The owners' assessment of "everyday dog memory"

A questionnaire study

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In a questionnaire study we surveyed the owners of 113 companion dogs. Owners had to mark on a four-grade scale how long their dog remembered particular memory items (persons, other animals, events, objects). Additionally we collected descriptive data on the demographical characteristics of the dog and the keeping conditions. A principal component analysis on the memory items resulted in five components. From these, two were connected to people ('Family' and 'Intruders'), three other components contained individual items of memory of objects and events ('Going out', Playing' and 'Doing something'). Analyses of variance revealed that the dog-owner relationship, the keeping conditions, age and breed of the dog affect the dogs' memory as described by the owner. The amount of time spent together or the education of the owner had no or minimal effect on these components. Our study showed that owners form stable opinions about their dogs' episodic memory capacity. Nevertheless, the results can be biased by such factors that affect either the owners' opinions about their dog-companions, or the dogs' access to particular stimuli, which can modify the formation of memory traces. In the future, these results can serve as a starting point for empirical testing of family dogs' memory.

Keywords: dogs; dog owners; memory; questionnaire

1. Introduction

So far, there is only scattered evidence for memory in dogs both in connection with the physical and social environment. Nevertheless, investigating the spatial memory of dogs, more precisely the use of different cues during the recovery of hidden objects has an ecological relevance in this species. Various canid species cache their surplus food mostly by burying it under the ground (foxes: Jeselnik & Brisbin

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1980; wolves: Phillips et al. 1990). There are plenty of (anecdotal) observations, that similarly to their wild relatives, dogs tend also to bury food and other objects that they may recover later. In the laboratory, dogs solve higher level object permanence tasks where they have to find invisibly displaced objects (Fiset et al. 2000; Watson et al. 2001). With the introduction of occluders, delays and dark periods between the hiding event and the onset of the dog's search, at least some dogs perform this kind of task with a capacity for true object permanence rather than using simpler perceptual/ conditioning mechanisms (like staring continuously at the correct hiding location) (Miller et al. 2009). Note, however, that in experiments the dogs had to remember only for short periods (15–30 s). In radial maze tests, where the task was to find hidden food with the lowest possible number of visits to the arms of the maze, dogs used the 'win-shift' (meaning: avoid those locations where the animal found reward earlier) rule rather than the 'win-stay' (meaning: re-visit those locations where the animal found reward earlier) method (Macpherson & Roberts 2010). Dogs rely on spatial (i.e. location-based) rather than on figurative (i.e. visual discriminatory) cues during their search behaviour (Dumas 1998). Dogs can use allocentric information during the recovery of hidden food rewards; they remember landmarks and metric information (Fiset et al. 2007).

Being a highly social species, one would expect dogs to remember their socially relevant conspecifics. Female dogs can recognize their offspring not only when they are still nursing, but also two years later, even if they lived separately in the meanwhile. Dog puppies also remember their mother for years. Interestingly, however, adult siblings can recognize each other only if they were living continuously with at least one of the siblings (Hepper 1994). This indicates that the offspring-parent related memory is stored and/or processed differently than the sibling related memories. Besides the social relationship with their conspecifics, dogs are unique even among other domestic species in that they live predominantly in the permanent companionship of humans. From the viewpoint of human sociology, Irvine (2004) examined through qualitative observations the characteristics of canine (and feline) memory in relationship to human-animal bond and interactions. At the same time, there is still a need for more empirical studies regarding the human-related memory capacity of dogs. Their special relationship with humans is characterized by strong social bonds to their owner (or caregiver), a phenomenon thought to be analogous to the attachment between mother and child (Topál et al. 1998). Attachment-like behaviour can be elicited from any dog with an owner, and it also emerges in dogs at dog shelters after a relatively short exposure to an unfamiliar human (Gácsi et al. 2001). There is thus no doubt that dogs must be able to form memories of particular humans in their environment.

As an addition to the above-mentioned very specific domains of dog memory that were proven to be testable with empirical methods, the every day life of an animal may involve a continuous string of events, which require prospective and/or retrospective memory capacity. In his recent paper, Zentall (2010) summarized how these types of memories can be tested in pigeons with meticulously designed learning tasks. However, specific events that occur unexpectedly and/or very sporadically might also shape a dog's memories about the past. The effect of these events can be recognized in the dogs' behaviour, but because of the nature of the high level of individual variability of the past events and the surrounding environment of the particular dog, a standard testing method would be very hard to devise. However, dogs live in large numbers as companions of humans in western societies, and therefore the owners, who share their life with these companions, may provide reports about the nature and duration of memory in dogs. Because of the often very intimate dog-human relationship, human owners represent a unique source of information about their dogs. Although these kinds of data (predominantly gained by questionnaires) should be used very cautiously as it is usually biased by the observational errors, opinions and emotions of the owners, nevertheless the observations of the dogs' closest human companions be not be underestimated. Questionnaire studies of dogs have usually been conducted when the studied phenomena (a) happen sporadically and mostly at home (for example events of dog-aggression: Hsu & Serpell 2003; Hsu & Sun 2010; attention deficit: Vas et al. 2007; separation anxiety: King et al. 2004); or (b) when the capacities under investigation can be mostly observed by the owners (for example dog-dog and dog-owner play patterns: Rooney et al. 2000; and 'understanding' of human verbal utterances: Pongrácz et al. 2001). In addition, this methodology shares a common ground with that applied in the case of children and their parents. In order to verify memory skills (or to detect possible neurological deficiencies) parents are asked to fill in questionnaires about their children's memories (Drysdale et al. 2004; Gonzalez et al. 2008).

Regarding long term memories of past events raises the question whether episodic-like memory could be investigated in dogs. The general difficulty in testing animals' capacity of episodic memory comes partly from the fact that scientists do not agree whether such types of memory exist in nonhuman animals (for a review see Clayton et al. 2003; Schwartz et al. 2005). Following the well-known description of episodic memory (in humans) by Tulving (1972), this subset of declarative memory deals with such events, where the time ("when"), the actor(s) ("who") and the location ("where") can all be retrieved. Although this approach offers a practical way to test episodic-like memory in non-human species as well (see for example in great apes – Menzel 1999; and Schwartz et al. 2002; scrub

jays – Clayton and Dickinson (1998)), there are also doubts whether the effect of training and/or forming expectations about the tasks involved can be avoided in such experiments (Zentall et al. 2008). In this latter case rule-based memory would take over instead of episodic memory, and there is little evidence (but see Zentall et al. (2001) in pigeons, and Mercado et al. (1998) in dolphins) that animals show inevitable signs of episodic-like memory where rule-based memory can be eliminated as a mechanism.

Dogs represent a specific opportunity to use extensive human experience of events that can highlight memory skills in this species. In this present paper we report the results of the first questionnaire survey conducted on dogs' long term memory. These results obviously cannot be regarded as evidence of any form of episodic-like memory capacity of the dog, rather as the everyday manifestation of the memory skills of an animal species that is closely observed by people who live in tight social bonds with their companion dogs. We are using this method to get a general overview of the nature of dog memory. The findings of this survey may provide the foundation for more experimentally oriented studies.

2. Methods

2.1 Subjects

Hungarian pet dog owners were asked to fill in our questionnaire. During the formation of our convenience sample we used only one limitation during the selection of the participants: the dogs had to live with their owner for at least six months at the time of completing the questionnaire. Otherwise we included all dogs, regardless of their age and breed. For this report we collected 113 questionnaires on individual dogs.

2.2 Procedure

For the study we used a questionnaire that was distributed via email and personal encounters with dog owners at various locations. One of the authors (V.B.) was available to assist while dog owners filled in the questionnaire; with the email version a detailed instruction sheet was sent out.

The questionnaire (see Appendix) consisted of two parts: (1) basic data of the dog and the owner; (2) memory evaluation. In the latter, we asked the dog owners to give their opinion about the memory span of their dog in several categories. These categories (i.e. what the dog can remember) were established as the result

of a pilot study. In the pilot study we did not suggest any categories to the owners (N = 20), but asked them to list those things, persons, events that they thought their dogs could remember.

We offered four options on the memory span to owners: (the dog) does not remember at all; he/she remembers for a short time; he/she remembers for a long time; he/she does not forget something.

Before the statistical analyses, we converted some of the descriptive variables to categories. These were the following:

- **Breed of dogs** – we sorted the dogs to three categories: (1) purebred dogs, with an original function of cooperative interaction with humans (like herding dogs, gundogs, lapdogs) (N = 49); (2) purebred dogs, with an original function of working independently (like sled dogs, terriers, live stock guarding dogs) (N = 35); (3) mixed breed dogs (N = 29). (Note that many mixed breed dogs can show strong resemblance to particular purebred breeds both in look or behaviour. However as any confirmation of the exact origin and characteristics of mixed breed dogs would be way beyond the scope of this article, we decided to group all mixed breed dogs into one category.)
- **Pedigree** – we formed three categories: (1) Dogs with pedigree (N = 31); (2) purebred dogs without pedigree (N = 53); (3) mixed breed dogs (N = 29).
- **Age of dogs** – we formed three categories: (1) younger than 24 months (N = 22); (2) age between 24 and 72 months (N = 42); (3) older than 72 months (N = 49).
- **Status of the dog in the family** – four categories were formed, according to the answers of the owners: (1) regarding the dog as a family member (N = 51); (2) regarding the dog as a child (N = 9); (3) regarding the dog as a friend (N = 29); (4) regarding the dog as a domestic animal (N = 24).
- **Keeping conditions of the dog** – three categories were formed, according to the answers of the owners: (1) the dog is kept in the flat (N = 20); (2) the dog is kept in the flat and in the garden (N = 39); (3) the dog is kept in the garden or in a kennel (N = 54).
- **Number of previously owned dogs** – three categories were formed: (1) this is the first dog of the owner (N = 32); (2) this is the second dog of the owner (N = 26); (3) the owner had more than one dog previously (N = 55).
- **Educational status of the owner** – three categories were formed: (1) elementary or technical school (N = 15); (2) high school (N = 63); (3) college / university (N = 35).
- **Time spent with the dog daily** – three categories were formed: (1) less than 3 hours (N = 38); (2) 4–12 hours (N = 54); (3) more than 12 hours daily (N = 21).
- **Time spent daily with the dog engaged in joint activity** – two categories were formed: (1) maximum 1 hour (N = 41); (2) more than 2 hours daily (N = 72).

2.3 Statistical analyses

In carrying out the statistical analysis, we first compared the memory span of dogs among the individual items (Friedman test with Dunn's post hoc test for non-Gaussian distributions). In the next phase we performed a two-step statistical procedure. In the first stage, a principal component analysis (PCA) was run to find out whether there are significant associations among the items regarding the owners' opinion about their dogs' memory. According to Dowling-Guyer and colleagues (2011) PCA is an exploratory data reduction technique used when the goal is to reduce a large number of variables to related and coherent sub-sets that are relatively independent of each other (Tabachnick & Fidell 1989). The items in each sub-set (components) are correlated with each other but are generally not correlated with other components; each component is thought to reflect an underlying construct (e.g. traits). The PCA was used with Varimax rotation with Eigenvalue >1 and the number of extracted components was decided also by the eigenvalue-rule (Kline 1994). Factor scores were calculated automatically by the SPSS software using the Regression method. Cranach's alpha was calculated to assess the internal consistency of extracted factors and for testing the repeatability of the questionnaire (DeVellis 1991). In the second stage we performed analysis of variance (ANOVA) on the factor scores that originated from the principal component analysis.

3. Results

We found significant differences among the memorability values of the individual memory items (Friedman test, $K^2(113,24) = 698,48$: $P < 0.001$). Because of the large number of comparisons, we considered a difference between two items significant only if the *P*-value was less than 0.001 (Dunn's post hoc test) (see Table 1). Individual memory items can be sorted into three main groups. Owners reported that their dogs basically do not forget the 'owner', 'family', 'leash', 'food' and the 'neighbor'. At the opposite pole, dogs remember 'pain', 'separation', 'unfamiliar dogs' and 'strangers' only for a short time. All the other individual memory items fall between these two extremes, in other words owners think that their dogs remember these for a longer time interval.

Table 2 shows the results of the principal component analysis. Five components were extracted from the significant associations in the individual questions about dogs' memory span. These five components were named after the common characteristics of the memory items that belong to them ('Going out', 'Family', 'Doing something', 'Playing' and 'Intruders'). The components were based on coherent items of memory; however, there are also some somewhat surprising

Table 1. Significant differences between the span of the individual memory items (Friedman test with Dunn's post hoc test, P > 0.001). Items printed in **bold** are followed by those items in the next column, which have significantly shorter memory spans, reported by the owners

owner	car cat place vet activity postman object punishment scary thing animals pain separation unfamiliar dog stranger	**familiar dog**	punishment animals pain separation unfamiliar dog stranger
		walk	punishment animals pain separation unfamiliar dog stranger
family	place vet activity postman object punishment scary thing animals pain separation unfamiliar dog stranger	**feeding**	punishment animals pain separation unfamiliar dog stranger
		ball	animals pain separation unfamiliar dog stranger
leash	postman object punishment scary thing animals pain separation unfamiliar dog stranger	**car**	pain separation unfamiliar dog stranger
		cat	pain separation unfamiliar dog stranger
food	postman object punishment scary thing animals pain separation unfamiliar dog stranger	**place**	unfamiliar dog stranger
		vet	unfamiliar dog stranger
		activity	stranger

(*Continued*)

Table 1. (Continued)

neighbor	punishment	**postman**
	scary thing	**object**
	animals	**punishment**
	pain	**scary thing**
	separation	**animals**
	unfamiliar dog	**pain**
	stranger	**separation**
play	punishment	**unfamiliar dog**
	animals	**stranger**
	pain	
	separation	
	unfamiliar dog	
	stranger	

results. Food and feeding were not included in any of the components, and neither were purely unpleasant memory categories, like punishment and pain. Interestingly, questions related to other dogs (familiar or unfamiliar) were not included either. A Friedman test comparing the memorability of the five components did not reveal any difference ($Chi^2(5,113) = 1.66$, $P = 0.80$).

Table 2. Results of the principal component analysis. Items with loadings less than 0.5 were excluded

Factor	Factor's name	Questions/Items	Load	Variance explained (%)	Reliability (Cronbach α)
1	Going out	Leash	0.824	25.7	0.69
		Vet	0.862		
		Walk	0.681		
2	Family	Owner	0.934	14.1	0.89
		Family	0.931		
3	Doing something	Activity	0.737	12.0	0.68
		Place	0.791		
		Object	0.688		
4	Playing	Ball	0.867	11.5	0.75
		Play	0.862		
5	Intruders	Stranger	0.811	9.8	0.52
		Postman	0.792		

There is a clear distinction between components related to people who belong to the dog owner's family (including the owner him/herself) and other people (including the 'postman'). The latter component therefore was named 'Intruders', referring the somewhat hostile reaction of dogs to these people. Another interesting distinction can be observed among the memory items related to 'pure' playing activity (including the 'ball') and items that are related to more various (but usually 'not-play') activities. While the 'objects' in the 'Do something' component may have unpleasant memories according to the owners' reports (like ones which caused accidents related to the dog), the 'Playing' component includes only the 'ball' as object, which can be considered a mostly positive memory category. Although most of the 'positive' memory items were characterized with longer memory spans by the owners (see Figure 1), there was no significant difference between the memory spans of the 'positive' (like 'ball' or 'play') and the sometimes 'unpleasant' (like 'object') items (see Appendix).

The components derived from PCA do not necessarily contain exclusively 'pleasant' or 'unpleasant' memory items. A good exemplar for this is the 'Going out' component. While people mostly consider leash and walking as positive memories for dogs, this factor includes the 'vet' also, who usually evokes evasive reactions from the dogs in the owners' opinion. Therefore this component comprises

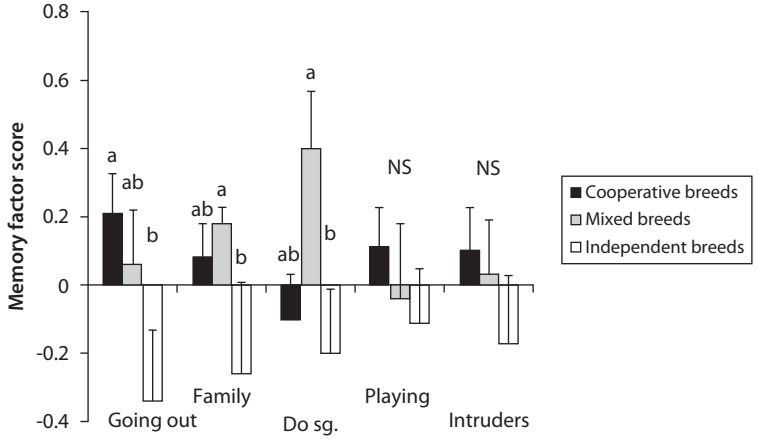

Figure 1. The effect of the dog breed on the memory components. Factor scores are not the same as the original memory values given by the owner, but they were calculated during the Principal Component Analysis. However, factor scores mirror the memory span: lower factor scores mean shorter memory, and higher factor scores mean longer memory. Significantly differing columns are marked with different letters. NS = no significant effect was found on the given component

memory categories with possibly different emotional backgrounds, however all of them are related to leaving the home.

We performed one-way ANOVAs (with Bonferroni post hoc tests) based on the score values of the previously detected five components (see Table 3). From the several fixed variables the 'Time spent with the dog daily' and the 'Time spent in joint activity daily' did not have a significant effect on any of the PCA components. We found the strongest effect in the case of the following fixed variables: 'Dog breed', 'Keeping condition' and the 'Status of the dog'. Each of these affected three of the five memory components. The independent working breeds had reportedly the shortest memory span in the case of the 'Family', 'Going out' and 'Doing something' components. Cooperative breeds had the longest memory span in the case of 'Going out', while for mixed breeds, owners reported the longest memory in the case of the 'Family' and 'Doing something' components (see Fig. 1). In relation to 'Keeping conditions' dogs kept in the garden alone had reportedly the longest memory span in the case of the 'Family' and 'Intruders', while just the opposite was true for the 'Going out' factor: here dogs kept in the house alone had the longest and dogs kept in the garden had the shortest memory span in the owners' opinion (see Figure 2). In the case of the 'Status of the dog' those dogs considered by their owners as 'domestic animals' had reportedly the shortest memory span for the memory factors 'Going out', 'Play' and 'Do something' (see Figure 3).

Table 3. Results of analysis of variance on the factor scores of owners' opinion about dogs' memory. One-way ANOVA with Bonferroni post hoc tests (* unpaired t-test). **Bold letters** mean significant effect

Fixed variable	Dependent variable	Degrees of freedom	F	p
Dog breed	**Going out**	**2,110**	**3.36**	**0.04**
	Family		**6.45**	**0.01**
	Doing something		**3.34**	**0.04**
	Playing		1.06	0.37
	Intruders		1.82	0.17
Pedigree	Going out	**2,110**	1.82	0.17
	Family		1.04	0.35
	Doing something		**3.51**	**0.03**
	Playing		0.01	0.99
	Intruders		0.35	0.71

(*Continued*)

Table 3. (Continued)

Fixed variable	Dependent variable	Degrees of freedom	F	p
Age of dog	Going out	**2,110**	0.18	0.83
	Family		**5.08**	**0.01**
	Doing something		1.13	0.33
	Playing		0.03	0.97
	Intruders		**5.42**	**0.01**
Keeping conditions	**Going out**	**2,110**	**4.72**	**0.01**
	Family		**4.28**	**0.02**
	Doing something		2.20	0.12
	Playing		1.33	0.27
	Intruders		**6.77**	**0.01**
Time spent with dog	Going out	2,110	1.78	0.17
	Family		2.80	0.07
	Doing something		2.75	0.07
	Playing		1.64	0.20
	Intruders		0.23	0.80
Common activity*	Going out	111*	1.66	0.10
	Family		1.27	0.21
	Doing something		0.26	0.80
	Playing		1.38	0.18
	Intruders		0.33	0.74
Previous dogs#	Going out	**2,110**	0.54	0.58
	Family		1.31	0.27
	Doing something		**4.27**	**0.02**
	Playing		1.06	0.35
	Intruders		0.99	0.37
Status of the dog	**Going out**	**3,109**	**6.61**	**0.001**
	Family		0.41	0.75
	Doing something		**3.91**	**0.01**
	Playing		**2.66**	**0.05**
	Intruders		2.20	0.09
Owner's education	Going out	**2,110**	0.66	0.42
	Family		1.46	0.24
	Doing something		**5.21**	**0.01**
	Playing		0.08	0.92
	Intruders		0.95	0.39

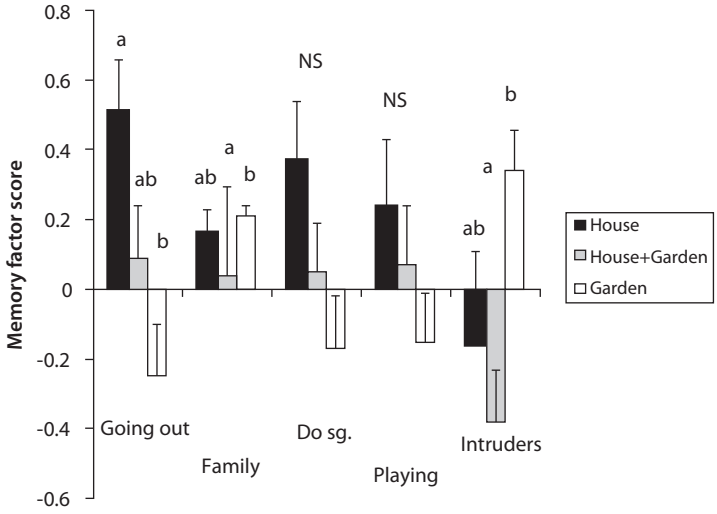

Figure 2. The effect of the dogs' keeping conditions on the memory components. Factor scores are not the same as the original memory values given by the owner, but they were calculated during the Principal Component Analysis. However, factor scores mirror the memory span: lower factor scores mean shorter memory, and higher factor scores mean longer memory. Significantly differing columns are marked with different letters. NS = no significant effect was found on the given component

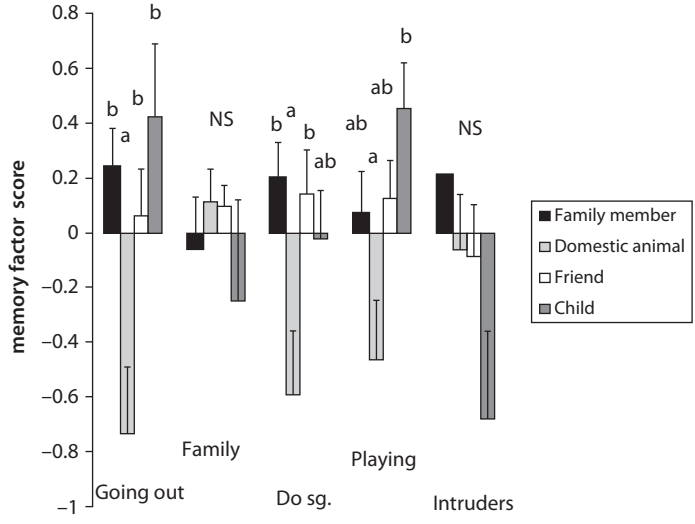

Figure 3. The effect of the dog's status on the memory components. Factor scores are not the same as the original memory values given by the owner, but they were calculated during the Principal Component Analysis. However, factor scores mirror the memory span: lower factor scores mean shorter memory, and higher factor scores mean longer memory. Significantly differing columns are marked with different letters. NS = no significant effect was found on the given component

The age of the dog had a significant effect on two memory factors. Dogs younger than 24 months had reportedly the shortest memory span in contrast to the two other groups of older dogs in the case of 'Family' and 'Intruders' (see Figure 4).

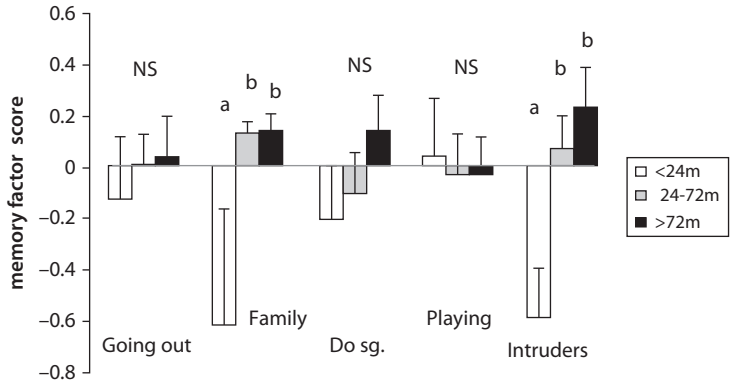

Figure 4. The effect of the dog's age on the memory components. Factor scores are not the same as the original memory values given by the owner, but they were calculated during the Principal Component Analysis. However, factor scores mirror the memory span: lower factor scores mean shorter memory, and higher factor scores mean longer memory. Significantly differing columns are marked with different letters. NS = no significant effect was found on the given component

Furthermore, three fixed factors (Pedigree, Number of previously owned dogs, Owner's education) had a significant effect on only one of the five memory factors: 'Doing something'. In this category, purebred dogs without pedigree and dogs of owners whose highest education was elementary or technical school had reportedly the longest memory span, and interestingly in the case of the number of owners who had previously owned dogs, second dogs of the owners received the lower memory scores.

4. Discussion

The results of our questionnaire study showed that pet dog owners experience behavioural episodes in their dogs' everyday life that they consider as evidence for long term memory. We identified five principal components on the basis of our questionnaire. Two of these refer to different kinds of humans (family members, including the owner versus possibly disliked strangers). The three other components are mixed categories of objects and actions, focusing on playing, leaving the home and being engaged in some kind of activity. Some memory items have been excluded from this type of multivariate analysis if most owners

gave the same (low or high) score to that item, or, the item does not correlate with any of the other items.

Furthermore, particular characteristics of the dog-human relationship (keeping conditions, the status of the dog) and the genetic makeup of the dog (breed or mixed breed) had a strong effect on the observed/assumed memory capacities of the dogs. At the same time the more owner-related features (like the time spent together with the dog, joint activity with the dog, the owner's education level) had only little or no effect on the reported memory capacity of dogs. This suggests that the memory skills attributed to the dogs may be affected by the contextual variables related to the dog but to a lesser degree by the characteristics of the owner and his/her anthropomorphic attitude.

Importantly, the results of this paper are based on the personal reports of the dog owners. The data collected by our questionnaires gives information on how people experience the long or very long term memory of dogs that would be very difficult to reveal by other methods. Most of the memory categories comprise highly variable and individual events that would be hard to validate in a standardized environment. Fiset and colleagues (e.g. 2003, 2007) could test only relatively short term working memory capacities (up to 4 min), although in well-controlled laboratory experiments, on a higher number of subjects. To our knowledge only Beritashvili (1965) conducted experiments on long term memory ('image driven memory') in dogs. He found that the memory span in dogs can reach several months. The power of our study comes from the relatively high number of independent questions that provided enough data to find strong correlations among particular memory items, which in turn could be analyzed as independent principal components.

The method used in this study has close resemblances to the procedures used with young children to study their autobiographical memory, because in both cases researchers rely on the assistance of an adult person, who is in a close relationship with the research subject (child or dog). Conway and Rubin (1993) point out that autobiographical memory not only references the self, but also personally significant content, relating to personal meaning that emerges from emotion and motivation. This is also an important feature of our dog study, because the content of these memories is the result of motivationally and emotionally significant events in the dogs' lives (positive motivations in the case of the family and playing, negative inner states in the case of intruding strangers). Based on the owners' reports, it is clear that individual dogs make an impression on people as though they had memories that are highly specific to the individual animal, and/or particular events in an individual dog's past. This offers an interesting analogy between the individuality of memories in children and dogs. The autobiographical memory of young children can encompass specific episodes (episodic memory;

Tulving 2002) but also generalized scripts, i.e. memories of the structures of routine events (Tulving 1983). The latter do occur in young preschoolers even before autobiographical episodes (Nelson & Fivush 2004). Here we can discover parallels to the results of the dog questionnaire, as components of reported dog memory contain specific, or sporadic events (like going to the vet) as well as more generalized routines (like playing with a ball).

Following the framework of Schwartz et al. (2005) we hypothesize the possible existence of episodic-like memory in dogs, if future research can show that (1) dogs are able to establish memories based on a few, preferably one event instead of repeated encounters; (2) dogs display long retention times; (3) their recall is spontaneous or sudden, instead of the product of continuous updating; (4) dogs display the sense of 'pastness' that means that the memories should refer to a specific state in the past rather than the present circumstances. Many of the memory items in our questionnaire study may be based on regular encounters/updating, as for example feeding, or the familiar persons around the animal. However there were certain unique and possibly once-only events also, such as some kinds of pleasant or unpleasant encounter with a particular object, animal or place, which might be more plausible candidates for episodic-like memory items.

It is worth mentioning one more comparable aspect of the studies on children's autobiographical memory and the owners' reports concerning the dogs' memory capacity. It is the effect of the social environment. Harley and Reese (1999) found that, over time, children of mothers who provided more elaborations in conversations began to recall more information and indicated more interest and attention than children of less elaborative mothers. This means that mothers who engaged regularly in reminiscing 'games' with their children in a more interactive manner, positively affected the children's autobiographical memory skills. In our study we found partly the same pattern: although generally the time spent together with the dog did not affect the memory span, dogs regarded as 'only' domestic animals had reportedly the poorest memory capacity, while those dogs that had a more human-like status in the eyes of the owners (like a 'child' or 'friend') gave owners the impression that they had better memory. The question remains however, whether these results solely mirror the owners' opinions, or whether a more or less supportive social environment can indeed affect the memory performance of dogs. The former would be based on positive or negative bias due to anthropomorphism leading to erroneous estimation of memory capacities in dogs. The latter, however, raises interesting experimental issues concerning whether human social factors may affect episodic memory skills in dogs.

Our study showed for first time the possible existence of long term memory about various social and non-social items in dogs. It is important to mention

that if the owners' observations are correct about their dogs' behaviour, then the development, storing and recalling of such memories takes place autonomously in dogs, representing a clear distinction from the experimentally induced or trained skills in other tests. In the future, besides controlled ethological tests on some of the findings of this article, a thorough study to the relationship between the psychological profile of the pet owner and his/her interpretation of the pet's behaviour would be useful to test the possible biases caused by the particular human observer.

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Appendix

Dog Memory Questionnaire **Date:**

The dog

name:

sex: bitch – male

neutered or spayed: yes – no

if neutered or spayed, when was it done? Before 1 year of age, between 1 and 2 years of age, 3y, 4y, 5y, 6y, 7y or older

date of birth (mm.yyyy)

breed:

pedigreed: yes – no

The owner

name:

date of birth (OPTIONAL):

address (OPTIONAL): phone (OPTIONAL):

email:

education: primary school, tech school high school, college, university

occupation: employee, self employed, manager, student, retired, homemaker, unemployed, other

Was your dog trained to do any sports or work?	Does your dog have a title or did she/he passed any exam, or does he/she compete regularly?
obedience	Yes – no
Schutzhund	Yes – no
Agility	Yes – no
Hunting	Yes – no
Search and Rescue	Yes – no
Assistance (blind guiding, therapy)	Yes – no
Herding	Yes – no
Other (like)	Yes – no
None	

How long are you engaged actively with your dog daily – like walking, training, playing etc. (in hours)?

How long are you with your dog daily (in hours)?

How many dogs did you own earlier? 0, 1, 2, 3–5, 6 or more

You regard your dog as: a child, a family member, friend, playmate, colleague, a working animal, domestic animal, other.

Where do you keep your dog? Inside the flat, flat and garden/kennel, garden, in kennel or chained.

Do you go with your dog for walks? Yes – no

How old was your dog when you got her/ him? He/she was born at my home, 1 week, 2 week, 3w, 4w, 5w, 6w, 7w, 8w, 9w, 10w, 11w, 12w, 4 months, 5m, 6m, 7m, 8m, 9m, 10m, 11m, 12m, 13m, 14m, 15m, 16m, 17m, 18m, 2 years, 3y, 4y, 5y, 6y, 7years or older

Which kind of behavioral problems do you encounter with your dog?

Separation anxiety	yes – no
Aggression	yes – no
Fear of things	yes – no
Jumping up	yes – no
Noise sensitivity	yes – no
Excessive barking	yes – no
Too active	yes – no
Recall problem	yes – no
other: …….	

Guidelines for completing the memory questionnaire

In the next part we ask your opinion about the memory capacity of your dog. You will find different categories where you have to indicate how long your dog does remember those persons, animals, objects, etc. Please, indicate with an X the most appropriate memory span in each category. Choose no more than one option per category.

	Not at all	Short time	Long time	Does not forget
Cat				
Other animals				
Familiar dog				
Unknown dog				
Owner				
Family members				
Neighbors				
Strangers				
Postman				
Vet				
Car				
Leash/ collar				
Walk				
Ball				
Toys / playing				

	Not at all	Short time	Long time	Does not forget
Feeding time				
Food / bowl				
Separation				
Places *				
Activities *				
Objects *				
Punishment				
Pain *				
Scary thing *				

Note: In the case of categories that are marked with an *, please describe briefly the exact nature of the given category.

*Places:

*Activities:

*Objects:

*Pain:

*Scary things:

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