CHAPTER 23

Vigilance and the Group-size Effect: Observing Behavior in Humans

JOANNA E. SCHEIB[1], LISA E. CODY[2], NICOLA S. CLAYTON[3], AND ROBERT D. MONTGOMERIE[4]
[1]*Department of Psychology, University of California, Davis, CA 95616, USA*
[2]*Animal Behavior Graduate Group, University of California, Davis, CA 95616, USA*
[3]*Experimental Psychology, University of Cambridge, Downing St., Cambridge, CB2 3EB, UK*
[4]*Department of Biology, Queen's University, Kingston, ON K7L 3N6, Canada*

INTRODUCTION

Many animals look up and scan the environment while they are eating. This scanning and alert behavior is called **vigilance** and can serve many functions (e.g., Lima 1990), the best understood one being predator detection (Caraco et al. 1980; Glück 1987; Lendrem 1983). A widely studied phenomenon is the "**group-size effect**," whereby **vigilant behavior**, operationalized as the frequency and/or duration of scans, decreases as the group size increases. Such a pattern has been observed in many nonhuman animals, including birds, mammals, and fish—species in which individuals associate with two or more conspecifics and thereby constitute a group (e.g., Bertram 1980; Caraco 1979; Godin et al. 1988; Holmes 1984; Roberts 1996; Studd et al. 1983; Sullivan 1984; but also see Treves 2000). The group-size effect has also been observed in humans (Barash 1972; Wawra 1988;

ISBN 0-12-558330-3

Wirtz & Wawra 1986), despite the virtual absence of predation in modern human societies. Thus the group-size effect in humans may be a relic of selection in the evolutionary environment of our ancestors.

The group-size effect has generally been attributed to the influence of predation risk on the behavior of individuals. For example, because every group member benefits when a predator is detected, individuals can reduce their own scanning rate, without decreasing the probability of predator detection, if all group members do some scanning for predators (Pulliam 1973). This is called the **many-eyes hypothesis**. An alternative, called the **dilution hypothesis**, states that an individual's chance of being caught by a predator during a given predator attack decreases as the group size increases (Hamilton 1971). Thus an individual's predation risk is dependent not on the vigilance of its foraging partners, as in the many-eyes hypothesis, but merely on their presence. As a result, an individual's scanning rate should decline as group size increases. There are at least two other factors, however, that could explain the group-size effect in the *absence* of predation risk (or at least are not relevant to predation risk). The first suggests that vigilance is related to competition for food within the group. As foraging group size increases, so does the competition for food within a foraging patch. Thus the observed decrease in vigilance with increasing group size may be a result of the need to spend more time foraging in the face of competition with other individuals (the **food competition hypothesis**; Bertram 1978). The final hypothesis suggests that the vigilance of group members may be directed toward detection of conspecifics rather than of predators. In social groups, the detection of conspecifics might be important, for example, for signaling status, avoiding dominant individuals, attracting potential mates, or guarding current mates. To the best of our knowledge, this **conspecific detection hypothesis** has never been tested, even though it may be particularly applicable to humans.

MATERIALS

You will need 1–2 of each of the following items per group of observers: pencil and eraser, clipboard, scanning data sheets (enough for each recording period), and stopwatch or wristwatch with a timer.

HYPOTHESES AND PREDICTIONS

Do exercise (i) and your choice of any *one* of exercises (ii), (iii), and (iv). Exercises (ii) through (iv) will give you an opportunity to examine the *function* of the group-size effect in humans.

Exercises

(i) Examining the Effect of Group Size on Vigilant Behavior

The size of a group is hypothesized to influence vigilant behavior in humans. As group size increases, an individual's scanning frequency and duration are expected to decrease. To test this, you will need to observe the behavior of focal subjects in groups of different sizes. First identify the sizes of groups you will observe, and then determine how you will operationalize scanning behavior. What do you predict will happen if the group-size effect is observed? What do you predict will happen if the effect is not observed? Further details on how to test the group-size effect are provided in the "Procedure" section.

(ii) Testing between the Dilution and Many-Eyes Hypotheses

The group-size effect has generally been attributed to the influence of predation risk on the behavior of individuals. The dilution and many-eyes hypotheses may help explain how this effect happens. The dilution hypothesis states that an individual's chance of being caught by a predator during a given predator attack decreases as the group size increases. Thus an individual's predation risk depends simply on the presence of its foraging partners. Alternatively, according to the many-eyes hypothesis, an individuals predation risk is dependent not on the mere presence of foraging partners but on their vigilance. If all group members do some scanning for predators, each individual is hypothesized to be able to reduce her or his own amount of scanning as the size of the group increases. One way to test between these alternative hypotheses is to measure how occupied the group members are (e.g., the amount of conversation). In this case, you would not need to vary the group size but would instead do all your observations on focal subjects in the same-size groups. What do you predict will occur if the dilution hypothesis is correct? What do you predict will occur if the many-eyes hypothesis is correct? Details on how to test these hypotheses are provided in the "Procedure" section.

(iii) Testing between the Predation Risk and Food Competition Hypotheses

Although the group-size effect has generally been attributed to the influence of predation risk, competition with foraging partners may also or may instead explain this effect. A general predation risk hypothesis states that as group size increases, an individual will decrease the amount and duration of her or his scanning for predators [this can be due to dilution or to many-eyes effects; see exercise (ii)]. Alternatively, the food competition hypothesis states that an individual will decrease scanning as group size increases, not because of reduced predation risk but because of the need to spend more time foraging in the face of competition with other individuals. One way to test between these alternative hypotheses is to compare the vigilance of focal subjects in groups who are sharing their food to that in groups who are not sharing. In this case, you would not need to vary the group size but would instead do all your observations on focal subjects in the same-size groups. What do you predict will occur if the predation risk hypothesis is correct? What do you predict will occur if the food competition hypothesis is correct? Further details on how to test these hypotheses are provided in the "Procedure" section.

(iv) Testing between the Predation Risk and Conspecific Detection Hypotheses

The conspecific detection hypothesis is another alternative explanation of the group-size effect that is not related to the influence of predation risk. This hypothesis states that an individual will decrease scanning behavior as group size increases, not in response to predation risk but because of the possibility of detecting conspecifics who might be passing by. One way to test between the predation risk and conspecific detection hypotheses is to compare the vigilance of focal subjects in groups who are exposed to high and low amounts of people traffic (e.g., how many people are walking within sight of the focal group or how crowded the eatery is). In this case, you would not need to vary the group size but would instead do all your observations on focal subjects in the same-size groups. What do you predict will occur if the predation risk hypothesis is correct? What do you predict will occur if the conspecific detection hypothesis is correct? Further details on how to test these hypotheses are provided in the "Procedure" section.

PROCEDURE

(i) Examining the Effect of Group Size on Vigilant Behavior

Work in pairs. For each pair of observers, one person will watch the scanning behavior of focal subjects eating in groups of 1–5 individuals; the other observer will record the data on the data sheet. To avoid possible confounds, we recommend that you focus on foraging groups that are entirely women or men and that the watcher be the same sex as your subjects (a woman observes women, and a man observes men). Select one kind of eating place in which you will observe your subjects, and focus on places where people are either sharing or not sharing food. To minimize potential confounds, make sure you record the time of day and location of your observations and keep these the same for each trial, because scanning behavior and group dynamics may differ among the various locations and with the time of day.

It will take approximately 6 hours to conduct the observations for this lab. Spend the first hour collecting pilot data so that you will be confident of how best to record your data and can assess what the problems and pitfalls might be. Collect pilot data for at least two individuals from groups of three different sizes (e.g., individuals alone, with one other person, and with two or more people). Think about what time of day it would be best for you to collect your data, bearing in mind not only your schedule but also when the probability will be highest of collecting good data. For example, you are more likely to see people eating, both alone and in groups, around common mealtimes—a somewhat obvious but nonetheless important consideration. Once you have a well-designed protocol, you can use the other 5 hours for collecting your data.

In each group that you study, you will be collecting vigilance data from only one member of the group. This individual is called the focal subject and is chosen randomly. Select your observation site carefully so that you can easily watch your focal subject and he or she is not aware of being watched. For this reason, we suggest that you sit at least 3 meters away, in a position where you can see your focal subject clearly. To test for the group-size effect, observe the scanning behavior of focal subjects (1) eating alone, (2) eating with another individual, and (3) eating in a group of either 3, 4, or 5 individuals (choose *one* of group size 3, 4, or 5). You will need to observe one focal subject for 5 minutes in at least 10 different groups per group size studied (not including pilot data).

Key variables to record for each foraging group include the number and sex of people eating at the table, the sex of the focal subject, the facial orientation of the focal subject with respect to you (head on, side on, etc.), the number of times the focal subject looked up and scanned (with head or eyes only), and the length of time spent scanning. Make sure that for each scanning bout recorded during a trial, you record the time at which the subject first looked up and the time at which the subject resumed looking down. Looking directly at another person at the same table should not be counted as scanning behavior. Use your pilot observations to decide how you will measure scanning behavior, and what criteria you will use. One consideration might be how much the looking-down gaze has to change to be recorded as the end of a scan. Another consideration will be how to record scans that are very short. If scans are less than 2 seconds in length, the recording durations can become very imprecise. How will you overcome this problem? Be consistent and use the same criteria and definition of scanning for every trial. You might also want to think about the order of testing and to ensure that you do not make all your observations of one group size during a single block of time.

Once you have determined how you will measure scanning behavior, each pair should perform an interobserver reliability test (do this while collecting pilot data). This test ensures that both observers measure and record behavior in the same way. To perform this test, both members of a pair measure and record the scanning behavior of focal individuals during the same 5-minute sample for each of the three group sizes. Members of each pair then compare results to ensure 90–95% agreement. Pairs should continue reliability tests until this level of agreement is achieved.

Plan to make use of partial sample periods only if they are at least 3 minutes long (sample periods may be shorter than 5 minutes as a result of changes in group-size, the departure of your focal subject during observation, etc.). Calculating the scanning rate (scans per minute) helps to control for variation in length of sample periods. Also, if a 5-minute sample interval ends while your focal subject is engaged in a scanning bout, you may include this bout in calculating the focal subject's scanning rate, but you should not include it in your calculation of the mean scanning bout duration for that subject.

Things to Think About

In this lab, you will need to decide how you are going to watch the subjects, when and where, and what factors you should try to control for. Please consider the privacy and welfare of your subjects and be as nonintrusive as possible, for their sakes and yours! Be prepared to deal with people who question you about why they are being observed. Your instructor may provide suggestions on how to do this.

(ii) Testing between the Dilution and Many-Eyes Hypotheses

Follow procedure (i), with the following modifications. (1) One person will observe and record the scanning behavior of the focal subject, while the second will observe and record the amount of conversation in the group. (2) Study only one group size between 2 and 5 individuals. You will still need to observe 30 focal subjects for a period of 5 minutes per subject, but this time make sure that at least 15 of the subjects belong to groups in which the members are talking, because you will need to compare the scanning behavior of subjects in groups exhibiting low vs high amounts of conversation. You can define low vs high amounts of conversation by categorizing the groups that fall below the median conversation time as the low-conversation groups and those that fall above the median as the high-conversation groups. As in procedure (i), do all your observations at the same time of day, focus on places where people are either sharing or not sharing food, and collect data on one focal subject per group. (3) Conversation time needs to be measured and then is calculated as the total time that group members spent talking in the 5-minute sample interval. Remember that looking directly at another person at the table does not count as scanning behavior.

(iii) Testing between the Predation Risk and Food Competition Hypotheses

Follow procedure (i), with the following modifications. Study only one group size between 2 and 5 individuals. You will still need to observe 30 focal subjects for a period of 5 minutes per subject, but this time make sure that 15 of the subjects belong to groups in which the members are sharing food, because you will need to compare the scanning behavior of subjects who are sharing food to that of those who are not. Be sure to do all your observations in the same eating place and where people are likely to be sharing food (e.g., pizza, fondue, or Chinese food). As in procedure (i), do all your observations at the same time of day and collect data on one focal subject per group.

(iv) Testing between the Predation Risk and Conspecific Detection Hypotheses

Follow procedure (i), with the following modifications. (1) Study only one group size between 2 and 5 individuals. You will still need to observe 30 focal subjects for a period of 5 minutes per subject, but this time make sure that 15 of the focal groups are in crowded (high-traffic) eateries and the other 15 are fairly isolated (low-traffic places where there are few other groups). As with procedure (i), do all your observations at the same time of day, focus on places where people are either sharing or not sharing food, and collect data on one focal subject per group. Also record the number of actual interactions (talking, waving, nodding, smiling) with passersby. (2) For each focal group, record the number of passersby as an index of the amount of traffic during your observation period (e.g., number of people walking within 5 meters of the focal group).

DATA RECORDING AND ANALYSES

Sample data sheets for each exercise are provided at the end of this chapter. Once you have recorded all your data, you can calculate the mean frequency of scanning per minute (rate) and the mean scanning bout duration for all focal subjects.

(i) Examining the Effect of Group Size on Vigilant Behavior

Calculate the mean scanning rate and the mean scanning bout duration for each experimental condition (e.g., for group sizes 1, 2, and 4 people). Because you are using mean scores to summarize the data, also calculate a measure of variance, such as the standard error, for each of the two mean scores in each condition. These means and measures of variance will help you compare behavior across the three conditions and will give you an idea whether your data support your experimental hypothesis (vigilance decreases with increasing group size) or the null hypothesis (vigilance does not differ across conditions). To test whether there is a statistical difference in the subjects' vigilance across the three conditions, use one-way analysis of variance (ANOVA).

(ii) Testing between the Dilution and Many-Eyes Hypotheses

Calculate the mean scanning rate and the mean scanning bout duration for each experimental condition (that is, for the high-conversation groups and for the low-conversation groups). Because you are using mean scores to summarize the data, also calculate a measure of variance, such as the standard error, for each of the two mean scores in each condition. These measures will help you compare behavior in the two conditions and will give you an idea whether your data support the many-eyes hypothesis (less vigilance is observed among the high-conversation groups than among the low-conversation groups) or the dilution hypothesis, which in this case is also the null hypothesis (vigilance does not differ between conditions). To test whether there is a statistical difference in the subjects' vigilance in the low- vs high-conversation groups, use independent-samples t tests.

(iii) Testing between the Predation Risk and Food Competition Hypotheses

Calculate the mean scanning rate and the mean scanning bout duration for each condition (that is, for groups who share food and for those who do not). Because you are using mean scores to summarize the data, also calculate a measure of variance, such as the standard error, for each of the two mean scores in each condition. These measures will help you compare behavior in the two conditions and will give you an idea whether your data support the food competition hypothesis (less vigilance is observed in groups who are sharing food than in those who are not) or the predation risk hypothesis, which in this case is also the null hypothesis (vigilance does not differ between conditions). Use independent-samples t tests to determine whether there is a statistical difference between the scanning behavior of subjects who share food and that of those who do not.

(iv) Testing between the Predation Risk and Conspecific Detection Hypotheses

Calculate the mean scanning rate, the mean scanning bout duration, and the mean number of interactions per passersby for each condition (that is, for groups in high-traffic and low-traffic areas). Because you are using mean scores to summarize the data, also calculate a measure of variance, such as the standard error, for each of the two mean scores in each condition.

These measures will help you compare behavior in the two conditions and will give you an idea whether your data support the conspecific detection hypothesis (more vigilance is observed in groups located in high-traffic areas than in groups located in low-traffic areas) or the predation risk hypothesis, which in this case is also the null hypothesis (vigilance does not differ between conditions). Use independent-samples *t* tests to test whether there is a statistical difference between the subjects' vigilance in low- and high-traffic areas.

For All Exercises

Provide graphical representation(s) (such as a table or figure) of your results. Please remember to label the axes and to include standard error bars in your figure. Note that you will need to do a separate test for each of your dependent measures (scanning rate and bout duration). Please see your instructor if you need help analyzing your data.

QUESTIONS FOR DISCUSSION

If you do not find an effect of group size on vigilant behavior in humans, what implication does this hold for proceeding with exercises (ii), (iii), and (iv)?

Are the dilution and many-eyes hypotheses necessarily mutually exclusive? Justify your answer.

Why did you use only one group size when testing between (1) the dilution and many-eyes hypotheses, (2) the predation risk and food competition hypotheses, and (3) the predation risk and conspecific detection hypotheses?

What do we assume when we use the amount of conversation as a method of testing between the dilution and many-eyes hypotheses?

What do we assume when we use sharing food vs not sharing food as a way to test between the predation risk and food competition hypotheses?

What do we assume when we use high-traffic vs low-traffic areas as a way to test between the predation risk and conspecific detection hypotheses?

Why is it important to examine the behavior of individuals in single-sex groups? Why should the observer be the same sex as the focal subject?

Aside from the hypotheses used in the exercises, what alternative explanation(s) could account for the group-size effect in humans? Might these hypotheses be applicable to other animals?

What further experiments would you conduct to better understand the group-size effect in humans?

Interpret your results in an evolutionary framework.

Do you think results obtained in these exercises, with modern humans, reflect the behavior of humans throughout their evolution?

Which of the hypotheses and results do you think are unique to humans? Which of the hypotheses and results would you expect to find in nonhuman animals?

ACKNOWLEDGMENTS

This lab was originally designed by Montgomerie for his behavioural ecology and sociobiology course at Queen's University in the late 1980s and was modified and expanded by Scheib, Cody, and Clayton for their animal behavior courses at UC Davis in the late 1990s. All authors contributed to the preparation of this manuscript. We thank D. Owings and L. Miyasoto for their assistance with this lab during the UCD winter animal behavior course. We thank Matthew Campbell, Liza Moscovice, Bonnie Ploger, and Ken Yasukawa for helpful comments on an earlier draft of this paper.

LITERATURE CITED

Barash, D. P. 1972. Human ethology: the snack-bar security syndrome. *Psychological Reports*, **31**, 577–578.

Bertram, B. C. R. 1978. Living in groups: predators and prey. In: *Behavioural Ecology* (ed. J. R. Krebs & N. B. Davies), pp. 64–96. Oxford: Blackwell Scientific.

Bertram, B. C. R. 1980. Vigilance and group size in ostriches. *Animal Behaviour*, **28**, 278–286.

Caraco, T. 1979. Time budgeting and group size: a test of theory. *Ecology*, **60**, 618–627.

Caraco, T., Martindale, S. & Pulliam, H. R. 1980. Avian time budgets and distance to cover. *Auk*, **97**, 872–875.

Glück, E. 1987. An experimental study of feeding, vigilance, and predator avoidance in a single bird. *Oecologia*, **71**, 268–272.

Godin, J.-G., Classon, L. J. & Abrahams, M. V. 1988. Group vigilance and shoal size in a small characin fish. *Behaviour*, **104**, 29–40.

Hamilton, W. D. 1971. Geometry for the selfish herd. *Journal of Theoretical Biology*, **31**, 295–311.

Holmes, W. G. 1984. Predation risk and foraging behavior of the hoary marmot in Alaska. *Behavioral Ecology and Sociobiology*, **15**, 293–301.

Lendrem, D. W. 1983. Predation risk and vigilance in the blue tit (*Parus caeruleus*). *Behavioral Ecology and Sociobiology*, **14**, 9–13.

Lima, S. L. 1990. The influence of models on the interpretation of vigilance. In: *Interpretation and Explanation in the Study of Animal Behavior*, Vol. 2 (ed. M. Bekoff & D. Jamieson), pp. 246–267. Boulder: Westview Press.

Pulliam, H. R. 1973. On the advantages of flocking. *Journal of Theoretical Biology*, **38**, 419–422.

Roberts, G. 1996. Why individual vigilance declines as group size increases. *Animal Behaviour,* **51**, 1077–1086.

Studd, M., Montgomerie, R. D. & Robertson, R. J. 1983. Group size and predator surveillance in foraging house sparrows (*Passer domesticus*). *Canadian Journal of Zoology,* **61**, 226–232.

Sullivan, K. A. 1984. The advantages of social foraging in downy woodpeckers. *Animal Behaviour,* **32**, 16–22.

Treves, A. 2000. Theory and method in studies of vigilance and aggregation. *Animal Behaviour,* **60**, 711–722.

Wawra, M. 1988. Vigilance patterns in humans. *Behaviour,* **107**, 61–71.

Wirtz, P. & Wawra, M. 1986. Vigilance and group size in *Homo sapiens*. *Ethology,* **71**, 283-286.

ADDITIONAL SUGGESTED READING

Bertram, B. C. R. 1978. Living in groups: predators and prey. In: *Behavioural Ecology* (ed. J. R. Krebs & N. B. Davies), pp. 64–96. Oxford: Blackwell Scientific.

Lima, S. L. 1990. The influence of models on the interpretation of vigilance. In: *Interpretation and Explanation in the Study of Animal Behavior,* Vol. 2 (ed. M. Bekoff & D. Jamieson), pp. 246–267. Boulder: Westview Press.

Roberts, G. 1996. Why individual vigilance declines as group size increases. *Animal Behaviour,* **51**, 1077–1086.

Treves, A. 2000. Theory and method in studies of vigilance and aggregation. *Animal Behaviour,* **60**, 711–722.

Wirtz, P. & Wawra, M. 1986. Vigilance and group size in *Homo sapiens*. *Ethology,* **71**, 283–286.

Sample Data Sheet, Exercise (i)

Sample data sheet for (i), vigilance and group size					
Copy 10 sheets for each group size, Use 1 sheet per focal subject.					
Behavioral codes:					
Subject's facial orientation relative to observer = (H) head on, (S) side on					
Use military time for scanning durations (e.g., 8:30:45 a.m. = 08:30:45, 5:25:23 p.m. = 17:25:23).					
Length of focal sample will either be 5 minutes or somewhere between 3 and 5 minutes.					
Group 1: One individual					
Subject:	Sex:	Orientation:	Focal length:		
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Sample Data Sheet, Exercise (i)

Group 2: Individuals		f = focal, o = other (Make observations only for the focal.)			
Subject:	Sex(f, o):	Orientation:	Focal length:		
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Sample Data Sheet, Exercise (i)

Group 3: Individuals		f = focal, o = other (Make observations only for the focal.)			
Subject:	Sex(f, others):	Orientation:	Focal length:		
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Sample Data Sheet, Exercise (ii)

Sample data sheet for (ii), testing dilution vs many-eyes hypotheses					
Measuring scanning					
Copy enough sheets for 30 subjects.					
Behavioral codes:					
Subject's facial orientation relative to observer = (H) head on, (S) side on					
Use military time for scanning durations (e.g., 8:30:45 a.m. = 08:30:45, 5:25:23 p.m. = 17:25:23).					
Length of focal sample will either be 5 minutes or somewhere between 3 and 5 minutes.					
	f = focal, o = other				
Subject:	Sex (f, o):	Orientation:	Focal length:		
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
Subject:	Sex (f, o):	Orientation:	Focal length:		
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Sample Data Sheet, Exercise (ii)

Sample data sheet for (ii), testing dilution vs many-eyes hypotheses					
Measuring Conversation					
These data are collected simultaneously with scanning behavior, so Subject 1 here					
is the same as Subject 1 on the scanning data sheet.					
Copy enough sheets for 30 subjects.					
Subject:				f = focal, o = other	
Conversation Bout	*Start*	*Stop*	*Duration (s)*	*f, o?*	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
	Total duration (s) =				
Subject:				f = focal, o other	
Conversation Bout	*Start*	*Stop*	*Duration (s)*	*f, o?*	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
	Total duration (s) =				

Sample Data Sheet, Exercise (iii)

Sample data sheet for (iii), testing predation risk vs food competition hypotheses					
Copy enough sheets for 30 subjects.					
Behavioral codes:					
Subject's facial orientation relative to observer = (H) head on, (S) side on					
Use military time for scanning durations (e.g., 8:30:45 a.m. = 08:30:45, 5:25:23 p.m. = 17:25:23).					
Length of focal sample will either be 5 minutes or somewhere between 3 and 5 minutes.					
Group size =	individuals	f = focal, o = other			
Subject:	Sex (f, o):	Orientation:	Sharing food (y/n):	Focal length:	
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
Subject:	Sex (f, o):	Orientation:	Sharing food (y/n):	Focal length:	
	Day:	Location:	Appr. dist. from subject (m):		
Scans	*Start*	*Stop*			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Sample Data Sheet, Exercise (iv)

Sample data sheet for (iv), testing predation risk vs conspecific detection hypotheses				
Measuring scanning				
Copy enough sheets for 30 subjects.				
Behavioral codes:				
Subject's facial orientation relative to observer = (H) head on, (S) side on				
Interactions with passersby may be scored as (T = talked, S = smiled,				
N = nodded toward, W = waved at, P = physical contact)				
Use military time for scanning durations (e.g., 8:30:45 a.m. = 08:30:45, 5:25:23 p.m. = 17:25:23).				
Length of focal sample will either be 5 minutes or somewhere between 3 and 5 minutes.				
	f = focal, o = other			
Subject:	Sex (f, o):	Orientation:	Focal length:	
	Day:	Location:	Appr. dist. from subject (m):	
Scans	*Start*	*Stop*	*Interactions*	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
Subject:	Sex (f, o):	Orientation:	Focal length:	
	Day:	Location:	Appr. dist. from subject (m):	
Scans	*Start*	*Stop*	*Interactions*	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Sample Data Sheet, Exercise (iv)

Sample data sheet for (iv), testing predation risk vs conspecific detection hypotheses				
Measuring traffic				
These data are collected simultaneously with scanning behavior, so Subject 1 here				
is the same as Subject 1 on the scanning data sheet.				
Copy enough sheets for 30 subjects.				
Subject:				
Interval (Every 30 s)	*Number of People Walking within 5 m of Group*			
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
	Average number of people =			
Subject:				
Interval (Every 30 s)	*Number of People Walking within 5 m of Group*			
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
	Average number of people =			

EXPLORING ANIMAL BEHAVIOR IN LABORATORY AND FIELD

An Hypothesis-Testing Approach to the Development, Causation, Function, and Evolution of Animal Behavior

Edited by

Bonnie J. Ploger
Hamline University, USA

Ken Yasukawa
Beloit College, USA

ACADEMIC PRESS
An imprint of Elsevier Science

Amsterdam Boston London New York Oxford Paris San Diego
San Francisco Singapore Sydney Tokyo

Senior Publishing Editor	Charles R. Crumly, Ph.D.
Senior Project Manager	Julio Esperas
Product Manager	Anne O'Mara
Cover Design	Monty Lewis
Copyeditor	Connie Day
Production Services	Matrix Productions
Composition	International Typesetting and Composition
Printer	Edwards Brothers

This book is printed on acid-free paper. ♾

ON THE COVER: An adult great egret (Ardea alba) in breeding condition preens its feathers. Preening not only removes feather lice but also repairs small tears in feathers that interfere with their aerodynamic properties. Preening and other types of grooming behavior are useful for learning to describe behavior (chapter 1) because such behavior is frequent, easy to see, and consists of repeatable elements that are often fairly easy to sketch and describe. In a variety of birds, including egrets, some courtship displays probably evolved from preening movements. Possible evolutionary sequences of such displays can be explored by mapping the displays of related species onto a phylogenetic tree (chapter 35). Photograph by Bonnie Ploger.

Given a choice of large and small nuts of various nutritive values and differing shell thickness, this female Eastern gray squirrel (Sciurus carolinensis) seems to be thwarting the experiment by taking two different types of nut simultaneously! Her attempt ultimately failed because, unlike some ground squirrels such as chipmunks, gray squirrels do not have cheek pouches sufficiently large to carry multiple nuts of the sizes shown. Squirrels are excellent subjects for studying the economics of foraging (chapter 19). While foraging, squirrels are vulnerable to predators, but may reduce such risks by responding to alarm calls given by conspecifics or even other species that have detected predators (chapter 26). Photograph by Bonnie Ploger.

This male strawberry poison frog (Dendrobates pumilio) was photographed while climbing onto its display perch. Males display by giving loud clicking calls while perching conspicuously on slightly elevated sites near the ground that they may defend for a week or more. After attracting a female, a male cares for the fertilized eggs until they hatch and the female returns to carry each tadpole to a separate, tiny pool formed by leaves of bromeliad plants. The vocal displays of frogs and toads provide good opportunities for investigating variation in male courtship in the field (chapter 30). Tadpoles make interesting subjects for investigations of behavioral thermoregulation (chapter 6), aggregation and kin recognition (chapter 17). Photograph by Bonnie Ploger.

In many fish, it is the male that builds the nest, as this male dwarf gourami (Colisa lalia) is doing by blowing bubbles to form a foamy mass in the duckweeds at the surface of the water. With its thread-like pelvic fins extended forward, this male is also displaying to attract females and defend his nest from rival males. Male characteristics such as size, color and behavior can influence the outcome of territorial disputes between males, and male ability to attract females. In many common aquarium fish, these characteristics are easily manipulated to study mate choice (chapter 31). Photograph by Emory Matts.

ACADEMIC PRESS
An imprint of Elsevier Science
525 B Street, Suite 1900, San Diego, California 92101-4495, USA
http://www.academicpress.com

Academic Press
84 Theobald's Road, London WC1X 8RR, UK
http://www.academicpress.com

Library of Congress Control Number: 2002104257
International Standard Book Number: 0-12-558330-3

PRINTED IN THE UNITED STATES OF AMERICA
02 03 04 05 06 07 EB 9 8 7 6 5 4 3 2 1