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Effects of stroking horses on both humans' and horses' heart rate responses[1]

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Abstract: The present study examined both human and horse heart rates (HRs) when humans stroked horses for 90 seconds; the subjective arousal levels of the humans were measured by the Tohoku Activation Deactivation Adjective Check List before and after stroking horses. Six male subjects with a positive attitude toward companion animals and 6 male subjects with a negative attitude were selected by their scores on the Pet Attitude Scale, and these two groups, together with a third group, of 6 subjects who were male members of the Doshisha University horse-riding club, participated in this experiment. The HRs of the human subjects during the first 10 seconds immediately after the stroking began were significantly higher than those obtained after that period, but these higher levels gradually returned to baseline levels. This tendency appears more clearly in the negative attitude group. The HRs of the horses increased during the first 20 seconds immediately after the human subjects of the NA group started stroking them, but gradually reduced as the stroking continued. The results of subjective arousal levels suggest a decrease in tension by stroking horses. These results suggest that a certain affectional interaction may exist between humans and companion animals.

Key words: heart rate, human–companion animal interaction, Pet Attitude Scale, subjective arousal, touching.

Very many families all over the world keep dogs, cats or even reptiles, such as snakes and tortoises, as their companion animals. Many psychological researchers have paid attention to some human–companion animal interactions, as well as human–human interactions. One area in the psychological research of human-companion animal interactions is to explore humans' attitude formations toward companion animals, personality characteristics of owners of companion animals, and so on (e.g., Cameron & Mattson, 1972; Edelson & Lester, 1983; Hyde, Kurdek, & Larson, 1983; Joubert, 1987; Kidd & Kidd, 1985, 1989, 1990; Kidd, Kelley, & Kidd, 1983; Levinson, 1972; Moroi, 1984; Penden-Levy, 1985; Poresky, Hendrix, Mosier, & Samuelson, 1988). Various questionnaires have been developed to measure people's attitudes toward companion animals: the Companion Animal Bonding Scale (Poresky, Hendrix, Mosier, & Samuelson, 1987), the Pet Attitude Inventory (Wilson, Netling, & New, 1987), the Pet Attitude Scale (Templer, Salter, Dickey, Baldwin, & Velever, 1981), and the Pet Relationship Scale (Lago, Kafer, Deloney, & Connell, 1988). The results of these studies

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suggest in general that companion animals give significant psychological, especially emotional, benefits to human beings.

Another research area is to study direct interactions between companion animals and people's physiological states, such as heart rate and blood pressure. As to the direct effects of touching companion animals on people's psychophysiological states, there are many experimental studies reporting the effectiveness of interactions with companion animals in reducing humans' cardiovascular variables such as heart rate and blood pressure (e.g., Friedman, Katcher, Thomas, Lynch, & Messent, 1983; Grossberg & Alf, 1985; Jenkins, 1986). For example, Katcher (1981) reported that when humans talk to, or touch, pets, their physiological arousal level, measured by blood pressure, tends to be lower than when they are with fellow humans. Wilson (1987) found that when humans touch dogs with which they have had no previous contact, their arousal level measured by blood pressure and heart rate is lower than when they read books alone. Vormbrock and Grossberg (1988) called the effects of companion animals on humans' cardiovascular responses and on their relaxation "pet effects." They found that "pet effects" predominantly resulted from direct contact with companion animals.

The results of these experimental studies suggest that subjects' increased physiological arousal in certain interpersonal situations, such as an interview, decrease with the presence of companion animals. The studies also revealed that such a lowering effect became especially significant when directly touching or petting companion animals.

Most of these studies have used dogs and cats. There are, however, many other kinds of companion animals, such as horses, turtles, snakes, and birds (Kidd et al., 1983). We decided in this study to use horses and to examine humans' psychophysiological responses to them. Horses have not been employed as animal subjects in previous human-companion animal psychophysiological studies.

In the present study, human subjects with a positive attitude toward companion animals and those with a negative attitude were selected by their scores on the Pet Attitude Scale (Templer et al., 1981). These two groups, together with a third group of members of a horse-riding club (who were not asked to rate the above scale), participated in this experiment. Jenkins (1986) conducted an experiment based on the hypothesis that dog owners, screened by the Pet Attitude Scale, with a positive attitude toward companion animals in general, would have significantly lower blood pressure and heart rate when petting their dog than when they were reading a book alone. The hypothesis was upheld. In our experiment, we measured subjects' heart rates while they were stroking a horse, and their subjective arousal levels before and after the stroking.

We expected that the heart rates of both the members of the horse-riding club and the subjects with a positive attitude toward companion animals would decrease when they stroked a horse. In contrast, the heart rates of the subjects with a negative attitude toward companion animals were tentatively expected to increase at the beginning of stroking a horse. We could not anticipate, however, the changes in heart rate, if any, when they kept on stroking the animal.

There are few studies on the physiological responses of companion animals when humans touch them. Lynch and McCarthy (1967, 1969) found that when electric shocks were given to a dog, its cardiovascular responses were accelerated at the beginning but then decreased as humans kept touching it. Similar findings were reported by Gantt, Newton, Royer, and Stephens (1966), and by Newton and Gantt (1968). In the present study, the heart rates of the horses kept by members of the horse-riding club were recorded when they were stroked by human subjects in the three groups mentioned above. One purpose of this study was to examine what differences would occur in the heart rates of the horses when they are stroked by humans with a positive attitude toward companion animals, and by humans with a negative attitude toward companion animals, who were not familiar with the horses or horses in general, and by some members of the horse-riding club with whom the horses used as subjects were familiar.

Method

Subjects

Humans. Subjects were 18 undergraduate male students. Six of them were members of Doshisha University horse-riding club (hereafter referred to as the horse-riding club group), and of the remaining 12, six had a positive attitude toward companion animals (the positive attitude group) and six had a negative attitude toward companion animals (the negative attitude group).

One hundred and thirty-six Doshisha University male students were administered the Japanese version of the Pet Attitude Scale (Moroi, 1984) and were asked to rate 18 items in the questionnaire on a five-point scale (for items 1, 2, 3, 5, 7, 8, 10, 11, 14, 16, 18, the points are from 5 = very much so to 1 = not at all; for the remaining items, they are from 1 = very much so to 5 = not at all). The total scores were calculated and the average of the total scores was 42.48 (SD = 12.50). Out of the above 136 students, only 24 expressed their willingness to participate in this experiment. Their mean score was 61.3 (SD = 13.24). Based on this mean score, six who had relatively high scores and who were available for this experiment were selected for the positive attitude group, and six who gave relatively low scores and who were available were selected for the negative attitude group. The mean score of the positive attitude group was 73.17 (SD = 6.71) and that of the negative attitude group was 55.83 (SD = 10.72). The analysis of variance (ANOVA) showed that there was a significant difference between the two groups ($F(1, 10) = 11.27$, $p < .01$). The subjects in these groups had no previous experience of touching horses.

Horses. Two castrated thoroughbred horses (born in Japan) kept for more than two years at the Doshisha University horse-riding club were employed as subjects. They were calm tempered and suitable for human subjects who had no previous experience with horses. One, named "Berlin," was nine years old and the other, named "Almani-Turbo," was eight years old. Two horses were employed as subjects, simply because one particular horse was not always available, owing to the schedules of the horse-riding club. For the same reason, these two horses could not be assigned equally to the human subjects of different groups.

Dependent measures

Heart rate. During the period when the human subjects stroked horses, electrocardiograms (ECG) of both the human and the horse were recorded by the wireless ECG monitor (Nihon Denki San'ei, Bioview 2G52X, Tokyo, Japan). The monitor receives ECG signals from the transmitter (1433X) connected with disposable electrodes (45352) attached to the subjects. ECG waves were recorded on a pen-recorder (BK-21) at a speed of 25 mm/s. Time constant was 0.6 s.

Three electrodes were attached to the human subjects for abdominal bipolar recording (CM5). For the horses, one negative electrode was attached to the abdomen of the left trunk, one earthed line electrode to the left side of the spine, and one positive electrode between these two electrodes.

Subjective arousal. In order to measure change in subjective arousal of the human subjects before and after stroking the horses, the Tohoku Activation Deactivation Adjective Check List (TAD-ACL), which was developed by Matsuoka and Hatayama (1985) based on Thayer's (1967) Activation Deactivation Adjective Check List, was administered. The TAD-ACL consists of 12 items: High Activation (tense, with pounding heart, and jittery), General Activation (pleasant, comfortable, and absorbed), General Deactivation (leisurely, unhurried, and relaxed), and Deactivation-Sleep (drowsy, languid, and tired). In this experiment, the subjects were asked to rate these items on a 7-point scale (the points are from 7 = very much so to 1 = not at all).

Procedure

The human subjects, sitting in a chair in the monitor room, received instructions on the outline of the experiment, and then electrodes were attached to them. The instructions included the manner in which to stroke the horse, such as stroking the neck gently, patting lightly, and being silent when approaching and stroking the horse.

After the electrodes were attached, there was a 10-minute rest period, during which the ECG baseline of the human subject was recorded. At the end of this rest period, the human subjects were asked to fill out the TAD-ACL, and then they were asked to leave the room quietly, to walk at their ordinary pace to an outdoor stable (a place for saddling and washing horses) 12 meters away from the monitor room, and then to approach a horse hitched there and stroke it.

Stroking lasted 90 seconds, and during that period the subjects stroked the horse as instructed, and their ECGs were recorded. The subjects stopped stroking the horse at a signal from the experimenter, and they were then asked to leave the horse and return to the monitor room. Lastly, they were required to fill out the TAD-ACL, rating their subjective feelings they had had while stroking the horse.

The horses, in their own indoor stable (where they are usually kept), had electrodes attached to them, and the baseline of the ECG was measured over five minutes. They were then taken to the outdoor stable where the experiment was carried out. About 10 minutes after a horse was taken to the experimental stable, a human subject approached it. The ECG of the horse was recorded as it was stroked by the human subject.

Results

Heart rate changes

For the human subjects, the numbers of R-wave spikes were counted on the basis of the ECG waves for the last minute in the 10-minute baseline period, and each subject's baseline level was calculated as average heart rate per minute. For the horses, the numbers of R-wave spikes were counted on the basis of the ECG waves for the last minute in the 5-minute baseline period, and each subject's baseline level was calculated as average heart rate per

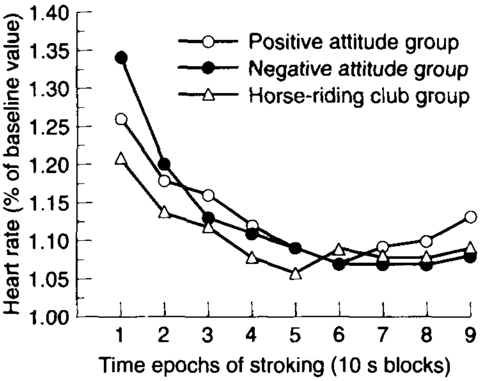

Figure 1. Heart rate as a percentage of baseline value in human subjects while they touched a horse.

minute. The average baseline levels of heart rates of the human subjects were 70.99 bpm (SD = 7.49 bpm) for the positive attitude group, 84.46 bpm (SD = 9.44 bpm) for the negative attitude group, and 73.67 bpm (SD = 2.05 bpm) for the horse-riding club group. An ANOVA with one factor revealed a significant difference in baseline level among the groups, $F(2, 15) = 5.11, p < .01$. The multiple comparison analysis according to Tukey's honestly significant difference test (HSD) revealed that the average baseline level of the negative attitude group was significantly higher than that of the positive attitude group ($HSD = 11.58, p < .05$). There was no significant difference in the average baseline level between the negative attitude group and the horse-riding club group.

We calculated average heart rates for each horse during the baseline period; Berlin's average heart rate during the baseline period was 32.11 bpm (SD = 1.69 bpm) and that of Almani-Turbo's was 32.56 bpm (SD = 2.95 bpm). An ANOVA for one factor revealed no significant difference between the horses.

For both human and horse subjects, the heart rates during the contact between them (90 seconds) were calculated, and then the average over every 10 seconds was obtained. Figure 1 shows the average of the human subjects' heart rates as a percentage of baseline value per 10 seconds for the three groups. Figure 2 shows the average of the horses' heart rates as a

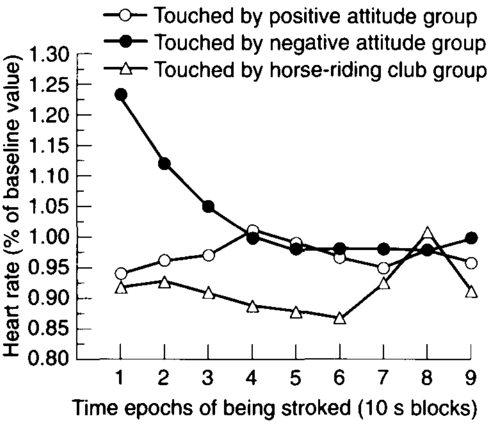

Figure 2. Heart rate as a percentage of baseline value in horses being stroked.

percentage of the baseline value per 10 seconds depending on the groups of human subjects by whom they were stroked. A 3 × 9 split-plot design of ANOVA was administered, with group of human subjects (positive attitude group, negative attitude group, and horse-riding club group) as a between-subjects factor, and with time epoch (nine 10-second bins) as a within-subjects factor.

Heart rate changes in humans. The split-plot design of ANOVA revealed a significant main effect for time course, $F(8, 120) = 22.83, p < .01$. The multiple comparison analysis according to the HSD revealed that, in each group, the heart rate changes during the first 10 seconds (bin 1) were significantly larger than those in other 10-second bins. Heart rate in each group was highest during the first 10 seconds of stroking.

Heart rate changes in horses. The split-plot design of ANOVA showed the significant effect for group × time course interaction, $F(16, 120) = 1.91, p < .05$. Analysis of the single main effect revealed a significant effect of group on bin 1, $F(2, 135) = 7.65, p < .05$. The multiple comparison analysis according to the HSD revealed that the heart rates of the horses were significantly higher in bin 1 when they were stroked by the subjects in the negative attitude group than when they were stroked by the subjects in the positive attitude group and the horse-riding club group.

Subjective arousal. Table 1 shows the scores for the four arousal states of the TAD-ACL. A 3 × 2 split-plot design of ANOVA was administered, with group as a between-subjects factor, and with "pre- and post-stroking" period as a within-subjects factor. As to the scores obtained on General Activation, the main effect for group was significant, $F(2, 15) = 5.99, p < .05$. The multiple comparison analysis according to the HSD revealed that the average scores for General Activation of the negative attitude group ($M = 3.17, SD = 1.03$) were significantly lower than those of the positive attitude group ($M = 4.11, SD = 0.44$) and the horse-riding club

Table 1. Mean scores on the Activation Deactivation Adjective Check List

Subjective arousal	Subjects' group	Pre-stroking	Post-stroking
High Activation	Positive attitude	4.11 (0.55)	3.84 (1.43)
	Negative attitude	4.11 (1.60)	3.67 (1.01)
	Horse-riding club	3.06 (1.14)	3.44 (1.31)
General Activation	Positive attitude	3.89 (0.46)	4.33 (0.30)
	Negative attitude	2.61 (0.91)	3.72 (0.88)
	Horse-riding club	4.17 (0.81)	3.50 (0.72)
General Deactivation	Positive attitude	3.84 (0.55)	4.44 (1.03)
	Negative attitude	3.45 (1.13)	4.22 (1.11)
	Horse-riding club	4.78 (0.86)	4.61 (1.15)
Deactivation-Sleep	Positive attitude	2.56 (1.26)	3.67 (1.35)
	Negative attitude	2.83 (1.46)	4.78 (1.15)
	Horse-riding club	2.94 (1.25)	2.94 (1.22)

Standard deviations in parentheses.

group ($M = 3.83$, $SD = 1.03$). Furthermore, the effect of group × "pre- and post-stroking" period interaction was significant, $F(2, 15) = 4.40$, $p < .05$. The single main effect of "pre-stroking" period on subject groups was significant, $F(2, 30) = 8.07$, $p < .05$, and the multiple comparison analysis according to the HSD revealed that in the "pre-stroking" period, the average scores for General Activation in the negative attitude group ($M = 2.61$, $SD = 0.91$) were significantly lower than those of the subjects in both the positive attitude group ($M = 3.89$, $SD = 0.81$) and the horse-riding club group ($M = 4.11$, $SD = 0.44$).

As for the scores obtained on Deactivation-Sleep, the main effect of "pre- and post-stroking" period was significant, $F(1, 15) = 13.51$, $p < .01$. The multiple comparison analysis according to the HSD revealed that the average scores for Deactivation-Sleep measured before stroking the horse ($M = 2.78$, $SD = 1.26$) were significantly lower than those measured after stroking the horse ($M = 3.80$, $SD = 1.40$). The effect of group × "pre- and post-stroking" period interaction was also significant, $F(2, 15) = 4.13$, $p < .05$. The single main effect of the "post-stroking" period on the factor of subject groups was significant, $F(2, 30) = 3.10$, $p < .05$, and the multiple comparison analysis according to the HSD revealed that in the "post-stroking" period, the average scores of Deactivation-Sleep in the negative attitude group ($M = 4.78$, $SD = 1.15$) were marginally significantly higher than those of the subjects of both the positive attitude group ($M = 3.67$, $SD = 1.35$) and the horse-riding club group ($M = 2.94$, $SD = 1.22$).

The results of this experiment can be summarized as follows:

1. The heart rates of the human subjects during the first 10 seconds of stroking were significantly higher than those obtained after that period. This means that heart rates increase when humans started stroking a horse, but these higher levels gradually return to the baseline levels. As shown in Figure 1, this tendency is more apparent in the negative attitude group.
2. The heart rates of horses increased during the first 20 seconds of stroking by the subjects of the negative attitude group, but there was little or no change in heart rate when they were stroked by the subjects in the other two groups. The increased heart rates due to stroking by the negative attitude group gradually decreased to the baseline level.
3. As to the General Activation scores (pleasant, comfortable, and absorbed), the scores of the subjects of the negative attitude group were lower than those of the other two groups, but their scores increased immediately after they experienced stroking the horses. As to the Deactivation-Sleep scores (drowsy, languid, and tired), the scores of the negative attitude group tended to be higher than those of the other two groups.

Discussion

There was a tendency for heart rates of human subjects to increase immediately after they started stroking but to decrease gradually to baseline levels. In this regard, the changes in heart rates shown by the subjects in the negative attitude group were especially interesting. That is to say, their heart rates for the first 10 seconds of stroking were higher than those of the other two groups during the same period, but their heart rates decreased to a level comparable to those of two other groups (see Fig. 1). The lowering of physiological arousal by stroking animals, horses in this case, agrees with the results of previous studies (e.g., Vormbrock & Grossberg, 1988).

In this experiment, arousal felt subjectively by humans before and after stroking a horse was measured. Of the four arousal indices, the effects of group × "pre- and post-stroking" period interaction were significant for General Activation and Deactivation-Sleep. These subjective arousal indices indicate remarkable changes in the subjects in the negative attitude group. According to the results of the questionnaire (TAD-ACL), the subjects in the negative attitude group had little experience of feeling pleasant, comfortable, or absorbed before stroking a horse. The stroking made them experience such feelings, but they felt more drowsiness, languidness, or tiredness after stroking a horse. This result seems contradictory. On this point we cannot reach any clear conclusion at this stage, and further examination is necessary. It could be said, however, that the results of subjective arousal levels measured before and after the stroking in this experiment suggest that subjective tension was decreased by stroking a horse.

It should be noted that the physiological and psychological states of the negative attitude group were extremely negative ones before they stroked the horse. It may be said that the cognitive sets and bodily states of the subjects in the negative attitude group were closely related to this experimental condition, in which they were forced to stroke an animal they did not like, such as a horse or companion animals in general.

In this experiment, the subjects' subjective arousal states were not measured during the stroking period and, therefore, the data were not available on their feelings during that period. The subjects' scores on the TAD-ACL showed that their subjective arousal levels changed from negative states to positive ones. It is not clear, however, whether the above changes in their subjective arousal were due to the fact that they felt good when they actually touched the horse, or due to the fact that they were relieved from the task of stroking the horse, which might have resulted in the reduction of negative psychophysiological states.

The heart rates of the horses did not change significantly from baseline levels when they were stroked by the subjects in the positive attitude group and the horse-riding club group, but their heart rates when stroked by the subjects in the horse-riding club group showed a slightly greater decrease than by those in the positive attitude group. On the other hand, the horses' heart rates significantly increased when they were stroked by the subjects in the negative attitude group at the beginning of the stroking, but gradually decreased. This reaction of the horses suggests that they seemed to discriminate between the subjects in the negative attitude group and those in the other two groups.

One possible explanation is the notion of emotional contagion proposed in recent studies (e.g., Hatfield, Cacioppo, & Rapson, 1994). Consciously or unconsciously, by imitating and synchronizing with others' emotional responses (facial expressions, postures, voices and body movements), people behave as others do by changing their expressive behaviors, and are submerged in others' emotional states as a result of the feedback of the expressive patterns into their conscious process. Emotional contagion cannot be applied directly to relations between humans and companion animals, because almost all previous studies are concerned only with interpersonal relations. In order to clarify these points further, it is necessary to record behavioral responses of both the humans and horses induced under the situations of this experiment, and to examine them in detail in future research.

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