HEART RATE AND FREQUENCY OF

ROCKING IN NORMAL ADULTS

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ABSTRACT

In previous studies in which rhythm has been observed and not created, few reliable means of measurement have been used. No experimenters had made a systematic study of normal adults in which biological rhythms and a behavioral rhythm were observed at the same time in a reliable fashion. It was the purpose of this study to investigate the relationship between heart rate and a behavioral rhythm, rocking in a rocking chair. The subjects were 16 female and 22 male undergraduate psychology students. Two thirty-second interval recordings of heart rate and two thirty-second interval recordings of rocking rate were measured on polygraph recording. Results indicated: (a) the first heart rate interval recording demonstrated statistically significant positive correlation with the first rocking rate interval recording at the .001 level; and (b) the second heart rate interval recording demonstrated statistically significant positive correlation with the second rocking rate interval recording at the .001 level. Comparisons within and by sexes, as well as comparisons with height and weight, were also computed. The present study demonstrated that in a controlled experiment, rocking rate approximated 72 rocks per minute. Subjects' rocking rates showed statistically significant positive correlation

with individuals' heart rates. These results appeared to support the observations of Lourie (1949), Coleman (1922), Salk (1962), and Morris (1973).

Chapter 1

INTRODUCTION

The pervasiveness of rhythmic behavior in humans extends from rocking in infancy to the frantic dancing of aborigine warriors, and rhythm affects the moods of us all from a soothing effect to tremendous excitation. Despite the fact that poets, authors, and scholars have expounded upon the virtues of rocking and rhythmic behavior, very little systematic study has been done in this field.

One early investigator (Lourie, 1949) observed the pervasiveness of rhythmic patterns in childhood in the form of rocking, crying, and walking. She also observed that the rate of rhythmic activity has a definite relationship to one of the time beats of the body, the breathing rate or the heart beat.

In an observational study performed by Coleman (1922) of animals in the zoological gardens in London, it was surmised that the heart served as a pacemaker of voluntary and involuntary muscular activity. A lynx was observed taking 120 steps per minute; as it stopped and turned its head, its carotid artery came into view. The observers found that its heart rate coincided with the number of steps per minute the animal had been taking. He found similar

results with a cheetah, badger, seal, leopard, etc. In another test, Coleman reported a man's pulse was 60 beats per minute. The subject was asked to walk at ease around a room and his steps were counted and found to be 60 per minute. Coleman further found respiration to be a related pacemaker of movements in certain animals.

> An elephantine tortoise breathed once for each step. A wolverine trotted at 17 steps in 7 minutes and, lying down, panted at the same rate. Similar findings were found for dogs, bears, horses, etc.

Simner's (1966, 1969) studies further explore the premise of the heart as a pacemaker. He demonstrated a positive correlation between cardiac rate and vocal activity in newly hatched chicks. In another experiment (1969) he found a reliable increase in heart rate toward fetal heart rate level immediately preceding the onset of non-nutritive sucking in neonates.

The work of Bridger, Birns, and Blank (1965) further supports the contention that heart rate and the neonates' behaviors are highly correlated. In a study with 20 neonates, behavioral ratings and heart rate measurements were recorded simultaneously under conditions of stimulation and non-stimulation. These results demonstrated that as heart rate increased, all the behavioral indices (i.e., overall excitation level, movement, vocalization, and muscle tension) also increased.

Salk (1962) postulated that not only is the heart the pacemaker of rhythmic behaviors, but, due to imprinting, rhythmic behaviors may, in fact, be imitating heart beat. It was his contention that fetal intrauterine imprinting takes place with maternal heartbeat at 72 paced beats per minute. With the knowledge that when in proximity of an imprinted stimulus an organism is relatively free of anxiety, Salk presented a normal heartbeat sound at 72 paired beats per minute to a group of newborn infants at a level of 85 decibels continuously for four days, except for feedings. The results were dramatic, as the experimental group made faster weight gains, cried less, and demonstrated less fear and anxiety than that of the control group. In a second study with 26 children from age 16 to 37 months, Salk again demonstrated that soothing effectiveness of this heartbeat imprinting. With the presentation of metronome sound (set at the same frequency as heartbeat) heartbeat sound, lullaby sounds, and no sound, the heartbeat sound group fell asleep in half the time in comparison to other groups.

In an observation study of imprinting in adults, Salk claimed that 78.1 percent of the left-handed mothers and 83.1 percent of the right-handed mothers held their babies on the left side, near the heart. This tendency appears to be automatic and Salk postulated that these biological tendencies have survival value.

> We find in nature many indications that the interaction between organisms involves mutual satisfaction. In this connection not only does the baby held by its mother on her left side receive sensations from her heartbeat, but the mother herself, by virtue of having contact in this area, has the sensation of her own heartbeat reflected back.

Further infant studies have been performed by Pederson and Ter Vrugt (1973) in which frequency of rocking seems correlated to soothing effectiveness. In a study with two-month-old infants, effectiveness of rocking was a positive function of frequency with 0, 30, 50, and 70 cycles per minute. The data was interpreted as indicating that effectiveness of rocking is determined by maximum acceleration. An alternative explanation might be that soothing effectiveness would be found to be a generalization gradient around 72 cycles per minute, with the Pederson and Ter Vrugt study representing only the lower end of this curve.

Still another observer, Morris (1973), postulated that the soothing effectiveness of rocking is a function of in utero conditioning with the maternal heartbeat at 72 beats per minute. He observed that mothers who rock their infants in rocking chairs do so at about 60-72 rocks per minute, imitating their heartbeat. He has also observed public speakers who body-rock at 70-72 rocks per minute imitating their own heartrates.

Greene (1972), as reported in Montagu, suggests that mothers who rock and pat their infants tend to rock toward synchrony with the mother's and/or the baby's respiratory rate, while the mother tends to pat the infant on the back at the mother's and/or the baby's heart rate.

Based upon unpublished research by this writer, the rate of rocking in normal adults may be harmonic of heart rate.

In previous studies in which rhythm has been observed and not created, few reliable means of measurement have been used. It has been found that an observer's own rhythms bias his observations (Maris, personal communication). No experimenters have made a systematic study of normal adults in which biological rhythms and a behavioral rhythm were observed at the same time in a reliable fashion. It is, therefore, the purpose of this study to investigate the relationship between heart rate and a behavioral rhythm, rocking in a rocking chair.

Chapter 2

METHOD

Subjects

The subjects were 16 female and 22 male undergraduate psychology students who had volunteered and who had no previous knowledge of the purpose of the experiment.

Apparatus

The experimental chamber measured six feet wide by ten feet long. It was eight feet in height and was dimly lighted. The floor was linoleum tiled. Subjects rocked in a wooden rocking chair with a mercury switch attached at the base of the rocker. A movement of 7.3° forward tripped the mercury switch. This movement defined one half of a rock and was recorded as such on the polygraph as an upward excursion of the recording pen. This half of a rock rate was multiplied by two to account for forward as well as backward movement for the purposes of tabulation. Heart rate was recorded through a digital pulse transducer comprised of a Clairex 603A resistive photocell and a General Electric Model 325 pilot lamp imbedded in a styrofoam ring-like apparatus. Power for this lamp was supplied by a two volt input from a Heathkit

Model IP-12 power supply, placed adjacent to the rocking chair in the experimental chamber. The digital pulse transducer was shielded from ambient light changes in the room by a black velvet bag which was tied around the subjects' right forefingers.

Both rocking movements and digit pulse were recorded on a Gras Model 79B polygraph in an adjacent room. Subjects were signaled to rock with a green signal light and signaled to stop rocking with a red signal light. These lights were controlled by the experimenter who also operated the polygraph.

Procedure

The subject was led into the experimental chamber and asked to be seated in the rocking chair. The digital pulse transducer was placed over his right forefinger and shielded with the black velvet bag. Subjects were assured that they would receive no electrical shock from the apparatus. They were shown the two signal lights and instructed to rock when the green light was on and to stop rocking when the red light was on. The subject was then left alone in the room.

Between one and two minutes were needed for the experimenter to adjust the digital pulse measure to the individual subject. The red light was on at this time. Following adjustment, heart rate was recorded for 30 seconds. The green light was then activated and rocking was recorded for six consecutive five-second intervals.

This was necessary because the subject did not always begin to rock immediately. The red light was again activated and the digital pulse rate was recorded for a second thirty-second interval, while the subject was at rest. The green light then signaled the final period during which rocking was recorded for six consecutive five-second intervals. The polygraph record of two heart rate measures and two rocking rate measures was removed from the polygraph and identified with the number of the subject.

In a brief interview that followed the experiment the subject's sex, height, and weight were recorded on the data sheet. The subject was thanked and then excused.

The polygraph record for each subject was tabulated by the experimenter. A naivé volunteer was instructed with regard to the computation of digital pulse and rocking movement via the excursion marks on the polygraph paper. Ten subjects' polygraph records were drawn at random. Separate tabulations were made by both the experimenter and the volunteer. High reliability was demonstrated in transferring the data from polygraph data sheets to numerical form. One hundred percent agreement was attained from the sample of rocking data and 90 percent agreement was attained for heart rate data. There was perfect correspondence between the two independent counts of rocking rate, and agreement for heart rate measurement was considered plus or minus one.

Chapter 3

RESULTS

Nonparametric statistical analysis was used because these data do not meet the requirements of the parametric statistical model. These requirements are that the observations must be drawn from a normally distributed population, and that the variables involved must have been measured in an interval scale.

The raw data and the group means, standard deviations, and medians are presented in Tables 1 and 2, respectively.

The first digital pulse measure (HR_1) was compared with the first rocking rate measure (RR_1) using the Spearman Rank Correlation Coefficient. A correlation of rs=.61 was computed with a t value of 4.61 which is significant at the .001 level (Siegel, 1956, p. 284), indicating a statistically significant moderate positive correlation. The second digital pulse measure (HR_2) was compared with the second rocking rate measure (RR_2) using the Spearman Rank Correlation Coefficient. A correlation of rs=.62 was computed with a t value of 4.74 which is significant at the .001 level (Siegel, 1956, p. 284), indicating a statistically significant moderate positive correlation.

Table 1

Raw Data

Subjects	HR_1	RR_1	HR_2	RR_2	W_1 (lbs.)	H_1 (inches)
Male	76	76	76	72	171	72.0
Male	86	68	86	64	155	73.5
Female	94	92	92	88	120	60.0
Female	88	80	76	64	128	63
Male	96	76	86	80	155	67
Male	80	80	80	76	190	70
Female	74	80	82	84	118	60
Male	68	60	68	60	146	71
Female	96	68	82	68	122	62
Male	78	68	78	72	153	71
Male	70	72	70	72	190	71
Male	70	60	74	60	185	68
Female	68	64	72	68	140	65
Male	66	76	66	76	189	75
Male	66	60	68	64	150	67.5
Female	82	80	82	84	115	62
Male	72	68	76	76	155	68
Female	81	84	80	80	125	63
Male	72	64	66	64	157	67
Female	98	80	94	84	132	68
Female	92	84	94	80	140	68.5
Female	88	92	96	84	125	64.5
Female	90	92	88	96	123	64.0
Male	80	76	76	76	145	69
Male	72	64	66	60	150	68
Male	64	64	64	64	155	68.5
Male	82	72	84	76	140	67
Male	84	72	86	72	138	68
Female	76	80	72	68	135	68
Male	72	76	72	68	210	71
Female	110	72	102	72	172	68
Female	88	88	90	90	115	61
Male	90	68	86	64	123	71
Male	78	60	80	60	190	73
Male	76	72	76	68	165	71
Female	88	84	82	84	160	64
Female	66	64	80	60	140	68
Male	66	48	66	40	210	74

Table 2

Group Means, Standard Deviations, and Medians

	HR_1	RR_1	HR_2	RR_2
Mean	80.11	73.26	79.32	72.05
Standard Deviation	10.85	10.06	9.37	10.71
Median	79	72	80	72

Male and female means and standard deviations for HR_1, RR_1, HR_2, and RR_2 are presented in Table 3.

Male HR_1 was compared with female HR_1 using the Median Test. The X^2 score of 5.28 yielded a probability that these groups are not significantly different (Siegel, 1956, p. 249). Male HR_2 was compared with female HR_2 using the Median Test. The X^2 score of 6.27 yielded a probability that these groups are significantly different at the .05 level (Siegel, 1956, p. 249). Male RR_1 was compared with female RR_1 using the Median Test. The X^2 score of 6.65 yielded a probability that these groups are significantly different at the .05 level (Siegel, 1956, p. 249). Male RR_2 was compared with female RR_2 using the Median Test. The X^2 score of 3.38 yielded a probability that these groups are not significantly different (Siegel, 1956, p. 249).

Male HR_1 was compared with male RR_1 using the Spearman Rank Correlation Coefficient. A correlation of rs=.45 was computed with a t value of 2.25 which is significant at the .05 level (Siegel, 1956, p. 284), indicating a statistically significant moderate positive correlation. Male HR_2 was compared with male RR_2 using the Spearman Rank Correlation Coefficient. A correlation of rs=.40 was computed with a t value of 1.95 which is significant at the .01 level (Siegel, 1956, p. 284) indicating moderate positive correlation.

Female HR_1 was compared with female RR_1 using the

Table 3

Means and Standard Deviations by Sexes

	HR_1	RR_1	HR_2	RR_2
Means				
Female	86.25	80.25	85.25	78.38
Male	75.64	68.18	75.00	67.45
Standard Deviation				
Female	11.04	8.88	8.50	10.02
Male	8.18	7.48	7.40	8.62

Spearman Rank Correlation Coefficient. A correlation of rs=.27 was computed with a t value of 1.04 which is significant at the less than .20 level (Siegel, 1956, p. 284), indicating low positive correlation. Female HR_2 was compared with female RR_2 using the Spearman Rank Correlation Coefficient. A correlation of rs=.53 was computed with a t value of 2.33 which is significant at the .05 level (Siegel, 1956, p. 284), indicating statistically significant moderate positive correlation.

Using the Sign Test, HR_1 and HR_2 were compared to determine significant differences. A Z score of .19 yielded a probability score of .84, indicating that these two groups are not significantly different at the .05 level (Siegel, 1956, p. 247). Using the Sign Test, RR_1 and RR_2 were compared to determine significant differences. A Z score of .58 yielded a probability score of .56, indicating that these two groups are not significantly different at the .05 level (Siegel, 1956, p. 247).

Comparisons of first and second interval recordings for heart rate and rocking rate by sexes are presented in Table 4. The Z scores and probability values demonstrate that all these groups compared are not significantly different at the .05 level (Siegel, 1956, p. 247). The Sign Test was used for these comparisons.

Using the Spearman Rank Correlation Coefficient, correlations of first and second interval recordings for heart rate and rocking rate by sexes were computed. The

Table 4

Comparison of First and Second Interval Recordings for Heart Rate and Rocking Rate by Sexes

SEX	COMPARISON	SCORE	P VALUE	SIGNIFICANCE LEVEL	
Female	HR_1 to HR_2	Z=.50	P=1.	N.S.	.05
Female	RR_1 to RR_2	Z=.29	P=.58	N.S.	.05
Male	HR_1 to HR_2	Z=.30	P=.60	N.S.	.05
Male	RR_1 to RR_2	Z=.50	P=1.	N.S.	.05

results are presented in Table 5. The correlations indicated statistically significant high positive correlation at the .001 level (Siegel, 1956, p. 284).

Using the Spearman Rank Correlation Coefficient, first and second interval recordings for rocking rate were compared with both weight and height. The results are presented in Table 6. The correlations indicated statistically significant moderate negative correlation at the .001 level (Siegel, 1956, p. 284).

Comparisons of rocking rate intervals to weight and height by sexes were computed using the Spearman Rank Correlation Coefficient (Siegel, 1956, p. 284). The correlations are presented in Table 7.

Table 5

Correlation of First and Second Interval Recordings for Heart Rate and Rocking Rate by Sexes

SEX	COMPARISON	SPEARMAN RANK CORRELATION COEFFICIENT	t VALUE	LEVEL
Female	HR_1 -- HR_2	rs = .74	t=4.15	α =.001
Female	RR_1 -- RR_2	rs = .82	t=5.53	α =.001
Male	HR_1 -- HR_2	rs = .92	t=10.65	α =.001
Male	RR_1 -- RR_2	rs = .84	t=7.04	α =.001

Table 6

Comparison of First and Second Interval Recordings of Rocking Rate with Weight and Height

INTERVAL	COMPARISON GROUP	CORRELATION	t SCORE
RR_1	W	-.46	3.12*
RR_2	W	-.44	3.00*
RR_1	H	-.46	3.17*
RR_2	H	-.51	3.56*

*p=.001

Table 7

Comparisons of Rocking Rates to

Weight and Height by Sexes

SEX	COMPARISON	SPEARMAN RANK CORRELATION COEFFICIENT	t VALUE	α LEVEL
Female	RR_1 to W	rs=-.37	t=1.49	α=.20
Male	RR_1 to W	rs=.18	t=.82	α< .20
Female	RR_2 to W	rs=-.54	t=2.40	α=.05
Male	RR_2 to W	rs=-.11	t=.49	α< .20
Female	RR_1 to H	rs=-.29	t=1.13	α< .20
Male	RR_1 to H	rs=.02	t=.08	α< .20
Female	RR_2 to H	rs=-.44	t=1.83	α=.10
Male	RR_2 to H	rs=-.23	t=1.05	α< .20

Chapter 4

DISCUSSION

Heart rate remained constant and approximated the accepted average of 72 beats per minute. Rocking rate remained constant across measurement periods for each subject. The rocking rate closely approximated the heart rate. The correspondence between these two measures was especially striking when one considered that differences were increased two times through the transformation of data from the thirty-second measurement intervals to the one-minute units reported. This close correspondence was consistent with Coleman's (1922) and Lourie's (1949) observations that behavioral rhythms closely approximate biological rhythms.

These observations were further supported by group data. It appeared, however, that rocking rate more closely approximated the average heart rate (72) than the actual heart rate measures. These results were consistent with Morris' (1973) observation that mothers rock their infants in rocking chairs at about 72 rocks per minute, and that public speakers body-rock at 70-72 rocks per minute. While he postulated that they may be imitating their own heart rate, Morris had no heart rate data. The data from the present study suggested that although heart rate may be higher due to situational anxiety, subjects tend to rock at 72 rocks per minute. Salk (1962) suggested that fetal intrauterine imprinting takes place with the maternal heartbeat at 72 paced beats per minute. It is this experimenter's contention that this imprinting was so pervasive that it remained with the individual throughout his lifetime.

A strong relationship was demonstrated in positive correlation between heart rate and rocking rate. This relationship held for both group data and comparisons made within sexes. This evidence suggested that to some extent the heart may serve as a pacing mechanism for rhythmic behavior. This effect, however, was not sufficiently strong so that rocking rate actually matched heart rate.

Both the heart rates and rocking rates were greater for females than for males. The finding that female heart rate was faster seems to be supported by the popular assumption that females have faster heart rates than males.

Even when the sexes were considered separately, significant positive correlation between heart rate and rocking rate remained on three of the four comparisons. This indicated a relationship between heart rate and rocking rate that was independent of sex differences.

Failure to demonstrate significant differences between the two measures of heart rate and the two measures of rocking rate suggested that the procedures involved in measurement for the four alternate intervals had no

demonstratable effect on heart rate or rocking rate. This suggested that people begin rocking immediately at their characteristic rate. Heart rate was not affected by habituation or by the previous rocking interval. Neither were any significant differences noted between these measures when comparisons were made for each sex group. Not only were there no significant differences between measurement periods for group data, but this consistency also held true for individual subjects, as is indicated in Table 5.

Although comparisons of rocking rates with height and weight measurement yielded statistically significant negative correlations, this apparent relationship appeared to be derived from a third factor--sex. Comparisons of rocking rates to height and weight for individual sex groupings yielded low nonsignificant correlations. The one significant correlation was not strikingly high and may have represented statistical effects of multiple correlation.

The present study demonstrated that for a group of normal subjects in a controlled experiment, rocking rate in a rocking chair approximated 72 rocks per minute. The subjects' rocking rates showed statistically significant positive correlation with individuals' heart rates. This rocking rate appeared constant for individuals, and how far it fluctuated seemed to depend on individual heart rate. These results appeared to support the observations of Lourie (1949), Coleman (1922), Salk (1962), and Morris (1973).

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