Being Sensitive To The Sensitive Period

Stephen D. Webster.

Animal Behaviour Research Group, Department of Zoology, University of Oxford,
South Parks Road, Oxford, OX1 3PS, UK

Introduction

In examining the development of canine behaviour there has been a tendency
to relate chronological factors and restricted experience during the first weeks of life
to subsequent measures of behaviour in the sub adult or adult dog (e.g. Fox and
Stelzner, 1966, 1967; Freedman et al, 1961; Melzack and Scott, 1957; Thompson and
Heron, 1954). There are three flaws in the reasoning behind these experiments and
their interpretation. First, the processes of cell division and of ageing can vary
between animals and individual dogs will develop at different rates. The animals' perception of their experiences may vary between individuals, as will the importance
of external influences upon behavioural development. Thus, a chronological measure
of development is only a very rough guide to the actual stage of development. The
effect of this upon the interpretation of results is to lose detail. Second, experiments
which have attempted to isolate animals from aspects of their environment during
rearing can only tell us what is not important for the development of behaviour
(Lehman, 1970). The details of what is important for the development of behaviour
are far more difficult to ascertain. Third, classifications of behavioural types in the
adult dog have been assumed through these experiments to be stable over time; an
assumption with little scientific backing. Behavioural development in many species
does not stop when physical maturity is reached but continues to develop throughout
life (Manning and Dawkins, 1993). There is no reason a priori to assume that this is
not true for canids.

The critical period for socialisation: the sensitive period

The concept of a critical period for socialisation (the sensitive period) is based,
in its application to dogs, upon the results of a number of isolation experiments and
upon observations of the development of non-isolated litters. In 1945 a series of
experiments into the heritability of behaviour was initiated at the Roscoe B. Jackson
Laboratory, Bar Harbor, Maine, US. Similar work was conducted by Melzack and
colleagues at the McGill University, Canada and by Fox and colleagues at Thudichum
Psychiatric Research Laboratory, Galesburg, Illinois. The influence of these studies
upon the contemporary understanding and interpretation of canine behavioural
development remains potent (e.g. Hawthorne et al, 1994; Hubrecht, 1995; Serpell and
Jagoe, 1995).

However, the early studies on the development of dog behaviour present us
with two types of evidence; statistically tested and "observations". While the latter can
be useful in hypothesis formation they can never be assumed to be fact. There is an
unfortunate habit, within the body of people who write on dog behaviour, of accepting
all that is published within scientific journals. Much of the early work on dog
behaviour was published in an era when anecdote was acceptable and should thus be
treated with caution. The point is not a new one, having been raised by J. A. King in 1958.

Scott and Marston (1950) first wrote of critical periods affecting the social behaviour of puppies, based upon observations of animals through the first five years of the Bar Harbor studies. Subsequent work did not in general aim to challenge the critical period hypothesis but rather to refine it, a problem confounded somewhat by the paucity of institutions which were working in this area. In what is frequently cited as evidence for the upper and lower boundaries of this critical period Freedman et al (1961) wrote, "the seventh week of age was the period in which the pups were most receptive to socialisation, and that two and a half to nine - thirteen weeks of age approximates a critical period of socialisation to human beings".

Freedman et al (1961) gave animals one week of "human socialisation" out of a total of fourteen weeks isolated with the dam up until weaning. On initial testing, five week old pups more readily approached a human handler than two, three or nine week old pups. Specifically, the two and three week old pups had inferior physical ability whereas the nine week old pups had a "tendency to avoid the handler". At the end of a week of initial testing the cohorts did not differ; on re-testing at fourteen weeks of age the pups given human socialisation at two weeks of age were initially less willing to approach a handler (although after two weeks the cohorts did not differ): at fourteen weeks of age the cohorts socialised at two and at three weeks of age were least easy to train to a leash.

As this is so often quoted as evidence for upper and lower boundaries of the critical period it is worth asking precisely what was found by Freedman et al. The long term effects of isolation to fourteen weeks which were claimed in this paper are discussed above. The low sample size of the nine week cohort (n=3) prevents the generalisation of results specific to this age. The lower boundary observed here is potentially due to differences in the motivation and ability of two to three week old pups in comparison to older pups. It remains possible that a handling regime different to that adopted by Freedman et al would negate the differences observed in subsequent tests, specifically in training to a leash at fourteen weeks. Thus the assertion that, "the seventh week of age was the period in which the pups were most receptive to socialisation, and that two and a half to nine-thirteen weeks of age approximates a critical period of socialisation to human beings", is at best tenuous.

Use of chronological measures

The use of a chronological scale against which canine behavioural development is measured rests upon the assumption that the rate of development of the domestic dog is invariant. Quite simply this assumption is invalid.

Variation in the rate of development of animals will arise through both innate and environmental factors. The processes of cell division and of ageing vary between animals and within a hypothetical "controlled" environment individual dogs will nevertheless develop at different rates. King (1958) justified the use of a chronological measure "in the absence of physiological and neurological correlates to behavioural development". However, with improvements in our ability to measure physiological and neurological changes this justification no longer holds true. The correlation of these measures with developmental changes would present us with a much refined model of the mechanisms involved.
An animals’ rate of development is affected by both nutritional and physical factors. For example, early exposure of infant rats and mice to cold can accelerate the development of thermo-regulation (Gelinoe and Gelinoe, 1952) and removal from the nest for ninety minutes per day promotes earlier eye opening (Barnett and Burn, 1967). While the experimental control of these factors is possible it has not been adequately achieved in canine behaviour research to date. For example Fox and Stelzner (1967) compared animals weaned early and isolated to those left on the dam up to eight weeks and yet failed to include valid checks on the nutritional states of the different groups.

Evidence suggests that psychological factors will directly affect the rate of development of an animal. The perception of the environment will differ between animals through differential experiences. Puppies will learn the consequences of their actions from an early date (Cornwell and Fuller, 1960) and differences in such consequences and in their timing will result in differences in learned associations and in their speed of acquisition. There is a myriad of differences in the environments of animals both within and between litters; the size of an animal relative to its littermates, the response of the dam and other pups to the activity and vocalisations of the animal and so on. Each of these factors will potentially affect the perception, behaviour and learning of the animal. However, the measurement and control of psychological factors presents the researcher with certain intractable difficulties which have prevented their direct analysis.

The interaction between the behaviour of the dam and the behavioural development of her offspring is well documented in a number of species including mice and rats (e.g. Barnett and Burn, 1967; Hoersten et al, 1993; Levine et al, 1967; Thoman and Levine, 1970), pigs (e.g. Beattie et al, 1996; Webster and Allen, 1997) and monkeys (e.g. Harlow, 1969) and it is not unfeasible to suggest that such an interaction will exist between canine pups and their mother. Such a relationship involves nutritional, physical (e.g. thermal comfort), physiological (e.g. the passage of hormones through the milk) and psychological elements and is potentially the greatest single influence upon the growth and development of the pup.

Thus, the use of a chronological measure on which developmental periods may be marked fails to take into account either innate individual variation in the process of cell division and ageing, variation in the physical environment, variation in the perception of the environment or the within and between litter variation in maternal style.

Use of isolation experiments

In ascertaining the existence and timing of "critical periods" the isolation experiment has been considered a powerful research tool. Through isolating pups from stimuli over particular age ranges experimenters have attempted to find which stimuli are necessary and at what ages if "normal" behavioural development is to proceed. There is a fundamental flaw in this argument relating to our own and our subjects' perceptions. If we knew that our own perception of a stimulus (or its absence) was identical to that of our subjects then we could happily state what it was that the subject had been isolated from. However, we may safely assume that our own perceptions are not the same as those of our subjects and so precise identification of stimuli is impossible. The problem is further confounded by the fact that one stimulus
may substitute for another and so it can never be known for certain whether a factor is essential. In fact isolation experiments can only tell us what is not necessary in the development of an animal (Manning and Dawkins, 1993).

The interpretation of isolation experiments is difficult for these reasons and for the reason that treatment in the post-isolation environment will continue to affect the behaviour of an animal. Fuller (1966a,b) demonstrated that the treatment of dogs with chlorpromazine, a tranquilliser and sedative, resulted in behaviour at emergence from isolation similar to non-isolated dogs. Thus, animals did not fail to acquire particular behaviours but rather failed to show these behaviours because of a general neophobia on exiting their cage. Animals which were not treated in this way continued to show a marked post-isolation syndrome. This also explains the finding of Freedman et al (1961) that a single dog, isolated from humans between birth and fourteen weeks of age, remained fearful despite many weeks of "petting". On emergence from isolation to handling this animal would have (potentially) associated the acute stress response characteristic of post-isolation syndrome with the handling episode. Subsequent handling and restraint would only serve to reinforce such an association and thus the fear of man.

Regardless of the interpretation of isolation experiments *per se*, a host of methodological flaws has surrounded the research into critical periods in dogs. For example, variation in the time elapsed between treatment and time of testing has been confounded with the age at which treatment occurred (e.g. Fox & Stelzner, 1966; Freedman et al, 1961); the time spent in isolation has been confounded with the age-range spent in isolation (e.g. Fox & Stelzner, 1967; Pfaffengerger & Scott, 1959) and the amount and type of handling and testing given at particular ages has not been standardised (e.g. Melzack, 1954). One reason for this is that the sheer cost of canine research prohibits the perceived worthiness of experiments designed to look at single factors. Whereas the rodent research is replete with studies examining in fine detail specific aspects of behavioural development, the canine research has consistently attempted to produce a single experiment with which to demonstrate the critical period hypothesis.

The concept that early experiences are of particular relevance in determining later behavioural types has been instilled in popular culture for a very long time. However, taking the above criticisms into account, the evidence upon which our understanding of canine behavioural development is based is not so strong as previously thought. Perhaps it is time to take a step back and take in a truly objective view of the processes involved.

**Consistence of behaviour**

Evidence exists for the existence of consistent behavioural types in rodents (e.g. Benus et al, 1991). However, the evidence for consistent individual variation in other animal species is less convincing. For example, despite a wealth of studies aimed at the identification of consistent behavioural types in the domestic pig there remains little evidence to suggest that these exist (Lawrence et al, 1991; Hessing et al, 1993; Jensen et al, 1995; Forkman et al, 1995; Spoolder et al, 1996; Webster and Jones, in press). Although it is common to assume that the behavioural traits of an animal which we might call "personality" are constant, such an assumption requires careful scrutiny. Evidence for consistent "personalities" within dogs comes primarily
from our experiences with pets. However, most pet owners and animal handlers will, quite unconsciously, constantly reinforce particular behaviours in the animals with which they interact. Thus the steady state personality may be a reflection of a continuous shaping of behaviour as opposed to a biologically fixed behavioural type; a fact long recognised by animal behaviour therapists. This is not to claim that dogs do not have "personalities" as such, rather that they are responsive to the social environment to an extent which may mask the more subtle differences between them.

Pfaffenberger and Scott (1959) analysed data on the life histories and training success of dogs from the Guide Dogs for the Blind, Inc., California. The principal finding within this analysis was that the length of time for which an animal was retained in kennels between twelve weeks of age and housing with a puppy walker was positively correlated with the success in training of the animals at twelve months. The analysis may be criticised on the grounds that animals perceived by kennel staff as being the best candidates for training as guide dogs would likely be homed first and those perceived as the worst candidates would likely be homed last. Although Pfaffenberger states that the allocation of animals to houses was randomised, this does not necessarily preclude a sequential re-homing strategy according to perceived trainability. However, recent work has demonstrated significant effects of housing on the behaviour of kennelled dogs in situ (Hubrecht et al, 1992; Bebak and Beck, 1993; Hetts et al, 1992). We may conclude that the behaviour of dogs may be altered in the short term, and quite possibly in the long term, by environmental factors in adulthood.

On the opposite side of the coin, Goddard and Beilharz (1994a,b) demonstrated that the behaviour of adult dogs could be predicted to some degree from fearfulness at three months of age but that the accuracy of this prediction increased with age. Disregarding the fact that these animal will have been subject to continual shaping of behaviour this is perhaps the strongest evidence for the consistence of behavioural types in dogs. Work aimed at disentangling the effects of continual shaping of behaviour and of consistent individual variation would take us a long way towards understanding the "personality" of dogs.

Conclusion
The concept of the critical period for socialisation, more recently termed the sensitive period, has had a direct impact. For example, guide dog associations now wean pups at six weeks of age so that they may become "shock proofed" against their working environment and puppy socialisation classes are increasing in popularity (Mugford, 1992). However, in order to further improve the success rate in training of guide dogs for the blind, of working police and military dogs and indeed of dogs kept as household pets we must now reach a far greater understanding of the developmental and environmental factors which predispose dogs to specific behavioural traits.

Guide dogs, to be successful, need to be confident decision makers (Johnson, pers. comm.). Confidence may arise through innate and environmental factors. We can hypothesise that there are periods in the animals life at which specific experiences will have a significant effect upon the confidence of the adult dog. Indeed we can hypothesise that these periods are significantly shorter than the two and a half to between nine and thirteen week period suggested by Freedman et al (1961), and that they will relate to physiological and psychological aspects of development as opposed to chronological aspects of development. We can examine these specific experiences
not in isolation but in relation to the behaviour and physiology of the dam. Perhaps most importantly we can examine alternative routes to the same objective; how we can create a confident dog without an optimal early environment.

Fewer than two percent of dogs placed on puppy walking schemes by the UK Guide Dogs for the Blind Association in 1995 were rejected for reasons of temperament before training. However, of the one thousand and forty dogs accepted for training in the same year over twelve percent were rejected for reasons of temperament, chiefly suspicion, sensitivity and distraction. Any improvement in our understanding of the development of behavioural traits in canids would serve to improve this figure. Given the Guide Dog for the Blind associations’ stated aim of achieving five thousand working dogs by the year two thousand it is perhaps time to move this field of research forward.

Acknowledgements

Many thanks are due to Danny Mills for giving the encouragement needed to put pen to paper and to Jonathan Cooper and Suzanne Held for helpful criticism of all that was written. Special thanks are due to Bruce Johnson for sharing his inspiring thoughts on guide dog behaviour.

References


Serpell, J. (ed.) The domestic dog: its evolution, behaviour and interactions with
Spoolder, H. A. M., Burbidge, J. A., Lawrence, A. B., Simmins, P. H. & Edwards, S. A.,
mother as a function of early experience treatments of the offspring. Phys. Behav., 5;
1417 - 1421.
Thompson, W. R. & Heron, W., (1954.) The effects of early restriction on activity in dogs.
J. Comp. Phys. Psych., 47; 77 - 82.
Webster, S. D. & Allen, F., (1997). Effects of the sow-piglet relationship on the weaning and
Webster & Jones, in press. Individual variation in the heart rate of piglets; evidence against