Many readers will spend much of their time working with owners to address unwanted canine behaviour. This can be in the form of preventative education and training or indeed helping owners to overcome established or emerging problems. In order to do this effectively it is important to have a good understanding normal canine behavioural development.

Both genetic and environmental factors influence behavioural development, the effects of the environment being more influential at key developmental stages. It is thought that genetic factors control the timing of the maturation of the brain and nervous system and in turn, the onset of specific stages in development (Fox, 1972; Bateson, 1979; 1981). Genetic factors will also influence individual disposition, such as the dog's reactions to fear-eliciting stimuli (Grandin and Deesing, 1998). Indeed, researchers identified some time ago the presence of a genetically inherited nervousness/fearfulness trait in the dog (Pfaffenberger, 1963; Murphree, 1973; Goddard and Beilharz, 1985). Genetics provide the background to every stage of behaviour development and can be considered as the ‘raw materials’ governing emotionality and future learning.

Having set the genetic background, canine behavioural development begins soon after conception during the prenatal period (whilst the puppies are in the womb). The emotional state of the dam is important as it has been shown in both rodents and primates that stress or trauma during pregnancy produces offspring that are more emotionally reactive and fearful (see Huizink et al. 2004, for a review of the literature).

Likewise, petting and fussing the relaxed pregnant bitch (known as the ‘gentling effect’) results in offspring that are more able to resist physical stress and less susceptible to emotional disturbances (Fox, 1972; Dehasse, 1994; Bourdin, 1999). It has been proposed that the ‘gentling effect’ results in activation of the parasympathetic nervous system which facilitates relaxation and later emotional attachment in the offspring, therefore aiding the process of socialisation (Fox, 1978).

The neonatal period runs from birth to approximately 13 days when the puppy’s eyes open. During this time the puppy is motivated by contact comfort and suckling (Fox,
1978; Scott and Fuller, 1965; Serpell and Jagoe, 1995). It has been shown that removing puppies from the litter before 15 days can result in an oral obsession and suckling of inappropriate items (Lindsay, 2000).

Even at this age puppies are capable of learning although this is limited by the development of their senses. Research has shown that neonatal puppies can learn both olfactory (scent - Fox, 1971) and tactile (touch - Fox and Stelzner, 1966; Bacon and Stanley, 1970) associations. During this stage of development, short periods of handling produce dogs that are more resistant to stress, cope better with isolation and have greater learning capacity (see Battaglia, 2005; Gazzano et al. 2007). However, recent research has called into question the usefulness of specific handling exercises (such as those described by Battaglia, 2005). Within an environment where the puppies already receive regular handling, early neurological stimulation procedures provide no extra benefits (Schoon and Berntsen, 2011). This indicates that, although early handling is necessary to provide early exposure to human scent, facilitating the process of socialisation (Appleby and Pluijmakers, 2004), there is a ‘ceiling’ to this effect, i.e. more is not necessarily better.

Between 13 and 21 days is the **transitional period** during which the puppy’s sensory and motor systems develop rapidly. Both the eyes and ear canals open and puppies show increased awareness of their surroundings and improvements in locomotor ability (Scott and Fuller, 1965; Fox, 1972). The focus of development moves from reflexive organisation to social awareness and identity (Lindsay, 2000). Play fighting with littermates will begin and puppies will also display distress vocalization when outside of the nest (Scott and Fuller, 1965; Serpell and Jagoe, 1995).

Learning capacity continues to improve during this period although the rate of learning exhibited by adults is not reached until 4-5 weeks of age (Scott and Fuller, 1965). Conditioned avoidance responses can be obtained at 15 days and reliability improves throughout this period reaching 90% by day 19 (Scott and Fuller, 1965). Clearly the mechanisms by which this is achieved are still limited by sensory capacity (Lindsay, 2000).

The **socialisation period** is characterized by rapid development of social behaviour patterns. Key research defining this period was conducted between the 1950’s and 1970’s at the Jackson Memorial Laboratories in Bar Harbour, Maine (Scott and Fuller, 1965). Scott and Fuller identified a ‘critical’ period occurring between the age of 3 and
12 -14 weeks. During this critical period the effects of the environment have a greater influence on the development of behaviour than at any other time. At this time emotional attachments are formed with both living (socialisation) and non-living (habituation) aspects of the environment (Scott and Fuller, 1965; Fox 1978).

In more recent literature the term ‘sensitive period’ is favoured as it is now recognised that the offset of this period is more gradual. During the sensitive period puppies begin to interact with, rather than simply react to, the social and environmental stimuli available (Fox, 1978). Virtually every functional behaviour system is strongly affected during this period including the formation of social relationships and the emergence of exploratory behaviour patterns (Lindsay, 2000).

Exposure to both social and environmental stimuli at this time is essential for normal behavioural development. Puppies raised in environments lacking a variety of sensory stimulation will suffer relatively permanent adverse effects to how the nervous system reacts to novel stimuli, being more fearful and reactive (Grandin and Deesing, 1998). This will also have the affect of hindering the process of socialisation and impeding future learning and trainability (Scott and Fuller, 1965, Fox, 1972; 1978).

Currently, there is still some debate surrounding the offset of the socialisation period. Some sources cite 8-10 weeks coinciding with the natural weaning process (McCune et al. 1995) with others citing 12 weeks (Lindsay, 2000; Shepherd, 2002). Breed and individual differences will result in variability in the exact timings of the socialisation process (Scott and Fuller, 1965; Serpell and Jagoe, 1995; Bailey, 2008). For example, Scott and Fuller (1965) suggest that the fearful responses of basenjis or the aggressiveness of fox terriers may serve to “limit socialisation from within” (page 140).

The onset of the fear response has been identified as the controlling factor for the end of the sensitive period. Research by Scott and Fuller (1965) investigated the willingness of a puppy to approach and maintain contact with a passive handler. Their results indicated that, up to the age of 7 weeks, attraction is more prevalent than fear, resulting in a willingness to approach novel stimuli confidently. The fear response begins at 5 weeks of age and increases throughout the remainder of the sensitive period, thus serving to limit the capacity for attraction. By 7 weeks, fear of novel stimuli begins to override attraction (see figure a). After seven weeks, although the acceptance of novel stimuli is still possible, it takes increasing lengths of time.
There is also evidence to suggest the emergence of a particularly sensitive period for fear imprints at 8-10 weeks (Appleby, 1997; Lindsay, 2000). Fox and Stelzner (1966) demonstrated this in testing how readily puppies recovered from an aversive event administered at 5-6 weeks of age, 8-9 weeks or 12-13 weeks. Within each group half of the puppies were exposed to an aversive event (electric shock) on reaching a human handler whilst the control group received pleasant contact. Ten trials were given daily for 5 days to create a conditioned avoidance response and then recovery trials were conducted (without electric shocks) 1 week and 2 weeks later.

During recovery trials the 5-6 week group demonstrated high recovery rates by readily approaching the handler. In contrast, puppies in the 8-9 week group showed the lowest recovery rates, being reluctant to approach the handler. Attempts to rehabilitate these dogs using food and social encouragement were unsuccessful. Of the puppies in the 12-13 week group, the majority did not learn to avoid the handler during the initial trials. This suggests that (at least in comparison to the 5-6 week group) an aversive experience between 8 and 9 weeks of age had the most marked and lasting effect on behaviour.
The juvenile period extends from the end of the socialisation period (around 12-14 weeks) to sexual maturity occurring at 6 months or later (Scott and Fuller, 1965). It is at this point where the exact timings of developmental stages begin to vary more widely between breeds (Fox, 1972; McCune et al. 1995).

During this period the development of motor capacities is limited to improvements in strength and skill rather than the emergence of new behaviour patterns (Scott and Fuller, 1965). Learning capacity develops fully and the foundations for future learning are established by 4 months of age. At this point the speed of the formation of conditioned reflexes begins to slow down (Scott and Fuller, 1965).

There is evidence to suggest that dogs with adequate prior experience may regress and become fearful, if exposure to social and environmental stimuli is halted during this period. Fox (1978) reports that restricting well socialised puppies to a kennel at 3-4 months, with no exposure to unknown people or a wider range of environmental stimuli until sexual maturity (6 months), results in dogs that are fearful and shy of strangers and are neophobic away from their kennel.

In pet dogs, anecdotal evidence suggests a second phase of heightened sensitivity to fear arousing stimuli around the onset of sexual maturity (Fox, 1972; Dehasse, 1994; Serpell and Jago, 1995; Shepherd, 2002). This is sometimes referred to as the ‘secondary sensitive period’ and occurs around the end of the juvenile period or during early adolescence depending upon breed and individual differences (Dehasse, 1994; McBride et al. 1995). It is important to note that an unpleasant experience occurring during this time may leave the dog permanently traumatised (Fox, 1972).

In the domestic dog, adolescence begins at sexual maturity and ends when the dog reaches social maturity at around 18 months - 2 years of age (Landsberg et al. 2003; Bailey, 2008). Once again, there is substantial breed variation and Dehasse (1994) suggests that social maturity may be reached anywhere between 8 months and 3 years. Larger breeds generally take longer to mature both physically and socially (Coppinger and Coppinger, 2002).

This stage of development is not apparent in wild canids as they reach both sexual and social maturity at 12-18 months (Fox, 1978; Shepherd, 2002). The process of domestication is thought to have resulted in a split in the timing of sexual maturation (earlier) and the maturation of the central nervous system (later) (Fox, 1978). In the
domestic dog humans have selected for precocious sexual development (Fox, 1978), and also for neoteny, with dogs retaining juvenile care-soliciting behaviours longer into adulthood (Coppinger and Coppinger, 2002).

The adolescent period is characterised by the refinement of social skills. Competition with same sex conspecifics may occur (Dehasse, 1994) and both territorial defence behaviour and aggression towards strangers (conspecifics and humans) emerge at approximately 12-18 months of age (Fox, 1978). During this time it becomes more likely anything perceived as a potential threat will be dealt with using aggression rather than avoidance or appeasement behaviour (Bailey, 2008).

In pet dogs, independence and increased interest in the environment (rather than the owner) is commonly associated with adolescence. The dog may also begin to test the boundaries set by the owner especially if these have not been applied consistently (Dehasse, 1994; Bailey, 2008). There is a prevalence of adolescent dogs in shelters that may reflect behaviour problems resulting from owner’s accidentally rewarding inappropriate behaviours at a time when the significance of social gestures is most acute (Shepherd 2002).

**Adulthood** begins once the dog reaches social maturity. This is the most stable stage of behavioural development and is followed by **old age** during which there is a progressive decline in physical and psychological functioning. The table below shows each of the stages of canine behavioural development (Thompson et al, 2009):

<table>
<thead>
<tr>
<th>Stages</th>
<th>Approximate Age*</th>
<th>Key Behavioural changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal</td>
<td>&lt; 0</td>
<td>Puppy’s subsequent temperament is influenced by genetics and the emotional state of the dam.</td>
</tr>
<tr>
<td>Neonatal</td>
<td>0–2 weeks</td>
<td>Early tactile stimulation can influence the later reactivity of puppies.</td>
</tr>
<tr>
<td>Transitional</td>
<td>2–3 weeks</td>
<td>Transition from the development of reflexive organisation to social awareness and identity.</td>
</tr>
<tr>
<td>Socialisation</td>
<td>3–12/14 weeks</td>
<td>Period of rapid development during which exposure to social and environmental stimuli is essential for normal behavioural development.</td>
</tr>
<tr>
<td>Juvenile</td>
<td>12/14 weeks – onset of sexual maturity (6 months)</td>
<td>Foundations for future learning are established by 4 months. Continued exposure to social and environmental stimuli is required to prevent the development of fear-based behaviour problems.</td>
</tr>
<tr>
<td>Adolescence</td>
<td>Sexual maturity – social maturity (18 months–2/3 years)</td>
<td>Social learning continues. Fear-based problems associated with the secondary sensitive period may become apparent. Dogs become increasingly independent which may also cause problem behaviour.</td>
</tr>
<tr>
<td>Adulthood</td>
<td>Social maturity - old age (7–8 years onwards)</td>
<td>Most stable stage of development. Problems arising during this time are most likely to be triggered by a specific external event or lifestyle change, or a medical condition.</td>
</tr>
<tr>
<td>Old age</td>
<td>Onset old age - death</td>
<td>Associated with a decline in physical and psychological functioning which may trigger the onset of behaviour problems.</td>
</tr>
</tbody>
</table>

* The exact timings of the socialisation period and the onset of both sexual and social maturity has been extensively altered via the process of domestication resulting in substantial variation in the onset of each stage between breeds. In general larger breeds take longer to mature both physically and socially.
This information raises a number of issues worthy of further discussion but perhaps the most notable is that a large proportion of behavioural development occurs before puppies are usually purchased by their owners. These include the influence of genetics, both in the form of breed traits and those traits directly inherited from the sire and dam, and also the influence of the breeding environment. The latter is of far greater importance as individual ‘personality’ is far less influenced by genetics than it is by early environment (Bradshaw, 2011). Furthermore, recent models of behavioural development suggest that the first few weeks of the sensitive period (3-5 weeks of age) forms the basis for all subsequent social and environmental learning (Pluijmakers et al, 2003).

This raises the question of whether it is all too easy to ‘blame’ owners for the difficulties that they are having with their dogs. In some cases these owners may in fact be the victims of poor breeding practice and/or an early environment that has not adequately equipped the puppy for its role as a companion.

It is common for puppies to remain under the care of a breeder for at least the first part of the socialisation period. Re-homing to pet owners most frequently occurs at 8 weeks (+/− 2 weeks) leaving the remainder of the socialisation period in the hands of the new owners. Vaccination programmes are often begun at the point of re-homing which then govern the age at which the new puppy can be safely taken out on walks.

Retrospective studies show that these timings (age of re-homing, age at which the vaccination programme is begun and age of first outing) alongside the quality of the breeding environment and the ongoing experiences provided by the new owner are all key factors in the quantity and variety of social and environmental stimuli encountered by the puppy during this key stage of development.

Both Jagoe (1994) and Appleby (2002) found that dogs obtained from non-domestic environments (such as pet shops, shelters, kennels, barns or sheds) were more likely to display problem behaviour, specifically relating to fear and/or aggression. Age of acquisition and subsequent vaccination were also found to be a significant factor as Appleby reports that dogs re-homed at 8 weeks of age or over were more likely to display avoidance or aggressive behaviour whilst Jagoe found that puppies receiving their first vaccination at 8-9 weeks or earlier showed a reduced potential for the development of problem behaviour. Jagoe also found that illness during puppyhood was associated with and increased prevalence of problem behaviour.
It is generally agreed that extremes of re-homing, too early (before 6 weeks) or too late (after 12 weeks), predispose puppies to develop adjustment problems later in life (Lindsay, 2000). In particular, problems relating to fear and aggression are often associated with late re-homing. O’Sullivan et al. (2008) found that over 60% of dogs that had been reported for biting a person were acquired at 12 weeks of age or over. McGreevy and Masters (2008) also report that the probability of displaying feed-related aggression (which is also based in fear - Jones-Baade and McBride, 2000) increases alongside the dog’s age at acquisition.

Many sources recommend re-homing between 6 and 8 weeks, right in the middle of the socialisation period (Fox, 1972; McCune et al. 1995; Lindsay 2000; Bailey, 2008) with some highlighting 7 weeks (Campbell, 1974) and others recommending 6 weeks (Freedman, 1991 as cited in Appleby 1997) as the optimal re-homing age. This allows sufficient time for socialisation with conspecifics whilst enabling the puppy to readjust to its new environment and socialise with the new owners before the fear imprint period at 8-10 weeks (McCune et al. 1995). There are some sources that suggest that 6-8 weeks is too early for rehoming (Overall, 1997; Bailey 1994). Dr. Bailey (1994) argues that reputable breeding environments provide sufficient human contact for socialisation and waiting until the dog is older (ideally 10 weeks) provides a better insight into the individual puppy’s physical and psychological attributes. In general, the optimal time for re-homing a puppy is highly dependent on the provision of socio-environmental stimuli within the breeding environment and how this compares to the ongoing experiences and training that will be provided by the new owners.

Some studies have found that attendance at puppy training classes are beneficial in preventing problem behaviours associated with fear and/or aggression (Sterry, 2005) whilst there is also evidence to suggest that command training can guard against the development of problem behaviour (Campbell, 1974; Jagoe and Serpell 1996; Kobelt, 2003). Interestingly, Seksel et al. (1999) found that dogs attending puppy classes did show improved responses to training commands but the classes had no significant effect on the puppies’ responses to social stimuli or to novel or handling stimuli. In fact, the most reliable predictor of future reaction to novel stimuli was in fact the puppies very first reaction to the stimulus.

Whilst, it would also be inappropriate to conclude that all behaviour is predetermined before a puppy is even obtained by its new owner, it is important
to appreciate that the basic foundations of emotionality and future learning are already becoming established. Still, training and behaviour specialists must work with what they are presented with and, whilst it is not possible to change the dogs genetics or its early environment, it is essential to formulate appropriate training programmes that take into consideration this background information (if it is known). This includes an appreciation of various breed traits and the developmental differences between breeds; the dog’s natural temperament (emotionality) as a product of its genetics and early learning; and the dog’s learning history to date. Of utmost importance is the trainer’s role in guiding the owner, helping them to understand their dog and establish realistic expectations and goals whilst supporting them as they work towards those goals.

For those providing training for puppies, it is especially important that problems are identified quickly and owners are given preventative and management advice. The owners of puppies already showing problems will need extra care and attention and very careful management of their puppy’s ongoing experiences, especially in a class situation. Other warning signs will include: puppies of breeds/types that you anticipate to be poor match to the owner’s lifestyle; puppies purchased from sub-optimal environments (most notably non-domestic breeding environments); puppies purchased later than normal (towards the end of the sensitive period or later) and puppies who have been ill or their vaccination programme has been delayed.

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