CHAPTER 5

THE PHYSIOLOGY OF POSITIVE INTERACTION THEORIES

5.1 Introduction

In 1929 it was found that when a person strokes a dog, the dog's blood pressure will drop, but it was only some fifty years later that it was determined that the person's blood pressure also drops with such positive interaction.[89] Erika Friedman,[146] a Professor and Chairperson of the Department of Health and Nutrition Sciences, Brooklyn College of the City University of New York, is a pioneer in this field. She earlier published with co-authors, but recently she published an article titled "The role of pets in enhancing human well-being: physiological effects", in which she discussed research on this topic since 1980. Parameters recorded were diastolic and systolic blood pressure, plasma cholesterol, plasma triglyceride and skin conductance responses. Other symptomatic indications of physiological effects were anxiety and stress relief, or in physiological terms the effects of the autonomic nervous system.

The theoretical perspective behind these measurements is that when people get upset, they have a stress response which activates the sympathetic nervous system. As part of the so-called fight-or-flight reaction, blood pressure rises and there is an increase in the heart and respiratory rates as well as hormonal changes which prepare the individual to cope with a threat. This response is adaptive when the individual is going to respond and after the activity of fight or flight, the physiological levels return to normal. However, if the activity does not take place there is no quick return to normal physiological levels. Frequent repetition or sustained periods of this response without quick relief, can cause damage to the cardiovascular system. Stress reduction techniques help a person to be less reactive to stressors, to redefine stressors to be less intense, or to remove the built-up stress hormones quickly. Animals can help people to avoid stress responses or decrease their impact, and they can help remove the stress hormones more rapidly by encouraging people to exercise.[146]

> "Thus, it has been hypothesised that pets can decrease anxiety and sympathetic nervous system arousal by **providing a pleasant external focus for attention** (my accentuation) promoting feelings of safety and providing a source of contact comfort. They can decrease loneliness and depression by providing companionship, promoting an interesting and varied lifestyle and providing an impetus for nurturing. Certain types of pets could help improve physical fitness by providing a stimulus for exercise. Pets therefore have the potential to moderate the development of stress related diseases such as coronary heart disease and hypertension. The range of benefits that owners might derive from their pets may not pertain only to pet owners; one could speculate that anyone, not just pet owners, could benefit from the presence of friendly animals".[146]

Apart from Friedmann and her co-workers, other reports also reflected animals as companions to be beneficial to human health in general. In an analysis of 52 published papers on research in the field of human-companion animal relationships, between 1988 and 1993, Barba[147] found that 11 studies dealt with the effect of animals on human health and illness. Most of these found a positive association between animal contact and health. However, three did not find such an association. With regard to stress, three found that animals can reduce such levels and one found no significant difference between owners and non-owners. The studies involving animals as specific therapeutic interventions were unanimous in reporting success. Other findings were that animal interaction tended to make people happier, more alert, less lonely, it stimulated touch, talk and smiling, owners exercised more and they were more satisfied with their social, physical and emotional status. Animal owners who had successful relationships often viewed their animals as members of the family.

Serpell[148] did a study on "Evidence for long term effects of pet ownership on human health" and he concluded:

> "The findings overall suggest that pet ownership can have a positive impact on human health and behaviour, and that in some cases these effects are relatively long lasting".[148]

Some results indicated that the pet-owning group reported a highly significant reduction in minor health problems, significant improvements in psychological well-being and self-esteem and they were less afraid of being victims of crime. Pet owners also took considerably more physical exercise.

Wilson[149] found that pets can be an anxiolytic intervention for people who experience anxiety. She used 92 self-selected undergraduate students, aged between 18 and 39 years. Students were not hypertensive and were healthy. Blood pressure was measured over a 10 minute baseline period for three test (stress) conditions, namely reading aloud, reading quietly and interaction with a friendly dog which was not their own dog. At the end students had to complete the state and then the trait scale of the Spielberger Self-Evaluation Questionnaires. The results indicated that the presence of a pet dog had a relaxing or anti-anxiety effect similar to relaxation activities such as quiet reading.

Anderson, Reid and Jennings[150] concluded in their study that pet owners in their clinic population had lower levels of accepted risk factors for cardiovascular disease, and this was not explicable on the basis of cigarette smoking, diet, body mass index or socio-economic profile.

Patronek and Glickman[151] came to very much the same conclusions:

> "In addition to known physiologic factors, such as hypertension, smoking and elevated plasma cholesterol, psycho-social factors including anxiety, marital status and social isolation have been shown to contribute to the risk of coronary disease. There is increasing evidence suggesting that pet ownership is associated with clinically significant health effects in people, including improved survival after a coronary event".[151]

The role pets play in this regard is seen as their ability to have a positive influence on psycho-social risk factors (such as providing attention). Pets should, however, not be considered as drugs to be taken whenever one feels unwell, but rather as having the ability to modify one's lifestyle and thus enhance health and quality of life.[146]

5.2 Interaction theories and physiological parameters

The studies discussed above focused on human health as related to stress and anxiety relief, and from this it is clear that physiological factors do play a role in positive human-animal interaction. Measurements, however, were only directed at relief symptoms (blood pressure, heart rate, etc) of already stressed persons, but apart from this "stress theory", they did not attempt to offer physiological support for a comprehensive theory of human-animal relationships. Physiological parameters which indicate such positive interaction supporting interaction theories, should thus still be established.

It has already been confirmed that, during positive human-human interaction, physiological parameters such as the role of neurotransmitters and hormones can support human-human interaction theories. Some measurements were done among humans and other were extrapolated to humans from interaction among other species. All information on this level was gathered on an intraspecies basis.

Walsh stated that:

> "Our needs for nurturance, affiliation, and attachment have never, as far as I am aware been considered anything but rooted in the biology of the species".[152]

This may, however, include interspecies interaction. A difference is made between romantic love as passion (eros) and the various other forms of love as compassion (a combination of agape - a concern for the well-being of others, and philia - friendship and companionship). The general love principle that is rooted in our biology, moves people to exert physical and psychic energies to move towards unity and growth.[152]

Michael Liebowitz,[153] a psychiatrist, is one of the pioneers in explaining positive interaction physiologically. His book "The Chemistry of Love" in 1983 popularised the concept that any thought, feeling or action people undertake, occurs only because of some form of biochemical activity in the brain. Adding a biological perspective helped him to become more effective in understanding and working with many individuals experiencing relationship difficulties. There is a biochemical basis for the normal "ups and downs" in relationships. It was also found that there are many similarities between these relationship highs and lows and other intense feelings.

The latter statement should be considered in terms of a statement by Barrett[154] when he inquired about the placebo effect of animals when they are used in therapy. If animals do cause some positive effect because of the novelty of this attention or even added attention by other people (therapists) involved in animal therapy, one can call it a placebo effect, but it is also explicable within the attention need theory. Because more than one emotion is associated with the same physiology, one should be cautious not to use a "placebo" which can elicit the same emotional response, because then it is no placebo any more. Attention needs are like hunger needs - there is no placebo for it, it is either fulfilled or not at all. One cannot fake the fulfilment of a basic need.

Liebowitz[153] felt that the association of psychological and emotional experiences with biochemical changes and vulnerabilities, was something very new. The tendency to separate biology from our important emotional experiences has led to a kind of psychiatry with either psychological or biochemistry thinking. However, people's ability to deal with separation or positive interaction depends on a complex combination of biological (biochemistry), psychological and social (cultural) factors.

An aspect of the effect of natural biochemical substances is (as in the case of administered drugs) that a gradual increase or decrease of the chemical has a less intense effect than sudden changes. This is known as tolerance - the brain learns to tolerate the drug. Changes in receptors are a possible mechanism for this. Chronic exposure to certain psycho-active drugs, or an excess of the neurotransmitters they stimulate, seems to lead to a reduction in the number of receptors, and this may be the explanation for certain forms of drug (or nondrug) experiences losing their impact. Tolerance appears to develop in many unchanging situations to which we are constantly exposed:[153]

> "Tolerance to nondrug stimuli may be an important but largely unrecognized aspect of human experience".[153]

Other drug principles include physical dependence, rebound and addiction. However, these effects are complex. Human beings cannot be reduced to simple biological reflexes and reactions, but they should also not be treated as entirely ethereal, spiritual or psychological creatures without bodies and brains. Drugs do not create any new biological reactions, but only alter the rate at which ongoing bodily functions proceed. Therefore, the same biochemical mechanisms that govern drug effects may play a role as well in shaping our biological, and thus emotional, reactions to potent nondrug experiences. In general, there are a limited number of ways of feeling good.[153]

Within thirty to sixty minutes after taking 10mg of amphetamine per os, increased alertness, decreased fatigue, elevated mood, greater initiative and an enhanced sense of self-confidence follow. Intravenous effects tend to be more rapid and more intense. Prolonged use can be followed by mental depression and fatigue when the drug is stopped, or by paranoia leading to psychosis if continuously administered over a period of days or repeatedly used in escalating doses over a longer period of time. Most human beings find single doses of an amphetamine to be generally pleasurable. However, certain depressed individuals whose brain chemistry is disrupted in some way do not even become temporarily euphoric in response to amphetamine. Sometimes they actually feel more sad or despondent following administration of the drug. Given similarities between drug-induced and naturally occurring excitement, it would appear that any nondrug experience is the result of tapping into some brain chemical reservoir, causing an outpouring of certain neurotransmitters. Just because the chemical effects are the same, it in no way means that amphetamines are a valid substitute for pursuing natural pleasure or excitement. What stimulant drug induction does, is to create a sense of excitement without accomplishing anything - a short-circuit of the natural effect.[153]

Physiological reactions are not the same for every individual, although there may be a general tendency to react the same to certain stimuli. In a population, reactions will be varied on a continuum and some people will be less responsive while other will be highly responsive. This is an important aspect for therapists using animals in therapy must keep in mind, because individual variations with regard to biochemical reactions should be allowed for:

> "What it comes down to, finally, is that (positive) feelings are not totally specific nor just nonspecific arousal which may then label as one feeling or another. Rather, they involve our highly individualized feeling of ... attachment, which are biologically, psychologically and culturally shaped, plus our secondary intellectual fine-tuning. While this may sound complex, we should be consoled. It tends to happen instantaneously and involuntarily - at least the first reaction. And it does make for variety".[153]

Psychiatrist Helen Kaplan[155] stated that the brain's love centre is located in the limbic system and even in primitive vertebrates, this system is the emotional control centre. In humans, this system has remained unchanged. The limbic system contains both activating and inhibitory centres linked to the so-called pleasure and pain centres of the brain. Love behaviour is shaped by the seeking of pleasure and avoidance of pain.

Although these studies were aimed at passionate love, Hatfield and Rapson[156] were of the opinion that most emotions have more similarities than differences with regard to neurotransmitters or other chemicals which increase or decrease the sensitivity of the brain receptors. Walsh[152] reaffirmed this statement, referring to phenylethylamine (PEA), when he stated that the relationship of PEA to love may still for the moment be speculative, but "there is little doubt that PEA is an important emotion-regulator".

5.3 Neurotransmitters

According to Guyton[157] more than 40 different chemical substances are proved or postulated to function as synaptic transmitters. There are two groups, namely the small molecule, rapid-acting transmitters and the larger molecule, slow-acting neuropeptides.

Rapid-acting neurotransmitters cause most of the acute responses of the nervous system, such as sensory signals to and inside the brain and motor signals to the muscles. These transmitters are synthesised in the cytosol of the presynaptic terminal and are then absorbed by active transport into the many transmitter vesicles in the terminal. Each time an action potential reaches the presynaptic terminal, a few vesicles at a time release their transmitter into the synaptic cleft, usually within a millisecond or less. The subsequent action on the postsynaptic membrane receptors usually also occurs within a millisecond or less. Most often the effect is to increase or decrease conductance through ion channels, e.g. increased Na^+ conductance causes excitation and increased K^+ or Cl^- conductance causes inhibition. Almost invariably only a single rapid-acting neurotransmitter is released by each type of neuron. It means that the presence of such a neurotransmitter can be highly indicative of behaviour associated therewith. However, the terminals of the same neuron may also release one or more neuropeptides at the same time. Whatever neurotransmitters are released at one terminal of the neuron, the same transmitters will be released at all other terminals of the same neuron, whether these be few in number or many thousands, as well as wherever these terminate within the nervous system or in peripheral organs. Examples of this group of neurotransmitters are:

Class I: Acetylcholine

Class II: The amines such as norepinephrine, epinephrine, dopamine, serotonin, histamine and phenylethylamine

Class III: Amino acids such as gamma-aminobyturic acid, glycine, glutamate and aspartate.[157]

Neuropeptides usually cause more prolonged action, such as long term changes in a number of receptors, long-term closure of certain ion channels and possibly even long-term changes in the numbers of synapses. They are synthesised by the ribosomes as integral parts of large protein molecules in the neuronal cell body.

The protein molecules are transported immediately into the endoplasmic reticulum, and subsequently the Golgi apparatus function together to enzymatically split the original protein into smaller fragments, releasing either the neuropeptide itself or its precursor. The Golgi apparatus packages the neuropeptide into minute transmitter vesicles that are released into the cytoplasm. Then the transmitter vesicles are transported all the way to the tips of the nerve fibres by axonal streaming of the axon cytoplasma, travelling at the slow rate of only a few centimetres per day. Finally these vesicles release their neurotransmitter in response to action potentials in the same way as the rapid-acting molecules. The vesicle is then autolysed and not reused. Because of this slow process, much smaller quantities of neuropeptides are released. However, this is partly compensated for because the neuropeptides are generally a thousand or more times as potent as the rapid-acting transmitters and they are longer-acting. Some of these effects can last for days or perhaps even months or years. Examples of these neuropeptides are:

Class I:	Hypothalamic-releasing hormones such as thyrotropin-releasing and luteinize-releasing hormone
Class II:	Pituitary peptides such as acetylcortico-trophic hormone, beta-endorphin, prolactin, vasopressin and oxytocin
Class III:	Peptides acting on the digestive system and brain, such as methionine, enkephalin, gastrin, cholecystokinin, neurotensin, insulin and glucagon
Class IV:	Neuropeptides from other tissue such as angiotensin II, bradykinin, carnosine, sleep peptides and calcitonin

Fisher[158] said that attraction (the beginning of positive interaction) may begin with a small molecule, called PEA, which has an amphetamine-like effect. It is known as the excitant amine, causing feelings of elation, exhilaration and euphoria. Other neurotransmitters, such as norepinephrine and dopamine, may also play a role.

5.3.1 Norepinephrine

Norepinephrine, acting as a neurotransmitter, usually exerts an inhibitory effect through the activation of ß-adrenoreceptors, although there are some excitatory effects on both α- and ß-receptors. Norepinephrine has been postulated to affect mood, functional reward systems and arousal. Norepinephrine is a neurotransmitter that is synthesised from tyrosine in nor-adrenergic neurons. Following synthesis, dopamine is further hydroxylated to form norepinephrine. Norepinephrene is stored in prejunctional vesicles and, when released, interacts with noradrenergic receptors. The effects of norepinephrine are primarily terminated by re-uptake at the prejunctional neuron, similar to dopamine. Norepinephrine is also broken down by monoamine oxidase.[159]

5.3.2 Dopamine

The distribution of dopamine in the brain is nonuniform but far more restrictive than that of norepinephrine. A large proportion of the brain's dopamine is found in the corpus striatum, the part of the motor system concerned with coordinated movement. Dopamine has also been found to be high in some regions of the limbic system. The monoamine group is divided into two classes, catecholamines and indoleamines. The catecholamines (norepinephrine), adrenaline (epinephrine) and dopamine are all synthesised from the same amino acid, tyrosine, and share a common chemical structure. The indoleamines serotonin (5-hydroxytryptamine) and melatonin are synthesised from tryptophan. The cell bodies for the neurons that produce these neurotransmitters are present in small groups of nuclei located in a relatively small area of the brainstem. The distribution of axons from these nuclei has a rather diffuse disposition affecting a large number of cells in various areas of the brain. Catecholamines are the neurotransmitters associated with the arousal of the autonomic nervous system.[160]

5.3.3 Phenylethylamine

Liebowitz[153] and his colleague Klein from the New York State Psychiatric Institute speculated that the feeling of attraction (or attention) comes about when neurons in the limbic system become sensitised by PEA and/or other brain chemicals. They came to the conclusion that some of their patients are what they called "attraction junkies" - people who crave a relationship, which often fails, indicating a need for PEA. These patients were given monoamine oxidase (MAO) inhibitors which block the action of a special enzyme MAO which breaks down PEA and other neurotransmitters such as norepinephrine, dopamine and serotonin. Thus, MAO inhibitors boost levels of PEA and other natural amphetamines. Within weeks, one perpetually lovesick man began to choose partners more carefully and he could also live without a mate. He was previously unsuccessful in applying what he had learned because of an overriding emotional response which was now controlled by the antidepressant drug, a MOA inhibitor. Psychiatrist Sabelli, Carlson-Sabelli and Javaid[161] independently arrived at the same conclusion about PEA. In a study of 33 people who were happily attached to a "significant other" and who reported that they felt great, all were found to have high levels of PEA metabolite in the urine. On the other hand, PEA levels were low in a man and a woman going through divorce.

PEA also has a positive effect on non-humans according to behaviour described in mice and Rhesus monkeys after they had been injected with PEA or PEA-like substances. However, it appears that PEA provides no more than a short-term feeling of exhilaration and apprehension. It is a chemical that accompanies a range of experiences, including positive interaction. Cultural (environmental experiences) may determine who one loves, when one loves and where one loves, but PEA and other chemicals will probably direct how you feel as you love. Love behaviour, like other behavioural patterns, is also determined by environmental and biological (genetic) factors. Likewise, in most identifiable behaviour traits there seems to be a variation in this experience from one individual to another.[158] A continuum of the need for attention may reveal that some people have no or little need for certain types of attention and some may have unusual ways of attracting attention owing to a craving for attention.

Liebowitz[153] found that after the initial positive feeling, an even more meaningful emotion emerges, namely attachment. This is the warm, comfortable and secure feeling caused by other chemicals, the endorphins. Like PEA, endorphins reside at the brain's nerve synapses and pool in specific areas in the brain, causing a sense of safety, stability and tranquillity. These effects may also be related to the stress-relief response postulated as theory for positive human-animal interaction by Friedman[146] and co-workers in section 5.1.

5.3.4 Endorphin

The neuropeptide group of short-chained amino acids includes endorphins, substance P and substance K. They function mainly as modulators of other neurotransmitters, evoking facilitation or inhibition of neurotransmitter activity at the postneuron receptor site. Central nervous system endorphin release has been implicated in some compulsive disorders.[160]

5.4 Hormones

Other chemicals involved in positive interaction are the hormones oxytocin, vasopressin, prolactin and cortisol.

5.4.1 Prolactin

Bekkedal and Panksepp[162] indicated that in domestic chicks, prolactin may be involved in social-bonding experiences other than maternal behaviour. Carter and Altemus[163] came to the conclusion that in mammals, oxytocin is important in a variety of positive social behaviours. With regard to prolactin they said that there is evidence that prolactin can reduce activity in the hypothalamic-pituitary-adrenal axis, but that the behavioural effects of prolactin and the possible actions of prolactin on behaviour and the nervous system has not been well-defined.

5.4.2 Oxytocin

Gingrich, Huot, Wong and Insel[164] found that oxytocin and vasopressin are involved in the formation of affiliative bonds in the monogamous prairie vole in a gender-specific manner. Vasopressin facilitates the formation of selective affiliation in males and oxytocin does the same in females. Ritters and Panksepp[165] observed that vasotocin (similar to vasopressin in mammals) in male Japanese quail appears to inhibit intermale aggression, which plays a role in social status.

Uvnäs-Moberg[166] said that, until now, only one oxytocin receptor has been identified but that data are emerging, showing that subpopulations of oxytocin receptors exist. Steroids and estrogen in particular stimulate the synthesis of oxytocin and the affinity to its receptors in certain regions. These morphological characteristics of the oxytocinergic system indicate that activation of oxytocin release may cause an integrative effect pattern. In various animal experimental models, oxytocin was shown to facilitate bonding or attachment or simply to increase the amount of social contact between individuals.

Hatfield and Rapson[156] said that neuro-scientists know little about the biological basis of companionate love and tenderness. They only recently began to identify oxytocin as the hormone which seems to promote close intimate bonds. The receptor areas for this powerful peptide in the brain are the ventral medial nucleus, amygdala and hypothalamus areas that are involved in joyous, affectionate, sexual and reproductive behaviour. It facilitates tactile contact between animals and is the beginning of the development of social attachment. In studies of rats, rabbits, sheep and other animals, researchers found that oxytocin acts on regions of the brain involved in affectionate behaviour. Oxytocin also promotes intense bonds between parents and children by increasing eagerness to nurture. It stimulates feelings of pleasure and satisfaction during bodily contact and is sometimes called the "happiness hormone".[167,168]

5.4.3 Cortisol

Carter, de Vries, Taymans, Roberts, Williams and Getz[169] reported an unanticipated finding that socially naive prairie voles respond to exposure to a novel stranger of the opposite sex with a decline in corticosterone, suggesting the hypothesis that pair bonding in prairie voles might be inhibited by the hormones of the hypothalamic-pituitary-adrenal axis. Removal of the adrenal gland facilitated the development of a preference for a particular partner. An endogenous increase in corticosterone production inhibited pair bond formation in female prairie voles, an effect that was reversed by adrenalectomy.

5.5 Absence of interaction

Proof that positive interaction is part of humans' and other social animals' basic needs, is not only based on the physiological framework in which the existing need can be fulfilled, but also in the negative reaction of the body if there is no interaction. Hebb[170] found that:

> "merely taking away the usual sights, sounds and bodily contact from a healthy university student for a few days can shake him right down to the base; can disturb his personal identity".[170]

Studies where healthy volunteers were exposed to an environment of social deprivation indicated that it is just as detrimental to the body to have no contact than to have negative or stressed experiences.[171] Among animals it was also found that rats which were kept in different environments, from those which came from a stimulus-rich environment could learn much more quickly to find their way through a maze than those coming from a stimulus-poor environment.[172]

5.6 Discussion

From the above, *attentionis egens* among humans as indicated by physiological parameters[153,155,156,158] supports the interaction theories in personology (Chapter 2), and there are also indications that the same physiology plays a role in the *attentionis egens* among animals which supports the ethological and evolutionary theories of interaction.[158,173] Furthermore, the mutual benefits for humans and animals exist not only on the basic utility level (such as humans providing food for animals and animals protecting humans), but also on the emotional-psychological need level (Chapter 3) with similar sets of physiological factors associated with it. What is missing is to find support from physiological parameters to link the interspecies positive interaction.

The main criticism against need theories is that they are circular in nature. A need is described as a cause of behaviour, while the behaviour is taken as an indication of the need. It is, however, possible that basic needs are circular in nature, because they operate as a feedback system. Murray[174] said in this context, that:

> "A wide variety of studies have shown that the brain remodels itself as it encounters the world ... the brain is built by behavior, even as behavior is predisposed by the brain".[174]

From a positivistic point of view, it is important to find some parameters which can objectively and repeatedly verify the feedback system in a measurable format. Thus, if physiological parameters can be identified which indicate the same behaviour in both human and animal during positive interaction on an interspecies level, and if these parameters are the same as were found to support positive human to human interaction theories and intraspecies animal affiliation, it can provide a theoretical framework for positive human to animal inetraction (Fig 5.1).

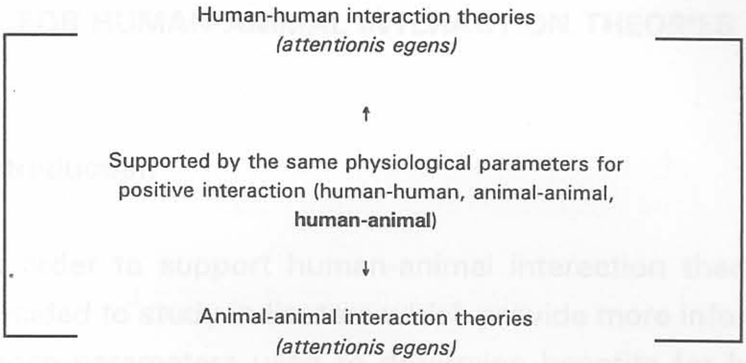

Fig 5.1: A model based on physiological parameters to link human-human, animal-animal and human-animal interaction theories

What is thus still needed is to extend the establishment of the same physiological parameters to an interspecies basis in order to link the positive interaction theories.

The next chapter will describe the methodology to measure physiological parameters during positive human-animal interaction.