INTERNAL AND EXTERNAL CUE UTILIZATION
FOLLOWING SEPTAL ABLATION IN THE RAT

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KENNETH EUGENE KRATZ

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Department of Psychology

KANSAS STATE UNIVERSITY
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Approved by:

James C. Mitchell
Major Professor

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Acknowledgements

Depending on the nature of the behavioral task, an animal may have many differential cues available which allow him to perform the required behavior. These cues can loosely be placed into two rather broad groupings: internal and external. External, often called exteroceptive, are those cues which impinge on the organism from his external environment (e.g., visual, auditory, olfactory). Such cues are easily definable since they are usually clearly observable characteristics of the external environment.

Internal cues, often called interoceptive and proprioceptive, are those cues which are produced within the organism. As such, these cues are more difficult to define than external stimuli. Clearly, somatomotor cues would be considered internal and could provide differential information in terms of a maze task. Amount of physical exertion could certainly be utilized in performing a two bar ratio task. However, a DRL task, which demands the use of an internal cue to discriminate the passage of time, does not lend itself to an obvious analysis of the nature of such cues.

A normal animal may use, to one degree or another, internal and/or external cues to solve a particular behavioral task. The question can be asked, however, to what extent animals with brain damage utilize internal and/or external cues and whether or not they differ in this respect from normal animals in the performance of the same behavioral task. The literature concerning septal lesions suggests that this is an important question;

the first indication coming from the observation that rats with septal lesions react differently than normals to external stimuli.

Brady and Nauta (1953) describe their observations of "septal rage" in terms of general hyperreactivity. Douglas and Raphelson (1966a) suggest that rather than general hyperreactivity, rats with septal damage show increased activity to only novel stimuli. Lints and Harvey (1969) report that septal lesions have the effect of lowering the jump threshold or increasing sensitivity to shock. Beatty and Schwartzbaum (1967; 1968) also report that rats with septal lesions show increased reaction over normals to sucrose (more licks) and to quinine (fewer licks). Green, Beatty, and Schwartzbaum (1967) reported that rats with septal lesions are hyperresponsive to light. Ellen and Bate (1970) later demonstrated that this same observation extends to the Dashiell maze behavior of rats with septal lesions in that they show an aversion for the white pathways, and a preference for dark pathways.

Recent work by Schwartzbaum, Kreinick, and Levine (1972) and Schwartzbaum, DiLorenzo, Mello, and Kreinick (1972) has shown that there seems to be a dissociation, caused by the septal lesion, between behavioral reactivity and the averaged visual evoked response (VER). The VER is a measure of electro-cortical arousal to photic stimuli, the development of which can be correlated with habituation of behavioral reactivity. Essentially, they find that behavioral reactivity to a light flash does not habituate after septal ablation, but that the VER shows the normal changes accompanying repeated pre-

sentations of the light flash. In other words, the animal's behavior does not accurately reflect what is happening in terms of cortical arousal to photic stimuli. All of these studies indicate that the septal animals reactivity to stimuli is in some way altered.

Other research which relates to cue utilization by the rat with septal ablation follow three patterns: timing behavior, two-bar ratio behavior, and alternation and reversal learning studies. Ellen, Wilson, and Powell (1964) observed that rats with septal lesions were less efficient than normal animals on a DRL schedule in that they apparently could not inhibit their responding so as to allow the proper lapse of time between responses. Ellen and Butter (1969) later demonstrated that the septal animal could in fact efficiently perform on a DRL schedule if an external cue, signifying the end of the interval, was available to the rat. Ellen and Butter postulate that the septal animal is deficient in his capability to monitor or utilize response produced or internal cues. They suggest that this deficiency either handicaps the animal in using response produced stimuli as discriminative stimuli for lever pressing or as reinforcing stimuli for maintenance of collateral behaviors to help them bridge the time delay properly.

Slonakaer and Hothersall (1972) further demonstrate that the septal lesioned rat is capable of efficiently performing a DRL task if it is provided with some external stimuli to facilitate development of collateral

behaviors. In this study the investigators discovered that if the animal

was provided with a block of wood or piece of cardboard to chew, so as to

structure and facilitate development of collateral behaviors, the septal

animal could adequately bridge and determine a time interval.

Van Hoesen, MacDougall, Wilson, and Mitchell (1971) found, however,

that rats with septal lesions could not perform a discrete trial DRL task

as well as operated controls. In this bar press task levers were retracted

and reinserted signifying the beginning of the DRL interval. The investiga-

tors hypothesized that such a discrete external stimulus should facilitate

performance. Contrary to expected results, septal animals still showed

deficits in acquisition of the task even with signaling of the beginning

of the interval. Morgan and Mitchell (1969) have reported that septal

animals could estimate a time interval on a free operant avoidance schedule

in which a foot shock was delivered every 20 seconds if no response was

made. The investigators discovered that the septal animals could actually

perform more efficiently on the task in terms of number of responses made

and number of shocks received. This evidence would seem contrary to Ellen's

and Butter's conclusions, in that the Van Hoesen, et al study presented an

external stimulus which did not facilitate performance on a DRL task, and

in the Morgan and Mitchell study septal animals could determine accurately

a time interval using only internal cues. Obviously this second study

involves a motivational difference which must be considered before any

conclusions can be made.

The studies discussed above all deal with timing behavior; a behavior closely connected to an animal's ability to utilize internal cues to signal the end of a time interval or in structuring collateral behaviors to help bridge the time interval. Another variety of research which examines internal cue utilization is two-bar ratio studies. This particular task demands that the animal make a certain number of responses on one lever and then shift to another lever to receive reinforcement. In this task it is important that the animal can determine how many bar presses have been made on one lever before pressing the other lever. Ellen and Butter's conclusion is further supported by the two-bar ratio study of Ellen and Kelnhoffer (1971). Here the investigators report that the septal animal is less efficient on the two-bar ratio task and conclude that the septal animal has a response-produced cue feedback deficit analogous to that seen in the timing behavior. Van Hoesen, MacDougall, and Mitchell (1972) interpret their two-bar ratio data to indicate that the septal animal is utilizing response-produced cue feedback to perform efficiently on the task, especially when required to shift from one ratio to another. The investigators show that the septal animal is approaching the task differently than the normal, but remains efficient in performing the task.

The last line of evidence to be discussed, alternation and reversal studies, looks more directly at this question of differences in cue

utilization between normal animals and animals with lesions of the septal

area. Douglas and Raphelson (1966b) demonstrated that rats with septal

lesions unlike normal rats do not demonstrate spontaneous alternation in a

T maze. Examining this behavior more closely, other investigators have

shown that septal animals, depending on the stimulus situation, demonstrate

systematic choice behavior in alternation tasks. Clody and Carlton (1969)

report that septal animals will alternate both T and X mazes at chance level

if the mazes are positioned in the dark. In a light situation the animals

show significantly less alternation. The investigators discovered that in

an X maze septal animals alternated body turns so that they ended in the

same arm of the maze. Dalland (1970), using a T maze with highly discrim-

inable arms and a reversable start arm, also found that septal animals would

perseverate by responding to the same external stimuli.

These studies led Thomas (1972) to a thorough investigation of spon-

taneous alternation under various stimulus conditions. Using a T and X

maze Thomas was able to successfully manipulate visual, olfactory, vestibu-

lar, and response-produced cues. By maze arm reversal, maze floor reversal,

or animal rotation Thomas was able to determine that septal rats consistently

choose to respond to external sensory rather than internal somatomotor cues;

whereas normal animals choose to respond to the latter.

Although the spontaneous alternation studies do not deal with learning

or discrimination tasks it is apparent that the septal animals behavior in

this situation is different from the normal animal's behavior, since they are controlled by different kinds of stimuli. Schwartzbaum and Donovick (1968) have shown that position discrimination reversal as opposed to a comparable brightness discrimination reversal is retarded by the septal ablation; indicating that external visual information may be more salient than internal position information to the experimental animal on this particular task. These results are analagous to the findings of Thomas (1972). An important issue from both the Schwartzbaum and Donovick study is that a true discrimination task is used and not merely a spontaneous alternation activity.

Considering the evidence which has been presented from the timing tasks, two-bar ratio studies, and alternation and reversal learning studies, one may conclude that in the rat, the septal lesion causes a differential effect with respect to internal and external cue utilization. Further it appears that this effect forces the septal rat to rely on external stimuli as more salient cues. Normal animals in the same situation when provided with differential internal stimuli can utilize such cues as salient information. The purpose of this study then, was to further examine internal and external cue utilization following septal ablation.

A circular chamber was constructed with three levers placed around the circumference of the chamber. This provided a task where the pattern of behavior in a response chain could be analysed. Initially the animal could

perform the response chain by utilizing external sensory information (cue lights) and/or internal proprioceptive information. These two sets of cues were therefore redundant with respect to the differential information they provided about the task. The animals were then tested for their reliance on these two sets of cues by placing the external and internal cues in opposition during extinction. The cue lights now moved in the opposite direction around the chamber, placing this information in conflict with the pattern of the previously reinforced internal cue information.

Method

Subjects

The subjects were 20 experimentally naive, male, Long-Evans hooded rats,

approximately 150 days of age and weighing 200 to 300 grams. All rats were

maintained on ad lib laboratory chow, and a 23-hour water deprivation schedule.

Surgery and Histology

All operations were conducted under Equi-Thesin anesthesia. Septal

lesions were made electrolytically by passing 1.5 mA anodal current for 20 sec-

onds through a 30 gauge stainless steel electrode, insulated except for a

.5mm bare tip. The circuit was completed with a rectal cathode. Coordinates

were measured in millimeters from bregma, midline, and top of the skull,

with the head at a 5-degree angle to the horizontal plane (nose up). Bila-

teral electrode insertions were made at 1.7 A, 0.5 L, and 6.0 D. 30,000

units of Flocillin were administered postoperatively.

As a control for incidental damage to the auditory system as a result

of ear-bar insertion, animals of the normal control group were also placed in

the stereotaxic apparatus. No further surgical treatment was given.

Following behavioral testing all rats were anesthetized and perfused

intracardially with 0.9% saline and 10% formalin. After extraction, all

brains were fixed in formalin, and the brains of lesioned animals were

dehydrated in pyridine, and embedded in celloidin. Coronal sections 20

micra thick and 60 micra apart were cut and then stained with cresyl violet.

Brains of the normal animals were given gross inspection to check for damage

to the septal area.

Apparatus

A gray plastic, circular operant chamber designed to minimize spatial

cues was used. The chamber was 23 inches in diameter and had three levers

placed equidistant around the circumference of the chamber with a white cue

light placed above each lever. Water reinforcement was presented in a small

depression tooled into a circular piece of brass, located in the center of

a black painted fiberboard floor. Diffuse illumination was provided indir-

ectly by four 25 watt bulbs. The test chamber was located in a sound

attenuating chamber built of 3/4" plywood lined with accoustical tile.

A blower provided ventilation and background noise within the sound attenu-

ating chamber. Each bar response was recorded by a three channel event

marker. Responses were also sequentially recorded on paper tape, punched

by a Teletypewriter.

Procedure

Subjects were divided into four groups of five animals each. Two of

the groups were given bilateral lesions of the septal area. One normal (N)

and one septal (S) group were trained to a criterion of 250 reinforcements

(designated a) on a chained behavior in which the animals were required to follow the cue lights above the three levers in a right-going sequence for two rotations around the chamber before receiving reinforcement. The other normal and septal groups were trained to a criterion of 500 reinforcements (designated b) on the same task.

Shaping and discrimination training: During initial shaping and discrimination training a V-shaped metal divider was placed in the chamber to further limit the training space to one lever and the reinforcement cup. Animals were shaped to bar press in the presence of a cue light over the lever. After 150 bar presses on continous reinforcement the animal was brought under stimulus control of the cue light. In this procedure the cue light was presented only after the animal had refrained from making a lever press for 20 seconds. The first lever press, after the cue light came on, resulted in reinforcement and also turned the cue light off.

Following 150 reinforcements on this schedule, the divider was removed, and the cue light was lit over one of the three levers. A bar press at this lever resulted in reinforcement, with the cue light again being lit at random over one of the three levers. If an incorrect response was made, reinforcement was not delivered and the cue light remained on over the correct lever.

Chained behavior training: Training of the chained behavior was then begun, and consisted of three phases. First, the animals were given 50

reinforcements for performing a chain in which they were required to press

lever one (R_1) when the cue light over that lever was lit (S_1). The light

over lever two was then lit (S_2) and the animal was required to press

lever two (R_2). The cue above lever three then came on (S_3) and the animal

was required to press lever three (R_3), at which time a reinforcer (S^R) was

delivered and the sequence was started again $(S_1\text{-}R_1\text{-}S_2\text{-}R_2\text{-}S_3\text{-}R_3\text{-}S^R)$. In-

correct response were not reinforced, nor did they change the position of

the cue light. During the phase of the training the cue lights came on

immediately following the previous response in the chain.

The second phase of this training was similar to the first phase ex-

cept that a two second delay was instituted between the lever press and

lighting of the next cue light. Bar presses to the correct lever during

the two second delay resulted in reinforcement. Phase two continued for

50 reinforcements.

At this time, a third phase began in which the animals were required

to perform two complete sequences of the phase two, right-going response

$(S_1\text{-}R_1\text{-}S_2\text{-}R_2\text{-}S_3\text{-}R_3\text{-}S_1\text{-}R_1\text{-}S_2\text{-}R_2\text{-}S_3\text{-}R_3\text{-}S^R)$. Daily 30 minute sessions were

run on this schedule until the animals reached their specified criterion

levels. The chained behavior could be maintained through the utilization

of two sets of cues; the cue lights or external cues and/or the internal

cues produced by the animal's right-going movements. During this portion

of the experiment internal and external cues were redundant with respect

to the differential information they provided.

Testing: Two test sessions of 30 minutes each were run during the two days following achievement of the criterion level. These test sessions were conducted in extinction with the cue lights following a left-going direction; opposite in direction of rotation to that of the acquisition training. This meant that during extinction testing, the pattern of the external cue lights was in conflict to the pattern of the previously reinforced internal cue information.

As an added control for differential cues, in addition to those provided by the external cue lights or internal cues generated by the animal's behavior, the starting position in the chamber was changed at the beginning of each day of training and testing.

Data Conversion

Since this study was concerned with cue utilization it was necessary to look at patterns of responses. Responses were recorded sequentially on paper tape during the last thirty minutes of acquisiton training and during the two extinction sessions. The extinction sessions were analyzed by dividing them in half on the basis of number of responses in that session. This provided four segments of testing during the extinction phase of the experiment.

A computer analysis provided a tabulation of overlapping blocks of

two consecutive responses into nine possible categories for each of the above sequences of behavior. Since three levers were available to the animal, considering them two at a time provided nine different categories of possible overlapping blocks (1,1; 1,2; 1,3; 2,2; 2,3; 2,1; 3,3; 3,1; 3,2). Therefore if a sample sequence of behavior (sequential lever responses) were (1,2,3,1); the first and second responses would have been tabulated in the category for (1,2)'s, the second and third response would have been tabulated in the category for (2,3)'s, the third and fourth responses would have been tabulated in the category for (3,1)'s. This procedure continued throughout the entire sequence of behavior to be analysed.

The nine categories were then combined into three response patterns or modes; based on the direction of responding in the circular chamber. These consisted of non-differentiated (ND) 1,1; 2,2; 3,3; right-going (R) 1,2; 2,3; 3,1; left-going (L) 1,3; 3,2; 2,1. The Non-differentiated patterns reflect responses made to the same lever. Right-going patterns reflect the direction and pattern of the reinforced chained behavior. Left-going patterns reflect the direction and pattern of behavior opposite to that of the reinforced chained behavior. The frequency of these three response patterns were then converted into a percentage of total overlapping blocks of responses for that particular sequence of behavior.

Results

Histological

All lesions were examined to determine the extent of damage to the septal nuclei and the amount of damage to neighboring structures. Septal lesions began in the vicinity of the genu of the corpus callosum and extended caudally to the descending columns of the fornix. Dorsally and ventrally, the lesions were confined to the area between the corpus callosum and the anterior commissure. Laterally, lesions were confined to the area between the lateral ventricles. Every lesion destroyed the major portions of the lateral and medial septal nuclei except in a few instances where the extreme ventral medial aspect of the septum was spared. Incidental damage to the corpus callosum, cingulate cortex, caudate, anterior commissure, and columns of the fornix was minimal or non-existent in all lesions. No differences were observed in the two groups of septally lesioned animals.

Data from two animals (S3a and S1b) were not included in any of the analyses as a result of histological examination of the brains. Although S3a's septal lesion was quite adequate by all standards, this animal suffered vast damage to the posterior neo-cortex. Dorsal lateral geniculate examination showed degeneration as a result of the cortical damage. S1b suffered only a unilateral septal lesion. Although some cells of the

contralateral septal nuclei appeared to be damaged, the damage was not

felt to be extensive enough to allow the inclusion of this animal's data

in the statistical analyses.

Behavioral

In order to examine differences between the three response mode alter-

natives (i.e., non-differentiated (ND), right-going (R), or left-going (L)),

the response modes were treated as repeated measures in analysis of variance

tests. The means of these data, as treated in these analyses are presented

in Table 1. The acquisition data yielded a reliable response mode main effect

($F=333.88$, $df=2/28$, $p<.01$). Inspection of the data shows that this effect

is due to the extreme percentage of right-going responses.

Since the within subject data for these scores (percentages) sum to

one, analyses of the extinction segments were conducted on the separate

normal and septal response mode data. For this same reason, criterion

levels were ignored in these analyses. An analysis of the first segment

of extinction resulted in no response mode effect for the normal group, but

a reliable response mode effect for the septal group ($F=13.70$, $df=2/12$,

$p<.05$). This was an indication that the septal animals but not the normal

animals showed a preponderance of one particular mode of responding.

Neither group, normal or septal, showed a reliable response mode effect dur-

ing the remaining extinction segments.

TABLE 1

Mean proportion of each of the three response mode categories for both normal and septal lesioned groups during acquisition (last 30 minutes of reinforced training) and the four extinction segments.

Group	Acquisition ND	L	R
N	.156	.072	.772
S	.111	.064	.825

Group	1st Extinction Segment ND	L	R	2nd Extinction Segment ND	L	R
N	.288	.329	.383	.316	.405	.279
S	.139	.334	.527	.184	.456	.360

Group	3rd Extinction Segment ND	L	R	4th Extinction Segment ND	L	R
N	.281	.391	.327	.352	.418	.229
S	.170	.438	.392	.206	.464	.331

N=Normal
S=Septal
ND=Non-Differentiated
L=Left-going
R=Right-going

As indicated above, the effect of the response mode alternatives variable was apparently due to the proportion of right-going responses. Statistical analyses were therefore conducted using the right-going percentage scores to test for a criterion and/or lesion effect. Mann-Whitney-U tests showed no differences between the percentages of right-going responses for the two criterion levels during acquisition or any of the extinction segments. In these analyses data of both normal and septal lesioned animals were combined for each criterion level. These data are presented in Table 2.

Mann-Whitney-U tests were also used to determine differences between the distributions of right-going response scores for the normal and septal groups (See Table 2). Criterion levels were considered together in these analyses. A comparison of the acquisition data for these scores showed no differences between the normal and septal groups. A test of the first extinction segment right-going response mode data demonstrated a reliable difference between the normal and septal groups (U=15, p<.05); indicating that the septal group showed a greater number of right-going responses than the normal group at this early point in the extinction situation. Analyses of the remaining segments showed no reliable differences due to the lesion manipulation.

The mean number of total lever responses during the various phases of the experiment are presented in Table 3. T-tests showed there to be no

TABLE 2

Percentage of Right-going responses (1,2; 2,3; 3,1) for each animal during each phase of the experiment. S1a made no responses during the second extinction session.

Subject	Acqui-sition	1st Ext. Segment	2nd Ext. Segment	3rd Ext. Segment	4th Ext. Segment
N1a	.820	.366	.493	.167	.000
N2a	.627	.253	.234	.095	.098
N3a	.734	.391	.185	.371	.433
N4a	.826	.600	.676	.500	.286
N5a	.845	.343	.113	.123	.037
N1b	.649	.230	.172	.212	.148
N2b	.833	.402	.367	.420	.130
N3b	.665	.336	.400	.423	.312
N4b	.848	.439	.345	.525	.325
N5b	.868	.758	.585	.432	.522
S1a	.802	.627	.571	---	---
S2a	.834	.423	.325	.361	.368
S4a	.881	.591	.402	.400	.353
S5a	.744	.536	.384	.318	.234
S2b	.948	.759	.675	.410	.175
S3b	.899	.812	.836	.646	.463
S4b	.627	.475	.389	.389	.400
S5b	.868	.382	.239	.218	.321

N=Normal
S=Septal
a=250 S^R (criterion)
b=500 S^R (criterion)

TABLE 3

Mean number of responses produced during each

phase of the experiment. Acquisition

refers to the last 30 minutes

of reinforced training.

| | To criterion | | | | |
Group	250 S^R	500 S^R	Acqui-sition	1st Ext. Session	2nd Ext. Session
N	2051	4293	350	219	118
S	2133	3976	587	230	120

N=Normal
S=Septal

differences between the normal and septal groups in terms of total number

of responses at either the 250 or 500 reinforcements criterion level. A

reliable difference between these groups was found, however, for the number

of responses emitted during the acquisition phase (last 30 minutes to

criterion). The septal group generated the greater number of responses

($t=2.83$, $df=17$, $p<.05$), and thereby showed a higher rate of responding.

Similar analyses for the first extinction session and second extinction

session showed there to be no reliable differences for these data.

As a result of the difference in rate of responding during acquisition,

a Spearman rho (r_s), rank correlation between the number of responses in

acquisition and the percentage of right-going responses during both the

first extinction session (first day of testing)($r_s=.38$, $df=16$, $p<.05$) and

the first segment of extinction ($r_s=.31$, $df=16$, $p<.05$) was calculated.

In both instances the correlation was not reliably different from zero,

indicating that acquisition rate had no effect on extinction behavior.

Discussion

The response mode difference data indicate that the animals with

septal lesions show a reliable difference in response modes during the

first part of extinction, whereas normal animals do not. Closer inspection

of the data as a result of this finding showed that this effect was due to

the high proportion of right-going responses in the septal group. That

the animals with septal lesions would show a greater number of right-going

responses was totally unexpected since this response mode is the pattern

of behavior indicative of internal cue control. Moreover, the finding of

a reliable difference between the normal and septal groups in terms of the

percentage of this response pattern during the early segment of extinction

testing is in contradiction to the initial hypothesis that the animals

with septal damage would rely on external information, and should therefore

have shown a greater proportion of left-going (light determined responses).

Since there was no difference between groups in the number of responses

emitted to reach criterion, the septal animals would not seem to be any

more efficient than the normal animals on the task. Still, it was suspected

that the higher rate during acquisition may have accounted for the dominant

right-going response pattern in the lesioned animals. The lack of correla-

tion between the number of responses emitted during acquisition (last 30

minutes) and the proportion of right-going responses during the first

segment of extinction however, discounts any effect of acquisition rate on the choice of response pattern during extinction testing.

It is interesting also that there were no differences between the normal and septal lesioned animals with respect to number of responses made during extinction. The literature has typically referred to the septal animal as perseverative during extinction. This was not found in the present study.

Another unexpected finding was the result showing that the normal animals did not display a high proportion of any one response pattern during extinction testing. This of course, is unlike the high number of right-going responses found in the animals with septal damage. A study by Mark (1964) using an apparatus similar to that used in the present study showed that normal animals displayed a dominant internally cued response pattern during a reversal of discriminative stimuli within a chained behavior scheme. Apparatus and procedural changes in the present study may account for the unexpected difference between the two studies.

Two plausible explanations of this particular finding seem worthy of mention. First, the normal animals may have extinguished very rapidly with respect to a dominant response pattern and reverted to a random type behavior. Should such a change have rapidly occurred, the measures used may not have been sensitive enough to demonstrate a dominant response pattern which may have occurred very early in testing. Further, if a subtle

external cue not apparent to the investigator were being used by the lesioned

animals, then this first explanation could account for the normal-septal

differnce during extinction. This does seem unlikely to the author,

however. Secondly, the normal animals may have displayed a random type

behavior during testing as a result of the two differential cue systems

being placed in opposition to each other. If the normal animals were using

both internal and external information to an equal degree during acquisi-

tion; their being placed in conflict during extinction may certainly have

led to confusion and random behavior patterns.

In light of this finding it would seem difficult to address these

results to the question of differences of degree of internal-external cue

utilization between normal animals and animals with septal damage. However,

a reliable difference was found between the normal and septal groups, in

that the normals display random behavior patterns and the animals with

septal ablations display a dominant right-going, internally cued response

pattern during extinction. This would seem to leave the proposed question

open, and still tenable in terms of degree of effect along an internal-

external dimension. Even though we have not been able to quantify this

effect, these data do indicate that the nature of the effect as proposed

in the introduction was certainly in the incorrect direction. Animals with

septal ablations apparently utilized internal over external cue information,

in this particular task where both types of cues were provided.

Further, these data do not support Ellen and Butters' (1969) conclusion that animals with septal damage suffer a response-produced cue feedback deficit. The present study, in conjunction with the Van Hoesen, et al (1972) study would seem to indicate that the brain damaged animals can in fact rely heavily on such internally cued information. It should be noted that two recent reviews (Lubar and Numan, 1973; and Caplan, 1973) propound a suggestion very similar to that proposed in the introduction to the present study. As a result of the findings reported here it would seem important that these suggestions be reconsidered and that further investigation along this line be pursued.

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INTERNAL AND EXTERNAL CUE UTILIZATION
FOLLOWING SEPTAL ABLATION IN THE RAT

by

KENNETH EUGENE KRATZ

B. A., Southern Illinois University, Edwardsville, 1969

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AN ABSTRACT OF A MASTER'S THESIS

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A test was conducted to determine whether rats with septal brain damage would depend heavily on exteroceptive information as a result of a proposed response-produced cue feedback deficit. Normal and septal lesioned rats were trained to perform a behavioral chain where both exteroceptive and response-produced cues could be used. During extinction, these two sets of cues were placed in conflict to determine their relative contribution to performance. Septal rats utilized response-produced cues whereas normal animals vacillated randomly in their use of available cues. It was concluded that normal and septal lesioned rats differed in their use of external and internal information but in a direction opposite to that suggested by the literature.