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Individual and group level trajectories of behavioural development in Border collies

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ABSTRACT

In order to assess dogs' personality changes during ontogeny, a cohort of 69 Border collies was followed up from six to 18–24 months. When the dogs were 6, 12, and 18–24 months old, their owners repeatedly filled in a dog personality questionnaire (DPQ), which yielded five personality factors divided into fifteen facets. All five DPQ factors were highly correlated between the three age classes, indicating that the dogs' personality remained consistent relative to other individuals. Nonetheless, at the group level significant changes with age were found for four of the five DPQ factors. Fearfulness, Aggression towards People, Responsiveness to Training and Aggression towards Animals increased with age; only Activity/Excitability did not change significantly over time. These changes in DPQ factor scores occurred mainly between the ages of 6 and 12 months, although some facets changed beyond this age. No sex differences were found for any of the tested factors or facets, suggesting that individual variation in personality was greater than male/female differences. There were significant litter effects for the factors Fearfulness, Aggression towards People and Activity/Excitability, indicating either a strong genetic basis for these traits or a high influence of the shared early environment. To conclude, from the age of six months, consistency in personality relative to other individuals can be observed in Border collies. However, at the group level, increases in fearful and aggressive behaviours occur up to 12 months and for some traits up to two years, highlighting the need for early interventions. Follow-up studies are needed to assess trajectories of personality development prior to six months and after two years, and to include a wider variety of breeds.

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1. Introduction

The notion that behavioural traits remain consistent over time is at the core of most definitions of personality (e.g. [Bergmüller and Taborsky, 2010](#); [Stamps and Groothuis, 2010](#)). Nonetheless, even if individual behavioural differences remain stable over the short term, developmental processes can have major impacts on behaviour across contexts and time, and thus lead to long-term changes in personality ([Stamps and Groothuis, 2010](#)). In humans, an individual's personality continues to develop throughout his/her lifetime but becomes increasingly more stable with age ([Roberts](#)

and [DelVecchio, 2000](#)). A meta-analysis indicated that rank order consistency (i.e. expression of personality traits relative to other individuals) increases from childhood (average trait consistency: 0.31) up into the fifties to seventies (average trait consistency: 0.74; range 0–1 with 1 corresponding to complete consistency, [Roberts and DelVecchio, 2000](#)). While individuals thus become more consistent in the expression of their personality as they get older, people in general also become less neurotic, extroverted and open, but more agreeable and conscientious with age ([McCrae et al., 2000](#); [Srivastava and John, 2003](#)).

Surprisingly little is known about the development and consistency of individual behavioural differences in non-human animals and which factors may influence them at any given time ([Stamps and Groothuis, 2010](#)). In captive rhesus macaques (*Macaca mulatta*), some correlations in social behaviour between the ages of 8, 16, and 52 weeks ([Stevenson-Hinde et al., 1980a](#)) were found, indi-

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cating consistency at early ages. However, the same authors found no correlation using the same behavioural tests conducted once at the age of one year and repeated at 2.5 years (Stevenson-Hinde et al., 1980b). Moreover, while ratings of confidence were stable at all ages, ratings for excitability showed no consistency until adulthood and those for sociability became stable only after the age of three years, demonstrating that stability was also dependent on the trait in question (Stevenson-Hinde et al., 1980a). Similarly, in domestic cats (*Felis catus*), behavioural consistency between the age of 4 months, 1 and 2 years was variable for different traits, with boldness being one of the most consistent traits (Lowe and Bradshaw, 2001). Partial consistency of some traits (e.g. social behaviours, fearfulness and reactivity to humans) but not others (e.g. behaviours in novel object tests and responses to handling) was reported also for young horses (*Equus caballus*) that were tested between the ages of 8–11 months and 1.5–2.5 years (Lansade et al., 2008a,b; Visser et al., 2001). These studies indicate that at least some specific traits may be consistent when assessed over short time intervals, but not necessarily over long time periods.

Given the close relationship between people and domestic dogs (*Canis familiaris*), studies on dogs' behavioural development are of especially high interest due to their implications for matching puppies, juvenile or adult dogs with the right owners, identifying predispositions towards behavioural problems early on, and predicting suitability for service dog work, police or military service. A recent meta-analysis suggested that personality is moderately consistent in younger dogs (<1 year of age when tested for the first time, $r=0.30$), and that consistency increased with age ($r=0.51$ in dogs >1 year of age when tested for the first time) (Fratkin et al., 2013). Based on the currently available literature and in conjunction with our own results, testing at an early age (<3 months) yields little predictive validity regarding future behavioural traits, although it may play a role in identifying negative extremes (Riemer et al., 2014a). Apart from the sensitive period between 4 and either 8 (Lord, 2013) or 12–14 (Freedman et al., 1961; Scott and Fuller, 1965) weeks, we also pointed to the importance of experiences during the adolescence period in determining the adult animal's behaviour (Riemer et al., 2014a). However, much of the literature on behavioural development in dogs focuses on behaviour in puppies younger than three months and then again on adult dogs (e.g. Asher et al., 2013; Svobodova et al., 2008; Wilsson and Sundgren, 1997a), largely neglecting the adolescent period, with a few exceptions discussed below.

Goddard and Beilharz (1984) found some correlations between dogs' behaviour at 3, 4, 6 and 12 months of age and adult fearfulness, but the older the dogs became, the more reliable were the assessments (Goddard and Beilharz, 1984). Sforzini et al. (2009) found that self confidence increased from 5 to 9 months in 32 German shepherd dogs that were trained as customs working dogs. In those dogs that were selected to continue training, re-assessments at 24 months showed an increase in attentiveness, self-confidence, and ability to solve problems and retrieve objects and a decrease in playfulness. Harvey et al. (2016) tested 93 Labrador dogs destined to become guide dogs, first at 5 and again at 8 months of age. They found that several behavioural measures, including jumping, barking, low posture during greeting and mouthing, but not those related to obedience, were significantly correlated between the two age classes. Results from both tests were found to be predictive of future qualification as guide dogs. Harvey et al. (2016) do not, however, report if and in what direction behavioural changes occurred at the group level.

There is also a lack of longitudinal data on individual behavioural development in dogs. The few studies that used behavioural tests were limited to the specific stimuli presented in those tests, which were typically identical for the initial test and re-tests (and were thus no longer novel during re-testing, e.g. Harvey et al., 2016;

Sforzini et al., 2009). Moreover, some studies used a biased sample in their later assessments by re-testing only those dogs that had passed the previous evaluations (e.g. Sforzini et al., 2009). One published longitudinal questionnaire study that has demonstrated high temporal consistency in dogs was limited to a single trait, impulsivity (Riemer et al., 2014b). Similarly, cross-sectional questionnaire studies have addressed only a small selection of behavioural traits. For example, these indicated increases in calmness (Kubinyi et al., 2009) but decreases in trainability (Kubinyi et al., 2009) and sociability with age (Bennett and Rohlf, 2007; Kubinyi et al., 2009). There are, however, some inconsistencies between studies: some authors report that anxious behaviours decrease (Bennett and Rohlf, 2007) or boldness increases with age (Strandberg et al., 2005), whereas others found a decrease in boldness as dogs got older (Kubinyi et al., 2009; Starling et al., 2013). Thus, it is currently not known from what age individual differences in behaviour can be reliably characterised in dogs, when personality as such stabilises or whether each trait stabilises at a certain point and independently from others.

Therefore behavioural development was studied in a cohort of Border collies. The main aims were firstly to assess to what extent personality is consistent (relative to age mates) during different periods of development (at the ages of 6 months, 12 months, and 18–24 months) and secondly to assess in what manner behavioural traits change from adolescence at 6 months to young adult age at 1.5–2 years. To this end, we asked the dogs' owners to fill in a dog personality questionnaire at three points in time, when their dogs were 6 months, 12 months and 18–24 months old.

2. Methods

2.1. Subjects

To rule out effects of breed differences in the ontogeny of behaviour (e.g. Feddersen-Petersen, 1990; Miklósi, 2008; Scott and Fuller, 1965; Scott, 1958; Seksel et al., 1999), only members of a single breed, the Border collie, were included in the study. The choice of breed was made by convenience as this is a common breed in Austria, and contact with the dog owners was established mainly through Border collie breeders who already cooperated with the Clever Dog Lab in other studies. The Clever Dog Lab is popular with Border collie owners due to the high need for mental stimulation in this breed, and several subjects of the current study also participated in other research (e.g. Müller et al., 2016; Riemer et al., 2014a,c).

The owners of 84 dogs volunteered to participate in the study by filling in questionnaires about their dogs' behaviour when the dogs were approximately six, 12 and 18–24 months old. The ratio of female to male respondents was 63: 18, of which three female respondents filled in the survey for two dogs. The dogs (46 females, 38 males) came from 23 litters from 17 breeders, with between one and seven subjects per litter. Except for the litter mates, the sample did not contain full or half siblings. Demographic data were available for 64 of the subjects. Of these, 18.8% lived with single adults. Thirty-seven point five percent came from households with two adults and no kids, 14.1% from households with 3 or 4 adults, 25% from households with two adults and 1–3 children, 1.6% from a household with 3 adults and one child, and 3.1% from a household with one adult and 1 or 2 children. 42.2% of the dogs were the only dog in the household; 28.1% shared their home with one other dog, and 29.7% came from households with three or more dogs. The owners of 90.6% of the dogs indicated that their dogs were kept as a member of the family or companion. 71.9% of the dogs were kept for sports (including agility, obedience, search and rescue, occasional sheep herding etc.), 3.1% for working (sheep herding), and 7.8% for breeding purposes (multiple responses were possible). 35.9% of the

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