THE EFFECT OF NOVEL STIMULI ON

CATS REARED IN A RESTRICTED ENVIRONMENT[1]

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ABSTRACT

Cats were reared in an experience restricted environment until 7.5 months of age. Control littermates were reared normally. At 15 months, subjects were tested in three situations involving novel stimuli. Restrictively reared cats were inhibited in normal exploratory behavior; responded to physical restraint with marked passivity; and gave larger autonomic responses to brief tone stimuli. These findings support the notion that novelty has an unusually large impact on subjects reared in an experience restricted environment.

Numerous investigators have observed the behavior of restriction reared chimpanzees (Menzel, Davenport, & Rogers, 1963), dogs (Fuller & Clark, 1966; Melzack, 1954; Melzack & Scott, 1957; Melzack & Thompson, 1956; Thompson & Heron, 1954), and rats (Zimbardo & Montgomery, 1957). These reports suggest that novelty has an unusually large impact on subjects reared in an experience restricted environment. Under nonlaboratory conditions restricted animals (or any animal) can be expected to avoid precipitous confrontation with highly novel situations, and if somehow confronted, to escape. However, in the usual laboratory setting, restricted animals are presented with an overload environment precipitously, and with no possibility of physical withdrawal. In these circumstances, restrictively reared animals may engage in various forms of psychological withdrawal, e.g. freezing, stereotypy, which are incompatible with the behaviors demanded by the experimenter: exploration, problem solving, adaquate social responses, and the like. Even when the testing situation is only moderately novel, restricted animals may still perform badly by engaging in nonadaptive exploration.

The purpose of this present study is to investigate the effect of a specifically novel situation on the behavior of restrictively reared cats. In particular we have tested the

hypothesis that full approach and "relaxed" behavior might
occur only after repeated exposures. On a more molecular
level, we have also studied the autonomic orienting responses
of the same subjects to repeated presentations of a simple,
discrete stimulus.

METHOD

Subjects.

The subjects of these experiments were cats, drawn
from a total of five litters. When a litter of kittens was
born, each half-litter was assigned randomly to the Control
(C) or to the Restricted (R) rearing condition.

Control Rearing.

Animals assigned to this condition were left with
their mothers until the normal time of weaning (at about 6
weeks of age) when they were placed together in a large cage
(6'x4'x2'). The cage was open wire mesh on three sides and
was outfitted with shelves, ramps, and toys. Up to the age
of seven months the C Ss were taken from their living cage
for play and handling several times a week. The C group
contained four females and one male. A fifth female (a
housepet of comparable age) was added to the C group when
it was eight months old.

Restricted Rearing.

Restricted subjects were taken from their litters at 1 to 12 days of age, and placed individually in cages (26" x 20" x 14"). Until 2 weeks of age, each kitten was aided by E in feeding from a nipple protruding into the cage. As well, Ss were stroked on their underbellies to aid the elimination of urine and feces. After 2 weeks of age, all Ss maintained themselves without help from E. Ss were gradually shifted to solid food when they were about 5 weeks old. A light bulb (40 watt) was mounted on an inside wall of each cage. One way observation of Ss was possible through a piece of heavy cloth mounted in the front cage wall, behind a removable panel. Until the animals were about 10 days old, light was on continuously to maintain a cage temperature of about 35°C. After this time light was cycled daily: 10 hours on, 14 hours off. Control Ss received the same schedule of light-dark from birth on. Noises from outside the restriction cages were reduced by insulated cage walls and partially masked by an exhaust fan mounted in a side wall of each cage. Each isolation cage was joined to another similar cage. Movement from one to the other was via sliding door. After 2 weeks of age Ss were required to change cages every third day by way of the

sliding door. While living in one cage, the adjoining cage was cleaned and restocked with food. The cats quickly learned to move to a fresh cage when the slide door was opened. With two exceptions, R animals had no contact with the outside world (E, other animals, etc.) from the age of 2½ weeks to age 30 weeks, when the restriction rearing was terminated. The two exceptions were: 1) all R cats were weighed at the age of 3 weeks, and 2) all cats were weighed and given distemper shots at 10 weeks of age. On final removal from isolation, the R animals were placed (2 to a cage) in lab cages situated in the same room with the C animals, who remained together in their large rearing cage. Handling and opportunities for new experience outside their living quarters from this point on were comparable for the two groups. At the time of the experiments reported here, subjects had been removed from their rearing conditions per se, some 8 months, and were about 15 months old.

EXPERIMENT I

In this experiment, restrictively and normally reared cats were observed when they were given the opportunity to approach and explore an unfamiliar room and its contents.

Method

The behavior of nine animals was observed (4 R, 5 C). All subjects were female. The one C male was excluded before testing, on the ground that if he left territorial urine markings in the test room, these might differentially effect the two experimental groups. The novel room measured 6' x 5'. It contained a ramp and 2' high platform - both cloth-covered, a cloth-covered wire cylinder (22" x 11" diam.), four twisted pipe cleaners placed around on the floor, a ball hanging from a string about 6" off the floor, and the start cage (15" x 9" x 8") with mesh sides and top. Lighting was provided by flourescent bulbs in the ceiling.

Each S was observed thru a one-way glass for 15 minutes on twelve consecutive days. The subjects were removed together from their living cages every morning, before being fed for the day. The order of observation was randomized by group on the first day, and then systematically shifted over the 12 days of testing. Before the start of an observation period S was placed in the start cage, which was covered with a cloth and placed at a standard location to one side of the novel room. The door and cloth cover of the start cage were removed by a rope system from outside the room. As the cloth cleared the cage scoring began and continued for 15 minutes.

Scores were obtained for three aspects of behavior: approaching the novel room, exploring in the room, and play in the room. Approach was defined as the latency to leave the start cage (time from start of session until all four paws of S are out and on the floor). Exploration comprised standing, locomoting and climbing. Play included any of the following: (a) playing with objects, e.g. pipe cleaners, (b) rubbing any part of body against objects, including the floor, and (c) claw pulling in cloth. Since these behaviors are generally episodic over short periods of time, behavior was continuously scored as play as long as the "spirit" of play was not broken, e.g. by looking away or walking off. Exploration and Play scores for any S in a session were the total amount of time (in secs.) engaged in such activities.

All scoring was done by an assistant who was unfamiliar with the rearing histories of the subjects. Inter-observer reliabilities for the three measures of this experiment were obtained as follows. The descriptions of the behaviors as above were given to a second assistant, who then scored several incidental cats by herself with no feedback from E. Then during the experimental sessions, both assistants scored all nine cats once, simultaneously and independently. The obtained inter-observer reliability

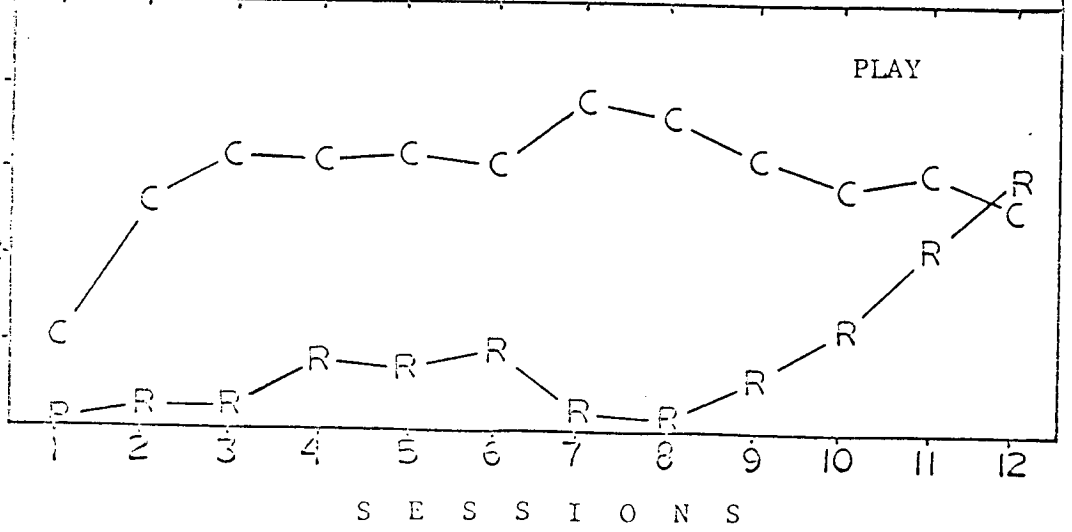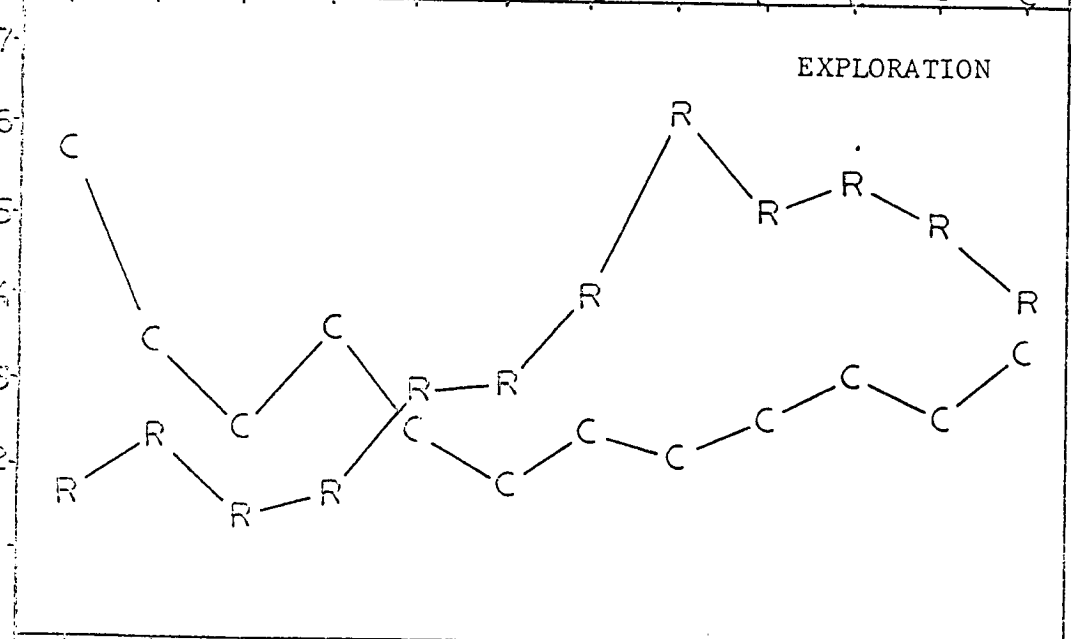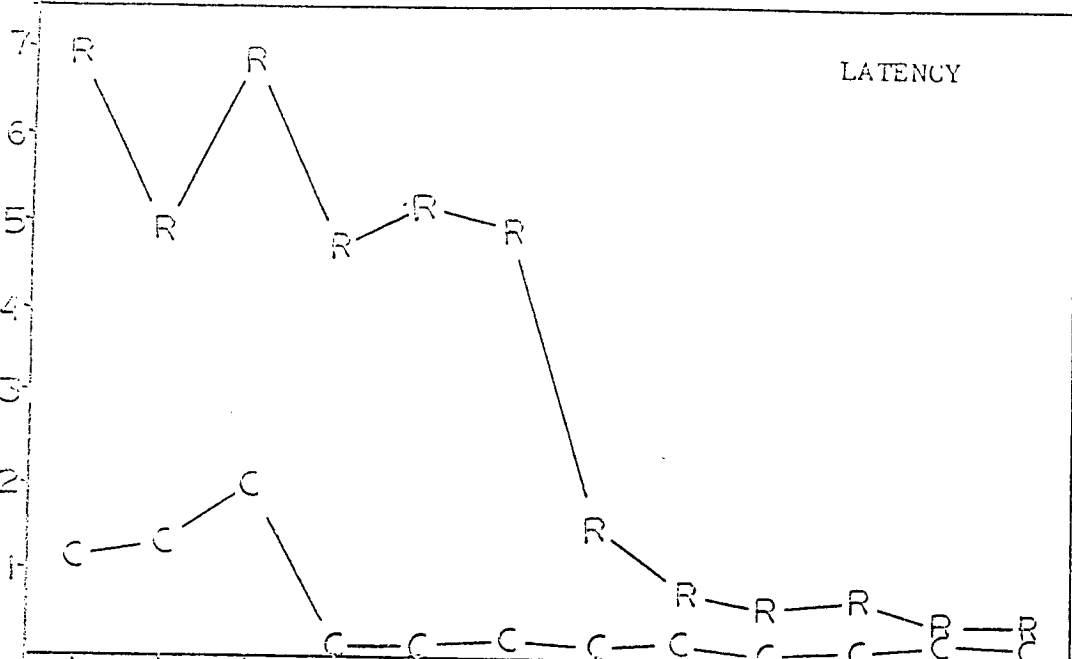coefficients for Latency, Exploration and Play were all 0.99.

Results

Latency. The Latency data presented in Figure 1 were transformed ($X' = \sqrt[3]{X+1}$) for the purpose of an analysis of variance (Groups X Sessions). Over all sessions, restrictively reared cats were more hesitant to approach the novel environment than were normally reared control cats ($F = 7.93$, df $= 1/7$, $p < .05$), although this difference diminished with repeated exposures, as indicated by the Groups X Sessions interaction ($F = 2.11$, df $= 11/77$, $p < .05$). Both groups were less hesitant to enter in later sessions ($F = 6.77$, df $= 11/77$, $p < .001$).

(Insert Figure 1 about here)

Exploration. The Exploration data of Figure 1 shows that normally reared cats engaged in extensive exploration on their first encounter with the novel room, and then rather quickly dropped to an intermediate level for the duration of the experiment. Restrictively reared cats, on the other hand, did little exploring in the early sessions. At this time the behavior of R cats consisted largely of crouching in the start box; but as they began to emerge into the room,

Fig. 1. Mean Latency, Exploration and Play scores

over 12 sessions for restricted (R) and control (C) groups.

they devoted increasing amounts of time to exploring - with
this behavior reaching a peak late in the experiment. This
was followed by a slow decline in exploration during the last
few sessions. An analysis of variance (Groups X Sessions)
of this data indicated a significant interaction (F = 3.68,
df = 11/77, p < .001) between experimental groups and
observation sessions.

Play. The Play data of Figure 1 suggest that playful
behavior develops after previous extensive exploration of a
novel environment. Normally reared cats developed a stable
level of play behavior early in the experiment, when their
exploratory behavior was dropping off. A similar relationship
between exploration and play was exhibited by restrictively
reared cats, but late in the experiment. By the last session
the two groups exhibited comparable amounts of play behavior.
An analysis of variance (Groups X Sessions) was done on
transformed play data: $X' = \log (X + 1)$ Overall sessions
C cats exhibited significantly more play behavior than R
cats (F = 5.28, df = 1/7, p ~ .06), although this difference
was larger in earlier sessions, as indicated by the Groups X
Sessions interaction (F = 2.56, df = 11/77, p < .01). There
was also a significant increase in play behavior across
sessions for both experimental groups combined (F = 3.26,

df = 11/77, p < .005).

EXPERIMENT 2

The findings of Experiment 1 suggest that behavior emerges in a complex novel environment in a particular sequence, viz. approach, explore, play. We hypothesize that a major variable controlling the emergence of these behaviors is the state of habituation of the subject with respect to the novel characteristics of the environment. Since the emergence of the sequence was delayed, and protracted, in the case of restrictively reared subjects, we assume that they found the testing environment to be more novel. In as much as the emergence of a sequence of behaviors is a rather inexact - though not necessarily uninteresting - measure of response to novelty, the present experiment was undertaken with a view towards more precise quantification of this response. Specifically, we measured the magnitudes of various autonomic orienting responses to presentations of simple novel tones in the R and C cats of Experiment 1. We also made systematic observations of subjects' reactions to the restraining procedure employed in obtaining the autonomic orienting responses.

Method

Subjects. The subjects of this experiment included

the 4 R cats and the 6 C cats - unless otherwise indicated.

Restraining Procedure. The subjects were restrained

for testing by drawing fore- and hind-limbs into openings in

a flat board; the neck was then secured in a stock, two

side boards slide up against the animal's sides, and padded

blocks placed over shoulders and hips. Each S's heart rate

was then monitored until it dropped to 180 beats/min. At this
the
time/testing session was begun. However, if heart rate did not

drop within 1½ hrs., S was removed and the procedure repeated

on another day. One subject did not adapt after five days,

but was nevertheless tested after the fifth day.

Testing procedure. After S was placed in the

restraining apparatus, the various recording leads were

attached and the animal moved to a sound-shielded testing

box. A dim light was left on in the box. Ambient sounds

were masked by an exhaust fan. The background noise in

the box was 55-58 db at the S's head (re = .0002 dyne/cm^2).

The stimuli were 2 sec. bursts of a 1500 cps tone (84 db at the

S's head), presented with a Grayson-Stadler Twin Oscillator

950-D, through a Jensen coaxial speaker placed in the center

of the ceiling of the testing box. Tone bursts were

automatically recorded on the polygraph records. After the

subject's heart rate met the 180/min. criterion, a ten

minute resting sample was taken of all measurement variables,

and the run was begun. All Ss were presented with 50

repetitions of a 1500 cps tone at random intervals. The
mean intertrial intervals for the R and C groups were
respectively, 39.4 and 38.3 seconds. The intertrial
intervals ranged from 12 to 60 sec., with a few longer
intervals when Ss were unusually active. The tones were
presented when S was quiet and skin resistance stable.

Measurements. A number of autonomic and behavioral
measures were obtained for each subject. 1. GSR (Galvanic
Skin Response): Small (5mm) Ag/Ag Cl electrodes were placed,
one each, on the footpads of the forelegs, after an application
of Offner electrode jelly. The electrodes were secured with
Elastoplast tape. The GSR measurement apparatus was a Fels
Dermohmeter (Model 22A), which led to an Esterline Angus
graphic ammeter (Model AW) pen recorder. A response was
measured (in ohms) as a drop in skin resistance, of any
size, during the interval from one second after tone onset,
to 2.5 seconds later. A response was considered artifactual
if (a) it began within one second after tone onset, or (b) there
was a body movement or vocalization in the two seconds before
the response began. A value for these trials was obtained
by averaging the responses immediately before and after the
trial in question. The mean percentages of derived GSR
responses in the reported data for R and C groups were
respectively, 8.5 and 4.0.

2. Respiration: An elastic band was attached around

S's midsection. The dorsal 1/3 of the band was made of

conducting rubber, which changes its resistance when stretched

(as when S breathes). The rubber strip was made part of a

resistance-bridge, so that as S breathed, the Grass polygraph

recorded sinusoid-like waves corresponding to inhalation and

exhalation. Changes in subjects' respiratory patterns often

occurred following tone presentation. The changes were

complex enough that any simple measurement, such as rate

or amplitude, would probably have been difficult or impossible

to make in a consistent and satisfactory way. Instead, a

more global approach was taken. A seven point rating

scale was devised for estimating the degree of respiratory

disruption in the 5 seconds following stimulus onset. The

highest scores were assigned to instances of respiratory

arrest (a marked flattening of the record); medium

scores to pronounced alterations in amplitude and/or

rate (generally smaller and faster); and the lowest scores

to slight and short lasting irregularities. All nine records

were scored by an assistant who was unaware of the rearing

history of the animals. One of us scored 4 of the same

records (2 R and 2 C). For each of these records the corre-

lation between ratings assigned by E and assistant was found. The

mean correlation (r) for the 4 doubly scored records was +0.78. Finally, the ratings produced by the assistant were used for subsequent analysis. Not all trials of a record could be scored. Trials were considered contaminated and not scored in any fashion if (a) the baseline in the 10 seconds prior to tone onset was noticeably irregular, or (b) struggling movement occurred in the period from 10 seconds before, through 5 seconds after, tone onset, or (c) vocalizations occurred in the 5 secs. after tone onset. Mean rating data presented in "Results" are based on scorable trials only. The mean percentage of contaminated responses was small in the R group: 8.5, and somewhat larger in the C group: 20.0.

3. Heart Rate: 16 mm wound clips were attached in a shaved portion of skin on the upper hind leg, and on the back of the neck. EKG leads were delivered from the wound clips to a Grass polygraph for recording heart rate. The heart rate record at a trial was subdivided and scored as follows. Within the 2 second tone interval, the largest number (X) of R wave (R-R) intervals were counted ($5 \leq X \leq 9$). This number then served as a basis for subdividing the heart rate record on this trial into five periods: 1) the X R-R intervals preceding tone onset, 2) the X intervals during

the tone, 3) the X intervals after the tone terminated,
4) the next X intervals, and 5) the next X intervals.
R-R interval measurements in each period were converted
to beats/min. It did not seem desirable to score heart
rate data on all trials. It was obvious that two kinds
of recorded accompanying behaviors had a profound and
irregular (since they could occur at any time) effect on
heart rate: struggling movements and vocalizations. Both
tended to produce a short latency acceleration of heart rate;
consequently, the occurrence of either of these behaviors
from 10 seconds before tone onset, through the heart rate
scoring periods, produced a contaminated trial. The
percentage of contaminated trials was small in the R group:
7.5%, and appreciable in the C group: 35%. Contaminated
trials were excluded from analysis.

4. Struggling Movement: Body movement was recorded
on the Grass polygraph by means of a phonograph cartridge
attached to a sideboard of the restrainer. Movement was
indicated on the polygraph record as a thickening of the
baseline. Struggling movement time was accumulated if the
expanded line was at least 3 times the baseline and persisted
for 2/5 seconds or more. These criteria were chosen so as to
exclude rhythmic leg bouncing and brief twitches. Struggling

movement time was accumulated through the run of 50 trials and expressed as a function of the total run time, i.e. as (seconds of movement/minute) x 100.

5. Vocalizations: "Meows" were monitored by microphone and manually recorded on the GSR paper record. Vocalizations were scored by counting the absolute number over the run of 50 trials, and expressing this number as a function of total run time, i.e. as "meows"/minute.

6. Spontaneous Galvanic Skin Responses: In the 10 minute period immediately preceding the first trial, a count was made of the total number of GSRs $\geqq$ 200 ohms. If responses were clearly associated with recorded vocalizations or struggling movements they were not counted.

Data transformations. For purposes of statistical analyses, raw data were transformed whenever the ratio of the largest to the smallest standard deviation of groups involved in a statistical comparison exceeded 2.0, and a plot of the means against standard deviations on log-log paper could be reasonably best-fitted with a straight line. In such cases, the transformation equation had the general form of $X_t = X_r^{1-k}$ (where "X_t" is the transformed score, "X_r" the raw score, and "k" the slope of the best-fit straight line).
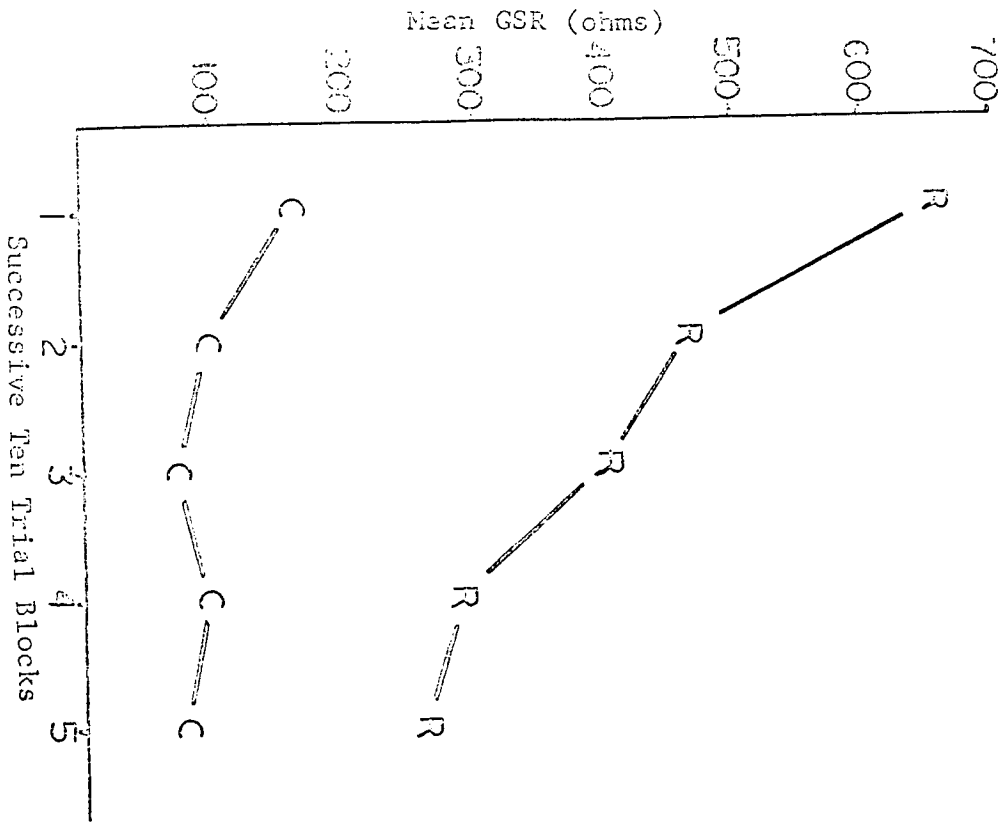
Results

Galvanic Skin Response. The GSR data of Figure 2 are based on 4 R cats and only 5 C cats. The sixth C cat failed to give a GSR to any stimulus (tone, pinch, etc.), and was excluded from the data analysis. The raw data was transformed: $X' = \log X$, for the purpose of an analysis of variance (Groups X Trial Blocks). Across all trials, restrictively reared cats gave much larger GSRs to tone ($F = 8.78$, $df = 1/7$, $p < .025$). The mean GSR (in ohms) over all trials for the R and C groups respectively, were 414.7 and 99.5. There was no overlap between subjects of the two groups on this measure. For both groups combined, there was a decrease in GSR over the course of fifty trials ($F = 4.79$, $df = 4/28$, $p < .005$), although the decrease did not bring the terminal level of the R group below the initial level of the C group. It appears that more trials would have been required to habituate the GSR of R cats to below the 100 ohm level.
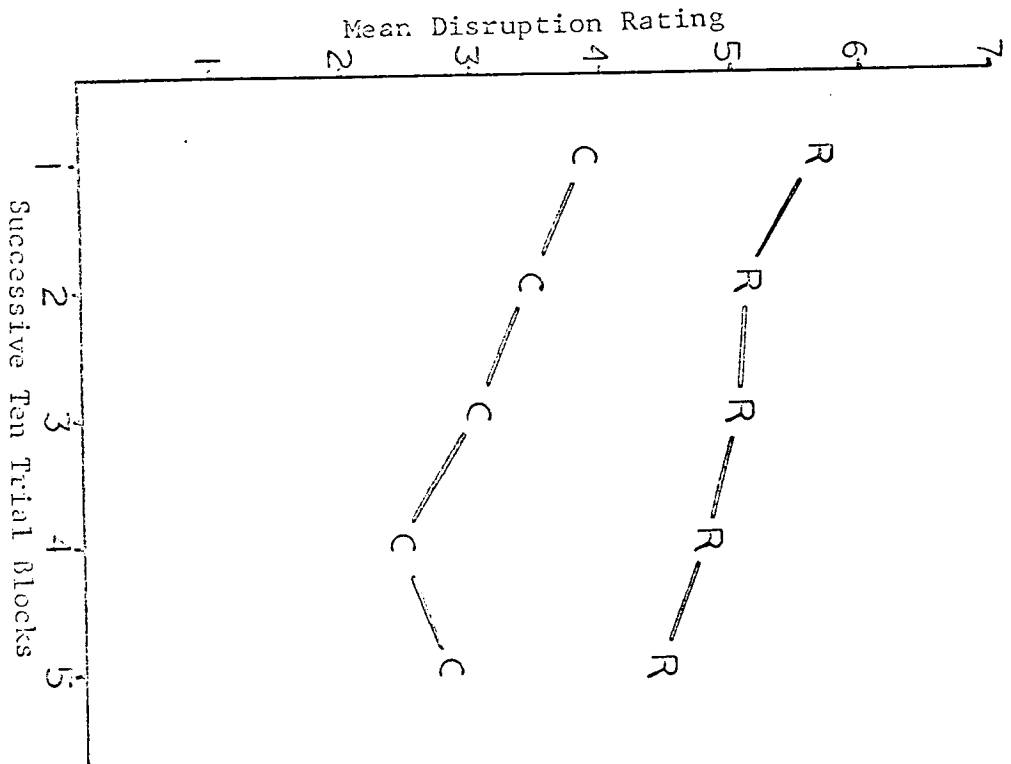
(Insert Figure 2 about here)

Respiratory Disruptions. An analysis of variance (Groups X Trial Blocks) was performed on the Respiratory Disruption ratings presented in Figure 2. Restrictively reared cats received an overall larger respiratory disruption

Fig. 2. Mean GSR and Respiratory Disruption scores over 50 trials of tone presentations for restricted (R) and control (C) groups.

GALVANIC SKIN RESPONSE

Mean GSR (ohms)

700 600 500 400 300 200 100

Successive Ten Trial Blocks

1 2 3 4 5

R R R R R

C C C C C

RESPIRATORY DISRUPTION

Mean Disruption Rating

7 6 5 4 3 2 1

Successive Ten Trial Blocks

1 2 3 4 5

R R R R R

C C C C C

rating than did normally reared control cats (F = 17.05, df = 1/8, p ⌐ .005). The mean disruption ratings over all trials for the R and C groups respectively, were 4.98 and 3.06. There was no overlap between subjects of the two groups on this measure. For both groups combined there was a decrease in disruption rating over the course of fifty trials (F = 12.68, df = 4/32, p ⌐ .001), although the decrease did not bring the terminal level of the R group below the initial level of the C group.

Heart Rate Responses. The experimental groups differed in the patterns of their heart rate responses to the tone stimuli. R cats generally exhibited an early and marked decrease in heart rate following tone onset. Late components of the response were variable. C cats, on the other hand, generally responded to tone onset with small, sustained increases in heart rate. In order to compare the groups in terms of the magnitudes of their heart rate responses, a peak to peak measure was extracted by calculating the largest difference (in beats/min.) between any two of the five scoring periods, for each S on each trial. These measures were averaged by subjects over all scorable trials of the two sets of trials: 1-25, and 26-50. Mean responses for the R and C groups over the first 25 trials were 17.9 and 9.3; over the second 25 trials,

mean scores were 18.6 and 10.4 A log transformation of this data was made and an analysis of variance (Groups X Trial Blocks) done on the transformed data. Over all trials, R cats tended to give larger heart rate responses (F = 3.24, df = 1/8, p ⌒ .10). There was no habituation of the response in either group.

Responses to the general testing situation. The reactions of the experimental groups to the general testing situation were strikingly different. Although more often quiet than not, control cats engaged in intermittent struggling against the restraining apparatus thruout the entire experiment. Contrariwise, restrictively reared cats never struggled, and remained quietly immobile thruout. These differences are reflected in a number of autonomic and behavioral measures. For all subjects presentation of tones was delayed until heart rate dropped to 180 beats/min. The delay times for R subjects were considerably briefer than for C subjects: $\overline{R}$ = 30 min., $\overline{C}$ = 185 min. ($\underline{t}$ = 2.02, df = 8, p ⌁ .10). Mean rates of struggling movements, expressed in (seconds of movement/minute) x 100, for the R and C groups were respectively: 5.8 and 78.5. Individual scores were transformed: $X' = \log (X + 1)$. The $\underline{t}$ for the group comparison, R vs C, was 3.04 (df = 8; p ⌁ .02). Mean rates

of voclaization, expressed as "meows"/minute, for the R and C groups were respectively: 0.27 and 2.62. The t for this comparison was 2.61 (df = 8; p < .05). Mean numbers of spontaneous GSRs in the 10 minute pre-run period for the R and C groups were respectively: 22.5 and 3.2. The t for this comparison was 6.95 (df = 7; p < .001). There was no overlap in the number of spontaneous GSRs for the members of the two groups. Thus R cats moved less, vocalized less and had more spontaneous GSRs than C cats.

There were a number of other measures of response to the general testing situation on which the two groups did not differ significantly. These were: (a) heart rate (beats/min.) in the two second period prior to each trial (over all trials: $\overline{R} = 184.7$, $\overline{C} = 204.0$); (b) respiratory rate (per min.) in the ten minute pre-run period ($\overline{R} = 68.9$, $\overline{C} - 61.3$); and (c) basal skin resistance levels through the tone presentation period.

DISCUSSION

The experiments reported here demonstrate that experience restricted rearing produces adult cats who are unusually susceptible to the impact of novel stimuli. Normally and restrictively reared subjects were presented

with a novel environment which they could approach, explore
and manipulate (i.e. play in). Both groups displayed the
behaviors in this sequence, but differed in the rate of
development of the sequence. Normally reared cats moved
quickly through the approach and explore phases, and spent
much of their time in manipulation (play). Restrictively
reared cats moved slowly through the sequence, and achieved
a normal level of play only during the last of the twelve
observation periods. Assuming that the major variable
controlling the emergence of these behaviors was the state
of habituation of the subjects with respect to the novel
characteristics of the testing environment, the delayed
and protracted development of the behaviors in R cats may
be interpreted to mean that they experienced the testing
environment as more novel - a conclusion which is consistent
with the nature of their experience restricted rearing.

It is apparent that the paucity of experience
possessed by R cats at the termination of rearing was not
completely compensated for by a moderate amount of additional
experience during the 8 months immediately prior to testing,
although it is probable that the additional experience did
have some effect, since R cats demonstrated in both experiments
that they are capable of habituation to novel stimuli. In

Experiment 1 the sequence of active behaviors did eventually emerge, and in Experiment 2, R cats showed habituation in those autonomic responses to a novel tone stimulus in which C cats also habituated (GSR, Respiratory Disruption), and at about the same rate as C cats. At all states of autonomic habituation, however, R cats gave larger responses than C cats. In fact, the terminal level of R cat response, exceeded the initial level of C cat response.

In the course of recording autonomic responses to tones, we had occasion to present subjects with yet another novel stimulus: a restraining procedure which, (a) placed numerous heavy pressures on many body surfaces, (b) pierced the skin in several places (for attaching recording leads), and (c) drastically restrained normal body movement. Normally reared cats responded with sustained sporadic attempts to escape, whereas restrictively reared cats responded with marked behavioral passivity. In addition, the rate of spontaneous GSRs was some seven times higher in restrictively reared cats. This last observation would lead us to expect a heightened state of alertness in these animals, if we may generalize from the results of Surwillo & Quilter (1965), who found that high rates of spontaneous skin potential responses are associated with high vigilance performance

in human subjects. We suggest that these different modes

of response (active vs passive) can be understood as

reflecting different states of habituation with respect

to the novel elements of the restraining procedure.

Confrontation with the procedure when the level of habituation

to novel elements is low might produce a state of behavioral

passivity and attentional vigilance in the subject, while

confrontation at higher levels of habituation might leave

the subject free to take appropriate action, e.g. attempt

to escape an uncomfortable apparatus. It is conceivable

that the same animal might exhibit both behavioral states

in sequence, passive then active, if he were to start at a

low enough level of habituation and remain long enough for

a sufficient amount of habituation to take place. Our

experimental groups, however, each exhibited only one of

the states. R cats failed to show any active behavior,

perhaps because they were not in the apparatus long enough

to sufficiently habituate. C cats failed to show initial

passivity, perhaps because the apparatus was not novel

enough. This last suggestion is supported by the observation

that in another experiment, in which a more radical restraint

of body movement was employed, C cats did exhibit an initial

period (10-20 mins.) of passivity, followed by a longer period of sporadic struggling. R cats again exhibited only passivity.

We report in Experiment 2 that restrictively reared cats produced many spontaneous GSRs and large orienting GSRs, while normally reared cats gave few spontaneous GSRs and small orienting GSRs. Since there was no overlap between groups on either variable, the tetrachoric correlation between spontaneous and orienting GSRs is + 1.0. A similarly positive relationship between these variables was reported by Lacey and Lacey (1958) for human subjects, and by Kimble, Bagshaw and Pribram (1965) for normal monkeys. The existance of this relationship raises a question of causality. Can differential rates of spontaneous GSRs account for differences in orienting GSRs? Assuming that orienting GSRs were in fact spontaneous responses which happened to occur in the scoring intervals following tones, we would expect (based on the spontaneous rates of the pre-run period) mean numbers of GSRs $\geq$ 200 ohms, during the tone presentation period, of 4.70 and 0.65 for the R and C groups respectively. The observed mean numbers of such responses, however, were 34.0 and 9.0. Thus our recordings of orienting GSRs do reflect more than spontaneous

responses.

Finally, there is evidence which could implicate fronto-limbic structures in the development of GSR hyper-responsiveness in restrictively reared subjects. Lesion of the lateral frontal cortex (Kimble, et al., 1965) or amygdalectomy (Bagshaw & Benzies, 1968) in monkeys, produce subjects who are GSR hypo-responders, the opposite effect of restricted rearing. Hyper-responsiveness, then, might depend on some kind of sensitizations of the fronto-limbic structures.

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