THE UNIVERSITY OF MANITOBA

INHIBITION OF INFORMATION TRANSFER BETWEEN THE CEREBRAL HEMISPHERES: DIFFERENTIAL DECREMENTS IN REPORTABLE RECOGNITION OF PUNISHMENT AND NON-PUNISHED WORDS

by

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Abstract

Since its introduction by Breuer and Freud, the concept of repression has undergone numerous revisions, and many studies have attempted to demonstrate repression or an analogue of repression. Dollard and Miller (1950) defined repression in learning theory terms as the motivated, automatic inhibition of responses. Several studies have employed a learning theory definition by investigation of "repression" as measured by decrements in correct response to shock-associated verbal material.

Advances in neuropsychology have added to the understanding of psychological processes. Much data has accumulated regarding cerebral specialization, i.e., differences between the cerebral hemispheres in information reception and processing. Basing his hypothesis on this data, Galin (1974) proposes that at least some instances of repression may be due to inhibition of information transfer between the cerebral hemispheres.

The present study was an attempt to investigate Galin's hypothesis utilizing a combination of methods from previous hemispheric specialization and repression studies. Subjects were tested for correct verbalization of unihemispherically presented words, some of which had been previously shocked. As a test of shock inhibition, it was predicted that previously shocked words would be correctly reported less often than words which had not been previously shocked. As a test of Galin's theory, it was predicted that previously shocked words presented to the right hemisphere would be correctly reported less often than previously shocked words presented to the left hemisphere.

The results for all subjects did not support the shock inhibition hypothesis. However, when the data was divided into a High and a Low Shock group on the basis of shock level set by subjects, Low Shock males showed the expected result. Low Shock males made significantly more errors on shocked words compared to nonshocked words.

The second hypothesis, that more errors from shocked words would be made from the right hemisphere compared to the left hemisphere, was not supported by the analysis of all subjects. However, males, Low Shock subjects, and Low Shock males showed trends in the expected direction. For these groups, more errors were made in verbalized recognition of shocked words presented to the right hemisphere compared to the left hemisphere or to nonshocked words presented to the right hemisphere.

Although sex was expected to be an important factor, the results were different than expected. In general, the female data was opposite of the predicted direction and male results were in the predicted direction. The analysis of all subjects revealed a significant Sex x Shock interaction. While males made more errors from shocked than nonshocked words, as predicted, females made significantly more errors from nonshocked compared to shocked words.

Although level of shock was not predicted to be a variable, there were important differences between the High and Low Shock groups. Analysis with shock level as a factor revealed a significant Shock x Level interaction. Relative to the High Shock group, the Low Shock group made more errors on shocked words compared to nonshocked words while the High Shock group made significantly more errors on nonshocked words.

The results are discussed in terms of possible explanations for the unexpected importance of shock level and unpredicted results for high shock and female subjects, difficulties with the design of the study, and suggestions for further investigation.

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CHAPTER I

INTRODUCTION

The Psychoanalytic Model of Repression

Repression has been a cornerstone of psychoanalytic theory and other personality theories that posit the existence of mental processes outside of awareness. Breuer and Freud introduced the term repression in their introductory chapter to *Studies in Hysteria* in 1893 (Breuer & Freud, 1955).

As the basis of the other defense mechanisms, repression was described as the removal from conscious awareness of unacceptable impulses and ideas. Freud described repressed mental contents as functioning completely outside the realm of consciousness. Instead, they functioned in a separate realm which was totally inaccessible to conscious recall by the person and verbal interrogation by others. The repressed mental content functioned according to its own rules and developed and pursued its own goals. Repressed contents affected bodily functions and other types of unconscious behavior.

The concept of repression has been changed with successive modifications by Freud of his own theory (for a review see Holzman, 1970), and psychoanalytic thinkers after Freud (for a review see Ellenberger, 1970). More recently, learning theorists have attempted to explain unconscious process in learning theory terms. Dollard and Miller (1950) first defined repression in learning theory terms as the motivated, automatic inhibition of responses.

A Learning Theory Model of Repression

A learning theory definition agrees with Freudian theory in stating that conflicting or painful material will be inaccessible to verbal recall. It differs, however, in its explanation of the mechanisms underlying repression. Freudian theory is dependent on formulations such as "psychic energy" and a "topographic mind," while learning theory can explain repression as a type of inhibition. An inhibited response in which the individual is unable to fully verbalize the relevant contingencies can be considered unconscious. In learning theory, consciousness can be conceptualized as occurring along a continuum of the degree to which a person can symbolize (usually in verbal symbols) the relevant contingencies. Repression, then, is the forgetting of stimuli that, under normal circumstances, have been learned well enough to be remembered (i.e., to be "conscious"). If a response (e.g., thought, recognition, or other mental event) is followed by punishment, the individual is less likely (i.e., less "motivated") to make that response in the future.

Furthermore, Martin (1972) speculates that such inhibitions may be associated with corresponding inhibitions of related brain processes. If particular brain processes are associated with punished and therefore painful thoughts, those brain processes are less likely to occur.

Learning Theory Paradigms of Repression

The learning theory approach has provided a powerful experimental model for studying repression. Several paradigms have been used productively to demonstrate repression. For example, Eriksen and Kuethe (1956) showed that verbal avoidance can be conditioned without conscious awareness. In their experiment, subjects were asked to give associations to 15 words. For each subject, 5 words were randomly chosen, and the associatiates given on the first trial to these words were shocked throughout the first part of the experiment. Subjects were told that they would be shocked for responding too slowly or for some other reason which they might discover on their own. Trials continued with the same stimulus words until all subjects had learned to avoid the initial shocked associations. The second part of the study consisted of asking subjects to continuously associate to each of the stimulus words for 15 seconds, with the assurance that they would receive no further shocks. Following the experiment, subjects were questioned to ascertain whether or not they had discovered a method for avoiding shock, and if so, what the method was. On the basis of this questioning, subjects were divided into 3 groups: an "insight" group of 11 subjects who were able to describe what they had done to avoid shock, a group of 5 subjects who showed partial insight into the reason for shock, and 11 subjects who were totally unaware of the link between critical associates and shock, and felt that they had not learned to avoid shock. Analysis of reaction times to the critical words gave further evidence of unconscious learning on the part of the "no insight" group. Reaction times to the critical stimuli after the first trial decreased for the "no insight" group while it increased for the "insight" group.

Glucksberg and King (1967) demonstrated a repression effect for distant associates of shocked words. In this study, subjects first learned pairs composed of a nonsense syllable and a word. Later, shock was associated to some words from a list of remote associates of the first group. When memory of the first list of words was tested, it was found that words whose distant associates had been shocked were remembered less well than words whose distant associate word had not been shocked. Furthermore, when questioned after completing the task, subjects said that they were unaware of any relationships between the two word groups, thus demonstrating that the inhibition effect (i.e., repression) of the shocked associates occurred outside awareness.

Corteen and Wood (1972) introduced a new experimental design into the work on unconscious influences. Subjects first heard a list of words, some of which were followed by shock. This was followed by a dichotic listening task in which subjects shadowed recorded prose played to their right ears, while a list of words was played to their left ears. GSR data showed that an autonomic response was registered for previously shocked words even though subjects were unaware that words were being played to that ear, and could not remember hearing that word.

As will be described in detail below, the present experiment will use a learning theory paradigm to explore the relationship of repression to brain functioning.

Recent Findings about Brain Functioning

The psychoanalytic model offered by Freud was originally formulated as having a neurological basis (Freud, 1966). Subsequent elaborations of psychoanlytic theory, however, did not pursue this neurological basis but adopted a more psychological focus. Freud himself had discontinued attempts to relate individual mental processes to specific anatomincal locations because the neurology of the time was insufficient (Freud, 1948).

However, recent advances in neuropsychology and neuropsychiatry have greatly added to the physiological understanding of some psychological processes. Until recently, focus was on simple sensory motor and perceptual activities. Only very recently complex psychological processes, among them repression, have been studied by neuropsychologists. Galin (1974) has offered a neuropsychological explanation of the process of repression.

Basing his hypothesis on present knowledge and research in cerebral specialization, Galin proposes that at least some instances of repression may be due to the inhibition of information transfer across the cerebral commissures.

Asymmetry of Hemispheric Functioning

There are significant differences in the manner in which the left and right cerebral hemispheres process information. In right handed adults, the left hemisphere dominates in language comprehension, speech production, reading, writing, calculation, and complete perception of the right visual hemifield (Gazzaniga 1970; Gazzaniga Bogen & Sperry, 1965). The right hemisphere is superior to the left in holistic or gestalt perception, visual-spatial relationship tasks, and complete perception of the left visual hemifield (Gazzaninga, 1970). The right hemisphere has been shown to use a non-verbal mode of representation, presumably auditory, tactile, kinesthetic and visual images (Bogen, 1969).

What most characterizes the differences between hemispheres is not that they are specialized to work with different kinds of material, but that each processes information in a different cognitive mode (Galin, 1974). The left hemisphere processes information in an analytic, symbolic, serial-order, focal or logical manner, while the right hemisphere processes information in an analogical, synthetic, parallel and diffuse manner.

Most of the evidence for hemispheric differentiation has been gathered from brain damaged subjects or those whose corpus callosum has been surgically severed to relieve epileptic seizures. However, lateral specialization in normal people has recently been demonstrated using a number of techniques: reaction time (Filbey & Gazzaniga, 1969), tachistoscopic split-field presentations (Rizzolatti, Umilta, & Berlucchi, 1971), dochotic listening (Kimura, 1967), recordings of eye movements (Galin & Ornstein, 1974), EEG's (Doyle, Ornstein & Galin, 1974; Galin & Ornstein, 1972), and evoked potentials (Galin & Ellis, 1975).

In the visual field, signals from the right visual half field project to the left cerebral hemisphere while signals from the left visual half field project to the right hemisphere, making tachistoscopic presentation to the visual half field a valid method of presenting material to a particular hemisphere. Due to the differing hemispheric functions verbal information is processed at a different speed when presented unilaterally to the right hemifield/left hemisphere compared to the left hemifield/right hemisphere presentations. Most studies have found more accurate recognition and quicker response to verbal material presented to the right hemifield (Kimura, 1966; Misken & Forgays, 1952; McKeever & Huling, 1970; White, 1969). Therefore, intrinsic differences are expected in reportable recognition of words using the tachistoscopic method.

It has long been recognized that there exists a relationship between preferred hand use and lateral brain asymmetry, particularly for speech functions. Based largely on examinations of clinical populations, it is estimated that 90-99% of all right handers have their language functions predominantly subserved by the left hemisphere (Levy, 1974; Penfield & Roberts, 1959; Pratt & Warrington, 1972; Wada & Rasmussen, 1960), while only 50-70% of left handed or ambidextrous people have their language functions localized primarily within the left hemisphere (Goodglass & Quadfasel, 1954; Piercy, 1964; Roberts, 1969; Wada & Rasmussen, 1960; Warrington & Pratt, 1973). Thus, there is a highly significant relationship between non-right handedness and right or bilateral location of language function in the brain (Hécaen & Saguet, 1971).

A number of studies indicate that females have less complete lateralization of linguistic abilities in the left hemisphere and spatial abilities in the right hemisphere compared to males. For example, with surgery patients, Lansdell (1961) found that left temporal lobe surgery disrupted only the performance of males on Gorham's Proverbs Test. Similarly, Lansdell (1962) reported that right hemisphere lesions led to a drop in scores for males but not for females on the Graves Design Judgment Test. McGlone and Kertesz (1974) also found that right hemisphere damage resulted in significantly lower scores for males but not for females on the Block Design subtest of the Wechsler Adult Intelligence Scale.

Several studies with normal subjects report comparable results. On a dot emuneration task, an equal number of females showed left and right visual field superiorities while a significant majority of males showed a left visual field superiority (McGlone & Davidson, 1973). Kimura (1966) reported a significant left visual field superiority for localization of a dot in a square or circular array by males. Females also obtained a significant left visual field superiority for dot localization with a circular array but a slight right visual field superiority with a square array.

Parallels between the Isolated Right Hemisphere and Repression

Galin (1974) has noted parallels between the functioning of the isolated right brain hemisphere and the operation of the mechanism of repression, and has developed a theory based on this. As stated before, this theory proposes that inhibition of information transfer across cerebral commissures may be responsible for at least some types of repression, particularly the blockage of transmission from right to left hemisphere. Galin states that:

> It does not seem implausible that parts of the transmission from one hemisphere to the other can be selectively

> blocked since selective gating has already been demonstrated in the central control of sensory input for all sensory modalities (Livingston, 1959; Pribram, 1971; Whitfield, 1967). Stimulation of callosal fibres can inhibit as well as excite neural discharge in the contralateral cortex (Asanuma & Osamu, 1962;Eidelberg, 1969). Noting these reports, Bogen (1969) proposed "...certain kinds of left hemisphere activity may directly supress certain kinds of right hemisphere action or they may prevent access to the left hemisphere of the products of right hemisphere activity."

Presumably there is also reciprocity: right hemisphere processes could interfere with or suppress left hemisphere activity.

Galin (1974) notes parallels between repression and cases where the right hemisphere is disconnected through sectioning of the cerebral commissures, or when the operation of one hemisphere is reduced or blocked because of injuries, surgery or shock. Dramatic examples of the effects of hemispheric dissociation can be found from the "split-brain" patients. These are people whose cerebral commissures were sectioned for the treatment of a rare type of epilepsy. The procedure leaves the person with two independently conscious hemispheres, each working in its own cognitive mode and unable to communicate directly with the other. Although these patients appear to be remarkably normal, closer examination reveals the effects of a lack of hemispheric communication. In some examples, the reactions of a split-brain patient seem very similar to the phenomena of repression. One of these occurs in a film clip photographed by Dr. Robert Sperry and his associates at the California Institute of Technology (Galin, 1977). The film shows a split-brain patient being tested with a tachistoscope so that pictures were shown to either the right or left visual field. In the midst of a series of dull geometric figures, a photo of a nude woman was flashed to the left visual field (right hemisphere). The patient blushed and giggled. Sperry asked, "What did you see?" She answered, "Nothing, just a flash of light," and giggled again. "Why are you laughing then?" asked Sperry, and she laughed again and said, "Oh, Dr. Sperry, you have some machine." The patient was reacting to the visual material which she could not verbalize about in a manner which seems very much like the repression of conflictual sexual material.

Similar reactions have been noted in persons whose corpus callosum is intact. In these cases it may be inferred that right hemisphere material is being actively inhibited due to its disturbing nature. For example, patients with right hemisphere lesions are more likely to display the "indifference reaction" (anosognosia) to their disability while patients with left lesions are more likely to show a "catastrophic reaction" (Critchley, 1957; Weinstein & Kahn, 1955; Gainotti, 1972). Galin suggests that this may occur because knowledge of the injury to the right hemisphere is blocked from the left hemisphere.

A similar hemisphere difference has been noted during administration of the Wada carotid amobarbital test. The test is administered to patients about to undergo brain surgery near the Sylvian regions, where knowledge of hemispheric speech lateralization is very important (Wada & Rasmussen, 1960). Injection of a small quantity of the anesthetic into one common carotid artery produces a contralateral paralysis of the lateral half of the body (hemiplegia), anesthetizes the ipsilateral hemisphere and produces a complete aphasia if it is the side dominant for speech. Terzian (1964) observed that some of his patients had a severe emotional reaction as the anesthetic was wearing off. Amobarbital on the left side induced a catastrophic reaction, while on the right side it produced a euphoric reaction.

Further evidence that knowledge of injury to the right hemisphere tends to be blocked from awareness comes from the literature on Electro Convulsive Treatment (ECT) for the relief of depression. Cronim, Bodley Potts, et al (1970) found that ECT to the left hemisphere was significantly less effective in relieving depression than ECT to the right. A study by Halliday, Davidson, Brown et al (1968) showed similar findings.

Here again the process may be one in which the dominant left hemisphere inhibits the expressions of the right hemisphere. However, during inactive periods the right hemisphere may be less inhibited. One example of uninhibited right hemisphere expression may be dreaming. As Galin (1974) points out, there is a parallel between the mode of cognition of the right hemisphere and the mode of expression in dreaming. Further as Galin states:

> The mode of cognition in dreaming is usually of the "primary process" type; mainly nonverbal, image representations, with nonsyllogistic logic, and violations of ordinary temporal sequencing.

Evidence of right hemisphere involvement in dreaming comes from a study which relates personality types to amount of dream recall (Austin, 1971), and reports of dream cessation following injury to the right hemisphere (Humphrey & Zangwill, 1951), and sectioning of the corpus callosum (Bogen, 1969).

Focus of the Present Research

The evidence supporting Galin's theory stated above has all been indirect. A more direct test of the theory could be made if one could present identical punished and unpunished stimuli independently to the right and left hemispheres, require verbalization of the stimuli, and then examine the rate of inhibition in each brain hemisphere. If, as Galin theorizes, repression occurs when the left hemisphere isolates itself from or inhibits the processing of stimuli from the right hemisphere, one would expect a larger decrement in the reportable recognition of shocked words compared to non-shocked words for stimuli presented to the right hemisphere compared to the left hemisphere.

The present study combines the tachistoscopic paradigm used in numerous investigations of lateral asymmetry, with the method of shock-induced inhibition of verbal response used in repression analogue studies. Tachistoscopic studies, such as the present study, have used words as the stimuli (Mishkin & Forgays, 1952), presented the stimuli unilaterally to either the right or left hemisphere (McKeever & Hulling, 1970), required verbalization of the stimuli (Hines, 1975), used error scores or percent correct as the dependent measure (Hines & Satz, 1970), and adjusted exposure duration individually to a criterion of percent correct response (Hannay & Malone, 1976).

In the present study this was investigated by a method in which subjects were asked to verbalize stimulus words, presented independently to the right and left hemispheres via a tachistoscope. Speed of stimuli presentation was adjusted individually to a criterion of 80% correct response from the right visual field. In the first experimental phase a new list of words were presented at a longer fixed speed (150 ms) and some of the words were followed after verbalization by shock. In the second experimental phase the same word list was presented without shock at the speed which was individually determined in the first phase.

It was first predicted that the previously shocked words would be correctly reported less often than the words which were not previously shocked. This would demonstrate the existence of a general inhibition effect. Secondly, it was predicted that decrements in reportable recognition of shocked words compared to non-shocked words would be greater for stimuli presented to the left visual field/right hemisphere compared to words presented to the right visual field/left hemisphere. This was the test of Galin's theory. Thirdly, it was predicted, as an exploratory hypothesis, that the differential decrement predicted in hypothesis two would be smaller for females compared to males.

CHAPTER II

METHOD

Subjects

Subjects were 20 female and 20 male introductory psychology students from the University of Manitoba Psychology Department subject pool. Subjects were right handed with no history of familial left-handedness, and with normal visual acuity.

Subjects were randomly assigned into three groups, each of which received a randomly different ordered sequence of 10 test and 40 pre-test words. Pre-test and test word lists were randomly selected from the same fifty words.

Apparatus

Subjects were tested in a soundproof room manufactured by Industrial Acoustics Co., Inc. They were seated in a chair facing the eye-piece of the tachistoscope, and were connected by intercom to an adjacent room which contained the projection and recording equipment. Stimulus words consisted of four-letter verbs with equivalent word-count frequency ratings from Thorndike and Lorge (1944). The words were presented vertically on slides two degrees from right or left of a central fixation point. Slides were viewed through a Scientific Prototype (Model 800F) tachistoscope modifed for use with a Kodak Carousel slide projector. Central fixation was a dot in the centre of the visual field provided by the blank field of the tachistoscope. Illumination levels of the stimulus field and the blank field were equivalent. Stimulus timing was supplied by Hunter Interval Timers, Model 111-C. The warning tone was produced by a Lehigh Valley Electronics Audio Generator, Model 1524. Shock was produced by a Farall Instruments AV-2 Visually Keyed Shocker and conducted to the subjects with two ½ inch copper electrodes.

Procedure

On arriving at the experiment, subjects were told that the study involved the use of brief presentations of shock and were offered the opportunity to decline participation and still receive full experimental credit. If they wished to participate, they were asked if there was any medical reason which would prohibit the use of shock, and if so, they would have been excluded from the study and given full credit.

Subjects were then questioned about their hand preference in various activities and the handedness of their family members, and were also questioned to ascertain that they had normal or corrected-to-normal vision. Subjects who were not fully right-handed, or had left-handed family members, or did not have normal visual acuity were excluded from the study and given full experimental credit.

Subjects were then seated in front of the tachistoscope and told:

> "This study is designed to measure the effects of a stressful stimulus on your visual reaction time. The intensity of the shock will be determined by you yourself, but, as you know, you are free to stop your participation in the experiment any time. Please put your head into position so you can see through the eyepiece. You will be doing this throughout the experiment. Now look at the black dot in the centre. When you hear a short tone, it is a signal that a word will be flashed on the screen. Please say this word out loud. Don't worry if some of the words are flashed too quickly for you to recognize them, but try hard to say the word."

When the experimenter was sure that the subject understood the instructions, Phase I of the experiment began. Pretest stimuli were presented to both visual fields at an initial speed of 100 msc. Responses were recorded and exposure time was adjusted to reach criterion of 80% correct responses from the right visual field. The final time was recorded and used subsequently with the individual subject. Response recording was on the form provided in Appendix A.

Next, shock levels were determined individually using a shock work-up procedure. Subjects were reminded that they could discontinue the experiment. If they agreed to continue, copper shock electrodes were fastened to the left forearm. Then the subject was told:

> "I am going to give you a shock work-up now, to set the level of shock to be used. I will start giving you small increasing increments of shock, beginning at zero. After each one you feel, I want you to say "OK" or "stop", when you feel that you can go no higher. It is very important that you say "stop" only when you feel that you can go no higher. It should be at a level that causes some discomfort. Are there any questions?"

After the experimenter answered any questions, the subject was given 500 millisecond shocks of increasing intensities from 0 to 10 on the intensity dial of the shocker. The dial setting was not increased until the subject responded "OK" to the previous level. When a subject responded with "stop," his intensity level was set at that point and the experimenter told the subject:

> "As I said before, this study is designed to measure the effects of a stressful stimulus on your visual reaction time. Once again, please put your head into position so you can see through the eyepiece and focus on the black dot. As before, a tone will warn you that a word is going to be flashed on the screen, and you are to say the word out loud. This time some of the words will be followed by shock. There is no way to prevent this. However, this is the only phase during which you will receive shock."

The experimenter returned to the equipment room. The experimental words were presented in random order at an exposure time of 150 ms (longest latency before eye movements occur, Alpern, 1971). Words were presented unilaterally to either the right or left visual field, but each individual word was shown in both fields during separate presentation. Each word was presented three times to each visual half field. Five of the ten words were followed by shock, one second after stimulus presentation. Words presented in this phase to each of the three experimental groups are presented in Appendix B.

In the second experimental phase, the same words were presented in a different order at the previously determined individual speed. No shocks were given. Subjects were told that there would be no more shocks and were asked to continue to verbalize the words on the screen.

CHAPTER III

RESULTS

The data were analyzed in a 2 x 2 x 2 Mixed Design Analysis of Variance with a Between Subjects factor of Sex and Within Subjects factors of Shock and Hemisphere. The analysis, shown in Table 1, tested all three hypotheses.

The first hypothesis, that more errors would be made in verbal recognition of previously shocked words compared to nonshocked words, was not supported. The predicted main effect for shock was not significant (Shock F = 1.78; df = 1, 38; p = .19). In fact, contrary to expectation, more errors were made for nonshocked than for shocked words. Mean number of errors in verbalization of Shocked and Nonshocked words are shown in Table 2.

When examined by sex, it can be seen that the female data accounted for the results being opposite of the predicted direction. Males were slightly in the predicted direction of more errors from shocked words (shocked: 2.62 mean errors, nonshocked: 2.50 mean errors, nonsignificant), while females had a stronger trend in the opposite direction (shocked: 2.65 mean errors, nonshocked: 4.00 mean errors, nonsignificant). Thus it appears that shock may have had a slightly inhibiting effect for males, but a facilitating effect for females. The male and female data were also analyzed separately in 2 x 2 ANOVAs with Within-

TABLE 1

Aanalysis of Variance for Number of Errors in Verbalized Recognition of Words, Shocked and Nonshocked, Presented to the Right or Left Hemisphere

Source	df	SS	MS	F
Sex	1	17.56	17.56	.97
Error	38	687.68	18.10	
Shock	1	10.51	10.51	1.78
Sex x Shock	1	28.06	28.06	4.74*
Error	38	224.69	5.91	
Hemisphere	1	0.01	0.01	.00
Hem. x Sex	1	4.56	4.56	1.89
Error	38	91.69	2.41	
Shock x Hem.	1	1.41	1.41	0.86
Sex x Hem.x Shock	1	0.76	0.76	0.46
Error	38	62.09	1.63	

*$p < .05$.

TABLE 2

Mean Number of Errors in Verbalized Recognition of Words, Shocked and Nonshocked

Shocked	2.74
Nonshocked	3.25

Subjects factors of Shock and Hemisphere. The male analysis revealed a trend for a Shock by Hemisphere interaction (F = 2.15; df = 1,19; p = .159). More errors were made for shocked words presented to the right hemisphere (3.15 mean errors) than to the left hemisphere (2.5 mean errors for each). This was in the predicted direction.

The female data showed a main effect for shock on the borderline of significance (F = 4.30; df = 1,19; p = .052). The trend was opposite of the predicted direction. That is, females made more errors for nonshocked (4.00 mean errors) than for shocked words (2.65 mean errors).

The second hypothesis, that more errors would be made in verbalization of shocked words presented to the right hemisphere compared to words presented to the left hemisphere, was not confirmed. As Table 3 shows, slightly more errors were made for words presented to the right hemisphere than to the left hemisphere. When examined by sex, it can be seen that only males were in the predicted direction while females were in the opposite direction. Males made more errors for shocked words presented to the right hemisphere (3.15 mean errors) than to the left hemisphere (2.50 mean errors, nonsignificant). However, the predicted interaction was not significant (Shock x Hemisphere F = .86; df = 1,38; p = .36).

The third, exploratory hypothesis, was that the amount of difference between the right and left hemispheres for shocked words would be smaller for females than for males.

Although the predicted triple interaction was not significant (Sex x Shock x Hemisphere F = .46; df = 1,38; p = .50), hemisphere differences were somewhat smaller for females compared to males. However, males made more errors from the right hemisphere while females made more errors from the left hemisphere. For nonshocked words, males made an identical number of errors from the right and left hemispheres, while females made more errors from the left hemisphere and with a larger hemisphere difference than from nonshocked words. Mean error scores are presented in Table 4.

An exploratory area of the study was that of sex differences, and one interesting finding did emerge. A significant Sex x Shock interaction was found (F = 4.74; df = 1,38; $p < .05$). Males were in the predicted direction of more errors for shocked words while females made more errors for nonshocked than for shocked words. The interaction is depicted graphically in Figures 1 and 2. Mean error scores are shown in Table 5. A t-test for Independent Measures performed on the difference between shocked and nonshocked error scores for females approached significance (t = 1.40; df = 38; $p < .10$). Thus, it was the female subjects who accounted for the unexpected tendency toward better performance on shocked words. A t-test for Independent Measures comparing males and females for errors on nonshocked words also approached significance (t = 1.6; df =

TABLE 3

Mean Number of Errors in Verbalized Recognition of Schocked Words Presented to the Right or Left Hemisphere

Right Hemisphere	2.82
Left Hemisphere	2.65

TABLE 4

Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words Presented in the Right or Left Hemispheres to Males and Females

Group	Males	Females
Shocked		
Right Hemisphere	3.15	2.50
Left Hemisphere	2.50	2.80
Nonshocked		
Right Hemisphere	2.50	3.80
Left Hemisphere	2.50	4.20

TABLE 5

Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words Presented to Males and Females

	Males	Females
Shocked	2.83	2.65
Nonshocked	2.50	4.00

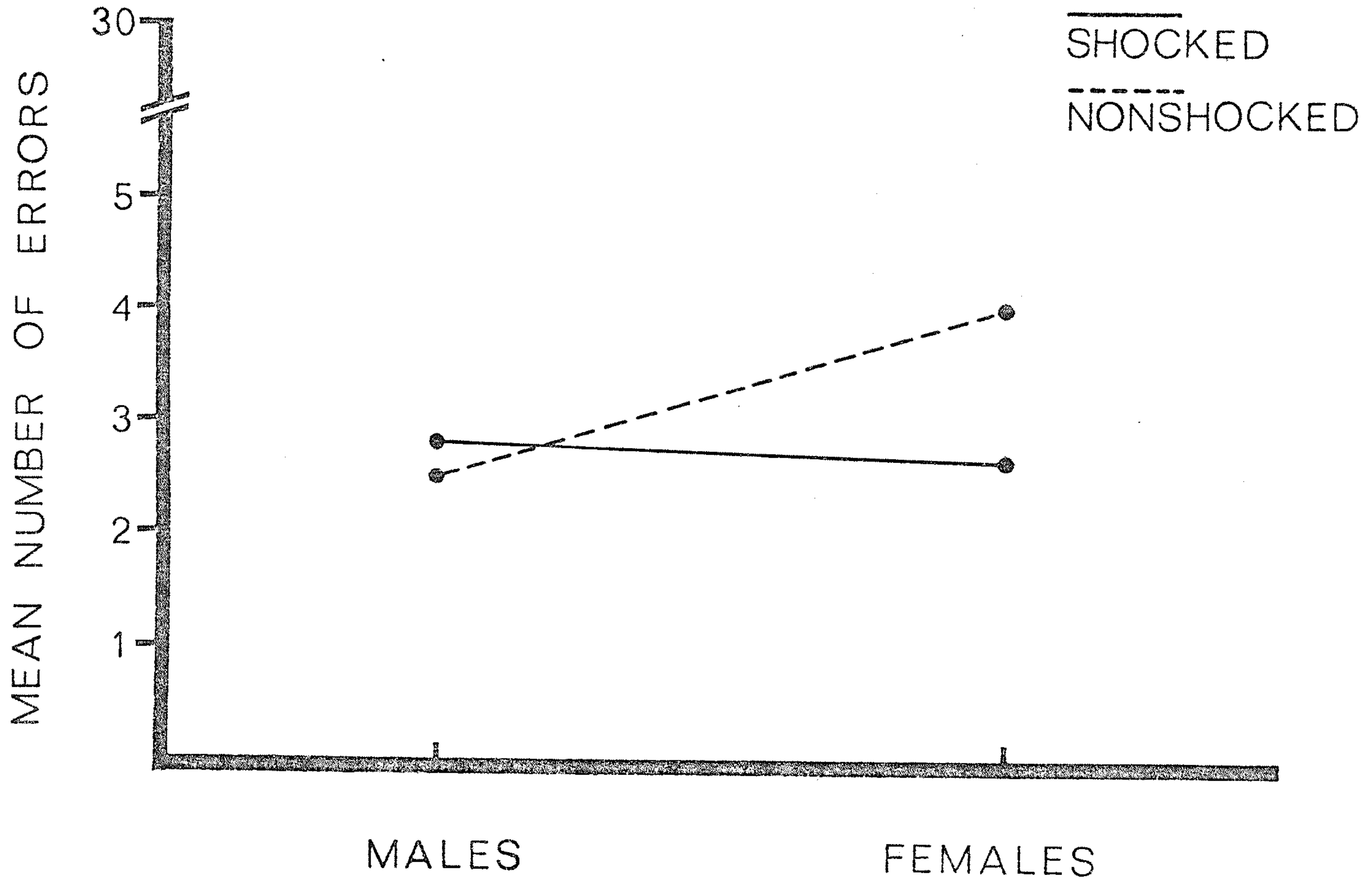

Figure 1. Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words by Sex of Subject

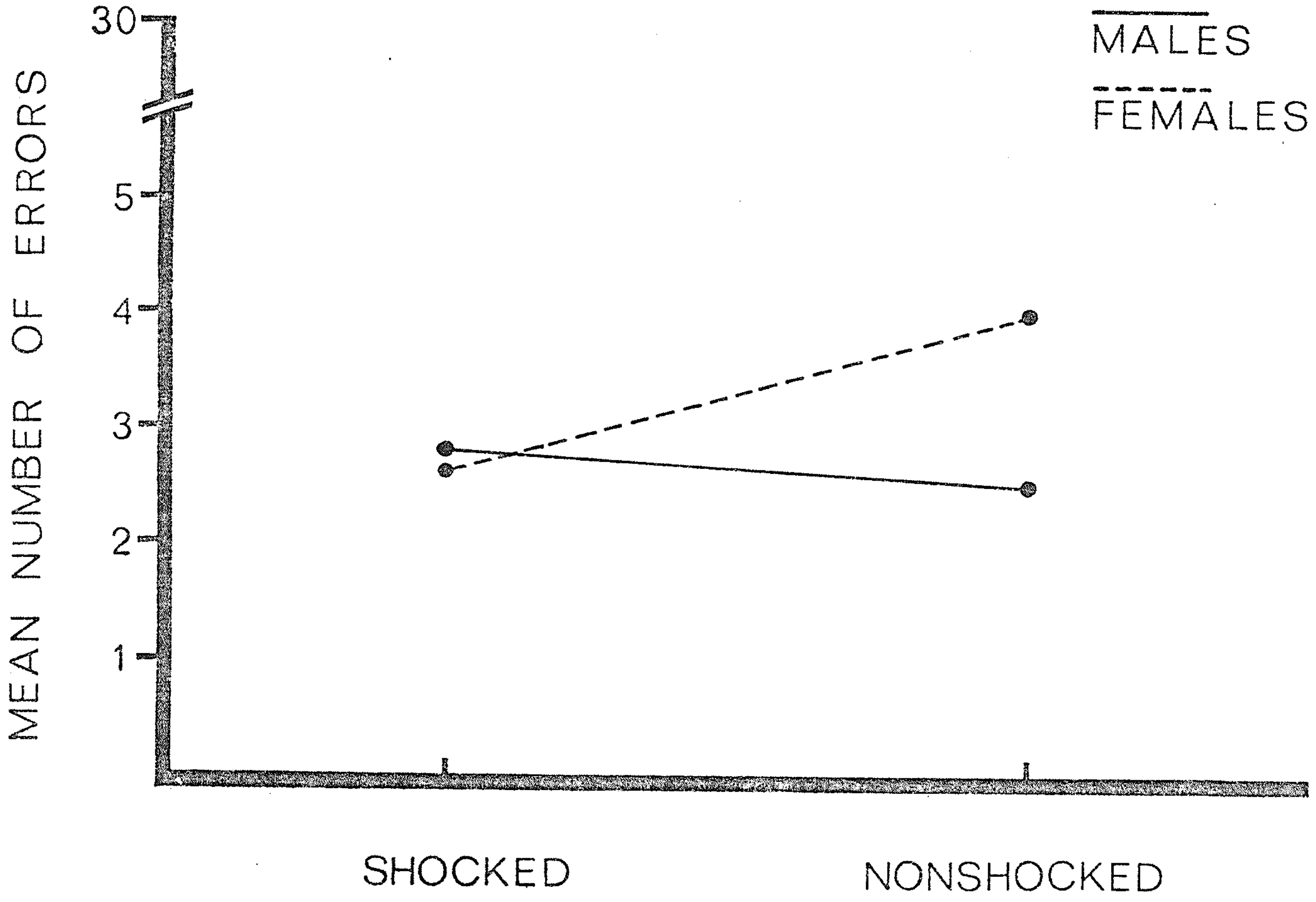

Figure 2. Mean Number of Errors Made by Males and Females in Verbalized Recognition of Words by Shocked and Nonshocked Words

38; $p < .10$). Males and females made nearly the same number of errors for shocked words, but for nonshocked words females made more errors than did males. Thus, it appears that shock may have had a somewhat inhibiting effect for males, but a facilitating effect for females.

Although level of shock was not predicted to be a variable, examination of the data suggested that it might be fruitful to look at the results separately by shock level. As described in the procedures, subjects set their own shock levels, which varied considerably, and were generally higher for males than for females. Male and female data were divided separately by their respective means (1.2 milliamperes for females, 1.8 milliamperes for males) into a High Shock and Low Shock group contained ten males and thirteen females and the High Shock group was comprised of ten males and seven females.

The High and Low Shock groups were each analyzed in a 2 x 2 x 2 Mixed Design Analysis of Variance with Between Subjects factor of Sex and Within Subjects factors of Shock and Hemisphere. The analyses are shown in Tables 6 and 7. As with the main analysis, the predicted shock and hemisphere effects were nonsignificant, but the male data was generally in the predicted direction while the female data was in the opposite direction. However, there were important differences between the low and high shock groups. For low shock males, the trends towards the predicted

TABLE 6

Analysis of Variance for Number of Errors in Verbalized Recognition of Words, Shocked, and Nonshocked, Presented to the Right or Left Hemisphere to High Shock Subjects

Source	df	SS	MS	F
Sex	1	35.14	35.15	2.42
Error	15	218.24	14.55	
Shock	1	36.53	36.53	7.56*
Sex x Shock	1	14.53	14.53	3.01
Error	15	72.44		
Hemisphere	1	0.05	0.05	0.03
Hem. x Sex	1	0.64	0.64	0.37
Error	15	25.98	1.73	
Shock x Hem.	1	0.13	0.13	0.05
Sex x Hem.x Shock	1	1.90	1.89	0.79
Error	15	35.84	2.39	

$^{*}p < .05$.

TABLE 7

Analysis of Variance for Number of Errors in Verbalized Recognition of Words, Shocked and Nonshocked, Presented to the Right or Left Hemisphere to Low Shock Subjects

S Source	df	SS	MS	F
Sex	1	0.13	0.13	38.86
Error	21	451.19	21.49	0.01
Shock	1	1.05	1.05	0.18
Sex x Shock	1	21.92	21.92	3.70*
Error	21	124.41	5.92	
Hemisphere	1	0.02	0.02	0.01
Hem. x Sex	1	4.20	4.20	1.35
Error	21	65.13	3.10	
Shock x Hem.	1	2.83	2.83	2.51
Sex x Hem. x Shock	1	0.05	0.05	0.04
Error	21	23.67	1.13	

*p = .068.

results were stronger than in the general analysis, and the low shock female results were less strongly in the opposite direction. The reverse was true of the high shock group. Compared to the general analysis, males were less strongly in the predicted direction and females were more in the opposite direction.

The low shock analysis revealed a nearly significant trend for a Sex x Shock interaction (F = 3.70; df = 1,21; p = .068). The trend is depicted in Figures 3 and 4, and in Table 8. As the tables show, males made more errors on shocked than on nonshocked words, while the reverse was true for females. This trend was similar to the significant Sex x Shock interaction found in the main analysis. However, in that interaction, significance was accounted for by females, while for the low shock subjects, the trend was accounted for by males. Low shock analysis also showed a trend for Shock x Hemisphere interaction (F = 2.51; df = 1,21; p = .128). More errors were made from the right hemisphere for shocked words, but for nonshocked words more errors were made from the left hemisphere. Separate analyses of variance of male and female low shock subjects revealed no significant effects for females, but for males the analysis showed a significant main effect for shock (F = 7.36; df = 1,9; $p < .05$). Low shock males made an average of 3.6 errors from shocked words compared to 2.4 errors from nonshocked words. Thus, low shock males showed the shock effect which was predicted for all subjects. Low

TABLE 8

Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words Presented to Low Shock Males and Females

	Males	Females
Shocked	3.6	2.69
Nonshocked	2.4	3.46

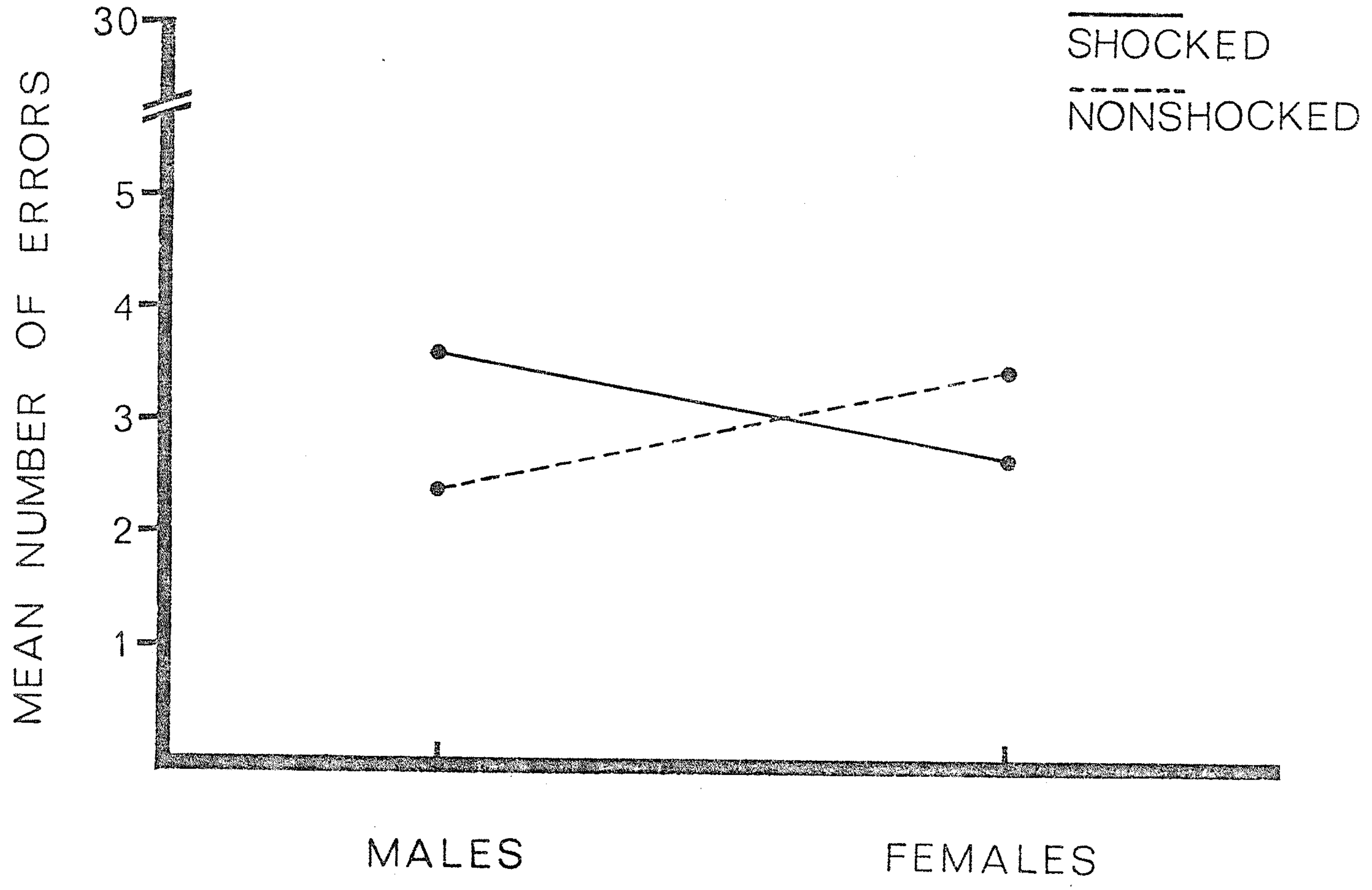

Figure 3. Mean Number of Errors Made by Low Shock Subjects in Verbalized Recognition of Shocked and Nonshocked Words by Sex of Subject

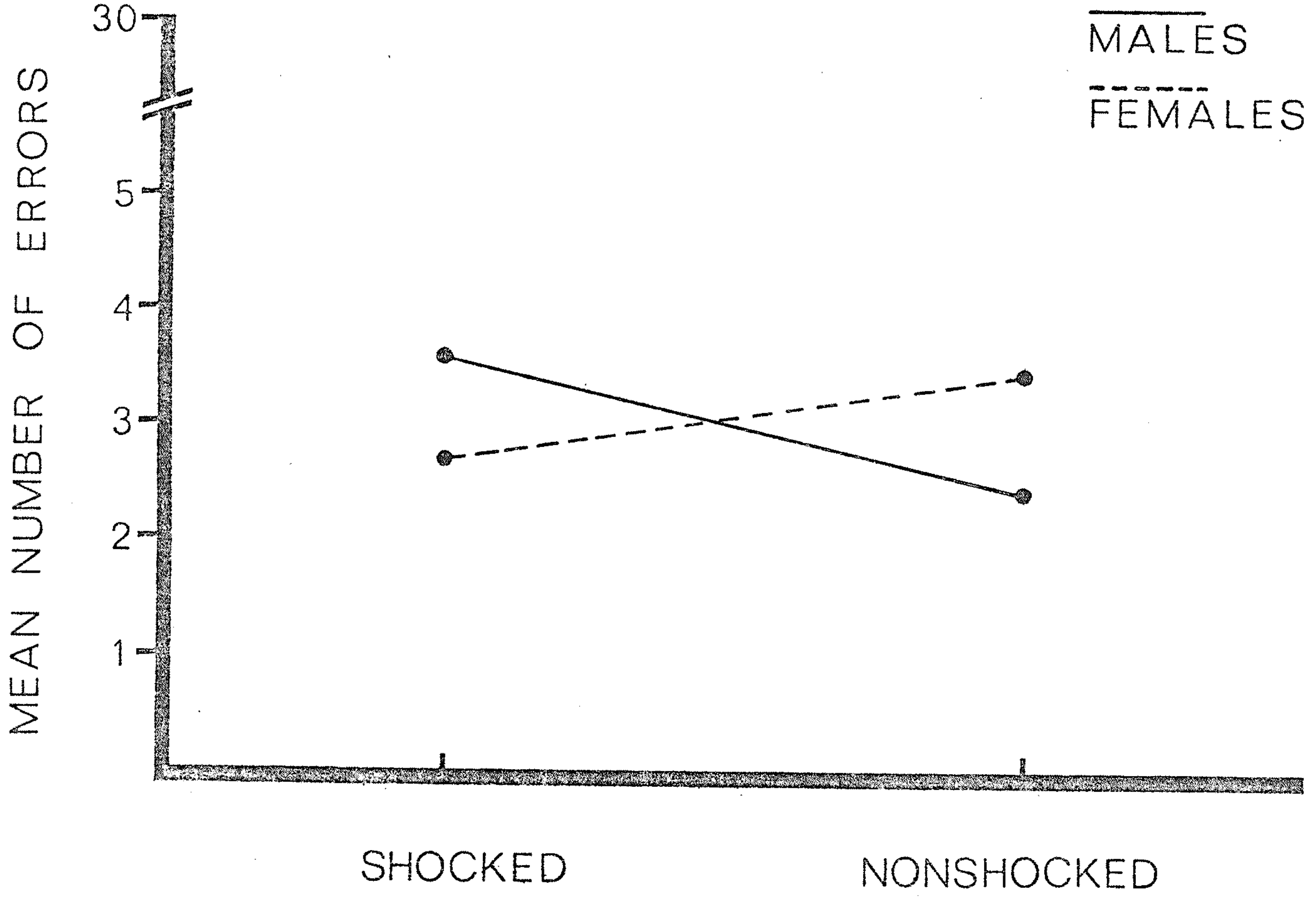

Figure 4. Mean Number of Errors Made by Low Shock Subjects in Verbalized Recognition of Shocked and Nonshocked Words by Sex of Subject

shock males also showed a trend for a Shock x Hemisphere interaction ($F = 2.67$; $df = 1,9$; $p = .137$). More errors were made from the right hemisphere for shocked words, but there was no hemisphere difference for nonshocked words.

As an additional analysis to test the effects of shock level, an Analysis of Variance was performed with Between Subjects factors of Sex and Shock Level and Within Subjects factors of Shock and Hemisphere. The analysis is shown in Table 9. A significant Shock x Shock Level interaction was revealed ($F = 6.45$; $df = 1,36$; $p < .05$). The interaction is shown in Table 10, and graphically in Figures 5 and 6. Low shock subjects made more errors on shocked compared to nonshocked words, while the high shock subjects made significantly more errors on shocked compared to nonshocked words.

TABLE 9

Analysis of Variance for Number of Errors in Verbalized Recognition of Words, Shocked and Nonshocked, Presented To the Right or Left Hemisphere, with Shock Level as a Factor

Source	df	SS	MS	F
Sex	1	22.53	22.53	1.21
Level	1	0.01	0.01	0.00
Sex x Level	1	18.25	18.25	0.98
Error	36	669.43	18.60	
Shock	1	15.46	15.46	2.83
Sex x Shock	1	35.27	35.27	6.45*
Shock x Level	1	27.69	27.69	5.06*
Sex x Shock x Level	1	0.02	0.02	0.00
Error	36	5.47	5.47	
Hemisphere	1	0.00	0.00	0.00
Sex x Hem.	1	3.75	3.75	1.48
Hem. x Level	1	0.07	0.07	0.03
Hem x Sex x Level	1	0.52	0.52	0.21
Error	36	91.11	2.53	
Shock x Hem.	1	0.67	0.67	0.40
Shock x Hem. x Sex	1	1.41	1.41	0.86
Shock x Hem. x Level	1	1.87	1.87	1.13
Shock x Hem. x Sex x Level	1	0.82	0.82	0.50
Error	36	59.51	1.65	

*$p < .05$.

TABLE 10

Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words by High and Low Shock Subjects

	Shocked	Nonshocked
High Shock	2.31	3.80
Low Shock	3.09	3.00

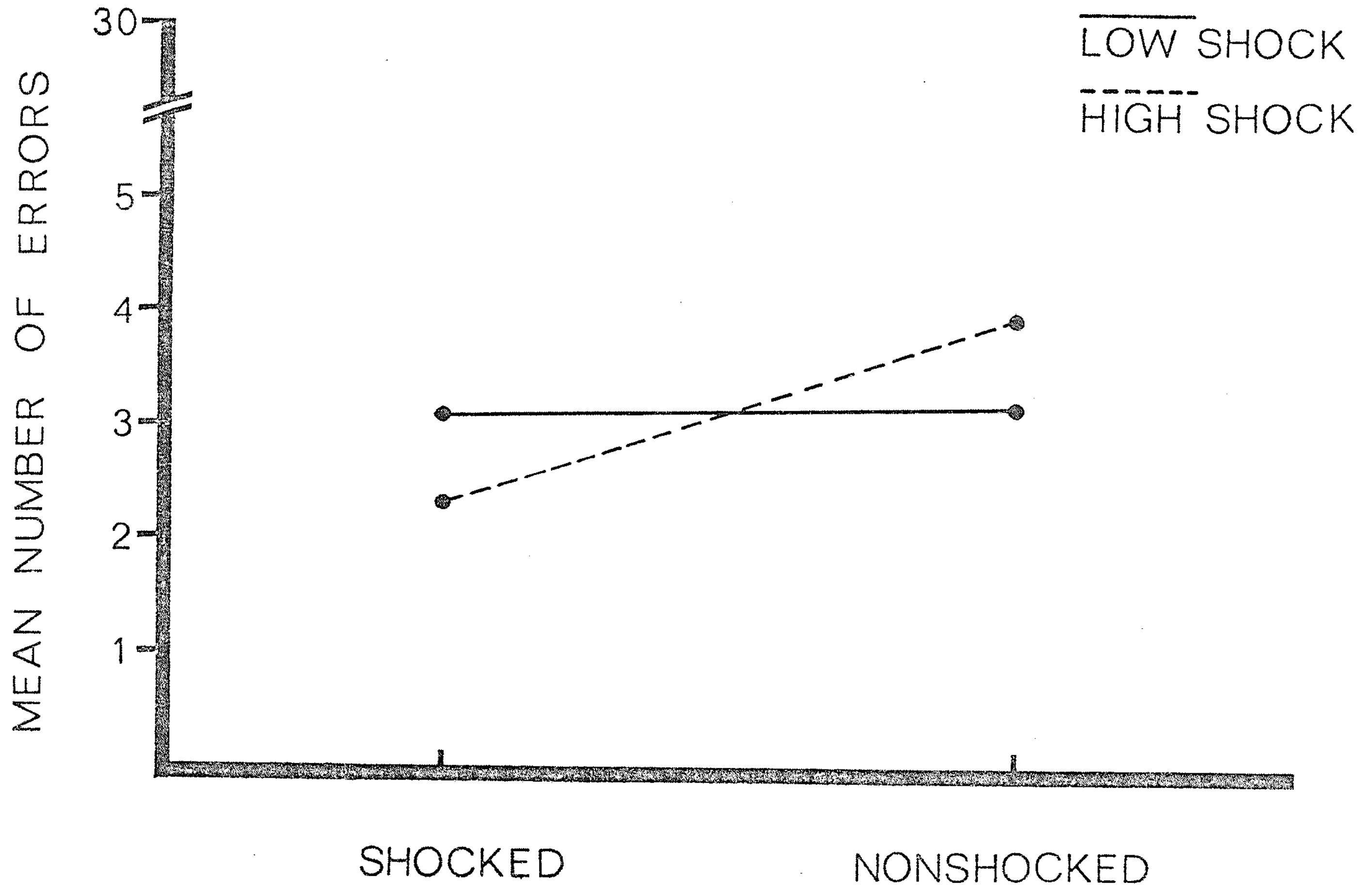

Figure 5. Mean Number of Errors in Verbalized Recognition of Shocked and Nonshocked Words by Low and High Shock Subjects

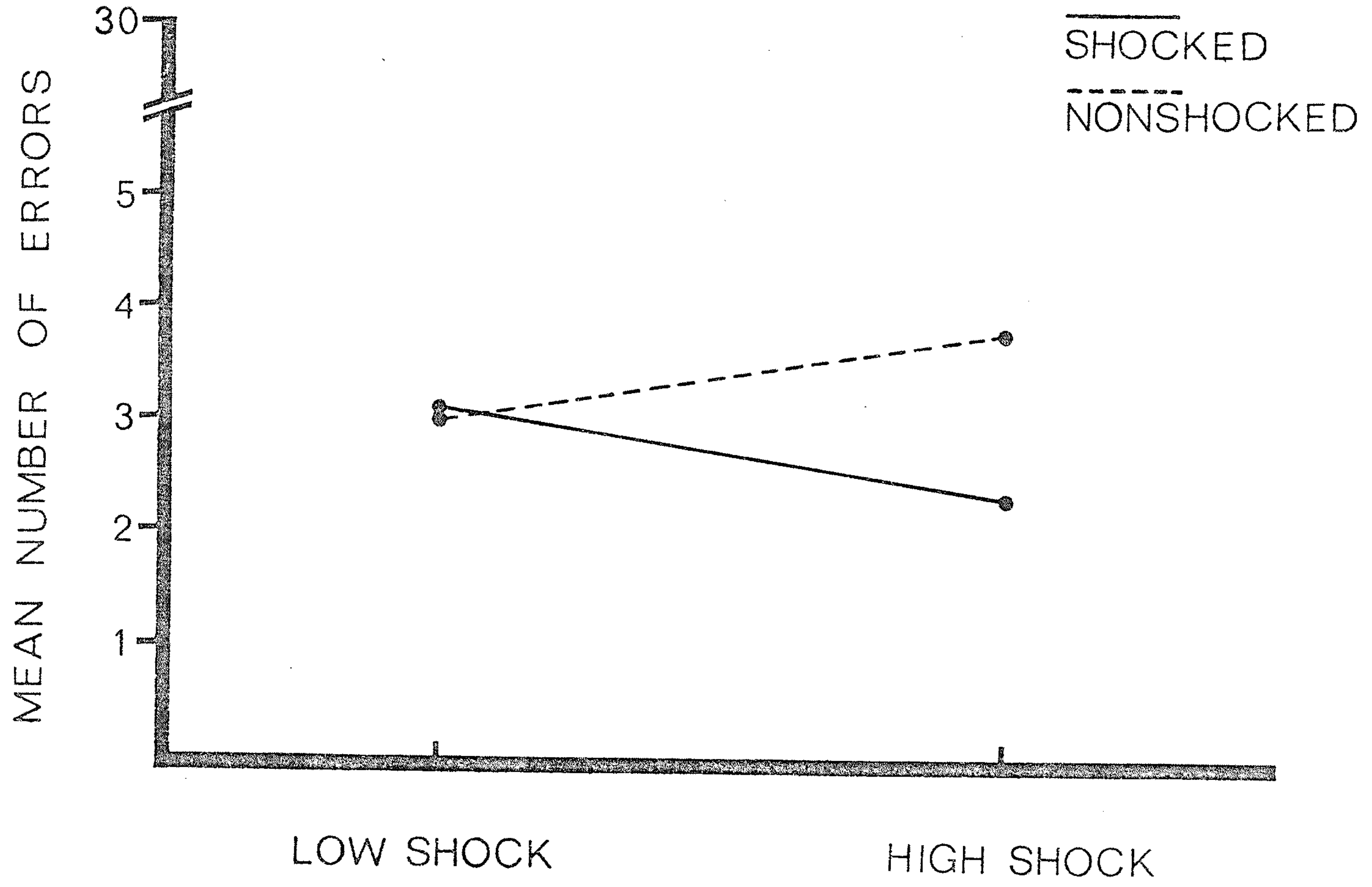

Figure 6. Mean Number of Errors Made by High and Low Shock Subjects in Verbalized Recognition of Shocked and Nonshocked Words

CHAPTER IV

DISCUSSION

A general inhibition effect was not found for shock. That is, shocked words were not correctly reported less often than nonshocked words. While it was predicted that more errors would be made for shocked words, in fact, more errors were made for nonshocked words (3.25 mean errors) than for shocked words (2.74 mean errors). This was due to the female subjects, who made significantly more errors on nonshocked words. The male data was in the predicted direction of more errors from shocked words, but not significantly so. Thus, it appears that shock may have had a facilitating effect for females, but a somewhat inhibiting effect for males.

When subjects were divided into High and Low Shock groups on the basis of the shock level which individual subjects set for themselves, shock level and shock interacted significantly. The Low Shock group was slightly in the predicted direction of more errors from shocked words while the High Shock group made significantly more errors from nonshocked words than from shocked words. It appears that, for those subjects who set relatively high shock levels for themselves, shock had a facilitating effect.

High shock males as well as females performed better on shocked words, although the difference between shocked and nonshocked error scores was greater for females. When the Low Shock group was examined by Sex, females made more errors from nonshocked words, although not significantly, while Low Shock males showed the predicted main effect for shock. Low Shock males made significantly more errors on shocked than on nonshocked words.

Shocked and nonshocked words when examined by hemisphere did not have significantly different error scores as was predicted. The hypothesis that more errors would be made from shocked words presented to the right hemisphere compared to the left hemisphere was not confirmed, although the data was slightly in the predicted direction. For shocked words, 2.83 mean errors were made from the right hemisphere, while 2.65 mean errors were made from the left hemisphere.

Sex differences for shock by hemisphere were similar to those found for shock effect. Males showed a trend for a Shock by Hemisphere interaction in the predicted direction while females were (nonsignificantly) opposite of the predicted direction. Male subjects made more errors for shocked words from the right hemisphere than for either shocked words from the left hemisphere or nonshocked words from the right hemisphere.

As with the first hypothesis, shock level was an unexpectedly important factor in the determination of shock by hemisphere results. The High Shock group made slightly more errors from the right hemisphere than from the left hemisphere for shocked words, but more errors from nonshocked than shocked words. The Low Shock group showed a trend towards a Shock by Hemisphere interaction in the predicted direction. The Low Shock group made more errors from shocked words presented to the right hemisphere than to either the left hemisphere or to nonshocked words from the right hemisphere. This trend came closer to statistical significance (p = .128) than either of the two other Shock by Hemisphere trends which were in the predicted direction (all males, p = .159; Low Shock males, p = .137). The Low Shock female data was opposite of the predicted direction, but not as strongly as in the main analysis, or the High Shock females.

The second hypothesis, then, received some support from males, and low shock subjects. For these groups there was a trend for more errors to be made from shocked words to the right hemisphere. For Low Shock males the trend was strongest, and they were also the group which made significantly more errors for shocked words.

The third hypothesis, that hemisphere differences would be smaller for females than for males, was not confirmed since males made more errors from the right hemisphere while females made more errors from the left hemisphere. However, there was generally a greater hemisphere difference for males for shocked words, and for females for nonshocked words. It is interesting that for males, hemisphere differences were greatest in the Low Shock group, while for females they were greatest in the High Shock group.

Thus, when all subjects were analyzed, the hypotheses were not supported. However, male and low shock subjects either supported or showed trends towards supporting the hypotheses. Surprisingly, female results tended to be opposite of the predicted direction. Also unexpected was the fact that shock level turned out to be an important factor. When split into High and Low Shock groups, the Low Shock subjects were closer to the expected results than the High Shock group.

The unexpected findings for females are difficult to interpret. Although females are thought to be less lateralized for brain functions (Lansdell & Urback, 1965; McGlone, 1976) this does not explain the female subjects' superior performance on shocked words or the trend toward right hemisphere superiority on both shocked and nonshocked words. There is some evidence to indicate that there are sex differences in reactions to shock (Liberson, 1973). A possible explanation is that sex differences in laterality interacted with reactions to shock to create the right hemisphere superiority for females but not for males. There is evidence to indicate that the right hemisphere is more involved with affective reactions (e.g., Davidson & Schwartz, 1976; Geschwind, 1965). This increased sensitivity could have resulted in a more accurate response to aversively associated stimuli, especially when the response called for was simple verbal recognition. If the normal left hemisphere advantage for verbal material is smaller for females than for males, then an affectively arousing stimuli of the parameters employed in the present study could result in a right hemisphere superiority for females but not for males. More importantly, perhaps, shock appears to have had a facilitating effect for females regardless of hemisphere presentation.

A similar kind of speculation has been suggested to interpret an unexpected right hemisphere superiority for verbal material in a study by Hawryluck (1977). In his study, shock was also used and a right hemisphere superiority was found on a simple verbal task but not on a more complex one. It is possible that an emotionally arousing experiment changes the relative effectiveness of the right and left hemispheres, in some way facilitating right hemisphere functioning. This possibility should be explored, perhaps by studying the effects of stimuli with different degrees of arousal (more and less aversive).

Shock level was an unpredicted but important factor.

Low Shock subjects were closer to the predicted results than were High Shock subjects. Since subjects set their own shock levels, perhaps the subjects who set relatively low levels found shock more aversive compared to subjects who set higher levels of shock. Since shock was more aversive to those who set lower levels, they tended to show the inhibition of response on shocked words and inhibition across the corpus callosum. Although females who set lower shock levels still showed an advantage for shocked words, it was much smaller than for the High Shock females. Future studies utilizing aversive stimuli should include a post-experimental questionnaire which would ask the subject to rate the aversiveness of the shocks and the extent to which aversiveness increased or decreased during the course of the experiment. It would also be helpful to administer a personality scale which could be related to selected shock level and the results of the experiment. Finally, shock level should be considered a factor, whether it is determined by the subjects or by the investigator.

A difficulty with interpretation of the data was the fact that correct verbalization scores were very near ceiling, resulting in a small range of error scores. Although exposure duration times were adjusted individually to 80% correct responses from the right visual field, mean percentages of correct test responses using those times was 95%.

This was due, at least in part, to the fact that exposure times were adjusted with ten pretest words which were shown four times in each visual field while the ten test words were shown six times in each visual field. Future studies using individually adjusted expoure times should provide an equal number of trials for test and pretest stimuli.

An additional change in method would be the use of reaction times rather than error scores as the dependent measure. A number of tachistoscopic investigations of hemisphere differences have employed error scores or percent correct (e.g., Hines, 1975; Hannay & Malone, 1976; Rosen et al., 1975). However, measurement of correct or incorrect responses is sensitive only to responses which have been entirely blocked or processed incorrectly, while reaction time measures are sensitive to delays in response due to transmission across the corpus callosum. Additional delay in verbal reaction times to punished stimuli presented to the right hemisphere would give evidence of partial blockage of callosal crossing. Gross (1972), in reporting on a study of hemispheric specialization, says "The present results indicate that evidence for hemispheric asymmetry, as indicated by Reaction Time differences, may be found even under conditions in which no significant difference in error rate is found (p.359)."

In the present study, results for males and Low Shock subjects were consistent with the hypotheses of shock inhibition and inhibition of transfer to the left hemisphere. Further investigation with the present design seems warranted, perhaps with the aversive stimuli as a multilevel factor, different types of aversive stimuli, and with reaction time as the dependent measure.

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APPENDICES

APPENDIX A

Record Sheet List: Exposure Adjustment

Date/Time______________________________Subject___________

Time:________
R WALK___
R DARE___
R DRAW___
___L WALK
___L VOTE
___L SEND
R VOTE___
___L DARE
___L DRAW
R SEND___

Time:________
___L GROW
___L INCH
R COOL___
___L MEET
R GROW___
___L WAIT
R MEET___
R INCH___
___L COOL
R WAIT___

Time:________
R DRAW___
___L DARE
___L VOTE
R SEND___
___L WALK
R VOTE___
___L DRAW
___L SEND
R DARE___
R WALK___

Time:________
R MEET___
R COOL___
___L COOL
R INCH___
___L MEET
R GROW___
___L GROW
___L WAIT
___L INCH
R WAIT___

Time:________
___L VOTE
R SEND___
R DARE___
___L WALK
___L DRAW
R COOL___
___L GROW
___L MEET
R DRAW___
R MEET___
R INCH___
___L WAIT
R VOTE___
___L DARE
R WAIT___
___L INCH
___L SEND
___L COOL
R WALK___
R GROW___

Time:________
R WAIT___
R COOL___
___L INCH
R SEND___
R INCH___
R DARE___
___L MEET
___L GROW
R GROW___
___L WAIT
R MEET___
R DRAW___
___L VOTE
R WALK___
___L COOL
___L SEND
___L WALK
R VOTE___
___L DRAW
___L DARE

FINAL TIME___________

SHOCK LEVEL__________

APPENDIX B

GROUP 1 SHOCK PHASE

PART L
BASE R
BASE L
HAND L
PART R
CAST L*
LOOK R
LOOK L
YELL L
TIME L*
MISS L*
EASE L*
YELL R
READ R*
READ L*
HAND R
EASE R*
CAST R*
TIME R*
MISS R*

EASE R*
CAST L*
READ L*
PART L
TIME L*
LOOK L
CAST R*
TIME R*
MISS L*
LOOK R
YELL R
HAND R
HAND L
READ R*
EASE L*
BASE L
BASE R
PART R
YELL L
MISS R*

PART R
PART L
BASE L
EASE L
LOOK L
HAND R
READ L*
YELL L
HAND L
MISS L*
TIME R*
TIME L*
YELL R
BASE R
EASE R*
CAST L*
READ R*
LOOK R
MISS R*
CAST L*

APPENDIX B

GROUP 2 SHOCK PHASE

LOOK L*
YELL L*
HELP R*
LEAD L
MISS L
GIVE L *
LEAD R
JOIN L
BURN R
BURN L
LOOK R*
HAND L*
HELP L*
MISS R
HAND R*
TIME L
GIVE R*
JOIN R
YELL R*
TIME R

MISS R
HELP R*
JOIN R
GIVE L*
YELL L*
BURN R
BURN L
LOOK R*
TIME L
LEAD L
LOOK L*
YELL R*
JOIN L
LEAD R
HAND L*
GIVE R*
HELP L*
TIME R
HAND R*
MISS L

YELL L*
HELP L*
BURN L
YELL R*
GIVE L*
TIME L
LEAD L
BURN R
LOOK R*
TIME R
MISS R
HAND R*
MISS L
HAND L*
LEAD R
JOIN L
LOOK L*
JOIN R
GIVE R*
HELP R*

APPENDIX B

GROUP 3 SHOCK PHASE

TALK R*
URGE R*
TALK L*
LEAD L
JUMP L*
TIME L*
YELL R
MISS R*
JUMP R*
HELP R
YELL L
SAIL R
MISS L*
SAIL L
IRON L
TIME L*
LEAD R
IRON R
URGE R*
HELP L

MISS R*
YELL L
MISS L*
YELL R
LEAD L
URGE R*
SAIL L
LEAD R
HELP L
JUMP L*
HELP R
IRON R
JUMP R*
TALK L*
SAIL R
TALK R*
TIME R*
IRON L
TIME L*
URGE L*

MISS R*
TALK L*
HELP R
TIME L*
MISS L*
TIME R*
LEAD L
YELL R
IRON R
JUMP R*
SAIL R
TALK R*
SAIL L
LEAD R
URGE R*
HELP L
JUMP L*
YELL L
IRON L
URGE L*

APPENDIX C

RECORD SHEET GROUP 1 TEST PHASE

R MISS___
*L READ___
*L TIME___
*R READ___
R YELL___
*L CAST___
*R EASE___
R BASE___
*R CAST___
L PART___
L LOOK___
L HAND___
*L MISS___
*R TIME___
*L EASE___
R LOOK___
R HAND___
L YELL___
L BASE___
R PART___

R BASE___
R LOOK___
*R EASE___
L BASE___
R PART___
*R TIME___
L PART___
*L EASE___
L YELL___
*L MISS___
*R CAST___
L LOOK___
*L CAST___
R HAND___
*L READ___
L HAND___
*R READ___
R YELL___
*R MISS___
*L TIME___

*R MISS___
*L EASE___
*L CAST___
*L READ___
*R TIME___
R YELL___
L PART___
*L MISS___
L YELL___
R HAND___
L BASE___
*R EASE___
L LOOK___
*L TIME___
R BASE___
L HAND___
*R CAST___
*R READ___
R LOOK___
R PART___

APPENDIX C

RECORD SHEET GROUP 2 TEST PHASE

R LEAD___
L BURN___
L MISS___
*L LOOK___
R JOIN___
L TIME___
*R YELL___
R MISS___
R BURN___
*L YELL___
*L HELP___
L JOIN___
*L HAND___
L LEAD___
*R GIVE___
*L GIVE___
R TIME___
*R LOOK___
*R HAND___
R JOIN___

*R HELP___
*L HELP___
L BURN___
*L YELL___
*L GIVE___
R BURN___
*R GIVE___
*R HAND___
*R HELP___
L JOIN___
R TIME___
*L HAND___
*L LOOK___
L LEAD___
*R LOOK___
L MISS___
*R YELL___
R JOIN___
R LEAD___
*R HAND___

L TIME___
R MISS___
R BURN___
*R YELL___
R TIME___
L LEAD___
L MISS___
*L HELP___
*L LOOK___
R LEAD___
L TIME___
*R LOOK___
L JOIN___
*R HELP___
*L GIVE___
R MISS___
R BURN___
*L HAND___
*R GIVE___
*L YELL___

APPENDIX C

RECORD SHEET GROUP 3 TEST PHASE

R LEAD___
R IRON___
L SAIL___
*L URGE___
L HELP___
*R URGE___
R SAIL___
L IRON___
*R TALK___
L LEAD___
*L MISS___
*L TIME___
*L TALK___
L YELL___
*L JUMP___
*R URGE___
R YELL___
*R JUMP___
*R TIME___
R HELP___

*L MISS___
L HELP___
R IRON___
*R TALK___
*R TIME___
L SAIL___
*R MISS___
*L TALK___
R YELL___
*R URGE___
*L TIME___
*L JUMP___
R LEAD___
R HELP___
R SAIL___
L YELL___
L LEAD___
L IRON___
*L URGE___
*L TIME___

R SAIL___
L HELP___
*R TALK___
*L TIME___
*R JUMP___
*L TALK___
L LEAD___
R HELP___
L IRON___
*R MISS___
*R URGE___
*L URGE___
*L MISS___
R YELL___
R IRON___
L SAIL___
L YELL___
*L JUMP___
*R TIME___
R LEAD___