



# Open source low-cost device to register dog's heart rate and tail movement

Project URL: <https://github.com/nekrum/DogVest>

Raul Hernandez\*, Edgar A. Morales and Laura V. Cuaya

## 1 Introduction

In dogs, the perception of an important stimulus can be related to physiological changes such as the heart rate (e.g., in socioemotional situations with humans [1] or dogs [2]) and the movement of their tail (e.g., tail-wagging has a bias that depends on the nature of the stimulus, a bias to the left is related to a withdrawal tendency and a bias to the right is related to an approach tendency [3]).

Although heart rate and the tail movement are important gateways to understand dog's cognition, just a few studies report these variables. Perhaps this is related to the difficulty of obtaining records of these variables in natural environments (e.g., parks), the elevated cost of a commercial data acquisition hardware (around \$5,000 USD [4]) or by inexistence of a tail-movement registering device. For these reasons, the goal of this brainhack project is to design and build a low cost device able to register the heart rate and changes in the tail movement in dogs, both in laboratory and in free movement conditions.

## 2 Approach

We decided to base our design in arduino hardware for its accessibility and broad use. The materials are detailed in the 1.

We designed and 3d printed a PLA case to contain the circuit. The case has a slot to add a strap to fix the device on the dog's back. The program for the arduino and the model for the case can be downloaded from the GitHub (scripts directory) repository of the project.

In order to assess if the device could reliably get readings from a dog, we tested it in three phases: baseline, stimulation/no-stimulation and free movement. All phases lasted two minutes and were repeated twice on two dogs. In both, baseline and stimulation/no-stimulation, the dog stayed in sphinx position without movement restrictions but under the command "stay". The stimulation/no-stimulation phase consisted in three interleaved repetitions of two types of conditions, stimulation and no-stimulation, each repetition lasted 20 s. In the stimulation condition the dog owner showed the dog a treat and mentioned the dog's name. In the free movement condition, the dog walked down a street without any specific command.

## 3 Results

In the stimulation/no-stimulation phase a Wilcoxon Signed Rank Test revealed statistically significant differences ( $p < 0.05$ ) between the beats per minute, beat amplitude and the tail movement amplitude 1.

By matching the data collected with observations of the movement of the tail, we notice that the data reflects the position of the tail but its resolution depended on the position of the electrode.

The data acquired from the free movement condition was affected by the movement and didn't seem reliable for testing.

## 4 Conclusions

We were able to build and test a non-invasive low cost device with the capacity to register the heart rate and the tail movement of dogs. We consider that the addition of a movement sensor could provide additional data to reduce the change on the signal due to movement.

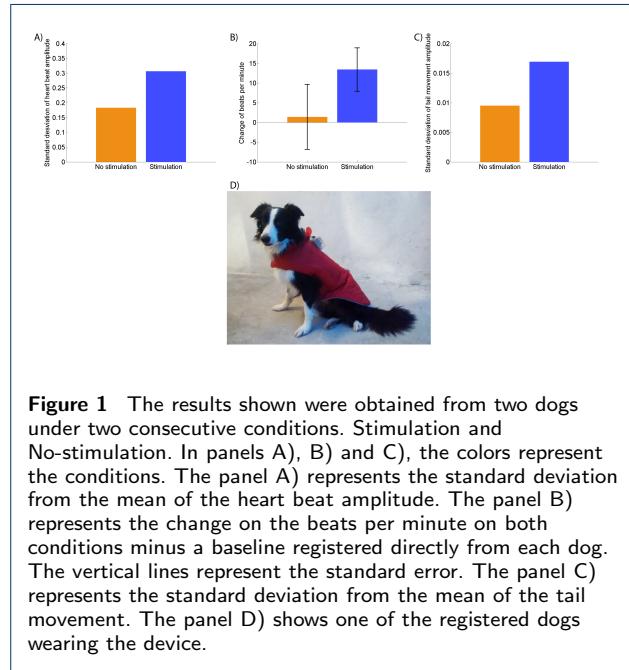
\*Correspondence: [sevenedenr@gmail.com](mailto:sevenedenr@gmail.com)

Instituto de Neurobiología, Querétaro, Boulevard Juriquilla 3001, 76230, Querétaro, Mexico

Full list of author information is available at the end of the article

**Table 1 Materials and cost.** The table shows most of the materials used and their approximated cost with a local provider. Other materials were used but their cost is negligible.

Materials	Aproximated cost (in USD)
Arduino UNO rev3	20
EKG-EMG-shield from Olimex with electrodes	48
Vibration sensor from phidgets	11
9v rechargeable battery	7
SD Card Reader module ARM MCU	1.2
Total	87.2



**Figure 1** The results shown were obtained from two dogs under two consecutive conditions. Stimulation and No-stimulation. In panels A), B) and C), the colors represent the conditions. The panel A) represents the standard deviation from the mean of the heart beat amplitude. The panel B) represents the change on the beats per minute on both conditions minus a baseline registered directly from each dog. The vertical lines represent the standard error. The panel C) represents the standard deviation from the mean of the tail movement. The panel D) shows one of the registered dogs wearing the device.

This device can be integrated in future research on dog's cognition. It can also be used in shelters and homes to easily measure the responses that dogs present to different sets of stimuli; for example, when a dog is left alone in its house and shows stress (i.e. increased heart rate, preferential tail movement to the left) the dog's carer could make changes in the environment to increase the well-being of the dog.

The low cost and the easy access to the materials needed to build the device make it a feasible option to study dog cognition. The results showed that the device could be used to distinguish between two different stimulation conditions.

#### Availability of Supporting Data

More information about this project can be found at: <https://github.com/nekrum/DogVest>. Further data and files supporting this project are hosted in the *GigaScience* repository REFXXX.

#### Competing interests

None

#### Author's contributions

LVC generated the idea for the project, made the research, help writing the report and acquire the data. EAM and RH designed the device, build it, wrote the code and help writing the report.

#### Acknowledgements

We would like to thank the organizers and attendees of Brainhack MX and to the Instituto de Neurobiología. Specially to Fernando Barrios Alvarez for the invitation and the support on the realization of the project. Laura V. Cuaya, Raul Hernández and Edgar Morales are a doctoral students from Programa de Doctorado en Ciencias Biomédicas, Universidad Nacional Autónoma de México (UNAM) and received fellowship 407590, 409258 and 215702 from CONACYT.

#### References

- Palestrini, C., Previde, E.P., Spieazio, C., Verga, M.: Heart rate and behavioural responses of dogs in the ainsworth's strange situation: A pilot study. *Applied Animal Behaviour Science* **94**(1–2), 75–88 (2005). doi:[10.1016/j.applanim.2005.02.005](https://doi.org/10.1016/j.applanim.2005.02.005)
- Siniscalchi, M., Lusito, R., Vallortigara, G., Quaranta, A.: Seeing left- or right-asymmetric tail wagging produces different emotional responses in dogs. *Current Biology* **23**(22), 2279–2282 (2013). doi:[10.1016/j.cub.2013.09.027](https://doi.org/10.1016/j.cub.2013.09.027)
- Quaranta, A., Siniscalchi, M., Vallortigara, G.: Asymmetric tail-wagging responses by dogs to different emotive stimuli. *Current Biology* **17**(6), 199–201 (2007). doi:[10.1016/j.cub.2007.02.008](https://doi.org/10.1016/j.cub.2007.02.008)
- SUPPLY, P.M.: Vmed Bluetooth Wireless Veterinary Monitors. <http://www.paragonmed.com/wirelessmonitors.shtml>. [Online; accessed 02-Dicember-2015] (2014)