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 communica-

tion. 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.