Deliverable 7.2

"Communicative interaction in specific collaborative tasks"

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LIving with **R**obots and int**E**ractive **C**ompanions

Department of Ethology

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CONTENT

1 INTRODUCTION

To our knowledge LIREC is the first ICT project in which the research on robotic behaviour is paralleled by ethological research. Although this situation is very advantageous, there is no experience on ways how ethology can and should inform researchers working on artificial agents. In LIREC we have planned for three phases. In the 1st phase we are concentrating on developing the basic tools for behavioural research, in the 2nd phase we will provide sophisticated behaviour analysis which is believed to make companion robots more believable, and finally, in the 3rd phase we will aim to compare the functioning robots with living companions under similar conditions.

Structure of this deliverable:

1. As a first step we had to work out **methodology** for this inter-disciplinary project in order to observe, study, compare and analyze behaviour (dog, human, robot…) effectively in collaboration with other WPs. This aspect is crucial because we need to find ways to quantify behaviour that is informative for companion robot research.

2. Next we had to identify aspects of behaviours which are important for companionship based on human-dog interaction. We suggest that the nature **of cooperative/ communicative interactions**, the **emotionality**, the **temperament and personality** are the most important targets of ethological research. These aspects of behaviour have been chosen after review of the relevant fields of ethology and robotics and following discussions of researchers involved in LIREC. We had to prefer those aspects of behaviour which play an important role in the dog-human relationship but have the potential to become realized in the behaviour of presently available robots in LIREC. Thus in any case we have to concentrate on the manifested behavioural traits in any form of dog-human interaction which can be implemented in robots, and hopefully also perceived by the persons who interact with these agents.

3. In cooperation with WP6 and other researchers we have started to design **scenarios** to establish the framework for investigating dog and robot behaviour in parallel contexts. The behaviour pattern displayed in these scenarios will be investigated from different points of view in order to arrive at describing the nature of human-dog interaction, the role of emotions, and the personality of the participants. In order to achieve this in a statistically reliable manner we need to test large uniform dog populations.

4. Based on the experiences of this first year of research we will outline the rough **plan for future work**. We identify a strategy how ethological observations can inform the design of behaviour for a robotic companion.

2 THE ETHOLOGICAL METHODOLOGY UTILIZED IN LIREC

2.1 The hierarchy of behavioural investigations

Keeping the main goals in mind LIREC has established a few "*Showcases*" which serve as a broad context ("a story") for behavioural investigations. These showcases are deconstructed into "*Scenarios*" which are detailed descriptions for possible interactions between the human and the robot within a showcase. Typically, the scenarios consist of a range of *elementary interactions*.

The role of WP7 is to identify possible scenarios within the showcase, replicate the behavioural interaction with human and dog, and provide a behavioural model for the dog's part in this interaction. This behavioural model will be used to inform designers of the robot behaviour in order to improve (enrich) the behavioural capacities of the artificial agent (see 2.2.). It is important that the interaction of human and dog should not be constrained by the scenario, that is, they should display naturally-occurring variability (richness) in social behaviour. For the future these scenarios will also serve as tools for comparison of human-dog and human-robot comparisons (see 2.3.).

2.2 Research strategies in behaviour modelling

2.2.1 Qualitative: Finding "interesting" displays for social interaction ("AIBO concept")

In terms of behavioural abilities the AIBO was the most sophisticated companion robot produced so far. Importantly, however, the AIBO was designed on the basis of typical dog behaviour (Arkin et al 2003). General knowledge on dog behaviour was then set in a hierarchical behavioural model by Timberlake's (2003) behaviour system model. This hierarchical model is based on "motivational processes" that help to organise and maintain behavioural output sequences and "perceptual-motor structures" that relate to species specific behaviour. The model discriminates four hierarchical levels: systems, subsystems, modes, perceptual-motor modules (see Figure X from Arkin 2003).

This approach shows the following constrains: (1) There was no wish to copy a particular breed or individual, AIBO performs behaviours that are usually described by people as dog-like. (2) The model is based on traditional ethological modelling of behaviour which aims to explain only species-specific ("inherited") behaviour. (3) The design of the model was not in any form facilitated by "real" data, that is, observation of dog behaviour. (4) As it can be seen the AIBO's model is designed for intra-specific interaction (e.g. it has got a sexual subsystem) but there are no aspects of the model which would control for interaction with humans. (5) As a result of all these deficiencies most people, even those with no direct experience of dogs, can easily see the obvious differences between the abilities of the AIBO and a real dog. In sum, the AIBO does not utilise a scientific method for collecting behavioural data for modelling, and it relies on "folk psychology" of dogs.

Nevertheless a well-qualified dog trainer can provide a lot of subjective insight on dog behaviour and forms of dog-human interaction in general. This approach can be extended by *ad libitum* observation on dogs and humans in various scenarios. Here is an example from an elementary social interaction:

Possible outcomes:
Observer reports a list of action types in relation to a specific context. For example:

When called the dog looks at the owner:

Action Owner: Fido!

Action Dog: (1) stops action, (2) head/face orientation toward owner's head/face

Implementation:
It is assumed that it is possible to program the robot in this way, that is, robot will have a head, will be able to turn it toward a sound source.

Disclaimer:
Importantly, if the robot will have no head, will not able to turn his head and/or localise sources of sound the whole "research" has no point. Further, the implemented behaviour may not be natural because we lack quantitative data on frequency (dogs may not always look at the human) and temporal structure (no data on how rapid the head turn etc should be) (see below).

2.2.2 Quantitative methods

The quantitative approach could be utilized at different levels and depth. Modern ethological research is based on observing a large number of subjects and a wide range of behaviours that are used to characterise the animal's reaction to environmental events. The results of such investigation can be formulated on the basis of statistically supported simple behavioural models. There two main aspects of this approach. (1) The sophistication of these behavioural models depends on both on the sample size and the number of observed behavioural variables. (2) The actual research question determines the choice of the statistical model.

2.2.2.1 Limited sample approach: "Focus group"

This method is an extension of the qualitative method described above, however it relies on collecting observational data on a few dogs in certain situation by objective methods (for more detail see D7.1.). These may be typical for certain types of interactions among dog owners and their dog (e.g. dog's for the disabled). Such observations reveal typically individual variations but the small sample size limits sophisticated statistical analysis.

In our present research this method was used for the behavioural analysis of *the "fetch and carry"* scenario (see below). We defined a protocol for measuring the behaviour of the dogs. We used a not very detailed behavioural ethogram and focused on some limited aspects of the interaction. The analysis is semi-quantitative, that is, the small number of individuals and observations do not allow for revealing the frequencies of behaviour, the effect of environmental events and nature of individual differences. No insight on the temporal dynamics of the interaction is gained. Here is an example from an elementary social interaction:

Possible outcomes:
Observer codes a list of action types chosen on the basis of subjective experience (e.g. joint attention, pointing gestures, verbal cue (type, number), duration of task, carrying 'style' (ahead-side-behind), O's position etc.). Observer reports that dogs frequently look for visual feedback at the owner, dogs go ahead of the owner (more typical for highly trained dogs) etc.

Implementation:
It is assumed that it is possible to program the robot to get and carry an object. The robot should be able to vary rapidly its speed in relation to the moving human. It is also able to determine his position relative to the human. The robot should also be able to react to commands (either verbal, or “text messages”).

Disclaimer:

Importantly, if the robot will lack any of the abilities listed above, there is not much point in running such experiments. The reported behaviours may well reflect specific aspects of the situation, but there is also a lack of quantitative data which may be needed for more “believable” programming.

2.2.2.2 Population based approach: Breeds and dogs in social environments

This method aims for a detailed description of the behavioural interaction in terms of variability in a given population, and may detect some sub-populations on the basis of intrinsic (e.g. dog breeds) or extrinsic factors (e.g. dogs kept in gardens). It is assumed that a large population will provide some insight of possible factors that may control some aspects of the interactive behaviour. This approach can focus on dogs with certain form of behaviour (breeds, e.g. German shepherds) or dogs representing a form of human-dog interaction (pet dogs, search dogs, police dogs etc).

In this case a large sample of dogs (N=60-100-120) is tested in a few limited general or more specific scenarios (e.g. greeting; localise hidden explosive). In addition independent variables are measured like dog age, owner gender etc. in order to account for the observed variability.

Possible outcomes:
This method offers two potential outcomes. First, a detailed behavioural description is possible based on an ethogram for both the human and the dog. The large sample size allows for more precise statistical analysis of the relationship between different variables both in terms of frequency and temporal relationship (see also below). Second, some effect of the independent variables can be estimated (e.g. the effect of owner’s gender on the certain behaviours of the dog).

Implementation:
It is assumed that it is possible to program to perform the same or some analogue form of actions as observed in the given scenario. This method offers a way to put in variability into the behaviour of the robot (parameter setting). For example, robot could behave differently toward man or women or the behaviour could appear more natural if it is controlled by an action model (program) which is developed on the basis of the quantitative data.

Disclaimer:
Importantly, if the robot will lack any of the abilities listed above, there is not much point in running such experiments. Similarly, such research is superfluous if the robot is not able to show the assumed variability in performing these actions.

2.2.2.3 Factorial approach: Effect of contextual factors

This method would aim for pinpointing certain important contextual factors which may influence behaviour of the dog (robot) in a given context. For example, in the case of the greeting scenario one could assume the effect of the following factors: (1) elapsed time since separation, (2) who left the other at the former separation, (3) are others present at re-union, (4) is the re-union expected or occurs unexpectedly, (5) familiarity of the partner (etc.). Thus one designs a factorial experiment testing the effect of one or more contextual factors on greeting behaviour. It is assumed that some of the factors may influence the quantitative and temporal structure of the interaction. Importantly, such studies rest also on a large overall sample size depending on the factors to be included (50-100 dyads).

Possible outcomes:
If we have a basic behavioural model of the greeting interaction (see above) such investigations could refine the working of the model because we may find that greeting behaviour is sensitive to the time since separation.

Implementation:
If the agent computes the time since separation this should influence its behaviour toward the human partner. Based on such research the "static" behaviour output becomes associated with certain extrinsic factors. The advantage is that the robot shows novel dimensions of sensitivity ("*flexibility*") in its behaviour.

Disclaimer:
Importantly, if the robot is not able to represent this level of sophistication, and the desired changes cannot be implemented, and such research may turn out futile. Obviously, we do not know in advance how and in what way one or another factor may (or may not) influence the "basic" pattern of the behavioural interaction.

2.2.2.4 Multivariate approaches: Structural modelling

This approach assumes that the behavioural variability can be explained by a few background (secondary) variables. Multivariate statistical methods offer the possibility for predicting such secondary variables which, then, can be used to design hypothetical behavioural models. Such approaches are very popular in personality research. Here the emphasis is on the reduction of variables and to explain personality by a fewer number of inner mental constructs (personality features, e.g. boldness) which determine general (situation independent) behavioural tendencies.

Interestingly, this approach has not been used to develop hierarchical behavioural models. For example the Timberlake's model described above could have been also devised on the basis of multivariate statistical analysis. However most aspects of behaviour subsystems are trivial constructs (e.g. "agonistic subsystem), thus any analysis to reveal such overall structuring of behaviour seems to be unnecessary.

This may not be the case in other situations when one looks in detail into the organisation of behaviour. For example, one well-known behavioural paradigm for describing the infant-mother relationship (attachment) is the so called Strange Situation Test (Ainsworth 1969) in which the infant and the mother is observed in a series of short episodes of social interaction and separation. This test was also applied to dogs and their owners (Topál et al 1998). However, in contrast to the human evaluation system, we modelled the behaviour of the dog by the means of a factor analysis, which revealed that there are three main inner controlling factors of the behaviour: boldness (to novel events), sociability (to strangers), and affection (to owner). This offers the possibility to build a behaviour model of "attachment" (the system) in dogs that is based on the existence of three subsystems which in turn controls a complex behavioural output a level of single action units.

Multivariate methods have the potential to be used also in the mental modelling of emotions. So far most behavioural models (in animals) are based on the supposedly innate emotional states described for humans. This approach offers a way of reverse engineering by first obtaining the behavioural data, and then designing the model for emotional control.

At present we have applied this approach to modelling the personality of dogs. We assume that the individual character of the partner ("personality") which is stable over (certain) situations and over (certain) time frame has a crucial influence on the quality of the interaction. Thus we have to determine possible aspects of personality (both in humans and dogs) that could be important in the chosen scenarios. The human personality can also be important from the prospective user's point of view (certain users may prefer certain type of robots). Having a way of evaluating personality dimensions experiments with participants representing the two ends of a spectrum could be staged. Importantly, the effect of personality should be revealed across situations, that is, the dyads have to be tested in at least 2 or 3 scenarios. Such studies rest also on a large overall sample size depending on the factors to be included (50-100 dyads).

Possible outcomes:
It may be revealed that certain aspects of the behaviour are characteristic in different scenarios. This may influence how the basic behavioural model of the robot has to be changed, in a way that it controls now more general aspects of actions which are partially independent from any given scenario. For example, individuals scoring high on "openness" (Big 5) may show interest in new things (rapid approach, much exploratory behaviour) but also would distance themselves more easily from others.

Implementation:
Such research could modify partly or extensively the behavioural model of robot. Potentially this research could achieve that the robot is viewed as an "individual" because the observer can "sub-consciously" sense some integrity in the behaviour of the robot across scenarios ("*robustness*").

Disclaimer:
Importantly, if the robot is not able to represent this level of behavioural sophistication, and the desired changes cannot be implemented, such research may turn out futile. In similar vein, effects of personality (in the robot) cannot be revealed because there is a limitation for different scenarios in which the robot can be tested.

2.2.2.5 Multivariate approaches: Contingency, congruence and timing

The time dependent analysis of behaviour has a long history of the behavioural sciences. In the simpler case researchers are interested in how behaviour is organised in time. In more complex situations researcher study the type of synchronisation between interacting partners. This may be of particular interest in the present case because the "believability" of social interaction rests to a large extent on the perceived dynamics of the partner. For example the detection of behaviour contingency in social interaction plays important role in infants' learning about the social partners in their world (Gergely and Watson 1996).

However, this interest on the part of the behaviour sciences was hampered by the complicated and also constrained mathematical and statistical models that were available to model behaviour in time (e.g. Markov chain). Most models could make only very simple predictions, and even for this they needed a relatively large amount of data.

In previous work (e.g. Kerepesi et al 2005) we analyzed the temporal dynamics of behavioural interaction between dog and owner. This approach provided useful information about the need for certain levels of synchronicity between the interacting partners. Dogs could execute a request successfully only if there was certain behavioural congruency. Thus we will utilize various statistical approaches for describing the temporal relationships of behavioural units that were displayed in dog-human interaction. We will use the THEME software designed specifically for the analysis of time pattern (Magnusson 2000).

Possible outcomes:
The temporal aspects of social behaviour can be very important in communicative and cooperative scenarios including teaching/learning (training) situations. This we will investigate such dog-human interaction in different situations. The study of temporal aspects

of behaviour results in a broadly defined model for how one action is (should be) followed by a second action in time. The detailed analysis of the behaviour can also reveal the connecting dynamics of social actions. For example, how rapid are eye/gaze shifts in a close range dog-human interaction.

Implementation:
The knowledge of broad temporal relationships of action could stabilize the behaviour output of the robot, especially if this ability is coupled with learning. Such controlling systems could be used for making social interactions more natural, as well as, to support long-term behaviour by the establishment of habits.

Disclaimer:
Importantly, the robot needs to show some level of behavioural variability and technical skill for the successful implementation of such models. If the robot is not able to execute actions in time and expected spatial conformation (because of the hardware or software) time pattern descriptions of behaviour could be useless.

2.2.2.6 Summary

It is important to understand that behavioural modelling can provide an input to robot control at various levels. First, observations can implicate the need for novel pattern of behaviour or novel ways of interaction in order to enrich the behaviour output of the robot. Second, behavioural observations could help in setting the parameters of the model controlling the robot. Third, detailed study of behaviour could provide alternative models for representing potential subsystems in the robot, and also by revealing important relationships between different subsystems. Fourth, ethological observations on personality can not only contribute to the individualisation of robotic behaviour but also make the system more robust. Finally, temporal models of behaviour may help to fine-tune of social interaction with regard of the mutually expected dynamics of behavioural exchange.

2.3 Ethological benchmarking

During the discussion of the project it became clear that behavioural measures will have a critical role in testing the achievements LIREC. This means that the evaluation of its novelty, usefulness and applicability will depend on showing that users (humans) are “more” satisfied to interact with the agents produced by LIREC in comparison to other robots (or earlier versions of LIREC products). Thus some benchmarks should provide more or less objective “measures” for this “satisfaction”. One can distinguish absolute and relative benchmarks:

(1) *Absolute benchmarks* are measures when the effect is compared to some sort of control situation without “treatment” In the case of robotics we could rely on a similar approach, one could compare a situation (e.g. fetch and carry) without a robot (carrying alone) versus with a robot (carrying together). Although, this would provide an absolute benchmark, such comparison seems to be trivial in most of our cases. The robotic case could be either much better or, if the robot’s abilities are very constrained. As a result not much can be learnt from this.

(2) *Relative benchmarks* are measures when the effect of the new treatment is compared to the effect of a traditional/well-established treatment (e.g. effect of a new drug versus the effect of a “traditional” drug, which has a well-known effect). If the novel invention is better (in any important aspect, not necessarily by being more effective but for example having less adverse effects) than the traditional one, one could rightly argue that the novel invention should be preferred. The question is what should serve as the control to which the novel/improved invention should be compared. There are the following possibilities:

(A) *Comparison to humans*: We could analyse what happens if the same interaction (e.g. fetch and carry) takes place between two humans or a human and a robot. Unfortunately, it is unlikely that the robot would “win” this comparison.

(B) *Comparison to dogs*: We could compare human-dog and human-robot interactions (e.g. fetch and carry), however, in this case we need to ensure during the planning that experimental procedures are the same. For example, recently UH suggested an experiment in which they use video footages for showing human subjects the joint action of humans and a robot. A similar set of video stimuli was obtained for dog-human interaction, and the same human subjects can judge both sets of stimuli in parallel. In addition, it can turn out that humans have difficulty in judging dog-human interaction, and in such a case it would be problematic to expect something similar in the case of the robots.

(C) *Comparison to other robots* (or former robots): This could be a useful method especially if there is a chance to improve the robots over the course of the project.

C-1: Across stimuli design: If we run the same experiments at the beginning of the study with “robot 1.0” and later with “robot 2.0” then we can show that the innovations did improve the performance of the robot. Alternatively, we could use other robots or borrow robots from other projects to reveal possible improvements.

C-2: Within stimuli design: A further variant of the method is to use various combinations of different abilities of the same robot. For example, the robot (or the video stimulus) displays different levels of complexity of the interaction, and each type of stimuli is judged by a different group of subjects. This method could provide some alternative ways of showing the effectiveness of the innovation.

3 ETHOLOGICAL FRAMEWORK FOR DOG-HUMAN INTERACTION

The important requisite of LIREC is that the behavioural observation of the dog-human interaction provides a rich input in the design of robotic behaviour. Recent interest in the scientific study of dog behaviour (e.g. Miklósi 2007) revealed a very rich pattern of social interaction between human and dog which has its roots in evolutionary history but is shaped also developmentally during human-dog cohabitation (see also D7.1.). However, for the present research we needed to restrict our interests to those aspects of human-dog interactions which can be implemented in the present conditions of the project. But even in this case we had to rely on a broader context that takes into account the ultimate and proximate causal factors behind the human-dog companionship (see also D7.1.). Accordingly, we suggest that this companionship is based on some simple forms of cooperative-communicative interactions in which there is a mutual satisfaction of some primary or secondary needs. These interactions are made possible because the (1) rich emotional communication between the partners, (2) special personality traits and (3) behavioural synchronicity.

Accordingly the behavioural models of dog-human interaction will rely on these three fundamental aspects. In contrast to previous approaches we offer a quantitative approach which is based on actual behaviours performed by the dog (and the human) during the interaction. The challenge is whether a detailed description of controlling systems can be modelled without much a priori assumptions about behaviour. For example, traditionally most personality models in dog were built on the basis of human-based approaches (Gosling et al 2003). Although, these are valid methods for developing a personality model for the dog, they cannot be used for designing a behavioural model of an artificial agent. Our method relies directly on the observable behaviour which provides the raw material for model development. Other, more traditional methods (e.g. questionnaires) will be used for validation of the behaviour-based modelling.

A similar method is also proposed for modelling emotional communication between human and dog. The study of animal emotions has also been hampered by anthropomorphic approaches. The case of dogs is especially revealing. The dogs are subscribed many if not all states of emotions, which are present in humans. However, there is no scientific evidence what so ever for this, in spite the fact, that serious ethologists would never deny the presence of emotions in dogs. We assume that engineering of robotic emotions should be preceded by the study of animal emotions in order to understand the mechanisms in creatures other than humans.

Most behavioural investigations are centred around the concept of scenarios. This means that aspects of personality, synchronicity, communication and cooperation (if applicable) will be described in situations which are potential parts of a scenario. In the following we will report on the work done so far. The emphasis was on developing a rich experimental methodology for measuring dog personality, and for developing a list of potential scenarios which can be used in future for investigating communicative-cooperative interactions between humans and dogs

4 THE DEVELOPMENT OF ETHOLOGICAL MODELS

4.1 Modelling personality and individual differences

Personality is often defined as an individual's distinctive pattern of behaviour (besides feeling and thinking) that is consistent across time and situations (e.g. Pervin and John, 1997). Personality studies in dogs have become very popular in the last decade. With the keywords “dog” and “personality or temperament,” Jones and Gosling (2005) found 51 references from science databases published between 1934 and 2004. In November 2008, according to our literature search in the Web of Knowledge, this number had increased with at least 30 recent publications. Extensive reviews have also been published recently (e.g. Jones and Gosling, 2005, Diederich and Giffroy, 2006). This indicates that dog personality is a matter of great public concern, and besides theoretical interest, it has a wide range of practical applications, including significant influence on the dog-human bond. For more information on the personality study of dogs see Deliverable D7.1.

Despite the increased interest, at present there is neither standard methodology nor standard terminology in dog personality studies, therefore we had to work out our own methodology. In the following we present our dog personality studies based on questionnaires and behaviour tests.

4.1.1 Dog and owner demographic characteristics and dog personality trait associations

The aim of this study was to analyze the relationships between four personality traits (calmness, trainability, dog sociability and boldness) of dogs and dog and owner demographics on a large sample size with 14,004 individuals. German speaking dog owners filled in an online questionnaire in German which was advertised in the “Dogs” magazine (published by Living at Home Multi Media GmbH, Hamburg) and the magazine’s website (www.dogs-magazin.de). Dog owners were asked to complete two different questionnaires.

1. The “Demography Questionnaire” inquired about demographic attributes of the dog and the owner and social attributes of their interactions. There were five demographic variables for dogs and nine for owners. Table 1 presents the variables and the descriptive statistics of the data.

2. The “Personality Questionnaire” was based on a 48-item Human Personality Inventory which is available at de.outofservice.com/bigfive/ and adapted for dog behaviour (Table 2).

Table 1. *Descriptive statistics of the dogs older than one year (N = 10,519)*

DOGS	
age	mean ± SD = 4.2 ± 3.1
sex	male: 56.1%; female: 43.9%
neutered status	intact: 56.9%; neutered: 43.1%
age at acquisition	bred by the owner: 1.9%; 2-12 weeks: 53.7%; 3-12 months: 22.6%; > 1 year: 21.7%
training experience	nothing: 35.3%; 1 type: 23.3%; 2 types: 21.5%; 3 types: 11.6%; 4 or more types: 8.3%
OWNERS	
gender	man: 20.4%, woman: 79.6%
age	< 18 years: 5.3%; 19-30 years: 26.9%, 31-60 years: 64.9%, > 60 years: 2.9%
education	primary school: 22.3%; secondary school: 40.3%; high school: 26.0%; college degree: 11.4%
number of people in the household	mean ± SD = 2.8 ± 1.4
number of other dogs in the household	0: 66.9%; 1: 20.6%; 2: 7.7%; > 2: 4.8%
purpose of keeping the dog	familymember exclusively: 45.1%; familymember + other: 48.2%; not familymember: 6.7%
number of previous dogs	mean ± SD = 1.2 ± 2.2
hours spent with the dog per day	0-1: 3.2%; 1-3: 27.0%; >3: 69.8%
frequency of playing with the dog per week	1: 3.3%; 2-3: 9.5%; 4-5: 10.6%; 6-7: 76.6%

Table 2. *Personality questionnaire applied in the study and the factor structure with loadings of items, explained variance, Cronbach's alpha and Eigenvalues of factors. *reversed scoring*

ITEMS The dog is…	CALMNESS	TRAINABILITY	DOG- SOCIABILITY	BOLDNESS
Is cool-headed even in stressful situations	**0.82**			
Is emotionally balanced, not easy to rile	**0.79**			
Is calm, even in ambiguous situations	**0.78**			
*Is sometimes anxious and uncertain	**0.73**			
*Can be stressed easily	**0.71**			
Is intelligent, learns quickly		**0.72**		
*Often does not understand what was expected from him/her during playing		**0.71**		
Is very easy to warm up to a new toy		**0.68**		
Is ingenious, inventive when seeks hidden food or toy		**0.64**		
*Is not much interested except in eating and sleeping		**0.62**		
Gets on well with conspecifics			**0.82**	
*Fights with conspecifics frequently			**0.81**	
*Is bullying with conspecifics			**0.76**	
Is ready to share toys with conspecifics			**0.54**	
*Is rather cool, reserved				**0.77**
*Is unassertive, aloof when unfamiliar persons enter the home				**0.71**
*Is sometimes fearful, awkward				**0.70**
Explained variance	23.81%	13.86%	11.41%	8.60%
Cronbach alpha	0.85	0.71	0.75	0.65
Eigenvalues	4.05	2.35	1.94	1.46

Two statistical methods were used for investigating the associations between personality and demographic traits: the more traditional general linear methods and regression trees that are ideal for analyzing non-linear relationships in the structure of the data.

The results showed that *calmness* is influenced primarily by the dog's age, the neutered status, the number of different types of professional training courses (e.g. obedience, agility) the dog had experienced and the age of acquisition. The least calm dogs were less than 2.5 years old, neutered and acquired after the first 12 weeks of age, while the calmest dogs were older than 6.9 years. *Trainability* was affected primarily by the training experiences, the dog's age, and the purpose of keeping the dog. The least trainable dogs had not received professional training at all and were older than three years. The most trainable dogs were those who participated in three or more types of professional training. *Sociability* toward conspecifics was mainly determined by the age, sex, training experience and time spent together. The least sociable dogs were older than 4.8 years and the owners spent less than three hours with the dog daily. The most sociable dogs were less than 1.5 years old. Males were less sociable toward their conspecifics than females. *Boldness* was affected by the sex and age of the dog and the age of acquisition. The least bold were females acquired after the age of one year or bred by the owner. The boldest dogs were males, acquired before the age of 12 weeks, and were younger than two years old. Other variables, including the owner's gender, age, education, previous experience with dogs, the number of people and dogs in the household, and purpose of keeping the dogs had minor, but detectable effects.

Below we list those findings which are relevant from the LIREC's point of view.

Calmness:

Main effects:

Owner gender: Men had calmer dogs than women ($F = 9.59_1$, $p < 0.001$).

Owner age: Owners under the age of 18 reported to have calmer dogs than others. 19-30-year-old owners had less calm dogs than others ($F = 8.57_3$, $p < 0.001$).

Other dogs in the household: More dogs were related to higher calmness ($F = 4.24_3$, $p < 0.01$).

Interactions:

Age at acquisition and education: Higher calmness was detected at dogs bred by the owner. In case the dog was acquired after its first birthday, secondary and high school educated owners had calmer dogs than primary school and university educated owners ($F = 2.02_9$, $p < 0.05$).

Age at acquisition and owner age: Children had the calmest dogs. Owners above the age of 60 years had generally less calm dog than others. However, in case of other owners, those, who acquired their dogs before the age of 12 weeks, reported moderately higher calmness compared to a delayed acquisition ($F = 1.89_9$, $p < 0.05$).

Purpose of keeping the dogs and hours spent together: Calmness increased with the longer time the owner and the dog spend together. However, among owners, who claimed that their dog has other function besides being the member of the family, the reported calmness did not differ between the dogs (since it was relatively high primarily, $F = 2.83_4$, $p < 0.05$).

Purpose of keeping the dog and owner age: Owners above the age of 60 years had less calm dogs in case they kept their dog as family member only ($F = 2.46_6$, $p < 0.05$).

Owner age and training experience: Dogs with at least two types of training experience were generally calmer than others, except in the group of owners under 18 and above 60 years ($F = 2.18_{12}$, $p < 0.05$).

Trainability

Main effects:

Number of people in the household: More people around the dogs was related to less trainability ($F = 5.03_1$, $p < 0.01$).

Purpose of keeping the dog: Dogs were reported to be more trainable in case their owner attributed specific function to the dog (work, guarding, etc.) not only being a family member ($F = 13.70_2$, $p < 0.001$).

Playing per week and hours spent together: Frequent playing was related to higher trainability. However, those owners who played only once with their dog weekly reported higher level of trainability than it could be expected compared to others ($F = 14.44_3$, $p < 0.001$).

Age at acquisition and owner gender: Women had more trainable dogs than men, except if they acquired the dog after its first birthday ($F = 3.01_3$, $p < 0.05$).

Age at acquisition and number of other dogs: Trainability decreased with the delayed acquisition of the dog. Dogs acquired after their first birthday and kept alone were reported to be the least trainable ($F = 2.33_9$, $p<0.05$).

Age of the dog and hours spent together: The negative correlation between the age of the dog and the trainability score was the strongest in the group of dogs which spent less than one hour with their owner daily ($F = 7.59_2$, $p < 0.001$).

Dog sociability

Main effects:

Education of owner: Owners who had basic school education only reported the lowest dog-sociality, while owners with a university degree the highest. Secondary and high school educated owners were in between, at a similar level ($F = 4.38_3$, $p < 0.01$).

Purpose of keeping the dog: Non-family member dogs were less sociable than family member dogs ($F = 7.24_2$, $p<0.001$).

Number of people in the household: Owners from more populated households reported having less dog-sociable dog ($F = 23.68_1$, $p < 0.001$).

Frequency of playing with the dog: More frequent playing was related to higher dog-sociability ($F = 6.26_3$, $p < 0.001$).

Interactions:

Acquisition of the dog and gender of the owner: Delayed acquisition of the dog was related to lower sociability in both genders of owners. However, dogs of men, bred by the owner or acquired after the age of first year had the lowest mean of sociability ($F = 3.40_3$, $p < 0.05$).

Boldness

Main effects:

Owner gender: Women's dogs were reported to be less bold ($F = 6.93_1$, $p < 0.01$).

Number of other dogs: Single dogs were the boldest, while dogs who shared the household with two other dogs were reported to be the least bold ($F = 3.16_3$, $p < 0.05$).

Interactions:

Purpose of keeping the dog and number of previous dogs: In dogs kept as family members exclusively, more experienced owners had less bold dog. In the groups of dogs who were kept for other purposes as well, there were no correlations ($F = 4.06_2$, $p < 0.05$).

Age of owner and training experience: Dogs of 19-30-year-old owners had bolder dogs than 31-60-year-old owners, except in the case of dogs who attended four or more training courses. Here the trend was opposite ($F = 2.15_{12}$, $p < 0.05$).

On-line questionnaires are a very effective means for collecting data about dog behavior, especially if owners are motivated by instant feedback. However, note that the characteristics of dogs in the present study were reported by the owners, and the associations with the traits do not necessarily represent a causal relationship.

4.1.2 A Cross-Cultural Comparison of Reports by German Shepherd Owners in Hungary and the United States

Cross-cultural comparisons of dog behavior and dog-keeping practices are limited. The current study compared the questionnaire responses of German shepherd owners in Hungary and the United States. Owners provided information about their dog-keeping practices, as well as reports of their own German Shepherds' behavior and temperament. Cross-cultural differences and similarities were revealed. For example, American owners were more likely to keep their dogs indoors during the day and at night, to report that their dogs were kept as pets, and to engage their dogs in a greater number of training types (e.g. conformation training, agility training; Table 3 and 4).

Table 3. *Observed Percentages for Binary Variables According to Country; Selected Results of Multiple Logistic Regressions Controlling for Demographic Variables*

Dependent Variable	Hungary	U.S.	*Nagelkerke* R^2	X^2	Odds Ratio (*OR*) for Country[1]	95% CI for Country *OR*	
						Lower	Upper
Kept indoors during the day	31%	88%	.69	50.37**	29.59**	2.70	324.61
Sleeps indoors at night	32%	96%	.71	36.72**	771.65*	4.44	134,257.54
Purpose: pet	26%	88%	.80	62.76**	2648.03**	15.46	453,605.43
Purpose: activity	77%	41%	.31	19.21**	.26	.04	1.63
Purpose: guarding	33%	18%	.15	7.81	.08	.01	.61

[1]Coded as 0 for Hungary and 1 for United States. Other predictors were owner age, owner sex, dog age, and neuter status. *$p < .05$, ** $p < .01$

Table 4. *Descriptive Statistics of Continuous Variables According to Country; Selected Results of Multiple Regressions Controlling for Demographic Variables*

Dependent Variable	Hungary	U.S.	R^2	F	*b* on Country[1]	95% CI for Country *b*	
						Lower	Upper
Number of adults in household	*M* = 2.43 *SD* = 1.25	*M* = 1.80 *SD* = .66	.30	4.80**	-.18	-.87	.51
Number of children in household	*M* = .36 *SD* = .63	*M* = .47 *SD* = .95	.25	3.87**	1.19**	.53	1.85
Number of dogs in household	*M* = 1.37 *SD* = 1.44	*M* = 2.73 *SD* = 3.76	.17	2.31	3.31*	.44	6.18
Number of previous dogs	*M* = 1.14 *SD* = 1.45	*M* = 13.50 *SD* = 25.66	.10	.98	12.66	-6.82	32.14
Hours of interaction per day	*M* = 1.91 *SD* = 1.14	*M* = 3.52 *SD* = 3.62	.09	1.33	1.62	-.76	3.99
Age of acquisition (mos)	*M* = 6.26 *SD* = 12.93	*M* = 7.68 *SD* = 15.91	.04	.52	3.95	-9.19	17.09
Number of training types	*M* = .99 *SD* = .84	*M* = 2.53 *SD* = 1.70	.34	6.48**	1.97**	.86	3.08

[1]Coded as 0 for Hungary and 1 for United States. Other predictors were owner age, owner sex, dog age, and neuter status. *$p < .05$, ** $p < .01$

Country was not significantly associated with the length of daily human-dog interaction, dog's age at acquisition, and the number of previous dogs owned. Concerning the behavior, American owners reported higher scores than Hungarian owners on the *confidence* and *aggressiveness* scales of the Budapest Canine Personality Survey (for the Survey see the Appendix A). The current study demonstrates that cross-cultural research on dogs can reveal important similarities, as well as differences. While there are marked differences in dog-keeping practices between Hungary and the United States, there are also many similarities. A pattern of cross-cultural similarities and differences can also be found in the owners' responses on questionnaires about their dogs' behavior.

These latter results, however, could have been influenced by the biases that owners carry about their own dogs or the breed of their dogs. In addition, there may be cultural variations in perceptions of the breed, which could have influenced the extent to which respondents in the two countries might have underreported negative behaviors and over-reported positive behaviors. Therefore, it would be important to follow-up the current study with additional research combining the use of surveys with observational methods in different countries.

4.1.3 Developing a test battery (scenarios) for measuring personality in dogs

Behavioural tests are independent largely from the perception biases of the observer, and provide the behavioural elements that are necessary for the implementation of dogs' behaviour in robots. Based on the literature (see Diederich and Giffroy, 2006 for a review) and our own experiences, we developed a test battery (Buda-Test of Canine Personality; BTCP) for measuring individual variability in dogs. The BCPT consists of 14 subtests (for the protocol see Appendix). We have measured 93 German shepherds in this test battery. In every subtest 1-3 behavioural variables were coded. The variables were subject of principal component analysis with varimax rotation. Four factors were obtained were named provisonaly *Playfulness*, *Sociality*, *Liveliness*, *Neuroticism*. The 4 factors explained 51% of the total variance. Cronbach alphas were 0.81, 0.67, 0.66, and 0.63, respectively (Table 5).

Table 5. Personality traits calculated on the basis of behavioural traits observed in the Canine Personality Test. Only loadings greater than 0.45 are presented.

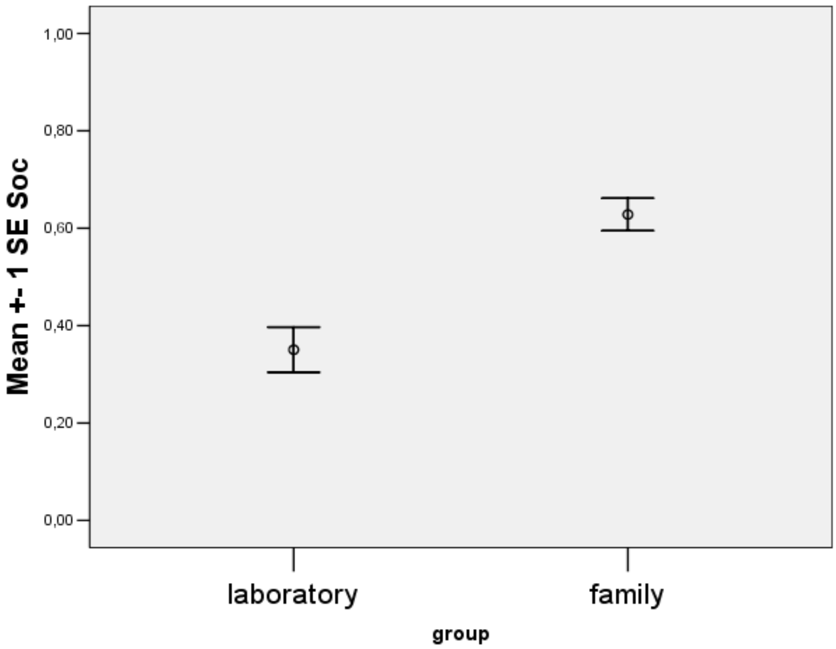
Item	**Subtest**	**Sociality**	**Playfulness**	**Liveliness**	**Neuroticism**
Intensity of greeting	Greeting	0.91			
Approaching the E	Greeting	0.87			
Intensity of greeting	Separation	0.74			
Friendliness	Threatening approach	0.50			
Intensity of playing with the owner	Separation		0.76		
Intensity of playing with the experimenter	Separation		0.62		
Intensity of retrieving	Ball playing		0.62		
Orientation at the cage	Problem solving		0.56		
Orientation at the pendulum	Pendulum		0.46		
Possessivity	Bone take away		0.45		
Activity	Spontaneous activity			0.71	
Activity1	Separation			0.63	
Activity2	Separation			0.60	
Struggling	Swab collecting			0.60	
Latency of laying down	Lie down			-0.48	
Aggressivity	Threatening approach				0.79
Sound	Threatening approach				0.75
Approaching style	Hiding				0.52
Getting up attempts	Lie down				-0.47
Orientation at the owner	Problem solving				0.45

The relationship between the factors and the demographic characteristics of the owners are still under examination.

4.1.4 Environmental effects on the personality of dog

Laboratory dogs are frequently used in scientific studies. The contrast between the quality of life of laboratory and family dogs is salient. Laboratory dogs are kept in a highly restricted environment, in a limited area (4 nm2 for 1-2 dogs). Usually they do not have human contact except with their caretakers, once a day in feeding and cleaning time. We tested 37 laboratory beagles and 33 family begales in the BCPT (see above), and compared their behaviour. We found that there was no difference in the *Liveliness* of the two populations, but *Playfulness* ($t=-4.28$, $p<0.05$) *Sociality* ($t=-4.86$, $p<0.05$; Figure XXX) and *Neuroticism* ($t=5.48$, $p<0.01$) were significantly differed.

Figure X. *Comparison of the Sociality of laboratory and family beagles.*



4.1.5 Summary evaluation of the research on dog personality

Research on dog personality has shown that using a battery of simple social interactions (which are based to a large extent on the scenarios developed for LIREC) can reveal stable behavioural aspects of dog behaviour that are independent from the actual situation. In parallel we have also shown that more traditional tools, like questionnaire-based assessment of personality is also possible in dogs.

The obtained background factors (*Playfulness*, *Sociality*, *Liveliness*, *Neuroticism*) seem to explain a considerable part of the dogs' behaviour which have the potential to be transformed into meaningful behavioural aspects of the robot. The diverse methods for obtaining personality models for the dogs can be also used to cross-validation. These models will play an important role to characterize the individual in more complex communicative-cooperative situations.

4.2 Behaviour analyses of dog-human interactions

In this section we list potential scenarios that can be used for behavioural observation of human-dog interaction, and testing human-robot interaction at a later stage of the project. These scenarios are based on the showcases described in other deliverables, and the present protocols have been developed in cooperation with other partners in LIREC. This is a non-exhausted list, and it may change as the project advances.

The evaluation of the scenarios takes place at two different levels. First, we develop videos that show either a dog or a robot interacting with a human in the same scenario(s) (see 4.2.1.). Both videos are evaluated by potential users. Second, the scenario will be used as a means of obtaining behaviour measures of the dog (and the human) (see 4.2.2.). This will provide the raw material for describing communication, personality and behavioural synchronicity between partners in future studies.

4.2.1 Test videos for evaluation

In the case of the Robot house showcase we have developed a test video for comparing a dog and a robot acting as a helper companion (see also D6.2). This video included a series of scenarios: Fetch and Carry, Greeting-Farewell, Embarrassment/Contact initiation. A Video-based HRI study presented a scenario to viewers for the purpose of investigating how an appearance constrained robot (Pioneer) can indicate to users that it is performing the following activities by using suitable non-verbal behaviours: greeting, farewell, fetch and carry, embarrassed behaviour, attention seeking behaviours. Inspiration for the behaviours presented by the robot in the VHRI study is to be based on those exhibited by dogs in similar situations. On the basis of the video-script and the observed 'behaviour' of the two filmed dogs and the robot we defined the situations (scenarios) in which group level data and individual differences in dogs should be analysed to provide more detailed input for the robot's relevant behaviour-patterns.

4.2.2 General method for the behavioural studies

Hereunder we present the focused behavioural analysis of about 30 dyadic dog-human interactions in several different contexts, including communicative and cooperative interactions. Different levels of behavioural analysis were based on the statistical analysis including isolated action frequency, dyadic actions and action coordination.

4.2.3 Ethological investigations of dogs and humans interactions

Here we present a list of scenarios that has been utilised or are planned to be utilised for behaviour testing. Together with colleagues we also describe the broader aspect of a scenario, and how it may be applied to HRI including the necessary conditions for the successful application.

4.2.3.1 Proximity-seeker

Background theory

Regulating the distances between us and other people provides us with several benefits, including:

Safety: When people are distant, they cannot surprise attack us.

Communication: When people are closer, it is easier to communicate with them.

Affection: When they are closer still, we can be intimate.

Threat: As a reverse: deliberately threatening occurs by invading the body space.

The social distances here are approximate and vary with culture and people (the following is based on Hall (1966) for Americans)

- *Public Zone: (3m): W*hen we are walking around town, we will try to keep at least 12 feet between us and other people. For example, we will leave that space between us and the people walking in front.

At many times this is not possible. Social distance theory tells us that we start to notice other people who are within this radius. The closer they get, the more we become aware and ready ourselves for appropriate action. When we are distant from another person, we feel a degree of safety from them.

- *Social Zone: (1.5m - 3m):* Within the social zone, one feels a connection with other people. When they are closer, we can talk to them without having to shout, but still keep them at a safe distance. This is a comfortable distance for people who are standing in a group but maybe not talking directly with one another. People sitting in chairs or gathered in a room will tend to like this distance.

- *Personal Zone (0.5m - 1.5m):* In the personal zone the conversation gets more direct, and this is a good distance for two people who are talking in earnest about something.

- *Intimate Zone (< 0.5m):*

When a person is within arms reach or closer then one can touch him in intimate ways. There is also more detail of their body language and looking in the eyes. When a person is closer, he also blots out other people so all we can see is him (and vice versa). Romance of all kinds happens in this space. Entering the intimate zone of somebody else can be very threatening. This is sometimes done as a deliberate ploy to give a non-verbal signal that they are powerful enough to invade your territory at will.

Source: http://changingminds.org/techniques/body/social_distance.htm

Key idea: The companion seeks for an ideal proximity which is non-disturbing for the owner/user, but expresses that the user is in the focus of its attention, affection and the companion is ready to cooperate, depending on the situation (active or passive)

Human-companion relationship: Companion as an attentive cooperative partner

Actors/Roles: One user, companion

Activity Description: The companion is continuously monitoring the user spatial position and action in order to recognize his/her activity and adapt its proximity to the relevant context. Manner of approaching (speed, tail-wagging, route etc) varies depending on the situation.

If the user

(1) - changes his/her position frequently, the companion rests at some place and does not follow, only if called;

(2) - stays at one place for longer than (3-10) minutes, the companion moves closer (0 cm-1 m), and stays still, ready for interaction (shows sign of it). After long social deprivation (0-30 min) the companion initiates interaction (e.g, physical contact with the user (puts a body part in the lap of the user) or wags its tail, blinks eyes, etc.). The companion moves into the intimate zone, but stops if asked to.

(3) - the companion follows/overtakes/escort the user and maintains a 50 cm -1 m distance if commanded to “come”

(4) – goes to the resting place if commanded to leave

The companion does not approach the user closer than 50 cm (1) except at greeting, (2) if asked to do so or (3) after a long (10-30 min) social deprivation.

Motivations for the user: The companion is always ready to interact with the user, but does not bother him/her.

Activity Model: The companion is able to recognize the user personally, and learns his specific way of actions and movements. If the user does not allow the companion to enters his intimate zone, the companion leaves, but makes a repeated attempt on a regular basis (once/week). Proximity seeking is connected to contact seeking. If the user pets the companion frequently, the companion tries to enter his intimate zone more frequently.

The companion makes a first, quick assessment of the "user's mood" and plans its first actions accordingly. This is achieved by memorizing at the end of each interaction with the user relevant events (e.g. petting frequency, communicative behaviour displayed by the user). This information is utilized in the execution of the next interaction. It also updates the user model if new relevant information was obtained.

Place/Setting: Physical setup, indoor location.

Cognitive and physical capacities (Artefacts/Media): Visual perception/transmitter, learning capacity, measuring distances, time, memory, individual recognition, making physical contact.

Time/Flow: Continuous

Research Questions include:

- Which is the ideal distance from a companion in different contexts?
- How distance affects social and affective interactions?
- How previous experience should be taken into account in planning subsequent interactions?
- *Suggested tests for dog-owner dyads:*
- Spontaneous (off leash) behaviour in an unfamiliar place with passive owner.
- Spontaneous (on leash) behaviour in an unfamiliar place with passive owner.
- Distance from owner in a game situation (pets)
- Distance from owner in a fetching task situation (assistance dogs for the disabled)

<u>*Behaviour test on dogs*</u>
<u>Interaction: proximity seeking, attending, contact initiation</u>
1. Owner is busy and passive

Owner is filling a questionnaire for a few minutes while the dog is free to do whatever it wants in a large unfamiliar room. Owner is writing for a while sitting in a chair behind a table, and then moves around the table and sits on the ground. She/he continues to fill the questionnaire in this position for a while.

Prediction: dogs' actions include several behaviours, some try to initiate contact with owner

Variables: exploration, looking at owner, proximity seeking, physical contact, tail wagging

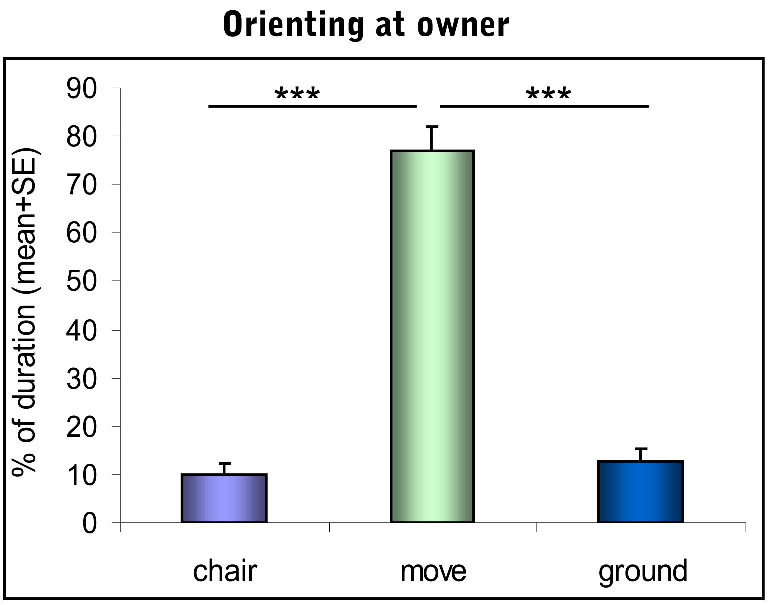
Results

Proximity seeking of the dogs (the time spent in close proximity of the owners) was not different in the three phases, but there was especially large variance across dogs in their tendency for seeking close proximity with the owner (from 0 to 100% of total time). It needs further analyses to determine if this variance has any association with the personality of the owner and/or the dog. The results suggest, however, that the proximity seeking behaviour might be rather consistent in individuals across situations, as we found strong correlation in this variable across the three situations (all $p<0.01$).

The occurrence of physical contact between dog and owner was differently distributed in the three phases, as dogs tended to approach the owner and initiate longer physical contact with her/him when she/he sat on the ground (X^2= 6.05, p=0.04).

The dogs oriented at the owner about 10% of the duration in both passive situations (sit in chair or on ground). However, they were orienting at the owner significantly more while she/he changed his/her position, even though the owner did not interact with the dog (i.e. did not talk to the dog) during this activity (X^2=38.87, $p<0.001$). We found correlation in the tendency to look at the owner across situations (all $p<0.05$).

During the test 38% of the dogs did not wag their tails at all, however, in case of 22% of the dogs we could observe more or less tail wagging behaviour in all three phases.



Interaction: proximity seeking, attending, tendency to get involved in the owner's activity

2. Owner is in action (not involving the dog)

The owner is carrying dice one by one in a large unfamiliar room from one part of the room to the other. The dog is free to do whatever it wants.

Prediction: some dogs show interest in owners' action, some even try to be involved

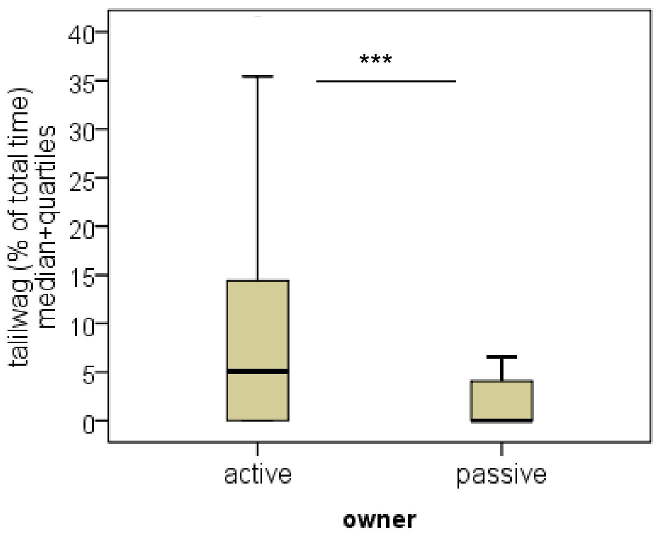
Variables: exploration, looking at owner, proximity seeking, physical contact, tail wagging, touching dice, carrying dice

Results

Although the mean value of proximity seeking of the dogs was not different in the situation where the owner was in action, the behaviour of the dogs was different in several respects. Most of them followed the owner for a while when she/he was walking from one part of the room to the other, and 85% of them even touched or carried the dice that the owner manipulated.

The dogs wagged their tails much more during the ‘owner in action’ test than in the ‘owner passive’ situation (Z=2.8, p=0.005), even though the owner’s activity was not directed at them, and the owner did not communicate with them during the observation.

Tail wagging in case of active and passive owner



4.2.3.2 Dependency

Background Theory

Social attachment is an asymmetrical social relationship that presumes the dependency of the attached individual on the object of attachment who can be used as a secure base. The evolutionary significance of attachment may be in supplying the offspring with resources for survival and with defence against predators by ensuring that offspring remains in the vicinity of the parent. The dependency of the attached individual manifests itself in behavioural preferences indicated by special behaviour patterns in choice situations.

In dogs the long-lasting selection for conflict-minimizing behaviour in human communities may have resulted in the ability for forming individual attachment relationship to humans, which manifests itself in analogous behaviour patterns to that of parent–child relationship.

Key idea: Companions are dependent on humans which manifests in their everyday behaviour

Human-companion relationship: Partnership that is based on the leadership of the human partner

Actors/Roles: One user, no particular needs addressed

Activity Description: Individual discrimination, turning to user in conflict situations and using it as social reference, decreased independent problem solving capacity

Motivations for the user: Increases the possibility of individual bonding, guarantees leadership, decreases the possibility of doing wrong

Activity Model 1 – problem solving/ conflict

Companion wants to play with ball, ball is on the table, companion could obtain it, but rather:

- follows user in flat,
- looks at him + vocalizes,
- leads him to table,
- "shows ball with nose"

Place/Setting: In any room, a table or similar furniture is required. There should be an object that is very important for the dog (e.g. ball/food)

Cognitive and physical capacities (Artifacts/Media)

Highly developed communicational skills (willingness to look at humans' face, capacity to show an object, going ahead while watching if being followed…)

Time/Flow: The time needed for the activity depends on the motivation of the companion and the user.

Research Questions include: How can companion successfully communicate what it wants; interaction initiation

Activity Model 2 – social reference

When the novel object (e.g. strange person) appears in environment (The object has biological significance for the companion).

- companion approaches to novel object a bit but not fully,
- looks at user, and
- its further behaviour is based on user's reaction/instructions

Place/Setting: In the house or outside, novel object to be placed visible for companion

Cognitive and physical capacities (Artifacts/Media)

Visual capacity for recognition of objects/persons,

Behavioural tools communication with user (e.g. turning head)

Time/Flow: The time needed for the activity depends on the nature of the stimulus

Research Questions include: Social understanding (behaviour reading), Social reference

<u>*Behaviour test on dogs*</u>
Situation: ambivalent/conflict situation in social context

Interactions: social reference, behaviour in case of social uncertainty

The dog is walking with the user in an unfamiliar environment, when a frightening/strange man appears and approaches. The owner responds in two different ways. She drops the leash and either steps back avoiding the stimuli or approaches the stranger. All subjects are tested in both situations (owner moves towards or back) in random order.

Prediction: The dogs' response depends on the owner's reaction: the dog does not show specific behaviour (walk along) or escorts the owner if he or she approaches the strange person, and avoid the stranger if the owner keeps off him.

Variables: looking at owner, proximity seeking with owner

<u>*Results*</u>
The dogs tended to draw near to the owner mainly when he/she avoided the stranger and stepped backwards; 59% of the dogs followed the owner and only one subject approached the stranger. However, in those cases when the owner approached the stranger, 38% of the dogs just walked along the original track, and 45% followed the owner towards the stranger.

4.2.3.3 Greeting

*Key idea**:*** The special individual attachment to the user manifests itself in behavioural preferences such as intense greeting.

*Human-companion relationship**:*** Asymmetrical but mutual interaction

Actors/Roles: One user, no particular needs addressed

*Activity Description**:*** Due to the stress activated by the separation from the owner the companion greets him upon reunion. The style and intensity of the greeting behaviour is regulated partially by the user's behaviour and other contextual factors

Motivations for the user: Facilitates individual bonding, increase user's self-esteem, decreases the effects of possible depression by possessing a unique companion.

Activity Model

Noticing user's arrival companion shows variety of intensive communicative (contact initiating) behaviours ("excitement") (e.g. soft whining, tail wagging, moving around)

Upon reunion the companion:

- quickly approaches user and moves around him
- looks at his/her face/eyes
- gets in physical contact with user
- displays communicative behaviours (e.g. tail wagging)

*Place/Setting**:*** Familiar or unfamiliar location where the companion can be separated.

Cognitive and physical capacities (Artifacts/Media)

ability for individual discrimination of the user, recognition of unfamiliar objects, ability to locate the user, recognition of the absence of the owner, communicative abilities, head turning, localize user, making contacting actions,

*Time/Flow**:*** It lasts about 20-40 s depending on the reaction of the owner. The response of the companion is immediate when it sees or hears the arriving owner.

Research Questions include: How does the duration of separation influence greeting behaviour?

<u>Behaviour test on dogs</u>

<u>Interaction - Greeting after separation:</u>
Experiment 1. Dog leaves the owner and returns

Owner and dog are together for a few minutes in an unfamiliar room then the dog is led outside by the unfamiliar E. They spend 2 minutes in front of the door then the dog is allowed to enter the room off leash.

Prediction: most dogs approach the owner upon reunion and show affectionate behaviour patterns such as tail wagging, physical contact initiation.

Variables: latency of approach, physical contact, tail wagging

<u>Results</u>
The average latency of approach was 5 s, and only 4 dogs did not approach the owner after entering the room. The duration of tail wagging during the greeting negatively correlated with the latency of the approach ($r=-0.55$, $p=0.003$), that is, dogs that run at once to the owner showed more tail wagging. About half of the subjects (17 out of the 32 dogs) got in physical contact with the owner during the greeting, in spite of the fact that the owners were instructed to ignore the approaching dogs.

Experiment 2. Owner leaves dog and then returns
Dog is tied to a tree with a long leash for 1 minute. The owner hides behind a building so that the dog cannot see him/her. Then owner returns, stands 5m from the dog. Then the E releases the dog.

Prediction: most dogs orient toward the owner during separation and greet the owner upon reunion.

Variables:

- whining, pulling leash (“separation stress”)
- duration of orientation towards owner while separated
- tail wagging during owner’s return
- tail wagging during reunion with owner’
- duration of orientation towards owner during reunion
- speed of approach
- contact initiator party
- duration of physical contact
- contact terminator party

Results

During the *separation* the dogs oriented characteristically towards the owners' assumed location, that is, in the direction the owner had left (67%). Only 28% of the dogs showed whining, pulling the leash ("stress related behaviour").

All dogs oriented towards the owner when he/she *approached* them after the separation, but only 34% of them wagged their tails during the approach.

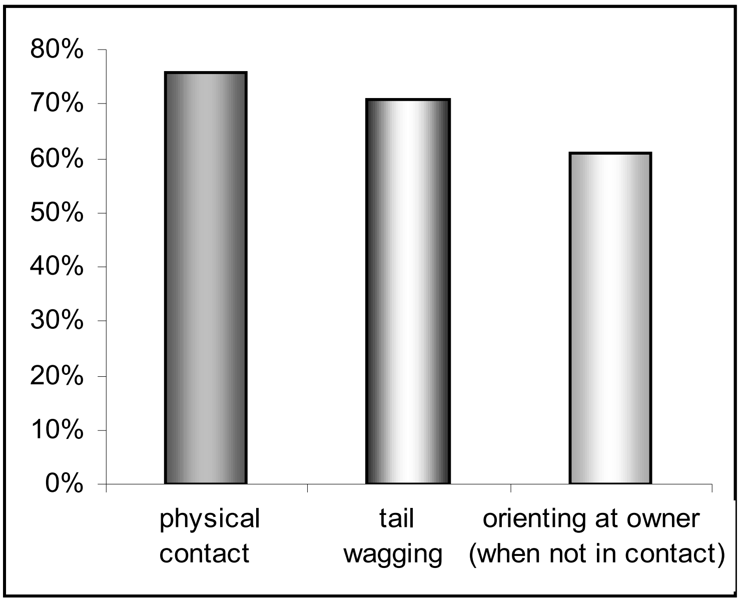
The dogs approached the owner with variable speed; 21% was relatively slow (walking), 31% approached in trot, and 48% sprinted at a gallop. The speed of the approach positively correlated with the total duration of the greeting (p= 0.019).

The greeting was initiated by the dog in about half of the cases (55%), and interestingly, was terminated mostly by the dog (79%). In case of dyads where the owner terminated the greeting, the dogs oriented significantly more towards the owner both during the separation (t=3.74, p=0.001) and the greeting (t=4.21, p=0.001).

The average total duration of the greeting was 10.5 s. During the greeting the most characteristic behaviour element showed by most of the dogs was tail-wagging that could be observed in 71% of the total duration of the greeting sessions.

As far as the interaction is concerned, most of the time during the greeting was spent in physical contact between dog and owner (76% of total duration). When the owner and the dog were not in physical contact, the dogs mainly oriented towards the owner (61% of total duration).

Characteristic behaviours during greeting



4.2.3.4 Fetch and Carry

This scenario was put together on the basis of the similar scenario for robots. Our model is based on the behaviour of an assistance dog that is trained to help disabled persons. One of their main tasks is to fetch and carry objects (see also D6.1.)

Key idea: An assistance companion helps in the transportation of objects

Human-companion relationship: Companion assists with tasks requiring physical activities

Actors/Roles: One user is involved in this scenario. Particular needs addressed in this scenario could be minor physical impairment making walking while carrying objects difficult. This may also include people who e.g. due to an accident or other conditions cannot walk well temporarily (e.g. using crutches).

Activity Description: This particular activity allows the companion to assist the user in (picking up and/or) carrying objects around the home and outside the house as well. It consists of the user manipulating a physical object and placing it in the harness of the companion or in a basket that the companion carries to another location.

Motivations for the user: This ability on the companion allows for greater ease in moving objects around the house. Increases independence and allows for a greater range of activities. While assistive, still requires movement and actions on the part of the user, thus increasing the amount of physical activity available to the user rather than decreasing it.

Activity Model: The user places an object in the harness of the companion or in the basket, then either instructs the companion to follow, or instructs it to the desired location. The user may communicate instructions to the companion by using specific gestures. The companion and the user move to the specified location at which point the user removes the object from the harness or take out of the basket and moves it to its final position.

Place/Setting: This activity takes place in the house as a whole, possibly and likely encompassing more than one room or outside the house. Required for the activity is that the harness/basket is made in such a fashion that placing the object in it does not require complex movement of the user. Likewise, the final position of the object should be reachable by the user without having to move.

Cognitive and physical capacities? (Artifacts/Media): Here is a list of behaviours which the companion has to capable of in order to fetch and carry a basket:

1. go to user on command
2. look at user's face
3. follow and understand pointing gesture(or understand verbal cue for 'basket')
4. take (hold of) basket
5. come closer
6. hold basket in reaching distance and with good orientation
7. carry basket
8. go ahead (with continuous feedback for user's orientation) or follow user
9. put down basket or hold it while the user packs out

The companion is trained to follow the user/move to the user, to carry objects in its mouth on command, to be ready to wear the harness, to be ready to release the object on command.

Time/Flow: This particular activity is driven by the user's needs and capabilities, the movement speed of the user regulates the time needed for completion.

Research Questions include: How do users experience the assistance by the companions? How easy do users find to communicate with the companion? What types of behaviours and interactions can be observed in dog-owner dyads when the dog performs an assistance task?

Behaviour test in dogs

What is the difference in the above behaviours depending on the (1) level of training and (2) whether the owner is in a wheelchair?

Procedure

Task: fetch a basket from a start point and carry to a given target place, which is about 10 metres from it. The only instruction for the owners was not to touch the dog or the basket.

The owner places an object in the basket, and then either instructs the dog to follow or to go ahead to the desired location. The owner may communicate instructions to the dog by using specific gestures. The dog and the owner move to the specified location at which point the dog should place the basket on the ground.

Independent variables:

- Training (novice – advanced)
- Owner movement (wheel chair – walk)
- Gender
- Age

Dependent variables:

1st phase – grab basket

- joint attention (yes – no)
- pointing gestures (yes – no)
- verbal cue (number)
- verbal cue type (name, inhibit, praise, object, task/verb)
- duration of task (s)

2nd phase – carry basket

- joint attention (yes – no)
- pointing gestures (yes – no)
- verbal cue (number)
- verbal cue type (name, inhibit, praise, object, task/verb)
- carrying ‘style’ (ahead–side–behind)

3rd phase – place basket

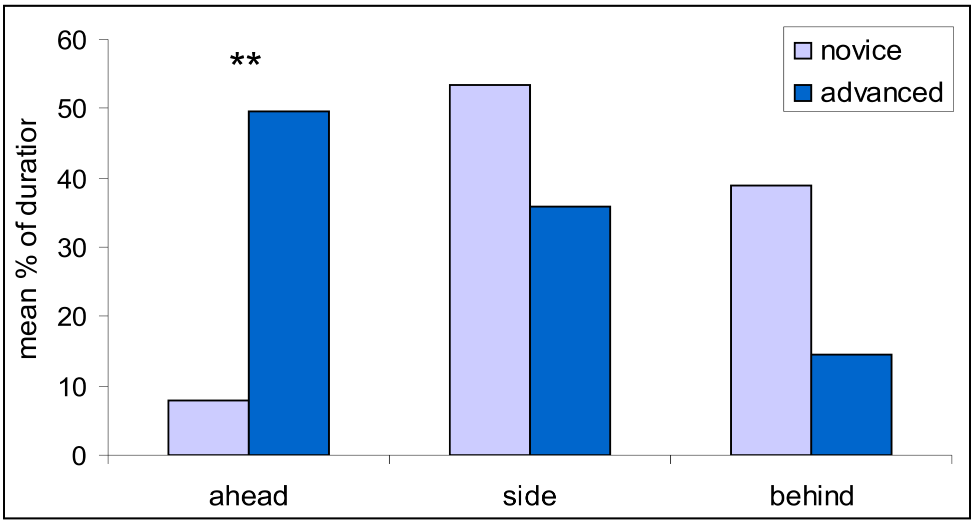
- joint attention (yes – no)
- pointing gestures (yes – no)
- verbal cue (number)
- verbal cue type (name, inhibit, praise, object, task/verb)
- duration of task (s)
- owner’s position (behind–side–front

Results

At the beginning of the test all participants (N=20) engaged in joint attention, that is the dog and owner looked at each other, mainly as a result of the owner's verbal cue (name of dog and/or 'watch'). Then 90% of the owners showed at the basket while they asked for it. The owners applied 3-4 verbal cues on the average to get the dog to catch the basket, 5-6 cues while carrying the basket and 7-8 cues during the placing. Most of these verbal cues were verbs (task names such as 'hold', 'bring', 'come'). Mainly at the beginning of the task most owners told the name of the dog and the object as well. The owners of the novice dogs praised their dogs at the end of all three parts of the task (catch, carry, place), while the owners of advanced dogs praised only at the end of the task (or never).

The novice dogs needed more time and verbal cues for placing the basket on the given place (Z=-2.5, p=0.024). The advanced dogs carried the basket more often in front of the owner than on the side or behind (Z=-2.43, p=0.015). Interestingly, there was no difference in any variables between the assistance dogs and pets, so moving with a wheelchair did not affect the performance.

Position of the dog relative to the owner while carrying the basket



4.3 Further potential scenarios

Here we list further potential scenarios which are at persent or will be under investigation in terms of dog-human interaction.

Key idea: The companion's individual attachment to the user is an asymmetrical social relationship that can be investigated via observable behavioural preferences

Human-companion relationship: Analogous to mother-child relationship

Actors/Roles: One user, no particular needs addressed

Activity Description

Attachment behaviour is activated during situations involving moderate stress:

- preference for user,
- separation distress,
- positive discrimination (special greeting) during reunions

Motivations for the user: Attachment increases the possibility of individual bonding, allows for possessing a unique companion, guarantees leadership, bearing responsibility

Activity Model 1 – separation

The companion is separated from the user in an unfamiliar environment. The companion shows separation distress (vocalizing, moving around, standing in door) when the user is absent and special greeting behaviour (approach, physical contact, tail wagging) during reunion. (See greeting behaviour in separate scenario.)

Place/Setting: Unfamiliar (or frightening) place where the companion can be separated

Cognitive and physical capacities (Artifacts/Media)

Individual discrimination of user, capacity for recognizing the absence of the user and unfamiliar location

Time/Flow: The distress response is immediate

Research Questions include: Stress behaviour, user's secure base role

Activity Model 2 – secure base

The companion is walking with the user (in an unfamiliar environment), when a frightening object/person appears/approaches. The companion nears the user and looks/vocalizes at him.

The companion stays with the user if the strange object/person approaches the user, and escorts the user if he approaches the object.

Place/Setting: Anywhere but in an unfamiliar place the effect is bigger

Cognitive and physical capacities (Artifacts/Media)

Recognition of unfamiliar objects, ability to locate the user

Time/Flow: The rapidity of the response depends on how frightening the object is.

Research Questions include: Is there a variation in the behaviour among dogs? Do they show clear secure base behaviour in the presence of the owner?

4.3.1 Social learning by observation

Background theory

Learning by observing the actions of knowledgeable individuals enhances the capacities of companions to collect information from the environment. This situation can be modelled through staged interactions between the companion (the dog) and a demonstrator (owner). Dogs are keen to pay attention to what humans do. Although the differences between dog and human anatomy (especially the lack of dexterity of the forelimbs in dogs) may result in difficulties in demonstrating tasks with object manipulation, however, learning about movement in a physical space evades this problem. In this scenario we demonstrate to the companion an alternative route for detour that is preferred by the demonstrator (user).

Key idea: The companion learns how to detour an 'obstacle' after seeing the user's demonstration.

Human-companion relationship: The companion is able to learn by observation from a demonstrating user, easier transmission of preferred habits of the user

Actors/Roles: The user acts as demonstrator, the companion stays and waits and watches him.

Activity Description: The goal is to teach the companion not to use the direct (optimal, straight, or shorter) route but detour around an obstacle. The obstacle can be an actual object, or an area (e.g. a polished wooden floor, freshly made lawn in the garden, etc.).

Motivations for the user: Humans have different/special rules, how to use the space in the house or in the garden. There are 'forbidden' zones, but companions do not know about these. As humans do not want to restrict totally the movement of their companions, it can be useful if companions used the routes preferred by the user, which are not necessarily the shortest. Social learning is a suitable means for teaching companions to use the longer route instead the (forbidden) short one.

Activity Model:

The user calls the companion's attention, and then performs the detour action. During the detour the user keeps on calling the companion's name, and maintains its attention. At the end of the detour, the user shows the target (reward) to the companion, and leaves it at the other end detour (where the companion is supposed to go). The reward is necessary for motivating the companion to perform the detour. The user returns to the companion and encourages him to solve the task. They repeat this sequence until the companion detours smoothly.

Place/Setting: This activity takes place either indoor or outdoor environment.

Cognitive and physical capacities (Artifacts/Media):

Orienting at user during communicative signals, the companion should be able to leave the human's vicinity for solving the detour task, visual tracking of human in space in relation to the obstacle and other objects

Time/Flow: The necessary time for a successful social learning depends on the complexity of the task

Research Questions include: What sort of communicative behaviour should be displayed by the demonstrator? How accurately does the companion copy the demonstrated route? How rapid can a companion change his preference for adopting less optimal routes?

4.3.2 Embarrassed behaviour

Background theory

Embarrassed behaviour emerges in conflicting situations. By observing such behaviours others can learn about the inner state of the agent. Both in dogs and humans the conflict different/ contradictory motivational states can result in embarrassed behaviour patterns. In humans embarrassed behaviour includes, for example, smiling that is accompanied by gaze aversion, lip press, lip bite, and/or body touching/self-adaptors.

Key idea: If companions get into a situation, which are unable to solve, then they show typical pattern of actions which can be identified as "embarrassed behaviour".

Human-companion relationship: Dominant-submissive relationship between companion and user.

Actors/roles: Companion and user

Activity description: Companion faces a problem-solving situation which it cannot solve. For example, the owner asks the companion to fetch an object for her but there is no object at the location indicated by pointing. The companion tries to obey the command, it goes and looks for the object but as he does not find it he "gets confused" and shows signs of embarrassed behaviour.

Motivation: It helps user to realize that his request is ambiguous or not executable.

Activity model: The companion shows the various out-of-context behaviours (e.g. mouth-licking, yawning, sniffing the ground, scratching the ground, pace up and down between the owner and the place, avoiding eye-contact, displaying other activities).

Place/setting: Indoors/outside

Cognitive and physical capacities (Artifacts/Media):

- cognitive capacities for fetching and carry objects to user etc,

- recognize target location of pointing, and presence/absence of objects

- display a set of out-of-context actions

Time/flow: The companion realizes the conflict and the user realizes that the companion has got a problem.

*Research questions include: Is the h*uman able to recognize conflict situation on the basis of the behaviour displayed by the companion?

4.3.3 Teaching-learning (training)

Background theory

Teaching-learning interactions are important aspect of any dog-human relationship. In most cases these interactions are accidental and sporadic, that is, owners try to regulate the dogs' behaviour by using various positive or negative incentives (e.g. “punishment” or “reward”) and different forms of human communicative signals. The success of these spontaneous teaching interactions depends very much on the owners' social skills, the dogs' genetic makeup, and the social relationship between the partners. In other cases teaching (training) takes place in more formal situations, and on a regular basis. Such owners understand the basic requirements of such training and dogs are also learning step by step how to react to the training situation. Simple training scenario was described for the AIBO, and we believe that such interactions may facilitate the establishment and social relationship between human and dog (robots). Observations on teaching-learning interaction will cover both novice and advance trainees in different situations.

Key idea: Humans find it rewarding if they train the robot to execute certain tasks like, name of objects, carrying a new object, executing an action on command, or ways of moving around.

Human-companion relationship: There is a teacher-pupil relationship between the human and the dog.

Actors/roles: Companion and user

Activity description: The human teacher prepares a situation that facilitates learning in the companion. For example, the human teaches the companion to come on command. The companions may learn to approach the incentive shown by the human on command. The situation is executed repeatedly by the human moving around to different parts of the room.

Motivation: Teaching-learning interaction facilitates the development of social relationship, in parallel with subjective experience of mutuality and trust.

Activity model: The companion shows various behaviour activities elicited by situation but it learns through repeated interaction do decrease the frequency of these behaviours, and approach the calling human on the shortest route possible.

Place/setting: Indoors/outside

Cognitive and physical capacities (Artifacts/Media):

- cognitive capacities for having a simple learning modul

- recognize target(s), recognise and localize owner, recognize simple human communicative cues (e.g. pointing direction, head direction, verbal commands)

- ability to carry out the learnt action

Time/flow: Repeated interaction of similar types between the human and the companion until improvements in the requested behaviour are experienced.

*Research questions include: Is the h*uman able to recognize conflict situation on the basis of the behaviour displayed by the companion?

5 CONCLUSIONS

The main goal of this work package is to assist in the robotic design by providing input for construction of a behavioural “believable” output. It is assumed that behavioural interaction between user and the robot is a critical aspect of any long-term relationship. Most robots engineered so far show a behavioural robustness in the expense of flexibility, but this makes them also “boring” from the user’s perspective. In order to solve this problem robotics may need to take a detailed look into how the behaviour of living agents is organized, especially when interacting socially. In this project we rely on the human-dog interaction for gaining information about behaviour, but more importantly we will use these interactions to build some sort of mental models which have the potential to explain most of the variation that is seen in the behaviour of the dog. We expect that these behavioural models will inform the computational architecture of agents that are built in LIREC.

In order to achieve this goal we work in parallel with colleagues to build up possible situation that at present serve as sources of information on human-dog interaction but can be used in the future to test human-robot interaction for comparative purposes. This method offers a potentially new way of benchmarking in social robotics.

Up to now our work revealed important aspects of human-dog interaction which should be taken into consideration for robotic behaviour. Most of this is derived from the ethological concept of companionship (see D7.1.). In our view long-term companionship has both individualistic and social components. Individualistic components include personality, ability for emotional communication. Social components refer to the ability to “being useful” and mutually helpful, show mutual interest and learning abilities, and being able to develop sophisticated ways of cooperation. Importantly, not all of these components are pre-condition for a companionship but the nature and strength of the social relations correlates positively with the number of components involved. Moreover this depends also on the users’ attitude and needs. Some user may prefer companions that show only “affection” whilst others go for a behaviourally richer social relationship. This variability can be traced well in the dog owner community, where companionship includes “lap dogs” and “working dogs” for which humans express the same level of bonding in psychological terms.

This deliverable reports on the first steps to establish behaviourally valid situations which can be used for testing dog (and human) personality, emotional communication, and various forms of collaborations.

We have shown that using simple scenario-like social interactions have the potential to provide a model for dog personality. In addition, we have also shown that similar personality model can be built based on questionnaires that will be used for validating our behavioural tests. Future goals will include extending this research in ways that suits more to the personality traits of a companion. We will refine the behavioural testing of dogs, including scenarios that are closer to the actual showcases, and that also reflect other aspects of social interaction (e.g. teaching-learning).

We have shown that it is possible to establish scenarios in which the behaviour of dogs and robots can be compared both by prospective users and by objective means of behavioural analysis. Based on this approach, similar scenarios will be used to study the manifold variation in human-dog interaction. Especial care will be taken to utilise scenarios for developing simple emotional models based on communicative behaviour dogs and the responses of humans.

These and similar scenarios will be used also to provide a detailed temporal description of human-dog interaction. This is important for modelling the short-term and medium-term temporal changes in the behaviour. Various aspects of timing (e.g. duration of actions, latency of responses, dynamics (“intensity”) of the actions, recognition of and action on contingencies etc) are so fare neglected aspects of behavioural design. Finally, it we aim to investigate how certain personality traits influence co-operability between partners.

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7 APPENDIX A

Budapest Canine Personality Survey (Horváth et al., in prep)

		5	4	3	2	1	
1 [a]	Very playful	☐	☐	☐	☐	☐	Not at all playful
2 [b]	Confident	☐	☐	☐	☐	☐	Nervous
3 [b]	Relaxed in unfamiliar situations	☐	☐	☐	☐	☐	Timid in unfamiliar situations
4 [d]	Strongly attached	☐	☐	☐	☐	☐	Not at all attached
5 [a]	Highly excitable, impulsive	☐	☐	☐	☐	☐	Calm, placid
6 [d]	Obedient	☐	☐	☐	☐	☐	Disobedient
7 [a]	Active, energetic	☐	☐	☐	☐	☐	Inactive, lazy
8 [c]	Friendly	☐	☐	☐	☐	☐	Unfriendly
9 [d]	Intelligent	☐	☐	☐	☐	☐	Slow in thinking
10 [b]	Brave	☐	☐	☐	☐	☐	Timid
11 [a]	Curious	☐	☐	☐	☐	☐	Not curious
12 [b]	Can handle being alone	☐	☐	☐	☐	☐	Cannot handle being alone
13 [d]	Requires lots of care and attention	☐	☐	☐	☐	☐	Does not require lots of care and attention
14 [a]	Pushy	☐	☐	☐	☐	☐	Not pushy
15 [a]	Highly possessive	☐	☐	☐	☐	☐	Not at all possessive
16 [c]	Aggressive with unfamiliar people	☐	☐	☐	☐	☐	Not aggressive with unfamiliar people
17 [c]	Aggressive with unfamiliar dogs	☐	☐	☐	☐	☐	Not aggressive with unfamiliar dogs

[a] Liveliness scale

[b] Confidence scale

[c] Aggressiveness scale (Item 8 is reverse-scored.)

[d] Attachment scale

8 APPENDIX B

BUDAPEST PERSONALITY TEST (BPPT)

(appr. 30 minutes)

E=experimenter

O=owner

In case it is not mentioned other, the subtests follow each other continuously.

1. SPONTANEOUS ACTIVITY

The O stands still without paying special attention to the dog while holding the dog on a leash (1.5-2 m). The dog is allowed to move freely within the range of the stretched leash and is not corrected or rewarded for any behaviour. The duration of this test is 1 min. E stays at a distance of at least 3 m from the dog without paying attention to the dog.

2. GREETING

E approaches the dog from 5 m (behaves in a usual manner), greets the owner and speaks continously to the dog by orienting toward it. E stops for 1 s at 1 m in front of the dog, and says „Hello” and the name of the dog. In the meantime, E orients toward the dog, while the owner is in the same position as in 1.

If the dog approaches and shows „friendly” behaviour (moving towards E, tail wagging), **or** it shows neutral behaviour (does not move away, no tail wagging).

then

1. E steps toward the dog, and pats a few times the top of the head, the back and the shoulder (in this order). E continuously talks to the dog: How are you, What a nice dog you are, etc.

2. E steps 1 m sideways within reach of the leash. If the dog does not follow, E calls the dog.

If the dog does not approach E crouches and calls it again.

In case the dog does not approach the E, E starts to call the dogs and crouches. If there is still no response E goes to the dog and pets it.

In any case E pets the dog again by touching a few times the head, the back and the shoulder (in this order).

If the dog avoids E (but without vocalisation and aggressive display)

then

1. E approaches the dog outside the reach of the leash, and tries to call the dog by name. This is done first in a standing position and if there is no response E crouches. E talks continuously to the dog. If the dog finally approaches E, and it is not aggressive, E steps to the dog and follows the instructions above. If the dog does not respond the trial is terminated after 30 s.

If the dog is aggressive (growling, barking)

then
E does not steps to the dogs, and remains out of the reach of the leash. E speaks continuously to the dog for 10 s and then terminates the session.

3. GETTING EPIDERMIS SAMPLE (for genotyping)

If the E could caress the dog, he/she asks whether it is safe to put the fingers into the dog's mouth. If the answer is yes, E gets an epidermis sample (swab) using two sticks made of plastic with cotton at one end. The E carefully rotates the sticks rubbing the inner side of the mouth, and puts the sticks inside a numbered sealed plastic tube. If the dog does not stand motionless, the owner can intervene and help to stop the dog. In any case of aggression the E asks to collect the sample.

The procedure is repeated on the other side of the mouth as well. The samples are put in different tubes labelled as A and B.

4. PENDULUM TEST

The dog is standing on leash, and the owner must not talk to the dog.

Phase 1.

E holds a sausage (10-12 cm long) in one hand and a tennis ball in the other. Both objects are fastened to a 30 cm long string. E shows the objects to the dog, and when the dog orients toward them, he/she expands the arms, and observe which object is chosen by the dog. In the following the preferred object is used as the stimulus.

Phase 2.

The trial starts after E called the name of the dog. E holds the object in front of the dog at 50 cm from his nose and swings it from left to right for 30 s. Finally, the object is placed on the ground in front of the dog at 50 cm. The E observers whether the dog eats or picks up the object for 5 seconds (i.e. it was motivated to get the object). If the dog does not eat the food, the owner can encourage it to do it.

Important: The head of the dog should be visible on the camera.

5. SEPARATION
The dog is tethered to a tree on 3 m leash. O hides behind a different tree or screen which is about 5-6 m away from the tree.
Phase 1

After 1 min has elapsed E approaches the dog and greets it (see description at Test 2: greeting).
Then E initiates play with a tug for 30 s. Then E steps back to the camera.
Phase 2
After 1 min has elapsed, E asks the O to come back and greet the dog (see description at Test 2: greeting).
Owner initiates play with a tug (same as above).

6. BALL-PLAY WITH THE OWNER

The dog is unleashed. (If the dog can be unleashed because it cannot be called back, it should be on an 8-m-flexi leash hold by the E.)

Owner asked to throw the ball 3 times and encourage the dog to grab the ball and give it back to the owner.

7. PROBLEM-SOLVING

E determines a location that cannot be left by the owner. E holds a cage, crouches in front of the dog, and shows the cage to the dog. The cage has a slit through which a piece of cut can fall out. E pushes the food item through the slit and the dog can eat it.

E stands up, put another food in the middle of the cage, and put it in front of the dog. Then steps back to the camera.

The dog is allowed to approach the cage and get the food by any means. Owner should encourage the dog verbally, but he/she is not allowed to leave the spot.

If the dog acquires the food, E puts another piece of cut again into the cage and the trial is repeated.

If the dog does not acquire the food in 1 minute, the E gives the food to the dog, then puts another piece of cut again into the cage and the trial is repeated.

8. BONE TAKE AWAY

E grabs an artifical hand, and wears it throughout the test.

The dog is teathered on the 3m long tree. E gives a 20-30 cm long cooked bone (pig or cow) to the owner who encourages the dog to take it and chew. A 3 m long string is fixed to the middle of the bone. E hold the string during the test with his/her free hand.

If the dog does not start to chew the bone in 30 seconds, despite the continuous encouragement, E steps to the dog and pats it on its head and back with the artificial hand, in order to see whether the dogs is afraid of the hand.

If the dog starts to chew the bone, E waits for 5 seconds, then approaches the dog from front-wise, out of the reach of the leash.

Steps of taking the bone away:

1. E crouches and pats the top of the head and the back of the dog with the artificial hand 3 times. He/she does not talk to the dog.

2. E says „please” and leans toward the bone with the artificial hand, but does not touch it.

3. E touches the bone with the artificial hand for 3 s.

4. E starts to pull the bone by the string, while the artificial hand is continuously on the bone.

If the dog growls or bites or the dog drops the bone, the test should be terminated.

If E could not take the bone, the owner is aked to take it away from the dog..

Important: Because growling might not be recorded by the video, it should be mentioned by the E verbally.

The test is repeated once more.

9. THREATENING APPROACH

The dog remains tethered to the tree and additionally it is leashed and the owner hold the leash. O asks the dog to sit down. Afterwards O is not allowed to talk to the dog.

Phase 1

E approaches the dog slowly with a slightly bent upper body and she is looking steadily into the eyes of the dog without any verbal communication. If the dog interrupts the eye contact he/she tries to attract the dog’s attention: makes some noise (cough, stamping).

The approach is terminated if

E reaches the dog or

the dog barks/growls at the E or

the dog hides behind the O.

In the latter two cases E takes an upright position, smiles and says: "OH, this was a joke only!"

10. UMBRELLA

E steps in front of the dog (2 m) with a closed umbrella in his/her hand. The umbrella points toward the dog. When the dog orients in his/her direction, he/she opens the umbrella, lifts it up slowly above his/her head. After one second E puts the umbrella on the ground in front of him/her, and steps away 3 metres in the opposite direction. The owner is asked to walk the dog next to the umbrella. If the dog avoids the umbrella, O steps next to the umbrella, waits for 5 seconds then touches the umbrella and calls the dog.

11. LAYING TO THE SIDE

The owner commands the dog to lie down. Then crouches and turns the dog to its side in a gentle way. O tries to keep the dog in this position for 30 seconds. In case the dog gets up before the 30 minutes elapsed, the session starts from the beginning. Caressing is allowed.

If the dog refuses to lie down, and the owner is not able to force it, the test terminates in 60 sec.

11. „COUNTING"

O stands still and holds the dog on the leash.

Phase 1

E turns back to the dog, and puts 1 food item on a white plastic table, and 8 food items on another. Then E with takes the two plates, hold them closely to each other, steps to the dog and shows both plates to it. Then E steps back 2 m. Then E expands the hands as far as possible and puts down the plates. Then E stands up, and tells the O to let the dog to make a choice.

Phase 2

Same as above, but instead of standing up, E steps to the plate with the one item, crouches down, grabs the food, imitates eating, says "Hmm-mmm" and puts the food back. Then E stands up, steps in the middle and tells the O to allow the dog to make a choice.

The position of the plates remains, if the 1-item plate was on the right in Phase 1, it is on the right in Phase 2 as well.

12. HIDING

E asks for the leash and grabs it. O hides behind a tree or a house (15-20 m). The dog continuously watches the owner.

After 30 seconds E releases the dog and says "Go!" if needed or pushes the rear end of the dog gently.

If the dog doesn't move in 5 seconds, E asks the owner to call the dog.

13. SPONTANEOUS ACTIVITY

same as 1.