5. Antrag Rault Jean-Loup vom 01.3.2023

Projekttitel:	Meditating dogs' well-being: Dogs breathe deep and keep calm
Name der Organisation:	Institute of Animal Welfare Science, University of Veterinary Medicine, Vienna
Strasse:	Veterinaerplatz
Zusätzliche Adressangaben:	1
PLZ:	1210
Ort:	Wien
Land:	A
Verantwortliche Person(en):	Prof. Jean-Loup Rault
Telefon (mobil):	+43664602576993
Datum der Einreichung:	01/03/2023
Thema:	Dog welfare
Beantragte Unterstützung (CHF):	13390
Bankverbindung (IBAN):	AT 74 1200 0520 7900
Vorgesehener Projektstart:	01/05/2023
Vorgesehener Projektabschluss:	31/10/2023
Kurzzusammenfassung des Projekts:	Deep breathing, by long inhalations and exhalations, is a core basis of some exercises like meditation and can induce relaxation. The ability is known only in humans but other animals can be trained to exert biofeedback. We hypothesize that dogs can deepen their breathing and derive similar benefits. Together with 2 certified dog trainers (Sabrina Karl, Annika Bremhorst; co-applicants), we recently develop a training protocol (unpublished) for deep breathing in dogs, through a pilot study. This project aims to test the generalizability of this training protocol on a larger population, and to study the effects of deep breathing practice on the dog's behaviour and physiological state, especially for stimulating parasympathetic activity linked to relaxation. 12 dogs and their owners will be enrolled in the study, and 2 certified dog trainers will instruct the owners on training their dogs to deepen their breathing for 1-2 min periods. We will conduct the intervention at home and with the dogs instructed by their owner to reduce potential stress effects, with remote monitoring and advice from the trainers. Once the participants fulfil pre-defined success criteria, biological changes in the dogs will be recorded non-invasively, using a video camera to record the dog's behaviour, and a telemetric monitor to record respiration rate and heart rate before, during and after the intervention, and after a control session. This represents the first scientific study to our knowledge on deep breathing in dogs, with potential important implications for dog welfare to induce

relaxation and possibly enhance emotional regulation, as a possible therapy against anxiety, restlessness and other stress-related problems. The scientific knowledge will be disseminated by presentations at scientific conferences (e.g. Canine Science Forum), and the publication of an open-access scientific paper in a high-impact scientific journal (e.g. PNAS).
Keywords: animal welfare, breathing, dog training, parasympathetic activity, relaxation.

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Aktueller Stand der Forschung auf diesem Gebiet

How deeply phylogenetic can meditation-related effects go?

Meditation has only recently attracted interest in Western countries but it has been popular in Asia for millennia. Knowledge of meditation remains confined to humans, despite our biological similarities to other animal species. One of the most basic and prevalent forms of meditation are breathing exercises. Breathing is essential to the life of humans and other animals alike and central to their survival and well-being (Beausoleil & Mellor 2015). **Breathing exercises that lead to relaxation and other benefits in humans are likely to have similar effects in non-human animals (hereafter, 'animals').**

Many animal species have been successfully trained to exert biofeedback, *i.e.* self-regulation to control their biological responses such as heart rate variability, brain activity (primates, dogs, cats, horses; Sitaram et al 2017) or holding their breath (Gallego et al 2001). Various biofeedback practices have been implemented in veterinary medicine and animal training, in particular to treat disorders in companion animals such as epilepsy, aggression, anxiety, or restlessness. Anecdotal evidence suggests that biofeedback can make animals calmer, more emotionally stable, and better at problem solving. **Nevertheless, these interventions lack a scientific basis.** Whether animals can be trained to practice meditation-like breathing exercises, and whether doing so benefits their well-being, remains to be investigated.

Breathing meditation practice and well-being: short- and long-lasting effects

Breathing is exceptional in that it is under both automatic and voluntary motor control (Beausoleil & Mellor 2015; Del Negro et al 2018). Although the mechanisms of generating breathing rhythms remain unresolved (Del Negro et al 2018), modification of the breathing pattern has immediate effects. The typical stress response induces shallow, faster breathing mainly utilising the upper chest area of the lungs (Del Negro et al 2018). This response can be consciously modified by using the diaphragm to engage in breathing patterns deeper than normal. **This technique is commonly referred to as 'deep breathing', diaphragmatic breathing or abdominal breathing.** It is widely used in yoga and meditation practices and has been incorporated in many relaxation programmes.

Deep breathing techniques typically involve performing a series of inhalations and exhalations longer than normal, leading to both a deeper and slower breathing pattern. Some techniques simply rely on longer inhalations and exhalations, *e.g.* inhaling and exhaling while silently counting to four for each phase or based on subjective feelings of lung extension or the abdomen rising. Other techniques have more complex patterns of exhalations longer than inhalations, and for some holding the breath in between, *e.g.* 4-7-8 breathing: inhale for 4, hold the breath for 7, exhale for 8. Deep breathing exercises are usually done for 5 to 10 min daily.

The physiological changes induced by deep breathing practice remain to be fully understood. It has been shown to modulate the autonomic nervous system by enhancing parasympathetic activity, leading to lower heart rate and lower systolic and diastolic blood pressure, altered oxygen consumption, increased theta brain waves, and other physiological changes (Jerath et al 2006).

In addition to immediate changes, deep breathing practice can have effects that outlast the session, although most evidence comes from anecdotal reports or often controversial scientific studies (Van Dam et al 2018). The main interest is in deep breathing as one of the most practical relaxation techniques (Jerath et al 2006). Mechanically, stretching of the airway muscles is encoded by the vagus nerve (Del Negro et al 2018), supporting a tight link between breathing and vagal activity. **This change in vagal activity likely underlies the long-lasting effects of deep breathing on biological functioning through the relaxation response (Benson et al 1974), characterised by higher parasympathetic activity, lower stress-related hormones, and behaviours indicative of a relaxed state.**

Attention to breathing has also been proposed to improve the ability to consciously attend to and modulate physiological arousal (Wielgosz et al 2016). These effects may be linked to a long-term modification of the normal breathing pattern as meditation practitioners tend to have slower baseline respiration rate also outside of practice sessions (Wielgosz et al 2016). Humans take 20 000 breaths a day but commonly breathe using the chest utilizing the top third of the lungs, whereas the bottom

third of the lungs can supply two-thirds of our breathing capacity. **The benefits of deep breathing practice may lie in mobilizing this untapped potential.**

Original approach and innovative aspects

An attempt to train non-human animals to deepen their breathing pattern has never been reported in the scientific literature, to the best of our knowledge. Like humans, dogs have been shown to use spontaneous diaphragmatic breathing to increase their breathing capacity (Callison et al 2019), they are highly trainable (*e.g.* dogs can be trained to sniff on command), and as mammals share a common breathing mechanism with humans (Del Negro et al 2018).

Deep breathing and other forms of meditation were viewed sceptically decades ago, but scientific approaches have now shown a plethora of benefits on human well-being. The science of meditation is considered a serious topic of research, with the scientific literature tripling in size in the last ten years (van Dam et al 2018). There is no doubt that these practices have biological effects, although the extent and magnitude of the benefits is sometimes exaggerated (Van Dam et al 2018), therefore requiring methodologically rigorous research.

Whether animals can be taught to deepen their breathing remains unexplored and could bring ground-breaking insights into a capacity that some argue is uniquely human, an argument that is likely fallacious as other animals can voluntarily control their breathing (Gallego et al 2001). To our knowledge, there is only anecdotal evidence that dogs can be trained to modify their breathing (*e.g.* Overall, 2010), which would be strengthened by systemic scientific evidence.

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Aktueller Stand der eigenen Foschung

I am a Full Professor at the University of Veterinary Medicine, Vienna (Austria) and Head of the Institute of Animal Welfare Science, composed of 6 scientists and 25 staff in total conducting research and teaching on the behaviour and welfare of domestic animals.

I have 86 peer-reviewed papers published (9 of them with my PhD supervisor) with 150 co-authors, including 35 papers as first author and 29 as last (senior) author, with 1 228 citations of my work and an h-index of 20 (source: Scopus; excluding self-citations) or 2 374 citations and an h-index of 28 (source: Google Scholar). A full list of my publications is available at: https://orcid.org/0000-0001-6015-8318 or https://www.scopus.com/authid/detail.uri?authorId=50862024400

Selected publications (citation: source Scopus)

***J.-L. Rault**, R. Binder, H. Grimm. 2022. Rethink farm animal production: The 3Rs. Science 378 (6622), 842 https://doi.org/10.1126/science.adf3351 Cited 0 times.*

I initiated and led the writing of this paper published in the prestigious journal Science, making a case for rethinking farm animal production using the framework of the 3Rs. Together with a philosopher and an animal law expert, we discussed how it could reconcile animal agriculture with the global societal challenges of climate change, food security, the environment and health as well as animal welfare.

***J.-L. Rault**, S. Waiblinger. X. Boivin, P. Hemsworth. 2020. The power of a positive human-animal relationship for animal welfare. Frontiers in Veterinary Science 7: 590867.* https://doi.org/10.3389/fvets.2020.590867 *Cited 32 times.*

This literature review covers the potential mechanisms involved in the development and maintenance of positive human–animal relationships from the perspective of the animal. We review the indicators that could be used to assess a positive human-animal relationship, the characteristics influencing thi relationship, and highlight implications for current practices and suggest simple solutions.

*J. Oliva, **J.-L. Rault**, B. Appleton, A. Lill. 2016. Oxytocin blocks pet dog (Canis familiaris) object choice task performance being predicted by owner-perceived intelligence and owner attachment. Pet Behaviour Science 1: 31-46.* https://doi.org/10.21071/pbs.v0i1 *Cited 15 times.*

This study demonstrates that an owner's style of attachment to his/her dog may affect both the type of human social cue that the dog can use, and the degree to which it can do so. The study also reveals the importance of past experiences of bonding, with both pets and children, in both the owners' perceptions of their dog's cognitive skills, and the style of attachment to it.

*J. L. Oliva, **J.-L. Rault**, B. Appleton, A. Lill. 2015. Oxytocin enhances the appropriate use of human social cues by the domestic dog (Canis familiaris) in an object choice task. Animal Cognition 18: 767-775.* https://doi.org/10.1007/s10071-015-0843-7 *Cited 57 times.*

This research supports a role for oxytocin in human-dog communication and furthered our knowledge of dog social cognition. Interestingly, it also showed a

***J.-L. Rault**. 2012. Friends with benefits: Social support and its implications for farm animal welfare. Applied Animal Behaviour Science 136(1): 1-14. https://doi.org/10.1016/j.applanim.2011.10.002 Cited 141 times.*

This review covered the factors influencing the benefits of social behaviour for animal welfare. More than half of the citations have come in the last 5 years and citations are rising year-to-year, demonstrating my early contribution and vision on a topic of increasing relevance.

Creativity and independence

I initiated and developed my PhD topic on the role of oxytocin in the social behaviour of domestic animals, which in 2008 was an innovative line of research that has allowed me to become a unique expert in the field. I now have collaborations with colleagues (in The Netherlands, Sweden, Norway, Denmark, Germany, France, Ireland, USA, Australia, Austria) to develop, validate and conduct oxytocin analysis on a wide range of species. I have published this research in top interdisciplinary journals such as Psychoneuroendocrinology (Rault, 2016; Lürzel et al., 2020), allowing me to cross disciplines, as some of my papers are cited well beyond my field in the medicine, nutrition, pharmacology, cognition, psychology and psychiatry literature (*e.g.* Rault et al., 2013 https://doi.org/10.1016/j.physbeh.2013.02.007).

I am an internationally recognized researcher in animal behaviour and animal welfare science. I was promoted to Full Professor in 2017 at 33 years of age thanks to my excellent scientific reputation and publications. This also shows my independence: I have sole responsibility for leading an institute comprised of 25 staff while continuing to be a prolific and high-level scientist. I have published several influential papers on my own (Rault 2012, 2016, 2019), demonstrating my creativity and independence, although I favour collaboration (150 co-authors) to benefit from intellectual synergy. I am one of seven scientific experts of a group of the World Organization for Animal Health to develop international guidelines for the welfare of laying hens. I am part of a successful 2022 EU COST Action on positive animal welfare (CA21124) and was elected leader of one of the three Working Groups, with the mission to define and harmonize the concepts surrounding positive animal welfare, a rising topic on which I have published (Rault et al., 2020) and co-edited a special issue in Frontiers last year.

I have developed and coordinate a new course “How Animals Feel” for Master and PhD students, covering the state-of-the-art in animal emotions, with 10 lecturers delivering perspectives from behaviour, physiology, cognition, neuroscience, and medicine, bringing in internationally renowned scientists as guest lecturers (Mike Mendl, Elodie Briefer).

Ground-breaking research

I initially developed a unique specialty on social behaviour and oxytocin in domestic animals, for which I am renown. For the last 5 years, I have focused on prosocial behaviour and broaden my research to lead the way on positive animal welfare, *i.e.* positive experiences in animals and their implications for animal welfare. I was awarded the International Society of Applied Ethology 2016 New Investigator prize as a recognition of my contribution to the field. My top publication (Rault, 2012) has been cited 141 times, which is a high number in my field, and was the second most cited paper for the journal the year after its publication and the fifth most cited over the next 5 years; it is today in the 96% percentile for citations in Scopus. A more recent paper (Rault, 2019) is in the top ten most cited papers for the journal over the last 3 years. I have also published unconventional papers, such as an opinion paper on the future of pets in the digital age (Rault, 2015) that with 27 532 views ranks in the top 1% of all Frontiers articles.

I strive to push the boundary of my field and to question scientific dogma and the status quo. I published the first literature review of prosocial behaviour for its implications for animal welfare (Rault, 2019), and highlighted promising avenues for research that my group and international colleagues are now pursuing. My innovative research earns me regular invited talks, such as an invited symposium talk at the European Conference on Behavioural Biology 2022, a leading European scientific society on behaviour, entitled “A stake in the well-being of others: the case of social animals”, a plenary talk at the French Society for the Study of Animal Behaviour (SFECA) 2022 entitled “Positive experiences in animals: how and why?”, a pause during the covid-related conference break in 2020 and 2021, a symposium talk at the International Behavioral Neuroscience Society 2019 entitled “Socio-behavioral neuroscience of animal welfare: What can we learn? What are we missing?”, a plenary talk at the International Conference on Applied Ethology 2018 (Freiburg) entitled: “Social behaviour: Objective approaches to subjective experiences”, a plenary talk at the International Society of Applied

Ethology 2017 entitled “Pro-social behaviour: Inside out”, and numerous other invited talks in university seminar series worldwide (Canada, United Kingdom, France, Germany, Switzerland, Austria).

I am an innovator. I have developed new bioanalytical methods, such as a new method to quantify oxytocin in pig cerebrospinal fluid (Rault, 2016) and in the saliva of pigs, cattle and goats (Lürzel et al., 2020), wireless electroencephalography in pigs (Rault et al., 2020), and the analysis of brain-derived neurotrophic factor in pigs (Rault et al., 2018). I strive for multi-disciplinary research. For example, I obtained a grant from our national research funding agency for scientific excellence (2020 FWF project P 33669, € 403 157) on the topic of positive pig-human interactions with a multi-disciplinary approach encompassing animal behaviour, physiology, neuroimaging, neuroendocrinology, pharmacology, immunology and proteomics, bringing together a number of expert collaborators in these disciplines. I am eager to seek collaborations that complement and strengthen my research, having worked together with computer and artificial intelligence engineers, psychologists, neurobiologists, cognitive biologists, microbiologists, immunologists, and audiologists amongst others. The combination of disciplines and thinking outside the box has allowed me to make significant intellectual and methodological contributions.

Project leadership

I have led and managed all research projects awarded as Principal Investigator, amounting to 22 competitive research grants for a total funding of € 1 635 098, on which I have always delivered peer-reviewed scientific publications and disseminated my findings through scientific conferences and popular press articles.

I am an experienced mentor of early-stage researchers, having acted as main supervisor for 12 Postdocs, 6 PhD students, and 26 Master students.

I have expertise in all the techniques proposed (animal behaviour, physiology) necessary to execute this project.

Detaillierter Forschungsplan:

Hypothesis and aim

We hypothesise that dogs can be trained to deepen their breathing pattern. In an initial pilot study, we created and established a training protocol with two certified dog trainers who instructed two dogs to modify their breathing pattern to take deeper and slower breaths. The proposed study builds upon this work by aiming to apply the developed training protocol on a larger sample size of dogs who will be trained to breathe deeply on command/verbal cue by their caretakers under the guidance of the two experienced dog trainers. This will help to test the generalisation abilities of our deep breathing training protocol on a larger sample of dogs, to further evaluate its effects on dogs' behaviour, respiration rate, and heart rate variability, and potentially to optimize our training protocol in the process.

Subjects

Twelve dogs and their caretakers will be recruited to participate in the study. The two co-applicants, Dr. Sabrina Karl and Dr. Annika Bremhorst (both behavioural scientists with a research focus on dogs and dog trainers certified with the official label "Dog trainer in accordance with animal welfare" of the Republic of Austria) will initially instruct the caretakers about the training procedures, follow their process, and regularly exchange with them about their training and evaluate their progress and training success. The training will be performed by the dog's caretaker or by one of the two co-applicants in presence of the caretaker, depending on how the caretaker and the dog are performing in the training process.

Deep breathing training

During training, dogs will learn to perform deep breathing sessions, in which they take a series of long inhalations and exhalations, to reach a slow, deep breathing rhythm. For this purpose, the dogs will be trained in incremental steps to control and deepen their breathing (normal dog breathing rate ≈ 20 breaths per min; depending on size and age), according to the training protocol that we developed in our pilot study. Exclusively positive, reward-based reinforcement will be used for this training. We teach the behaviour to the dogs mainly by means of (free) shaping, a training method that leads to progressively refining the behaviour towards the training goal by breaking down the task into small achievable steps. We will attempt to train for a maximum of six weeks, with regular weekly sessions (at a time convenient for the dog caretaker and their dog) of maximum 45 minutes, including breaks. The training will be adapted to the individual demands or learning progress of the respective dog.

If the trainer deems the training successful, with the dog breathing deeply, the dog's breathing behaviour will be quantified. For this purpose, the dog's respiratory rate will be measured by placing a non-invasive telemetric monitor (BioHarness®, BioPac, CA, USA) on the dog's chest, which can record inhalation and exhalation rates based on thoracic movements. The monitor will gently be attached to the dog, as the monitor is attached to an extensible and adjustable belt with as little handling as possible. The dogs are then given time to get used to wearing the monitor, checking that they do not show any behaviours that suggest they perceive the monitor as disturbing (*e.g.* manipulating the monitor with their mouth or paws, attempting to wipe it off). If the monitor appears to cause

discomfort to the dog, based on its behavioural response, the monitor will be removed. While wearing the monitor, the dog will be asked to remain in a constant position (standing still, sitting, or lying) to avoid locomotory movements that could interfere with the measurement, but on a voluntary basis and therefore without fixation. We will also video record the sessions, and experienced coders will analyse the behaviour of the dogs using an ethogram, with a focus on signs of relaxation such as head in contact with the floor, low hanging ears, tail low and still, etc. The BioHarness® record respiratory rate as well as heart rate (inter-beat interval, R-R). We will calculate mean heart rate, and the root mean square of successive differences between RR intervals (RMSSD) as a time-domain measure of parasympathetic activity. We will also perform spectral analyses by Fast Fourier transformation using the software AcqKnowledge® (included with the Bioharness device) to estimate high frequency HRV as a frequency-domain measure of parasympathetic activity.

We will also include a control session, where the dog will go through a similar procedure on a different day, using a counterbalanced design, being asked to perform a skill it knows without modifying its breathing pattern for the same duration to compare results and assess changes specifically linked to the breathing exercise (behaviour, respiration rate, heart rate). The owner will also be instructed to have a task that requires the dog to assume a similar position and similar level of focus as for the deep breathing session, but without asking the dog to deepen its breathing.

General care

The study is designed to elicit positive affective states and thus no states such as pain, suffering, lasting harm, or fear are expected to occur in the dogs.

We will brief and check with the dog caretaker that the dogs feel comfortable at any time and are motivated and able to learn the training steps to reach the final training criteria, i.e. deep breathing. Moreover, we will adapt the training steps according to the dogs' well-being and their individual learning speed. If there are noticeable signs or precursors of discomfort in the dog's behaviour or body language, the training will be stopped and the situation adjusted to continue positively with the dog. The involved dog trainers (and experimenters) are highly qualified for dog training and experienceed in detecting discomfort signals in dogs, and dealing with dog caretakers in similar studies. If the training sessions are interrupted on three consecutive sessions due to the repeated reluctance to participate or avoidance behaviour towards the trainer, this dog will be excluded from the study.

No difficulties are foreseen as we will use only non-invasive procedures and training will exclusively be based on positive reinforcement. We will only enrol and continue with dogs with the written consent of their caretakers (a consent form will be signed by the dog caretakers prior to starting the study). We will study dogs of both sexes allowing us to test whether male and female dogs respond differently. A training session will be interrupted if the dog starts to move around and cannot assume a constant position, or shows panting behaviour over a continuous duration of 5 minutes, *e.g.* due to high external temperatures, as this would interfere with their ability to breathe deeply, and therefore with our study aim.

Outside of the training sessions, the dogs will follow their daily routine.

Project risk management

Professional dog trainers will be used to ensure consistent training methods, and we already confirmed through our pilot study that it is possible to train dogs to deepen their breath. The study will be conducted with dog caretakers, which is representative of the population but also likely to be more heterogeneous in terms of training than if the dogs were trained by a professional trainer. We will adjust for the higher heterogeneity, which brings the benefit of higher external validity, by instructing the dog owners on the training, having the researchers check training success and the quality of the data collected. We choose to conduct the intervention at home and with the dogs instructed by their caretaker to reduce potential stress effects. We have an extensive list of contacts of dog trainers and dog caretakers allowing us to enrol a sufficient number of subjects in case participants drop out. We have experience in using all the proposed measurements.

Statistical analysis

We will use descriptive data based on the notes on each dog's progress throughout the training, and the recording of the respiratory rate obtained. The outcomes of this study should provide the first data to allow us to calculate sample sizes for follow-up studies, as there is currently no data on training animals to breathe deeply and it is difficult to extrapolate the sample size from human studies.

Schedule

Description	**Project month**					
	1	**2**	**3**	**4**	**5**	**6**
Recruitment of participants	■					
Preparation of material for initial briefing session, regular follow-ups, and training evaluation	■					
Briefing session	■					
Training phase (including regular follow-ups and training evaluation)		■	■			
Data analyses				■		
Write-up					■	■

Budget

- Dog trainers: briefing and following the participants and evaluating progress and success: 19.5 € per hour × 5 hours per week × 16 weeks × 2 dog trainers = 3120 € or 3090 CHF.
- Participants gift/voucher: 100 € × 12 participants with their dogs = 1 200 € or 1 195 CHF.
- BioHarness® heart rate monitor to record heart rate for WP5 heart rate variability, 3 082 € including shipping + 20% VAT: 3 698 € or 3658 CHF.
- 1 GoPro cameras to record the final breathing session, with tripod, battery and SD card: 630 € or 623 CHF.

- Posting fee to send the harness (with a package insurance of 3700 €) and camera to the participants and return: within Austria: 42.26 € × 2 (send and return) x 6 participants = 507 €; within Germany: 23.49 € × 2 (send and return) x 6 participants = 282 €; from Austria to Germany: 192.59 € × 2 times = 385 € ; from Germany to Austria: 69.99 € × 2 times = 140 €. Total: 1314 € or 1302 CHF.

- 3 hard drives for storage of project data (respiration rate, videos): 312 € or 309 CHF

- 1 conference presentation (*e.g.* Canine Science Forum; conference registration, transport, hotel accommodation): 800 € or 791 CHF.

- Open access scientific publication (*e.g.* Proceedings of the National Academy of Sciences (PNAS), or Scientific Reports): 2595 USD or 2 422 CHF

TOTAL: 13 390 CHF

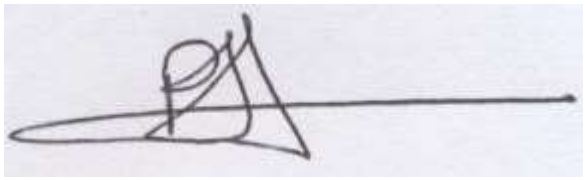
Erwartete Resultate und Ziele des Projektes:

Breathing is key to life and well-being, an aspect that we tend to forget as it is most of the time under automatic unconscious control. Despite its importance, the power of breathing has long been underappreciated. Deep breathing practices are now being increasingly used by a variety of professions and in various situations for humans, from US elite forces to helping people cope with a broad range of diseases and situations. This project aims to investigate whether dogs can benefit from deep breathing practice, and therefore it challenges the untested assumption that its potential benefits are restricted to humans. Use of an animal model will advance our understanding of the effects of deep breathing on biological functions, while opening a ground-breaking area of research for animal welfare science. It will offer an innovative model to study the effects of biofeedback interventions on well-being and bring knowledge on relaxation in animals, a poorly understood topic. This project therefore promises to open new lines of research for its effects on attention, emotion regulation, and cognitive abilities in animals. From a practical point of view, the work has tremendous potential to lead to innovative interventions in veterinary medicine, preventive or therapeutic, supported by scientific evidence. This would undeniably fuel a revolution in our approach to the well-being of animals, potentially benefiting the over one billion dogs worldwide and other animal species.

Tierversuchsbewilligung bzw. Erklärung:

We have already applied for ethical approval of this study and are currently awaiting the decision of the commission. No difficulties are foreseen as animals will be used according to the 3Rs and the work will rely on previously approved methods using non-invasive procedures that will be applied with the consent of the dog caretakers. We have already obtained animal ethics approval for our pilot study that used similar methods as the ones proposed for the current study. The pilot study protocol was approved by the Ethical Committee of the University of Veterinary Medicine (Vetmeduni) Vienna (approval number ETK-095/05/2022).

Application signature



Prof. Jean-Loup Rault

Dr. Annika Bremhorst

Dr. Sabrina Karl