AN ABSTRACT FOR THE THESIS OF
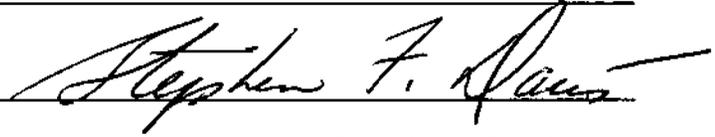
M. Melissa Richard _____ for the _Master of Science_

in _Psychology_____ presented on _December 1986_____

Title: _TRANSFER OF INFORMATION EFFECT IN THE FREE-FORAGING_

SITUATION: TWO OBSERVERS RECEIVING DIFFERENT DIET MESSAGES

Abstract approved: _____

Stephen F. Davis

For many years, scientists have asserted that social
interaction plays a significant role in the transfer
of information concerning food preferences.
Posadas-Andrews and Roper (1983) identified two methods
by which colonies of rats can obtain diet information:
(1) directly, by ingesting the food itself, and/or (2)
indirectly, by interacting with a conspecific, or
animal of the same species. Recently, Galef and his
colleagues (e.g., Galef, 1983; Galef, Kennett, &
Wigmore, 1984; Galef & Wigmore, 1983) have repeatedly
shown that a recently fed rat (a demonstrator) may
transfer information regarding the type of food it
has consumed to a naive animal (an observer). Such
experiments typically have been conducted in

wire-mesh cages or a wooden maze. In conjunction with previous experiments conducted iu our laboratory, the present study sought to extend the transfer of information paradigm to the open-field foraging situatiou. Thus, rather than having only two food sites to choose from, the animals would he confronted with six food sites. It has been shown in our laboratory that following interaction with a demonstrator which had consumed a specific test diet, the observer, when exposed to the free foraging situation, successfully exhibits an enhanced preference for the diet of its demonstrator partner. Additionally, studies conducted in our laboratory have found the same to be true when two observers receiving the same diet message were simultaneously tested in the foraging situation. The purpose of the present study was to expand these findings further. More specifically, two observers each provided with a different food-type message were tested. Positive results were obtained in the present study which mirrored the previous free foraging situation findings. Moreover, it could he concluded that the demonstrator is a viable source of diet iuformation, and that animal-animal interactions which occurred between the two observers were not powerful enough to overthrow the two demonstrators original messages.

TRANSFER OF INFORMATION EFFECT

IN THE FREE-FORAGING SITUATION:

TWO OBSERVERS RECEIVING DIFFERENT DIET MESSAGES

_____

A Thesis

Presented to

the Department of Psychology

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M. Melissa Richard

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Finally, none of this could have been possible without my family. To my mother, for supporting me, both emotionally and financially. To my sisters and brother, and their families, who have always brought happiness to my life (i.e., spoiled me rotten). I love you all!

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CHAPTER 1

INTRODUCTION

Social interaction plays an important role in the
transfer of information concerning food preferences in
many species. As humans, we are cognizant of the
biological factors, such as gustatory and olfactory
cues, involved in food selection, and we can identify
environmental factors (e.g., cultural differences) that
influence our diet selection. It has been observed that
within a species, animals will seek out foods for
ingestion that are similar. Young (1968), in an attempt
to explain the incompatible results of food preferences
in animals, concluded that a combination of sensory
stimulations caused an animal to acquire certain food
preferences. Additionally, he stressed the importance
of hedonic processes and how they interact with the
sensory components. Young focused on the biological
aspects of preferred foods. The scope of contemporary
research focuses more on the social or environmental
influences. For example, Galef (1977) asserted that
one must not neglect the social context in which feeding
behavior occurs, as well as the biological factors
involved in food preferences. Two methods utilized by
colonies of rats to obtain diet information have been
identified (Posadas-Andrews & Roper, 1983). First, rats

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can obtain information by directly ingesting the food,
or second, they can receive information indirectly by
interacting with a conspecific, or animal of the same
species.

It is thought that social transmission of
information can serve an adaptive function by informing
animals in their natural environment about the available
resources, while saving the animal time and reducing its
risk (Galef, 1977). Several researchers (e.g., Galef,
1977; Galef, 1982; Strupp & Levitsky, 1984) have cited
Steiniger, an ecologist working on rat extermination in
the 1950's, as being an early investigator of the
effects that social learning has on adaptive behavior.
For example, Strupp and Levitsky (1984) cited Steiniger
for introducing the concept of "bait shyness." He found
that rats when given poison bait in a specific area
were, at the onset, accepting of the bait. However,
with extended exposure to the poison bait their
acceptance of it substantially decreased. This decrease
in acceptance was even more noticeable in their
offspring. Another example noted in Steiniger's writing
of how social transmission of information for food
preferences exists among animals was cited by Galef
(1977). This example involved members of select
colonies of rats in Germany. These colonies were

observed engaging in such behaviors as stalking, killing, and eating sparrows, while other various colonies did not exhibit this eating behavior even though sparrows were present within their environment.

These earlier findings have encouraged researchers to explore the mechanisms by which the transfer of distinctive feeding behaviors occur. Galef and his colleagues (e.g., Galef, 1983; Galef, Kennett, & Wigmore, 1984; Galef & Wigmore, 1983) are the most recent researchers to investigate this area. Their basic procedure involves allowing a recently fed rat (a demonstrator) to interact with a naive conspecific (an observer). They have found that the observer can extract sufficient information from its demonstrator partner, to enable it to subsequently identify and consume the specific food eaten by the demonstrator. This transfer-of-information process is shown clearly by the observer's enhanced preference for the diet eaten by its respective demonstrator.

Strupp and Levitsky (1984) used a slight variation of this basic procedure to look at the effects of an demonstrator-observer pair that were housed together for a period of time. Separated only by a wire mesh partition, the observer gained information from the demonstrator about the two food choices on a continuous

basis. Subsequently, the observer was tested for food preference in the wire mesh cage with the demonstrator present. In that the observer consumed more of the diet that its demonstrator partner had consumed, the results showed that the presence of the demonstrator did affect the observer's food preference.

Because the demonstrator plays a crucial role in the transfer of food-related information, Galef, Kennett, and Wigmore (1984) reported a series of studies designed to determine the generalizability of this phenomenon under different demonstrator-observer conditions. They found that the transfer-of-information effect was displayed by the following: (1) first generation wild rats (Rattus norvegicus), as well as domesticated rats; (2) food-deprived and nondeprived observers; (3) familiar and unfamiliar pairs of demonstrators and observers; (4) observers selecting fluids or solids; and (5) juvenile, as well as adult rats. Galef and Kennett (1985) reported data indicating that the cues emitted by the demonstrators are effective for up to 4hr after the ingestion of the diet.

Upon establishing the basic premise that a demonstrator rat can indeed transmit food related cues to a conspecific, the next obvious step was to ascertain the underlying mechanisms involved in this phenomenon.

Galef, Kennett and Stein (1985) stated that the first delineation to be made in considering such mechanisms should he a determination of the role of the demonstrator. For example, it might be argued that the presence of the demonstrator simply aids the observer in becoming familiar with the novel diet, thus reducing the observer's possible neophobic response to that diet. Neophobia, as described by Domjan (1977), suggests that rats tend to eat less of a novel substance than of a more familiar substance. Support for this argument was demonstrated hy Posadas-Andrews and Roper (1983) when they found that simple preexposure to a novel diet enhanced the observer's preference for that diet. Hence, simple familiarity resulting in a reduction of neophobia may be an underlying mechanism.

Galef et al. (1985) sought to evaluate the underlying mechanisms that are induced by the demonstrator. Their procedure involved preexposing the observer animal to the two test diets, thus making both diets familiar on the test day. If simple familiarity with the test diet is a crucial factor, one might surmise that the subsequent demonstrator-observer interaction would have no effect on the observer's food preference. On the contrary, the results showed that the observer's diet selection was influenced by the

interaction with the demonstrator. It was concluded

that the demonstrator does provide some type of

contextual cue(s), which enable the observer to gain

pertinent diet information. Additional supportive

evidence for this conclusion also was reported by Galef

et al. (1985). For example, an animal that has been

anesthetized following consumption of the test diet is

equally successful at transmitting the diet message as

an alert animal. On the other hand, a surrogate "rat",

constructed of cotton batting wrapped in surgical gauze

and rolled in a specific test diet, does not influence

the diet preference of the observer animal. Hence,

simple preexposure to the test diet is not sufficient to

produce the diet-preference effect in observers, rather,

the mechanisms involved are directly related to

demonstrator influence (Galef, Kennett, & Stein, 1985).

Having established the importance of the

demonstrators per se, the next research issue dealt with

the specific nature of the cues involved. What are the

cues emitted by the demonstrator that cause its paired

observer to prefer the designated diet? The most

obvious candidates would appear to be those associated

with the olfactory and/or gustatory modalities.

Posadas-Andrews and Roper (1983) observed the contact

between animals after the demonstrator had been given

access to a specific diet. They found that upon placing the animal back into the common cage, it was subjected to a thorough examination, such as sniffing, grooming, pawing, and licking, especially in the facial region. Observing this behavior lead them to suspect that the observer engages in these behaviors in order to gain information concerning the diet the animal had eaten. Hence, Posadas-Andrews and Roper (1983) identified several possible ways that food cues could be transmitted. First, particles of food that adhered to the demonstrator's face and paws could provide sufficient information. Second, they speculated that food odors could be detected on the demonstrator's breath, or in its feces.

Galef and Stein (1985) investigated the importance of facial contact between the demonstrator and observer. More specifically, they attempted to ascertain the minimum amount of time required for a succesful information exchange to occur. It was found that demonstrator-observer interactions as short as 2 min were sufficient. Having obtained this information, they observed demonstrator-observer 2 min interactions and recorded the animal-animal contacts. Much to their surprise, they found that the observers spent an average of only 21.6 sec in direct contact with the

demonstrator. The majority of the time was spent in
contacts involving the lower body area, while only a
brief period of time was spent investigating the head
and/or mouth. They did find, however, after analyzing
the data that there was a direct correlation between the
observer's preference for the demonstrator's diet and
the mouth/face contact between the two animals.
Further, it was shown that demonstrators which had been
stomach loaded could successfully transmit information.
In other words, food residing in the digestive tract can
produce effective cues. These finding are in agreement
with the earlier statment made by Posadas-Andrews and
Roper (1983), that particles of food adhering to the
demonstrator's face and paws and/or odors on its breath
could be important contextual cues provided by the
demonstrator.

Clearly, the transfer-of-information effect has
been established as a viable form of social learning.
Galef and his colleagues have presented an elegant
series of experiments delineating not only the sensory
cues, but also the contextual cues provided by the
demonstrator which are involved in this phenomenon. The
ultimate goal in testing this effect would be to take it
into the natural environment and apply the laboratory
findings to animals in the wild. Before this procedure

could actually be engaged in, several basic questions
remained unanswered. One such question involves the
mechanisms by which the animal stores incoming
information. Under natural circumstances, an individual
rat might receive several different diet messages from
conspecifics before it actually has the opportunity to
forage. If this is the case then one must consider the
effect of the multiple messages received, the time delay
between when the demonstrator receives the initial
message and transmits it to the observer, and the time
delay that exists from when the observer actually
utilizes the information conveyed to it by the
demonstrator(s).

Galef (1983) has identified several capabilities
that the recipient of information must have in order to
effectively process incoming information from several
conspecifics. First, the rat must be able to acquire
sufficient information from each of the successive
foragers in order to identify each diet message.
Second, the rat must be able to encode the information
in separable units for each encounter. Third, the
animal must be able to hold the information in storage
until it is ready for retrieval.

In order to test the cognitive capabilities of the
animals, an experiment was designed in which the

observer was exposed to a series of four demonstrators, each of which had been given a different diet message (Galef, 1983). Subsequently, the animals were tested by presenting them with two test diets, one of which was novel, and the second of which had previously been eaten by one of the four demonstrators. The results of this experiment showed that the observer was able to differentiate between the two test diets by selecting the diet that it had previously been exposed to via one of its four demonstrator partners. The next question asked by Galef (1983) concerned the duration of such memory storage. In a subsequent experiment, the observers were divided into five groups: 0-, 6-, 12-, 24-, or 48-hr delay following the demonstrator-observer interaction. Results showed that under the 0-, 6-, and 12-hour delay conditions, the observer still exhibited an enhanced preference for the diet of its paired demonstrator. In the 24- and 48-hr delay conditions, the animals showed no specific diet preference. Hence, an observer appears capable of storing and retrieving informaiton for up to 12 hours.

Despite the information that has been gathered, there are additional issues involving the transfer-of-information effect that must be resolved. A previous set of experiments (Davis, Richard, & Burke,

1986; Richard, Harrell, Davis, Wurtz, & Burns, 1986)
conducted in onr laboratory sought to replicate and
extend the original Galef studies. Other than testing
observers for food preference in a three-choice wooden
maze (Galef, 1983; Galef & Wigmore, 1983), it does not
appear that this phenomenon has been evaluated in other
than suspended wire cages in the laboratory. Hence, the
purpose of onr first experiment was to determine if
appropriate food-choice behavior would be displayed in a
more naturalistic environment, such as the free-foraging
situation offering access to six food sources. The
results of this exneriment were in agreement with those
of Galef and his colleagues. The finding that an
observer placed in the open-field foraging laboratory
will seek out the specified diet consumed by its
demonstrator from amongst several food sources is
impressive. However, rats are seldom afforded the
opportunity to forage in isolation. Thus, we conducted
a second experiment in which two observers were
concurrently exposed to the foraging laboratory
following interaction with the same demonstrator. It
was our intent to explore the animal-animal interactions
between the two observers and to determine if these
interactions interfered with retention of the original
diet message. The results of this experiment clearly

indicated that pairs of observers given the same diet
information will seek out and consume the diet of their
demonstrator partner. In addition to showing support
for the transfer of information phenomenon, the data
provided pertinent information about observer-observer
behavior. By way of closed circuit television,
interactive behaviors were identified and quantified.
We found that both observers spent significantly more
time in contact with the appropriate food patches and
that their first major eating bout tended to occur on an
appropriate diet patch. These data suggest that the
message provided by the demonstrator is quite robust and
capable of withstanding animal-animal interactions,
especially those in which one or both members of the
pair had previons contact with a non-demonstrator food
patch. In view of these findings, one must qnestion the
effect that two observers would have on foraging
behavior if each observer was given a different diet
message. The present stndy is designed to specifically
evaluate this issue.

CHAPTER 2

METHOD

Subjects

Forty, 90-day old male Holtzman rats served as
subjects. The animals were maintained on ad lib food
and water in individual wire-mesh cages, with the
exception of the conditions mentioned below. The
animals were randomly assigned to four groups ($\underline{n}$ = 10):
Demonstrator 1 (DEM1), Observer 1 (OBS1), Demonstrator 2
(DEM2), and Observer 2 (OBS2). Subsequently, one
subject from each group was randomly assigned to a
permanent DEM1-OBS1-DEM2-OBS2 squad. In each of the ten
squads, the DEM1-OBS1 pair received the Cinnamon
condition (CIN), whereas the DEM2-OBS2 pair received the
Cocoa condition (COC).

Apparatus

Demonstrator chambers. Demonstrators received
experience with their assigned test diet in a 10 g,
glass aquarium (25.00 cm wide, 45.00 cm long, 30.00 cm
high). Four such chambers, two for the habitnation of
the two demonstrators, one for the cinnamon (CIN) test
diet, and one for the cocoa (COC) test diet, were
located in a room adjacent to the general animal colony.
A 4.00 cm layer of San-I-Cel animal bedding material
(Paxton Processing Co., Paxton, IL) comprised the floor

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of each enclosure.

Interaction chambers. Because the groups consisted
of both a CIN demonstrator-observer pair, and a COC
demonstrator-observer pair, independent interaction
chambers identical to the ones described above were
utilized.

Foraging laboratory. A 8.23 m by 2.21 m room, as
shown in Figure 1, served as the foraging laboratory.
The floor of the foraging lab was covered with 300 lbs
of San-i-cel, average depth of 2.00 cm, in order to
provide a more naturalistic environment. Six foraging
patches were situated on the floor of the foraging lab.
Each patch consised of a piece of pine lumber to which
the bottom portion of a one-gallon, plastic milk carton
had been stapled. Subjects were given access to food
via plastic tumblers which were attached with velcro
fasteners to the center of the milk carton. The food
cups were then surrounded with clay kitty letter to
provide support and avoid spillage.

Procedure

In order to provide some degree of
generalizability, the diets developed by Galef and his
colleagues (e.g., Galef, 1983; Galef, Kennett, &
Wigmore, 1984) were employed. Six days prior to
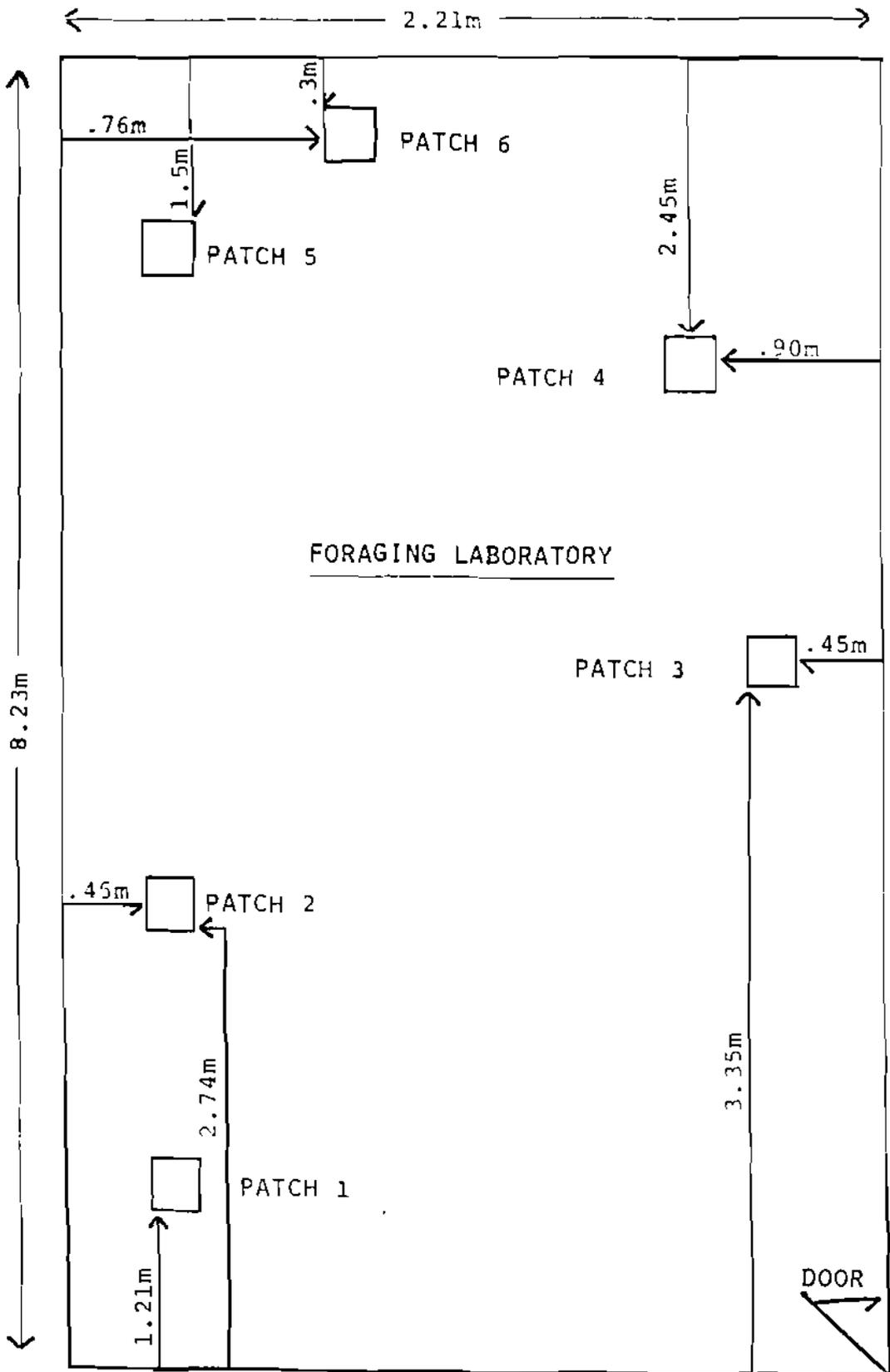diet-preference testing, the four animals in the

FIGURE 1: Diagram of the foraging laboratory. Three patches contained the cinnamon diet (CIN), and three patches contained the cocoa diet (COC) during diet-preference testing.

designated squad were placed ou food deprivation for 24

hr. Subsequently, the DEM subjects received a 24-hr

habituation session in the separate demonstrator

chambers, which contained unadulterated, powdered Purina

Laboratory Rodent Chow and a full water hottle. During

this time, the OBS animals received a 24-hr habituation

session in the foraging laboratory with powdered Purina

Laboratory Rodent Chow available at each patch. Water

was available in the foraging lab, via four 50-ml

centrifuge tubes. Upon completion of the habituation

session, the DEM animals and OBS animals were placed

together in a double-size suspended cage (42.5 cm x 24

cm x 17.5 cm; Wahmann Co., Baltimore, MD) in the

vivarium with food and water freely available.

Twenty-four hr prior to diet preference testing all

animals were again placed on food deprivation.

Twenty-three hr later, the DEM animals were transported

to separate test rooms and allowed 30-min access to the

specified test diets, one received CIN, while the other

received COC. The CIN diet consisted of powdered Purina

Laboratory Rodent Chow into which 1%, by weight,

McCormick's ground cinnamon was blended. The COC diet

consisted of 2%, by weight, Hershey's pure cocoa blended

into the powdered Purina Laboratory Rodent Chow.

Following exposure of the DEM animals to their

appropriate test diets, they were placed with their respective observers, in the interaction chambers for 30 minutes. The OBS animals were then taken directly to the foraging laboratory for a two hour preference test session.

During diet-preference sessions, three foraging patches contained the CIN diet (40-60 g each), while the remaining three patches contained the COC diet (40-60 g each). The initial determination of the three CIN and three COC patches was random, but remained in effect for the testing of all OBS pairs. Water was available throughout the testing session. The order for testing the four-animal sub-groups was randomly determined.

CHAPTER 3

RESULTS

An analysis of variance (see Kirk, 1982)
incorporating one between subjects factor (Type of
Demonstrator: CIN versus COC) and one within subjects
factor (Type of Diet: CIN versus COC) was performed on
the mean food consumption scores. Likewise, an analysis
of variance was performed on the mean
time-of-patch-contact scores, which considered the main
effects of Type of Observer (CIN versus COC) and Type of
Diet (CIN versus COC). Simple main effects analyses
were used to probe significant interaction effects. In
order to compare the first major eating bouts of the CIN
and COC observers, a chi-square analysis was employed.

Following the completion of each preference test
session, the amount of food consumed (g) was determined
for each patch. The three CIN and three COC scores were
then added together to yield a single CIN consumption
score and a single COC consumption score for each OBS
pair. It was expected that the pairs of observers would
preferentially consume a different diet, thus,
comparable CIN and COC consumption scores would be
predicted. Analysis of variance supported this
prediction, $\underline{F}(1, 8) = 1.09$, n.s.

The behavior of each observer pair was viewed on

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closed circuit television during the two hour preference test. The following behaviors were recorded for each OBS animal: (1) patch contact scores (specific patch contacted and the duration of the contact), and (2) interaction scores (the amount of time spent in physical contact between the two OBS animals). Each member of the OBS pair was independently viewed by a separate experimenter with the assignment of the specific OBS animal being random at the start of each test session.

Mean time-of-patch-contact scores for the first 20 patches contacted were analyzed, and the results are shown in Figure 2. Analysis of variance of these scores yielded significance for the Type of Observer x Type of Diet interaction, $\underline{F}(1, 18) = 7.531$, $\underline{p} = .012$. Simple main effects analyses employed to probe this interaction indicated that the CIN observers spent significantly more time, $\underline{F}(1,36) = 4.86$, $\underline{p} < .05$, contacting cinnamon patches, while COC observers spent significantly more time, $\underline{F}(1, 36) = 4.18$, $\underline{p} < .05$, contacting cocoa patches. Additionally, the occurrence of the first major eating bout, defined as a patch contact of 30 sec duration or longer, for both the CIN and COC observers were considered. For the CIN observers, 8 of 10 such feeding bouts occurred at cinnamon patches, while 9 of 10 such bouts occurred at cocoa patches for the COC
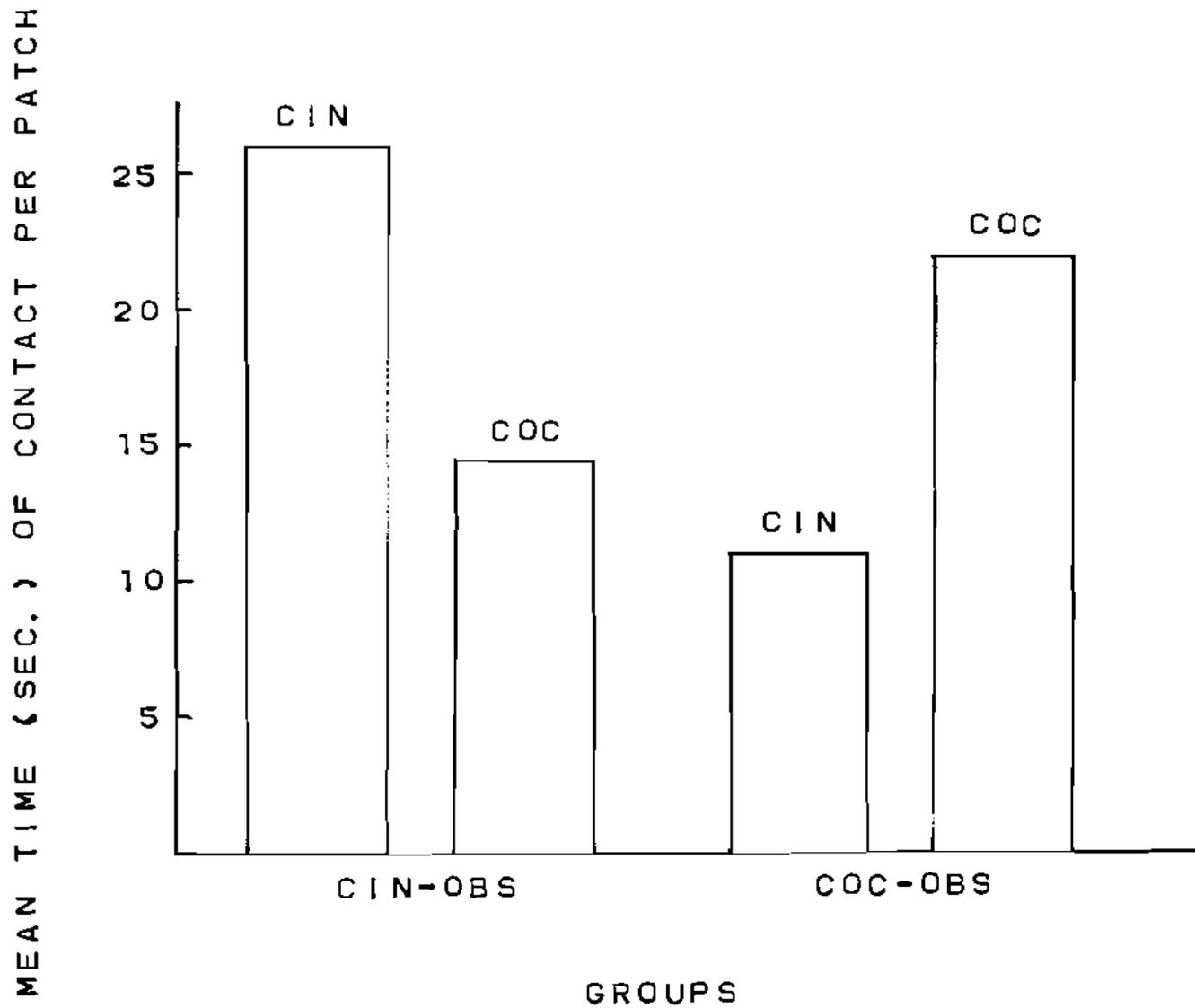
FIGURE 2: Mean time-of-patch-contact scores (seconds) as a function
of Type of patch and Type of Observer.

observers, χ^2 (1) = 7.27, $\underline{p}$ < .01. Clearly, these results indicate that the message originally provided to each observer is quite pervasive and resistant to change by a variety of factors.

CHAPTER 4

DISCUSSION

To recapitulate, the purpose of the present study
was to assess the extension of the transfer of
information findings to the free foraging situation.
More specifically, the present study sought to evaluate
the animal-animal interactions and the effect of these
interactions when considering the presence of two
observers that had been given different diet messages.

This experiment extends the initial work of Galef
and his colleagues (e.g., Galef, 1983; Galef, Kennett, &
Wigmore, 1984; Galef, & Stein, 1985; Galef & Wigmore,
1983) in several important ways. First, it demonstrates
that the transfer of inforamtion phenomenon can be
generalized to the open-field foraging situation. This
generalization is quite impressive when one considers
the fact that the animals were confronted by six eating
sites to choose from, compared to only two containers
employed in the previous studies. Additionally, the
present data support a second generalization. As the
previous studies reported by Galef and his colleagues
have employed hooded rats as subjects, the present
experiment involved the use of albino rats, clearly
supported the generalization of this behavior to a
second strain of rats.

The robustness of this phenomenon is displayed further when one considers the dependent variable measures presented in this study which were the time-of-patch-contact scores, and the occurrence of the first major eating bout. It has been established in a previous experiment (Davis, Richard, & Burke, 1986) involving the foraging laboratory that a message simultaneously transmitted by a single demonstrator to two observers can endure direct contacts with the second observer. The present experiment extended these results by showing that two observers independently provided different food-type messages prior to a joint foraging session chose those patches containing the diet that corresponded to that of their respective demonstrator partner.

Given these results, one might conclude that some rather dramatic event must occur to modify the demonstrator's message once it has been processed by the observer. Thus, the interaction of observers that had just consumed an alternate food is insufficient to alter the message. The lack of effective observer-observer communication suggests that animals may need to have food-stuff present in the digestive system for a certain period of time for the transmission of diet-preference information to be successful. Sufficient time in the

digestive tract may not have elapsed in the present

study for the non-demonstrator foods to become effective

cues for transmission. It will be recalled that Galef

and Stein (1985) reported positive effects when the

mouth of the demonstrator was contacted, when the

stomach was loaded, and when a rat (not a surrogate) was

employed to transmit the cues. These data would appear

to be supportive of the type of mechanism proposed here.

As stated, the results of the present study extend

the transfer of information phenomenon to the

free-foraging situation. Additionally, the results

reiterate the importance of the demonstrator by

indicating that animal-animal contacts between the two

observers with different diet messages have no effect on

the original demonstrator message. Thus, the mean

time-of-patch-contact scores and the occurrence of the

first major eating bouts were in accordance with the

appropriate type of demonstrator and type of patch

contact. However, the picture is still unclear

concerning rodent foraging behavior. When given

multiple diet messages, with all of the specific foods

accessible for consumption, which diet message would the

animal attend to? Hence, in this situation one might

successively expose a single observer to a CIN

demonstrator and then to a COC demonstrator (and vice

versa) and then record the observer's diet preference.
Such an experiment would address the importance of
primacy versus recency of demonstrator's message to the
observer. Another possible research issue would be to
explore the direct transfer of information concerning a
food aversion, rather than a preference. These research
topics have been briefly addressed in the literature.
However, additional studies are warranted to provide a
greater understanding of the mechanisms involved in the
transmission of diet information.

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