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Effects of runway length and delay of reward on the frustration effect

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EFFECTS OF RUNWAY LENGTH AND DELAY OF REWARD ON THE FRUSTRATION EFFECT.

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ABSTRACT

Effects of Runway Length and Delay of Reward on the Frustration Effect.

The effects of delay on the frustration effect (FE), as manipulated by varying runway one (R1) length and delay at the first goal box (G1) in a double runway apparatus, were investigated. A distinction between within-chain delay and total delay was made possible by this procedure. Also provided was a test of the frustration and response inhibition hypotheses, two explanations for the origin of the FE.

Two experiments were carried out. In Exp. I total delay was held constant while within-chain delay varied. In Exp. II total delay was allowed to vary via its correlation with runway one length. Ss were 48 experimentally naive albino rats.

Large and highly significant FEs were found in both experiments. When total delay was allowed to vary large differences in FEs were found. These differences disappeared when total delay was held constant. These results suggest that differences in within-chain delay alone are not sufficient to produce differences in FE.

Consistent with the frustration hypothesis were the findings that: delay before G1 did not enhance R2 speeds of control Ss never rewarded in G1; experimental Ss ran faster in R2 following nonreward than control Ss. However, the fact that experimental Ss ran faster in R2 following reward than control Ss suggests that a modification of the frustration hypothesis is necessary to adequately handle the present data.

INTRODUCTION

The purpose of the present study was to investigate the effects of delay on the frustration effect (FE). Within-chain delay (Hull, 1952) involves instrumental response chains of different lengths. Non-chaining delay (Spence, 1956) involves the introduction of a period of delay during or at the end of the response chain, and before the reinforcing event.

In two experiments, within-chain delay was manipulated by varying runway one (R1) length in a typical double runway apparatus. In Exp. I total delay was held constant for three groups having different R1 lengths by varying the period of delay before the first goal box (G1). In Exp. II total delay was allowed to vary by having a constant period of delay before G1, R1 length varying as in Exp. I. Total delay (period of time from entrance of R1 to entrance of G1) was defined as the sum of within-chain and non-chaining delays. If within-chain delay is sufficient, differences in the FE should be found in both Exps. I and II; if differences in total delay are necessary, only Exp. II would be expected to show changes in FE. Amsel, Erhart, and Galbrect (1961) found that FE varied directly as a function of R1 length when G1 and R1 were homogeneous. However, the Amsel et. al. study did not differentiate between within-chain delay and total delay. Exp. II, in part an expanded replication of Amsel's (1961) study, in conjunction with Exp. I allows for this distinction.

Amsel et. al. (1961) maintain that the greater the R1 length before the frustrating event (nonreward in G1) the faster the runway two (R2) speed following this event. This phenomena is explained within the r_g-s_g framework, i.e., the longer the duration of r_g eliciting stimuli, the greater the likelihood that r_g has been evoked and is strong. If this interpretation is correct, differences in FEs should be found in Exp. II, but not in Exp. I.

While Amsel's frustration hypothesis explains the FE by assuming that speed <u>increases</u> in R2 following nonreward (f) in G1, the response inhibition hypothesis assumes speed <u>decreases</u> in R2 following reward (r) in G1. A second purpose of the present study was to further evaluate these two explanations for the origin of the FE. This was done by adding control groups which never received reinforcement in G1 (Wagner, 1 959). According to the frustration hypothesis, nonreinforcement would not be frustrative to these groups since Ss would never be reinforced in G1. On f trials experimental Ss would be expected to run faster in R2 than the control Ss. According to the response inhibition hypothesis, on r trials experimental Ss should run slower than co ntrol Ss, since the control Ss would not have their motivational level reduced by feeding in G1. On f trials experimental Ss should run at about the same speed as the control Ss. Previous literature (Wagner, 1951; Robinson and Clayton, 1963) appears to support the frustration hypothesis. However, a consistent, though not significant, finding has been that r speeds are also somewhat faster than control group speeds. Such a result is not explainable by either hypothesis, and if shown to be reliable, some modification of the frustration hypothesis would seem necessary.

METHOD

The present study was carried out in two parts. Six groups of animals were run in Exp. I, and six groups of animals were run in Exp. II.

Subjects

Ss were 48 experimentally naive male albino rats, 80-130 days old at the beginning of training. Six groups of four animals were run in each experiment. Upon arrival of each shipment of animals, Ss were randomly assigned to groups, and housed two to a cage. Ss in both experiments were maintained on a 23 hour schedule of water deprivation, starting 14 days prior to the beginning of training. After each day's trials, Ss were fed four grams of dry mash. This schedule has been shown to produce a highly stable thirst drive (Amsel and Hancock, 1957).

Apparatus

A double runway apparatus, with a right angle turn after G1, was used in both experiments. The goal box of the first runway served as the start box of the second runway. Each section of the apparatus was 5" in height, and 3" wide, except for G2 which was 6" wide. The lengths of the sections were: start box-12"; R1(three interchangeable lengths) 24", 96", or 168"; G1-24"; R2-96"; and G2-15". Guillotine doors, operated manually, were situated at the end of the start box, before and at the end of G1, and at the entrance to G2. A delay box, 15" in length (prior to G1) was used to control the non-chaining delay period. After S entered the delay box, the delay box door was closed behind him to prevent retracing. The entire runway was constructed of 3/4" plywood, and covered with 1/8" plexiglass. It was painted metallic grey inside and out. A random noise generator was always in operation.

Running times were read from Standard Electric clocks operated by Lehigh Valley infrared beam photocells. Photocells one in. after the start door and one-half in. before the delay box door defined R1 running time; R2 running time was measured over a siven ft. segment with photocells six in. after and six in. before G2.

Design

Exp. I: Equal Total Delay. Three experimental groups were defined by the different R1 lengths: short (two ft.), medium (eight ft.), and long (14 ft.). Combined with these three R1 lengths were three delay periods: 13 sec., 11.66 sec., and 10 sec. respectively. The three non-chaining delay periods were included to equate total delay for the three groups. A pilot study was used to estimate asymptotic running time in the three different R1 lengths. Times of .77, 2.05, and 3.71 sec. were obtained for the short, medium, and long R1 lengths respectively. Non-chaining delay was set at 10 sec. for the long R1, and delays for the two shorter R1s were set in accordance with the corresponding differences in running times.

Exp. II: Unequal Total Delay. The three experimental groups were defined by three different R1 lengths as in Exp. I. They differed from Exp. I only in that the non-chaining delay for all groups was held constant at 10 sec. Thus total delay also varied directly with R1 length.

Each of the experimental groups in Exps. I and II had its own control, i.e., the same R1 lengths and delay at G1 as the corresponding experimental groups. The experimental and control groups differed only in that control groups never received reinforcement in G1.

Procedure

The procedure followed was identical for both experiments. Preliminary training consisted of nine days during which Ss were handled and gentled by E. On days five through nine Ss were handled, following which they were allowed to explore the apparatus for five min. The timing device was operative during this exploration period in order to allow Ss to adapt to the clicking noises that were present when a timing device was activated.

Training consisted of 25 days during which experimental Ss were rewarded continuously in G1. When S had held a three sec. orientation toward the start door, the door was raised and S was allowed to traverse R1; S was then delayed in the delay box according to the prearranged scheme. After this period of delay the door leading into G1 was raised allowing S to enter G1 and consume two drops of water. Thirty seconds after S entered G1 the door leading into R2 was raised allowing S to traverse R2 and enter G2, the G2 door then being closed. In G2 S was again allowed to consume two drops of water. S was removed from G2 after a 30 sec. period and placed in his home cage. Ss were run three trials a day during each of the 25 days of training with an inter-trial interval of approximately 15 min. Control Ss in both experiments underwent the same preliminary pre-training and training procedures as the experimental Ss, but never received reinforcement in G1.

Following training, testing consisted of 24 days during which rewarded trials (r) were interspersed with nonrewarded trials (f) in G1 for the experimental groups. Three trials per day were run according to the following schedule: rfr, frf, rrf, ffr, rff, frr for one half of the Ss in each experimental group; and frf, rfr, ffr, rrf, frr, rff for the other half. Each of the above sequences (six sets of three trials) constituted one cycle of trials. Testing consisted of four such cycles per S. Control groups received the same number of trials, but never received reinforcement in Gl. Each experiment required 58 days for completion.

RESULTS

Exp. I: Equal Total Delay. As a validation check on the method used to equate total delay before R2, an analysis of variance was performed comparing total delay (mean running speed plus delay before G1) for the three experimental groups: 14.08, 13.83, and 13.79 sec. for the long, medium, and short conditions respectively. Although total delay for the long R1 was somewhat longer, the analysis of variance indicated no reliable difference among the three total delays, $F(2,9)=2.73$, $p>.05$.

The usual index for the FE (FE=f-r) was computed by taking mean reciprocal running speeds x 1000 for r trials and f trials for each S over the 72 test trials. Group means, t values and the corresponding probabilities are presented in Table 1. The FEs for all experimental groups were highly reliable, and an analysis of variance indicated no significant difference among them, $F(2,9)=.58$, $p>.05$. There was little day to day variation in r and f speeds over the 72 test trials.

No significant difference was found among R2 speeds over the 72 test trials for the three control groups, $F(2,9)=1.47$, $p>.05$. Ninty-five percent confidence limits were computed for the grand mean (332) using the error term from the analysis of variance. All r and f speeds for the three experimental groups fell well above the upper confidence limit (352).

Exp. II: Unequal Total Delay. As expected significant differences in total delay before R2 were found for the three experimental groups: 13.68, 12.13, and 10.80 sec. for the long, medium, and short conditions respectively, $F(2,9)=11.8$, $p<.001$.

Group means, t values and the corresponding probabilities are presented in Table 2. Again the FEs for all experimental groups were found to be highly reliable. As in Exp. I there was little day to day variation in r

TABLE 1

Mean r and f times, FEs, t values and the corresponding probabilities that the FE for each group is reliable.

Exp. I

GROUP	N	f	r	f-r(FE)	t	p
short (R1=2')	4	592	520	72	21.02	<.001
medium (R1=8')	4	596	524	72	20.45	<.001
long (R1=14')	4	610	531	79	34.60	<.001

TABLE 2

Mean r and f times, FEs, t values and the corresponding probabilities that the FE for each group is reliable.

Exp. II						
GROUP	N	f	r	f-r(FE)	t	p
short (R1=2')	4	568	530	38	29.4	<.001
medium (R1=8')	4	574	527	47	22.8	<.001
long (R1=14')	4	592	524	68	33.3	<.001

and f speeds over the 72 test trials. However, in contrast to Exp. I, an analysis of variance indicated a highly significant difference among the FEs for the three groups, $F(2,9)=75.6$, $p<.001$. The FE increased directly with R1 length (see Table 2).

Since significant FE differences were obtained, r and f speeds were analysed sepratly. The groups differed in f speeds, $F(2,9)=15.01$, $p<.001$, but not in r speeds, $F(2,9)=1.08$, $p>.05$. The FE therefore appears attributable to differences among f speeds only.

As in Exp. I no significant difference was found among R2 speeds over the 72 test trials for the three control groups, $F(2,9)=2.13$, $p>.05$. Again all r and f speeds fell well above the upper 95% confidence limit (343) for the grand mean of the three control groups (328).

DISCUSSION

The procedure used in these two experiments proved highly effective in producing large and highly significant FEs with relatively small N. Large differences among FEs were obtained as a direct function of R1 length, but these differences disappeared when total delay before G1 was equated. Differences in within-chain delay alone are clearly not sufficient to produce differences in FE. This result supports Amsel et. al. (1961) in their contention that R1 length should affect the FE via its correlation with total delay before G1.

The equal R2 speeds in the three control groups in each experiment show that, when S is never reinforced in G1, increase in delay before G1 is not a sufficient condition for the enhancement of R2 speed. This is consistent with the frustration hypothesis, nonreward not being considered frustrative without prior reward. Also consistent with the frustration hypothesis is the usual finding that experimental group f speeds were faster than control group R2 speeds. However, experimental group r speeds were also faster than control R2 speeds. Although previous studies have not found significant differences between r speeds and control R2 speeds, the direction has been consistently toward faster r speeds (Wagner, 1959; Robinson and Clayton, 1963). Although the frustration hypothesis is able to explain faster f speeds, it can not, in its unmodified form, explain these significantly faster r speeds. A natural modification would be to postulate that the introduction of nonreward effects not only the immediatly following R2 speed but, to a lesser extent, speed on subsequent trials as well by raising the general activity level of Ss under this condition. The fact that the runway one speeds of all experimental groups increased significantly (t ranging from 15.63 to 47.5, $p < .001$ in all cases) following the introduction of nonreward in G1 lends support to the assumption that the introduction of nonreward following continous reward causes a general increase in activity.

The large and statistically significant differences obtained in the present experiments, in addition to the strong FEs and large FE differences obtained as a function of delay, suggests that the methods used were especially effective for investigating FE. These results suggest that relatively long total delay before G1 was an important factor in the present experiments, however it is impossible to specify the critical variables at this time.

APPENDIX I A
(Exp. I)

TABLE 3

Summary of analysis of variance carried out on the mean total period of delay in R1 for the three experimental groups in Exp. I.

SOURCE	SS	df	Ms	F	p
SS_t	8	11			
SS_b	3	2	1.50	2.73	$>.05$
SS_w	5	9	.55		

TABLE 4

Summary of analysis of variance carried out on the FEs of the three experimental groups in Exp. I.

SOURCE	SS	df	Ms	F	p
SS_t	485	11			
SS_b	55	2	27.5	.58	$>.05$
SS_w	430	9	47.7		

TABLE 5

Summary of analysis of variance carried out on R2 speeds of the three control groups in Exp. I.

SOURCE	SS	df	Ms	F	p
SS_t	965	11			
SS_b	237	2	118.5	1.47	$>.05$
SS_w	728	9	80.5		

APPENDIX IB
(Exp. II)

TABLE 6

Summary of analysis of variance carried out on the mean total period of delay in R1 for the three experimental groups in Exp. II.

SOURCE	SS	df	Ms	F	p
SS_t	17.3	11			
SS_b	12.5	2	6.25	11.8	$<.001$
SS_w	4.8	9	.53		

TABLE 7

Results of analysis of variance carried out on FEs of the experimental groups in Exp. II.

SOURCE	SS	df	Ms	F	p
SS_t	2147	11			
SS_b	2026	2	1013	75.6	$< .001$
SS_w	121	9	13.4		

TABLE 8

Results of analysis of variance carried out on r times of the experimental groups in Exp. II.

SOURCE	SS	df	Ms	F	p
SS_t	476	11			
SS_b	92	2	46.0	1.08	$>.05$
SS_w	384	9	42.7		

TABLE 9

Summary of analysis of variance carried out on the f times of the experimental groups in Exp. II.

SOURCE	SS	df	Ms	F	p
SS_t	1639	11			
SS_b	1261	2	630.5	15.01	$<.001$
SS_w	378	9	42.0		

TABLE 10

Results of analysis of variance carried out on R2 speeds of the control groups in Exp. II.

SOURCE	SS	df	Ms	F	p
SS_t	566	11			
SS_b	182	2	91.0	2.13	$>.05$
SS_w	384	9	42.7		

TABLE 11

Total period of delay broken down into two components, R1 length and delay at G1. FE for each group also shown.

Exp. I

Group	R1=14'	R1=8'	R1=2'
R1 time (sec.)	4.08	2.17	.79
Delay at G1(sec.)	10.00	11.66	13.00
FE	79	72	72

Exp. II

Group	R1=14'	R1=8'	R1=2'
R1 time (sec.)	3.68	2.13	.80
Delay at G1 (sec.)	10.00	11.66	]3.00
FE	69	47	38

APPENDIX IIA
(Exp. I)

Fig. 1. Mean running times and base rates for the three R1 lengths in the pilot study, (three trials per day per S with five Ss per group.

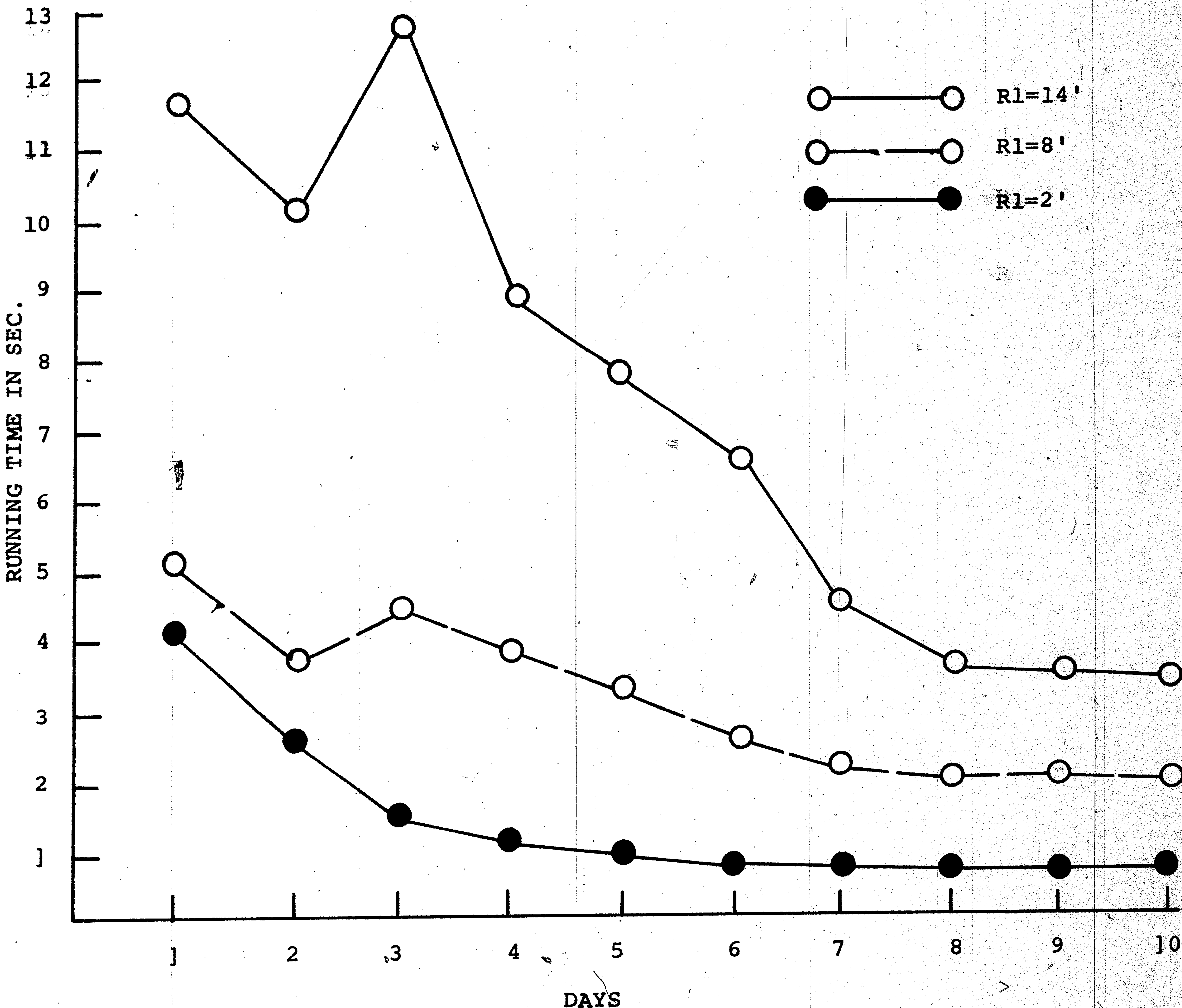

RUNNING TIME IN SEC.
13
12
11
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
DAYS
R1=14'
R1=8'
R1=2'

Fig. 2. Mean running times for R2 in pilot study (three trials per day per S with five Ss per group).

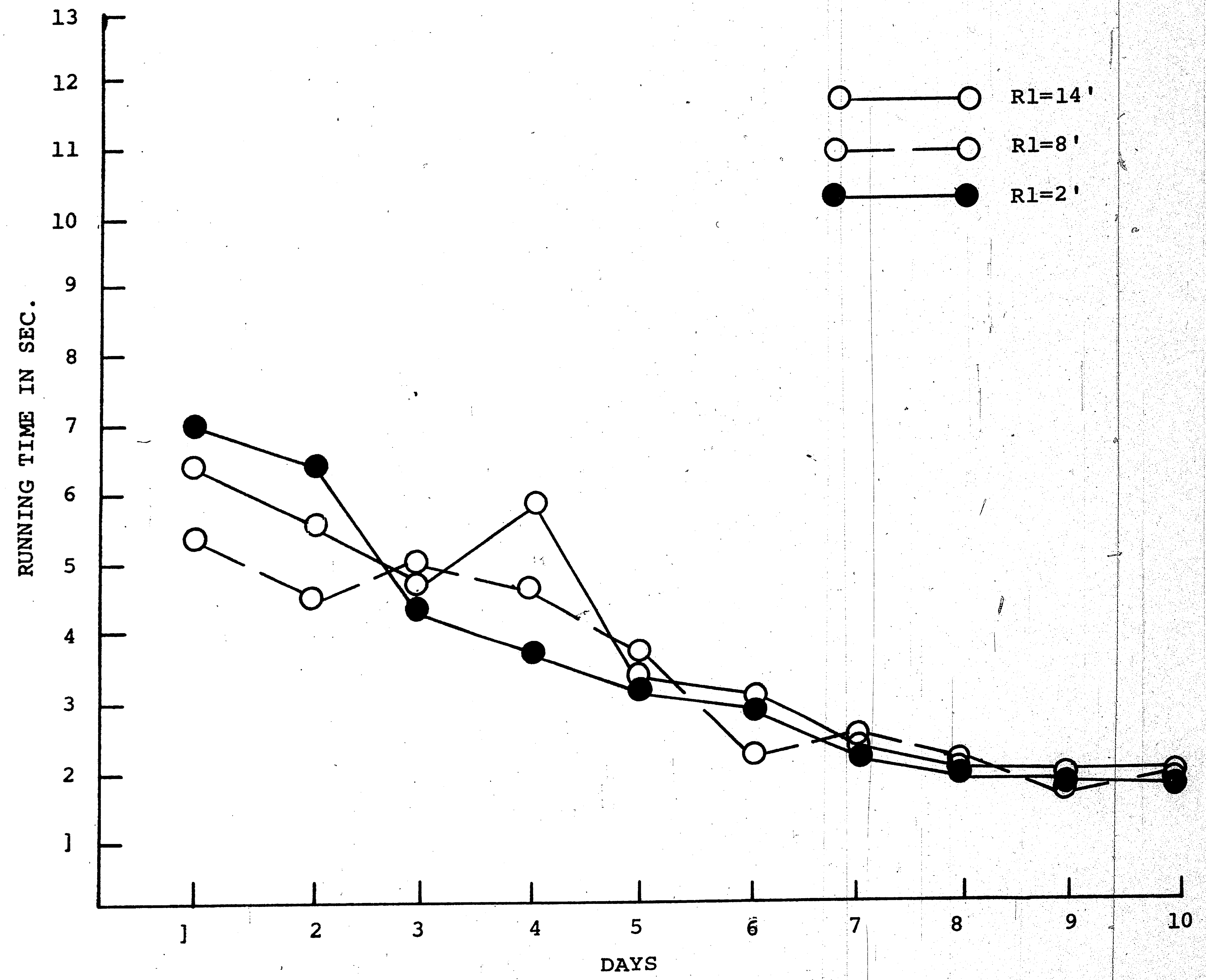

RUNNING TIME IN SEC.
13
12
11
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
DAYS
R1=14'
R1=8'
R1=2'

Fig. 3. Mean f and r speeds for the short group in Exp. I plotted over 12 two day blocks.

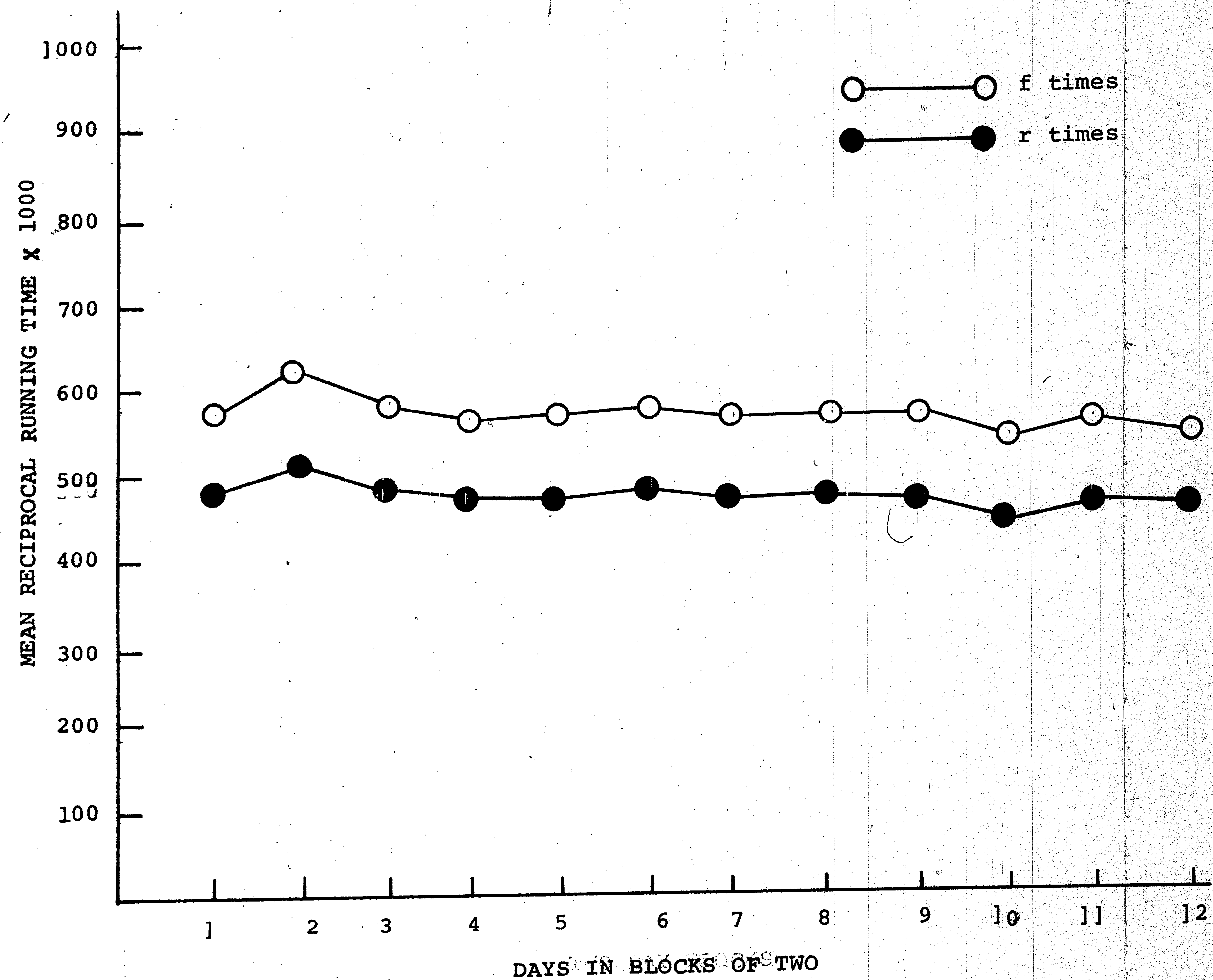

f times
r times
MEAN RECIPROCAL RUNNING TIME x 1000
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

Fig. 4. Mean f and r speeds for the medium group in Exp. I plotted over 12 two day blocks.

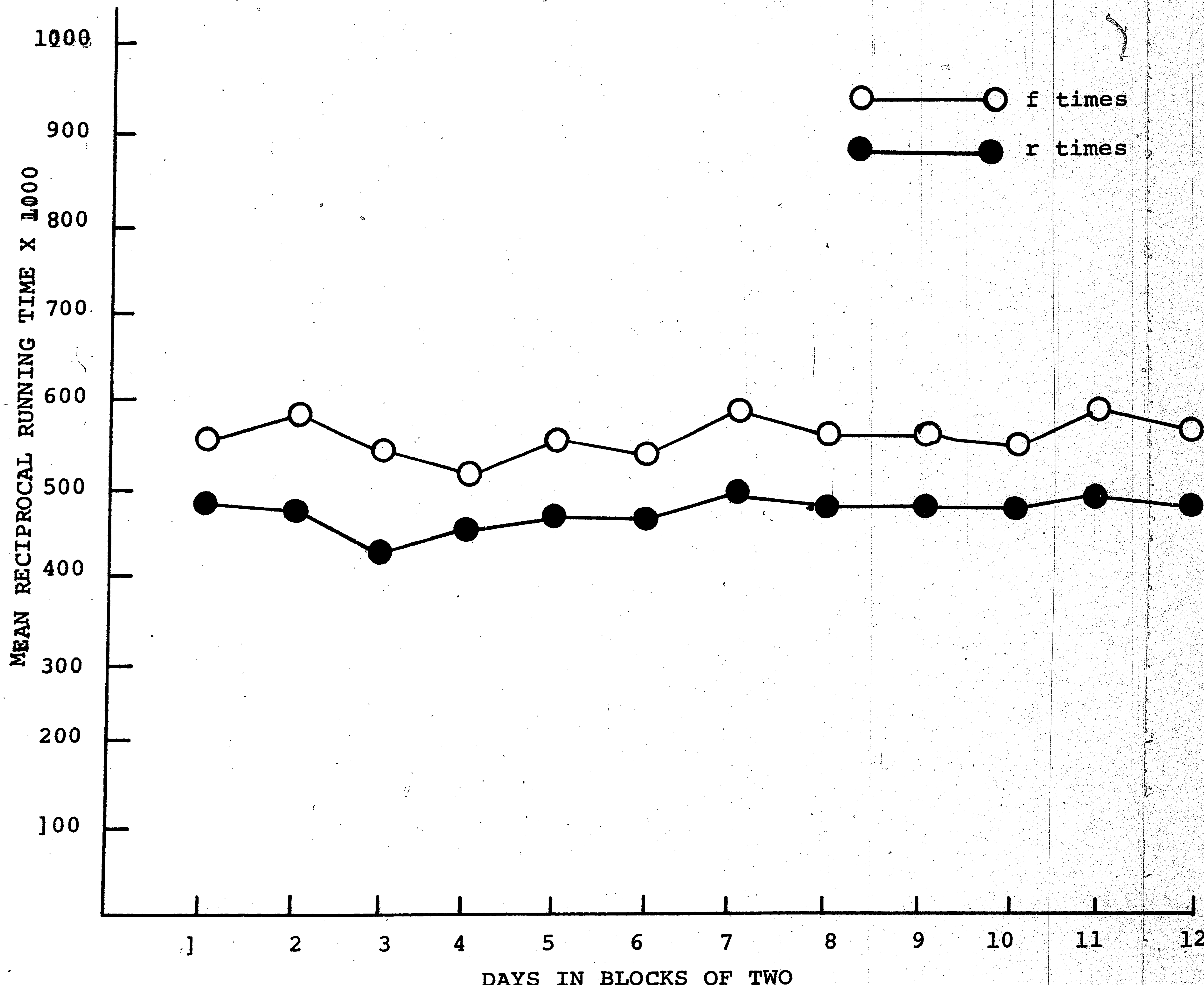

f times
r times
MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

Fig. 5. Mean f and r speeds for the long group in Exp. I plotted over 12 two day blocks.

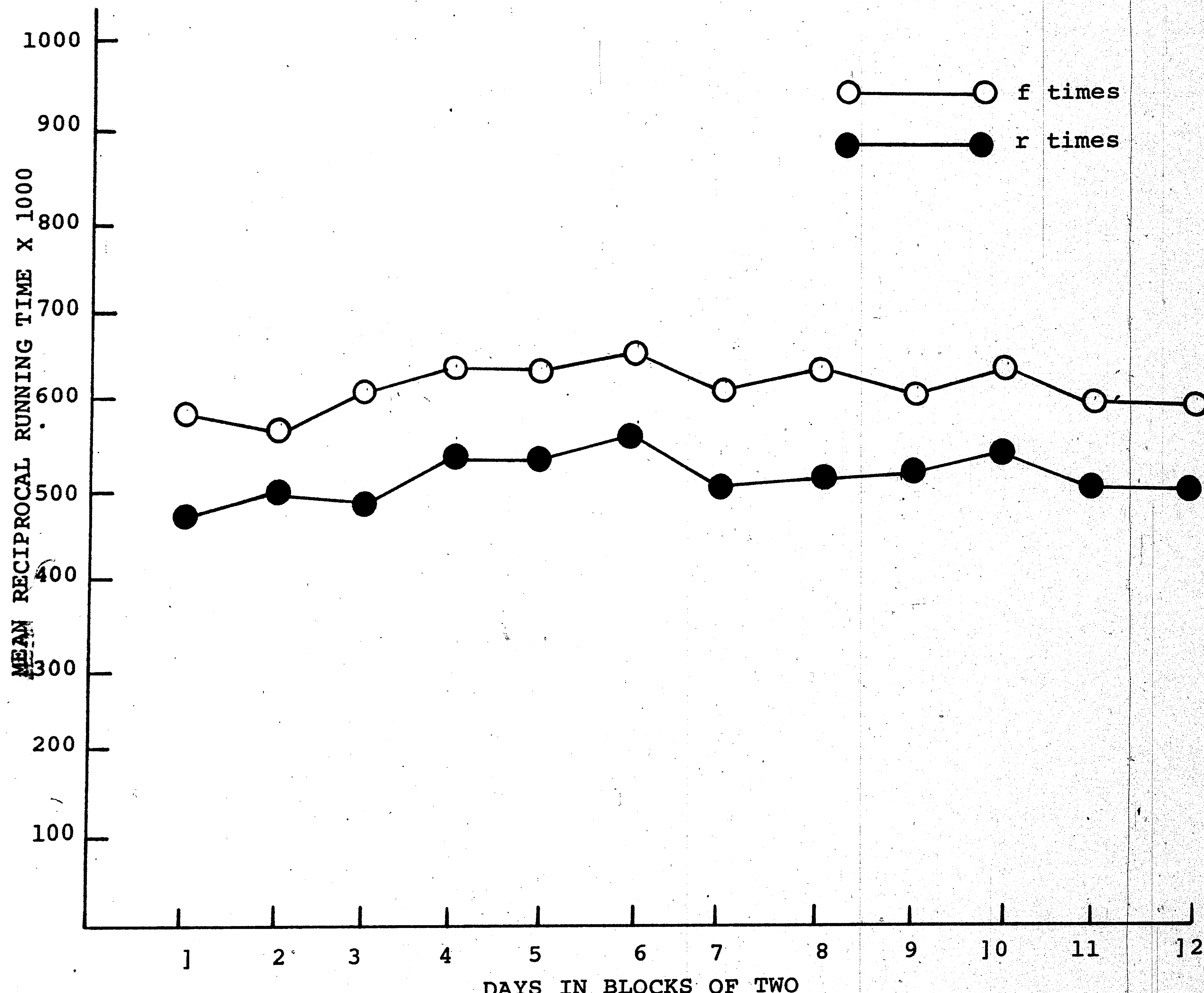
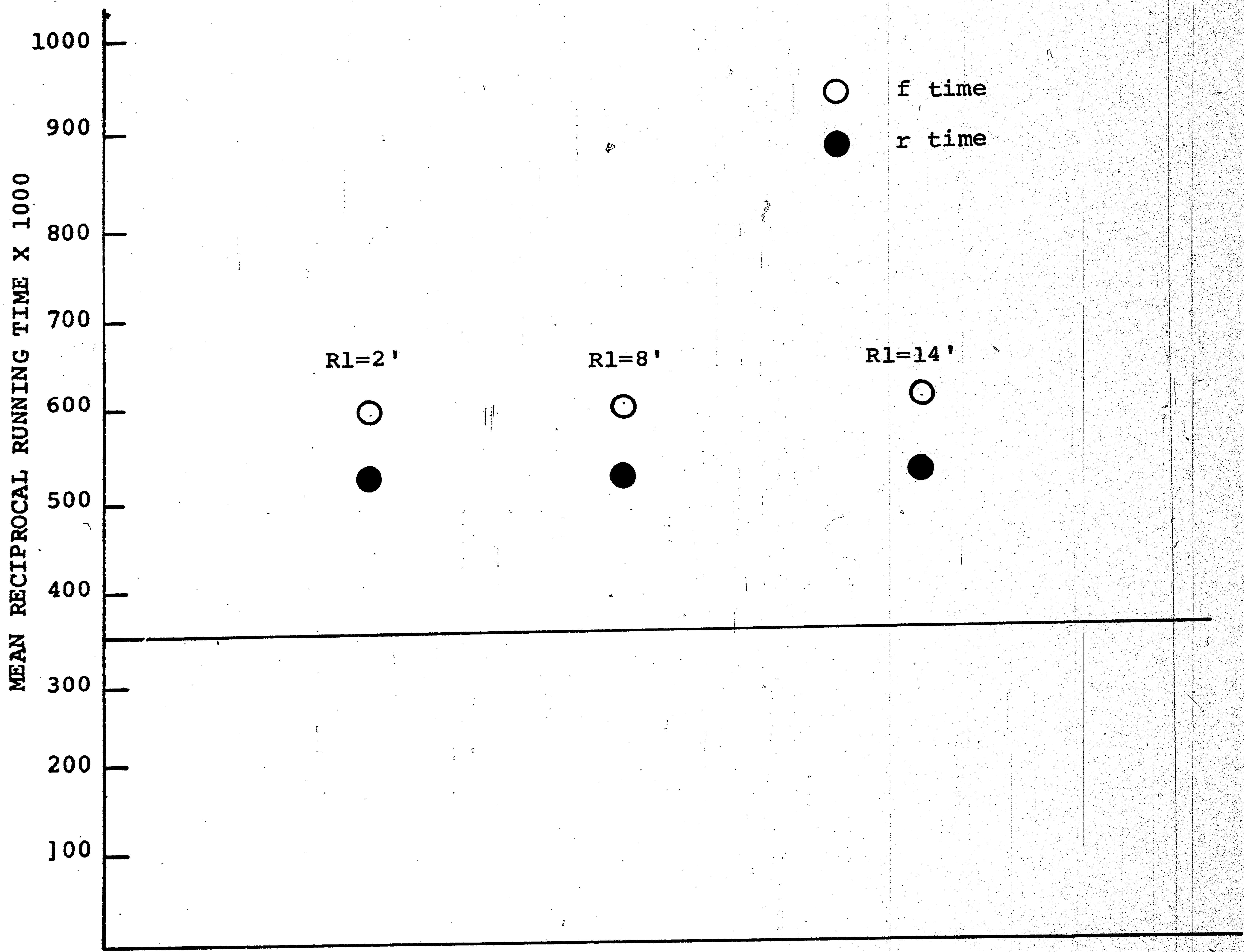

MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
f times
r times
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

Fig. 6. Comparison of experimental f and r speeds with R2 grand mean of the control groups in Exp. I.


MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
f time
r time
R1=2'
R1=8'
R1=14'

APPENDIX IIB
(Exp. II)

Fig. 7. Mean f and r speeds for the short group in Exp. II plotted over 12 two day blocks.

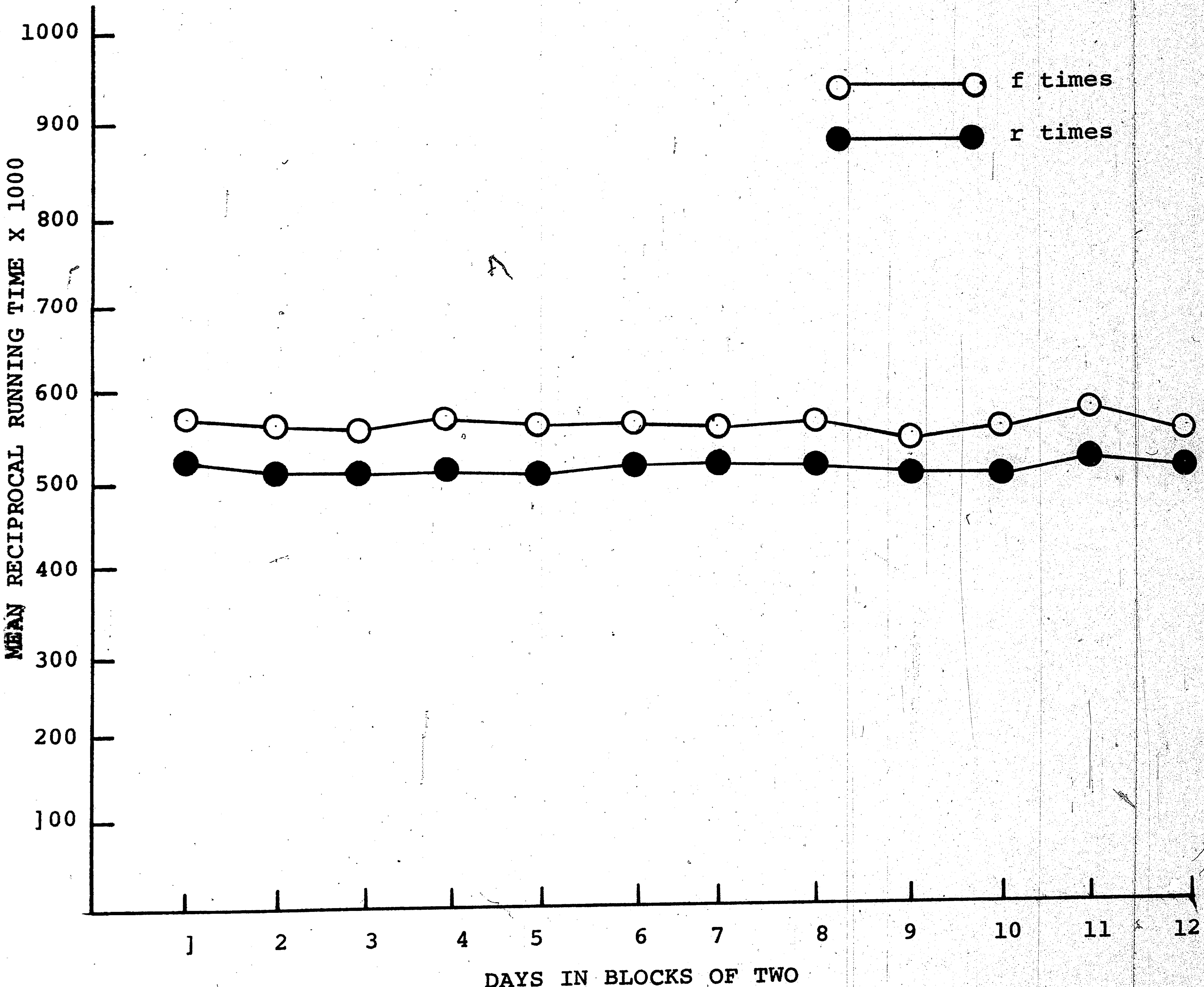

MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
f times
r times
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

Fig. 8. Mean f and r speeds for the medium group in Exp. II plotted over 12 two day blocks.

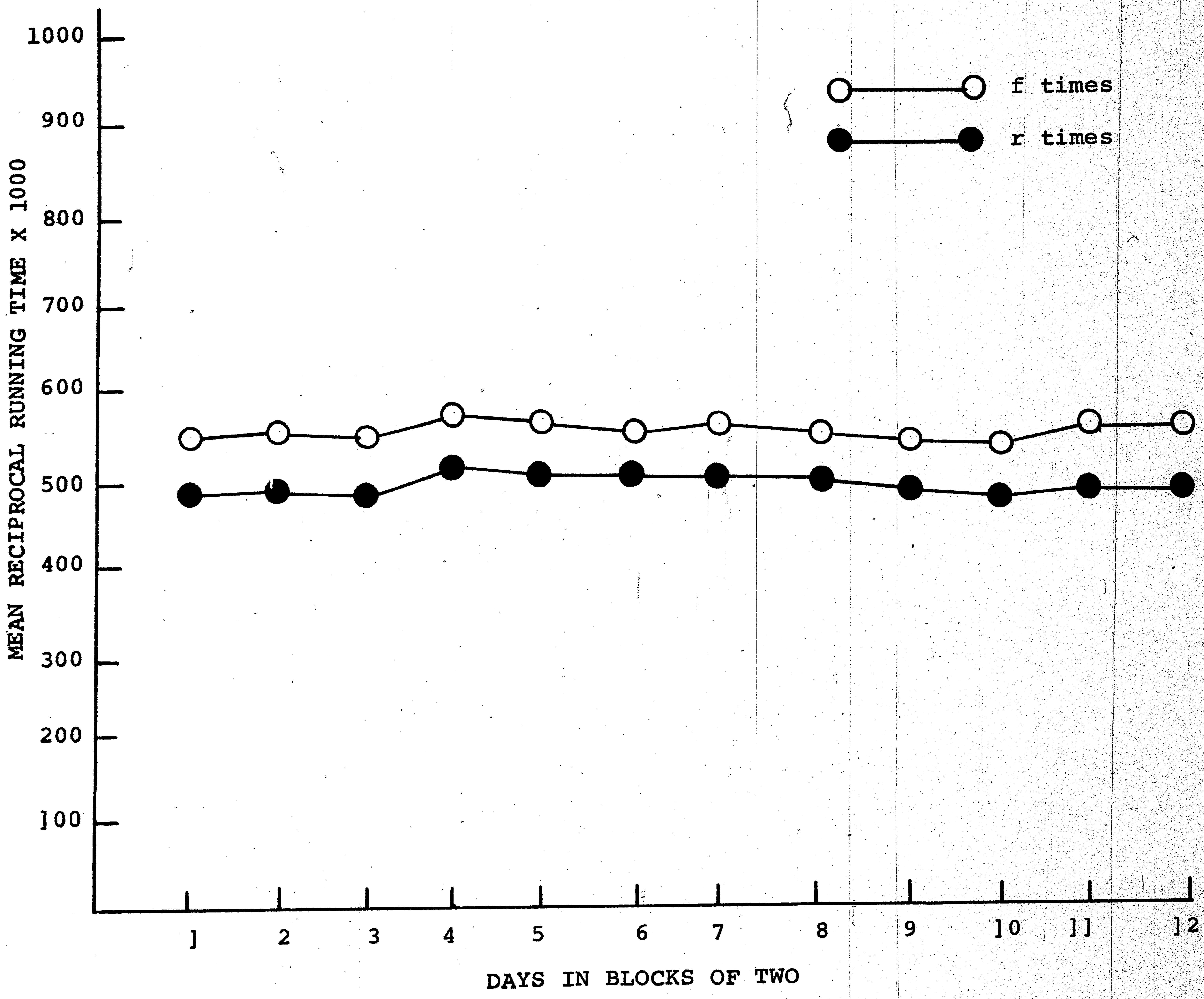
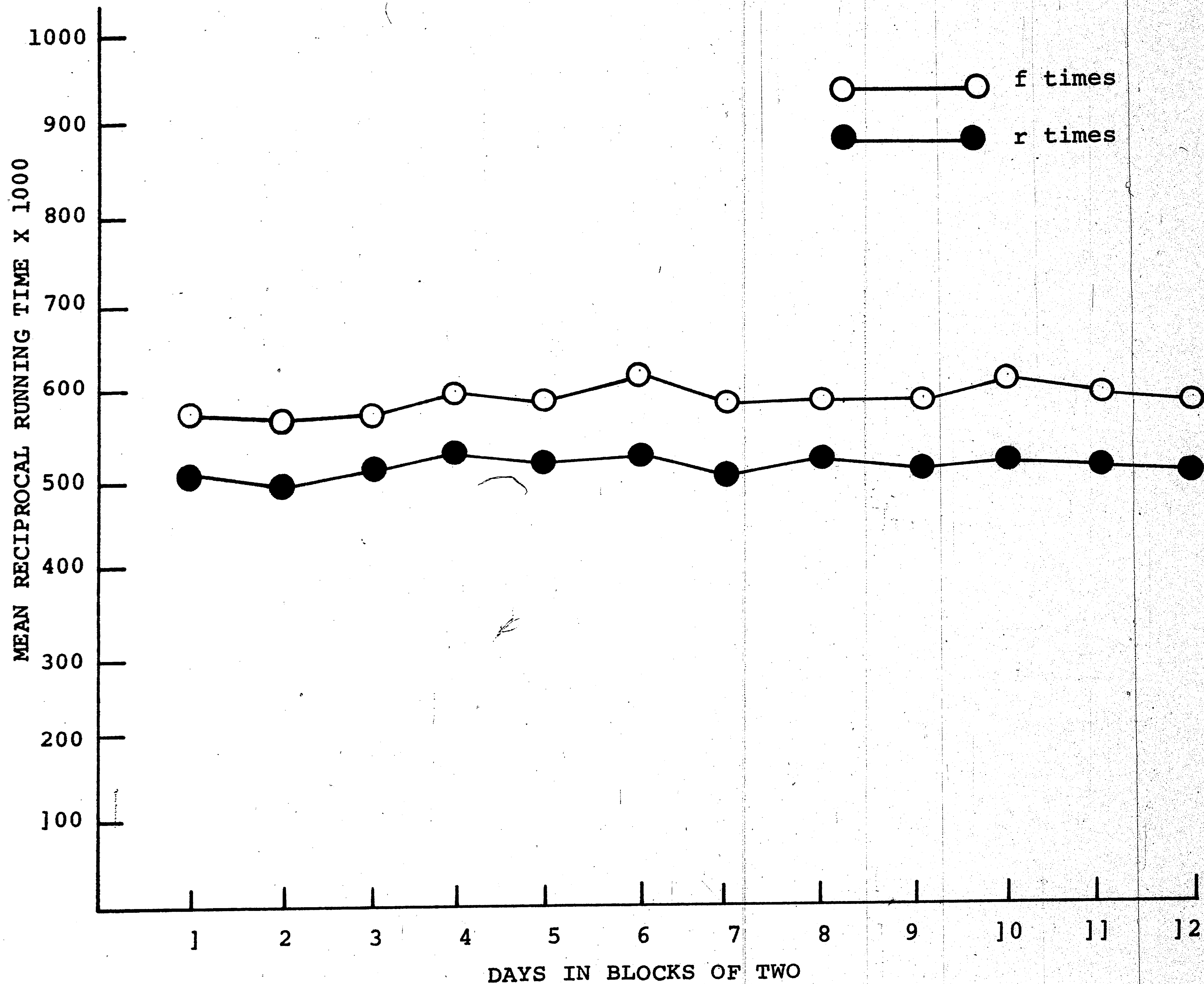

f times
r times
MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

Fig. 9. Mean f and r speeds for the long group in Exp. II plotted over 12 two day blocks.


MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
f times
r times
1
2
3
4
5
6
7
8
9
10
11
12
DAYS IN BLOCKS OF TWO

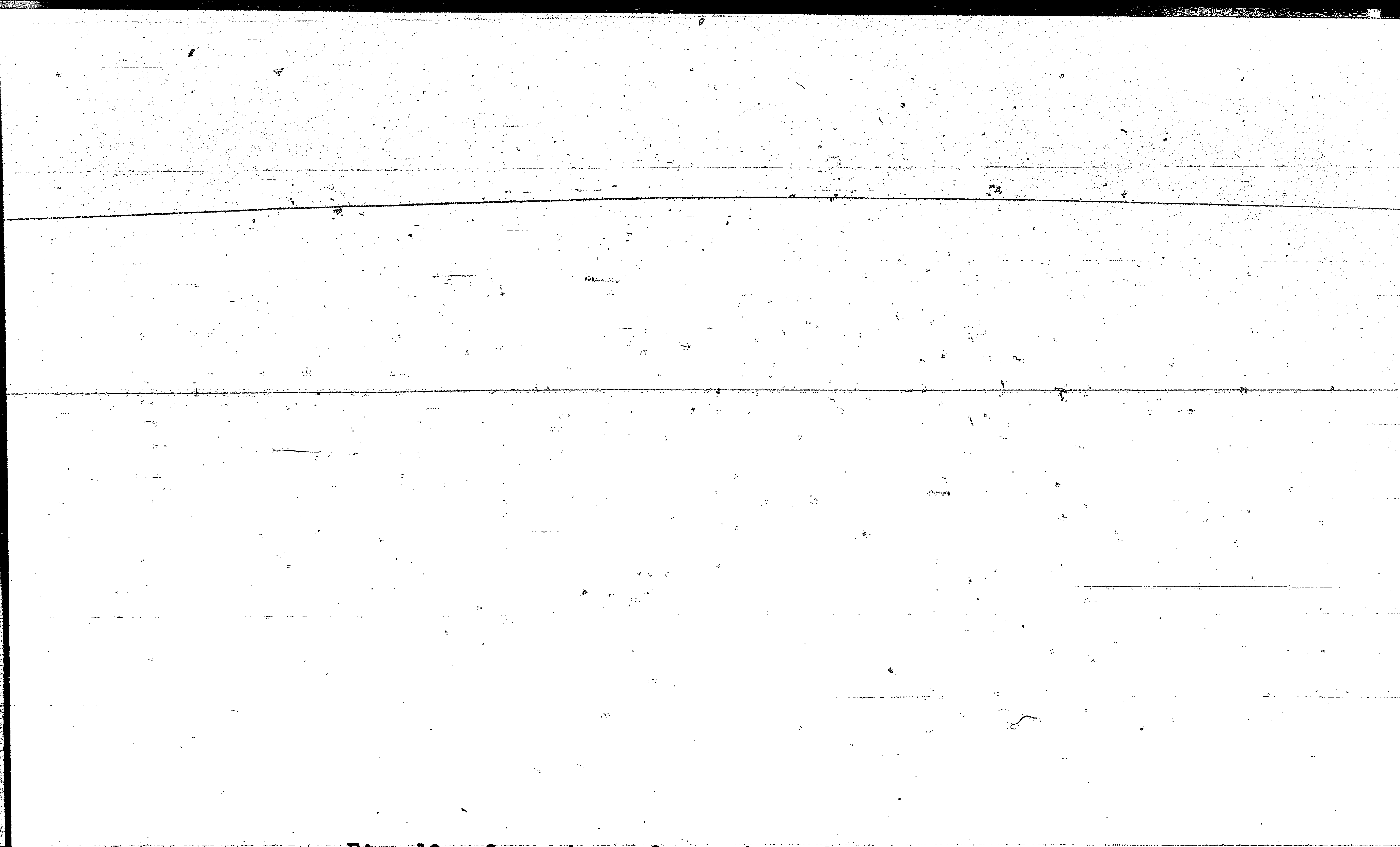


Fig. 10. Comparison of experimental f and r speeds with grand mean of R2 speeds for control groups in Exp. II.

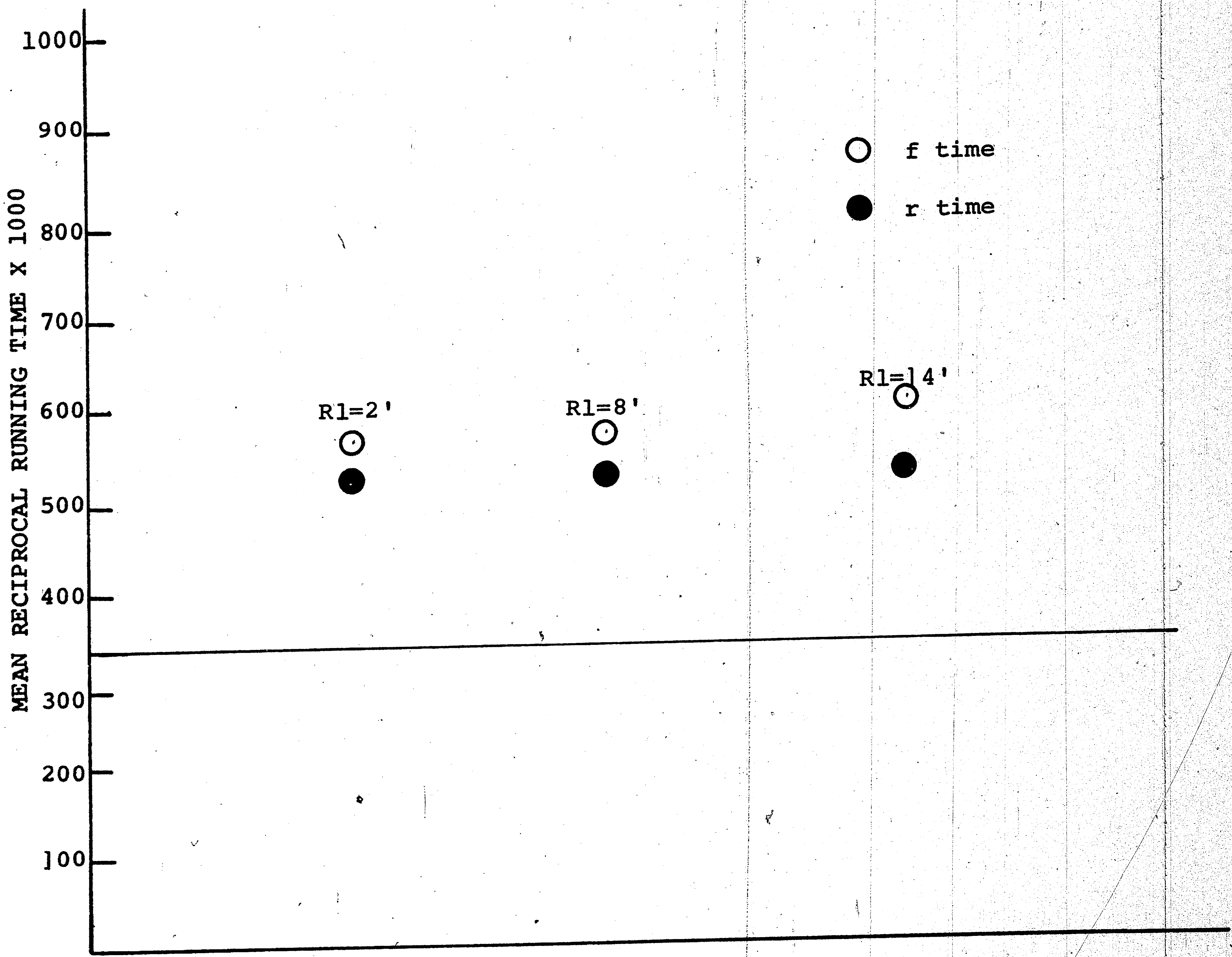
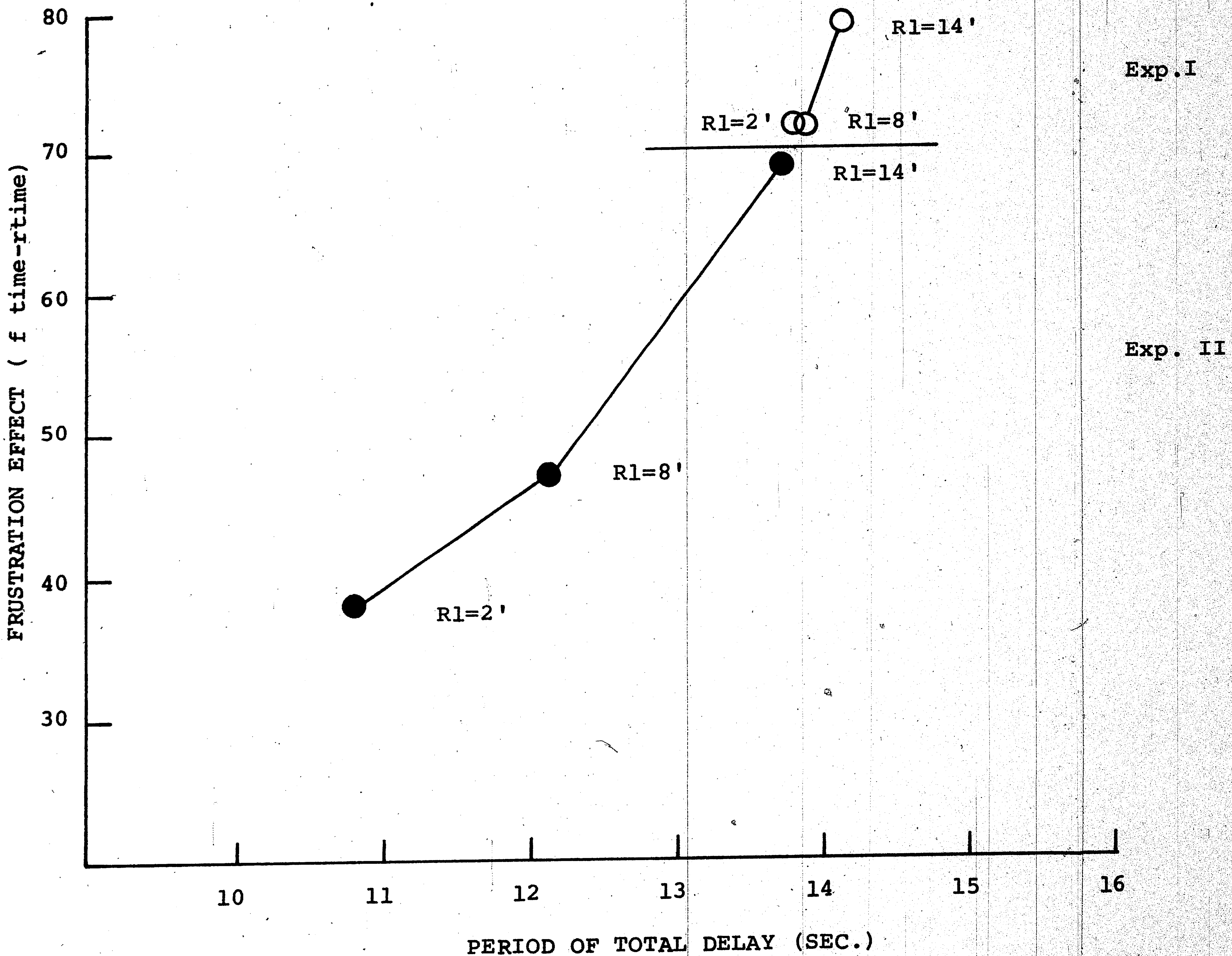

MEAN RECIPROCAL RUNNING TIME X 1000
1000
900
800
700
600
500
400
300
200
100
f time
r time
R1=2'
R1=8'
R1=14'

Fig. 11. Frustration effect as a function of period of total delay (Exps. I and II).


FRUSTRATION EFFECT (f time-rtime)
80
70
60
50
40
30
R1=14'
R1=2'
R1=8'
R1=14'
R1=8'
R1=2'
Exp.I
Exp. II
10
11
12
13
14
15
16
PERIOD OF TOTAL DELAY (SEC.)

REFERENCES

Amsel, A., Erhart, C. B., & Galbrect, C. R. Magnitude of frustration effect and strength of antidating goal factors. Psychological Reprints, 1961, 8, 183-186.

Hull, C. L. A Behavior System. New Haven: Yale University Press, 1952.

Robinson, A. W. & Clayton, K. N. Effects of duration of confinement in a nonbaited goal box on the "apparent frustration effect". Journal of Experimental Psychology, 1963, 66, 613-614.

Spence, K. W. Behavior Theory and Conditioning. New Haven: Yale University Press, 1956.

Wagner, A. R. The role of reinforcement and nonreinforcement in an "apparent frustration effect". Journal of Experimental Psychology, 1959, 57, 130-136.

VITA

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