

Man and Wolf

*Advances, Issues, and Problems
in Captive Wolf Research*

Edited by

HARRY FRANK

*Department of Psychology
University of Michigan-Flint
FLINT*

1987 **DR W. JUNK PUBLISHERS**
a member of the KLUWER ACADEMIC PUBLISHERS GROUP
DORDRECHT / BOSTON / LANCASTER



Distributors

for the United States and Canada: Kluwer Academic Publishers, P.O. Box 358, Accord Station, Hingham, MA 02018-0358, USA

for the UK and Ireland: Kluwer Academic Publishers, MTP Press Limited, Falcon House, Queen Square, Lancaster LA1 1RN, UK

for all other countries: Kluwer Academic Publishers Group, Distribution Center, P.O. Box 322, 3300 AH Dordrecht, The Netherlands

Library of Congress Cataloging in Publication Data

Man and wolf.

(Perspectives in vertebrate science ; 4)

Based on an international conference hosted by the University of Michigan-Flint, in Oct. 1981.

Includes index.

1. Wolves--Congresses. 2. Wolves--Behavior--Congresses. 3. Social behavior in animals--Congresses. 4. Mammals--Behavior--Congresses. I. Frank, Harry, 1942-. II. University of Michigan--Flint. III. Series.

QL737.C22M35 1986 599.74'442 86-15329

ISBN 90 6193 614 4 (this volume)

ISBN 90 6193 890 2 (series)

Cover-illustrations: Johanna Dinnissen McLeod

Copyright

© 1987 by Dr W. Junk Publishers, Dordrecht.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publishers,

Dr W. Junk Publishers, P.O. Box 163, 3300 AD Dordrecht, The Netherlands.

13. Ontogeny of approach and flight behavior towards humans in wolves, poodles and wolf-poodle hybrids

Erik Zimen

Introduction

A wolf pup of eight weeks raised by its mother, is normally extremely fearful of an approaching human. Almost any dog pup of the same age, on the other hand, will be more attracted by its new human companion than to conspecifics within hours after the first time in its life it has had human contact separated from mother and littermates (cf. Scott 1980).

This most striking difference in the behavior of the dog and its wild ancestor (Herre and Rohrs 1973) attracted my interest almost 20 years ago, when I first started to compare wolf and dog behavior. The comprehensive work of Scott and Fuller (1965) had just been published. In order to better understand the behavioral genetics of domestication, it was my intention to analyze specific traits in wolves, dogs and wolf-dog hybrids. Their approach and flight behavior in response to my presence seemed ideal for this purpose, but I soon concluded that my task was much too ambitious. The behavior of the test animals turned out to be strongly influenced by social and environmental conditions which were all but uncontrollable in the naturalistic setting in which the observations were made.

Because of the difficulty interpreting such complex and potentially confounded data, my results were never reported. However, recent work performed by MacDonald (Chapter 14) under laboratory conditions yielded results that complemented my own in several respects and, at the instigation of the volume editor, persuaded me to report on what I experienced so many years ago, when crawling into the dens of poodles, wolves and those little black hybrid pups we called Puwos.

Method

It was my intention to observe wolf, poodle, F_1 - and F_2 -hybrid pups from the time they opened their eyes (approximately 14 days of age) until the age of 8

weeks. Litters of each group were either to be raised by their natural mother or by me, after being removed from their mother on the 14th day.

Subjects

First, two F_2 Puwo litters raised by their mother were observed in the fall¹ of 1966 at the Kiel University Zoo² (Table 1). In the spring of 1967 an F_1 Puwo litter raised by their wolf mother was also observed in Kiel. At the same time, I handreared one litter each of wolves, poodles, F_1 and F_2 Puwos at the Rickling field station close to Kiel (Zimen 1972). The wolf pups, however, were already 21 days old when I acquired them from the Rotterdam Zoo. They showed increasing flight behavior when approached and never became socialized. In 1968, therefore, another litter of wolf pups was handreared by me from 14 days of age. Additionally, in 1967, one single wolf pup was raised from six days of age separately from all other pups.

A litter of three poodles raised by their mother was also observed in Rickling in 1968. However, it took seven years for the wolves to reproduce and, consequently, for me to observe their pups raised naturally. These observations were made in the large research enclosure in the Bavarian Forest National Park (Zimen 1978). Although the mother was rather tame, it was only possible to observe the pups from Day 29 when they first left their natural den to Day 42, after which they always disappeared into the den or other cover when I approached to make the observations. The data presented in this paper are based on these 11 litters. Discussion of the results, however, also includes references to observations on 10 additional litters of wolves and poodles I have seen growing up.

Except for the wolves in Bavaria, all animals were kept in 100–1000 m² outdoor enclosures. In each enclosure the animals had access to a large indoor room (approximately 10 m²) where the females ordinarily gave birth and raised their pups. The naturally reared wolf and poodle pups lived in a pack of 13 and a group of three, respectively. The handreared pups were kept together with their littermates, but separated from other pups until approximately six weeks of age. After that, they dug so many holes in the fence separating the litters that I gave up trying to keep them apart.

All wolves observed or used for breeding were of European origin. The poodles were all bred in Kiel. They were rather large with males averaging 55 cm in height and females ranging from 45 to 50 cm.

¹ F_1 female hybrids come into estrus twice a year, just as dogs.

² Haustiergarten, Institut für Haustierkunde, Director: Prof. Dr. W. Herre.

In an earlier report (Zimen 1978, pp. 20–25) I suggested that behavior of wolf pups toward human beings appeared to be governed by two distinct behavioral trends. The first I labeled 'tendency toward socialization' and refers to behavior that in other humans we might call friendly or affectionate, that is, a disposition to approach and engage in harmonious interaction. Pups that possess this characteristic might, for purposes of discussion, be described as 'sociable' and those that do not exhibit this trait as 'indifferent' to human contact. The most obvious behavioral measure of this trait is a spontaneous tendency to *approach* humans. The absence of the trait is not, however, expressed by retreat, but by lack of interest or passive avoidance. The second trait I identified as 'flight', a tendency to actively *retreat* from humans. Pups displaying this tendency are variously described as 'timid' or 'fearful' or 'shy' in contrast to pups that seem more 'trusting', 'confident' or 'tame'.

The reaction of the pups when I entered their room or came close to their den was recorded daily from their 15th to 56th days of age. With the maternally reared pups, I normally waited until the mother was away before I approached. With the hand-reared pups it was generally the first early morning contact. After I had entered the room (or, later, their outdoor enclosure) I sat down and presented as neutral a social stimulus as possible, initiating no interaction and responding to their behavior only insofar as necessary to protect notes, clothing, etc.

The behavior of each individual pup was recorded at entry and thereafter every 60 seconds for 10 minutes, using the rating scale in Table 2. Each pup's daily flight and approach scores were calculated using the following algorithm:

$$d = \frac{5R_0 + \sum_{i=1}^{10} R_i}{15}$$

where R_0 is the rating at entry and R_i is the rating assigned at the i th minute thereafter. The pups' initial reactions (R_0) were weighted more heavily than subsequent reactions because it was felt that these were least influenced by the behavior of littermates. In Figs. 1 to 11, the daily scores are summed to yield weekly totals for the individuals or groups identified in the captions.

Results

The wolves

Independent of the way they were raised, all wolf pups showed first flight reactions (a sudden jerk, movements away from the source of disturbance,

Table 1. The animals

Litter No.	No. of pups	Year of birth	Separated from mother at day	Raised at	Raised by	Behavior as juveniles/adults	
						Sociable	Fearful
<i>Wolves</i>							
1	1	1967	6	Rickling	Author	Yes	No
2	4	1968	15	Rickling	Author	Yes	Partly outside enclosure
3	3	1967	21	Rickling	Author	No	Reduced
4	4	1973	-	Bavaria	Mother in pack of 13	No	Strong
<i>Poodles</i>							
5	3	1967	14	Rickling	Author	Yes	No
6	6	1968	-	Rickling	Mother in group of 3	Yes	Partly outside enclosure
<i>F₁ Puwos</i>							
7	4	1967	14	Rickling	Author	Partly	Reduced when familiar
8	4	1967	-	Kiel	Mother alone	No	Yes
<i>F₂ Puwos</i>							
9	4	1967	14	Rickling	Author	2 yes, 2 no	2 yes, 2 reduced
10	4	1966	-	Kiel	Tame mother	No	Yes
11	9	1966	-	Kiel	Timid mother	No	Some strong, some reduced

Table 1. (Continued)

Additional litters observed:											
<i>Wolves</i>											
12	1	1967	appr. 35	Rickling	Author	No	Very timid				
13	5	1961	28	Bavaria	Author until day 40	No	Reduced				
14	1	1971	18	Bavaria	Author until day 28	No	Strongly				
15	3	1972	14	Bavaria	Author until day 42	No	Reduced				
16	7	1974	-	Bavaria	Mother in pack of 13	No	Strong				
17	2	1975	15	Bavaria	Students until day 57	Partly	Reduced familiar				
18	2	1980	14	Freyhaus	Author	Yes	Partly				
<i>Poodles</i>											
19	6	1969	-	Rickling	Mother in group of 5	Partly	Strong outside enclosure				
20	5	1969	-	Rickling	Mother in group of 9	Partly	Strong outside enclosure				
21	5	1969	-	Rickling	Mother in group of 8	Partly	Strong outside enclosure				

Table 2. Rating of flight and approach behaviors of pups at entry and thereafter at each full minute during a 10-minute observation period

Rating	At entry	During observation
	RETREAT	
-5	As -4 plus urination and defecation	As -4 plus repeated urination and defecation
-4	Flight head over heel	Stays inactive, curled up, at furthest end of room
-2	Stands up and withdraws slowly	Observes intruder constantly at some distance
-1	Jerks but does not move away	Lies or sleeps with occasional observation of intruder
0	No observable flight reaction	Sleeps calmly or no flight response
APPROACH		
0	No observable approach reaction	Sleeps calmly or no approach behavior
+1	Lifts its head, moves tail shortly	Occasional observation of intruder with tail movements or comes closer
+2	Comes closer slowly	Stays close without constant direct contact
+3	Comes running, tail wagging	Constant direct contact, play
+4	Comes running, active submission	Passive or active submission, play
+5	As +4 plus rolls on back, vocalization, urination	Intensive and constant body contact, submission, play

hiding the head) during their third week around the 18th day. About 4 days later, first approach tendencies including tail wagging and a sudden twist of head or body were observed.

The further development of the pups was highly dependent upon the way and with whom they were raised. My first wolf was taken away from her mother at the age of 6 days and handreared without any contact with other conspecifics until the 8th week. The first fear reactions were soon suppressed by overwhelming approach and social behavior, including the whole repertoire of active and passive submission (Schenkel 1947), play and urination (Fig. 1). Measured by the intensity of her expressive behavior she became the animal most socialized to humans of all pups I have ever raised. She showed strong social deprivation symptoms every time she had to be kept in the enclosure, even when in company of other wolves. As Klinghammer and Goodmann (Chapter 2) point out, however, 'socialized' in no way implies an absence of aggression, and by the age of 2 years, this wolf had become so aggressive that she had to be given away (Zimen 1978).

Four pups taken from their mother on the 15th day and hand-reared, also

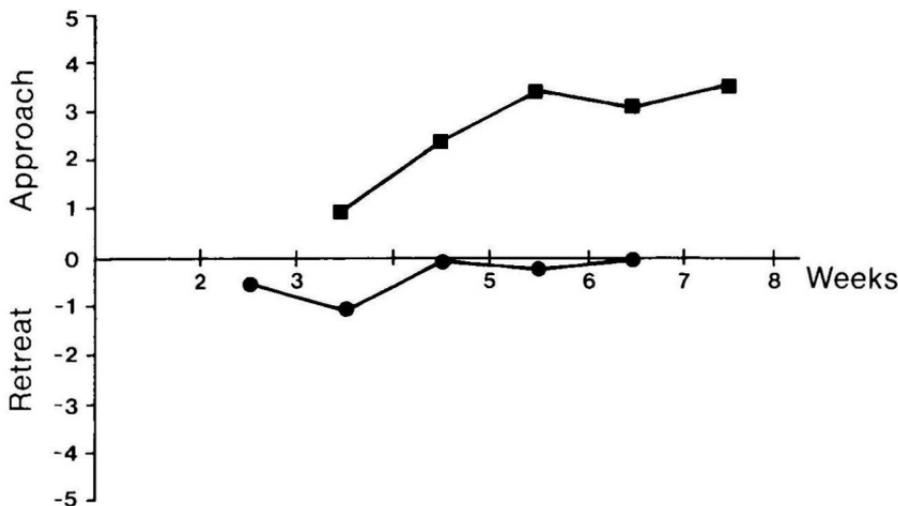


Figure 1. Retreat and approach scores for one female wolf hand-raised alone from six days of age (1967).

became completely tame and socialized to humans, although their approach and social contacts with me were much less intensive than that of the individually, hand-reared pup (Fig. 2). In the 5th week all social behavior patterns involved were fully developed. The continuous increase in approach reaction from then on was largely a matter of more persistent play close to or with the observer, as is typical of all socialized pups. The flight reactions observed occurred almost exclusively at entry, or when the observer suddenly stood up.

Until the age of eight weeks, no distinct individual differences were observed in the four pups. Later, however, one of them especially ('Alexander'; Zimen 1978) became very tame, rather non-aggressive and dependent, never to disappear from home more than a few hours. The three others also stayed well socialized, but showed more tendency to flight when outside of the enclosure and approached by a stranger. On these occasions when they escaped from the enclosure or bolted from me during walks; they often disappeared for days. One remained at large for four months and ten days before he returned to the enclosure (Zimen 1978).

Three pups taken away from their mother just one week later, on the 21st day, showed increasing flight reactions from that day on. Also, although they showed some approach tendencies and also friendly reactions at a distance (tail wagging, etc.), their general social development was mainly influenced by their fear of man. They never became socialized, but accepted human approach inside the enclosure up to a few meters before they withdrew.

Finally, four pups that were left with their mother and a pack of 13 in the large enclosure in the Bavarian Forest were first seen outside the den on the 29th day. Approached by me, they immediately disappeared into the den, but soon

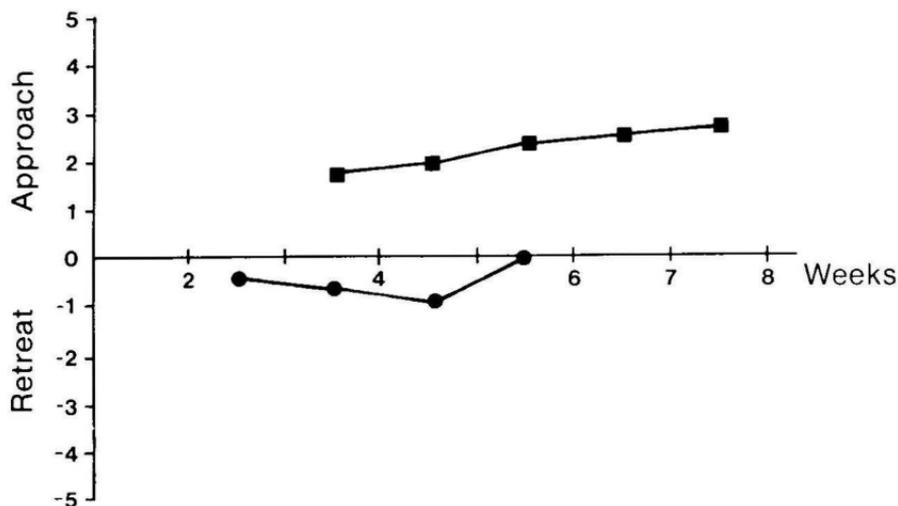


Figure 2. Average retreat and approach scores for three male wolves and one female wolf hand-raised from 15 days of age (1968).

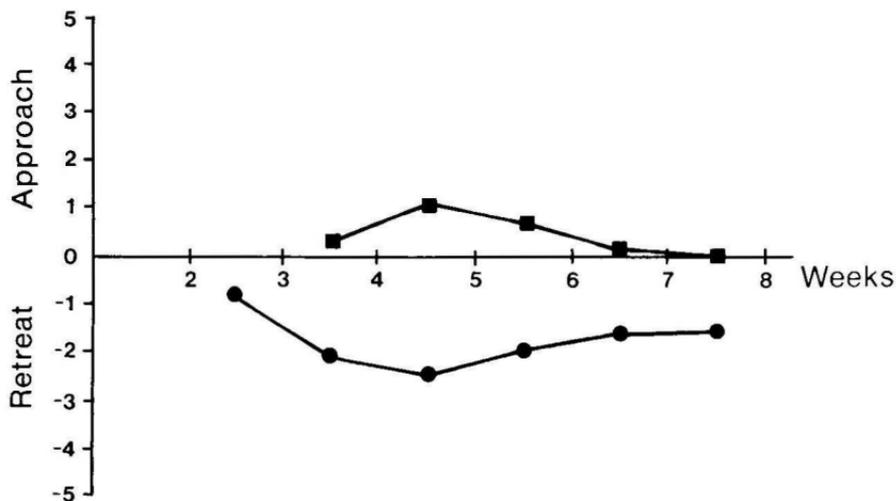


Figure 3. Average retreat and approach scores for two male wolves and one female wolf hand-raised from 21 days of age (1967).

came out again and either ignored me or curiously approached and then fled once more. Although these behaviors might indicate the early appearance of individual differences in approach tendency, it is more probable that they simply did not recognize me when I sat still. Fourteen days later, flight behavior was their only reaction, and from then on they did not come into open again when I was close.

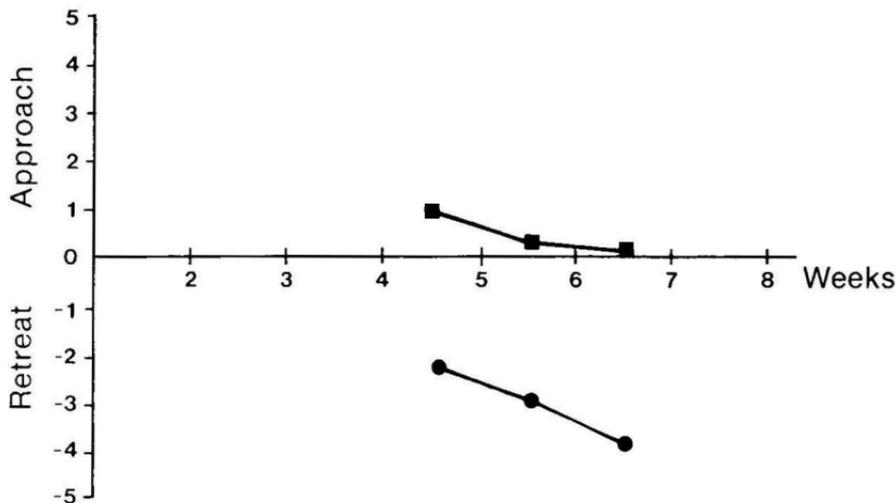


Figure 4. Average retreat and approach scores for three male wolves and one female wolf maternally reared in large enclosure with pack of 13 wolves (1973).

The poodles

Out of a litter of three, two pups were taken away from their mother on the 14th day. Like other breeds of domestic dog (e.g., border collies, Bakarich 1979, and Malamutes, Frank and Frank 1982) they were clearly less agile than the wolf pups. This might explain their somewhat delayed social development: A sudden jerk at strange noises or movements and tail wagging were first observed on the 21st day, while the first clearly socially motivated approach was seen on the 25th day. From this time on neither my entry nor my further presence released any flight reactions.

The third pup remained with her mother without human contact for 35 days. When first taken from her mother she was rather shy and withdrew quickly if approached. Within a day with human contact, however, she behaved just like the other two pups. All three of them became well socialized, although their contacts were never as impetuous as that of the wolves.

In the maternally reared poodle pups flight tendencies were observed, especially in one male at the age of five weeks. Yet, they all became just as socialized to humans as the hand-reared pups. As adults, however, they were noticeably less dependent on humans. When allowed outside the enclosure, for example, they ranged farther from me and engaged in more independent exploratory behavior than the hand-reared poodles. Such behavior was especially true for poodles born in later litters. Raised and kept together with the other poodles, they had little human contact. On occasion some showed rather strong flight tendencies when approached, and none of them became strongly socialized to

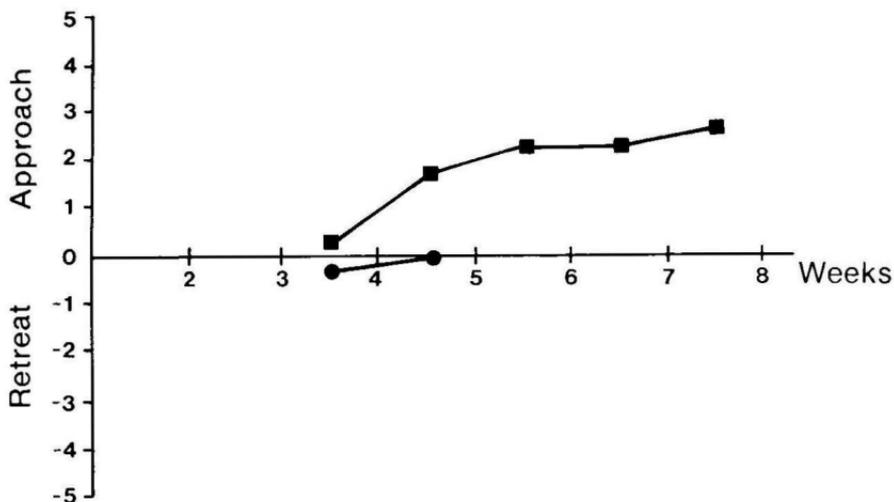


Figure 5. Average retreat and approach scores for one male poodle and one female poodle hand-raised from 14 days of age and one female hand-raised from day 35 (1967).

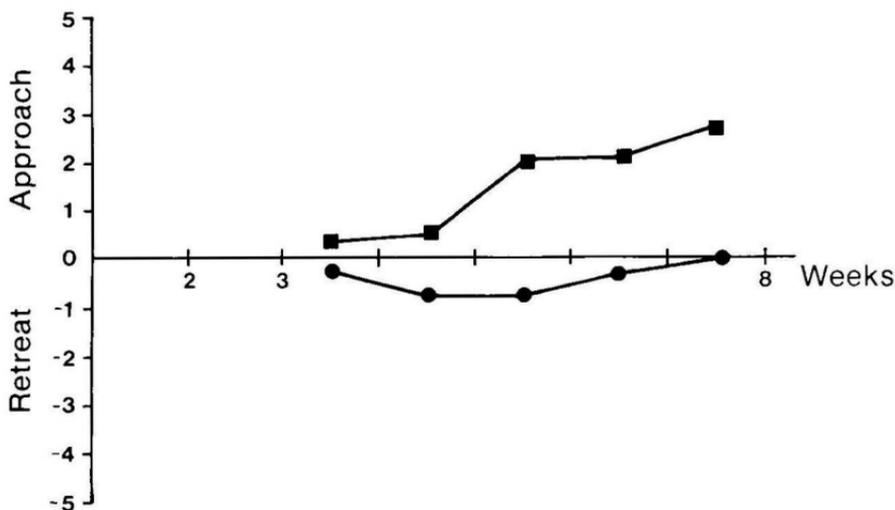


Figure 6. Average approach and retreat scores for one male poodle and two female poodles maternally reared in group of three (1968).

humans as long as they were kept in the group. As adults, they sometimes broke out and disappeared for days. Seen outside the enclosure in the fields, they all had a large flight distance. Given away to private people as pets, however, even those that were nearly a year old soon became socialized to their new masters, although they remained very shy with strangers.

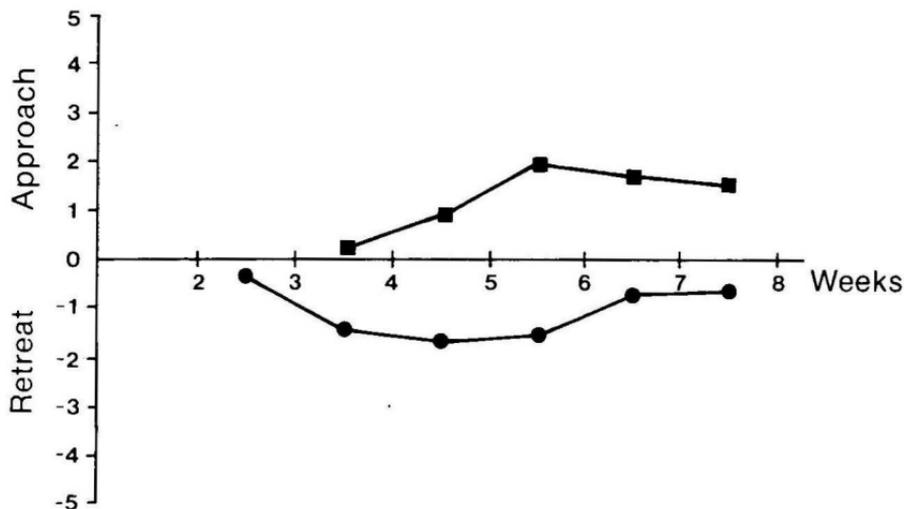


Figure 7. Average approach and retreat scores for two male and two female F_1 pupwos hand-raised from 14 days of age (1967).

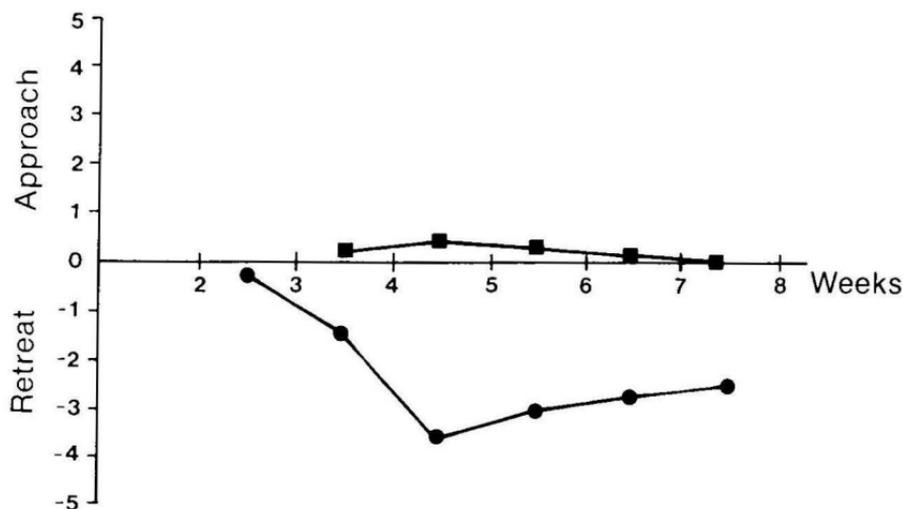


Figure 8. Average approach and retreat scores for three male and two female F_1 pupwos maternally reared in small enclosure (1968).

The F_1 Pupwos

The development of the hand-reared F_1 hybrids is very similar to that of the wolves (Fig. 7). The hand-reared pups all showed flight reactions before the 21st day and first social approaches approximately one week later. They all became socialized to me, but continuous high flight tendencies prevented direct contact

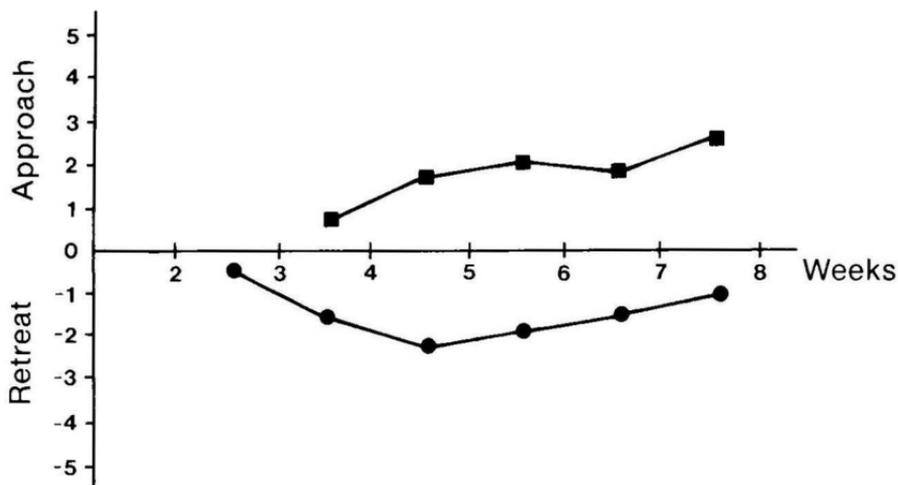


Figure 9a. Approach and retreat scores for male F_2 puwo hand-raised with three littermates from 14 days of age (1967).

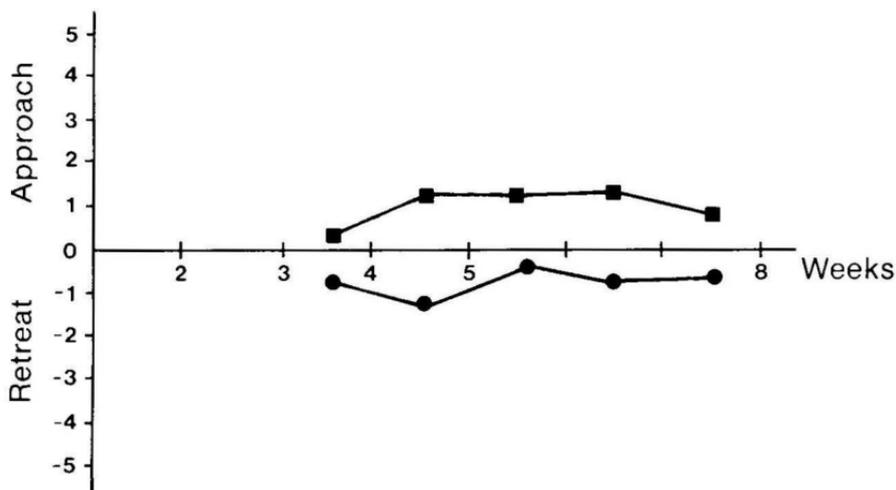


Figure 9b. Approach and retreat scores for male F_2 puwo hand-raised with three littermates from 14 days of age (1967).

with strangers. Except for the daily observation period, they were less exposed to human contact than were the wolf pups (Fig. 2), which may account for their persistent flight reactions and the somewhat low scores on the approach scale.

Initially, the maternally raised pups were extremely fearful, but soon calmed down in the small enclosure (Fig. 8). As juveniles and adults, they behaved very much like wolves, reared and maintained under the same conditions, not socialized, but rather tolerant of human disturbance.

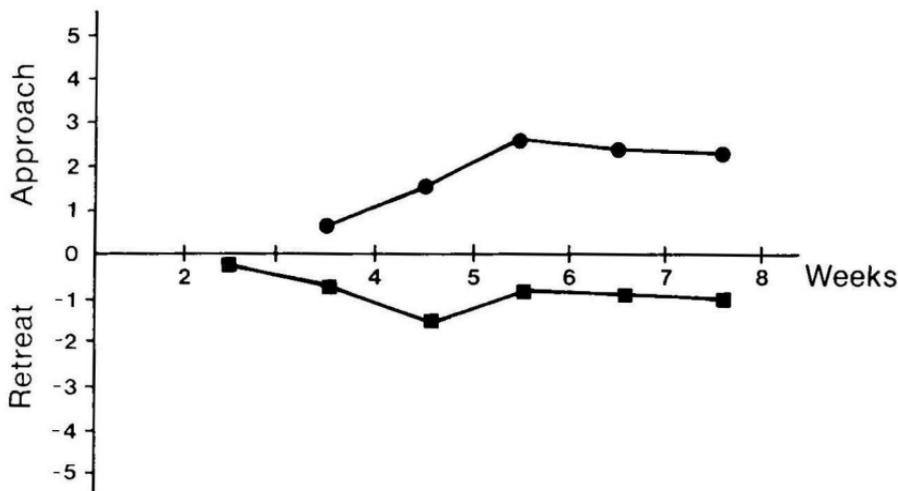


Figure 9c. Approach and retreat scores for female F_2 puwo hand-raised with three littermates from 14 days of age (1967).

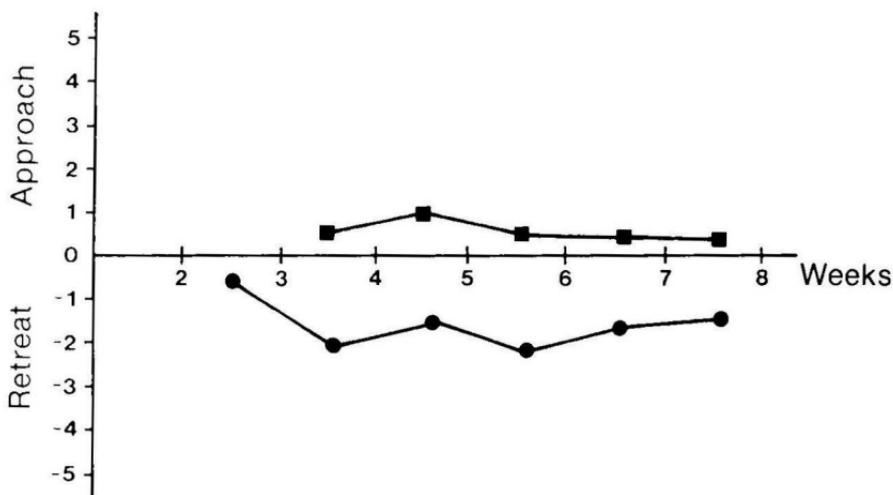


Figure 9d. Approach and retreat scores for female F_2 puwo hand-raised with three littermates from 14 days of age (1967).

The F_2 Puwos

The individual differences among the four hand-reared F_2 hybrids was most striking. Four distinct combinations of behavior were evident in these pups: One female showed low flight and high social approach tendencies (Fig. 9a). The other female was very fearful and showed only weak approach tendencies (Fig. 9b). One male was highly socially motivated, but also very fearful (Fig. 9c).

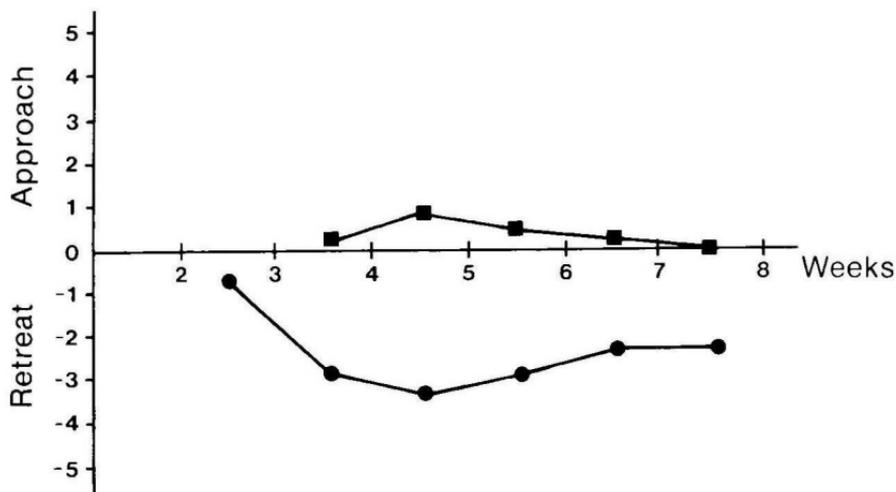


Figure 10. Average approach and retreat scores for two male pups and two female F_2 pups maternally reared in small enclosure by highly socialized mother (1966).

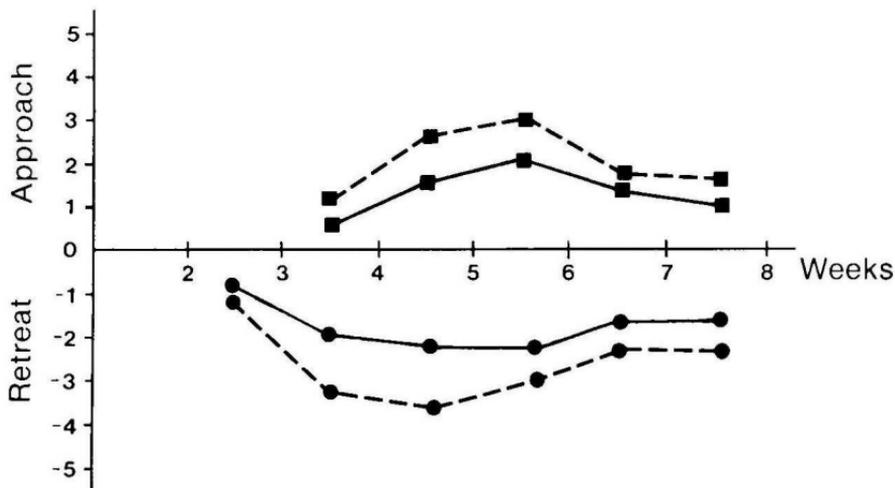


Figure 11. Average approach and retreat scores for 5 male pups and 4 female F_2 pups maternally reared in small enclosure by non-socialized mother. Broken lines are scored for most sociable pup and most timid pup (1966).

The second male, by far the heaviest of the four, was almost phlegmatic, exhibiting neither strong approach nor retreat tendencies (Fig. 9d).

As juveniles and adults, the two pups that exhibited approach tendencies became very attached to me, especially the male, although he remained extremely shy and jumpy in any strange situation. The two other pups did not socialize.

Two maternally reared F_2 litters were observed. One litter had a mother socialized to humans. She reacted with excited friendly approaches to any

human entering the enclosure. The other mother behaved just like any other non-socialized female canid kept under such conditions; whenever I approached, she quietly disappeared and held her distance.

The pups of the socialized mother all reacted with flight behavior to the mother's noise and excitement during each experiment. They all stayed shy and non-socialized (Fig. 10). The nine pups of the timid mother, however, again reacted very differently to my approach (Fig. 11). Until their 6th week, some of the pups readily came close and hardly showed any flight behavior; others quickly hid themselves or disappeared and stayed away all the time without any approach tendencies, and others showed either a combination of all four possibilities or intermediate reactions. From their 6th week on, however, the large individual differences levelled off. It seems that the strong flight reactions in some of the pups slowly influenced the more sociable ones to retreat, just as their approach seemed to moderate the flight tendencies of the fearful ones. At eight weeks, much of the individuality had already disappeared.

Discussion

The results show that the social development of wolf and dog pups is highly influenced by external factors. To standardize these would require that the pups be raised under highly controlled and socially restricted conditions, such as those described by MacDonald (Chapter 14). Also, the data are much too limited to permit far-reaching conclusions on the genetics of socialization. The results do, however, allow some preliminary statements:

Flight reactions to strange objects or noises are first seen in wolf pups between their second and third week, while approach behavior and socially motivated contacts with a human caretaker are first seen days later.

With respect to the poodle pups, the development of these behavior patterns is delayed almost one week. Their flight reactions are also much reduced and socially motivated approaches to humans occur whether they are maternally reared or hand-reared and whether or not they are reared in isolation from littermates. Also, socialization to humans is not restricted to an early age.³ In the hybrids, flight reactions mature as early and are as pronounced as in the wolf pups, just as their social behavior seems to just like that of the wolves.

³ According to the observations of Woolpy and Ginsburg (1967), this is also true for North American wolves, in which socialization is possible at any age, although with increasing efforts. To my knowledge, similar experiments have not been conducted on European wolves. However, it seems to me highly improbable that a normal healthy adult wolf would ever behave the way described for the American ones. On the whole, reading their paper, I often have the impression we are dealing with two different species. So for instance, first signs of fear are supposed to be exhibited around the sixth or seventh week; i.e., at an age all wolves I have ever observed will be most fearful of man, if not already tamed. And to socialize an eight-week-old pup, who has had no prior contact with man, in one (although prolonged) sitting-in session with it, sounds to me like a tale from another world.

The F₂ hybrids also show much stronger fear than most poodles. Remarkable individual differences, however, exist among littermates, with some pups very fearful and others more relaxed. The same is true for their approach behavior toward humans; some pups are highly motivated to seek human social contact, others hardly at all.

The high variability in the behavior of the F₂ Puvos and the fact that some of the pups were very sociable and at the same time very fearful, others neither fearful nor sociable, indicate that socialization in wolves and dogs is controlled at least by two genetically independent motivational systems. In wolves, the early development of fear reactions normally prevents any social contacts and, therefore, social bonding with a strange species. However, they can become socialized to humans if the first flight tendencies are overcome, although in my study only the socially deprived pup raised in isolation from larger conspecifics and intensively cared for became as fully attached to humans as a dog. Also, pups raised with their littermates will later often show social preference for other wolves. In most cases, the lower motivation to seek human contact in these pups again will lead to increasing fear reaction and consequently prevent lasting socialization. In all, only seven of the 30 hand-reared wolf pups were successfully socialized (see Table 1), although most of the others retained a much reduced flight distance to humans even when they grew older.

In dog pups raised without human contact, fear of man will also mature. As also demonstrated by Scott and Fuller (1965), such deprived dogs will become quite fearful. Yet, it is possible to socialize even a most timid dog, although it will normally stay fearful with strangers or in novel situations.

Consequently, in both dogs and wolves, early social contacts to man will suppress fear. The difference in their behavior is that wolf pups will only become socialized to man in the absence of larger conspecifics and fear, while dogs will become socialized despite the presence of conspecifics and fear. Besides reducing flight tendencies, domestication has thus strongly increased the motivation to seek social contact with man.

The strong genetic fixation of fear, seen in both wolves and hybrids, indicate that the process leading to domestication must have lasted for many generations. Large individual differences in wolves, however, also indicate that the necessary genetic variability for selection of fearlessness and sociability was available.

We do not know of the relationship between late paleolithic man and wolf. Since both are competitors for the same game, however, it seems most likely that the inferior was afraid of the dominant. This might not have been of the same magnitude as it is today in modern European wolves after some thousand years of eradication endeavours by farmers and hunters. So although they were probably too fearful to seek social interaction, it is entirely likely that they nonetheless exploited his garbage as do wolves in areas of North America today (Mech and Hertel 1983). Wolves congregating around the paleolithic settlements

might therefore have been the foundation stock for the domestic dog. However, it seems most unlikely that domestication began with such a loose association between man and a wild species. The strong social bond between man and wolf is only to be achieved by socializing young wolf pups, animals that would thereafter direct social behavior toward members of new 'pack' and consequently follow it on its year around movements.

With respect to the handraised wolves, the less fearful, the sociable, non-aggressive and dependent individuals stayed, while the timid, indifferent or independent ones either returned to their wild conspecifics or, if they became too aggressive or troublesome, were killed. Thus confidence and sociability were selected for early. However, since the presence of even a highly socialized mature wolf will prevent socialization of pups, some sort of repeated and possibly even culturally ritualized orphanage must have been involved during parts of the domestication process. Reed (1977) has argued that such behavior is inconsistent with typically conservative male sex-roles in hunting cultures. Moreover, the wolf was probably the first animal to be domesticated, so only human milk was available to feed the young pups. Women, therefore, must have played an important role in domesticating the wolf, thereby setting the stage for paleolithic man's evolution from a hunter-gatherer society to modern civilization.

Summary

The work reported in this chapter investigates the development of two behavioral tendencies in wolf pups, poodle pups and wolf-poodle (puwos) hybrid pups toward humans. Tendency toward socialization (sociable-indifferent) is assessed by approach behavior and tendency to flight (timid-confident) is assessed by retreat behavior. The evidence suggests that these two tendencies develop independently and that wolf pups can be socialized to humans only if:

1. innate flight tendencies are overcome by extensive, early contact with humans, thereby permitting free expression of tendencies toward socialization and,
2. the tendency toward socialization is not co-opted by the presence of larger conspecifics.

In contrast, reduction of flight tendencies in dogs requires much less effort, and approach behavior is not subject to influence by adult conspecifics.

These results are consistent with Scott's (1980) suggestion that domestication has endowed the dog with the capacity for dual 'identification' and present intriguing possibilities for reconstructing the conditions under which dogs were originally domesticated by paleolithic man.

References

- Bakarich, A. C. (1979). Comparative development in wolves (*Canis lupus*) and dogs (*Canis familiaris*). Unpublished masters thesis, Trinity University, San Antonio, Texas.
- Frank, H., and Frank, M. G. (1982). On the effects of domestication on canine social development and behavior. *Applied Anim. Ethol.* 8: 507-525.
- Herre, W., and Rohrs, M. (1973). Haustiere: Zoologisch gesehen. G. Fisher, Stuttgart.
- Mech, L. D., and Hertel, H. H. (1983). An eight-year demography of a Minnesota wolf pack. *Acta Zoologica Fennica* 174: 249-250.
- Reed, C. A. (1977). A model for the origin of agriculture in the Near East. In C. E. Reed (ed.), *Origins of agriculture*. Mouton, The Hague, pp. 543-557.
- Schenkel, R. (1947). Ausdrucks-Studien an Wölfen. *Behaviour*, 1: 81-129.
- Scott, J. P. (1980). The domestic dog: A case of multiple identities. In M. H. Roy (ed.) *Species identity and attachment: A phylogenetic evaluation*. Garland STPM, New York.
- Scott, J. P., and Fuller, J. L. (1965). *Genetics and the social behavior of the dog*. University of Chicago Press.
- Zimen, E. (1972). *Wölfe und Königspudel: Vergleichende Verhaltensbeobachtungen*. Piper Verlag, München.
- Zimen, E. (1978). *Der wolf: Mythos und Verhalten*. Meyster-Verlag GmbH, Wien.