Psychophysiological Effects of Human-Animal Interaction

Theoretical Issues and Long-Term Interaction Effects

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Abstract: This paper reviews literature published on the psychophysiological effects of long-term human-animal interaction (i.e., pet ownership, pet adoption). A literature search was conducted using PsycInfo and Medline databases. Although the available evidence is far from being consistent, it can be concluded that, in some cases, long-term relationships with animals may moderate baseline physiological variables, particularly blood pressure. Results proved more coherent in studies where animals were adopted by owners as part of the procedure. This paper examines existing hypotheses seeking to account for these effects and the supporting evidence. Two major hypotheses have been suggested to explain the psychophysiological effects of long-term interaction, namely (1) stress-buffering effects of noncritical social support provided by pets; and (2) classical conditioning of relaxation. These mechanisms may partially account for the long-term health outcomes observed in a number of human-animal interaction studies.

Key Words: Blood pressure, stress-buffering hypothesis, cardiovascular reactivity, classical conditioning, human-animal interaction, social support.

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A number of studies have suggested that human-animal interaction (HAI) may play a relevant role in improving health and preventing emotional distress. In this connection, increased likelihood of survival after infarction (Friedmann and Thomas, 1995), less need of medical attention associated with life stressors (Siegel, 1990), and reduced cardiovascular reactivity among hypertensive patients (Allen et al., 2001) have been frequently cited.

According to Collis and McNicholas (1998), the framework for the likely relationship between pets and health may be explained by (a) indirect effects on health by facilitating person-to-person relationships; (b) other factors that influence both pet ownership and health; and (c) direct effects. Some authors have reported indirect effects, such as the association between pet ownership and treatment adherence, walking, and other health behaviors (Dembicki and Anderson, 1996; Herrald et al., 2002). There is little evidence, however, to support direct effects of pet ownership on physical health; indeed, there is abundant literature reporting mixed results (Parslow and Jorm, 2003a; Stallones et al., 1990). Among the sparse references addressing the direct effects of pets on health, those that report cardiovascular functioning associated with pet ownership and interaction have suggested reduced cardiovascular levels and reactivity (Allen et al., 1991; Anderson et al., 1992).

Identification of the psychophysiological processes that underlie interspecies relationships may provide a framework for the likely direct effects of pets on health.

To address the possible relaxing effects of interaction with animals, three main hypotheses have been highlighted, which respectively postulate the following:

1. The spontaneous relaxing effects of tactile interaction with pets on cardiovascular activity. Lynch et al. (1974, 1984) reported that human tactile contact could result in lowered cardiovascular activity and arrhythmia. Based on this literature, Vormbrock and Grossberg (1988) mentioned this mechanism as a likely causal pathway for the effects of pets.
2. The buffering cardiovascular effects of noncritical (i.e., non-evaluative) emotional support (i.e., social support [SS]) provided by pets (Allen and Izzo, 1999; Allen et al., 1991; DeMello, 1999).
3. Classical conditioning of relaxation response. This means that the individual associates the animal with an atmosphere of peace, quiet, and leisure, so that in time the presence of the animal would prompt physiological relaxation (mentioned by Vormbrock and Grossberg, 1988).

All three effects have been tested during brief experiments, and there are thus few reports based on long periods of intervention that could serve to test the long-term effects of human animal interaction on cardiovascular and other physiological measures. In contrast, there is abundant literature to support the contention that long-term behavior patterns (which, in turn, lead to exposure to differing degrees of distressing and relaxing situations) play an important role

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vis-à-vis cardiovascular health. Lifestyle and cardiovascular reactivity to psychological stress have been linked to hypertension in a number of studies (see, for instance, Gullette et al., 1997; Mathews et al., 2004; Ming et al., 2004). This paper seeks to review the psychophysiological mechanisms that accompany HAI and, in particular, any possible autonomic deactivating effects deriving from long-term interaction with animals (e.g., long-term ownership). We have chosen to focus on long-term interaction (studies testing the effect of interacting for periods longer than a week with the same animal), usually in the context of the ownership or adoption of a pet, to allow for long-lasting effects that might possibly be associated with health as a result of influencing subjects' lifestyle and exposure to stress.

LITERATURE ON THE PHYSIOLOGICAL EFFECTS OF LONG-TERM HAI

We conducted two searches in the following bibliographic databases.

1. PsycINFO (1872–2004) using the WebSPIRS (SilverPlatter) information retrieval system. This entailed using the Boolean operator "AND" in binary combinations of the following key words: *animal*, *cardiovascular*, *dog*, *human-animal*, *human-pet, interaction*, *ownership*, *pet*, *psychotherapy*, *therapy* (excluding "dog AND animal"; "cardiovascular AND therapy"; "cardiovascular AND psychotherapy"; and "cardiovascular AND interaction").
2. Medline (1950–2004) using PubMed: *bonding*, *human-pet* [MESH] AND *blood pressure* [MESH] OR *heart rate* [MESH] OR *stress, psychological* [MESH].

The time frame of the search was that of the databases. Journal papers and book chapters, though not dissertations, were selected. A secondary search was then conducted based on the reference sections of the studies found. Only studies assessing human-animal relationships for periods longer than a week (i.e., adoption, ownership) on physiological dependent variables were included. This literature has been summarized by comparing the reported results where possible. Due to the lack of comparable designs, a comprehensive meta-analysis was not performed. Specific features of the studies found are shown in Table 1 (e.g., subjects, experimental conditions).

We identified two groups of studies relating to the psychophysiological effects of long-term interaction with pets, which differed in terms of design (within-subject versus between-subject) and targeted (1) cross-sectional studies testing differential effects between pet owners and nonpet owners (pet ownership studies); and (2) longitudinal studies testing differential effects among pet owners after the adoption of their pet (adoption studies).

PET OWNERSHIP

In a pioneering series of studies, Friedmann et al. (1979, 1980) showed that pet owners with medical heart conditions (myocardial infarction, angina pectoris, and so forth) enjoyed a higher likelihood of survival at 1 year of follow-up. A physiological severity index accounting for known predictors of survival showed no correlation with pet ownership. Friedmann and Thomas (1995) consistently reported that pet owners had a lower mortality 1 year after myocardial infarction in a sample based on the Cardiac Arrhythmia Suppression Trial. In addition, heart rate variability—a variable inversely associated with disease and mortality—was higher in a sample based on the same study. The authors suggest that differences in cardiac autonomic modulation are a physiologic mechanism underlying the differences in survival between pet owners and nonpet owners (Friedmann et al., 2003).

Another set of studies in this category have been conducted using quasiexperimental designs, with physiological dependent variables being compared across pet-owner and nonpet-owner groups. Wilson (1987) reported systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) to be similar in pet and nonpet owners. The results remained consistent at baseline levels and across several interaction modalities (viz., reading aloud, reading quietly, and interacting with a dog). DeMello (1999) reported convergent results using a correlation index, namely, there were no differences in SBP, DBP, and HR across pet and nonpet owners, when subjects were tested in a number of demanding experimental tasks. It should be noted here that, in both studies, the animal chosen to be in the experimental protocol was unfamiliar to the participants.

Allen et al. (2002) tested the differences between pet owners' and control nonpet owners' cardiovascular baseline levels and autonomic reactivity and recovery when subjects were required to cope with demanding laboratory tasks (mental arithmetic, pain tolerance test). The authors reported lower baseline SBP, DBP, and HR levels for pet owners, with the result that physiological reactivity was reportedly lower and cardiovascular recovery faster among pet owners in the mental arithmetic task. SBP and DBP reactivity was likewise lower among pet owners versus nonpet owners. Furthermore, Anderson et al. (1992) and Moody et al. (1996) also reported reduced baseline SBP levels among pet owners. Anderson et al. (1992) found pet owners' triglyceride levels to be significantly lower in a large sample (467 pet owners, 4957 nonpet owners). However, Moody et al. (1996) detected a higher average DBP and HR among pet owners when cardiovascular activity was continuously monitored. It should be noted that that this study was undertaken with a small sample of hypertensive participants ($N = 8$). Parslow and Jorm (2003b) replicated Anderson et al. (1992), controlling for a number of hypertension-related factors, with negative results, in that they found DBP to be significantly higher among pet owners in a sample of 5079 subjects (57% of whom were pet owners). Finally, a recent study by Odendaal and Meintjes (2003) reported a lower mean arterial pressure, along with an increase in serum β-endorphin, oxytocin, prolactin, phenyl acetic acid, and serum dopamine, and a decrease in serum cortisol after a 30-minute period of talking softly and gently stroking a dog, in a sample (some of whom were dog owners) possessing feelings of affection toward dogs.

Pet ownership studies show some evidence of reduced cardiovascular reactivity due to interaction with attached pets

TABLE 1. Literature on the Psychophysiological Effects of Long-Term Interaction With Pets (i.e., ownership, adoption)

Reference	Subjects (age)	Animals	Design[a]	Independent Variable[b] and Setting	Dependent Measures
Allen et al. (2001)	Stage II[c] hypertensive subjects: 18 white men, 6 black men, 18 white women, 6 black women	Cat or dog	BS (pet ownership): EXP randomized assignation BS (social support): QEXP WS: EXP	Pet ownership (lisinopril [20 mg/d] plus pets, lisinopril only) Level of perceived social support Task (rest, stressors [MAT, speech]) Time (pretreatment [before animal introduction and lisinopril treatment], 6 months later) Setting (office, home) only for resting SBP and DBP	SBP, DBP, HR, PRA
Allen et al. (2002)	120 married couples: 120 men (M = 42) and 120 women (M = 41), half of whom had a single pet	SOP (dogs and cats)	WS (pet presence): QEXP BS (pet ownership, gender): QEXP	Task 1 (baseline, MAT) Task 2 (baseline, cold pressure) Pet ownership (owners, non-owners) Presence of others (alone, with pet [pet owners]/friend [non-owners], with spouse, with spouse and pet/friend) Gender (male, female) Setting: home	SBP, DBP, HR
Anderson et al. (1992)	Population of patients attending a free risk assessment clinic: 3394 men and 2347 women (20–60) 476 pet owners, 4957 non-owners	SOP (476 dog-owners, 421 cat-owners, 136 bird-owners, 106 fish-owners, 48 others)	BS (pet ownership, gender): QEXP	Pet ownership (owners, non-owners) Gender (male, female)	SBP, DBP, Plasma triglycerides levels, cholesterol levels
DeMello (1999)	14 men and 36 women (26–50) 10 men and 26 women were pet owners	1 male Maltese cross dog, 1 toy poodle dog and 1 kid goat Unfamiliar	WS: QEXP	Task-protocol of interaction[d] (Task A plus dog absent, Task B plus dog presence, Task C plus dog tactile interaction) Attitude toward pets Setting: laboratory	SBP, DBP, MAP, HR, Subjective arousal
Friedmann et al. (1978), Friedmann et al. (1980), Katcher (1981)[e]	AMI and angina pectoris patients: 67 men and 29 women (37–79)	SOP	Correlational	Pet ownership (owners, non-owners)	Physiological severity index (accounting for diagnosis, congestive heart failure, cardio-megaly, arrhythmia and age) Survival at 1 year
Friedmann & Thomas (1995)	Survivors from an AMI: 314 men and 55 women, 86 dog owners, 41 cat owners, 246 non-owners	SOP (dogs and cats)	Correlational with multiple psychosocial and physiological assessments	Physiological variables (ventricular ejection fraction, presence of myocardial ischemia, congestive heart failure) Psychosocial variables (social support questionnaire-6, pet ownership/attachment inventory, social readjustment rating scale, state-trait anxiety inventory, self rating depression scale, Jenkins Activity Survey, expression of anger scale)	Survival at 1 year of AMI

(*Continued*)

TABLE 1. (*Continued*)

Reference	Subjects (age)	Animals	Design[a]	Independent Variable[b] and Setting	Dependent Measures
Friedmann et al. (2003)	Survivors of AMI with ≥6 ventricular premature complexes per hour on pre-treatment: 85 men and 17 women (M = 59.7), 31 pet owners, 71 non-owners	SOP (22 dogs and 13 cats)	Correlational with multiple demographic, social, clinical and physiological measures	Pet ownership	Heart rate variability assessed by 24-hour Holter monitor
Moody et al. (1996)	2 men and six women (58–82) with essential hypertension 6 pet owners, 2 non-owners	SOP (1 bird, 3 dogs, 2 cats)	BS (pet ownership): QEXP WS (period, pet presence): QEXP)	Period of observation (4 periods of 2 hours [measures taken every 30 minutes]) Pet presence (pet absent) [recorded while resting quietly and reading aloud in period 1], pet present [resting quietly and reading aloud in period 4]) Pet ownership (owner, non-owner) Setting: home	SBP, DBP, MAP, HR, MAP X, HR, perceived relaxation (0–5)
Odendaal & Mein-tjes (2003)	8 men and 10 women (M = 30), some of whom were pet owners	SOP for pet owners, dogs with "placid temperament" for non-owners (18 dogs) Attached	WS (protocol): EXP	Protocol of interaction (before interaction, after interaction [talking and petting]). Blood was sampled when five stable blood pressure changes equivalent to a decrease of 5–10% from the control value, could be demonstrated over a 2-min period Setting: laboratory	MAP, plasma concentration of β-endorphin, oxytocin, prolactin, phenyl acetic acid, dopamine and cortisol
Parslow & Jorm (2003b)	2528 adults (40–44) and 2551 (60–64), 57% of whom were pet owners	SOP	BS: QEXP with multiple socio demographic and cardiovascular risk-related measures	Pet ownership	SBP, DBP
Riddick (1985)	22 men and women (57–94)	Aquarium	BS: QEXP	Pet presence (6 months with aquarium plus biweekly maintenance visits [N = 7], biweekly visits for 6 months [N = 8], and control group [N = 7] Setting: subsidized housing complex	SBP, DBP, LSS,[f] STAI-Trait scale[g]
Walsh et al. (1995)	12 patients with Alzheimer dementia and 2 with schizophrenia	1 trained male Labrador dog	BS: EXP control group matched in sex and diagnosis	Pet presence (group with dog in ward [6 hours a week for 12 weeks], group without dog) Setting: residential facility	SBP, DBP, HR
Wilson (1987, 1991)[e]	15 men and 77 women (18–39) 66 owners, 26 non-owners	1 mixed breed 1-year-old dog	WS (protocol): EXP order randomly alternated BS (sex): QEXP, BD (ownership) QEXP, only analyzed for STAI-State and STAI-Trait scales	Protocol of interaction (baseline, reading aloud, reading quietly, interacting with pet dog) Pet ownership (owners-non-owners) Sex (male, female) Treatment order Setting: laboratory	SBP, DBP, MAP, HR, STAI-State scale, STAI-Trait scale[g]

Note. AMI = acute myocardial infarction; BS = between-subjects design; DBP = diastolic blood pressure; EXP = experimental design; HR = heart rate; MAP = mean arterial pressure; MAT = mental arithmetic task; PRA = protein-renin activity; QEXP = quasiexperimental design; SBP = systolic blood pressure; SOP = subjects own pet; WS = within-subjects design.

[a]Manipulation procedure of each independent variable (e.g., within-subjects, between-subjects) with each variable in parenthesis. Type of study after the colon (i.e., experimental, quasiexperimental, correlational) and control procedures, if known (e.g., randomized assignation). [b]Independent variable with its levels in parenthesis and the setting where the study was conducted, if known. [c]Resting blood pressure ≥160/100 mm Hg. [d]Arithmetic, coding, and cancellation tasks were administered in randomized order. [e]Publications reporting the same study. [f]Leisure Satisfaction Scale (Beard and Ragheb, 1980) considers psychological, educational, social, relaxational, and physical effects of leisure. [g]State-Trait Anxiety Inventory (Spielberger et al., 1983).

during short-term experimental stress. In contrast, these studies offer mixed results when the level of physiological variables is measured, though an exception should be made for heart rate variability, which would benefit from further replication.

ADOPTION STUDIES

A small number of reports have focused on the experimental psychophysiological effects of pet ownership, namely, the adoption of an animal companion. Riddick (1985) introduced an aquarium into the homes of seven normal subjects. The participants received biweekly maintenance visits during the 6 months that the experiment lasted. Systolic blood pressure, DBP, and other self-reported indices were monitored before and after this period. The author reported that DBP was lower in the posttest measurement. A control group ($N = 7$), matched solely in terms of the time period between visits, failed to show the decrease in the post-test measurement. Walsh et al. (1995) had a dog make weekly 6-hour visits to a psychiatric ward over a 3-month study period. Baseline SBP, DBP, and HR were monitored before and after the visits. A control group was matched in sex and diagnosis (i.e., schizophrenia, Alzheimer dementia). A significant decrease in HR was demonstrated in posttest measures for the experimental group. Allen et al. (2001) randomly assigned hypertensive subjects to pet adoption or control groups. Both groups concurrently received antihypertensive medication (lisinopril 20 mg/d). Six months after adoption, subjects in the lisinopril-plus-pet group scored lower in SBP and DBP reactivity to a stressing arithmetic task. In addition, a main effect of pet ownership was found for HR and protein-renin activity 6 months posttreatment. Roughly similar results were reported for perceived SS level, i.e., subjects with a higher level of SS scored lower in baseline and reactivity measures (Table 1).

HYPOTHESIZED MECHANISMS

Despite inconsistencies in the available literature, it is possible to conclude that there is some evidence that pet ownership (long-term interaction with a pet) could result in lower cardiovascular levels, particularly if the animal were experimentally adopted by the participant. In addition, familiar pets could contribute to buffering autonomic reactivity to experimental acute stressors.

As mentioned, two major causal pathways have been proposed to account for the physiological effects of long-term interaction with animals: (1) buffering cardiovascular effects related to nonevaluative SS (Allen et al., 1991, 2001; DeMello, 1999); and (2) conditioned relaxation response (mentioned by Vormbrock and Grossberg, 1988).

Insofar as the first proposal is concerned, K. Allen and her group suggest that nonevaluative SS may enhance coping in situations of acute stress (Allen et al., 1991, 2001; see also Kamarck et al., 1990). This approach should be considered in the context of the literature addressing physiological effects of SS (Buela-Casal and Virués, 2000; Uchino et al., 1999). This hypothesis is poorly supported as participants' perception of the animals was not directly assessed. Further specification of this analogy is called for.

Classical conditioning is involved in an additional causal pathway associated with the deactivating effects of HAI. Some authors have pointed out that animals tend to be associated with holiday periods and rest (Vormbrock and Grossberg, 1988). Consequently, interaction with the animal or its mere presence (conditioned stimulus) would elicit psychophysiological deactivation (conditioned response). However, this hypothesis, though it may have some heuristic value, has no direct supporting evidence.

CONCLUSION

This paper reviews the available literature on the psychophysiological effects of long-term HAI. An overall evaluation of the field is still premature given the fact that scant research is available and there is a dearth of comparable studies. However, two major conclusions have been highlighted: (1) there is some evidence to show that pet ownership (i.e., long-term interaction with a pet) could result in lowered cardiovascular levels, particularly in longitudinal studies; and (2) familiar pets could serve to buffer autonomic responses to acute stress. These mechanisms may contribute to explain health outcomes observed in correlational and animal-assisted therapy research (Allen and Blascovich, 1996; Friedmann and Thomas, 1995; Siegel, 1990), though studies on pet-related effects on physical and self-reported health are far from being consistent (e.g., Parslow and Jorm, 2003b).

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