The Determination of Environmental Enrichment in Laboratory Baboons (*Papio cyinocephalus*)

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ACKNOWLEDGEMENTS

I would like to thank the following people, for without their help this investigation would never have been completed: Dr. Bonnie Beaver, the staff at L.A.R.R., Todd C. Harris, Sandy Andrews, Stacy LeBlanc, my family, Charlotte Jamieson, Sharon Dent, the Honors Office at Texas A&M and of course the baboons!

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ABSTRACT

The purpose of this investigation was to determine the effects of rope pulling for a food reward as a method of environmental enrichment in laboratory baboons, measured by activity where cage size is limited and the animals are housed individually.

The investigation used six adult female baboons (Papio cyinocephalus) housed in one of two environments differing with regard to size. One style of cage had the dimensions 4' X 3' X 4', while the alternative design had the dimensions 8' X 4' X 8'. Prior to the investigation, each baboon was monitored using time lapse video tape equipment, such that a twenty-four consecutive hour period of activity was recorded to serve as a control. Following this initial taping, each baboon was conditioned to pull a rope for a food reward. Eventually, the animals would have to move to pull the rope and move again to receive the reward. Each animal was conditioned fifteen minutes per day for a total of for weeks. A second video taping followed the conditioning procedure using the same guidelines as the first taping.

Data was recorded based on the baboon's activity durations and locations to the nearest one minute of duration. Averages were obtained for pre- and post-conditioned animals of both groups. Comparisons were made

between the same group as well as between differing groups.

The results indicated that activity levels in the large caged group increased significantly ($P < .05$). In addition, the large caged animals displayed a greater degree of variability in both activity distribution and intensity regardless of conditioning. This may indicate that cage size alone has an effect upon behavior.

The rope pulling was an easily taught behavior and was received well by the baboons, as indicated by their motivation to manipulate it. This device has good potential as a self feeder and may become an effective environmental enrichment technique used to promote the psychological well being of primates.

INTRODUCTION

The enrichment of artificial environments has been a topic of growing concern for animal behaviorists (Broomstrand, Riddle, Alford and Maple, 1986; Tripp, 1985; Markowitz, 1982). With the growing concern in environmental enrichment, many zoos have moved towards naturalism. While this may provide an adequate "backdrop" for the animal, Hal Markowitz suggests that behaviors simply cannot be paralleled no matter how lush the exhibit (1982). The next progressive step would be to provide an environment which could increase the behavioral opportunities for the captive animal. Robert Yerkes in his book Almost Human (1925) states:

> ". . . If the captive [animal] cannot be given the opportunity to work for its living it should at least have abundant chances to exercise its reactive ingenuity and love of playing with things."

Apparently the United States Congress agrees with Mr. Yerkes. As of late 1985, Congress amended Section 13 of the Animal Welfare Act to include that research facilities provide "a physical environment adequate to promote the psychological well-being of primates."

Prior to Section 13, enrichment studies have been performed in zoos (Markowitz; Tripp) and in the Laboratory (Westergaard and Fragaszy; Broomstrand, Riddle, Alford and Maple. Levison and Levison described that rhesus monkeys (Macaca mulatta) deprived of early visual stimulation shortly after birth were less likely to seek out new visual stimuli than those monkeys who were not deprived (1971). While these studies have shown beneficial results correlating enrichment with activity, they all involve groups of animals in spacious environments. Wilson indicates that primates are strongly social animals who make diverse use of space and are susceptible to the influences of animate as well as inanimate spatial factors. With this in mind, it will be advantageous to study single animals in environments with reduced space to achieve an evaluation of environmental enrichment which may be meaningful to a laboratory research facility.

The purpose of this investigation is to determine the effects of rope pulling for a food reward as a method

environmental enrichment in laboratory baboons (Papio cynocephalus), measured by activity, where cage size is limited and animals are housed individually.

Materials and Methods

The subjects for this investigation were six adult female baboons (Papio cynocephalus). Prior to, and during the investigation, the baboons were individually housed in one of two different environments located at the Texas A&M Laboratory Animal Resource and Research Facility (LARR) where size of cage was the distinction. One style of cage was made of stainless steel with bars on five sides and a solid wall comprising the sixth side. Its dimensions were 4' X 3' X 4'. The alternative enclosure was also made of stainless steel, but had two solid sides and bars comprising the front, back, and top. Its dimension were 8' X 4' X 8'. Each cage regardless of size contained a waterer, feeder and perch. The watering device was a self waterer located in the back of the cage. The baboons were fed Purina Primate Chow in the morning and afternoon, with fruit being supplemented three times per week. All daily feeding and sanitary care was handled by the LARR personnel throughout the investigation. Each baboon was within visual and vocal communication with other baboons at all times. Three animals from each of the environmentally housed groups were selected for the investigation. Each group was treated independently, however they both followed the same experimental procedures.

Prior to behavior manipulation, each baboon's activity durations and locations were recorded over a twenty-six consecutive hour period using time lapse video tape equipment. This provided a base line for normal activity and thus served as a control.

After this initial taping, each baboon was conditioned to pull a rope in order to receive a food reward (peanut M&Ms). The rope was attached outside of the cage and placed through the bars in a position easily accessible to the animal. The reward was hand placed in the feeder from the opening outside of the cage, where the rope was first touched and later pulled. This phase of conditioning occurred over a two week period in which each baboon was conditioned once daily for a fifteen minute session.

A two week period on non-conditioning followed this initial rope pulling phase. Modification of this procedure was necessary for one individual and will be discussed further in the results.

Following this interim period, the rope was attached to a specially designed box located outside of the cage. By pulling the rope attached to this box, the baboon caused its own reward to be mechanically delivered into the feeder. Eventually, the position of the rope was moved such that the animal had to move to pull the rope and move again to obtain the reward. Each animal was conditioned once daily for a fifteen minute session over a two week period. The smaller caged group provided an exception to this schedule which

will be discussed further in the results.

After the move-pull-move-reward level of behavior, the activity duration and locations were monitored for each animal over a twenty-six consecutive hour period using time lapse video tape equipment. The pre- and post-conditioning video tapes were reviewed and the data was recorded with respect to the baboon's behavior and location quantified to the nearest one minute of duration. A twenty-four hour period (1440 minutes) was recorded for each baboon, such that the time required for feeding and sanitary maintenance was excluded from the original twenty-six hour observation period. Data was compiled and averages were obtained for pre- and post-conditioned baboons of both environmentally housed groups.

RESULTS

Procedure Modification

As previously mentioned, there were procedural modifications that had occurred during the investigation which need to be clarified. During the initial conditioning phase, individual 167 from the run caged group was very frightened by the presence of humans, especially males. This delayed the conditioning process. Therefore, it was necessary to extend the conditioning procedure for this animal into the two week interim period. This proved to be quite successful as indicated by the eagerness of the baboon to complete the rope pulling task at the end of this time.

An additional complication arose regarding members of

the small caged group. During the investigation, these animals were sold to another research facility located in Hawaii. As a result, the final rope pulling phase (move-pull-move-reward phase) was limited to one week instead of two weeks. However, after the first week, the animals were very motivated to perform their rope pulling task and thus the absence of the second week is not considered to affect the results.

Data Compilation

The data was recorded for each baboon over a twenty-four consecutive hour period in which activity durations and locations were quantified to the nearest one minute of duration (thus 1440 data points). These values for each individual are located in Appendix A. Averages were obtained for both groups and both conditions (pre- and post-) such that comparisons could be made (Appendix B). The behaviors were qualified as being either active or inactive. Active behavior were represented by standing, hanging, grooming and brachiating, while sitting and lying constituted inactive behaviors. This overall appraisal was broken down into active and inactive behaviors at specific locations. In addition, locations and activities were observed independently such that individual changes in either category could be readily detected.

Active Versus Inactive

An overall evaluation shows that activity was less in

the small caged group as compared to the run caged group (Figure 1, page 39). A large deviation occurred in the post-conditioned animals of the run cage in which activity increased significantly ($p < .05$; using a chi square test). Appendix C gives a listing of significant chi square values. If activity is broken down into locations (Figures 2 - 5, pages 40 - 43), significant changes are detected primarily for the run caged baboons. One prominent observation is the increase in time spent inactively at the feeder ($p < .001$).

Activities

Noticeable differences for post-conditioned animals of the run caged group are an increase in sitting ($p < .001$) and a decrease in lying ($p < .001$) (Figure 6, p. 44). In addition, the small caged group shows a post-conditioned increase in lying ($p < .001$) and a decrease in hanging ($p = .05$).

Locations

The small caged group showed little change in locations after conditioning (Figure 7, p. 45). One noticeable change was an increase in time spent at the waterer ($p < .001$). More variation occurred for the run caged group after conditioning (Figure 8, p. 46). Decreases occurred with time spent at the perch ($p < .001$), while increases occurred in time spent at the feeder ($p < .001$) and on the front wall ($p < .001$).

DISCUSSION

As Dr. Scott W. Line suggests, it is impossible to know what is essential to promote the psychological well-being of primates. An acceptable approach to this problem may be to provide the opportunity to perform natural behaviors that occur in the wild such as foraging (1987). This was the pretext behind this investigation. By allowing the baboons to simulate foraging behavior (working for food), they may be satisfying a behavioral need to do so.

Based on the small sample size and thus high degree of variance, the results should not be taken as being conclusive by themselves. However, they do provide insight in relation to the effects of cage size and behavior variability. Boot and Vlug indicate a significant correlation ($p < .05$) between cage size and pregnant females that raised infants to weaning age in M. fascicularis (1987). As suggested by my results, the small caged animals displayed little activity change as a result of conditioning. Since these animals are limited in their mobility, this result should not be unexpected primarily because everything (the feeder) is located in such close proximity to the animals. Whereas in the run cage, there is greater variability in both the distribution and intensity of the behaviors which were displayed regardless of conditioning (Figures 6, 7 and 8). In addition, significant differences are detectable for post-conditioned animals in this group. Thus increasing cage size for individually

housed primates may be an effective means of promoting the psychological well-being of these animals in the laboratory.

Rope pulling was found to be an easily taught behavior and when present, the rope promoted the activity level of the animals greatly. Optimistically, the rope mechanism could be used to allow the animal to feed itself, not just receive peanut M&Ms for fifteen minutes per day. The mechanism could become a permanent addition to the cage such that the rope is positioned further away from the feeder (i.e., the back of the cage), then this experiment could provide. A consequence of having all the activity at the front of the cage (pulling the rope and receiving the reward) seems to cause an increase in the time spent in front of the cage specifically the feeder and the front wall (Figure 8). Markowitz has shown this concept to be quite successful (1982). This procedure is currently being developed by Dr. Bonnie Beaver at Texas A&M University. This increase is not dramatic but is significant and should be taken into account for future procedures.

If this enrichment device is taken to its full potential as a self feeder, an effective method of promoting the psychological well being of primates may be established.

REFERENCES

Broomstrand, M., Riddle, K., Alford, P. and Maple, T.L. (1986). Objective evaluation of a behavioral enrichment device for captive chimpanzees (pan croglodytes). Zoo Biology 5 (3), 293 - 300.

Levison, Cathryn A. & Levison, Peter K. (1971). Effects of early visual conditions on stimulation seeking behavior in young rhesus monkeys: II. Psychonomic Science 22 (3), 145 - 147.

Line, S.W. (1987). Environmental Enrichment for laboratory primate. Journal for the American Veterinary Medical Associate 190 (7), 854 - 859.

Markowitz, H. (1982). Behavioral Enrichment in the Zoo, New York, Van Westrand Reinhold, Co.

National Research Council. (1985). Guide for the care and use of laboratory animals. A report of the Institute of Laboratory Animals Resources Committee on Care and Use of Laboratory Animals. N.I.H. publication No. 85-23. U.S. Dept. of Health and Human Services, Washington, D.C., 83.

Tripp, Jill K. (1985). Increasing activity in captive orangutans: provision of manipulable and edible materials. Zoo Biology 4 (4), 225 - 234.

Westergaard, Gregory C. & Fragaszy, Dorothy M. (1985). Effects of manipulable objects on the activity of captive capuchin monkeys (Cebus apella). Zoo Biology 21 (21), 317 - 327.

Wilson, Carolyn C. (1972). Spatial factors and the behavior of nonhuman primates. Folia primatologica 18 (3 - 4), 256 - 275.

Yerkes, R.M. (1925). Almost Human, London, Jonathan Cope.

APPENDIX A:

INDIVIDUAL BABOON

DATA

Small Cage

166 Initial

Perch	Totals Location
Sit = 85 (82.29%)	
Stand = 51 (3.59%)	1288 (89.44%)
Lie = 52 (3.61%)	Active = (3.54%) 51
	Inactive = 1237 (85.90%)
Opposite Feeder	
Sit = 2 (.14%)	2 (.14%) = Inactive
Waterer	
Stand = 17 (1.18%)	17 (1.18%) = Active
Brachiate	
= 7L (5.00%)	7 L (5.0%) = Active
Right Wall	
middle = 1 (.07%)	1 (.07%) = Action
Front Wall	
Right = 1 (.07%)	
Left = 3 (.21%)	6 (.42%) = Active
Entire = 2 (.14%)	
Right-Back/Back-Right	
= 42 (2.92%)	42 (2.92%) = Active
Front-Right/Right-Front	
= 8 (.56%)	42 (2.92%) = Active
Right-Front/Front-Left	
= 4 (.28%)	4 (.28%) = Active

Activity Totals

Sit = 1187 (82.43%)

Stand = 68 (4.72%)

Lie = 52 (3.61%)

Brachiate = 72 (5.00%)

166 Initial

Hang = 61 (4.24%)

Total Active = 201 (13.96%)

Total Inactive = 1239 (86.04%)

168 Initial

Perch	Location Totals
Sit = 1235 (85.76%)	Active = 75 (5.21%)
Stand = 33 (2.29%)	1268 (88.05%)
Groom = 42 (2.92%)	Inactive = 1193 (82.85%)
Opposite Feeder	
Stand = 15 (1.04%)	Active = 15 (1.04%)
Lie = 1 (.07%)	16 (1.11%)
	Inactive = 1 (.07%)
Right Wall	
Front = 7 (.49%)	7 (.49%) Active = 7 (.49%)
Front Wall	
Right = 44 (3.06%)	61 (4.24%) - Active = 61
(9.24%)	
Entire = 17 (1.18%)	
Back-Right/Right Back	
= 88 (6.11%)	88 (6.11%) - Active = 88 (6.11%)
Activity Totals	Total Active = 246 (17.08%)

Sit = 1235 (85.76%)

Stand = 48 (3.33%)

Lie = 1 (.07%)

Groom = 42 (2.92%)

Hang = 156 (10.83%)

198 Initial

Total Inactive = 1199 (82.92%)

Location Totals

Perch

sit = 1259 (87.43%)

Stand = 68 (4.72%)

Groom = 3 (.21%)

Pave = 1 (.07%)

perch total =
1327 (92.15%)

Active = 71 (4.93%)

Inactive = 1256 (87.22%)

Opposite Feeder

Sit = 20 (1.39%)

Stand = 19 (1.32%)

Opposite Feeder
Total = 39 (2.71%)
Active = 19 = (1.32%)
Inactive = 20 (1.39%)

Waterer

Stand = 26 (1.80%)

26 (1.80%) = Active

Front Wall

Right = 5 (.35%)

5 (.35%) = Active

Right Wall

Front = 3 (.21%)

3 (.21%) = Active

Back-Right/Right-Back

= 40 (2.78%)

40 (2.78%) = Active

Activity Totals

Sit = 1279 (88.82%)

Total Active = 164 (11.39%)

Stand = 113 (7.85%)

Hang = 48 (3.33%)

Groom = 3 (.21%)

Pace = 1 (.07%)

166 Final

Total Inactive = 1276 (88.61%)

Location Totals

Perch

Sit = 1266 (87.92%)

Stand = 10 (.69%)

Lie = 6 (.42%)

1282 (89.03%)

Active = 10 (.69%)

Inactive = 127L (88.33%)

Opposite Feeder

Stand = 2 (.14%)

2 (.14%) = Active

Waterer

Stand = 39 (2.71%)

39 (2.71%) = Active

Brachiate

= 43 (2.99%)

43 (2.99%) = Active

Front Wall

Right = 1 (.07%)

Left = 1 (.07%)

Entire = 2 (.14%)

4 (.28%) = Active

Right-Back/Back Right

= 69 (4.79%)

69 (4.79%) = Active

Front-Left/Right Front

= 1 (.07%)

1 (.07%) = Active

Activity Totals

Sit = 1266 (87.92%)

Total Active = 168 (11.67%)

Stand = 51 (3.54%)

Lie = 6 (.42%)

Brachiate = 43 (2.99%)

Hang = 74 (5.14%)

168 Final

Perch

Sit = 1107 (76.88%)

Stand = 56 (3.89%)

Lie = 169 (11.74%)

Groom = 65 (4.51%)

Opposite Feeder

Sit = 6 (.42%)

Stand = 27 (1.88%)

Lie = 10 (.69%)

Waterer

Stand = 1 (.07%)

Front Wall

Right = 15 (1.04%)

Entire = 10 (.69%)

Back-Right/Right-Back

= 39 (2.71%)

Activity Totals

Sit = 1113 (77.29%)

Stand = 89 (5.83%)

179 (12.43%)

Groom = 65 (4.51%)

Location Totals

1332 (92.51%)

Active = 121 (8.4%)

Inactive = 1211 (84.10%)

43 (2.99%)

Active = 27 (1.88%)

Inactive = 16 (1.11%)

1 (.07%) = Active

25 (1.73%) = Active

39 (2.71%) = Active

Total Activity = 213 (14.79%)

Total Inactivity = 1227 Lie =

(85.21%)

Total Inactive = 1272 (88.34%)

Hang = 64 (4.44%)

198 Final

Location Totals

Perch

Sit = 1254 (87.08%)

Stand = 72 (5.0%)

Lie = 3 (.21%)

1329 (92.29%)

Active = 76 (5.28%)

Inactive = 1253 (87.01%)

Opposite Feeder

Sit = 3 (.21%)

Stand = 15 (1.04%)

21 (1.46%)

Lie = 3 (.21%)

Active = 15 (1.04%)

Inactive = 6 (.42%)

Waterer

Stand = 39 (2.71%)

39 (2.71%) = Active

Front Wall

Right = 1 (.07%)

Left = 1 (.07%)

15 (1.04%) = Active

Entire = 13 (.90%)

Back-Right/Right-Back

= 36 (2.5%)

32 (2.5%) = Active

Activity Totals

Sit = 1257 (87.29%)

Stand = 126 (8.75%)

Lie = 6 (.42%)

Total Active = 181 (12.57%)

Hang = 51 (3.54%)

Groom = 4 (.28%)

Total Inactive = 12.59 (87.43%)

RUN CAGE

167 Initial

Location Totals

Perch

Sit = 249 (17.29%)

Stand = 11 (.76%)

Lie = 53 (3.68%)

313 (21.73%)

Groom = 77 (5.35%)

Active = 22 (1.52%)

Inactive = 291 (20.21%)

Feeder

Sit = 228 (15.83%)

Stand = 31 (2.15%)

Lie = 109 (7.57%)

368 (25.56%)

Groom = 77 (5.35%)

Active = 108 (7.5%)

Pace = 3 (.21%)

Inactive = 260 (18.06%)

Opposite Feeder

Sit = 285 (19.79%)

Stand = 31 (2.15%)

Lie = 365 (25.35%)

681 (47.29%)

Pace = 1 (.07%)

Active = 31 (2.15%)

Inactive = 650 (45.14%)

Waterer

Stand = 61 (4.24%)

61 (4.24%) = Action

Pace = 2 (.14%)

Back Wall

Right = 3 (.21%)

Middle = 1 (.07%)

Left = 9 (.63%)

13 (.91%) = Active

Front Wall

Right = 4 (.28%)

4 (.28%) = Active

Activity Totals

Total Active = 239 (16.60%)

Sit = 762 (52.92%)

Stand = 134 (9.31%)

Total Inactive = 1201 (83.40%)

Lie = 527 (36.60%)

Groom = 88 (6.11%)

Pace = 6 (.42%)

Hang = 17 (1.18%)

169 Initial

Perch

Location Total

Sit = 321 (22.29%)

Stand = 4 (.28%)

325 (22.57%)

Groom = 72 (5.0%)

Active = 76 (5.28%)

Inactive = 249 (17.29%)

Feeder

Sit = 89 (6.18%)

Stand = 48 (3.33%)

881 (61.18%)

Lie = 744 (51.67%)

Active = 76 (5.28%)

Groom = 1 (.07%)

Inactive = 832 (57.78%)

Opposite Feeder

Sit = 18 (1.25%)

Stand = 54 (3.75%)	109 (7.57%)
Lie = 37 (2.57%)	Active = 57 (3.96%)
Groom = 3 (.21%)	Inactive = 52 (3.61%)
Waterer	
Stand = 38 (2.64%)	38 (2.64%) = Active
Front Wall	
Right = 14 (.97%)	19 (1.32%) = Active
Left = 5 (.35%)	
Back Wall	
Right = 59 (4.10%)	
Medium = 2 (.14%)	68 (4.72%)
Left = 7 (.49%)	
Activity Totals	Total Active = 307 (21.32%)
Sit = 428 (29.72%)	
Stand = 144 (10.00%)	Total Inactive = 1133 (78.68%)
Lie = 781 (54.24%)	
Groom = 76 (5.28%)	
Hang = 87 (6.04%)	
170 Initial	
	Location Totals
Perch	
Sit = 330 (22.92%)	
Stand = 1 (.07%)	1202 (83.47%)
Lie = 871 (60.49%)	Active = 7 (.49%)
Groom = 6 (.42%)	Inactive = 1195 (82.99%)
Feeder	
Sit = 64 (4.44%)	

Stand = 34 (2.36%)

Pace = 2 (.14%)

98 (6.81%)

Active = 34 (2.36%)

Inactive = 64 (4.44%)

Waterer

Sit = 1 (.07%)

Stand = 19 (1.32%)

20 (1.39%)

Active = 19 (1.32%)

Inactive = 1 (.07%)

Front Wall

Right = 41 (2.85%)

Middle = 1 (.07%)

Left = 5 (.35%)

47 (3.26%) = Active

Back Wall

Right = 46 (3.19%)

Middle = 6 (.42%)

Left = 21 (1.46%)

73 (5.07%) = Active

Activity Totals

Sit = 395 (27.43%)

Stand = 54 (3.75%)

871 (60.49%)

Groom = 6 (.42%)

Pace = 2 (.14%)

Hang = 120 (8.33%)

167 Final

Total Activity = 180 (12.50%)

Total Inactivity = 1260 Lie = (87.30%)

Perch

Sit = 931 (64.65%)

Groom = 72 (5.0%)

Location Total

931 (64.65%)

Active = 72 (5.0%)

	Inactive = 859 (59.65%)
Feeder	
Sit = 172 (11.94%)	
Stand = 159 (11.04%)	
Lie = 114 (7.92%)	445 (30.9%)
Groom = 1 (.07%)	Active = 160 (11.11%)
Pace = 24 (1.67%)	Inactive = 285 (19.79%)
Opposite Feeder	
Sit = 2 (.14%)	10 (.70%)
Stand = 8 (.56%)	Active = 8 (.56%)
	Inactive = 2 (.14%)
Waterer	
Stand = 29 (2.01%)	29 (2.01%) = Active
Front Wall	
Right = 21 (1.46%)	21 (1.46%) = Active
Back Wall	
Right = 4 (.28%)	4 (.28%) = Active
Activity Totals	Total Active = 294 (20.49%)
Sit = 1105 (76.74%)	
Stand = 196 (13.61%)	Total Inactive = 1146 (79.58%)
Lie = 114 (7.92%)	
Groom = 73 (5.07%)	
Pace = 25 (1.74%)	
Hang = 25 (1.74%)	
169 Final	
Perch	Location Total
Sit = 214 (14.86%)	

Groom = 46 (3.19%)	214 (14.86%)
	Active = 46 (3.19%)
	Inactive = 168 (11.07%)
Feeder	
Sit = 90 (6.25%)	
Stand = (2.08%)	863 (59.93%)
Lie = 743 (51.60%)	Active = 43 (2.99%)
	Inactive = 121 (8.40%)
Waterer	
Stand = 36 (2.5%)	36 (2.5%)= Active
Opposite Waterer	
Sit = 25 (1.74%)	
Stand = 1 (.07%)	26 (1.81%)
Groom = 15 (1.04%)	Active = 16 (1.11%)
	Inactive = 10 (.70%)
Front Wall	
Right = 60 (4.17%)	88 (6.11%) = Active
Left = 28 (1.94%)	
Back Wall	
Right = 16 (1.11%)	49 (3.40%) = Active
Left = 33 (2.29%)	
Activity Totals	
Sit = 357 (24.79%)	
Stand = 110 (7.64%)	
Lie = 836 (58.06%)	
Groom = 61 (4.24%)	
Pace = 3 (.21%)	

Hang = 137 (9.51%)

Total Active = 308 (21.39%)

Total Inactive = 1132 (78.61%)

170 Final

Perch	Location Totals
Sit = 259 (17.99%)	
Lie = 22 (1.53%)	282 (19.58%)
Stand = 1 (.07%)	Active = 29 (2.01%)
Groom = 28 (1.94%)	Inactive = 253 (17.57%)
Feeder	
Sit = 137 (9.51%)	958 (66.53%)
Lie = 808 (56.11%)	Active = 13 (.90%)
Stand = 13 (.90%)	Inactive = 945 (65.63%)
Opposite Feeder	
Stand = 3 (.21%)	3 (.21%) = Active
Waterer	
Stand = 74 (5.14%)	
Lie = 2 (.14%)	76 (5.28%)
Pace = 1 (.07%)	Active = 74 (5.14%)
	Inactive = 2 (.14%)
Front Wall	
Right = 81 (5.63%)	
Middle = 1 (.07%)	94 (6.53%) = Active
Left = 12 (.83%)	
Back Wall	
Right = 4 (.78%)	27 (6.53%) = Active
Middle = 8 (.56%)	

Left = 8 (.56%)

Activity Totals

Sit = 396 (27.50%)

Stand = 91 (6.32%)

Lie = 832 (57.78%)

Groom = 28 (1.94%)

Pace = 1 (.07%)

Hang = 121 (8.40%)

Total Active = 240 (16.67%)

Total Inaction = 1200 (83.33%)

APPENDIX B

GROUP AVERAGED

DATA COMPILATION

Small Cage Initial

Active = 203.67 (14.14%); S.D. - 41.055

Inactive = 1236.33 (85.86%); S.D> - 41.065

Small Cage Find

Active = 187.33 (13.01%); S.D. - 23.159

Inactive = 1252.67 (86.99%); S.D. - 23.159

Run Cage Initial

Active = 242 (16.81%); S.D. - 63.553

Inactive = 1198 (83.19%); S.D. - 62.553

Run Cage Find

Active = 280.67 (19.49%); S.D. - 35.907

Inactive = 1159.33 (80.51%); S.D. - 35.907

Small Cage

Perch

Pre

Active - 65.67 (4.56%); S.D. = 12.86

Inactive - 1228.67 (85.32%); S.D. = 32.32

Post

Active - 69 (4.79%); S.D. = 55.83

Inactive - 1245.33 (86.48%); S.D. = 31.24

Opposite Feeder

Pre

Active - 11.33 (.79%); S.D. = 10.01

Inactive - 7.67 (.53%); S.D. = 10.69

Post

Active - 14.67 (1.02%); S.D. = 12.50

Inactive - 7.33 (.51%); S.D. = 8.08

Waterer

Pre

Active - 14.33 (1.0%); S.D. = 13.20

Post

Action - 26.33 (1.83%); S.D. = 21.94

Brachiate

Pre

Active - 24 (1.67%); S.D. = 41.57

Post

Active - 14.33 (1.00%); S.D. = 24.82

Right Wall

Pre

Active - 3.67 (.25%); S.D. = 3.06

Post

Active - 0

Front Wall

Pre

Active - 24 (1.67%); S.D. = 32.05

Post

Active - 14.67 (1.02%); S.D. = 10.50

Right-Back/Back-Right

Pre

Active - 56.67 (3.94%); S.D. = 27.15

Post

Active - 48 (3.33%); S.D. = 18.25

Front-Right/Right-Front

Pre

Active - 2.67 (.19%); S.D. = 4.62

Post

Active - 0

Right-Front/Front-Left

Pre

Active - 1.33 (.09%); S.D. = 2.31

Post

Active - .33 (.02%); S.D. = .58

Run Cage

Perch

Pre

Active - 35 (2.43%); S.D. - 36.29

Inactive 578.33 (40.16%); S.D. = 534.45

Post

Active - 49 (3.40%); S.D. = 21.66

Inactive - 426.67 (29.63%); S.D. = 376.82

Feeder

Pre

Active - 63.67 (4.42%); S.D. = 39.12

Inactive - 385.33 (26.76%); S.D. = 399.05

Post

Active - 67.67 (4.70%); S.D. = 80.41

Inactive - 687.67 (47.75%); S.D. = 353.12

Opposite feeder

Pre

Active - 29.33 (2.04%); S.D. = 28.54

Inactive - 234 (16.25%); S.D. = 361.20

Post

Active - 18 (1.25%); S.D. = 21.79

Inactive - 41 (2.85%); S.D. = 69.29

Waterer

Pre

Active - 39.33 (2.73%); S.D. = 21.03

Inactive - .33 (.02%); S.D. = .58

Post

Active - 46.33 (3.22%); S.D. = 24.21

Inactive - .67 (.05%); S.D. = 1.15

Opposite Waterer

Pre

Active - 0

Inactive - 0

Post

Active - 5.33 (.37%); S.D. = 9.24

Inactive - 3.33 (.23%); S.D. = 5.77

Back Wall

Pre

Active - 51.33 (3.56%); S.D. = 33.29

Post

Active - 26.67 (1.85%); S.D. = 22.50

Front Wall

Pre

Active - 23.33 (1.62%); S.D. = 31.83

Post

Active - 67.67 (4.70%); S.D. = 40.53

Small Cage - Locations

Perch

Pre - 1294133 (89.88%); S.D. = 30.01

Post - 1314.33 (91.25%); S.D. = 28.04

Opposite Feeder

Pre - 19 (1.32%); S.D. = 18.88

Post 22 (1.53%); S.D. = 20.51

Waterer

Pre - 14.33 (1.00%); S.D. = 13.20

Post - 26.33 (1.83%); S.D. = 21.

Brachiate

Pre - 24 (1.67%); S.D. = 41.57

Post - 14.33 (1.00%); S.D. = 24.83

Right Wall

Pre - 3.67 (.25%); S.D. = 3.06

Post - 0

Front Wall

Pre - 24 (1.67%); S.D. = 32.05

Post - 14.67 (1.02%); S.D. = 10.50

Right-Back/Back-Right

Pre - 56.67 (3.94%); S.D. = 27.15

Post - 48 (3.33%); S.D. = 18.25

Front-Right/Right Front

Pre - 2.67 (.19%); S.D. = 4.62

Post 0

Right-Front/Front-Left

Pre - 1.33 (.09%); S.D. = 2.31

Post - .33 (.02%); S.D. = .58

Run Cage Locations

Perch

Pre - 613.33 (42.59%); S.D. 509.84

Post - 475.67 (33.03%); S.D. = 395.79

Feeder

Pre - 449 (31.18%); S.D. = 397.73

Post - 755.33 (52.45%); S.D. 272.92

Opposite Feeder

Pre - 263.33 (18.29%); S.D. = 365.79

Post - 59 (4.10%); S.D. = 91.00

Waterer

Pre - 39.67 (2.75%); S.D. = 20.55

Post - 47 (3.26%); S.D. = 25.36

Front Wall

Pre - 23.33 (1.62%); S.D. = 21.83

Post - 67.67 (4.70%); S.D. = 40.53

Back Wall

Pre - 51.33 (3.56%); S.D. = 33.29

Post - 26.67 (1.85%); S.D. = 22.50

Small Cage Initial - Activities

Sit = 1233.67 (85.67%); S.D. = 46.01

Stand = 76.33 (5.30%); S.D. = 33.29

Lie = 17.67 (1.23%); S.D. = 29.74

Brachiate = 24 (1.67%); S.D. = 41.57

Hang = 88.33 (6.13%); S.D. = 58.96

Groom = 15 (1.04%); S.D. = 23.43

Small Cage Final - Activities

Sit = 1212 (84.17%); S.D. = 85.85

Stand = 87 (6.04%); S.D. = 37.59

Lie = 63.67 (4.42%); S.D. = 99.88

Brachiate = 14.33 (1.00%); S.D. = 24.83

Hang = 63 (4.38%); S.D. = 11.53

Groom = 2.3 (1.60%); S.D. = 36.43

Run Cage Initial - Activities

Sit = 528.33 (36.69%); S.D. = 203.03

Stand = 110.67 (4.69%); S.D. = 49.33

Lie = 726.33 (50.44%); S.D. = 178.40

Hang = 74.67 (5.19%); S.D. = 52.60

Groom = 56.67 (3.94%); S.D. = 44.29

Pace = 2.67 (19%); S.D. = 3.06

Run Cage Final - Activities

Sit = 619.33 (43.01%); S.D.= 421.05

Stand = 132.33 (9.19%); S.D. = 55.95

Lie = 594 (41.25%); S.D. = 415.70

Hang = 94.33 (6.55%); S.D. = 60.58

Groom = 54 (3.75%); S.D.= 23.30

Pace = 9.67%); S.D.= 13.32

APPENDIX C

SIGNIFICANT CHI SQUARE VALUE

X^2 Values

Run Cage: Active (Post)

$X^2 = 6.18$ $p < .05$

Inactive

$X^2 = 1.25$ $p \sim .125$

Run Cage - Per Inactive

$X^2 = 39.77$ $p < .001$

(less inactive - post)

Run Cage - Feeler Inactive

$X^2 = 237.22$ $p << .001$

(greater inactive - post)

Run Cage Opposite Feed - Inactive

$X^2 = 159.18$ $p << .001$

(less inactive post)

Run Cage Back Wall Active

$X^2 = 11.85$ $p \sim .001$ (<)

(less active - post)

Run Cage Front Wall Active

$X^2 = 84.27$ $p <<< .001$

Small Cage Waterers

$X^2 = 10.28$ $p < .001$

(waterer great post)

Run Cage Perch

$X^2 = 30.90$ $p < .001$

(perch less - post)

Run Cage Feeder

$X^2 = 209$ p .001

(Feeder greater-post)

Run Cage Opposite Feeder

$X^2 = 158.55$ p .001

(opposite feeder less - post)

Run Cage Front Wall

$X^2 = 84.27$ p << .001

(Front Waller greater - post)

Run Cage Back Wall

$X^2 = 11.85$ p < .001

(Back wall less - post)

Run Cage Post Sitting

$X^2 = 15.68$ p .001

(post - increase)

Run Cage Post - Lying

$X^2 = 24$ p < .001

(post - decrease)

Small Cage Post Lying

$X^2 = 117.56$ p << .001

(post increase)

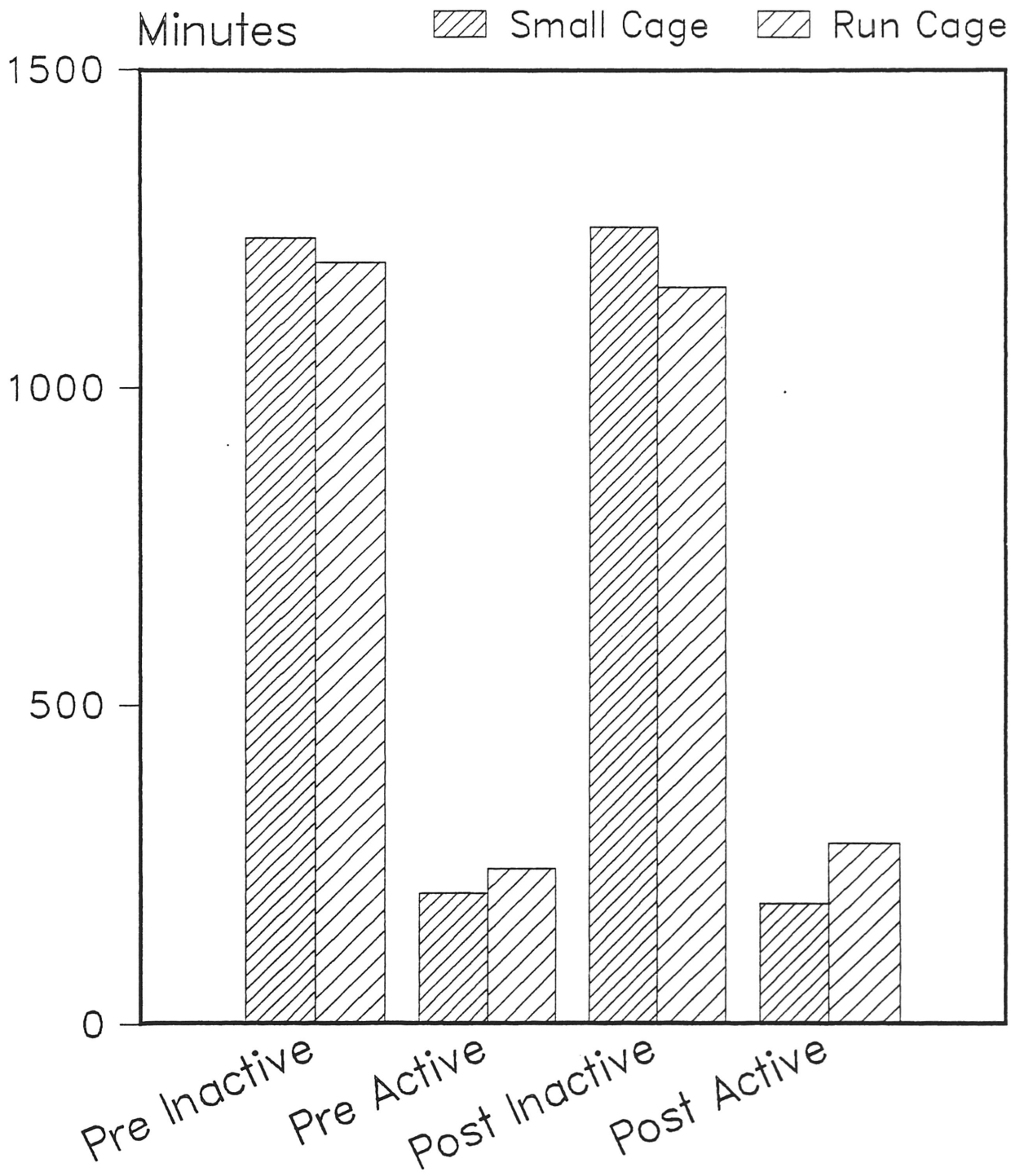
Small Cage Post Hanging

$X^2 = 7.1$ p = .05

(post decrease)

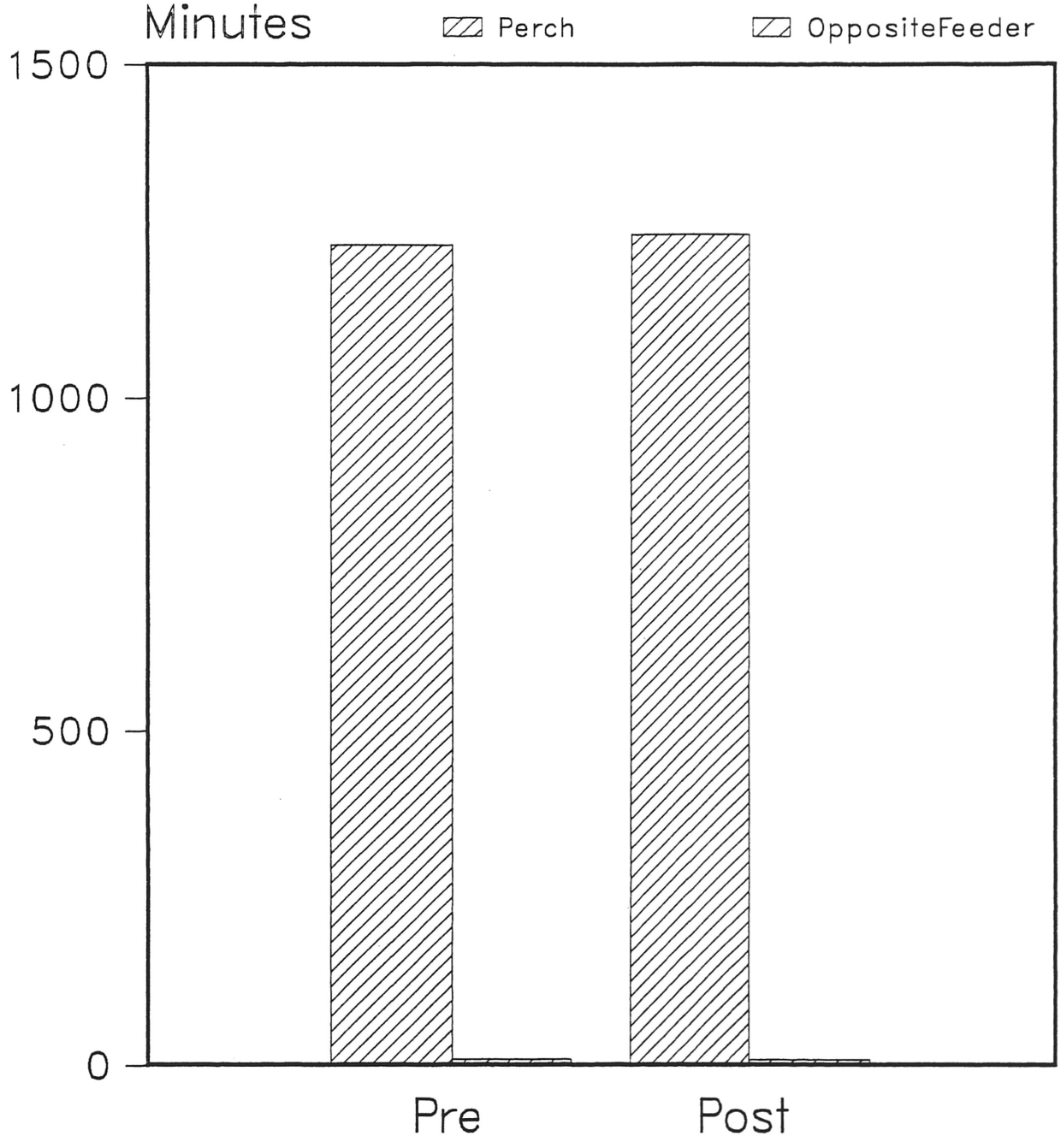
Activity Comparison Between Groups

Figure 1



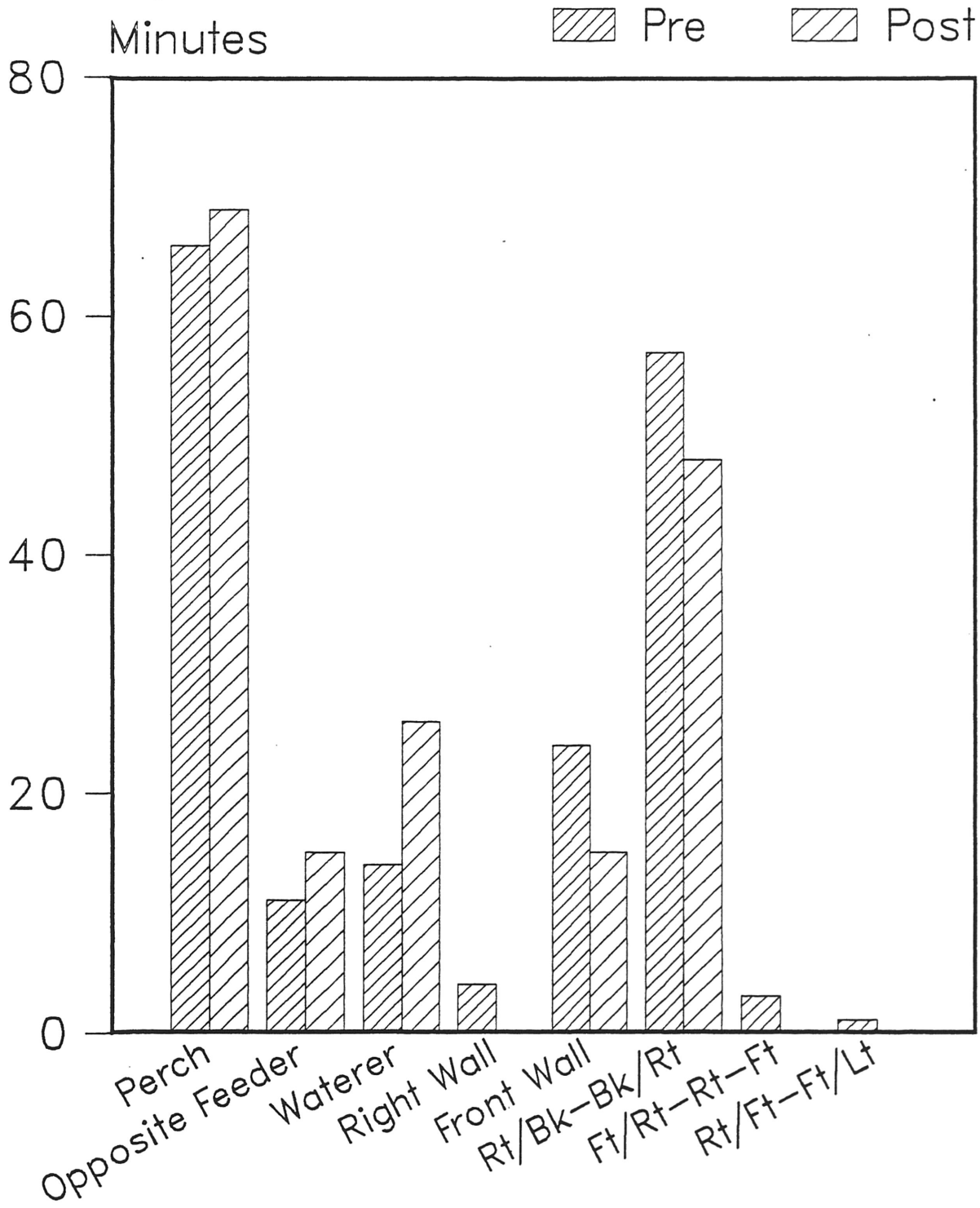
SmallCage Inactivity Locations

Figure 2



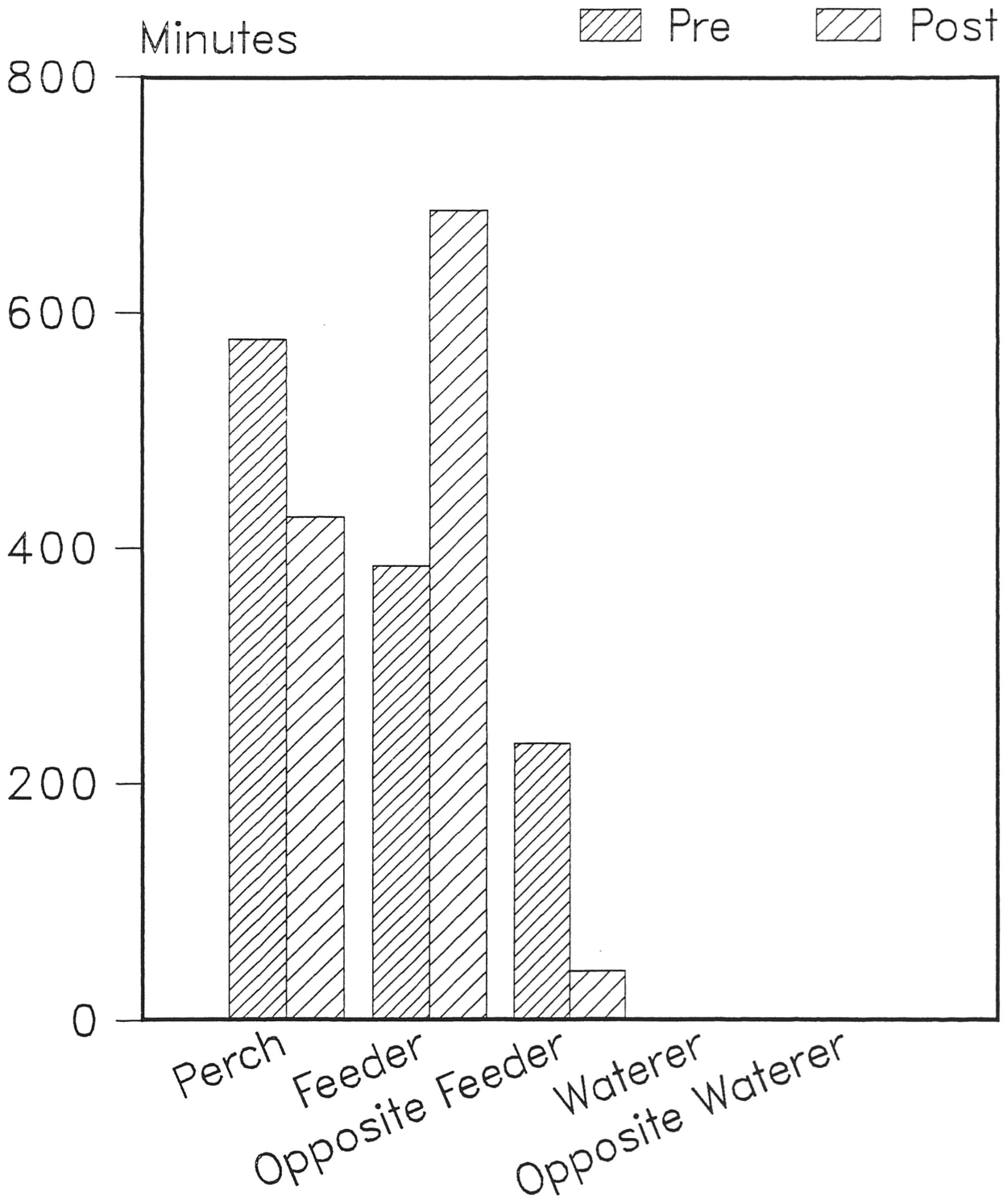
Small Cage Activity Locations

Figure 3



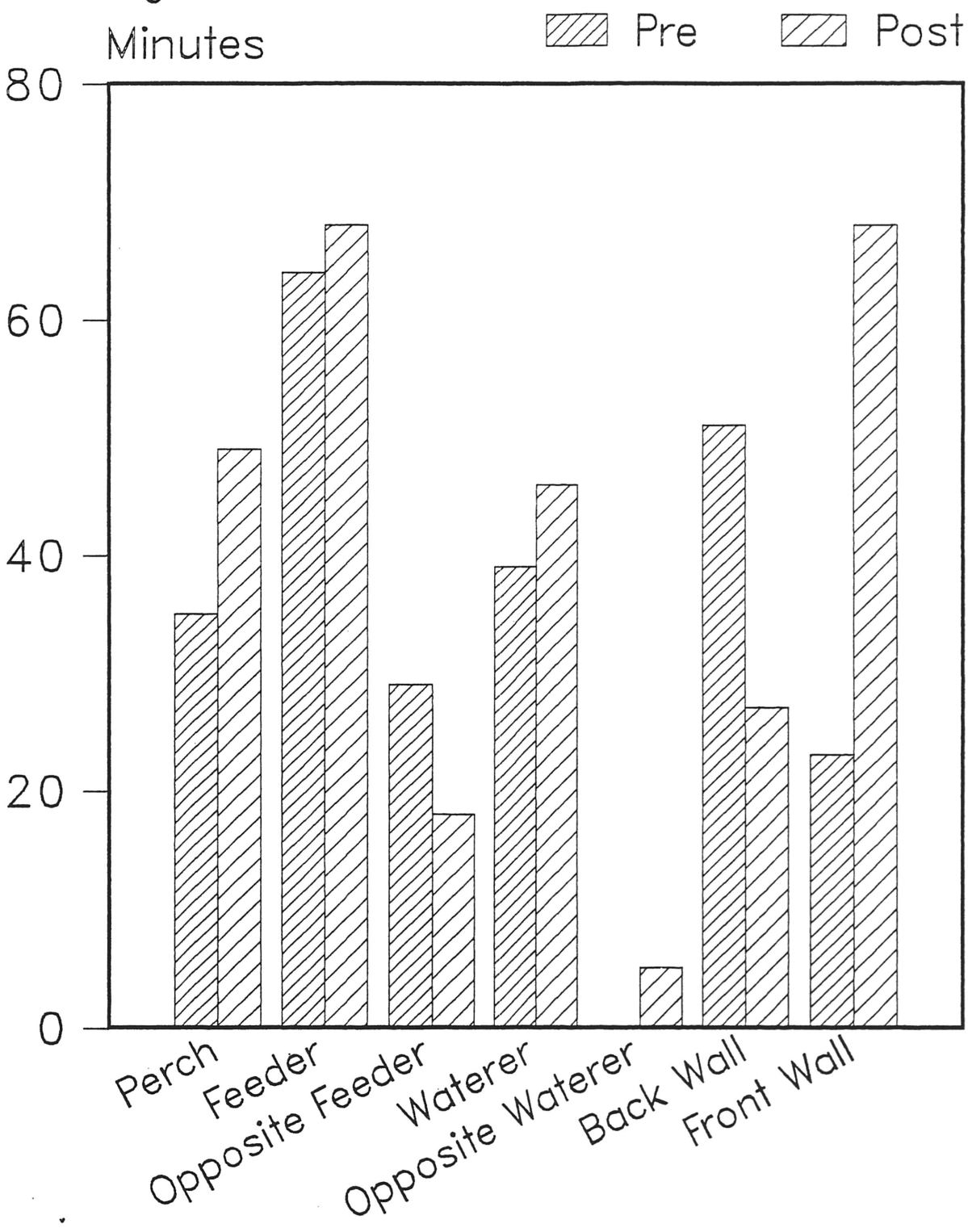
Run Cage Innactivity Locations

Figure 4



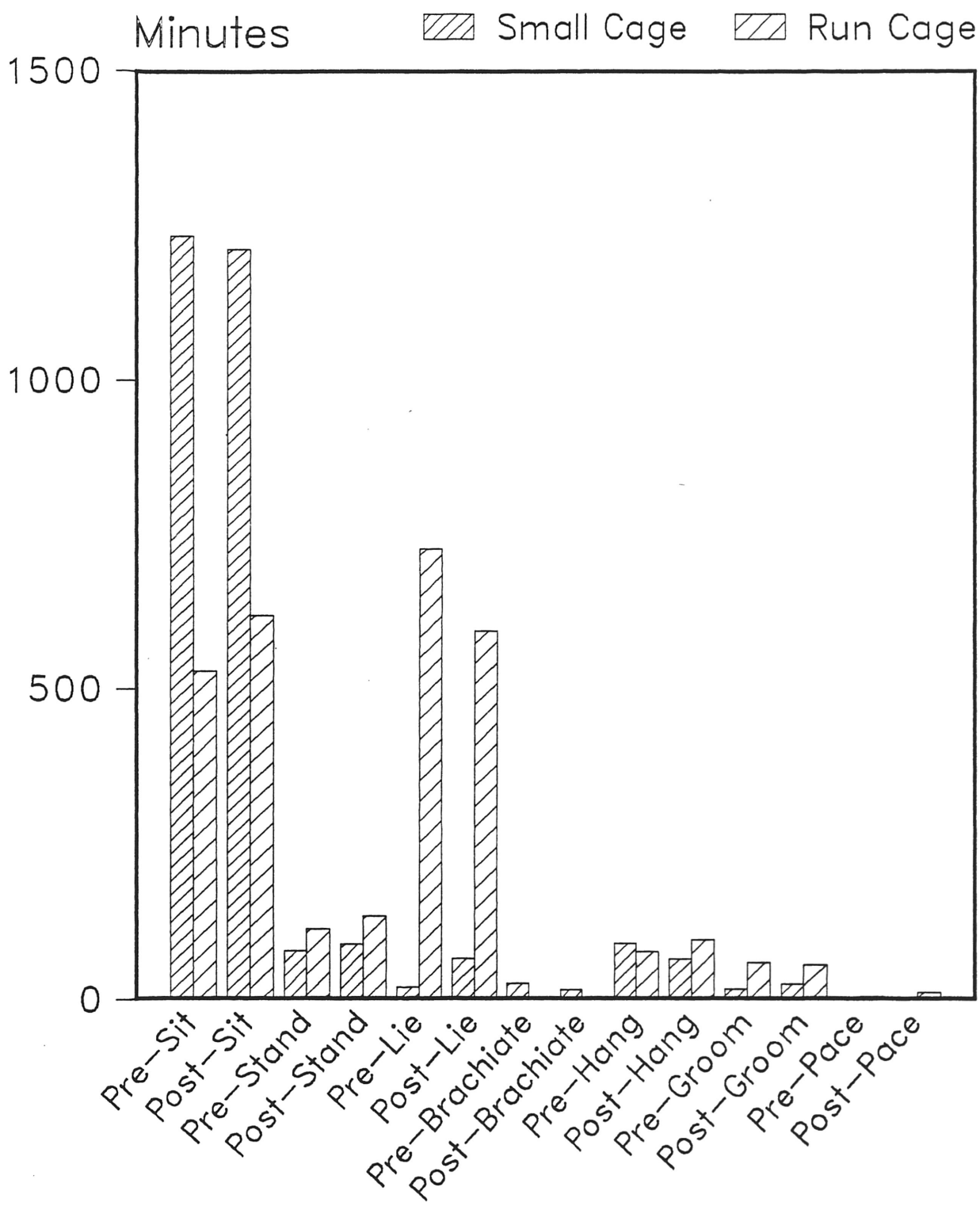
Run Cage Activity Locations

Figure 5



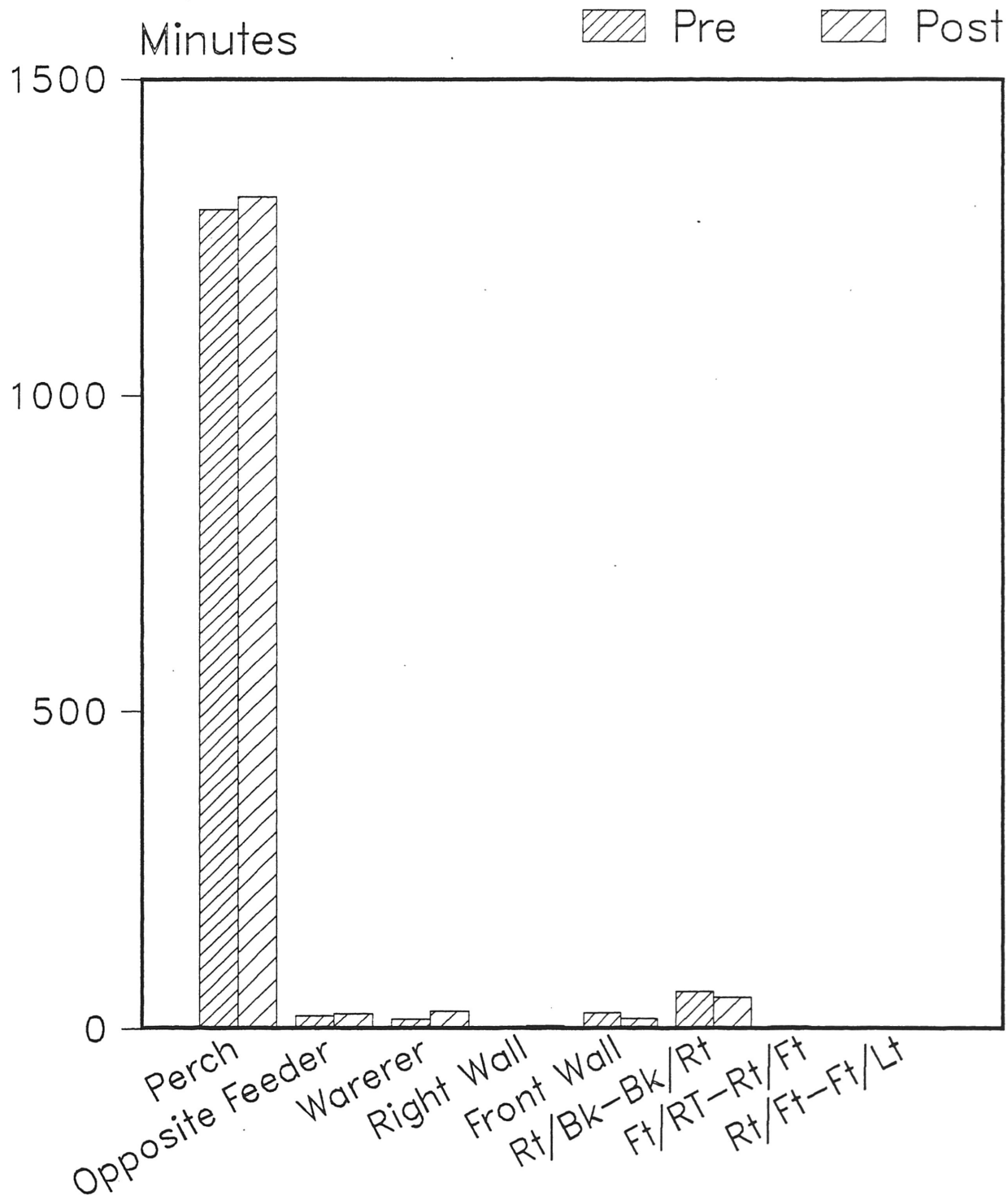
Small/Run Cage Activities

Figure 6



Small Cage Location Totals

Figure 7



Run Cage Location Totals

Figure 8