural connections of the inferior frontal lobe and the basal ganglia may be crucial for initiating the retrieval process. This appears to be contrary to the temporal lobe epilepsy literature in which temporal lobe lesions have been more likely to produce disturbances in long-term memory while leaving short-term memory intact.

CONCLUSION

A number of brain structures are known to be involved in both emotion and memory. The exact nature of the involvement has not been established. Emotion and memory are separated in the literature, with very few, if any, investigators showing a real interest in both. Since theories of emotion and theories of memory, based as they are on animal and clinical studies, of necessity are highly speculative, any attempts to formulate an integrated theory of emotion and memory would be precipitate.

The temporal lobes appear to be significant. They are important for perception and learning, as well as emotion and memory and may be the site of dynamic interaction between these processes. However, the work done on temporal lobe epilepsy patients must be regarded with reservations until a great deal of research has been conducted comparing these patients with normal people on a wide variety of tasks and phenomena. So far this is a sadly neglected area of research.

Chapter Four

LATERALITY

Laterality refers to the preference or use of one side over the other. In human research this is usually applied to hands, feet, face, ears, eyes and the brain. The two hemispheres of the brain control most of the functions and actions of the contralateral side. One exception is vision, the half-field of each eye being controlled by separate hemispheres. The relative activity of one hemisphere over the other is inferred from the use of motor and sensory operations on the side it controls.

Mapping the actual control centres for sensory-motor processes has been fairly straightforward, but pinpointing control sites for cognitive processes has not met with the same success. The various activities associated with language are controlled, in most normal right-handers, in the LH, while spatial abilities are controlled in the RH. Apart from these, however, the many other cognitive processes that may or may not be lateralized to one hemisphere are still being disputed with varying degrees of certainty.

The research literature on hemispheric specialization is vast. Even a superficial review of it is beyond the scope of the present work. Consequently, this chapter will deal briefly with only those aspects that are particularly concerned with the topic of this thesis. These include research methods, several different theoretical approaches to laterality and their utility for explaining laterality effects in general and the two-structure memory in particular. Research problems will also be discussed. Furthermore, for reasons discussed in the previous chapter, research on clinical populations will be avoided as much as possible.

RESEARCH METHODS

A number of different methods are used for researching laterality effects. Frequently these involve tasks that require dual processing. Similtaneous presentation of two stimuli, either dichotically or by tachistoscope is the most common. Measures are taken of reaction time (RT), or of correct responses and errors. Stimuli may be presented instead to one visual field at a time, or monaurally. In more direct methods elecrocortical recordings are made from different sites on the head during the performance of various tasks. A relatively new and dramatic method is observing regional cerebral bloodflow. Scintillation detectors arranged systematically over the two hemispheres are used to measure the uptake of an inhaled radio-isotope Xenon-133 which circulates in the blood. Active areas of the brain require more blood and this is reflected in a greater concentration of the isotope in the active areas. Less direct methods include observation of lateral eye movements, facial expressions and gestures.

STRUCTURAL THEORIES

There are basically two theoretical approaches to laterality; the structural and the attentional. Within the structural approach there are several different models. All are, to some extent, fictions in that they attempt to account for perceptual and cognitive responses by analogy, rather than trying to relate them to specific neural activities. In some models, and this applies to the attentional model also, the two hemispheres could be visualized as two separate, but connected 'black boxes.' Others bear a resemblance to a Lamson tube, in which information is sucked by a vacuum from one centre to another. Yet another is based on the neural network with similar activating and inhibiting functions.

Direct Access

Most structural models are based on one of two assumptions. The first is that each hemisphere is specialized in processing different stimuli. The most obvious of these hemisphere specific functions is the LH involvement in language, powerful evidence for which has been gained from the clinical research. A model of laterality that is based on this assumption is the direct access model (e.g. Kimura, 1966). In RT studies verbal stimuli observed in the right visual field (RVF) or in the right ear has an advantage over stimuli perceived in the left visual field (LVF) or the left ear. Since verbal processing is a function of the LH this suggested that stimuli presented to the right side had direct access to that hemisphere. Stimuli presented to the left side, however, would enter the right hemisphere and would need to be transmitted via the corpus callosum to the left hemisphere for processing. While this model can explain many of the asymmetries that have been reported Kinsbourne (1970) pointed out that it does not account for response latencies that are far greater than the time it takes for an impulse to pass through another synapse, nor for studies in which a right side advantage was observed for a non-lateralized task.

Dichotomies

The other assumption is that each hemisphere has contrasting but complementary strategies for processing the same stimuli. For instance, while the language processor of the LH is involved in extracting the meaning of say, the spoken words, the RH assesses the tone of voice. A number of these contrasting strategies have been suggested. These include such specialties for the left and right hemispheres respectively as verbal-non-verbal, verbal-visuospatial (e.g. Milner, 1971), and analytic-holistic (e.g. Nebes, 1974; Bradshaw and Nettleton, 1981). Dichotomies such as these can be so intuitively right and have so much supporting evidence that they have become assumptions in their own right. Nevertheless, they have their critics.

In these types of theory the aim is to find the dichotomy that is fundamental to lateralized functions. However, which aspects are the most fundamental is disputable. Furthermore, whatever the dichotomy there always exists conflicting results which can be used to cast doubt upon it. An example is the conflicting results that have been obtained in testing Navon's (1977) local versus global hypothesis, which is a version of the analytic-holistic dichotomy. Testing has been carried out by using Stroop-type stimuli consisting of large letters made up of small similar or conflicting letters. While the work of Martin (1979 a,b) and Sergent (1982) supported this hypothesis Alvisitatos and Wilding (1982) found that the RH was able to process analytically, if required to do so. Moreover, Boles

(1984) found that both hemispheres could recognize both local and global patterns and that asymmetries were due to the type of response employed, vocal versus manual.

Some researchers (e.g. Milner, 1971; Bradshaw and Nettleton, 1981) have argued that lateral differences may be more quantitative than qualitative, that they may be more appropriately viewed as a continuum rather than as a dichotomy.

Limited Resources

Another underlying assumption of most structural theories is that attention is a limited resource. While little or none may be required for automatic operations, such as walking, increasing amounts are required for tasks of increasing difficulty. In the single channel theory of task performance a limited amount of attention is devoted to one task. No other non-automatic task can be performed at the same time. Any apparent similtaneous performance of two tasks is serial, rather than parallel. While this theory could account for many results gained in cognitive psychology it has very little utility for hemispheric specialization.

Experiments in hemispheric asymmetry typically use dual task designs, the results of which require a somewhat more complex model than single channel theory. Multichannel theories allow for the concurrent performance of more than one task by means of different channels for processing subsystems, and sensory and response modes. If the sensory and motor systems of the two hemispheres are regarded as separate channels then this type of theory can account not only for the types of tasks that can be successfully performed together, i.e. in different channels, but also for those tasks that interfer with one another, i.e. in the same channel. However, not all dual tasks processed by one hemisphere produce interference. Some may be enhanced (Kinsbourne, 1970; Hellige and Cox, 1976). Before continuing with this discussion on structural models of laterality a digression will be made to consider a functional model.

THE ATTENTIONAL MODEL

To account for some of the inconsistencies Kinsbourne proposed his attentional model of lateral asymmetries (1970, 1973,1975). One of the problems in perceptual asymmetry experiments, he pointed out, was that attention prior to the presentation of stimuli is assumed to be distributed symmetrically. Expectancies of stimuli from a particular point in space, or stimuli of a particular type are of extreme importance. According to the attentional model (1) when stimuli is expected on one side the contralateral hemisphere will be activated and stimuli arriving at that hemisphere will be more efficiently processed, and (2) when stimuli of a particular type are expected the hemisphere specializing in processing that stimuli will be activated and stimuli appearing in the contralateral side will be processed more efficiently than stimuli presented in the ipsilateral side. However, language is processed in the left hemisphere and if the subject is thinking in words prior to presentation the LH will be primed and will more efficiently process incoming stimuli than will the RH. These notions have been supported by many experiments carried out by Kinsbourne and his colleagues, and by others. Not all experimenters have been able to support them though (e.g. Moscovitch and Klein, 1980), nor even replicate Kinsbourne's findings (e.g. Gardner and Branski, 1976).

One group of researchers led by Hellige (Hellige and Cox, 1976; Hellige, Cox and Litvac, 1979) have conducted a number of experiments on selective hemisphere activation. Some of their results have supported Kinsbourne's theory in that a lateralized and concurrent memory task can enhance the performance of the hemisphere specializing in that type of processing. However, it occurs only within certain limits. When the memory load is increased or removed then a hemisphere shift results. Hellige and his associates considered that this was further evidence for the theory that the hemispheres are limited capacity information processing systems.

INFORMATION PROCESSING AND LIMITED RESOURCES

The concept of the hemispheres as limited capacity information processing systems is common among theorists who have an information processing bias (cf Moscovitch, 1979). An example of this approach is Friedman and Polson's model (Friedman and Polson, 1981; Friedman, Polson, Dafoe and Gaskill, 1982). A review of the laterality literature convinced them that the widely differing results could all be explained by a model in which the two cerebral hemispheres are seen as two independant pools of resources. The "resource supply for each hemisphere is fixed, limited,inaccessible to the other hemisphere, and undifferentiated" (Friedman and Polson, 1981, p. 1040). While there may be different perceptual and cognitive mechanisms in each hemisphere, these compete for a fixed supply of resources. Some tasks may draw on the resources of only one hemisphere, while other tasks will require resources from both hemispheres in different proportions. The proportions will vary for task, type of stimulus, instructions, or subject. Each hemisphere is probably capable of performing most tasks, but resource allocations differ in the two hemispheres. This model is simple in that the brain is seen as two independant but interacting 'black boxes' or pools of resources, but it is also very complex in its many conditions so that it may account for a very wide range of data. Even so, a counterexample can be found that Friedman and Polson's model would not predict. According to their model task interference would occur within hemispheres but not between, since resources of each hemisphere are limited and inaccessible to the other hemisphere. Yet in a two-limb step tracking task Briggs and Kinsbourne (1978, reported in Kinsbourne and Hicks, 1978, a) found that interference was greater between the two hands or the two feet (i.e. different hemispheres) than it was between ipsilateral limbs (i.e. same hemisphere).

THE FUNCTIONAL CEREBRAL DISTANCE MODEL

In a more recent theoretical development Kinsbourne has proposed an alternative to multichannel, limited capacity processors in which the brain itself is the model (Kinsbourne and Hicks, 1978, a,b; Kinsbourne, 1982, 1983). He describes the brain as a differential neural network in which all parts are interconnected. Activation in any locus could spread throughout the brain. As activation spreads synapses may be points of confluence or inhibition, creating patterns that are alterable by experience Kinsbourne, (1982, 1983). This network Kinsbourne calls functional cerebral space, and priming and interfering effects are explained by the concept of funtional distance. In his model control centres of tasks that are very similar are very close together in functional space, and the control centres of those that are different are set at a distance. Activation from one particular centre will spread to others nearby, promoting and enhancing congruent behavioural operations, and interfering with incongruent ones. The spread of activation to distant centres within or between hemispheres is minimal because of the greater likelyhood of inhibiting synapses. Thus tasks that are controlled in widely spaced loci can be performed similtaneously.

In dual processing tasks closer centres controlling incongruent tasks will be subject to distortions from one task to another. Each task has its own pattern of neural activity. The problem of concurrent performance is differentiating between these patterns. A person may try to perform both equally, or depending on pay-offs, try to safeguard one from distortions by the other. With sufficient practise the person can learn to differentiate the patterns of activity, i.e. construct inhibiting barriers with synapses between the patterns, and will then be able to perform the two tasks successfully. While some theorists would label this discriminable distinction a 'channel' Kinsbourne regards such a concept as a serious misrepresentation of what actually occurs in the brain. A limited number of discrete channels do not describe the large and ever-varying number of patterns of responses.

Kinsbourne sees hemispheric specialization as adaptive, providing distance between "complementary component processes that combine to program a unitary pattern of behaviour" (1982, p. 413). To suggest that the two hemispheres offer alternative and independant strategies for one task makes little sense. Modes of thought do vary between the hemispheres, however. The LH is involved in cognitive processes that are analytic and specific, such as logical sequences of item information. The RH is concerned with the complex relationships between the items, providing the context. This dichotomy is not necessarily the most important one in human behaviour, nor are other dichotomies necessarily sited in different hemispheres.

The purpose of hemispheric specialization is to keep separate different classes of cognitive operations that need to be performed concurrently and without interference. Specialization, Kinsbourne maintains, reroutes different components of a single activity, not separate activities.

TRANSMITTED LATERALIZATION

The notion of rerouting different components of one activity is central to Moscovitch's (1979) transmitted lateralization theory. On the basis of research carried out by himself and his colleagues(e.g. Moscovitch, Scullion and Christy, 1976) Moscovitch proposed that asymmetries arise late rather than early in perceptual processing, since extraction of features is common to both hemispheres. The asymmetries emerge at a later stage when information is integrated by a central processor from peripheral channels and represents it in the mode peculiar to each hemisphere. Moscovitch made a serious, though understandably cautious attempt to relate cognitive processes to neural structures and functions. He suggested that only some of the structures need to be specialized in function. Some major structures in each hemisphere, such as the hippocampus, are identical and interchangeable. Where one hippocampus varies from the other is in the type of information it receives.

Agreement on specific biological aspects does not necessarily lead to general agreement, however. Moscovitch (1979) couches his theory in terms of multichannel processing and limited capacities.

TWO-STRUCTURE MEMORY AND LATERALITY

Eventually the question must be addressed- which model or theory best accounts for the two-structure memory hypothesis? Posner and Snyder's (1975) suggestion was that there are two independant memory structures. In their experiment on impression formation, using trait adjectives, one was an item memory consisting of the adjectives, while the other, the emotion memory, consisted of an abstract impression of a combination of traits. The step between this notion and the concept of the analytic, item processing functions of the LH, together with the relational functions of the RH, is a short one. Since Posner and Snyder's work very much involved parallel processing and capacity limitations there is no doubt that an information processing model of lateralization would be an appropriate extension of their research. Nevertheless, Kinsbourne's functional cerebral distance model is equally able to account for the two-structure memory.

The choice is between the hypothetical construct of the human mind being an information processing machine and an attempt, however inadequate, to relate cognitive phenomena to actual neural structures and processes. To reiterate a point made in the second chapter, the information processing model is potentially a closed system that risks circular cause-effect relationships. While it can generate useful hypotheses about real world phenomena the results are usually interpreted in terms of its own fiction rather than those of the real world. For this reason the information processing model will not be considered further.

This is not to say that Kinsbourne's theory will be embraced wholeheartedly. It will be favoured in attempts to explain phenomena where it seems appropriate. No model incorporates all the evidence. Whether a theory is based on a simple, seemingly fundamental dichotomy, or is a complex and comprehensive model there are always counter-examples a theorist can cite to cast doubt on the views of his opponents. This is due in part to weaknesses in the models, but it is also due to weaknesses in the research methods and the assumptions on which they are based.

RESEARCH PROBLEMS

In the study of hemispheric specialization the number of different methods used to test a wide variety of theories has given rise to a large number of research problems. Zaidel (1983) expresses this notion rather forcefully.

> Lateral research on normal subjects... (has reached)

> a point of diminishing scientific returns attributable to many poorly trained, uncommitted, or over zealous experimenters. The result is that the field is now replete with unreliable, unreplicated findings, conflicting results, and one-time dramatic superficial demonstrations of hemispheric specialization on this task or that. (p. 524).

Problems can contaminate the research in three areas. They can arise in the theoretical approach or the assumptions of the experimenter; or result from some aspect of the experiment, such as the type of stimuli, or method used; or they can reflect the individual differences of the subjects. These problems are now too numerous to deal with adequately here. Instead, a brief and biased summary will be given.

One of the difficulties that can occur as a result of the experimenter's assumptions is due to extrapolation. It was pointed out in Chapter Three that generalizing findings from clinical to normal populations is risky, since much of the research has been carried out on patients suffering from extreme forms of epilepsy. Another form of extrapolation that should be avoided is from one cognitive process to another. For example, a large proportion of the research on laterality in normals has been concerned with perceptual asymmetries. These need not be identical with higher order processes such as semantic discrimination or memory.

Problems in experimental methods are legion. They include practise effects (e.g. McKeever, Nolan, Diehl and Seitz, 1984) and order effects (Hiscock and Bergstrom, 1982), on dichotic listening. Tachistoscope studies can be affected by light intensity (e.g. Milner and Lines, 1982) and exposure duration (Sergent, 1982). Lateral eye movements have been found to be unreliable predictors of hemispheric activation (Erlichman and Weinberger, 1978; Hatta, 1984).

Perhaps the greatest number of problems are a consequence of individual differences between the subjects and the variations in the strategies they use to perform a task. For example, sex differences have been observed in many areas of laterality research (e.g. Day, 1977; Safer, 1981; Davidson and Schwartz, 1976), yet many investigators either fail to control for sex, or they do not report the sex of their Ss. Similarly, handedness can influence results. Satz, Achenbach and Fennell, (1967) found that self-reported 'left-handedness' was a unreliable estimate of dexterity. Nor is assigning Ss to groups on the basis of their writing hand a reliable method. Many researchers fail to report the handedness of their Ss, or rely on self-report, or do not state the criteria on which selection was made.

The Ss' different strategies for accomplishing the experimental tasks can also affect results. These have been reviewed in an excellent discussion by Bryden (1978). They include attentional effects, such as the S attending more to the ear that is not performing as well as the other in dichotic listening. Expectancy of stimuli on a particular side, or of a particular type, may prime one hemisphere so that it will process stimuli more efficiently than the other. Or in tachistoscope studies, expecting stimuli in a particular field may cause drift from the fixation point.

The research problems outlined here are general. More specific problems relating to emotion and laterality will be discussed in the next chapter.

Chapter Five

LATERALIZATION OF EMOTION AND MEMORY: RESEARCH ON NORMAL POPULATIONS

The research on the lateralization of emotion and memory is based on clinical studies and although the body of normal research is growing there are still great gaps that can be filled only by clinical data and speculation. Furthermore, while the research on emotion has gained impetus in the last decade the lateralization of memory has attracted few investigators. Consequently, this chapter will be concerned largely with emotion. A discussion of the specific interaction between emotion, memory and laterality appears in the next chapter.

In the present chapter there will be a consideration of two aspects of emotion and hemispheric asymmetry, mood and the LH positive-RH negative hypothesis, that should be taken into account when analyzing individual experiments. This will be followed by a review of verbal studies, and a brief discussion on a selection of face studies. A few other studies will be considered, and some theoretical issues addressed. Finally, there will be a short section on memory, though memory will be discussed prior to that whenever it is relevant.

In her review of the lateralization of emotion Campbell (1982) considered the effect of mood on laterality. Nearly all of the small number of studies concerned with the effect of mood that she cited used either EEG recordings or LEMs. The results are inconsistent and difficult to interpret since, as Campbell pointed out, it is difficult to know if a particular mood facilitates or inhibits one hemisphere or the other. However, she believed that mood does somehow affect lateralized processes even though there is only one reasonably consistent finding, that depressed mood reduces RH performance. Anxiety, whether trait or induced, affects some lateralized processes, but what they are or how they are affected may depend on the procedures, the method of recording, or in the case of EEG studies, the site of the electrodes.

The methods of inducing moods range from lengthy, hypnotic-type induction (Tucker, Stenslie, Roth and Shearer, 1981), to simply telling the S to feel sad (Ladavas, Nicoletti, Umilta and Rizzolatti 1984). Tucker et al. (1981) conducted two experiments: one measuring the effects of induced mood on lateralized tasks (arithmetic and word problems, and visual imagery), and the other recording brain activity during induced mood. The Ss' performance on arithmetic problems did not differ between the two moods, euphoria and depression, but their ratings of visual imagery was significantly lower in the depressed mood. For the second experiment the mood induction procedure was just as long but it did not involve hypnosis. The EEG record showed increased activity in the right anterior region during depressed mood.

This result is rather different from that of Harman and Ray (1977) who found that negative emotion generated more activity in both hemispheres , but particularly in the LH. Although these results have been supported by Davidson, Schwartz, Saron and Goleman (1979)there is a procedural problem that could have activated the LH. During each 35 secs of EEG recording the experimenter provided "non-stop verbal stimuli" (p. 458), coaching the S in producing the emotion. The differences in activity between negative and positive emotion may reflect the different coaching strategies between negative emotion (sad, fearful or angry) and positive emotion (calm-pleasant), and the amount of verbal processing required for each strategy. For the negative emotion the verbal coaching may have been more vigorous, contributing to the relatively greater LH activity.

In Ladavas et al's (1984) study a sad mood interfered with RH performance on a non-lateralized RT task. The Ss were instructed to feel very sad. Imagining unhappy scenes was useless, they were told. Each S took less that a minute to comply. If a mood can be induced so quickly and so simply that can produce substantial differences in performance over control sessions then any experimental procedure that could in some way modify or alter a S's mood may yield results that are not entirely due to the independant variable. Many of the studies that will be reviewed in this chapter could be to some extent affected by this problem, yet it is rarely, if ever, taken into consideration. Furthermore, the problem is a difficult one. If non-emotional RH activities are disrupted by a sad mood would emotional processes be similarly disrupted, or would they be enhanced?

The other important issue in the research on emotion and laterality is whether the RH is responsible for all emotional processing or if positive emotions are processed by the LH and the RH processes negative emotions. Although most of the evidence supports RH emotion processing the LH positive- RH negative hypothesis has had some impact. The latter is chiefly propounded by investigators with a psychophysiological orientation. Schwartz, Ahern and Brown (1979) recorded facial electromyography in response to questions, and found greater right than left muscle activity for positive emotion questions, suggesting greater LH activity, while for negative emotion questions more right muscle activity was recorded. The same researchers (Ahern and Schwartz, 1979) observed LEMs in response to questions and found a similar pattern of lateral activity. In their EEG study mentioned earlier, Harman and Ray (1977) recorded activity in both hemispheres during negative emotion, but more in the LH than in the RH. Reuter-lorenz, Givis and Moscovitch (1983) presented two photographs of the same person, one emotional and one neutral, similtaneously to separate visual fields. Subjects were required to indicate which side the emotional face appeared in. The RT data showed that the RVF was faster for happy faces and the LVF was faster for sad faces.

Subjects in Natale, Gur and Gur's (1983) series of experiments rated emotional faces or composite chimeric faces as positive or negative. For the full-face experiment Ss rated expressions more negative when presented to the LVF (RH). Expressions on chimeric faces containing both happy and sad expressions were judged more positive than negative when presented to the RVF. No such bias was shown by the RH. Natale et al. interpreted their results as showing RH superiority in judging emotional valence, but that the LH has an 'optimistic bias.'

WORDS

The use of verbal stimuli in research on emotion and laterality is limited, possibly because the LH is expected to dominate in experiments involving words. The results have been mixed, depending on the methods used, and the picture is further confused by sex differences, which may or may not be related to procedure rather than to actual neurological differences Several studies involving verbal stimuli will be discussed here and others that also include a memory component will be reviewed in the next chapter.

Tone of Voice Versus Content

According to Kinsbourne's attentional model verbal stimuli should activate the LH and inhibit the RH. However research has shown that the RH need not be inhibited. Indeed, when a person is listening to natural speech the RH is sensitive to the tone of voice. Several dichotic or monaural listening experiments have demonstrated this. The first was Haggard and Parkinson's (1971, Expt. 2). They played familiar sentences in different tones (angry, bored, happy and distressed) to one ear and bar babble to the other ear. The results showed a left ear advantage (LEA, RH) for identifying the emotional tone, but no ear advantage for the sentences.

Safer and Leventhal (1977) conducted two monaural experiments. The first was unstructured in that the Ss were required to judge spoken passages, but they were not told whether to judge the emotional tone of voice or the content. Those who listened with the right ear were more likely to judge by content, while those who listened with the left ear were more likely to judge by emotional tone. However, in the second experiment Ss were required to judge both the tone and the content and this produced a REA for both, which was highly significant ($p < .005$) for content and just reaching significance ($p < .05$) for tone. Safer and Leventhal agreed with Haggard and Parkinson's suggestion that it is task demands, rather than stimulus qualities that determine cerebral dominance. The verbal task in their experiment was more complex than that used by Haggard and Parkinson and it may have required more analytic-type processing. Furthermore, their method did not employ competing stimuli, so that the hemisphere that was not being stimulated was left free to participate. It is interesting to note that it was the Ss who heard the passages with their left, rather than their right ears and who were required to judge content first, and emotional tone second, that were the most likely to make mistakes. For these Ss the stimuli entered the RH, which specializes in processing the non-verbal aspects, then they had to respond first to the verbal content (LH) before identifying the tone (RH). Thus both tasks were disadvantaged.

Ley and Bryden (1982) controlled for strategy effects by telling the Ss which ear to attend to. They used short sentences read in different tones of voice (happy, sad, angry and neutral) and similar sentences read in a neutral tone were used as competing stimuli. This produced a clear LEA for emotional tone and a REA for content ($p < .001$ for both). Lateralization on the two tasks was statistically independant, suggesting that they are not necessarily complementary. A very similar experiment (Saxby and Bryden, 1984) was carried out using three groups of children aged 5-6 years, 9-10 years and 13-14 years. All groups showed a LEA for emotional tone and a REA for content. In these two experiments it was th RH, rather than both the RH and the LH, that was involved in judging emotions.

A left ear superiority for non-verbal human sounds has also been found. King and Kimura (1972, Expt. 2) used both emotional and non-emotional sounds, and Carmon and Nachson (1973) used only emotional sounds.

<u>Emotional Versus Neutral Words</u>

Another approach, and one that is of particular importance to the present study, is testing for hemispheric asymmetry in recognizing emotional, compared with neutral words. A lexical decision task was employed by Graves, Landis and Goodglass (1981). Subjects were required to discriminate real English words from pronounceable nonsense words which were presented briefly by tachistocope. There were highly significant emotional word and RVF advantages. However, they found sex differences that make the results difficult to interpret. The male Ss showed a significant RVF superiority, but emotion was the best predictor for accuracy in the LVF. For the females, on the other hand, there was no visual field advantage, due to five of the twelve who showed an overall LVF advantage. Emotion was the best predictor for the RVF among the females.

This experiment was extended by Strauss (1983). In her first experiment Strauss used positive and negative emotional words, rather than mixed emotional and neutral words that Graves et al. had used. Positive words were read more accurately than negative words and both types of words were read more accurately when presented to the RVF rather than to the LVF. She also observed sex differences. The RVF advantage was significant for the males, but was just a trend for the females. In view of the LH advantage for processing both negative and positive emotional words Strauss attempted to replicate Graves et al's findings, varying only the presentation duration. The same emotional word and RVF advantages obtained, but there were no sex differences. Strauss reported that the experiment was repeated using a computer, rather than the tachistoscope, and the same exposure duration as that used by Graves et al., with no change in the results.

It would appear then, that although emotional words are recognized more accurately than neutral words the LH is more accurate at processing both types of words. However, it should be noted that the Ss had only to indicate that they had seen a real English word. There was no requirement for them to report the word nor remember it. Furthermore, the exposure durations (150 msecs for Graves et al., 50 msecs for Strauss) and the 1000 msec limit for manual response gave the Ss very little time to dwell upon the meanings of the words. The problem of varying sex differences is difficult to explain. Considering the effect that mood can have on Ss' performance, how much influence does the sex, attractiveness and personality of the experimenter have?

Unfortunately, such personal details are rarely reported.

LEMs

Another method using verbal stimuli is observing lateral eye movements in response to questions. Schwartz, Davidson and Maer (1975) used four types of questions; verbal-non-emotional, verbal-emotional, spatial-non-emotional and spatial-emotional. Although the verbal questions produced significantly more right than left LEMs there were fewer right LEMs and more left LEMs for emotional questions. The spatial-emotional questions produced the most left LEMs, and the least right LEMs, indicating RH activation, while the verbal-non-emotional questions produced the most right LEMs and the least left LEMs. However, as Safer and Leventhal (1977) have pointed out, the nature of the spatial questions introduces a strong visual imagery element that may cause a greater number of left LEMs. In an extension of their LEM study Ahern and Schwartz (1979) included questions that were positive and negative in emotional tone. Although happiness and excitement produced more left than right LEMs than did fear, sadness produced a pattern very similar to that of the positive emotions.

Words and Faces

Some researchers have attempted to compare emotional and neutral aspects in both verbal and face processing. Hansch and Pirazzolo (1980) briefly presented emotional words and faces which had to be matched with spoken cue words. They obtained a significant verbal-facial interaction due to reduced RT latencies for verbal stimuli in the RVF and for facial stimuli in the LVF, but only the facial emotion produced produced significantly shorter RTs. The use of cue words for every condition in this experiment was an unusuual choice, especially since it was introduced to avoid attentional bias.

Safer (1981, 1984) conducted two experiments comparing Ss' recognition of laterally presented faces after they had memorized the target faces by either applying verbal labels or empathizing with the facial expression. The between Ss experiment (Safer, 1981) produced a LVF superiority for the empathy Ss, but none for those who had used labels. A repeated measures version of the experiment (Safer, 1984) produced a significant LVF in recognition accuracy, but the various strategies used by the Ss were cancelled out by the analysis. While 41% showed a RH superiority for empathy and a LH superiority for labelling, a further 31% showed a RH superiority for both instructions. Here perhaps it was the empathy instructions that induced an attentional bias in some of the Ss.

FACES

Although the interest of the present study is in verbal stimuli the research on emotional facial expressions is more extensive, and in some respects, more advanced. For this reason a small selection of face studies will be discussed because they provide convergent evidence for RH involvement in emotion processing and memory. Faces are very different from words in that they are processed in the RH. Any emotion laterality effect may be masked by face, and possibly spatial, processing. Thus emotional facial expressions need to produce an effect over and above the expected

RH advantage for faces.

Several researchers have been able to show that recognition of facial expression can be separated from facial identity. Ley and Bryden (1979) used cartoon drawings of five different characters, each with five different expressions; neutral, mildly and extremely positive, and mildly and extremely negative. They obtained a significant LVF for both character and emotional expression. The LVF superiority for emotion was dependant on the intensity of the emotion, extremely negative showing the greatest difference. The pattern of errors suggested that the LVF superiority for character and that for emotional expression were independant. Strauss and Moscovitch (1981), using photographs, obtained a similar LVF superiority, with the character and expression components being separable by processing time.

Attempts have been made to find asymmetries in emotion memory using face stimuli. However, although successfully demonstrating a RH memory for emotion the experimental procedure could have induced a mood in the Ss. For example, Suberi and McKeever's (1977) Ss spent five full minutes studying the target faces, which were emotional for half the Ss and neutral for the other half. Then they studied the faces for a further three minutes at the end of each block of trials. There is a strong possibility that this procedure induced a mood in at least some of the Ss who had studied emotional faces. Suberi and McKeever used only female Ss and since many sex differences have been reported in the literature McKeever and Dixon (1981) repeated the experiment, using equal numbers of males and females. They also changed the procedure in an important way. Using only the neutral target faces from the earlier study they instructed the Ss to imagine that something terribly sad had happened to the people depicted in the target faces and the Ss were encouraged to feel sad for them. They were given the same five minute study period before the experiment and three minutes at the end of each block of trials. This condition was contrasted with the neutral instruction in which the target faces were described as composed and relaxed people. Only females in the sad imagery condition showed a significant LVF superiority. However, a post hoc analysis revealed that it was the Ss who later rated the target faces as emotional who produced the RH superiority. This effect was significant even when the data for the female emotion-imagery group was removed. It seems likely that mood affected some of the Ss, possibly by enhancing RH activity.

RESEARCH PROBLEMS

Most of the difficulties arising from experimental methods have already been discussed. Perhaps the most pervasive, and the most neglected problem is that of mood, whether it is produced by the stimuli, the procedure, interaction with the experimenter, or some other variable. Mood may be at the root of the perplexing inconsistencies that abound in the literature.

Another complication arises from sex differences. It was suggested earlier that sex differences may sometimes be related to mood effects for which the experimenter was, albiet unwittingly, responsible. The lack of any sort of pattern in the differences makes this notion a viable one. Bryden and Ley (1983) pointed out that the more consistent and predictable effects should be observed in men than in women because according to McGlone (1980) cerebral lateralization is more clearly established in men than in women. Yet this cannot account for all the following differences. Men were more accurate than women at recognizing emotional words (Strauss, 1983), and more accurate for emotional words presented to the RH (Graves et al. 1981). More men than women showed a faster RT for faces presented to the RH (Rizzolati, Umilta and Berlucchi, 1971; Suberi and McKeever, 1977), and they were less accurate than women at recognizing facial expressions presented to the LH.

However, women were faster at discriminating facial expressions presented to the RH, while men showed no consistent lateral asymmetry (Ladavas, Umilta and Ricci-Bitti, 1980). Women, but not men, showed a RH advantage when sad imagery was applied to neutral faces (McKeever and Dixon, 1981). Women showed a RH superiority for both 'same' and 'different' judgements of facial expression, while men showed a RH superiority for 'same' judgements and a trend toward the LH for 'different.' Finally, girls had more pronounced laterality effects than did boys in a dichotic task which produced a LH advantage for content and a RH advantage for tone of voice in spoken sentences (Saxby and Bryden, 1984).

In addition to the problems already mentioned there may be any number of unconsidered variables that affect results. For example, McLead and Bryson (1985) have demonstrated that the type of rating scale by Natale et al. (1983) could have been responsible for stimuli presented to the LVF being rated more positive than those presented to the RVF. In their experiment involving unilateral and central presentation of faces McLean and Bryson found that judgements of emotional expression depended on the type of scale used. Positively acsending scales yielded a LH positive bias and negative ascending scales yielded a LH negative bias.

THEORIES OF EMOTION AND LATERALITY

The most ambitious attempt to work out an intergrated theory of emotion and laterality is that of Tucker (1981). Gathering evidence from a large number of clinical and normal studies he based his model on the analytic/holistic dichotomy. A clue to this was found in his own studies. Shearer and Tucker (1981) showed Ss slides of a sexual or aversive nature and asked them either to facilitate or inhibit their emotional arousal. An auditory attention bias probe suggested that there was relatively greater RH activation during aversive emotional arousal. The cognitive strategies used by the Ss suggested that inhibition of arousal was more often brought about by verbal/analytic thinking, while imaginal/global ideation was more often used for facilitating arousal. Tucker (1981) suggested that cognition arises from the same basic neural arousal processes that produce emotion. These basic processes are lateralized. The LH focal, analytic cognitive style and the RH diffuse, holistic cognitive style reflect the basic structure and neuronal processes of the two hemispheres, which also modulate different emotions. Normal functioning requires the contribution of both arousal systems. Affective and cognitive disturbances occur when the balance is upset, either by exaggeration of the hemispheres' processes, as in psychoses, or by unilateral damage. Arousal in the LH is subjectively experienced as anxiety, and that in the RH as mood level.

Ley and Bryden (1981) suggested that the RH is more sensitive to emotional information, particularly negative information, that need not reach the level of consciousness, but which influences the emotional tone of the internal dialogue. Damage to the RH leads to euphoria or indifference due to the disruption to the part of the brain that is most sensitive to negative emotion. Damage to the LH usually disrupts language processes which will result in a relatively greater involvement of RH verbal mechanisms. This allows the emotional processing of the RH, including the negative aspects, to exert a stronger influence over the internal dialogue, resulting in the typical pattern of negative affect and depression.

In a later paper (Ley and Bryden, 1982) they pointed out that evidence for specific left and right hemisphere involvement in emotion is gained from mainly clinical data on the expression of emotion, while research on perception and judgement of emotion in normal Ss usually involves only the RH. They suggested that the RH is superior for perception and recognition of both positive and negative emotion, but that each hemisphere may have characteristic functions in the expression of different emotions.

Ley and Bryden's theory is supported by Ladavas, Nicoletti, Umilta and Rizzolatti (1984), who believe that the basic organization of emotion is bilateral, since it stems from structures such as the hypothalamus and the amygdala, which do not appear to be lateralized. The fact that the RH is superior in recognizing emotions is not proof that it is also superior in mood production. Their research has been largely involved with interference. In this particular study (Ladavas et al., 1984) sad mood, but not neutral imagery interfered with RH performance. According to them interference occurs at the premotor level, "those cerebral areas where sensory input is translated into neural activity suitable for the organization of a motor act" (p. 482). They maintain on the strength of their continuing research, that interference is structural, rather than functional, and it occurs when neural messages for motor responses for the primary and interfering tasks compete in the premotor areas. The state of sadness is mediated by the RH and is closely related to the motor organization involved in the expression of this emotion. To further support their theory the cited EEG studies on normal Ss (Davidson et al., 1979; Tucker et al., 1981) in which activity was observed in the appropriate area during negative affect, and also on clinical populations. Lateral eye movement studies also lend support (Schwartz et al., 1975; Tucker et al., 1977; Ahern and Schwartz, 1979).

This theory of interference is compatible with Kinsbourne's (1982) functional cerebral space model. Furthermore, Kinsbourne considers the sensory motor dichotomy of approach and withdrawal tendencies to be abstracted into various lateralized functions of the human brain. Emotions are lateralized in a complementary fashion, as are other lateralized functions, such as the analytic and spatial processing required for shape copying. The LH appears to consider the benefits while the RH considers the costs, providing balance between approach and withdrawal. Thus lateralized emotional and cognitive functions are related, since "approach is to a specific point, whereas withdrawal is into a space defined by the spatial relations between the organism and the object to be avoided" (Kinsbourne, 1982, p. 415).

It would seem then, that although the field of research is fraught with difficulties and confused by inconsistencies the emerging picture is clear enough for four different theories to have considerable agreement and overlap.

MEMORY AND LATERALITY

It is likely that memory follows laterality patterns similar to those found in cognition and emotion. The notion that verbal information is stored in the LH and memories of sad events are stored in the RH appears to be self-evident, rather than speculative. However, speculative it is until adequate research can provide proof.

Although there are few studies specifically testing memory and laterality some experiments have a memory component as part of the procedure. For instance, experiments employing a same/different task incorporate memory, though storage intervals may vary from msecs to hours. Some of these have already been mentioned in regard to emotion where the RH advantage was greater for emotional expression than it was for character identity (Suberi and McKeever, 1977), and a RH advantage obtained for faces later rated as emotional (McKeever and Dixon, 1981). When there is no emotion involved the results are not so clear. Hay and Ellis (1981) obtained a LVF advantage for 'same' judgements only when the memory set (faces) was the same throughout, but when the memory set was changed for each trial a LVF advantage for both 'same' and 'different' judgements obtained. Jones' (1979) Ss showed a LVF superiority for recognizing old from new faces after 48 hours, suggesting that long-term as well as short-term storage for faces is a function of the RH.

That memory is involved in laterality effects is evident in a series of experiments conducted by Moscovitch, Scullion and Christy (1976). They found that hemispheric asymmetries emerge when same/different comparisons require higher order processing such as those involved in memory when the interstimulus intervals are 100 msecs or more. Strauss and Moscovitch (1981, Expt.3) combined emotion, memory and complex comparisons. Subjects studied all the stimuli, faces showing happy, sad or surprised expressions, knowing which of the three expressions would be the target for them. Then two faces were presented similtaneously. Each pair of faces were arranged so that there were four types of stimuli; same face-same expression, different face-same expression, same face-different expression, and different face-different expression. Half of the Ss had to indicate if one of the faces showed the target expression (positive condition), while the other half indicated if both were different (negative condition). In the positive condition both males and females responded faster to same rather than to different expression, irrespective of face, but whereas females showed a LVF superiority for both same and different expression, males showed a LVF superiority for same expression and a trend toward RVF for different. In the negative condition there were no visual field differences for the females. Males responded significantly faster to same rather than to different expressions, particularly when the right rather than the left hand was used to respond to stimuli presented to the LVF. There was an overall LVF superiority for expressions, irrespective of affect, suggesting that even when memory is involved emotion is processed in the RH.

Further evidence is provided by Dee and Fontenot (1973), who found a LVF superiority for recall of complex random shapes when the delay between presentation and recall, with or without visual interference, was 10 or 20 seconds. There were no visual field superiorities in the no delay and the five second delay conditions, suggesting that short-term memory for spatial stimuli is also sited in the RH.

An interesting study by Berrini, Capitani, Dela Sala and Spinnler (1984) suggests that while the RH supplies supplementary resources to the LH, the LH does not support the RH in a similar manner. For stimuli they used letters, and stars with different spatial relations. These were presented either to the left or the right visual fields. When all 12 had been presented the Ss were required to identify the old from the new among 24 stimuli. Half the Ss saw the stimuli in the same visual field as before (the uncrossed condition) and the other half saw them in the other field (the crossed condition). In the uncrossed condition the LH was superior for identifying letters and the RH for identifying star patterns, but in the crossed condition the RH for first presentation and the LH for second produced a considerably letter recognition compared to the LH to RH or the uncrossed conditions.

In another study in which Spinnler was involved (Spinnler, Sterzi and Vallar, 1984) it was found that selective interference of the RH short-term recall for visually presented CCC trigrams occurred when interfering stimuli (digits, geometric shapes) were presented visually, but when the digits were presented aurally there was no visual field difference.

The effects of concurrent verbal memory on lateralized tasks is probably the most researched area in the memory and laterality literature. All of these studies are mentioned elsewhere. Those of Kinsbourne and Hellige and their respective associates are discussed in the previous chapter in relation to capacity limitations, and Ley's priming studies (Bryden and Ley, 1983, a,b) which will be discussed in the next chapter. Kinsbourne (1970, 1975) found that concurrent memory (6 words) facilitated the detection of right side gaps compared with left side gaps, whereas there was no difference in the detection of right and left gaps in the absence of the memory task.

In Hellige's series of experiments the effects of concurrent memory for shapes as well as words was used variously on verbal and shape recognition. They found that although the LVF is superior for shape recognition, holding 2 or 4 words in memory brought about a shift to RVF superiority. This shift was evident for a 6 word memory set only if the words were easy to remember (Hellige and Cox, 1976, Expt. 1). For the verbal identification task, which normally produces a RVF superiority, the LH advantage was reduced (Ibid. Expt. 2). Concurrent shape memory interfered with overall form but not word identification)Hellige, Cox and Litvac, 1979, Expt. 1). Same/different judgements of two similtaneously presented shapes were only slightly affected by concurrent verbal memory (Ibid. Expt. 2), but both RT and response accuracy was affected when a shape was added to the verbal memory set (Ibid. Expt. 3). In the last two experiments Ss were required to say if two letters, one upper and the other lower case, had the same name. Speed and accuracy was higher in the RVF than in the LVF for no words in memory, for the same name pair judgements. When there were 2, 4 or 6 words in memory this effect was reversed. There were no significant differences for different pair judgements (Ibid. Expts. 4 and 5). These findings show that a concurrent memory task can activate one hemisphere so that within strict limits it is able to process more efficiently even material that is normally processed in the other hemisphere.

Ley (Bryden and Ley, 1983, a, b) used words varying in emotion and imagery as a concurrent memory task with both face and verbal recognition. The emotional word memory set enhanced face recognition and led to a shift from LH to RH advantage for the verbal task.

Finally, an experiment that compared FR with CR was conducted by Williams (1981). This was a partial replication of Turvey, Pisoni and Croog (1972, in Williams, 1981). Turvey et al. used a method of cueing recall for words similar to Waugh and Norman's (1965) probe recall for digits. Waugh and Norman presented 16 digits read on tape. The last digit was the probe and it had appeared once before in the list. The Ss had to say which digit followed the first appearance of the probe. Turvey et al.

obtained a significantly higher number of correct responses following monaural right ear presentation. Williams used a similar presentation for the 16 words, but he employed FR instead of probed recall. He did not get a REA. There was a significant Ear by Speed (of presentation) Serial Position interaction which Williams interpreted as indicating that the right ear (LH) retrieved more from long-term memory, while the left ear relied more on the right ear for short-term store. Unfortunately the type of words used in either experiment is not reported. However, it is possible that the cues in Turvey et al's experiment primed the LH, whereas in William's experiment priming did not occur.

Chapter Six

EMOTION, MEMORY AND LATERALITY

The central theme of the present study is the interaction between emotion, memory and laterality, specifically how the emotional connotations of words may be processed in the RH, while the words themselves are processed in the LH. Research reviewed in the previous chapter suggests that emotion, along with faces and spatial relations, is processed in the RH, but the locus of memory storage is not so well established. Very few reseachers have studied the interaction of emotion, memory and laterality in normal people, fewer still have had their work published. Of the studies that have been published all have been concerned with faces. The three studies that have employed verbal stimuli are unpublished doctoral dissertations. This chapter will begin with a review of these studies. In the second part of the chapter the proposed experiment will be outlined and the assumptions on which it is based will be discussed.

All the studies on emotion, memory and laterality using facial stimuli have been mentioned earlier (Suberi and McKeever,1977; McKeever and Dixon. 1981; Strauss and Moscovitch, 1981). Although these studies contain a number of inconsistencies regarding same/different responses and sex differences the overall finding is clear. The RH is dominant for precessing faces and facial expressions, and the asymmetry obtains when memory is involved.

The studies using verbal stimuli are not so straightforward. In the first (Smith, 1977) a dichotic listening task was employed to test the effects of emotion and different types of recall. The experiment had three conditions; synonym recognition, direct recognition and free recall. Forty-eight pairs of nouns were presented in groups of three pairs. The six words within each group were matched for frequency and their position within the concrete-abstract and emotional-neutral dimensions. For example, an abstract, frequent, emotional pair was 'peace' and 'desire,' while a concrete, infrequent emotional pair was 'infant' and 'warfare.' On the basis of the research he reviewed Smith expected a LH advantage for FR and recognition, and a no-ear advantage for synonym recognition (essentially cued recall), However, a LH advantage obtained for all conditions. There are several problems with Smith's study. The most important was that it was the first of its kind, carried out before most of the major findings on emotion and laterality, using normal Ss, were published. Consequently, Smith had little to go on. The assumptions on which he based his study have since been discredited. For instance, he predicted no ear advantage for synonym recognition because he believed that both hemispheres would process the meaning, whereas for FR and recognition understanding the meaning was not necessary and only the LH need process words in these conditions. His hypothesis was that emotional and non-emotional words would produce different patterns of hemispheric processing in the synonym recognition condition, which is opposite to my prediction for such a task. However, the LH advantage obtained for the FR condition also, which would not be my prediction.

Methodological problems could account for the LH advantage for emotional words in FR. Dichotic presentation of matched pairs meant that same-category words competed against each other. It may have been better to have presented words from different groups in each pair. Furthermore, the large number of words presented in a relatively short time may have activated the LH to the point of inhibiting the RH. Yet another problem is that for a word to be remembered it must first be perceived. Some of the word pairs are similar in structure and/or sound (e.g. flask-slush) and others may also be difficult to distinguish (e.g. criterion-exactitude). Therefore it is possible that perception and memory were confounded.

As Friedlander's disseration has not been seen this discussion is based on the abstract. Friedlander conducted three experiments, testing the effect of emotional arousal on verbal learning. In the first experiment the Ss performed a verbal learning task in which half the words were presented to the left ear and the other half to the right. The method of recall was not mentioned. Then the Ss saw pictures of physically abused children to induce emotional arousal. A second verbal learning task using an equivalent set of words was then performed. The second task produced an advantage for words presented to the left ear and a decreased recall for words presented to the right ear, suggesting greater RH than LH activation. The second experiment controlled for the possible RH bias caused by visual processing, by showing the Ss both emotional or neutral photographs. No significant results were obtained. A replication of the first experiment, with a control group who saw only neutral photographs, was conducted. For the group who saw neutral pictures there was an increase in recall for words presented to the left ear. However, the group who saw emotional pictures improved recall for words presented to the right ear. Thus he failed to replicate the findings of his first experiment. Friedlander favoured the view that emotion can enhance information processing.

Ley's priming studies (summarized in Bryden and Ley, 1983, a, b) measured the effects of verbal learning on lateralized tasks. Two experiments were conducted. In one the lateralized task was face recognition, which normally shows a LVF superiority, while the other involved dichotically presented stop consonant-vowel pairs, which usually produce a REA. Six lists of 20 words were used, one for each condition. Each list contained words from one category; high imagery-positive emotion, high imagery-negative emotion, low imagery-positive emotion, low imagery-negative emotion, and high and low imagery groups with neutral affect. The procedure was the same for both experiments. A baseline was established for the lateralized task, then the Ss had five minutes to learn one list before being retested on the lateralized task. Finally, the Ss were tested on the recall of words. The results revealed that those Ss who had learned high imagery words and emotional words showed an overall left side (RH) improvement. For the face experiment the LVF was enhanced, and for the verbal experiment the REA became a slight LEA. There was no three-way Side by Imagery by Affect interaction in either study, which indicates that imagery and emotion were independant.

In these experiments, as in Friedlander's first experiment the emotional stimuli primed the RH to greater activity over baseline levels. As Bryden (Bryden and Ley, 1983, a) points out this is quite different from Kinsbourne's attentional model which would predict greater LH activation due to the processing of verbal stimuli. He suggests that the affective quality of the verbal stimuli activates the RH. However, two recent attempts to extend the auditory experiment have failed to replicate the original results (Bryden, personal communication, 1985). A number of parameters were altered in these later studies, but he did not mention what they were. This leaves the issue somewhat confused. The method of recall used in Ley's studies was not reported, but if he used FR, and CR or recognition were employed in subsequent experiments then this may account for the different results.

THE PROPOSED EXPERIMENT

The hypothesis for the present study is that in FR both sides of the brain are free to contribute to recall, allowing an emotional word advantage, while in CR the special processing required for the word search and match will produce relatively greater activation of the LH and a consequent inhibition of the RH. Under CR conditions emotional words will be processed as any other words and no emotional word advantage will obtain. How can such an hypothesis be tested?

The first requirement is a collection of appropriate emotional and neutral words for the recall task. Some sort of lateralized task must be incorporated to test the relative involvement of the two hemispheres. Since the emphasis is on recall rather than learning the lateralized task should be performed at recall.

A dual task design in which the recall task was performed concurrently with the lateralized task seemed most appropriate.

It was decided to use two concurrent memory tasks, one involving the words and the other calling on the special processing capabilities of the two hemispheres. For the second task auditory stimuli containing verbal and non-verbal material would be used. At first it was intended to present the sounds monaurally, and a tape was prepared with the sounds on separate channels. However, in order to keep the tasks as close to normal processing as possible it was thought more appropriate, and simpler, to present the sounds through speakers, rather than headphones. If the auditory stimuli are indeed lateralized then monaural presentation would not be necessary. The types of sounds envisaged were human, either non-emotional speech (LH), or non-verbal emotional sounds (RH).

The following sequence of events was decided upon. To begin with the emotional and neutral words would be presented for learning. To ensure that each word had an equal chance they would be presented singly by a slide projector with a timing device. Next the auditory stimuli would be presented. Then the S would recall the words, and finally answer questions about the sound.

With two types of sound and two types of recall being employed it was decided to test between groups, FR and CR, to avoid putting too much strain on the Ss. As for the Ss, the sex differences in the literature suggested that it would be prudent to test one sex only. Since the experimental design was not a rigorously controlled one, as are say tachistoscope studies, a particularly homogeneous group might reduce the number of different strategy effects. Such a group was available in the nearby Engineering School, where there was a large pool of young men with approximately similar basic skills, capabilities and aspirations. Because of a full generation difference in ages an interaction between the sex of S and that of E was not considered likely. The handedness of the Ss would be assessed and perhaps left-handers excluded. A questionnaire such as the Edinburgh Handedness Inventory (Oldfield, 1971), which is sensitive to relative laterality, rather than just indicating a right/left dichotomy may provide a clue to the cognitive and hemispheric activity interaction.

ASSUMPTIONS

The hypothesis and the experimental procedure are based on certain assumptions which could be regarded as contentious. Each assumption has research to back it up, but because of the conflicting results to be found in the literature each also has research to refute it. Nevertheless, the evidence, which has been discussed in this and the previous two chapters, seems to be more strongly for than against these assumptions.

1. In normal right-handed people language is processed in the LH and emotion in the RH.

2. in the normal integrated brain there is a free flow of information between hemispheres, each hemisphere contributing its own specialized abilities. The process is dynamic, with the balance of activity being either

equal, or shifting from one hemisphere to the other, according to the information being processed, the task being performed, or the mood of the person.

3. The nature of the task can gain the attention of the hemisphere specializing in that task so that that hemisphere becomes temporarily dominant and the other hemisphere is, to a varying extent, inhibited.

4. A superimposed hemosphere-specific task will influence that hemisphere's performance on a shared task either by interference or by enhancement, depending on the quality and type of material being processed.

5. Relative activation of one hemisphere over the other can be inferred by the type of cognition, as well as the motor output. This assumption is important because of the absence of controlled lateralized presentation of stimuli and response.

An elaboration of these assumptions and the predictions made on the basis of the experimental procedure may be found in the introduction to the main experiment, Chapter Eight. The chapter following this one describes preliminary research leading up to the main experiment.

Chapter Seven

PRELIMINARY RESEARCH

Before work on the main experiment could begin it was necessary to obtain two sets of stimuli, one verbal and the other auditory. Furthermore, an appropriate duration for the exposure of each word during the learning phase was required. In this chapter three separate studies will be described, each concerning one of these aspects- words, sounds and time.

THE WORDS

When verbal stimuli are needed for an experiment the usual course for a reseacher to take is to choose words from a published standardized list. There are many of these lists, Some, for example, Thorndike and Lorge (1944), or Pavio, Yuille and Madigan (1968) are used more frequently than others. The words on these lists are offered to a large number of people, usually students, to be judged on several dimensions, such as meaningfulness, concreteness, association and imagery. The scores each word obtains on the judged dimensions makes it possible to compare the words in a fairly objective manner, and to make up lists of words that are approximately equal on the dimensions of interest.

For the present research it was decided not to follow this course for two reasons. The first was that the English language has changed so much in the last forty years, and in the last decade particularly, that long established norms may not now be appropriate. The frequency of many words has changed, for some the meaning has changed, and many more words have been added to the language. The second reason is that the only list found in which the emotional value of the words was rated (Brown and Ure, 1969) appeared to be very much a product of its time and reflecting the biases of the judges.

Brown and Ure (1969) obtained ratings of 650 words on five dimensions including emotion, goodness and pleasantness. They used 353 judges and of these 95% were between the ages of 17 and 22, and 70% were females. The word that was rated highest in both pleasantness and emotionality was 'kiss.' 'Intercourse' was rated third in emotionality after 'love,' which is not surprising, but 'marry,' 'boyfriend' and 'bride' were all rated much higher than 'orgasm,' 'vagina' and 'masturbate.' These ratings seem to give more information about the judges than the words. The attitudes are those of young women of the pre-Women's Lib era. Such ratings would be irrelevant in a study using men as Ss. It was decided, therfore, to obtain a list of words that had been rated by judges drawn from the same population as the Ss.

Two types of words were required, emotional and neutral. To control for the categorization of emotional words (Manning and Julian, 1975) complementary categories for emotional and neutral words were chosen. See Table 7.1.

Emotional	Neutral
sex	food
violence	leisure
medical	educational

Table 7.1. The six word categories

The emotional words were collected first and then the neutral words were matched to them. Matching was informal, the aim being for the words to be similar in sound, appearance, length and number of syllables. It was rarely possible to conform to three or more of these similarities while maintaining category membership and the emotional-neutral contrast. As a result many of the matches are superficial. Frequency of words in the language was not controlled for apart from rejecting any word that was not readily recognizable by intelligent youg adults. Six lists of 13 words were prepared. Two alternatives were added for 'cancer' (essay, stanza) and 'vagina' (vinegar, vitamin), making a total of 80 words.

The order of the words was partially randomized by drawing, one at a time, from a box. The one proviso was that a weakly emotional word should not follow a strongly emotional word. These were incorporated into a Questionnaire (see Appendix). Judges were asked to rate the words on a 4-point scale; not at all emotional, slightly emotional, fairly emotional, and strongly emotional. They were also asked to indicate their sex and whether they were aged under 25 years or not.

The questionnaire was administered to a second professional year engineering class. To further control for frequency the students were to cross out any word the meaning of which they were not sure about. Sixty-nine filled questionnaires were obtained. Of these 17 were rejected because either the form was not completed, or the judge was male aged 25 or over, or a female. This left 52 questionnaires on which the emotionality scores were calculated.

A frequency count was made for each emotional word, apart from those that had a high count in the 'not at all emotional' rating. Also, the frequency of words crossed out was counted. Low frequency words such as 'coition' and 'megadeath' were the most often crossed out words. Words that were crossed out by more than five judges werenot considered further.

A score was allocated to each rating as follows:

0 not at all emotional

1 slightly emotional

2 fairly emotional

3 strongly emotional

A word score was calclated for each of the qualifying emotional words and their neutral mates.

After a pilot experiment using introductory psychology students had been conducted the questionnaire was administered to three lab. groups in the same class, but not those from which the Ss had been taken. Completed questionnaires were obtained from 57 judges, 34 women and 25 men. This included a number of mature students. The 20 highest scoring emotional words from the engineering group's ratings were compared with the same words from the psychology group's ratings. With only one exception ('vagina') the psychology group rated the words higher than did the engineering group, so much so that the difference between mean ratings of the two groups was highly significant ($t = 4.4956$, df 38 $p < .001$). This result reinforced the decision to use stimuli rated by members of the target population. The 20 highest scoring words and their neutral mates were chosen for further use.

For the cued recall condition each word was given a cue. These were constructed to give a clue to the word, but in a way to reduce the possibility of guessing. The 40 words and their cues are listed in the Appendix.

THE SOUNDS

The sounds were selected using a similar method to that for choosing the words. A large number of different sounds were collected on tape. Some were provided by TVNZ and the rest were collected by the Experimenter from real-life situations, from radio, and with the help of actresses reading specially prepared scripts. From these, 10 verbal and 10 non-verbal sounds were selected for rating. Within each of the two groups the sounds ranged from positive, through neutral to negative emotions.

A tape was made of the 20 sounds. Each sound was approximately 10 secs long, and there was a 10 second break between. A response sheet was prepared for judges to indicated their ratings, using the same 4 point scale as before. They were also asked to judge the sounds as pleasant or unpleasant where appropriate. Once again sex and age group (under 25, 25 and over) was required. See Appendix for a copy of the response sheet.

The sounds were presented to another second professional year engineering class and the responses of the target group, 61 males under 25 years, were analyzed. The highest rated sound was of a woman (actress) weeping quietly, followed by the sound of a baby crying in rage. The lowest scoring sound was of a visiting politician who bumbled his words as he tried to explain why he came to New Zealand. This was followed by the sound of a truck changing gear.

Since the highest scoring sound was non-verbal emotional and the lowest scoring sound was verbal non-emotional these sounds were chosen to be used in the main experiment.

Although the sounds were not to be used in an experiment involving psychology students, because of the large difference between the engineering and psychology groups' ratings of the words, the sounds were presented to a third year psychology class for rating. This group consisted of 34 women and 20 men. There was no significant difference between the two groups on the mean ratings of the sounds. The psychology group rated several sounds lower than that of the visiting politician, but the two highest were the baby crying, followed by the woman weeping. The sound that gained the widest variation of ratings by both groups was of a chanting croud at a protest rally.

TIME

There were three reasons for conducting the pilot experiment. In addition to testing two exposure durations for the words it was also planned to test the hypothesis that in FR more emotional than neutral words would be recalled, but that in CR both types of words would be recalled equally well. The third reason was to give the experimenter some experience before the more complex main experiment was tackled.

Method

Subjects. Twenty-four introductory psychology students acted as Ss. There were 14 women, five of whom were over 25 years, and 10 men, all under 25.

Apparatus. A memory drum with automatic settings of 2 and 4 secs was used to present the words. Two different drums were prepared with two lists for FR and a third for CR. Thus each of the prepared lists were used for FR, but only two were used for CR. Cues for each CR list were included on the appropriate drum. Each drum was used for 12 Ss.

Stimuli. The 20 highest scoring words and their neutral mates from the engineering group's ratings were divided into 4 lists. The words were allocated according to emotional score and category, so that each list had a similar total score and was a representative sample of the categories, with the exception of the medical and educational categories, which had only three words each. The emotional and neutral word lists were prepared separately and then put together so that no list contained a matched pair. A random order was established for the first list, then the positions for emotional and neutral words were exchanged for the second list. The order of these were reversed for the other two lists, so that order and position were counterbalanced.

Procedure. To streamline the procedure the order of presentation was not varied. The two FR lasts were presented first, followed by the CR list. The duration that the words in each list was presented was counterbalanced. See Table 7.2.

Free Recall_1	Free Recall_2	Cued Recall
2	4	2
2	4	4
4	2	2
4	2	4

Table 7.2. The time in seconds that the words in each list were presented.

Each combination for each drum was given to three Ss. To ensure randomness a set of 12 response sheets marked with the duration order, for each drum was prepared and these were shuffled. A response sheet was laid out in readiness befor the S entered the room.

The S sat in front of the memory drum in a small room with only the experimenter present. In the FR condition the S was asked to first look at each of the words in a list of 10, then write down all that he or she could remember in any order and without using mnemonics. This was done for each of the FR lists. Then for the CR condition the S was told that to help him or her to recall the words a clue would be shown. The word was not to be written until the clue had been seen. To display the cues the drum was turned manually, allowing each S to take his or her own time.

Results

Significantly more emotional than neutral words were recalled in FR ($t = 5.1962$, df 23, $p < .001$). In CR the two word types were recalled equally well. See Figure 7.1.

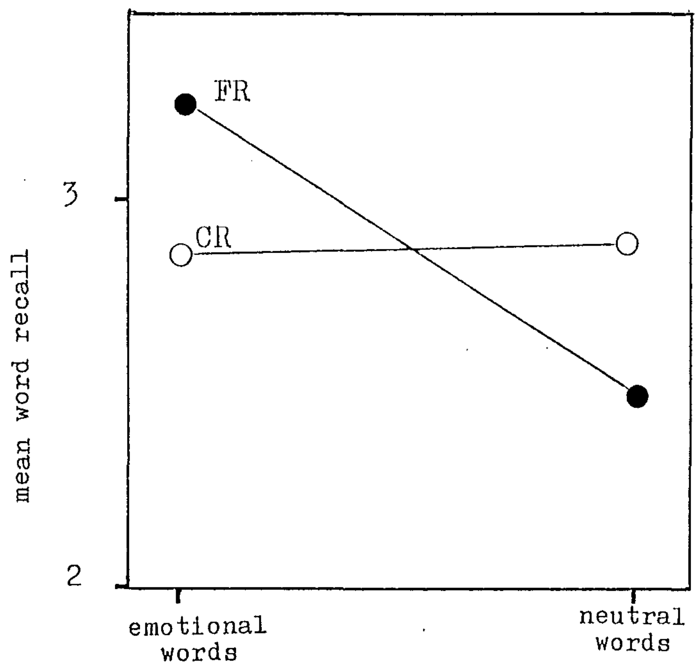

Figure 7.1. Recall of emotional versus neutral words in free recall and cued recall. (The FR mean is averaged over the two lists).

Ther were no significant differences between the number of words recalled for either 2 secs of 4 secs in both FR and CR. However, in FR there were some order effects. Significantly fewer neutral words were recalled in the second list regardless of duration ($t = 2.3583$, df 46, $p < .05$), and fewer emotional words were recalled in the 2 second presentation when it followed the 4 second presentation. See Table 7.3.

	2 secs.	4 secs.
emotional words	40	40
neutral words	32	25
	4 secs.	2 secs.
emotional words	45	32
neutral words	37	27

Table 7.3. Order effects in free recall.

Breaking down the recalled words by category shows that words in the sex category were more frequently recalled than words in the other categories. See Table 7.4. The violence category included

	Sex	Violence	Medical
emotional words	.21	.13	.13
	Food	Leisure	Education
neutral words	.12	.14	.13

Table 7.4. Mean number of words recalled in each category.

the word 'rape, which was one of the most frequently recalled words and is likely to be regarded as a sex word by many Ss. This supports Manning and Julian's (1975) finding that sex, but not violence words were more frequently recalled.

Discussion

Because of the equivocal results of the exposure time testing this is still not settled. Some of the Ss did less well on the 4 second exposure because they said their minds wandered. These were cancelled out by the Ss who performed poorly on the 2 second exposure because, they said, they could not think quickly enough.

Since the Ss in the main experiment will be required to attend to sounds as well as recall words a longer duration of 3 or 4 seconds may be more appropriate than 2 seconds.

Immediate recall in the FR condition allows for simple rehearsal in short-term memory, while waiting for the cues prevents rehearsal. This could account for some of the differences between FR and CR. In the main experiment it is proposed to introduce the sound after the final word in the list has been presented, which may be sufficient to prevent short-term rehearsal. In order to force the S to attend to the sound he will be told that he will have to answer questions about it.

There may be some disadvantage in the CR condition when it always follows FR. Counterbalancing the order, or using separate Ss for each condition, should overcome this.

Another problem that emerged was the low recall score for one of the of the lists. The lists were carefully constructed to represent each category, while at the same time add up to similar total scores. The problem list contained the highly rated violence words 'murder' and 'torture' which were offset by relatively low rated sex words 'foreplay' and 'ejaculate.' Obviously some adjustment is required to ensure that each list is equal regarding sex word scores. Unfortunately, this list was also used for CR, which also could have affected the results. One reason that more words were recalled from the sex category than the other emotional word categories is that there were more words in that category; 9 words, compared with 8 in violence and

3 in medical.

Finally, the large differences in the ratings of engineering and psychology students is yet another reason for the highly significant emotional word advantage in FR to be treated with caution.

Chapter Eight

THE EFFECT OF EMOTIONAL SOUNDS ON WORD RECALL

Two experiments were carried out. The first was intended to test the hypothesis propounded in this thesis, and the second experiment was conducted to clarify a problem raised in the first. Together the two experiments constitute only a very small body of research on a topic that has the potential to generate a number of experiments. They raise more questions than they provide answers and this research could branch out in several directions.

Usual methods of testing hemispheric asymmetry, such as dichotic and tachistoscopic presentation of stimuli, have not been used in the present study. Such methods, while often successful at demonstrating hemispheric asymmetries, were not considered an appropriate extension of the word recall experiments reviewed in the second chapter. The stimuli were presented centrally, one at a time. This, of course, is a weakness of the study. Relative activity of the two hemispheres can be inferred only tenuously from the data.

In this chapter the two experiments will be described in detail. A general discussion will follow in the next chapter.

EXPERIMENT ONE: THE MAIN EXPERIMENT

It has been found in a number of studies on the recall of words from previously seen lists that emotional words have an advantage over non-emotional words when free recall is used (e.g. Grosser and Walshe, 1966; Manning and Julian, 1975; Strongman, 1982). However, there is no such advantage when recall is cued (e.g. Kleinsmith and Kaplan, 1963; Walker and Tarte, 1963, both for the short-term condition).

In considering this phenomenon from a neuropsychological perspective it may be possible to explain why it occurs. There is abundant evidence in both clinical and normal studies to show that in a vast majority of people (a) word processing is a function of the left cerebral hemisphere, and (b) most emotional processing is carried out in the right hemisphere.

According to Kinsbourne's (1970, 1973, 1975) theory the two hemispheres are in reciprocal balance in their control of lateral dominance (see also Tucker, 1981). One hemisphere can gain dominance over the other in two ways. (1) Incoming stimuli expected from one side of the person will activate the contralateral side (the orienting response). (2) When incoming stimuli of a particular nature is expected the hemisphere specializing in the processing of that material will be activated. For example, if verbal stimuli is expected then the LH will be activated, and the RH will be inhibited, while non-verbal stimuli, such as spatial cues, or music, will activate the RH and the LH will be inhibited. It is the second proposition that will be considered here.

Kinsbourne's theory is based on the results of unilateral presentation of stimuli. To apply it to bilateral presentation or real world experiences may be considered an extrapolation of the theory. However, in his more recent model of hemispheric asymmetry (Kinsbourne, 1982) he argues that lateralized cognitive functions are those that are involved in focal attending and these he does relate to the real world.

The reciprocal balance theory is not intended as an either/or dichotomy, in which only one side of the brain is being used at any one time. Obviously both hemispheres are active all the time, otherwise our motor and cognitive functions would be hopelessly disjointed. Rather it refers to the relative balance between the the two hemispheres. Verbal stimuli will bias cognitive activity toward the LH, but the RH remains active. In real world, ongoing situations the special cognitive functions of each hemisphere are complementary.

The hypothesis of the present study is that free recall allows both hemispheres to contribute to the response, producing the emotional word advantage, but that in cued recall the word search and cue match biases the cognitive processing more strongly to the left hemisphere. This hypothesis was tested by presenting auditory stimuli between learning and recall. It was predicted that:

1 There would be an emotional word advantage in free recall, but not in cued recall.

2 In free recall an emotional non-verbal sound would bias recall toward the RH, enhancing the emotional word advantage.

3 In FR a non-emotional verbal sound would bias processing toward the LH, reducing the emotional word advantage.

4 In CR neither sound would have a measurable effect on word recall.

Since many variables, such as sex and intelligence, may contribute to the effect the Ss were selected from a very homogeneous population. The Edinburgh Handedness Inventory (Oldfield, 1971) was administered in the hope that it would give some indication of the Ss' degree of lateralization, the assumption being, albeit shaky, that greater use of the left hand in right-handers suggests greater RH involvement.

Method

Subjects. Forty-eight males aged 20 to 24 years volunteered to take part in the experiment. All had similar cultural backgrounds and were in at least their third year at University. Of these 42 attended the School of Engineering and the rest were studying a science, There were three left-handers, all in the CR condition. Subjects were randomly assigned to either the FR or CR conditions before hand preference was known. It was subsequently found that the responses of these three Ss were well within the range of responses made by the right-handers.

Apparatus. A Kodak corousel slide projector fitted with a

Lafayette four bank timer (model 52 010) was used to project the words on to a screen for 2 secs with a one sec break between. The screen was a white card measuring 720mm x 490mm, held upright by two slotted wooden blocks. The words appeared in negative (i.e. white on a dark background) one at a time on photographic slides. When projected on to the screen the words were approximately 35mm high. The sounds were played through a Sony stereo tape recorder with removeable speakers. The speakers were placed on either side of the Ss' chair at a distance of approximately 1.5m. The two sounds were recorded on separate channels so that the non-verbal sound was heard from the left speaker, and the verbal sound from the right speaker. However, since the Ss were not prevented from turning their heads toward either speaker this separation was not expected affect the results. A digital stopwatch was used to time the recall period. Separate response sheets were used for each of the two trials. The CR response sheets had cues typed, with a typed line along side for the word to be written on. The cues were in a different random order from the words. The FR response sheets had fourteen typed lines. A questionnaire, which was the same for both conditions, contained a printed copy of the Edinburgh Handedness Inventory (EHI) and some questions. All response sheets were headed "Memory Experiment." (See Appendix for copies of the response sheets and questionnaire).

Stimuli. A separate list was used for each of the two trials. Each list contained 14 words, 7 of which represented the three emotional categories of sex, violence and medical, and 7 from the neutral categories of food, leisure activities and education. See Table 8.1 for the word lists and cues. The two sounds were the highest and lowest scoring sounds from the study described in the previous chapter. The non-verbal sound was of an actress making weeping noises without voice. The verbal sound was of a visiting politician explaining in a bumbling manner why he came to New Zealand. Each sound lasted for 20 seconds.

LIST ONE	LIST TWO
Words	
murder	blackboard
essay	vagina
cornflour	torture
cancer	orange
orgasm	singing
vinegar	rape
homosexual	hamsteak
confection	killing
castrate	gliding
sailing	erection
skate	abortion
intercourse	asparagus
suicide	croquet
theatre	foreplay
Cues	
sour sauce	upright
neuter	Hawaiian meat cut
on ice	forced entry
assignment in prose	chalk
sweet	on the lawn
climax	coloured fruit
self inflicted	termination
lovers alike	before the act
playhouse	green shoots
intimacy	unpowered flight
maize ground	words and music
cold blooded	persuasion
across the sea	birth canal
growth	slaughter

Table 8.1. Words and cues in order of presentation.

Procedure. The Ss were seen one at a time in a small laboratory. They were seated at a desk, the near edge of which was 2m from the screen. It was explained to the S that once the experiment was under way no discussion could be entered into. This was to minimize extra verbal processing. The instructions were read, and if necessary they were clafified before proceeding. (See Appendix for the instructions). The first set of words was shown, followed immediately by one of the sounds. A response sheet was given to the S and the stopwatch started. Three minutes were allowed for recall. When the time was up the response sheet was taken and the questions concerning the sounds were asked. The caousel and tape were adjusted for the other set of words and sound and the procedure was repeated. Finally, the S was asked to fill in the questionnaire.

The order of presentation of word lists and sounds were counter-balanced within each condition, producing 8 cells with 6 Ss each. Sets of response sheets, with the condition and the order of word lists and sounds predetermined were prepared in advance and used in rotation as a method of assigning Ss randomly to one condition or the other.

Results

For each S the emotional and neutral words on each list were counted separately and entered into a matrix (see Table 8.2). This allowed separate analysis of word recall for the two different types of words and the two sounds.

		SOUNDS emotional	neutral	total
WORDS	emotional			
	neutral			
	total			

Table 8.2. Matrix for entering word recall by type and accompanying sound.

Laterality quotient (LQ) was calculated on the basis of the 10 hand items of the EHI.

The difference between recall of emotional words and neutral words in FR was significant ($t = 3.487$, df 23, $p < .002$). There were no differences in CR. See figure 8.1.

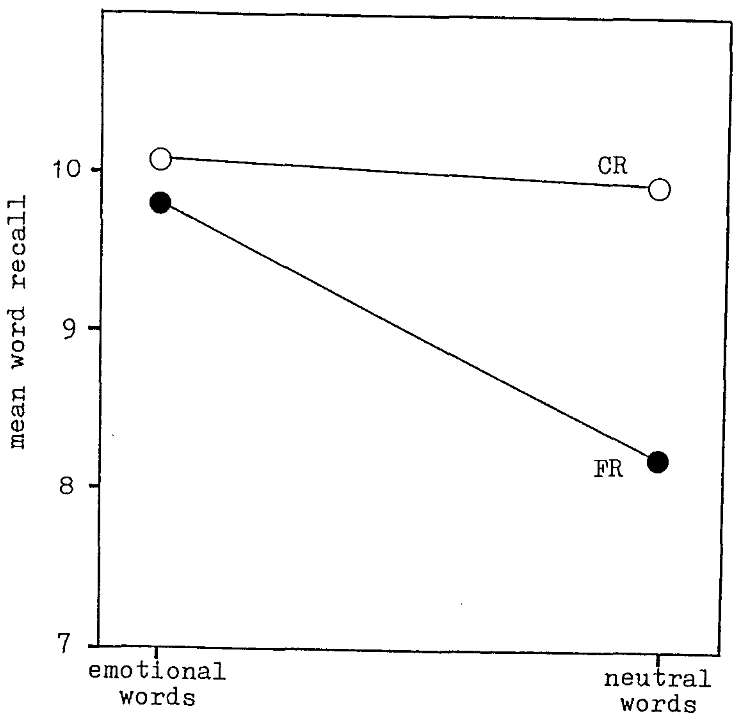

Figure 8.1. Recall of emotional vs neutral words

The Effect of Sounds on Recall

The effect of the emotional non-verbal sound on word recall was significant in FR ($t = 3.65$, df 23, $p < .002$), with an increase in recall of emotional words and a reduction in recall of neutral words. The non-emotional verbal sound produced a non-significant trend in the same direction. There were no differences in CR. See Figure 8.2.

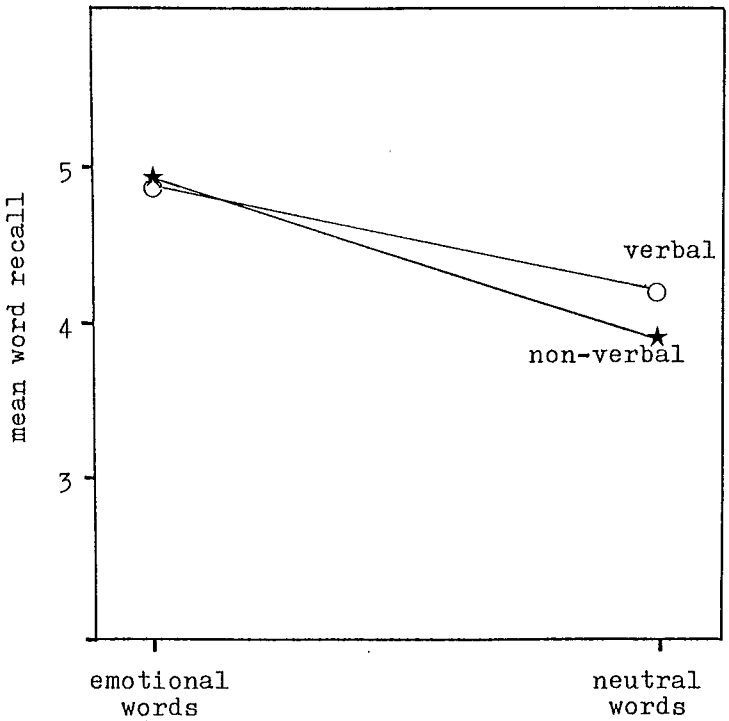

Figure 8.2. Effect of sounds on word recall.

The Effect of Laterality Quotient on Recall

The data of FR subjects were sorted into two groups on the basis of more emotional than neutral words being recalled or not. The mean LQ of the two groups was significantly different ($t = 2.7058$, df 22, $p < .02$) Subjects with the lower LQ scores, i.e. those who reported using their left hand for some of the tasks on the questionnaire, recalled more emotional than neutral words.

Within each condition the data were sorted into two groups according to LQ score. Those with a LQ of 90 or more became the high LQ group (N = 10 in each condition) and those with a LQ below 90 became the low LQ group (N = 14 in each condition). In FR the difference between emotional and neutral word recall was significant for the low LQ group ($t = 4.861$, df 13, $p < .001$). There were no significant differences for the high LQ group in FR nor for the two groups in CR. See Figure 8.3.

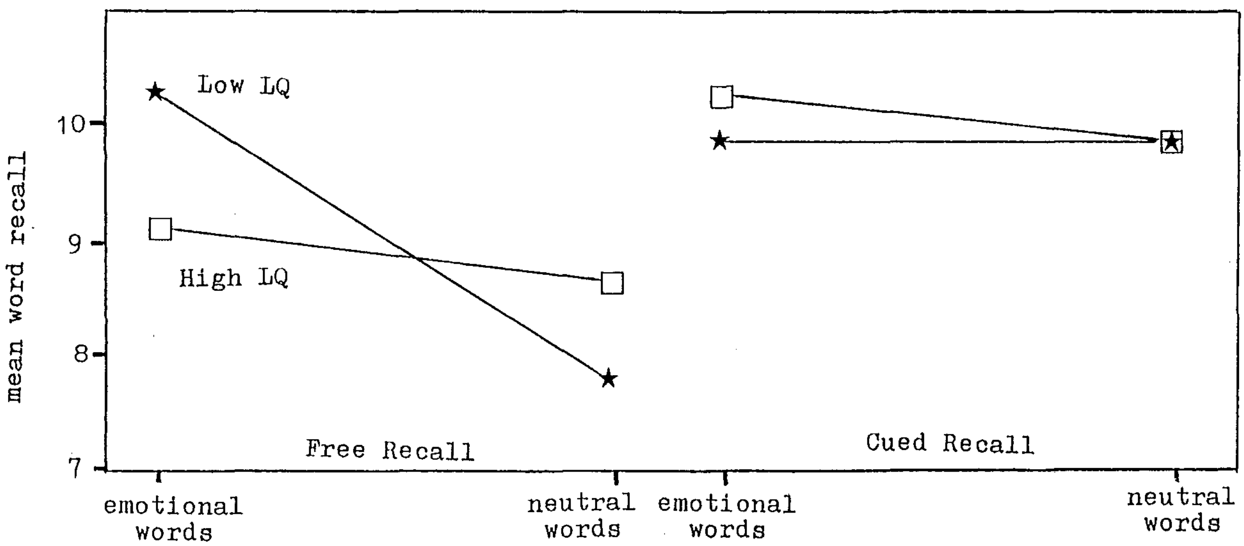

Figure 8.3. The effect of laterality on word recall.

In FR the effect of the sound on word recall was significant for the low LQ group: for the non-verbal emotional sound ($t = 4.84$, df 13, $p < .001$), and for the verbal non-emotional sound ($t = 2.785$, df 13, $p < .01$). Once again there were no differences for the high LQ group in FR, nor for the two groups in CR.

If the foot and eye items on the EHI are included in the calculation of LQ then the effects are even stronger, the low LQ group (LQ less than 85, N = 15) being entirely responsible for the differences between emotional and neutral word recall (t = 5.824, df 14, $p < .001$). See Figure 8.4.

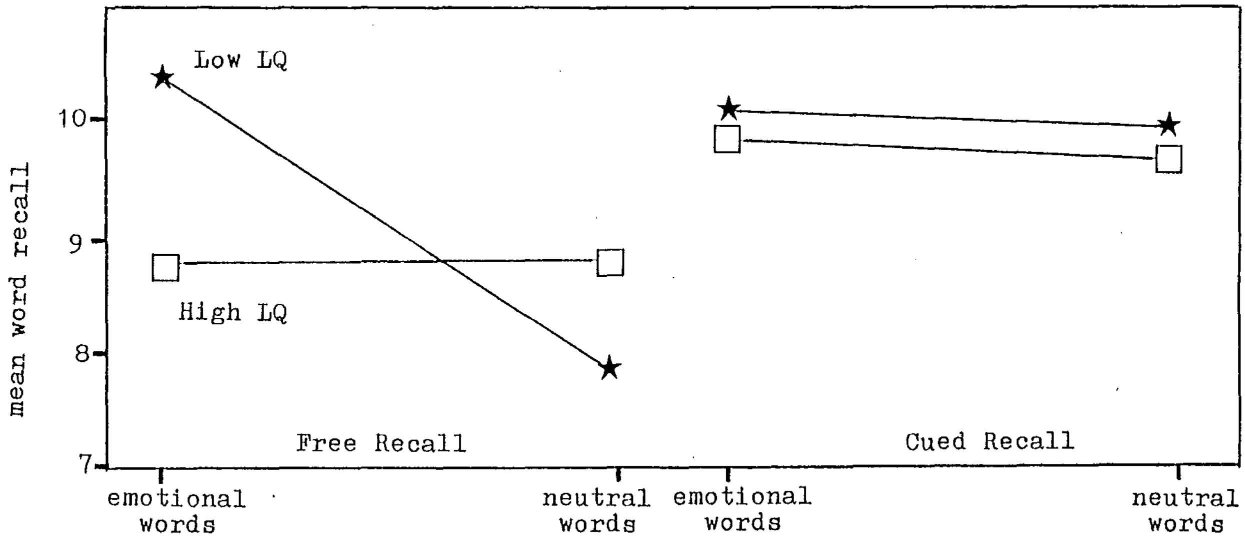

Figure 8.4. The effect of laterality quotient on word recall when eye and foot items are included.

Recall By Category

In considering the word recall frequency by category two problems emerge. One concerns the cues. Comparison of individual word frequencies between conditions is not advisable since the cues obviously facilitated recall. Furthermore, since the cues were not equally helpful comparison within CR should be done with caution. The other problem is a weakness of category construction. The words 'rape' and 'castrate' were included in the violence category, but these words have strong sexual meaning. 'Rape' equalled both 'vagina' and 'blackboard' in frequency, being recalled by 47 Ss. The frequency of 'castrate' varies somewhat and cannot be compared with any other word.

There were no significant differences between FR and CR in mean recall within categories. However, within these conditions there were some differences between LQ groups. See Table 8.3. The biggest differences occurred in the sex category for both FR and CR. Subjects with low LQ recalled significantly more sex words than did Ss with high LQ. The effect was stronger in CR than in FR.

Category	Free Recall	Cued Recall
sex	$p < .02$	$p < .01$
violence	$p < .05$	N.S.
medical	N.S.	N.S.
food	N.S.	$p < .05$
leisure	N.S.	N.S.
education	N.S.	N.S.

Table 8.3. Comparisons between high and low LQ groups on word recall within categories.

Between categories within the two conditions, there were a number of significant differences in word recall for the separate LQ groups. These are summarized in Table 8.4. The most and strongest differences between categories occured in the FR low LQ group, followed by the CR low LQ group. The CR high LQ group by comparison had very few differences.

The Emotional Ratings of Words

The replies to the other questions on the questionnaire and the four questions about the sounds are too variable to be analyzed statistically. Of importance to the results is the emotional rating of sounds. Most of the Ss rated the non-verbal

Categories compared	FREE RECALL Low LQ	FREE RECALL High LQ	CUED RECALL Low LQ	CUED RECALL High LQ
sex vs violence	N.S.	N.S.	p< .01	N.S.
sex vs medical	p< .001	p< .002	p< .01	N.S.
sex vs food	N.S.	N.S.	N.S.	N.S.
sex vs leisure	p< .001	p< .05	p< .01	p< .05
sex vs education	N.S.	N.S.	N.S.	N.S.
violence vs medical	p< .001	p< .02	N.S.	N.S.
violence vs food	N.S.	N.S.	N.S.	N.S.
violence vs leisure	p< .002	N.S.	N.S.	p< .01
violence vs education	N.S.	N.S.	N.S.	N.S.
medical vs food	p< .01	p< .01	p< .02	N.S.
medical vs leisure	N.S.	p< .05	N.S.	N.S.
medical vs education	p< .05	N.S.	p< .05	N.S.
food vs leisure	p< .05	N.S.	N.S.*	N.S.
food vs education	N.S.	N.S.	N.S.	N.S.
leisure vs education	p< .01	N.S.	p<.01	p< .05

* Obtained t =2.21; t criterion, .05 = 2.22.

Table 8.4. Between category comparisons in word recall.

emotional sound as strongly emotional and the verbal non-emotional sound as slightly emotional. Very few rated the latter sound as non-emotional. See Table 8.5. This table also shows that the FR low LQ group were more likely than the other groups to rate the words as unpleasant, to rate the verbal sound as not at all emotional, and to rate the non-verbal sound as more strongly emotional. Furthermore, this group showed a greater contrast between their ratings of the two sounds than did the other groups.

Most Ss recalled hearing a man speaking and a woman weeping, but few were able to report on the content of the verbal message.

	FREE RECALL		CUED RECALL	
	Low LQ	High LQ	Low LQ	High LQ
	N=14	N=10	N=14	N=10
<u>WORDS</u>				
pleasant	7	-	7	10
unpleasant	57	40	36	50
neither	30	50	50	30
(both)	-	10	7	10
<u>SOUNDS</u> Verbal				
not at all emotional	36	20	21	20
slightly emotional	36	70	57	50
moderately emotional	29	10	21	30
strongly emotional	-	-	-	-
<u>SOUNDS</u> Nonverbal				
not at all emotional	-	-	-	-
slightly emotional	-	-	-	-
moderately emotional	14	30	21	30
strongly emotional	86	70	79	70

<u>Table 8.5.</u> Emotion ratings of words and sounds. Percent of Ss within groups who responded to each rating of words and sounds. Although 'both' was not a choice for the words three Ss insisted on rating the words as such.

Many did not understand the speaker, whose English was not fluent.

<u>Discussion</u>

Three of the four predictions were supported by the results. More emotional than neutral words were recalled in FR, but in CR both types were recalled equally well, irrespective of sound. The emotional word advantage in FR was enhanced by the non-verbal emotional sound and to a much lesser extent by the verbal non-enotional sound. However, 75% of the Ss rated this sound as emotional (see Table 8.5), which may account for the unexpected trend.

The dramatic interaction between emotional word recall, emotional sound and LQ appears to give strong support to the hypothesis. If differing hand preference is indeed an indicator of cerebral lateralization then it was those Ss who showed greater involvement of the RH who produced the emotional word effect. In contrast, the high LQ group, most of whom reported using their right hand for all the tasks, recalled emotional and neutral words equally well. As with the CR Ss this suggests that the word memory task was processed in the LH.

The Reliability of Handedness Inventories. While the notion of low LQ indicating greater RH involvement is attractive it places heavy emphasis in the EHI. Several researchers have found this instrument, or others like it, to be unreliable. Raczkowski, Kalat and Nebes (1974) tested the reliability of a list of questions on hand and foot preference, which included some of the EHI items. One month after completing the questionnaire the Ss were asked to actually perform the tasks and to answer the questions again. While agreement on the initial test with performance and the retest was generally high one EHI item (which hand is on top of the broom handle?) scored lowest. For this item the test-performance agreement was .78, and the test-retest agreement was .74.

A factor analysis on two handedness questionnaires, including the EHI was performed by Bryden (1977). This showed that the first five items on the EHI contributed to the main factor, which was related to familial handedness. The other factor was specific to the second five items, all of which required careful thought to answer and which produced considerable disagreement among right-handers. Two factors similar to these were also obtained by White and Ashton (1976). While the major factor could be called 'handedness' the other seemed to the authors to be an artifact arising from the wording of some of the items. These favoured a response for the non-preferred hand. Since these items demand some thought on the part of the Ss the authors speculated that mental imagery may have been used, the Ss imagining themselves carrying out the tasks.

Following Bryden's (1977) advice the FR subjects' LQ was reassessed on the basis of the first five items only. When the emotional word advantage was tested within each of the resulting two groups it reached the same level of significance ($p < .05$) for both. Either the shortened inventory failed to measure a real characteristic of the Ss or the instability of the second five items was related to some aspect of the experimental procedure. The fact that the effect was even stronger when LQ was assessed on the 10 items plus the foot and eye items suggested that the interaction was a important one.

A further experiment to clarify this problem, and also the role of the auditory stimuli, was indicated.

EXPERIMENT TWO

If the emotional word advantage-LQ effect is a stable characteristic of the Ss then it should obtain under different conditions. A second experiment was conducted, using the basic free recall task, but varying other parameters. The Ss were a large mixed group tested similtaneously. Instead of auditory stimuli the Ss were asked to sit quietly for 20 seconds. The other main difference was the words. A list of 16 new words was chosen by the experimenter in consultation with her supervisor and two postgraduate students.

Method

Subjects. The Ss were 158 students in a Stage I non-advancing psychology class. Of these 87 were males, 69 were females and two did not indicate their sex. There were 9 female and 10 male left-handers.

Apparatus.

The same projector with the timer was used as in the first experiment. The words were projected onto a large screen in front of the class. They were large and clearly visible from all parts of the lecture theatre. Each word was presented, as in the main experiment, for two seconds, and there was a one second pause between words.

Stimuli. The stimuli were 16 words representing two emotional categories of sex and violence, and two non-emotional categories of food and leisure. None of these words were used in the first experiment and on the whole the emotional value was somewhat milder, e.g. 'assault' rather than 'murder.' See Table 8.6 for the list of words. Each S was given a response leaflet which consisted of a single sheet of paper printed on both sides and folded in half. On the front were 16 typed lines for writing the recalled words on. Inside were the Edinburgh Handedness

porridge
pervert
circus
actor
assault
tampon
muffin
victim
snooker
lentils
masturbate
corpse
mushrooms
lesbian
chess
sadist

Table 8.6. word list in order of presentation, Experiment 2.

Inventory and some questions concerning the Ss' age group, sex and major subject. The Ss were also asked to indicate if they were studying full- or part-time, and how many years they had been at University. On the back was a single item used to illustrate imbedded figures (Witkin, Moore, Goodenough and Cox, 1977). This spatial task was included to see if it correlated with emotional word recall or LQ, though of course nothing significant was expected from only one item. (See Appendix).

Procedure. The response leaflets were handed out with the typed lines uppermost. The Ss were asked not to open them or to turn them over until told to do so. The procedure was explained and

Ss were asked to sit quietly when all the words had been presented. Then, at a signal, they were to write down as many words as they could recall in any order. After the last word had appeared 20 seconds, timed by stopwatch, were allowed to lapse before the signal to start writing was given. One minute was allowed for recall, after which the Ss were asked not to add to their list even if they recalled more words. The Ss were then asked to turn to the middle of the response leaflet. Instructions for filling in the EHI were given and the Ss were asked to answer the questions. Finally, they were asked to solve the puzzle by finding the simple figure facing the same way in the complex figure. Forty secs were allowed for this.

Results

Significantly more emotional than neutral words were recalled ($t = 4.57$, df∞, $p < .001$). See Figure 8.5.

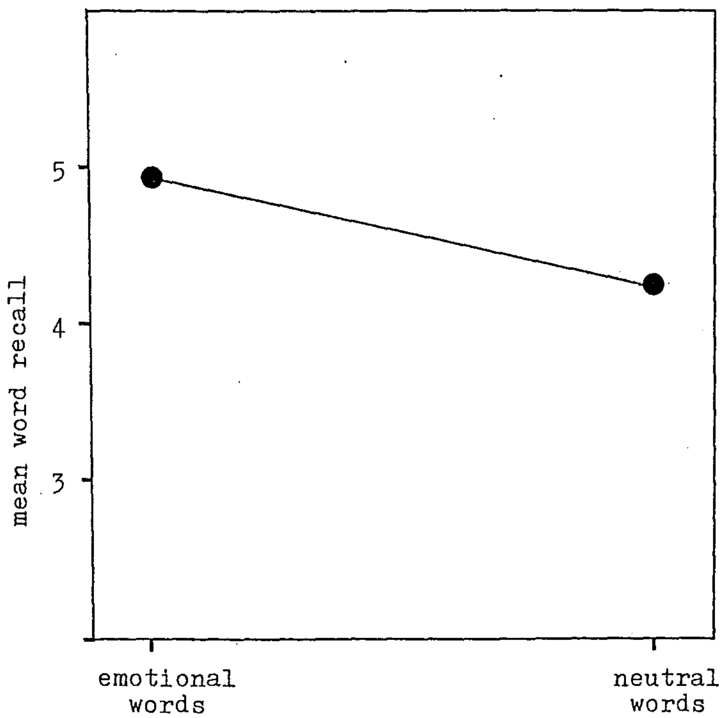

Figure 8.5. Recall of emotional vs neutral words.

LQ and Word Recall. There was no significant difference between Ss who recalled a greater number of emotional words (N = 81) and those who did not show an emotional word advantage (N = 77). However, the mean LQ of Ss who recalled equal numbers of emotional and neutral words (N = 32) was significantly higher than those who recalled a greater number of emotional words ($t = 2.25$, df 101, $p < .05$). The mean LQ of Ss who recalled more neutral words (N = 45) was between these groups. See Table 8.7.

	Emotional word advantage	Equal	Neutral word advantage
N	81	32	45
$\bar{X}$ LQ	72.15*	81.59*	75.96
* $p < .05$			

Table 8.7. Mean LQ of subjects in the three word recall groups.

The Target Group. A group of 22 Ss who were most similar to the Ss in Experiment One was sorted out for further analysis. These Ss were males aged 20 to 24 years, were studying full-time and were in at least their third year at University. A large proportion of them were studying commercial subjects, the rest consisted of small numbers from the Arts, Sciences and Law. Cultural background could not be controlled and the sample almost certainly included non-Europeans and non-New Zealanders. Within this group the differences between recall of emotional and neutral words summed to zero. Furthermore, only if the cutoff is LQ 60 does the low LQ group show a reasonably consistent emotional word advantage, and this is not significant.

Sex Differences. Women recalled more emotional than neutral words ($t = 4.27$, df 60, $p < .001$). Men also recalled a greater number of emotional words, but to a lesser extent ($t = 2.13$, df 80, $p < .05$). The mean recall of emotional words was significantly different between men and women ($t = 4.09$, df ∞, $p < .001$), but there was no difference in recall of neutral words. Men and women did not differ on mean LQ, nor was there any difference in the proportion of men and women in the three word recall groups- emotional word advantage, neutral word advantage, and equal.

The Puzzle. There were no significant differences or interactions with word recall, LQ, or sex, and puzzle solution.

Discussion

A strong emotional word advantage obtained even though no emotional sound was presented between learning and recall, and the emotional words were relatively weak compared to those used in the first experiment. Much of this emotional word advantage was due to the women, however. The target group of men most similar to the Ss in Experiment One did not recall more emotional than neutral words. This suggests that the emotional strength of the words, or the emotional sounds, or both, contributed to the emotional word effect in the previous experiment.

There was no difference in mean LQ between Ss who recalled more emotional than neutral words and those who did not. Therefore the notion that people with low LQ are likely to recall greater numbers of emotional words must be ruled out.* The interaction between emotional words and sounds, and responses on the EHI is yet to be explained. This matter, together with related topics will be discussed in the next chapter.

* While the group of Ss (20%) who recalled equal numbers of emotional and neutral words did differ in mean LQ there is no comparable group in the first experiment. Exploring this intriguing result is beyond the scope of the present study.

Chapter Nine

GENERAL DISCUSSION

If low LQ is not a necessary or sufficient condition for the recall of more emotional than neutral words then the emotional word/sound-LQ interaction must be considered from a different angle. While the auditory stimuli probably influenced recall the administration of the EHI could not have done, since it was given to the Ss only after the two memory trials had been completed. Thus any effect must be in the order of words and sounds on the responses to the handedness inventory, or all three were caused by some fourth variable.

This suggests that those Ss who recalled more emotional than neutral words were so affected by the words and sounds , or perhaps some other variable, that they biased their responses to the second five and the foot and eye items when filling in the EHI. These items cannot be answered automatically as one can do to such questions as "Which hand do you write with?" they require some thought and perhaps some mental imagery, and they are less reliable than the first five items (Bryden, 1977; White and Ashton, 1976).

It is suggested here that for those Ss the emotional words and sounds so involved the activation of the right hemisphere that they biased their responses to the last seven items in the EHI in a manner that either favoured the left hand , foot and eye, or at least did not strongly favour the right side. Since emotional processing and also mental imagery (Bryden and Ley, 1983b; Koff, Borod and White, 1983) are functions of the right hemisphere this is claimed as support for the hypothesis. The emotional word advantage does appear to result from greater activation of the RH in relation to the LH.

LATERALITY QUOTIENT AND RESPONSE BIAS

If a handedness inventory is indeed subject to such a response bias then this should be detectable in any study in which it is administered after a lateralized task. Unfortunately, suitable studies are difficult to find since two features are necessary. A indication of which point in the procedure the inventory was administered, and reporting the results in a manner that allows comparison between groups of Ss with differing handedness scores. All too often the results are reported on the basis of a right hand/left hand dichotomy, or worse still, only those Ss with strong right or left hand scores are included in the analysis.

One study that does comply with these requirements is that of Burnett, Lane and Dratt (1982). They tested Ss on the spatial visualization section of the Guilford-Zimmerman Aptitude Survey and on all 12 items (including foot and eye) of the EHI. They were looking for sex and familial handedness differences and their results are complex. Nevertheless, inspection of their graphed results leads one to suspect that a response bias due to priming of the RH for some of the Ss is possible. See Figure 9.1.

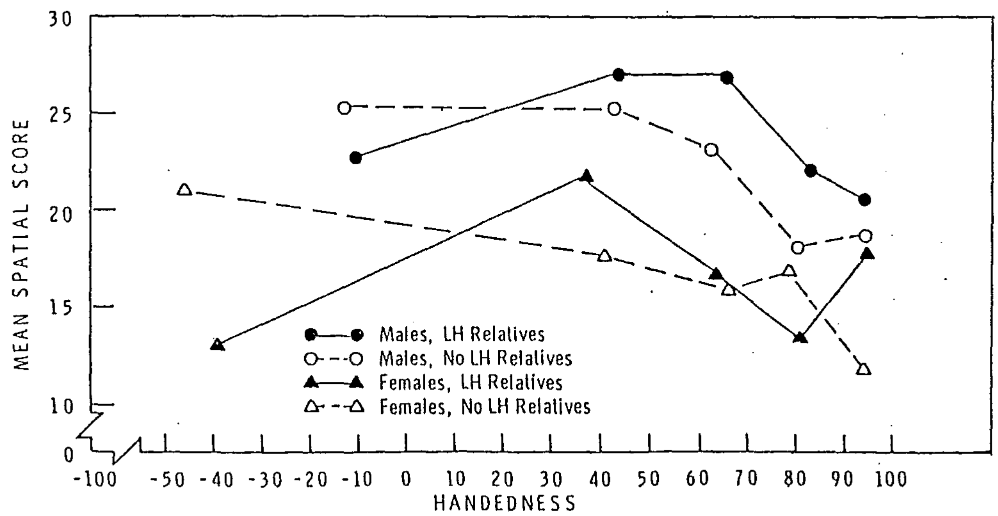

Figure 9.1 Mean Guilford-Zimmerman spatial score as a function of score on the Edinburgh Handedness Inventory. (From Burnett, Lane and Dratt, 1982).

If the data for the two male groups are combined to make them more comparable with those in Experiment One of the present study, then the effect is more obvious. See Figure 9.2.

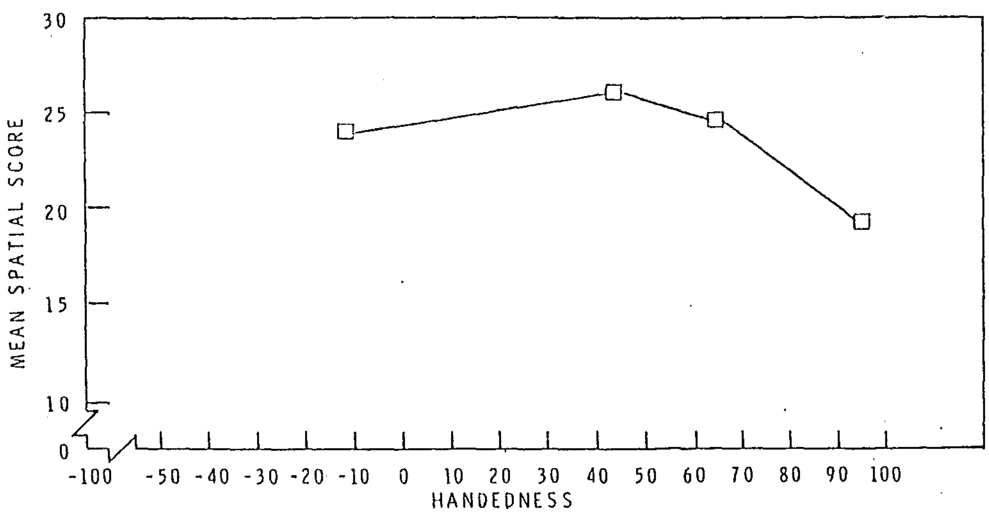

Figure 9.2 Mean Guilford-Zimmerman spatial score as a function of score on the Edinburgh Handedness Inventory: all males. (Adapted from Burnett, Lane and Dratt).

The quadratic relationship between the G-Z scores and LQ over all the groups was significant ($p < .01$). There was also a negative linear relationship between these two scores ($p < .01$). For a comparison with the FR group in Experiment One a correlation coefficient was calculated for emotional word recall and LQ based on all 12 items in the EHI. The resulting negative relationship was significant ($r = .4787$, $p < .02$). Burnett et al. interpret their results as meaning that people who are less strongly lateralized have greater spatial ability. An alternative explanation is that the spatial nature of the task primed the RH's of some of the Ss, causing them to bias their responses on the EHI toward greater use of left hand, foot and eye.

In another study on the relationship between spatial ability and handedness no such effect obtained for males. Sanders, Wilson and Vandenberg (1982) analyzed data from a large-scale survey of cognitive skills in Hawaiian families. Sex and ethnic group (European, Japanese and Chinese) were among the variables controlled for. A handedness questionnaire was administered in a test booklet that included a battery of 15 verbal and spatial cognitive tests. Although not the EHI it was very similar in both the types of questions and the manner of scoring. One item, "removing the lid from a jar" was omitted because of relatively low correlations between this and the other items. Once again, because of the number of variables the results were complex, but if just the results of the male Europeans are considered then there appears to be no difference in spatial ability between strongly right-handed Ss and less lateralized right- and left-handers. See Figure 9.3.

Althought the position of the handedness questionnaire in the test booklet is not stated, this may not be of great importance. since the total task was much more verbal than spatial. In this

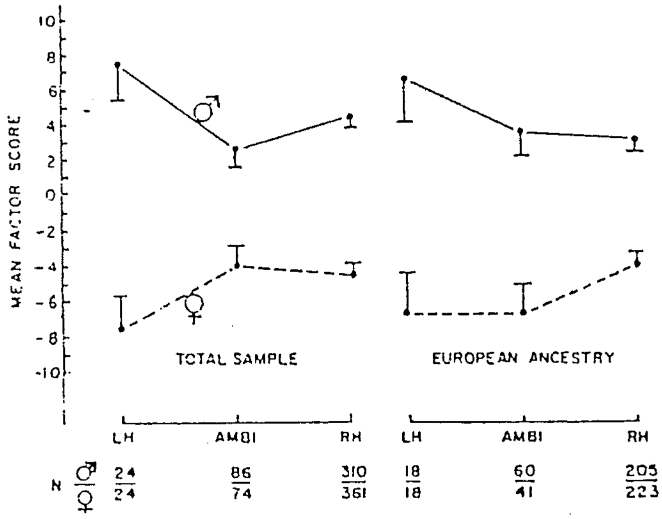

Figure 9.3 Spatial ability and handedness. Subjects with Japanese and Chinese ancestry omitted. (Adapted from Sanders, Wilson and Vandenberg, 1982).

study there is no evidence of biased responses toward greater use of the left hand. Unfortunately, a similar graph showing the relationship between verbal ability and handedness is not given. This may have proved interesting because the strongly right-handed group is disproportionately large compared with the ambidextrous group (142 and 44 respectively). Any response bias could possibly be to the right. However, this trend to the right may be due in part to the removal of the item that produced variable responses.

PRIMING EFFECTS

In the present study there were two contrasting groups in the FR condition of the main experiment. According to Kinsbourne's (1970, 1973, 1975) attentional model one hemisphere may be primed by the nature of the task to be performed and that hemisphere will become dominant. A verbal task, he maintains will activate the LH and inhibit the RH. This is supported by the high LQ Ss in FR and also by the CR Ss. Indeed, one could suggest that for the high LQ Ss the verbal nature of the task inhibited the RH to the extent that they biased their responses on the EHI toward stronger right hand preference.

The Ss who responded to the emotional content of the stimuli did so, even though they were involved in seeing, hearing and writing verbal material. Either the two hemispheres were in active equalibrium or all these responses were processed in the one hemisphere. The present state of the research on hemispheric specialization cannot actually disprove the notion of one hemisphere, left or right, for all processes. However, the suggestion that both hemispheres are active together is the more likely explanation. In the motor domain, at least, balanced activation of both hemispheres is critical to normal movement. On finding a similar pattern of emotional-verbal activation Bryden and Ley (1983b) considered that it resulted from greater right than left hemispheric activity.

Granting this, two possibilities are suggested by the differing performances of the two FR groups. One is that in some people the two hemispheres work together, while in others the nature of the task will activate one and inhibit the other. The other possibility is that for the low LQ Ss some characteristic of the experiment, or some other event prior to their coming to the experiment, had produced a state or mood that made them more receptive to emotional stimuli. It is possible, for instance, that the auditory stimuli produced a particular mood.

MOOD INDUCED AT RECALL

A few researchers have studied the effects on word recall of induced mood at the time of recall. These have specifically tested for congruency between the induced mood and the type of word recalled. In Isen, Shalker, Clark and Karp (1978, Expt.2) mood was induced by arranging for the Ss to win or lose a computer game. Subjects in a good mood recalled more positive than negative and neutral personality trait words and neutral non-trait words, regardless of their mood at the time of learning. Subjects who were less likely to be in a good mood at the time of recall did not recall significantly more negative trait words.

Teasdale and Russell (1983) used the same words as those used by Isen et al., but mood was induced by means of self referent statements. The Ss recalled significantly more positive than negative words in an elated mood, and significantly more negative than positive words in the despondant mood. There were no mood effects for neutral words.

Using the same mood induction procedure as Teasdale and Russell's Edwin (1985) tested Ss' recall of positive, neutral and negative abstract nouns, varying the length of the list and the duration between learning and recall. One significant mood congruous effect was obtained in the short (18 words) list and for the short (1 hour) retention time.

Although it is impossible to test the data from these studies for levels of significance, all show that the proportion of emotional words recalled was greater than the proportion of neutral words. Of particular interest to the present study was a group of Ss excluded from Teasdale and Russell's (1983) experiment. They rejected Ss whose mood induction scores failed to reach a certain criterion. Fifty-six people were tested before they had 32 suitable Ss (12 men and 20 women) to fill the cells in their experimental design. Thus 43% of the Ss (11 men and 13 women) were relatively unaffected by the mood induction procedure. The data of these Ss were analyzed separately and were found to yield no significant interactions between mood and the type or number of words recalled.

STRATEGY EFFECTS

Groups of Ss who respond in a different manner to identical experimental conditions are not uncommon in the research on hemispheric specialization. Strategy effects are discussed in Chapter Four of this thesis. According to Bryden (1978) attentional biases may be expected in any experiment where the S is free to deploy his attention, for example, where no fixation control is used in tachistoscope studies.

An example of biased attention in dichotic listening is demonstrated by Bryden, Munhall and Allard (1983). They found that the laterality effect could largely be attributed to 'biased attenders.' These Ss showed an asymmetry of intrusions in focused attention in that more intrusions from the right ear while attending to the left occured than intrusions from the left ear while attending to the right. The authors did not consider this to support the spatial bias described in in Kinsbourne's (1975) attentional model. Rather they saw it as "indicative of an asymmetry in perceptual discrimination between the two ears" (p. 247). For the biased attenders the right ear was superior in both focused and divided attention. The authors concluded that some Ss were able to focus attention equally well to either ear, while others were not.

In a very different experiment using a tachistoscope Safer's (1984) Ss were required to make same/different judgements of emotional facial expressions. The expressions were memorised by either using verbal labels or empathy. Two clear groups of Ss emerged. One group was consistent in that they showed either a RH superiority (N = 10) or a LH superiority (N = 2) for both types of instructions. The other group showed either a RH superiority for empathy and a LH superiority for labelling (N = 13), or a LH superiority for empathy and a RH superiority for labelling (N = 5).

A parallel could be drawn between the pairs of groups in these two studies and the high and low groups in the FR condition of the present study. Bryden et al's stimuli were verbal and the biased attenders were those who showed a right ear (LH) superiority that over rode spatial cues. In Safer's emotional expression experiment the Ss in the consistent group showed a single hemisphere superiority irrespective of the type of instructions. The data of these two groups, together with those of the high LQ group support Kinsbourne's (1970, 1973, 1975) model; the nature of the task activates one hemisphere and inhibits the other. No such inhibiting influence was evident in Bryden et al's non-biased attenders, Safer's contrast group, and the low LQ group in FR of the present study.

On the basis of his results Safer believes that individuals may differ in the metacontrol of hemispheric asymmetry. Metacontrol is a term derived from split-brain studies (Levy and Trevarthen, 1976) and it "refers to the neural mechanisms that determine which hemisphere will attempt to control cognitive operations prior to actual information processing" (Safer, 1984, p. 23, emphasis his). Safer suggests that for some Ss metacontrol of laterality may be flexible, the lateral control of cognitive activity and response changing with different strategies, expectancies, circumstances, etc. For other Ss however, metacontrol is rigid, with processing remaining in one hemisphere irrespective of different instructions.

Is metacontrol of lateralization flexible or fixed? Safer believes that rather than being a fixed trait it is " a description of the individual's resources for meeting the information processing demands of a particular task" (p. 23). While the question cannot be answered without carefully controlled experiments where metacontrol of lateralization is the dependant variable, rather than an extraneous one, Safer's explanation is a reasonable one. The demands made on Ss by some experimental procedures can be quite heavy. In research on hemispheric specialization the similtaneous presentation of conflicting stimuli, or the similtaneous performance of conflicting cognitive and/or motor tasks are the most used methods. Such demands are encountered infrequently in the real world. Usually one task is well practised, overlearned even, before a conflicting task can be performed successfully at the same time. Depending on the Ss' resources at the time they may be able to activate the special processing powers of both hemispheres, or else will attend more to one task than to the other in order to cope.

The interesting question then becomes- what are the Ss' resources? In the main experiment of the present study such variables as sex, age, intelligence, cultural background and, to a certain extent, choice of profession, were controlled for. All Ss were willing to take part in the experiment, since there was ample opportunity to back out.

It would seem likely that the S's mood had a strong influence on his performance, but to what extent was the mood induced by the sounds, or was it already established before he came to the lab? Overt mood was noted, but unfortunately not recorded, in a number of the Ss. Some seemed tense, their behaviour and comments suggesting that it was important to them to perform well. Nine were under considerable pressure because an assignment worth two papers was due in that week, yet they felt sufficiently in control of their work to devote time to the experiment. Another three Ss were tested within an hour after sitting a maths exam. Several were casually relaxed, two were embarrassed and angry with thenselves because they had lost their way and arrived late, and one was elated because the foul weather promised snow on the mountains for his weekend tramp.

Mood can be affected not only by events but also by a person's state of health, fatigue, food ingested, and even by the time of day.

If mood does have a strong influence on the strategy used for dealing with some experimental procedures then it could have important consequences not only for research on cognition, perception and hemispheric specialization in particular, but also for intelligence, aptitude and personality testing.

CHOICE OF STIMULI

Yet another source of variation within the main experiment and between the two experiments of the present study would be the choice of words and sounds that were used as stimuli. The emotional words used in the main experiment were somewhat stronger in emotional tone than those used in the second. Sex words such as 'orgasm' and 'vagina' may be sufficiently arousing in themselves, whereas words such as 'tampon' and 'masturbate' are probably not. This could affect the recall of these words.

An obvious difference is the one between ratings by judges and the responses to both words and sounds by the Ss. Rating stimuli anonomously in a large group is a very different task from responding to the stimuli in the context of an experiment, where individual performance is measured and the S's name and major subject is known to the E. Using stimuli that has scored the highest agreement in ratings by judges drawn from the same population as the Ss of the main experiment was a serious attempt at objectivity. However, words scoring high in emotional value such as 'cancer' and 'homosexual' were not recalled at high frequencies, whereas a very low scoring word such as 'blackboard' was. In the case of 'blackboard,' that it is a very concrete word, easily visualized and a common feature of student's everyday life, no doubt gave it an advantage, as well as the fact that it appeared first on a list.

As for the auditory stimuli, the choice of the verbal sound was unfortunate and due entirely to dogmatic objectivity. My choice would have been a verbal sound in which a clear but uninteresting message was conveyed. Two suitable examples were included in the set for rating, but both were ruled out because they gained higher scores than the one chosen. The problem could be overcome by using two or more sounds for each of the verbal non-emotional and non-verbal emotional conditions. This was not practical in the present study however, as it would require many more Ss to fill the increased number of cells in the design, or several more trials for each S if he were to be tested for each sound. The second alternative would require more word lists and probably, to avoid fatigue, the Ss would need to be tested in two or more sessions.

Chapter Ten

CONCLUSIONS

In the present study support for the hypothesis is not as strong as one would hope. It lacks rigour in that there were no strictly lateralized controls over input or response. Relative activation of the two hemispheres is inferred from the manner of response and the existing knowledge about the types of processes each hemisphere engages in. The main experiment was planned with a reasonably clear notion of what operations would occur, yet it was vague as to how they would be manifested, apart from producing an emotional word advantage in one condition and not in the other. Administration of the EHI at the end of testing may seem to have been fortuitious in providing the required evidence, but it was purposely held until the end to avoid possible LH priming which could have reduced the emotional word effect. Although this study risks the sort of criticism Zaidel (1983, refer quote in Chapter Four) levelled at the research on laterality it is defended on the grounds of its pioneering nature.

Scientific investigations are normally planned to provide a yes or no answer. Such precision is not always possible, or in some cases not even advisable, since it means that knowledge is dependant on the types of questions asked. In a new area of research, and the dearth of published literature suggests that this is a new area, open ended questions need to be asked. The narrowly focused, rigorously controlled experiments must come later, for if they lead then the field is in danger of resembling a multichannel model of laterality, with tunnels leading here and there, some dead end or abandoned, some circling back on themselves, while others, though discovering much may push on between outcrops of unnoticed phenomena. Open questions can provide an aerial view, surveying the field so that complex communication networks can be laid out among the control centres in such a way that points of confluence and inhibitory barriers can be rearranged as knowledge grows. The former model is linear, analytic and item orientated, but the latter incorporates the relational aspects as well. Kinsbourne (1982) has suggested that while the communication of information was verbal, drawing on the specialized processing of one hemisphere only an imbalance existed in the range of human achievement. It was when communication methods allowed the dissemination of relational information, in pictorial form, that technology and design thrust forward.

To study the interaction between emotion, memory and laterality it was necessary to integrate information from several different areas of psychology. What started out as a search for a physiological basis for the two-structure memory has ended in the realization that the brain is a very complex unit with an immense number of interconnections among its various structures. It is capable of processing meaning and connotation and storing them independantly. Yet this capability is not fixed since it is alterable by experience and environmental conditions.

Whether meaning and connotation are in balance, or one is suppressed in favour of the other, depends to a large extent on the coping strategy of the individual person.

Strategy effects must be rigorously controlled in most experiments if fundamental processes are to be discovered. However, strategy effects are interesting in themselves because they reveal the diversity and the vast potential of the human brain. Thinking is largely self-taught. It is therefore not surprising that individual differences in cognitive operations occur. Exploring these differences could teach us as much about the brain as pinpointing the similarities. To extend the present research in this direction the main experiment could be repeated using a more heterogeneous group of Ss, and comparing males with females. Probably a much larger group of Ss would be required since an increase in the range of strategies could be expected.

Priming effects could be explored with the aid of the EHI. For example, a 'memory' experiment could be conducted in which the EHI is used as a distractor. Verbal non-emotional, or non-verbal emotional sounds would be presented with the Ss knowing that questions would be asked about them later. The EHI would then be administered, ostensibly to minimize rehearsal. For the sake of credibility the questions should be carefully prepared. The test would be repeated after several weeks, the order of presentation of the different stimuli being counterbalanced between two groups. A control group exposed only to neutral stimuli would complete the design. The method of analysis should compare the differences, rather than cancel them out.

If clearly defined groups emerge from this experiment then they could be compared on several dimensions. For example, in an adaptation of Safer and Leventhal's (1977) first experiment, would one group be more likely to respond to the content and the other group to the tone of voice of sentences read in different emotional tones? They could be tested on any of the standard lateralized tasks, such as comparisons between visual field superiority for neutral versus emotional, or verbal versus spatial stimuli, or dichotic tasks.

In the second experiment of the present study 20% of the Ss recalled equal numbers of emotional and neutral words, and as a group their LQ was significantly higher than those who had recalled a larger number of emotional words. Was this coincidence, or would such a group emerge whenever the number of Ss was large enough? If so, then how do they differ from other groups?

Another possible line of research involving laterality could be extended into the study of personality. It is likely that LQ is stable in many people, but changing to the situation in others. Is the latter group unstable, or are they more flexible? Contrasting groups could be tested on personality inventories, such as the California Personality Inventory.

It is apparent that the present study is capable of generating more research, but to be of value it must have useful applications. An understanding of the various strategy effects and individual differences that may influence results in experiments involving emotion and laterality would increase our ability to control them. The research may also have extensions and applications in the area of vocational guidance, either by assisting people to select occupations suited to their characteristic mode of thinking, or preferably by training them to make better use of their potential. Obviously, some strategies are more effective than others. Discovering what they are in order to teach them may be of some value.

This thesis began with an admission that it was inspired by a fascination for the power of words to conjure up feelings and images that go far beyond the mere meaning of the words themselves. It has traced a course through scientific literature and empirical research to find that words and their connotations are processed in opposite sides of the brain. This is no accident, for if Kinsbourne (1982) is right in suggesting that control centres are more distantly spaced for activities that need to be performed concurrently, then the evolutionary value becomes apparent. In those long ages when the communication of ideas, histories and tales depended on the spoken or written word, people developed the ability to generate images and feelings as they perceived the words. This ability has added much to the richness of human experience.

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Frontpiece: The two hemisphere of the brain, as depicted in the seventh book of anatomy of Vesalius, De Humani Corporis Fabrica, 1542. Reprinted in The Neurosciences: Third Study Program, F.O. Schmitt and F.G. Worden, Eds., Cambridge, Mass. The MIT Press. 1974.

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APPENDIX

Contents

EMOTIONAL CONTENT OF WORDS

Words differ considerably in their emotional content. Below is a list of words for you to judge. Mark the space that you consider most appropiate for each word. There is no need to think deeply about the words. Work quickly and rate the words according to your initial response.

Ratings

Not at all emotional | Slightly emotional | Fairly emotional | Strongly emotional

__:__:__:__

Judges' Personal Data

Sex ☐ Female ☐ Male

Age ☐ Under 25 ☐ 25 and over

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fondue __:__:__:__
amputate __:__:__:__
hypodermic __:__:__:__
academic __:__:__:__
copulate __:__:__:__
spectator __:__:__:__
essay __:__:__:__
coronary __:__:__:__
orgasm __:__:__:__
injection __:__:__:__
stationery __:__:__:__
athletics __:__:__:__
murder __:__:__:__
homosexual __:__:__:__
arithmetic __:__:__:__
blackboard __:__:__:__
vitamin __:__:__:__
abortion __:__:__:__
photograph __:__:__:__
omelette __:__:__:__
theatre __:__:__:__
suicide __:__:__:__
cornflour __:__:__:__
brainwash __:__:__:__
cancer __:__:__:__
pastel __:__:__:__
lobotomy __:__:__:__

erection __:__:__:__
vinegar __:__:__:__
electrocute __:__:__:__
vagina __:__:__:__
orange __:__:__:__
fracture __:__:__:__
killing __:__:__:__
confection __:__:__:__
glider __:__:__:__
foreplay __:__:__:__
maim __:__:__:__
analyse __:__:__:__
pizza __:__:__:__
condom __:__:__:__
student __:__:__:__
hamsteak __:__:__:__
pistol __:__:__:__
chocolate __:__:__:__
croquet __:__:__:__
ejaculate __:__:__:__
game __:__:__:__
euthanasia __:__:__:__
laboratory __:__:__:__
appendicitis __:__:__:__
rape __:__:__:__
tuition __:__:__:__

penis __:__:__:__
pencil __:__:__:__
sailing __:__:__:__
scalpel __:__:__:__
educate __:__:__:__
mutant __:__:__:__
chicken __:__:__:__
menstruate __:__:__:__
singing __:__:__:__
coition __:__:__:__
gymnasium __:__:__:__
paralyse __:__:__:__
persecute __:__:__:__
skate __:__:__:__
castrate __:__:__:__
eraser __:__:__:__
mustard __:__:__:__
megadeath __:__:__:__
painting __:__:__:__
stanza __:__:__:__
asparagus __:__:__:__
masturbate __:__:__:__
lecture __:__:__:__
intercourse __:__:__:__
mincemeat __:__:__:__
genocide __:__:__:__
torture __:__:__:__

(Slightly reduced)

THE 40 HIGHEST SCORING EMOTIONAL WORDS AND THEIR NEUTRAL MATES, WITH THE CUES

(In rank order of emotional words within categories)

Violence	cues	Leisure	cues
rape	forced entry	skate	on ice
murder	cold blooded	glider	unpowered flight
suicide	self inflicted	sailing	across the sea
torture	persuasion	theatre	playhouse
castrate	neuter	croquet	on the lawn
killing	slaughter	singing	words and music
persecute	harass	spectator	watcher
brainwash	indoctrinate	painting	brush on

Sex		Food	
orgasm	climax	orange	coloured fruit
erection	upright	confection	sweet
vagina	birth canal	vinegar	sour sauce
intercourse	intimacy	asparagus	green shoots
foreplay	before the act	cornflour	maize ground
homosexual	lovers alike	hamsteak	Hawaiian meat cut
copulate	mating	omelet	French eggs
ejaculate	spurt	chocolate	biscuit coating
masturbate	solo sex	mustard	hot and yellow

Medical		Educational	
cancer	growth	essay	assignment in prose
abortion	terminate	blackboard	chalk
amputate	cut off	educate	instruct

RATING OF SOUNDS

Listen to each sound then immediately rate it for emotion according to this scale:

0 not at all emotional
1 slightly emotional
2 moderately emotional
3 strongly emotional

Draw a circle around the number you consider most appropriate.
If you rate a sound emotional then indicate if you regard it pleasant or unpleasant by drawing a circle around + for pleasant and - for unpleasant.

A	0	1	2	3	+	-
B	0	1	2	3	+	-
C	0	1	2	3	+	-
D	0	1	2	3	+	-
E	0	1	2	3	+	-
F	0	1	2	3	+	-
G	0	1	2	3	+	-
H	0	1	2	3	+	-
I	0	1	2	3	+	-
J	0	1	2	3	+	-
K	0	1	2	3	+	-
L	0	1	2	3	+	-
M	0	1	2	3	+	-
N	0	1	2	3	+	-
O	0	1	2	3	+	-
P	0	1	2	3	+	-
Q	0	1	2	3	+	-
R	0	1	2	3	+	-
S	0	1	2	3	+	-
T	0	1	2	3	+	-

Please tick the appropriate box

Sex	☐ male	Age	☐ under 25
	☐ female		☐ 25 and over

(Slightly reduced)

INSTRUCTIONS FOR EXPERIMENT ONE

This memory experiment is in two parts. Both parts are the same, except different stimuli will be used. Within each part there are two tasks. One involves words and the other sounds.

I'm going to show you 14 words. They'll be presented briefly one at a time on the screen. Then you'll hear a sound from the speakers. I want you to pay attention to this sound as I'll be asking you questions about it later.

Free Recall

When the sound stops write down on the paper I'll give you as many of the words as you can remember, in any order. Don't worry if you can't remember all of them. I'll give you three minutes to write them down. Is that clear?

Cued Recall

When the sound stops I'll show you some hints to help you recall the words. Write down the words alongside the appropriate hint. Don't worry if you can't remember all of them. I'll give you three minutes to write them down. Is that clear?

The Questions asked about the sounds

Verbal	Do you recall why he came to New Zealand? What did he hope to broaden?
Non-verbal	Do you recall what the sound was? Was the person male or female?

MEMORY EXPERIMENT

MEMORY EXPERIMENT

sour sauce ---------------------------

neuter -------------------------------

on ice -------------------------------

assignment in prose ------------------

sweet --------------------------------

climax -------------------------------

self inflicted -----------------------

lovers alike -------------------------

playhouse ----------------------------

intimacy -----------------------------

maize ground -------------------------

cold blooded -------------------------

across the sea -----------------------

growth -------------------------------

MEMORY EXPERIMENT

upright -----------------------------------

Hawaiian meat cut -------------------------

forced entry ------------------------------

chalk -------------------------------------

on the lawn -------------------------------

coloured fruit ----------------------------

termination -------------------------------

before the act ----------------------------

green shoots ------------------------------

unpowered flight --------------------------

words and music ---------------------------

persuasion --------------------------------

birth canal -------------------------------

slaughter ---------------------------------

MEMORY EXPERIMENT

Do you find words easier to remember than numbers ?

Yes No

Do you use a trick to help you remember ?

Yes No

On the whole would you say the words were

Pleasant
Unpleasant
Neither

How would you rate the sounds you heard ?

The man
Not at all emotional
Slightly emotional
Moderately emotional
Strongly emotional

The woman
Not at all emotional
Slightly emotional
Moderately emotional
Strongly emotional

EDINBURGH HANDEDNESS INVENTORY

Surname.................................. Given Names..................................

Date of Birth.................................. Sex..................

Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column*. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put ++*. If in any case you are really indifferent *put + in both columns*.

Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		LEFT	RIGHT
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Knife (without fork)		
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening box (lid)		
i	Which foot do you prefer to kick with?		
ii	Which eye do you use when using only one?		

L.Q.		Leave these spaces blank	DECILE	

Please circle the appropriate response

Sex: Female Male

Age: under 20 20-24 25-34 over 35

Studying Full-time Part-time

Year at University: 1 2 3 4 5 or more

Major subject, if decided ________________

If undecided which course do you most enjoy? ________________

Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column.* Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put* ++. If in any case you are really indifferent *put* + *in both columns.*

Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		LEFT	RIGHT
1	Writing		
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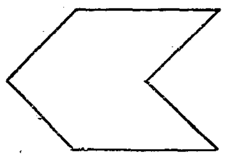
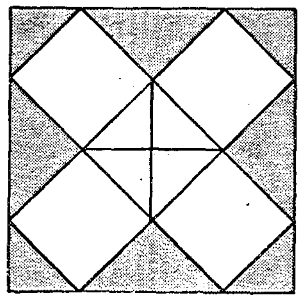
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening box (lid)		
i	Which foot do you prefer to kick with?		
ii	Which eye do you use when using only one?		



Simple figure



Complex figure

Find the simple figure in the complex figure above and trace around it