The effect of novelty and familiarity on the conditioning of learned aversions to gustatory and nongustatory stimuli in coyotes (Canis Latrans)

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THE EFFECTS OF NOVELTY AND FAMILIARITY ON THE CONDITIONING OF LEARNED AVERSIONS TO GUSTATORY AND NONGUSTATORY STIMULI IN COYOTES (*CANIS LATRANS*)

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ABSTRACT

Previous experience with gustatory cues associated with illness is an important parameter in taste aversion conditioning. Familiarity interfers with conditioning while novelty enhances it. The present study examined the extent to which this relationship also applies to nongustatory cues. Six coyotes were familiarized with a food in their home kennel over 20 feeding events. This food was then laced with LiCl and placed in a novel arm of a T-maze where consumption occurred resulting in illness. In the testing phase, coyotes received three choices: eating the familiar food in the novel place (FF-NP) (the LiCl treatment area), eating the familiar food in a familiar place (FF-FP) (the home kennel), or eating a novel food in a novel place (NF-NP) (the other arm of the T-maze). The familiarization events, treatment, and testing were then repeated with different foods and different goal boxes. Results indicated avoidance of the FF-NP on all trials. The FF-FP was chosen on 75% of the trials and the NF-NP on 25% of the trials. The results suggest that the coyotes avoided the FF-NP because the associability of the cues with illness was potentiated due to the novelty of the place. Preference for the FF-FP was due to a place and taste familiarity

effect which interfered with conditioning. Additional trials with the same subjects indicated the establishment of LiCl shyness after two LiCl treatments based on an olfactory-gustatory discrimination.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXPERIMENT I

Introduction

The Assumption of Equivalent Associability

According to the Pavlovian model of conditioning a neutral stimulus will become converted into a conditioned stimulus (CS) if it repeatedly precedes in close spatial and temporal contiguity an unconditioned stimulus (US) leading to an unconditioned response (UR). Once converted to a CS the stimulus gains the ability to evoke a conditioned response (CR) in the absence of the original US. Basic to this paradigm is the assumtion of equivalent associability (Seligman, 1970); that is, any naturally occurring neutral stimulus randomly chosen can be converted into a conditioned stimulus. Current research, however, has demonstrated that rats appear capable of associating some stimulus events more readily than others. For example, several researchers (Domjan & Wilson, 1972; Garcia & Koelling, 1966; Green & Holmstrom, 1974) found that rats were able to learn an association between shock (US) and an audio-visual CS but they were relatively less able to learn an association between shock and a gustatory CS. Conversely, rats were able to learn an association between gastrointestinal distress (US) and a gustatory CS but they were relatively less able to learn an association between gastrointestinal distress and an audio-visual CS. In another study, Garcia, McGowan, Ervin, and Koelling (1968) found that the size of the food pellet served as an effective CS when size was associated with shock as a US. However, size was ineffective as a CS when the US was gastrointestinal distress (hereafter referred to as GID). Conversely, the gustatory attributes of the pellet served as an effective CS when associated with GID but not when associated with shock. Apparently, for the rat the gustatory qualities of the food are more readily associated with illness than with peripheral cutaneous pain. On the other hand, nongustatory stimuli are more readily associated with peripheral pain than with illness. Additional confirmation of an apparent nonequivalence of associability between certain categories of stimuli in rats has also been demonstrated by Garcia, Kovner, and Green (1970) and Hargrave and Bolles (1971). The earlier Pavlovian notion of equivalent associability no longer appears tenable. In addition, rats are able to associate gustatory stimuli with GID on the basis of a single CS-US pairing (Garcia, Kimeldorf, & Koelling, 1955; Nachman & Jones, 1974) with delays of up to several hours between the two stimulus events (Etscorn & Stephens, 1973; Garcia, Ervin, & Koelling, 1966; Revusky, 1968; Smith & Roll, 1967). These findings are contrary to generally accepted principles included within traditional classical conditioning learning theory and call for a re-examination of such principles.

Nonequivalence of Associability Across Species

The most striking evidence in support of a nonequivalence of associability across species is found in Wilcoxon, Dragoin, and Kral's (1971) study in which they contrasted the behavior of quail to that of the rat. The quail is deficient in odor and taste receptors and chooses its food primarily on the basis of visual cues. The rat, on the other hand, possesses refined odor and taste receptors but relatively poor vision and chooses its food on the basis of gustatory and olfactory cues. When confronted with visual and gustatory stimuli, the quail more readily associated the visual stimuli to GID than did the rat. The rat, however, more readily associated the gustatory stimuli to GID than did the quail. These associations occurred over a single, long-delayed, ingestion illness consequence.

Johnson, Beaton, and Hall (1975) examined a species of higher order intelligence, the green monkey (Cercopithecus sabaeus), that is similar to the quail in that it possesses a keen sense of vision that is used for food gathering. Johnson found that these animals, unlike the rat but similar to the quail, readily associated visual color cues to illness.

Some interesting variations in associability appears in hawks, another highly visual animal. Brett, Hankins, and Garcia (1976) studied the buteo hawk with the purpose of determining its ability to associate gustatory and/or nongustatory stimuli with illness. They found that the hawks were capable of associating either the gustatory or the nongustatory stimuli with illness. In addition, they found that when the two cues were presented together as a compound stimulus, the nongustatory-visual aspects of the prey acted as a signal to the hawk that the gustatory qualities of the food were unpalatable. This result is similar to what Brower (1969, 1975) found in the blue jay. The blue jay, after a single encounter with a toxic monarch butterfly avoided future encounters with this unpalatable prey on the basis of the butterfly's distinctive wing markings. The blue jay also avoided the viceroy butterfly, a nontoxic butterfly, that mimics the wing markings of the monarch butterfly.

Braveman (1974) investigated the associative ability of guinea pigs, an animal that relies on both gustatory and visual stimuli in food selection. He hypothesized that the guinea pig would readily learn aversions to nongustatory stimuli as well as to gustatory stimuli. The results confirmed his beliefs. When he presented guinea pigs with either a clear sweet tasting or a flavorless red colored solution they readily associated either solution with GID. In conclusion, various species exhibit their own unique

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gustatory cue together with a nongustatory cue one stimulus would be more associable with illness than the other. He presented the guinea pigs with a sweet tasting, red colored solution and induced GID upon consumption of that solution. He found that the guinea pigs developed much stronger aversions to the taste than to the color of the solution. Thus, for the guinea pig, gustatory qualities of food are more associable with illness than nongustatory-visual stimuli. Braveman then varied the amount of novelty or familiarity the guinea pigs experienced with the two types of stimuli in order to determine the effects this would have on their associability with illness. He familiarized the guinea pigs to the more readily associated taste cues while at the same time maintained the less readily associated color cues in a novel status. After the guinea pigs consumed the familiar tasting but novel-looking solution, GID was induced. Contrary to the previous results the guinea pigs now exhibited much stronger aversions to the color of the solution.

Braveman's findings are in agreement with Carr (1974) and Schnur (1971) who found that if rats were initially trained to suppress responding when a light-tone compound was presented and then tested with either the light or the tone, more complete suppression was obtained with the light than with the tone. However, if rats were exposed to the light prior to training with the light-tone compound, suppression was more complete to the tone than to the light. Thus, taken together with the Braveman study, it appears that control of behavior by the less associable element of a compound stimulus is facilitated if it remains unfamiliar, and the more associable element is made familiar through pre-exposure to that stimulus.

Additional evidence concerning the modifying effects of novelty and familiarity upon the associability of stimuli with illness can be found in Mitchell, Kirschbaum, and Perry's (1975) study where cues relatively less familiar were more associable. In this study, rats received a varying number of familiarity trials with two different containers containing the same food. After eating from either container, the rats received an intraperitoneal injection of LiCl to induce GID. In each case they avoided eating from the container with which they had experienced fewer familiarization trials and reverted to eating almost exclusively from the more familiar container.

The tendency of novelty and familiarity to modify the associability of stimuli with illness was also observed by Ahlers and Best (1971) and Revusky and Bedarf (1967). They familiarized rats to one food while keeping another novel. They then had the rats eat both foods in succession, varying the order of presentation before the induction of GID. Regardless of the order of presentation the rats always associated the illness event with the novel food. Even when the familiar food intervened between exposure to the novel food and the onset of illness an aversion was still formed to the novel food and not to the familiar food. The researchers concluded that for tastes already familiar, in relation to GID associative strength is attenuated; for novel taste, associative strength is enhanced.

A similar situation occurred for Shettleworth (1972) who shocked young chicks after drinking water of either a familiar or unfamiliar color. Under the unfamiliar conditions the chicks developed relatively long latencies to consume water of that color. In contrast, chicks showed little hesitation in continuing consumption of the familiarly colored water.

Vogel and Clody (1972) reported that rats familiar with a taste prior to GID did not differ in subsequent consumption of that food from control subjects similarily familiarized to the food but without undergoing the illness episode. A group unfamiliar with the taste substantially suppressed consumption when their first encounter with the food resulted in GID.

In summary, there exists a preponderance of evidence indicating that the associability of gustatory and non-gustatory stimuli with GID can be manipulated by varying the degree of novelty and/or familiarity of these stimuli. An excellent example of this novelty-familiarity effect was provided in the Braveman (1975), Carr (1974), and Schnur (1971), studies where behavior was controlled by the less associable element of a compound stimulus by maintaining this element in a novel state and at the same time reducing the associability of the more associable element through pre-exposure.

Statement of the Problem and Hypothesis

After becoming ill from eating meat injected with LiCl, coyotes and wolves associate the taste of the meat with illness and subsequently become averted to that meat (Ellins, Catalano, & Schechinger, 1977; Gustavson & Garcia, 1974; Gustavson, Garcia, Hankins, & Rusiniak, 1974; Gustavson, Kelly, Sweeney, & Garcia, 1976; Stream, 1976). A major theme emerging from the study of acquired taste aversions is that animals such as the coyote readily associate the gustatory qualities of the food to illness but do not readily associate the nongustatory stimuli surrounding the illness event (Rudy et al., 1977). This theme, however, does not take into consideration the effects of novelty and familiarity on the associability of stimuli. The purpose of the following study is to examine these novelty and familiarity effects on the conditioning of learned aversions to taste (gustatory) and place (nongustatory) stimuli in coyotes. Specifically, the study is designed to explore the following hypothetical problem.

If a coyote consumes a familiar food in a novel location and subsequently experiences GID, will the coyote (a) demonstrate no aversion to the familiar food in any location;

(b) demonstrate an aversion to the familiar food only in the novel LiCl treatment location; (c) demonstrate an aversion to the familiar food in all locations including a familiar location where prior consumption of the food has occurred in safety?

It is hypothesized that the coyote will demonstrate an aversion to the familiar food only in the novel LiCl treatment location. This hypothesis is based on the evidence from the previously cited research indicating that relatively less familiar stimuli (the novel LiCl-treatment location) are more likely to be associated with illness than highly familiar stimuli (the familiar location) thus causing the coyote to avoid consumption of the familiar food in the novel location but not in the familiar location.

METHOD

Subjects

The subjects were six coyotes (Canis latrans) ranging in age from 8 months to 2 years. Four of the subjects were males (Chester, Bonkers, Wally, and Charley) and two were females (Gloria and Linda). All of the animals, with the exception of Wally, were raised in captivity.

Apparatus

The research facility was constructed of chain link fence and consisted of four kennels, a choice arena, and four goal boxes (Figure 1). Wire netting was placed over the structure and underground to prevent escape. The kennels had chain link doors that opened into the choice arena. The kennel floors were cement and the roof over the kennels was corrugated aluminum sheeting. The kennels were separated from each other by a chain link fence with fiberboard paneling attached. Within each kennel were two light gray porcelain bowls 27.5 cm in diameter for food and water and a plywood dog house 1.22 x .91 x .85 m positioned at the end opposite the door. Of the four goal boxes (labeled X, Y, A, B), goals X and Y were similar to each other in that each contained white plywood panels rising 45 cm from the floor on three of its four sides.

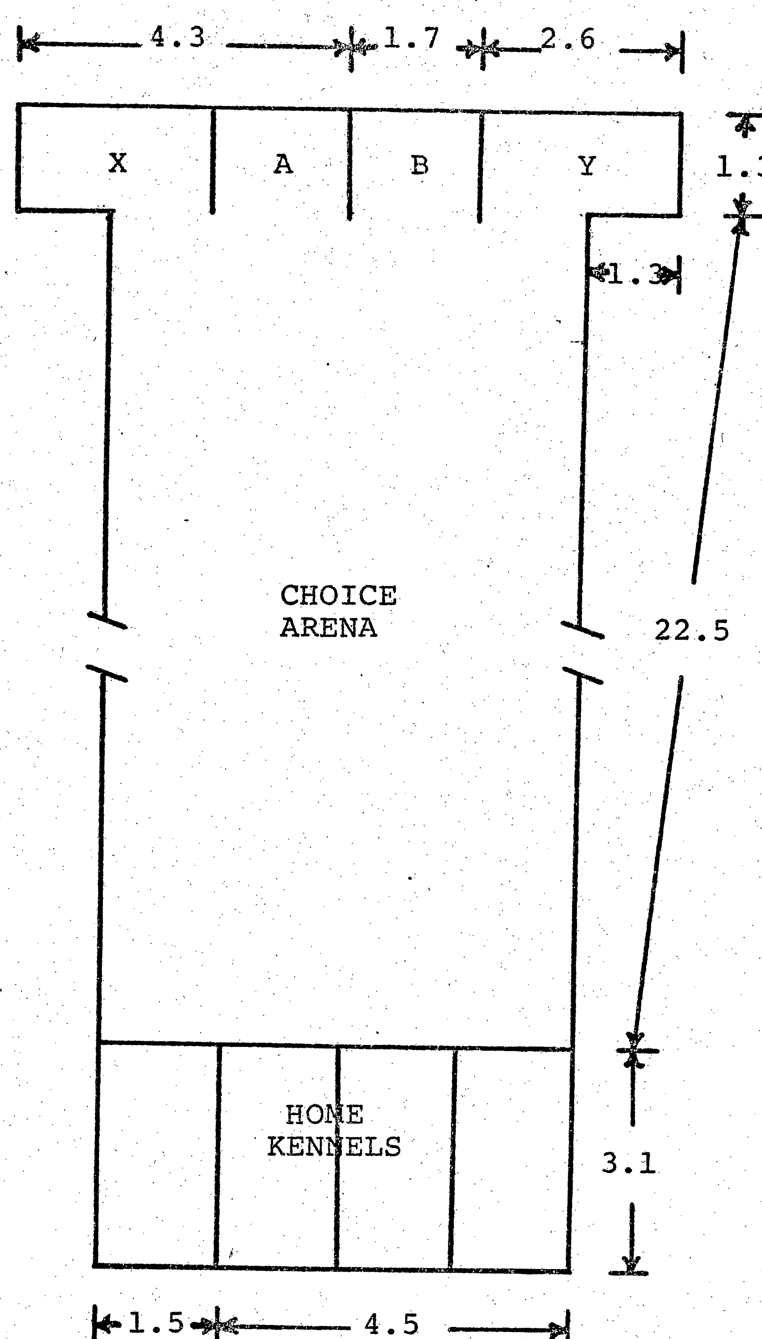

Figure 1. Outdoor Canid Kennels and Choice Arena Dimensions in Meters (1 cm = 1 m).

In addition, an automobile tire was placed in the corner of each of these boxes to serve as a feeding bowl. Goals A and B were similar to each other in that each contained plywood panels painted in a red and white cross-hatched pattern rising 45 cm from the floor on three of its four sides. In addition, an aluminum trash can lid with the center painted red was placed in the corner of each of these boxes to serve as a feeding bowl. The distinctive panels and feeding bowls within the two sets of goal boxes were to serve as novel nongustatory stimuli during the treatment phase of the experiment. One set of similar goal boxes would be used per trial per animal.

Procedure I[1]

Pretreatment. The subjects were assigned one to a kennel where each animal remained during the pretreatment phase of the experiment. Within these "home" kennels the subjects received 20 familiarization events with a particular food. For Gloria, Linda, and Bonkers, defeathered but otherwise whole chicken was used. For Wally, Chester, and Charley, Vets brand regular dog food was used. One event occurred if any amount of food had been eaten in a 24 hour period. The subjects were administered the familiarization events in a staggered order so that they would finish the required number of 20 events individually. This was

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[1] Refer to Table 1.

Table 1

Summary of Procedures I and II for the Pretreatment, Treatment and Test Phases of Experiment I

	PRETREAT		TREATMENT		TEST					
SUBJECTS	FF	FP	FF	NP	FF	FP	FF	NP	NF	NP
Procedure I										
Gloria	Ch	HK	Ch	X	Ch	HK	Ch	X	BK	Y
Linda	Ch	HK	Ch	X	Ch	HK	Ch	X	BK	Y
Bonkers	Ch	HK	Ch	X	Ch	HK	Ch	X	BK	Y
Wally	VR	HK	VR	B	VR	HK	VR	B	BK	A
Chester	VR	HK	VR	B	VR	HK	VR	B	BK	A
Charley	VR	HK	VR	B	VR	HK	VR	B	BK	A
Procedure II										
Gloria	VR	HK	VR	B	VR	HK	VR	B	BL	A
Linda	VR	HK	VR	B	VR	HK	VR	B	BL	A
Bonkers	VR	HK	VR	B	VR	HK	VR	B	BL	A
Wally	Ch	HK	Ch	X	Ch	HK	Ch	X	BL	Y
Chester	VCh	HK	VCh	X	VCh	HK	VCh	X	BL	Y
Charley	VCh	HK	VCh	X	VCh	HK	VCh	X	BL	Y

Note. Key to table abbriviations:

FF - Familiar/Food
NF - Novel/Food
FP - Familiar/Place
NP - Novel/Place
HK - Home Kennel
X, Y, A, B - goal boxes

VR - Vets Regular
Ch - Chicken (whole)
VCh- Vets Chicken
BK - Beef Kidney
BL - Beef Liver

necessary so that only one animal would be ready to participate in the treatment and test phases of the experiment at any one time.

Treatment. Twenty-four hours after the end of the 20th familiarization event for each subject the now familiar food was prepared in the following manner: For Gloria, Linda, and Bonkers (the subjects familiarized on chicken), one defeathered but otherwise whole chicken was sliced in numerous areas about the head, neck, body, and legs; the chicken was then soaked in 11.36 liters of water mixed with 450 g of lithum chloride (LiCl) for 30 minutes. This chicken was then placed in goal box X containing the novel nongustatory stimuli. For Wally, Chester, and Charley (the subjects familiarized on Vets regular dog food), 6 g of LiCl was thoroughly stirred into 439 g of Vets regular (one can) and placed in goal box B containing the other set of novel nongustatory stimuli. Only one animal participated in the treatment phase of the experiment at any one time. The entrances to all other goal boxes were closed off with plywood paneling so that the subject could neither see nor enter these areas. In addition, the door was shut on the home kennel after a subject left this area for the choice arena so that it could not return to this area during treatment. The treatment session ended for each subject when visual verification of food eaten and vomit in the choice arena was made. The subject was then returned to its home kennel.

Test. Subjects participated in the test phase of the experiment individually. Twenty-four hours after being returned to the home kennel a subject was simultaneously presented with the following three conditions: the familiar food in the familiar place (FF-FP) (the home kennel area), the familiar food in a novel place (FF-NP) (the previously novel LiCl treatment area), and a novel food in a novel place (NF-NP) (a previously unused goal box). For Gloria, Linda, and Bonkers (the coyotes familiarized on chicken), the NF-NP condition involved 454 g of beef kidneys in goal box Y. For Chester, Charley, and Wally (the coyotes familiarized on Vets regular), the NF-NP condition involved 454 g of beef kidneys in goal box A. All subjects began the test in the center of the choice arena. Their first and second choices were recorded. A choice was considered to have been made when a subject was observed eating food from a particular goal box.

Procedure II[1]

The procedure was repeated using the same subjects with the following exceptions. In the pretreatment phase the subjects formerly familiarized with chicken--Gloria, Linda, and Bonkers--received familiarization events with Vets regular dog food. The subjects formerly familiarized with Vets regular dog food--Wally, Chester, and Charley--received

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[1]Refer to Table 1.

familiarization events with chicken. Wally received defeathered but otherwise whole chicken. Chester and Charley received Vets chicken flavored dog food. The reason for the decision to change to canned chicken dog food was to better regulate the LiCl dosage level and food quantity presented so that a closer match between these trials and trials with Vets regular flavored dog food could be made.

Exceptions in the treatment phase involved Gloria, Linda, and Bonkers receiving the familiar food-LiCl mixture in goal box B (formerly received in goal box X in procedure I). Wally, Chester, and Charley received the mixture in goal box X (formerly received in goal box B in procedure I).

Exceptions in the test phase involved the NF-NP condition where 454 g of beef liver was placed in goal box A for Gloria, Linda, and Bonkers and in goal box Y for Wally, Chester, and Charley.

RESULTS

During the test phases of procedures I and II the six subjects, given a total of 12 opportunities, chose first the familiar food in the familiar place 9 times and the novel food in the novel place 3 times. For their second choice, the familiar food in the familiar place was chosen 3 times and the novel food in the novel place 9 times. On no occasion did they choose the familiar food in the novel LiCl-treatment area (Table 2).

Table 2

The Number of First and Second Choices by Subjects per Choice Condition

	Procedure I		Procedure II		Procedure I & II	
Choice Condition	1st Choice	2nd Choice	1st Choice	2nd Choice	Total 1st	Total 2nd
FF-FP	4	2	5	1	9	3
NF-NP	2	4	1	5	3	9
FF-NP (LiCl)	0	0	0	0	0	0

DISCUSSION

The results indicate that after becoming ill on a previously safe familiar food eaten in a novel place, coyotes, on all trials, stopped further consumption of that food in that place. However, on a majority of trials after conditioning, the coyotes ate the same familiar food in a familiar place where, prior to conditioning, it had been consumed in safety. On a minority of trials following conditioning, a few coyotes avoided the familiar food in both places and switched to a novel food in another novel place. Apparently, the coyotes had developed a strong aversion to the stimuli associated with the familiar food/novel place condition and a much weaker aversion to the stimuli associated with the familiar food/familiar place condition. In the few cases where the coyotes consumed the novel food in the novel place and avoided the familiar food in both places, apparently an aversion of sufficient strength developed in response to both familiar food conditions that overcame any neophobia that may have occurred in relation to the novel food/novel place condition.

The results of Experiment I are in agreement with other researchers who have developed the concept of learned safety (Bolles, Riley, & Laskowski, 1973; Kalat & Rozin, 1973; Nachman, 1970; Nachman & Jones, 1974; Rozin & Kalat, 1971). According to this concept, stimuli that are associated with positive benefits (the familiar food/familiar place condition) signal safety. Once considered safe, animals experience difficulty in formulating subsequent associations between these stimuli and illness. On the other hand, novel stimuli (the novel LiCl treatment area), due to an innate neophobic response, are regarded with suspicion. Consequently, when paired with illness, such stimuli are readily associated with punishment.

To explain the results of Experiment I in conditioning terms, consumption of the familiar food within the context of the familiar place was reinforcing over many trials. However, consumption of the familiar food within the context of the novel place was not reinforcing but, on the contrary, was punished. These conditions served to establish discriminitive properties in the place cues that provided the coyotes with information as to whether or not the food located therein was safe. Unfortunately, due to the nature of the experiment it is not known if the avoidance of the familiar food in the novel place was due to an aversion to place alone or to some interaction between place and taste (Rusiniak, Hankins, Garcia, & Brett, 1978). It is evident that the avoidance was not due to an aversion to taste alone as in the majority of cases the coyotes continued to consume the familiar food in another (familiar) place. To determine the exact nature of the aversion it would have been necessary to place a second familiar food (FF_2) in the LiCl treatment area subsequent to testing with FF_1 in that area. If the subjects had eaten FF_2 in that area then it could have been assumed that the original avoidance of FF_1 in that area was due to an aversion to a specific interaction between the taste stimuli of FF_1 and the place stimuli of the LiCl treatment area. If the subjects had refused to eat FF_2 in the LiCl treatment area this would have indicated a place aversion wherein the place cues alone acquired discriminitive properties signaling unsafe eating conditions that was not limited to a specific food/place interaction. In this condition an aversion to the novel place cues would have been potentiated above an aversion to a specific food/place combination.

In addition to the preceding interpretation of the results, Experiment I can be interpreted in terms of the activation of a general arousal system (Konorski, 1967; Rudy, Krauter, & Gaffuri, 1976; Rudy et al., 1977). According to this theory, increases in arousal in the presence of a CS facilitates conditioning to that stimulus. In addition, it is assumed that novel stimuli are more arousing than familiar stimuli. In support of this view Rudy et al. (1977) found that substantial taste aversion conditioning occurred in rats either when the taste itself was novel or when novel nongustatory stimulation was present concurrently with a familiar taste. Relatively little conditioning occurred when both the gustatory and contingent nongustatory cues were familiar. Rudy hypothesized that when the tastes were familiar and contingent nongustatory stimuli were unfamiliar, aversive properties were conditioned to those familiar taste because the stimulation provided by the novel nongustatory stimuli activated the arousal system. Based on this analysis, the FF-NP LiCl-treatment condition activated the arousal system of the coyotes due to the novelty of the place. This arousal potentiated the associability of the stimuli found in this area with illness. This potentiation occurred only in the LiCl treatment area and did not carry over to the FF-FP condition probably due to a learned safety effect occurring in this area.

Regardless of the theoretical explanation it is evident that the coyotes in Experiment I were able to establish associations between gustatory experiences <u>in particular locations</u> with either illness or safety. Furthermore, the establishment of these associations was due in part to the <u>degree of past experience</u> the coyotes had had with the stimuli found in these locations. These findings are important primarily due to the fact that relatively little is known in regards to the effects of novelty and familiarity on conditioned taste aversions and the role nongustatory stimuli play in the development of such aversions.

Seligman (1970) hypothesized that organisms, due to their unique evolutionary histories, possess specialized sensory-motor and associative neural equipment that predispose them to associate certain events more readily than others. Different species, having experienced completely different evolutionary histories exhibit their own unique associative preparedness. Seligman proposes a continuum of associative preparedness ranging from instinctive behavior in which an organism is biologically prepared to respond consistently from the very first presentation of a stimulus, to contraprepared responses where acquisition occurs only after extensive pairings, or may not occur at all. Support for Seligman's notion of preparedness comes from Rozin and Kalat (1972) who proposed that learning is a situational-specific adaptation that has evolved in different species according to their particular environmental challenges. The survival of organisms is to a great extent dependent upon their capacity to respond in ways that fit the demands of their ecological niche. Those organisms that respond appropriately to the array of stimuli in their environment are more likely to survive, creating populations that are more prepared to make particular stimulus-response associations than others.

An obvious survival advantage would accrue to organisms relatively more prepared to respond appropriately to stimuli on the basis of their novelty or familiarity. For example, the activation of a general arousal system in response to novelty which in turn facilitates conditioning to noxious stimuli along with an enhanced ability to learn "safety" within the context of familiar and beneficial stimuli would certainly increase an organisms survival advantage during biological evolution. Thus the likelihood that a predisposition or "preparedness" to respond to stimuli in the above manner having been developed and passed down from generation to generation appears very high. Evidence from Experiment I indicates that this theoretical perspective appears quite tenable. The coyotes definitely responded to the stimuli differentially depending upon the amount of perceived novelty or familiarity they experienced in the stimuli. Consequently, an organism's associative preparedness with respect to novelty and familiarity appears to be an additional feature of the overall preparedness concept. It is important that the preparedness concept take this into account primarily because the degree of novelty or familiarity the organism perceives in a stimulus appears to affect the position an organism occupies along the preparedness continuum with respect to that stimulus-response association. Since the degree of novelty or familiarity experienced in a stimulus is a highly variable or fluid aspect of that stimulus; and since an organism responds differentially to this variable; the positioning of an organism on a continuum of preparedness in terms of their ability to make particular stimulus-response associations must also be variable. The inclusion of novelty and familiarity into the conception of associative preparedness converts Seligman's model from that of a static to a fluid model where organisms occupy ranges of preparedness depending on the degree of stimulus novelty or familiarity involved rather than fixed positions.

EXPERIMENT II

Introduction

Experiment I indicated that coyotes become averted to a familiar food in a relatively unfamiliar location if their first encounter with that food in that location resulted in GID. In the majority of cases, however, they did not demonstrate an aversion to the familiar food in a familiar location where, prior to conditioning, it had been consumed in safety. These findings were explained in terms of the effects novelty and familiarity have on associability. The stimuli found in the familiar food/novel place condition were highly associable with GID due to the novelty of the unfamiliar place cues. This was a highly specific association, however, and did not carry over to the same taste stimuli in the familiar food/familiar place condition due to a learned safety or familiarity effect.

The purpose of Experiment II was to examine this familiarity effect further by determining whether or not an aversion would develop to the familiar food in the familiar place if consumption of that food in that place results in GID. It is hypothesized that an aversion will not develop due to the interference of "learned safety" occurring in this area (Bolles et al., 1973; Kalat & Rozin, 1973; Nachman, 1970; Nachman & Jones, 1974; Rozin & Kalat, 1971).

PROCEDURE

The four subjects used were Gloria, Linda, Bonkers, and Wally from Experiment I. The same structure was used as in Experiment I with the exception that the previous goal boxes were closed off and two new goal boxes were constructed out of cardboard and measured 100 x 75 x 75 cm. Each goal box was positioned on opposite sides of the choice arena 11.27 m from the home kennels. The subjects were placed on a 10-event refamiliarization schedule in their home kennels using a previously familiar food from Experiment I--Vets regular dog food. This food was placed in the same porcelain feeding bowls used in Experiment I. As in Experiment I, one event was considered to have occurred if any amount of food had been eaten in a 24-hour period. The subjects were kept enclosed within their home kennels during the refamiliarization period and were not allowed access to the choice arena. Twenty-four hours after the 10th refamiliarization event, 439 g of Vets regular dog food was mixed with 6 g of LiCl and placed within each subject's porcelain feeding bowl in their home kennels. At this point it was observed that all of the subjects refused to eat the Vets-LiCl mixture. Due to this refusal the treatment phase of the experiment could not be administered and the experiment was terminated.

DISCUSSION

During the refamiliarization period all of the subjects regularly ate Vets dog food. However, when Vets containing LiCl was presented to them after the end of the 10th refamiliarization event, all subjects refused to eat it. Before rejecting the food, the subjects were observed smelling the Vets-LiCl mixture thoroughly; even pushing their noses into the food. Two of the subjects urinated on the mixture; all eventually left the feeding bowl area. When this Vets-LiCl mixture was removed and replaced with another Vets-LiCl mixture containing one-half of the former's dosage level (3 g of LiCl per 459 g of Vets), the subjects still refused to eat the mixture even when it remained in their feeding bowls for 24 hours. This occurred in spite of the fact that all of the subjects had been food deprived for 24 hours prior to the initial presentation of the LiCl-food mixture. It was at this time that the experiment was formally terminated due to the inability to administer the required LiCl treatment. After termination the LiCl-Vets mixture was removed from their bowls and replaced with fresh non-LiCl Vets which the subjects immediately consumed.

Bonkers, who was the least shy of all the subjects and would literally eat inches from the experimenters presence, was chosen to participate in several informal experiments for the purpose of closely observing his behavior. He was presented with a bowl of Vets containing a small portion without LiCl in the center of a larger portion with LiCl (6 g of LiCl per 148 g of Vets). The LiCl Vets was pushed up around the non-LiCl Vets so that the two were visually indistinguishable. Within approximately two seconds Bonkers had found the non-LiCl Vets and began consuming it, carefully avoiding the LiCl Vets. He appeared able to distinguish the LiCl from the non-LiCl Vets on the basis of odor alone as he ran his nose over the top of the bowl before finding and consuming the non-LiCl Vets. This procedure was repeated with the same dosage level and with dosage levels of one-half and one-fourth the former level (3 g and 1.5 g of LiCl respectively). The results were always the same--he refused the LiCl Vets.

Based on the observations of Bonkers and the general outcome of Experiment II it was tentatively concluded that the subjects were averted to food containing LiCl. In addition, there was some evidence that the subjects were capable of distinguishing the presence of LiCl on the basis of odor. This aversion apparently developed during Experiment I when, on two separate occasions, the subjects experienced the novel flavor (and odor) of LiCl mixed in with their familiar food prior to the onset of GID. The following experiments (III & IV) were designed to explore further these tentative conclusions.

EXPERIMENT III

Introduction

In Experiment I coyotes experienced GID on two separate occasions after eating a highly familiar food containing LiCl--an unfamiliar taste. The outcome of Experiment II led to the possibility that in Experiment I the coyotes had developed an aversion to food containing LiCl. The purpose of Experiment III was to determine if the coyotes were in fact averted to LiCl.

In studies with rats, researchers (Balagura, Brophy, & Davenport, 1972; Nachman, 1963; Smith, 1971; Strom, Lingenfelter, & Grody, 1970) report that subjects, after drinking an LiCl solution, readily learn to avoid drinking that substance again. The aversion to drinking solutions containing LiCl was observed to be highly stable and did not diminish over time. This occurred in spite of the observation that rats are not initially adverse to the taste of LiCl as they drank it as readily as control subjects drank H_2O (Nachman, 1963). It is generally concluded that this learned aversion is based on an association between the taste of LiCl and the toxic aftereffects of the substance.

Experiment III was designed to explore the existence of a LiCl aversion further in the coyotes that had participated in Experiment I by specifically examining the following questions: (a) Will these animals avoid food when it contains LiCl? (b) Will they exhibit an aversion to unfamiliar foods mixed with LiCl--foods with which no previous LiCl induced illness had occurred? (c) Is the aversion operative over a length of time, for example, one month?

METHOD

Subjects

The subjects were the same six coyotes that had participated in Experiment I--Gloria, Linda, Bonkers, Wally, Chester, and Charley. Each subject had previously experienced two LiCl treatments with two different familiar foods which resulted in GID. Three weeks had passed for each subject since the last LiCl treatment in Experiment I.

Apparatus

This experiment was conducted in the home kennels which were set up the same as in Experiment I. The same porcelain feeding bowls (27.5 cm in diameter) used in Experiment I were also used in this experiment.

Procedure

The experiment consisted of four trials. On trial one a food unfamiliar to the subjects (170 g of Petuna fish flavored cat food) was positioned on the left side of the feeding bowl. Positioned on the right side of the bowl was an equal amount of the same food with 3 g of LiCl thoroughly stirred into it. Approximately 12 cm of space between the two portions of food was maintained so that they did not contact each other. The subjects were observed making their choices. When only one side was eaten the remainder was left in the kennel for 24 hours. At the end of this time, the bowls were removed and cleaned and trial two begun. Trial two was identical to trial one with the exception that the positions of the LiCl and non-LiCl food in the bowls were reversed. Trial three occurred one month after the end of trial two. During this one month interval the subjects were fed dry dog food. Trial three was identical in procedure to trial one with the exception that a different unfamiliar food was used--Vets beef and cheese flavored dog food. Trial four was identical in procedure to trial two with the exception that the Vets beef and cheese flavored dog food used in trial three was also used in trial four.

RESULTS AND DISCUSSION

In trials one and two all six subjects consumed the non-LiCl food and refused to consume any of the LiCl food. The same results were obtained one month later in trials three and four. This amounted to a total of 24 tests wherein all of the subjects completely avoided the food containing LiCl preferring instead the same food without LiCl. On all of the tests the LiCl food was still present and undisturbed in their feeding bowls 24 hours after its introduction.

The subjects were observed passing their noses approximately 8 to 15 cm over the food on both sides of the bowl before making their choices. They then took large mouthfuls of the non-LiCl food. On no occasions were they observed tasting the LiCl food prior to choosing the non-LiCl food.

The results of this experiment indicate that the coyotes in Experiment I had in fact developed an aversion to food containing LiCl and that this aversion was maintained over a period of one month (in fact over 1 1/2 months had passed for each animal from the end of Experiment I to the end of trial four in Experiment III). In addition, this aversion occurred even when the coyotes had had no prior experience with the food presented, LiCl mixed with the food, or illness resulting out of such a mixture. This indicates that the aversion to food containing LiCl is independent of any specific food-LiCl combination associated with previous illness. In making their initial choice, their behavior seemed to indicate an ability to make an olfactory discrimination between the LiCl vs. non-LiCl food.

It is believed that the results of Experiment III can be explained in terms of the effects novelty and familiarity have upon associability. In Experiment I the coyotes had, on two separate occasions, consumed a novel substance (LiCl) that was mixed into a highly familiar food resulting in GID. It is believed that against this highly familiar food background the coyotes easily distinguished the novel LiCl stimuli from the familiar food stimuli. They then associated the cause of their illness to the novel LiCl due to an innate neophobic response paired with an aversive consequence. The familiar (positively reinforced) food stimulus by itself was not associated with illness due to the interference of a "learned safety" effect. Two such encounters with the LiCl stimuli were apparently necessary to establish the LiCl aversion as the coyotes exhibited no such aversion to LiCl in treatment phase two of Experiment I even though they had experienced a LiCl connected illness in treatment phase one of that experiment. This interpretation is in agreement with research showing that GID is more likely to be associated with novel stimuli than to familiar stimuli (Ahlers & Best, 1971; Bolles et al., 1973; Kalat, 1974; Kalat & Rozin, 1973; Mitchell et al., 1975; Revusky & Bedarf, 1967; & Shettleworth, 1972).

EXPERIMENT IV

Introduction

The results of Experiment III clearly indicated that in Experiment I the coyotes had developed strong aversions to foods containing LiCl. In addition, observation of their behavior indicated the possibility of a discrimination between foods with and without LiCl on the basis of olfactory stimuli alone. Experiment IV was designed to determine if the coyotes in Experiment III were in fact able to discriminate LiCl vs. non-LiCl food on the basis of olfaction alone.

Previous studies indicate that odor can become an aversive stimulus. Distinct olfactory stimuli paired with GID have been shown to be effective in suppressing responses to substances paired with that odor (Lorden, Fenfield, & Braum, 1970; Supak, Macrides, & Chorover, 1971). Taukulis (1974) placed rats in a chamber containing a specially devised drinking spout which simultaneously delivered both unadulterated water and a stream of odorized air to the rat. GID was induced after the rats had consumed the water in the presence of the odor. In subsequent tests, presence of the odor decreased the amount of water consumed, indicating an aversion to the odor. Taukulis found that strong odor aversions developed after a single CS-US pairing with odor-toxicosis delays of as much as four hours. For the coyote, an animal which has a much more highly sophisticated olfactory sense than the rat, the capacity to readily associate odor with aversive consequences would aid in its ability to discriminate safe vs. unsafe foods without the necessary energy expenditure to capture and taste the food.

In order to test for an aversion to the presence of LiCl in food on the basis of olfaction, two boxes with a wire netting on top and a narrow opening at one end were utilized. Positioned inside each box was either a LiCl or a non-LiCl food mixture. It was assumed that a coyote would smell the contents of each box through the wire netting at the top. If the coyote does in fact distinguish the presence of LiCl in food on the basis of odor, then it should reject the box containing the LiCl-food leaving its contents undisturbed. The non-LiCl box, however, would contain no aversive odor stimuli and, consequently, its contents would be disturbed by efforts to obtain the food. The condition of the contents of both boxes was the criteria for determining how the choice was made, i.e., by olfaction or gustation. It was hypothesized that only the contents of the non-LiCl box would be disturbed while the contents of the LiCl box would remain undisturbed.

METHOD

Subjects

The subjects used were the same six coyotes that participated in Experiment III. All of the subjects demonstrated an aversion to food mixed with LiCl as compared to the same food without LiCl.

Apparatus

Two rectangular boxes of 1 cm plywood, 31.5 cm long and 24 cm wide were used. Each box consisted of two side pannels, a rear pannel, and a floor. The top and front of each box were open. A wire netting of 1.3 cm squares was placed over the opening at the top in an arch that measured 9 cm from its apex to the floor of the box. The wire netting was attached to the two side pannels which were 6 cm high, and to the rear pannel which measured the same height as the side pannels up to the point where an arch began on the rear pannel which conformed to the arch of wire netting over the top of the box. Inside of each box white paper plates 23 cm in diameter were placed to hold the food.

The same kennels were used as in the previous experiments with the exception that the porcelain feeding bowls were removed and the plywood feeding boxes substituted in their places.

Procedure

One feeding box containing 219.5 g of Vets regular dog food mixed with 3 g of LiCl was placed on the right side of each kennel. The other feeding box containing an equal amount of Vets regular without LiCl was placed on the left side. The food in the boxes was positioned approximately 18 cm from the entrance of each box and 7 cm from the apex of the wire netting over the top of each box. In a second trial everything was identical to the first with the exception that the positions of the LiCl and non-LiCl boxes in the kennels were reversed. The boxes were left in each kennel for 12 hours at which time one trial was considered complete and the contents of each box checked for disturbances.

RESULTS AND DISCUSSION

There were a total of 12 olfactory discrimination tests in the experiment (6 subjects x 2 trials). On 10 of these tests five of the subjects on each of their two trials left the contents of the LiCl boxes completely undisturbed but removed and consumed the contents of the non-LiCl boxes. These five subjects were observed smelling the food through the screen on the top of each box shortly after the boxes were placed in their kennels. They then ignored the LiCl box and eventually either pulled the non-LiCl food out with teeth and paws or reached in and grabbed a mouthful of it. On no occassion were they observed attempting to obtain the food in the LiCl boxes. Only one subject, Wally, on each of his two trials, disturbed the contents of both the LiCl and non-LiCl boxes; however, only the non-LiCl food had been eaten. Although this does not necessarily indicate that he tasted the food from the LiCl box the possibility cannot be ruled out; consequently, he was not included among the other subjects who made their choice on the basis of odor alone.

Since five of the six subjects did not remove and taste the LiCl food before rejecting it, it is evident that their choice was made on the basis of olfaction and that an aversion to the odor of the LiCl mixture had developed.

Hankins, Garcia, & Rusiniak (1973) argue that olfaction plays a minor role in the regulation of feeding behavior, and that its primary function is to serve as a telereceptor. In an experiment with rats they found that the olfactory system did not seem to adhere to the same principles of one-trial learning and long-delay reinforcement that are common to the gustatory system. The results from Experiment IV, however, seemed to indicate the contrary for coyotes. The coyotes used the olfactory cues in much the same way as taste cues for the regulation of food intake.

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