12-1971

The Effects of Diagonal Band of Broca Lesions upon Pain-Elicited Fighting and Water Intake

David A. Nolley
Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses
Part of the Experimental Analysis of Behavior Commons

Recommended Citation
https://scholarworks.wmich.edu/masters_theses/2915

This Masters Thesis-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Master's Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
THE EFFECTS OF DIAGONAL BAND OF BROCA LESIONS UPON
PAIN-ELICITED FIGHTING AND WATER INTAKE

by

David A. Nolley

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
December 1971
ACKNOWLEDGEMENTS

The author would like to express sincere appreciation to Dr. Frederick P. Gault, chairman of the thesis committee, for his instruction and advice during the entire course of this thesis. Thanks are also to be given to Dr. Bradley Huitema and Dr. Ronald Hutchinson, the other members of the thesis committee, for their suggestions and constructive criticism. The author is also indebted to Miss Leta Hunt for help with the reliability measures and to Mrs. Judy Buelke for assistance with the final preparation of the manuscript.

Finally, I would like to thank my wife, Barbara, for her assistance, constructive criticism and patience during every portion of the thesis.

David A. Nolley
Masters Thesis M-3214

NOLLEY, David Allen

THE EFFECTS OF DIAGONAL BAND OF BROCA LESIONS
UPON PAIN-ELICITED FIGHTING AND WATER INTAKE.

Western Michigan University, M.A., 1971
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan

THIS DISSERTATION HAS BEEN MICROFILMED EXACTLY AS RECEIVED
PLEASE NOTE:

Some pages have indistinct print. Filmed as received.

UNIVERSITY MICROFILMS.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>ii</td>
</tr>
<tr>
<td>II</td>
<td>iii</td>
</tr>
<tr>
<td>III</td>
<td>iv</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>VI</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>VII</td>
<td>14</td>
</tr>
<tr>
<td>VIII</td>
<td>21</td>
</tr>
<tr>
<td>IX</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>27</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
LIST OF FIGURES AND TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE I</td>
<td>18</td>
</tr>
<tr>
<td>FIGURE I</td>
<td>19</td>
</tr>
<tr>
<td>TABLE II</td>
<td>20</td>
</tr>
</tbody>
</table>
INTRODUCTION

There is a marked difference in affective behavior resulting from lesions of the septal area and the amygdala. Septal lesions have generally resulted in hyperirritability and hypersensitivity to preoperatively neutral stimuli (Brady and Nauta, 1953; 1955; King, 1958). Conversely, the weight of evidence has suggested that lesions of the amygdala produce a relatively docile, hyposensitive animal (Ahmad and Harvey, 1968; Schreiner and Kling, 1953; Rosvold, Mirsky and Pribram, 1954; Weiskrantz, 1956; Shealy and Feele, 1957; King, 1958).

With respect to water intake, Grossman and Grossman (1963) reported that hyperdipsia resulted from posterior-ventral amygdaloid lesions. The effects, however, were not permanent unless the lesions were quite substantial. In the same study, electrical stimulation of the anterior amygdala increased water consumption, while stimulation of the posterior amygdala depressed water intake. Lesions of the medial amygdaloid nuclei resulted in profound adipsia (Collier and Gault, 1969). Grossman (1964) reported increased water drinking with chemical stimulation of the septal area. However, several authors have reported hyperdipsia after septal lesions (Harvey and Hunt, 1965; La Vaque, 1966; Kasper-Pandi, Schoel and Zysman, 1969) and suction ablations (Lubar, Boyce and Schaefer, 1968).

After Broca's (1878) description of the diagonal band as a part of the limbic lobe, a number of authors have referred to it as a fiber pathway between the amygdala and the septal area. Johnston (1915; 1923),
Loo (1931), Young (1936), Humphry (1936) and Fox (1940) traced, from the medial septal nucleus, medial diagonal band fibers to the anterior nucleus of the amygdala and a lateral component of the band to the globus pallidus. Fox (1940) notes that as the diagonal band of Broca (DBB) passes through the medial forebrain bundle, some of its fibers separate to compose the nucleus pre-opticus magnocellularis. The band then continues, ventral to the medial forebrain bundle, on to the amygdala.

The pronounced behavioral differences resulting from lesions of the septal area and the amygdala, together with the hypothesis that the DBB provides interconnections between the two areas, points to the proposition that the diagonal band may convey some influence of one of these structures over the other. This study presents data concerned with correlated changes in affective and water intake behavior resulting from lesions of the DBB and septal area. Pain-elicited fighting (Ulrich and Azrin, 1962) was used to measure changes in affective behavior, while daily water intake measures were made. Each pair of animals was used as its own control for the data reported.
METHODS AND PROCEDURES

Subjects

Thirty male, experimentally naive Sprague-Dawley rats, weighing between 180 and 310 grams at the initiation of the study, served as subjects. The animals were randomly assigned to pairs, concurrent with the requirements of the pain-elicited fighting paradigm. Data are reported for only fourteen of the fifteen pairs because severe post-operative debility was observed in one member of one of the pairs. Changes in water intake are reported for twenty-three of the subjects. The animals were housed individually and were allowed free access to ad lib food and measured quantities of water.

Surgical Procedures

All surgeries were conducted under clean but not aseptic conditions using sodium pentobarbital (40 mg/kg intraperitoneal) anesthetic. Atropine sulfate was used to reduce respiratory secretions. Subjects were placed in a Kopf\(^1\) stereotaxic instrument consistent with the procedure described by König and Klippel (1963). Burr holes were made in the skull at the appropriate coordinates for the specific operation after a midline incision was made and the periosteum retracted. In all cases, bilateral lesions were produced electrolytically using stereotaxically placed electrodes (Clay-Adams\(^2\) #00 insect pins, insulated with Formvar\(^3\), except for 0.5 mm at the tip), passing anodal DC through the uninsulated tip of the electrode. The lesion circuit was completed by a reference
electrode clipped to the ear bar.

For septal lesions, an angular approach was utilized, using the coordinates: anterior 7.1 mm, lateral 0.6 mm and 0.8 mm above zero (Konig and Klippel, 1963). Septal lesions were made by passing a current of 2.0 ma for thirty seconds. For DBB lesions an angular approach was employed to the coordinates: anterior 8.0 mm, lateral 0.2 mm and 2.0 mm below zero. A current of only 1.0 ma for 25 seconds was used because of the smaller size of the diagonal band relative to the septal area. For sham operates, electrodes were placed in the appropriate structure without passing current and then withdrawn.

Since the Konig and Klippel atlas was constructed upon rats weighing 150 grams, a correction for growth of the brain was made for the heavier rats used in this study, for coordinates which exceeded 1.0 mm from atlas zero. For rats weighing 200-245 grams at the time of surgery, 10% was added to the appropriate coordinates. For rats weighing from 250 to 305 grams, 15% was added. Animals weighing 310 to 385 grams required a 20% correction. Animals weighing 390 to 445 grams required a 25% correction. For those animals weighing over 450 grams, 30% was added to the appropriate coordinates.

In all cases, both animals in a pair were operated upon after an appropriate number of daily sessions was allowed for a baseline of behavior. Eighteen to thirty hours were allowed for recovery before the first post-operative measurements were made.

From five to twenty-three daily sessions were run previous to the first surgery, for normal pre-operative baselines. In the case of sequential procedures, seven to fourteen sessions were allowed after
diagonal band lesions and six to eight sessions after DBB sham lesions. Only the first six to ten sessions after septal lesions were used in the manipulation of the data, because of the transitory quality of the "septal syndrome" (Brady and Nauta, 1955; Yutzey, Meyer and Meyer, 1964). However, two of the pairs which received septal lesions as their second surgery were run up to fourteen sessions after their surgery. One of these pairs had previously received diagonal band lesions, the other had received sham DBB lesions.

With the exception of four pairs, all subject pairs were assigned their first surgery by a random method. The assignment of second surgeries, in the case of sequential procedures, depended upon the type of surgery given first. All pairs were generally run every day, approximately every eighteen to thirty-six hours.

At the completion of the experiment, the animals were sacrificed with an overdose of sodium pentobarbital and perfused intracardially with saline and 10% formol-saline. The brains were removed from the head, sectioned at fifty micra intervals and the lesions verified histologically using the method of Guzman-Flores, Alcaraz and Fernandez-Guardiola (1963).

Apparatus and Materials

Pain-elicited fighting sessions were run in a chamber with an effective fighting area of 9 1/4 x 9 1/2 x 12 inches. The chamber was positioned approximately three inches from a one-way mirror through which the experimenter viewed the subjects. Three walls of the chamber were constructed of 1/2 inch plywood, painted flat black on the inside.
to maximize contrast for photography. The fourth wall was constructed of 3/8 inch plexiglas. The floor of the chamber was constructed of eighteen parallel 1/8 inch stainless steel rods, approximately 1/2 inch apart at the centers. Chamber illumination was provided by a fifteen watt bulb, protected by a wire cage set high upon one of the plywood walls of the chamber. The hinged plexiglas top of the chamber had ten 1/2 inch holes drilled through it to provide ventilation. Scrambled foot shock was delivered by a Grason-Stadler E6070B shock generator/scrambler. Amperage delivered by the shock generator, though consistently the same during the usefulness of each pair, differed among pairs to demonstrate that the pain-elicited behavior was not specific to any particular level of current. Three pairs were run at 0.3 ma. Three pairs were run at 0.8 ma. Eight pairs were run at 1.3 ma.

During each session, 0.5 second shocks were delivered with a 15.0 second intertrial interval for a total of 120 trials, programmed by a Lehigh Valley 1436 digital Countdown Timer, two Grason-Stadler E1100H Running Time Meters and associated electromechanical circuitry. The experimenter in the observation room recorded fighting responses and trials during which fighting took place using hand operated micro-switches. Fighting responses and shock presentation were recorded on a Gerbrands cumulative recorder.

A duplicate recording system was used for sessions in which reliability checks were made, with the cumulative recorders measuring fight responses placed in another room such that there was no auditory feedback to contaminate the measures of reliability. The two observers...
sat side by side in front of the one-way glass to approximate an identical view of the animals in the chamber.

Dependent Measures

There were two dependent measures used to record fighting behavior. One was a simple binary measure: the presence or absence of fighting responses during each trial of each session, which was then converted to a percent measure of trials per session during which fighting occurred. The other was subjective measure of cumulative fighting responses during each session observed by the experimenter. Fighting responses were similar to those employed by Bryant (1969). A response was defined as contact made by the paws of one subject on the other subject inclusive of an area defined by a line between and just behind the ears and running diagonally and posteriorly to a point where the abused rat's elbow would rest when down and drawn in toward its body. Contacts were not counted if: a) the defined response area was contacted with the hind feet of the other subject; b) if the subject making the attack had one of its front paws on the grid, even though proper contact was being made with the other paw; or c) if the abused subject had not made at least one paw swipe at his attacker during that trial.

Water intake was measured in milliliters consumed daily and was measured approximately every twenty-four hours.
RESULTS

Affective Behavior

Diagonal band lesions consistently depressed fighting rate, as reflected by the percent of trials measure and the total cumulative number of fight responses, in all pairs. The diminution in aggressive behavior was abrupt, occurring during the first session after surgery. This occurred whether the lesion had been preceded by a normal baseline or one heightened by septal lesions. The depression was maintained throughout the seven to twelve post-DBB sessions used to establish a baseline prior to septal surgery.

In the pairs given diagonal band surgery after a septal baseline, the startle response, characteristic of the "septal syndrome" (Brady and Nauta, 1953), did not generally diminish until four to five daily sessions after the band of Broca surgery. Characteristic, however, of the pairs receiving DBB surgery after a normal baseline, these pairs consistently attempted to avoid facing each other by either facing a corner or arranging themselves such that they were facing opposite walls of the experimental chamber. This behavior was evident from the first session post-surgery and was observed to occur even after a strong startle response was elicited by the footshock during the early portion of the DBB baseline.

Two pairs were maintained on their DBB baseline without the septal surgery to gauge the long term effects of band of Broca surgery upon affective behavior. The depression in these pairs was maintained at
least twenty-one daily post-operative sessions. Between twenty-one and twenty-five sessions after the diagonal band surgery, both pairs again fought several sessions at their pre-operative rate. One pair, then, again approximated its diagonal band baseline while the other pair remained near its pre-operative rate of fighting.

As shown in Table 1, the subject-pairs given DBB sham lesions after an unoperated baseline showed no significant difference in either of the dependent measures. Their fighting was unremarkable when compared with their pre-operative baseline. The dominant-submissive relationships established during the pre-operative baseline in the experimental chamber did not change post-operatively, as did a number of those relationships established in pairs which received septal or band of Broca lesions.

All pairs given the septal surgery fought on a higher percent of trials when compared to their normal pre-operative baseline (ns). With the exception of pair Z, mean cumulative number of fighting responses were also higher (ns) after septal lesions. Normal pre-operative fighting in these subject-pairs, however, was so high that there may have been a diminished opportunity for the septal surgery to illustrate a change in fighting sufficient to reach significance. Since paw contacts of a specified topography were used as the criterion for fighting behavior, the enhanced startle exhibited by all septally lesioned animals for the first few sessions after surgery often prohibited proper positioning for paw contact in the defined response area.

As a case in point, septal lesions given after a sham DBB lesion
baseline resulted in significantly higher percent of trials in which fighting occurred and cumulative fighting responses when compared with the sham diagonal band baseline. None of the sham pairs had fought with either as high a percent of trials or cumulative responses, pre-operatively, as the pairs given septal lesions after a normal baseline. In all other respects, the behavior of the animals given septal lesions after band of Broca sham lesions mimicked the affective behavior of the animals with septal lesions given after a normal baseline. The characteristics of pain-elicited fighting prior to and subsequent to septal lesions have been adequately described by Bryant (1969).

Septal lesions given after diagonal band lesions raised both affective dependent measures to an extent approximating that observed in subject-pairs lesioned after a pre-operative or sham DBB baseline. However, as depicted in Figure 1, this heightened fighting was quite transitory, lasting not more than two sessions in two of the pairs and not more than five sessions in the other two pairs. Both affective measures then approximated and remained at the DBB baseline until the animals were sacrificed. Unfortunately, there were insufficient data to statistically compare this group with an adequate control group.

Measures of the reliability of the observation technique were gathered at least once during each baseline period for each pair of animals. The Person Product-Moment correlation between the percent of trials fighting occurred tallied by the two observers was .978. The correlation between the cumulative number of responses observed was .989.
Water Intake

As shown in Table 2, diagonal band lesions given as a first surgery, given after a septal baseline, and compared with DBB sham surgery increased water intake significantly. Only one of fifteen subjects failed to increase daily water intake subsequent to the band of Broca surgery. Eight of these subjects increased their intake on the day following their surgery. Two of these eight subjects had received their DBB surgery after a pre-operative baseline. In these animals, water intake began to fall after four days, eventually approximating the pre-operative intake. The water intake of the other six subjects, those that had received their DBB lesions following a septal baseline, did not deviate from the elevated level until they were sacrificed and perfused.

In six of these fifteen animals, an increase in water intake did not begin until two to four sessions after the band of Broca surgery. The intake then remained at this elevated level in three of these six subjects while it fell to the pre-operative level in the other three animals. There was no systematic correlation between type of pre-operative baseline and consumption of water in these six animals.

In seven of twenty-three subjects, there was an increase in water intake following septal lesions. Five of these seven animals began drinking at elevated levels by the first post-operative day; the other two increased their intake two to four days after surgery. Four of these subjects continued to drink at an elevated level until they were either sacrificed or given their second surgery. There was no
systematic correlation between type of pre-operative baseline and consumption of water in these seven subjects. The differences between the pre-operative and DBB sham baselines, the pre-operative and septal baselines, the DBB sham followed by septal baselines and the diagonal band followed by septal baselines did not reach significance.

Histological Verification

Lesion placements are not reported for two subjects whose brains received extensive destruction, presumably as a result of the perfusion procedure. Partial reconstruction of lesion damage is available for sixteen of the remaining twenty-eight animals. In four animals, cortical infection invaded the radiation of the corpus callosum.

In animals with septal lesions only, there was bilateral destruction of the anterior portions of the medial and lateral septal area in all animals, with posterior septal destruction in two subjects. In rare instances, the anterior portion of the fornix, the cortical portion of the columns of the fornix, the precommissural fornix, the septo-hypothalamic tract, the nucleus of the stria terminalis, the genu of the corpus callosum, the corpus callosal tract, the triangular septal nucleus, the hypothalamic tract and the hippocampal commissure were damaged.

In animals with diagonal band of Broca lesions only the nucleus and tract of the diagonal band were destroyed in all subjects. In one or two animals each, the lesions invaded the medial forebrain bundle, the medial preoptic nucleus, the anterior commissure and the nucleus of the stria terminalis.
In animals that received both septal and diagonal band lesions, destruction of these structures was as described above. Less frequently involved structures were the corpus callosum, the septo-hypothalamic tract and the medial preoptic nucleus. In one or two animals each, there was involvement of the nucleus of the stria terminalis, the lateral preoptic nucleus, the medial forebrain bundle, the hippocampus pars anterior, the supra-chiasmatic preoptic nucleus, the periventricular preoptic nucleus, the genu of the corpus callosum, the nucleus accumbens, the anterior commissure, the superior portion of the fornix and the columns of the fornix. In three of the subjects, the posterior lateral septal area was also destroyed.
DISCUSSION

There are ample data (Schreiner and Kling, 1953; 1956; Weiskrantz, 1956; Shealy and Peele, 1957; King, 1958; Reynolds, 1965) to demonstrate that amygdaloid lesions produce deficits in affective behavior, particularly when placed in a "social" environment, although Spiegel, et al. (1940), Bard and Mountcastle (1948) and Bard (1950) have presented conflicting observations. Most of the ablation studies dealing with the amygdala, however, have involved the entire amygdaloid complex, a factor which has contributed to the confusion regarding the influence of this structure upon affective behavior. Studies which have attempted to delimit more precisely the nuclear masses involved and correlate the behavioral changes with selective partial destruction of the amygdala have contributed a great deal towards resolution of some of the confusion. Green, Clemente and de Groot (1957), after an extensive analysis of the amygdala, were able to confine their results which showed hypoactivity and hypoirritability to lesions of only the anterior amygdala.

One of the two efferent terminuses of the diagonal band of Broca is in the anterior amygdala (Johnston, 1915; 1923; Loo, 1931; Young, 1936; Humphry, 1936; Fox, 1940). The present study has shown that diagonal band lesions clearly mimic the effects of anterior amygdala lesions with respect to the depression of irritability and pain-elicited aggression, even when this type of affective behavior has been heightened by septal lesions. The abject lethargy reported by Green,
et. al. (1957) after lesions of the anterior amygdala was not observed in these subjects given diagonal band lesions.

Because of its rich connections with subcortical structures, several investigators have suggested that the chief function of the amygdala is a modulatory one (Bard and Mountcastle, 1948; Gloor, 1955). Further evidence for this position is suggested here. There is the implication that the nucleus of the diagonal band of Broca shares the function of modifying affective behavior with a number of other subcortical structures including the septal area (Brady and Nauta, 1953; 1955; King, 1958), the hippocampus (MacLean and Delgado, 1953; Naquet, 1954), the cingulate gyrus (Smith, 1944; Ward, 1948; Bard and Mountcastle, 1948) and the hypothalamus ( Hinsey, 1940; Egger and Flynn, 1964). It is proposed that this mitigating influence of the diagonal band upon irritability or rage is then modulated by the anterior portion of the amygdala. That the band of Broca lesions did not result in the "clay-like rigidity" reported by Green, et. al. (1957) after anterior amygdaloid lesions, gives this interpretation some weight and suggests that the depression in affective behavior modulated by the amygdala is influenced by one or a number of other structures aside from the band of Broca.

Further support for this proposition is provided by Bryant (1969) and Rosvold, et. al. (1954) who indicated that lesions of the amygdala exerted a profound influence upon aggressive behavior. Bryant was able to reduce pain-elicited fighting in rats 60% to 90% after normal pre-operative baselines and heightened septal baselines. Rosvold, et. al. reported that their amygdalectomized monkeys never emitted aggressive
responses towards other monkeys in a social situation after their surgery. The diagonal band lesions in this study rarely reduced pain-elicited fighting more than 60%.

In addition, Bryant gave his amygdalectomized subject-pairs septal lesions, after stabilization of their amygdaloid baseline, with the result that no differences in these pairs' depressed rate of fighting was observed. As shown in this study, septal lesions given after a diagonal band baseline of aggression can again raise the frequency and intensity of pain-elicited aggression, if only for a transient period.

In every case, depression of affective behavior after diagonal band lesions that was not as severe as that observed in most of the subject-pairs, was correlated with lesion damage which had invaded the nucleus of the stria terminalis. According to Fox (1943), the stria terminalis in cats contains exclusively efferent fibers which arise from the cortical-medial amygdala and are distributed primarily to the septal, preoptic and hypothalamic areas. Reynolds (1965) proposes that the "septal rage" is a function of incidental damage to other structures. Though the use of affective measures other than emotionality ratings and checklists have give additional credence to the persistence of hyperirritability resulting from septal lesions (Wetzel, Conner and Levine, 1967; Bryant, 1969), there is the implication that the stria terminalis, as a afferent input to the septal area, assumes either one of two functions. There is the possibility that it functions in a primary position in altering affective behavior mediated by the septal area, or it may carry an influence upon the septal area from those
portions of the amygdala which have been shown to influence affective behavior. In either case, lesions which invaded the stria terminalis may have had an effect upon the affective measures employed in this study.

Partial reconstructions were made of the lesions of six of the seven subjects that showed an increase in water consumption after septal lesions. In five of these subjects, the septal lesions invaded the posterior portions of the lateral septal area. In none of the other septal lesions performed, was there damage to the posterior septal area. These results are consistent with those of Lubar, et. al. (1968). Kasper-Pandi, et. al. (1968), however, were unable to show a pattern of damage within the septal area consistently associated with hyperdipsia, though they consistently produced hyperdipsia with septal lesions. Their results are consistent with those reported by Harvey and Hunt (1965) and La Vaque (1966). In the twenty-three animals in this study that received septal lesions, however, only the seven previously cited became hyperdipsic after septal lesions.

It has been shown that the diagonal band of Broca arises in the medial nucleus of the septal area (Johnston, 1915; 1923; Loo, 1931; Young, 1936; Humphry, 1936; Fox, 1940). Only one subject of the fifteen in this study given DBB lesions failed to show an increase in water intake. It is proposed that, via interconnections with the medial septal area, the posterior septal area influences the diagonal band with respect to drinking behavior, and that the effects of septal lesions upon water intake are primarily those of the posterior lateral septal nuclei.
<table>
<thead>
<tr>
<th>Treatment Comparisons</th>
<th>obt. t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal lesions followed by DBB lesions</td>
<td>15.15</td>
<td>3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Preoperative followed by DBB lesions</td>
<td>7.14</td>
<td>5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>*DBB lesions compared to DBB shams</td>
<td>10.02</td>
<td>8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>DBB sham followed by septal lesions</td>
<td>9.01</td>
<td>3</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>DBB lesions followed by septal lesions</td>
<td>Assumptions for statistical treatment of this group could not be satisfied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative followed by septal lesions</td>
<td>2.46</td>
<td>3</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Preoperative followed by DBB shams</td>
<td>1.74</td>
<td>3</td>
<td>&gt;.10</td>
</tr>
</tbody>
</table>

Table 1. Summary of changes in Affective Behavior. Tests are t-tests for difference between means using correlated samples except *, which is test using independent samples.
<table>
<thead>
<tr>
<th>Treatment Comparisons</th>
<th>obt. t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal lesions followed by DBB lesions</td>
<td>4.54</td>
<td>8</td>
<td>&lt; .002</td>
</tr>
<tr>
<td>Preoperative followed by DBB lesions</td>
<td>2.74</td>
<td>5</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>*DBB lesions compared to DBB shams</td>
<td>3.26</td>
<td>12</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>DBB shams followed by septal lesions</td>
<td>.40</td>
<td>7</td>
<td>&gt; .50</td>
</tr>
<tr>
<td>DBB lesions followed by septal lesions</td>
<td>.66</td>
<td>5</td>
<td>&gt; .50</td>
</tr>
<tr>
<td>Preoperative followed by septal lesions</td>
<td>1.27</td>
<td>8</td>
<td>&gt; .20</td>
</tr>
<tr>
<td>Preoperative followed by DBB shams</td>
<td>.14</td>
<td>7</td>
<td>&gt; .50</td>
</tr>
</tbody>
</table>

Table 2. Summary of Changes in Water Intake. Tests are t-tests for difference between means using correlated samples except *, which is test using independent samples.
FOOTNOTES

1 Kopf Instruments, Tujunga, California
3 General Electric, Bridgeport, Connecticut
4 Grason-Stadler, West Concord, Massachusetts
5 Lehigh Valley Electronics, Fogelsville, Pennsylvania
6 Harvard Apparatus Company, Dover, Massachusetts


Bryant, J.H., Effects of septal and amygdaloid lesions on pain-elicited


Fox, C.A., Certain basal telencephalic centers in the cat. *Journal of Comparative Neurology*, 1940, 72, 1-62.


Guzman-Flores, C., M. Alcaraz and A. Fernandez-Guardiola, Rapid procedure to localize electrodes in experimental neurophysiology.


Johnston, J.B., The cell masses in the forebrain of the turtle, Cistudo carolina. *Journal of Comparative Neurology*, 1915, 25, 393-481.

Johnston, J.B., Further contributions to the study of the evolution of the forebrain. *Journal of Comparative Neurology*, 1923, 35, 337-481.


5, 409-410.

Loo, Y.T., The forebrain of the opossum, Didelphis virginiana, Part II.
Journal of Comparative Neurology, 1931, 52, 1-148.

Lubar, J.F., B.A. Boyce and C.F. Schaefer, Etiology of polydipsia and
polyuria in rats with septal lesions. Physiology and Behavior,

MacLean, P.D. and J.M.R. Delgado, Electrical and chemical stimulation
of frontotemporal portions of limbic system in the waking animal.
Electroencephalography and Clinical Neurophysiology, 1953, 5,
91-100.

Naquet, R., Effects of stimulation of the rhinencephalon in the waking
cat. Electroencephalography and Clinical Neurophysiology, 1954,
6, 711-712.

Reynolds, R.W., Equivalence of radio frequency and electrolytic lesions

Rosvold, H.E., A.F. Mirsky and K.H. Pribram, Influence of amygdalecetomy
on social behavior in monkeys. Journal of Comparative and

Schreiner, L., and A. Kling, Behavioral changes following rhinencephalic

Schreiner, L. and A. Kling, Rhinencephalon and behavior. American

Shealy, C.N. and T.L. Peele, Studies on amygdaloid nucleus of cat.
Journal of Neurophysiology, 1957, 20, 125-139.

Smith, W.K., The results of ablation of the cingular region of the


