DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Centro E. Piaggio
bioengineering and robotics research center

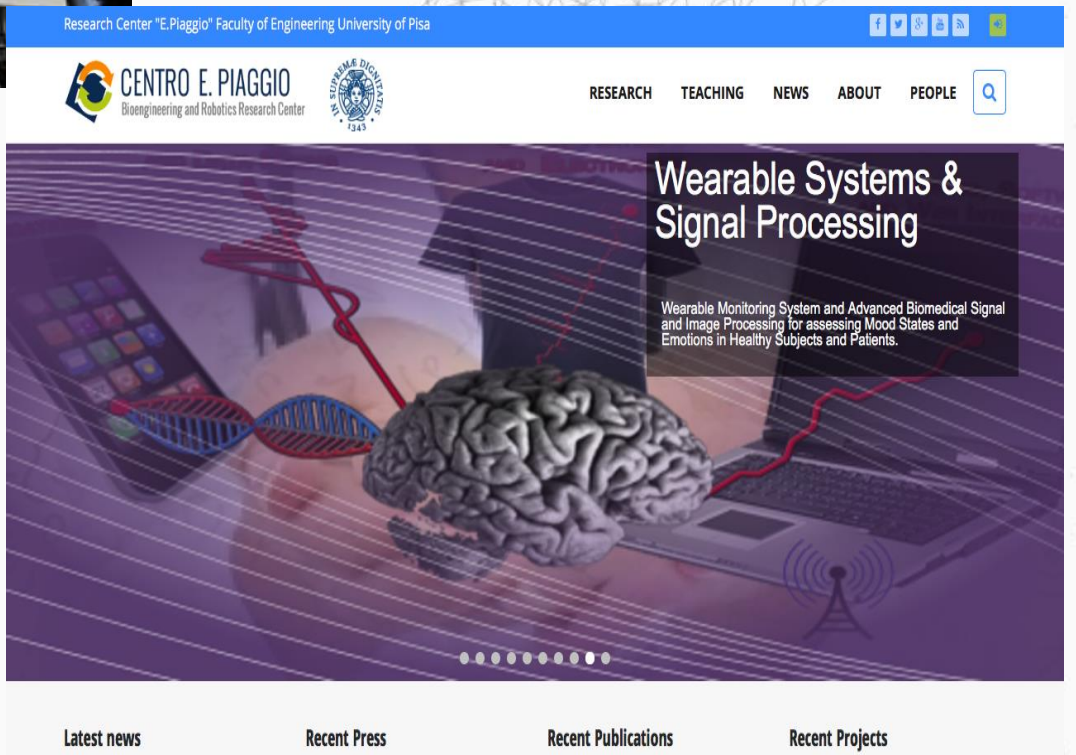
Riflessioni sugli esiti di una ricerca multidisciplinare

Enzo Pasquale Scilingo, PhD

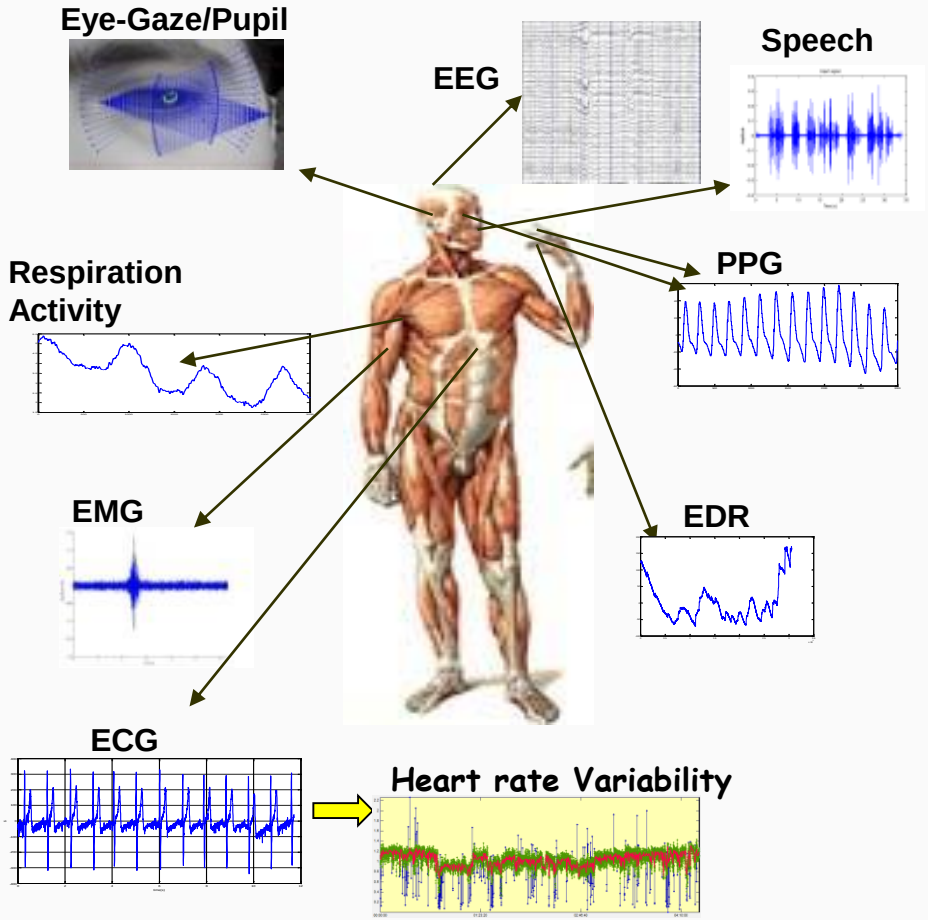
Computational Physiology & Biomedical Instruments Group

UNIVERSITÀ DI PISA

Collaborazione



Studying Autonomic and Central Nervous System Dynamics through Signal Processing and Wearable System



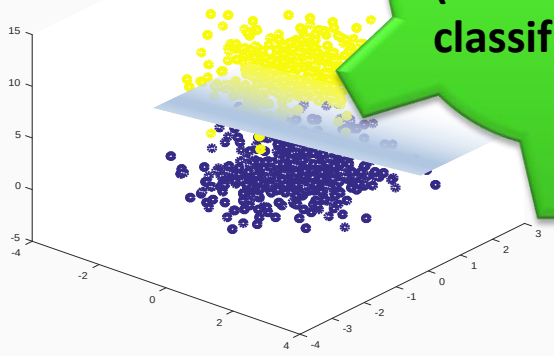
Commercial hardware

Research on new Sensors and Wearable Systems for physiological monitoring

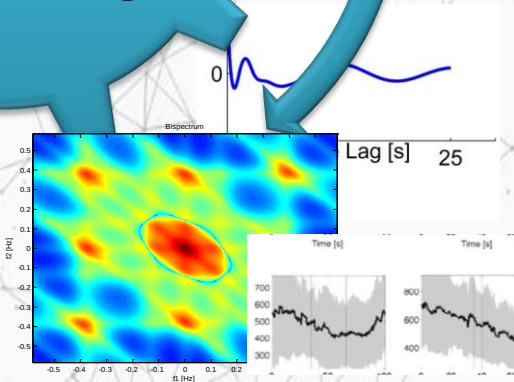
Monitoring Systems: An overview

Wearable systems

Machine learning (modeling, classification)



Biomedical signal processing

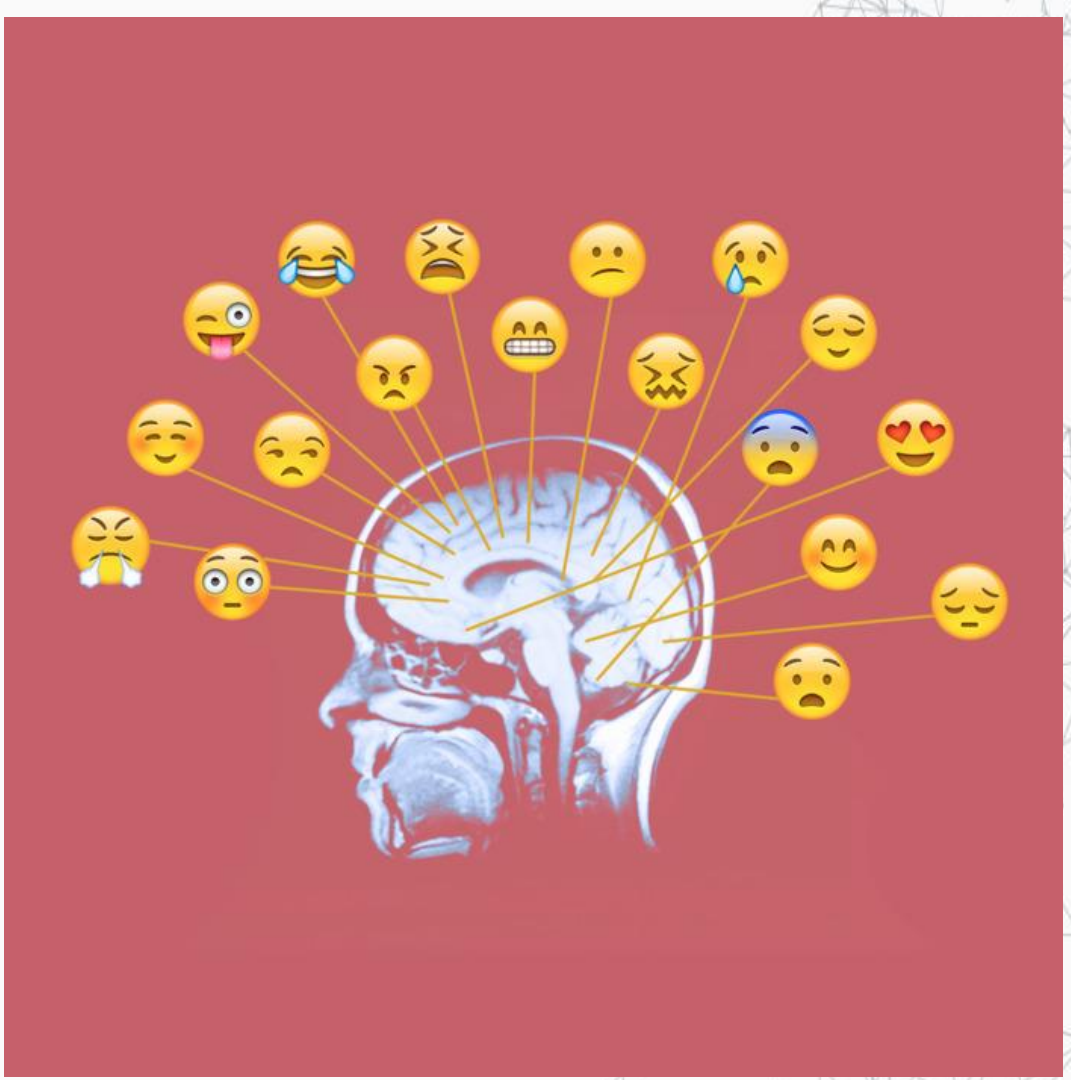


Emotions


SADNESS
JOY
FEAR
DISGUST
ANGER
INSIDE OUT

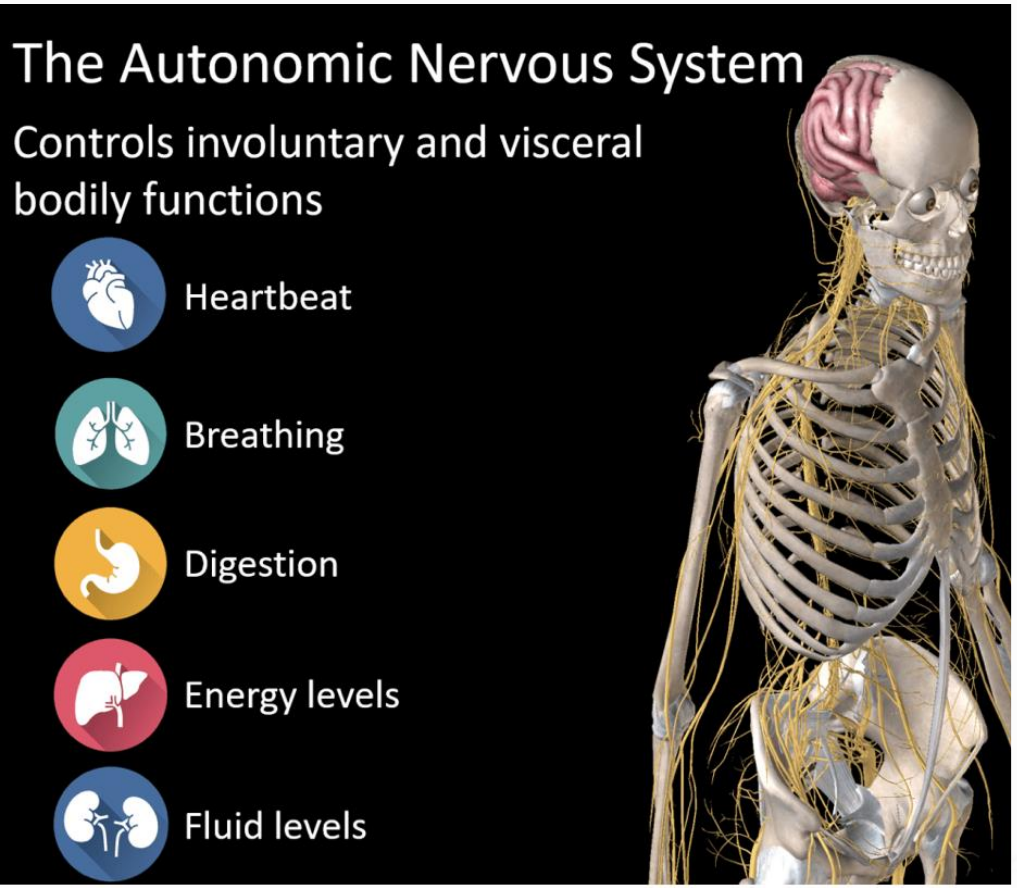

Mental
Emotional
Spirtual
Phyiscal
Social
Wellbeing

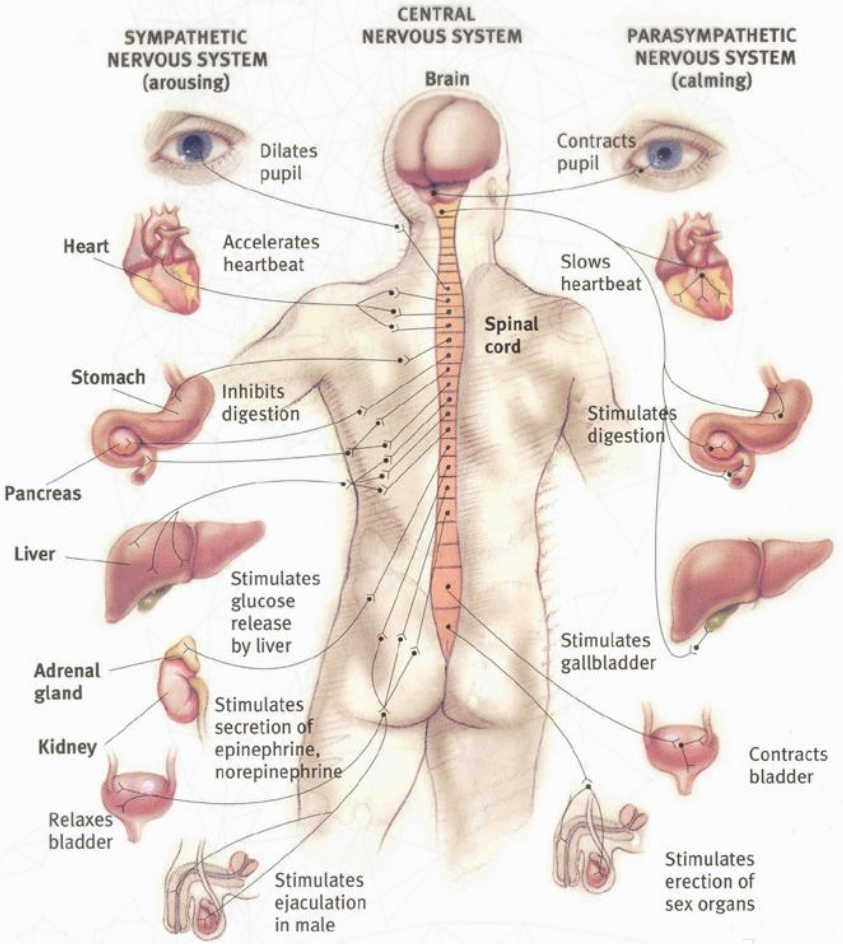
Where do they come from?



AUTONOMIC NERVOUS SYSTEM RESPONSE -

SUBJECT'S INNER STATE ASSESSMENT





Animal Welfare

Welfare: the state of doing well; well-being

Come tutto ha avuto origine

WHY INTERACTION BETWEEN HUMANS AND ANIMALS?

WHY INTERACTION BETWEEN HUMAN AND ANIMALS?

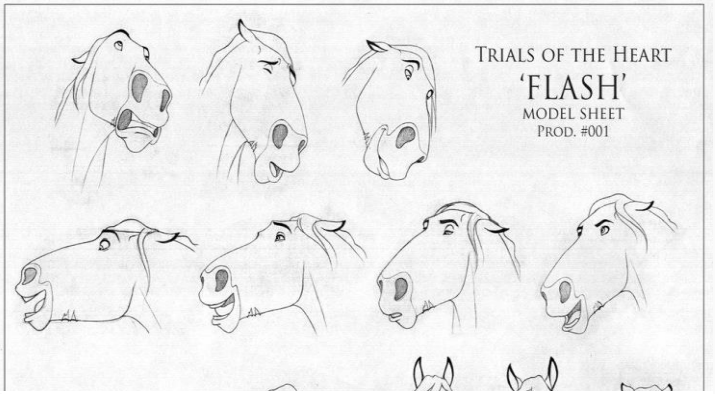
1 - HOW MUCH ARE HORSES SIMILAR TO HUMANS?

2 – AUTONOMIC NERVOUS SYSTEM INTERACTION

HOW MUCH ARE HORSES SIMILAR TO HUMANS?

Horses have feelings
The way emotions are processed in the human brain is different from the **horse due to** the compartmentalization of the **horse's** brain.

Horses simply feel emotion (without reasoning) because they don't **have** the ability to rationalize the **feeling**.



SCIENTIFIC REPORTS

OPEN **Horses discriminate between facial expressions of conspecifics**

J. Wathan[1], L. Proops[1,2], K. Grounds[1] & K. McComb[1]

PLOS ONE

RESEARCH ARTICLE

EquiFACS: The Equine Facial Action Coding System

Jen Wathan[1]*, Anne M. Burrows[2], Bridget M. Waller[3], Karen McComb[1]*

Horses can express feeling

…and Horses can recognise human emotions

Report

Current Biology

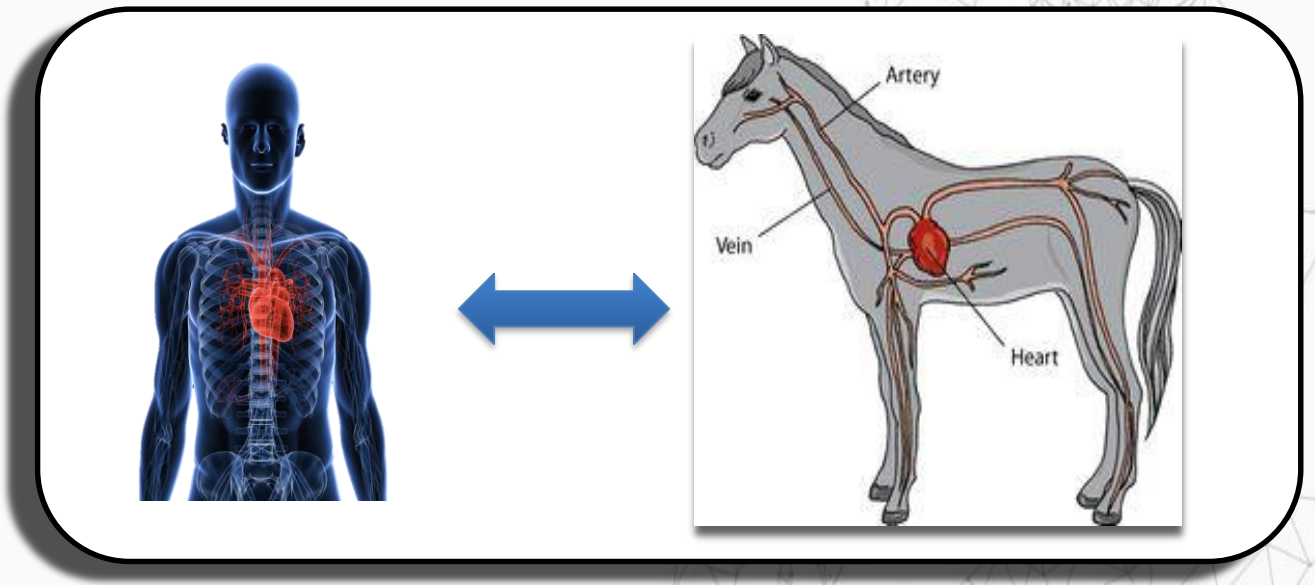
Animals Remember Previous Facial Expressions that Specific Humans Have Exhibited

2 – AUTONOMIC NERVUOS SYSTEM INTERACTION

HORSE PRODUCES SWEAT: THE ELECTRICAL IMPEDANCE OF THE HORSE'S SKIN CHANGES DUE TO LIQUID PRODUCTION

- AUTONIMIC MODIFICATIONS -SIMPATHOVAGAL MODIFICATION
- HEART – HEART COUPLING

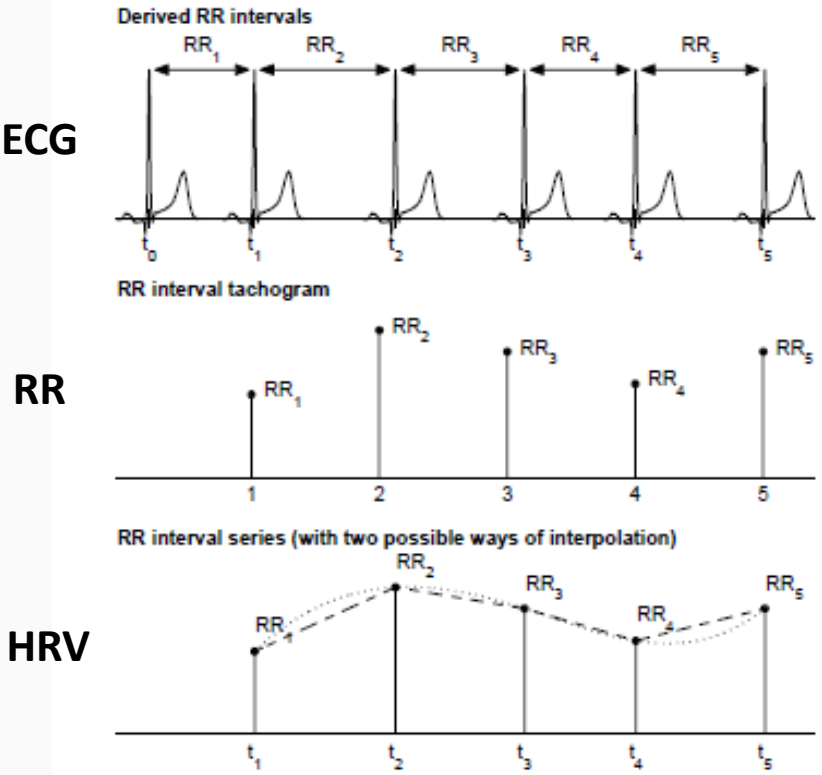
IT MEANS THAT MANY OF THE SYSTEMS DEVELOPED FOR HUMANS CAN BE RE-USED FOR HORSES



Heart Rate Variability is:

A measure of neurocardiac function that reflects heart-brain interactions and Autonomic Nervous System dynamics.

- ✓ Rapid fluctuations in HR usually reflect PNS control.
- ✓ Slower fluctuations in HR reflect combined SNS and PNS + other psychological and emotional influences.

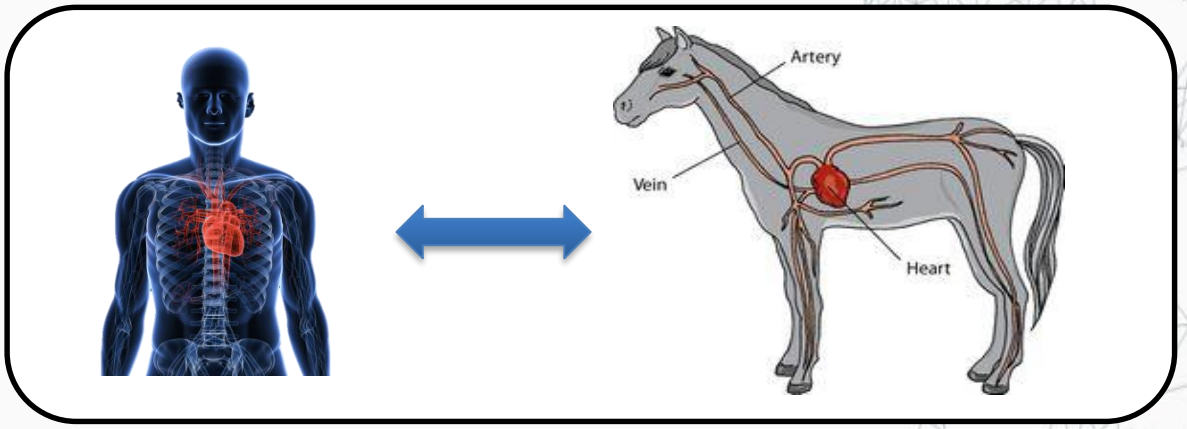


Human – Horse

Journal of Theoretical Biology
Volume 16, Issue 1, July 1967, Pages 15-42

Biological rhythms and the behavior of populations of coupled oscillators ☆

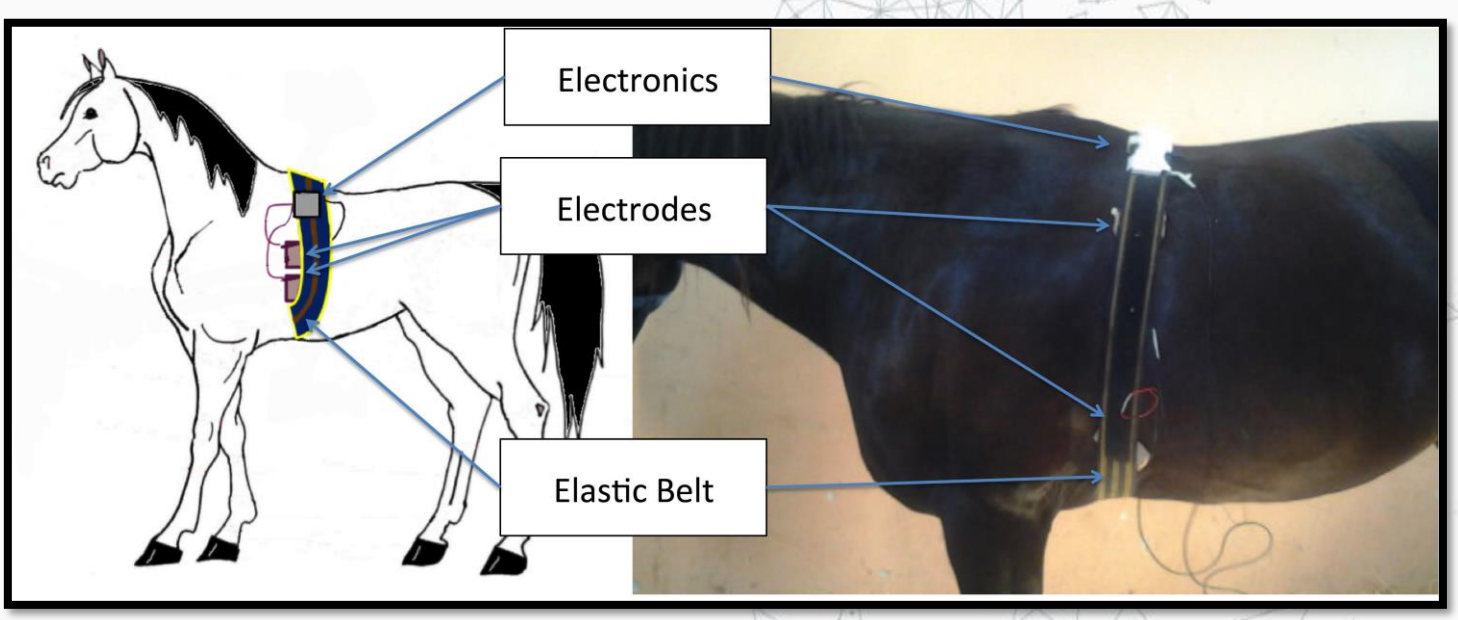
- **Human-Horse = Dynamic Time Variant System**
  → Complex Oscillation

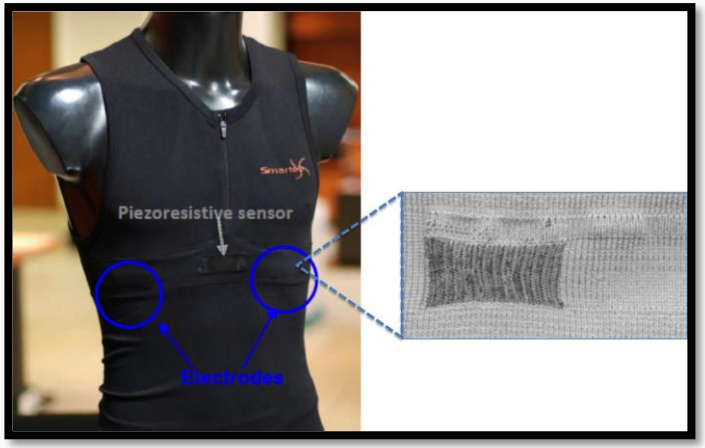


- Cardiac Activity → Heart Rate Variability – HRV
  - Involuntary Response Autonomic Nervous System
  - “Fight / Flight” Reaction
  - Emotion

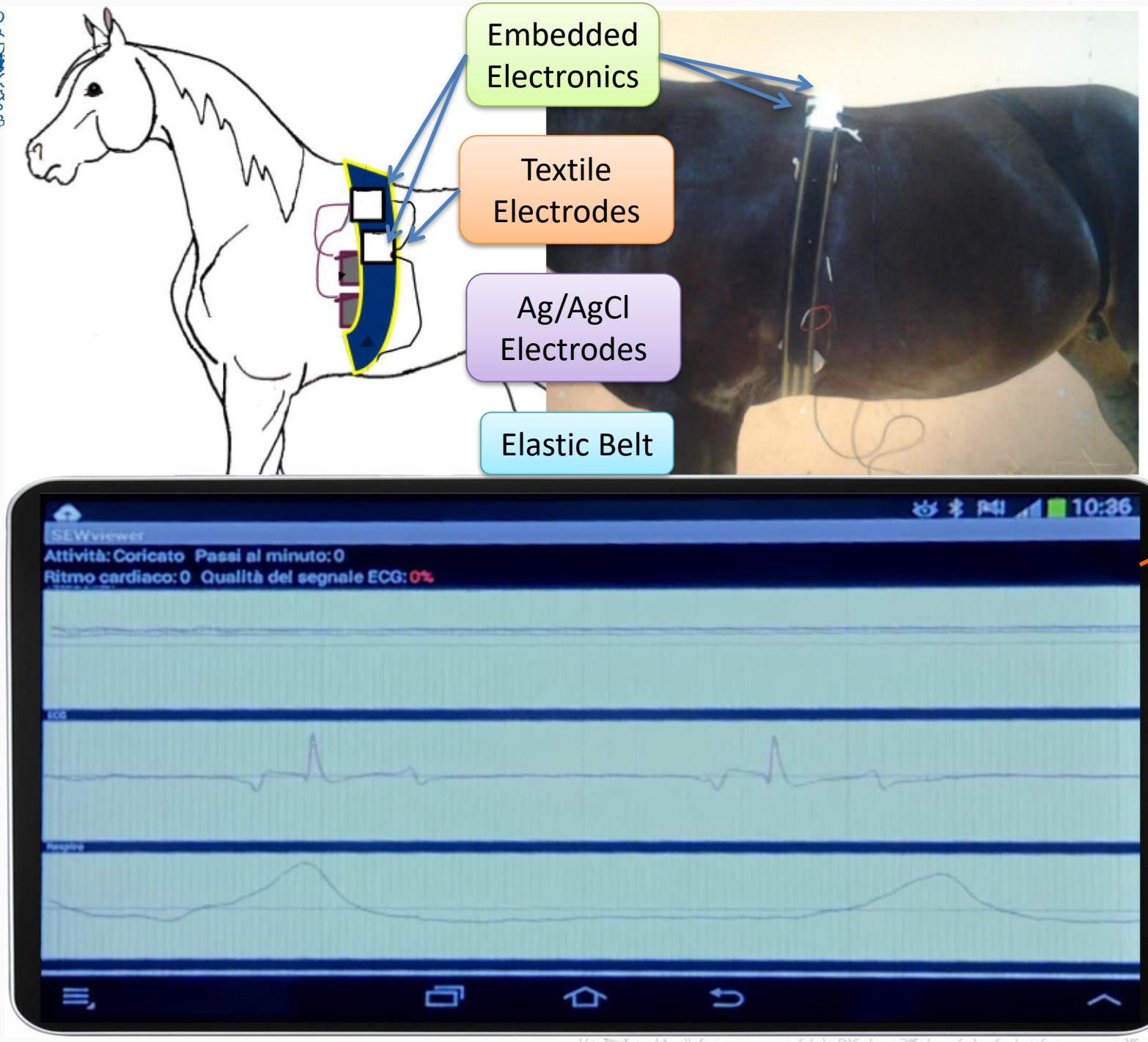
Wearable System

- ECG 250Hz
- Resp 25 Hz
- Acc 25 Hz





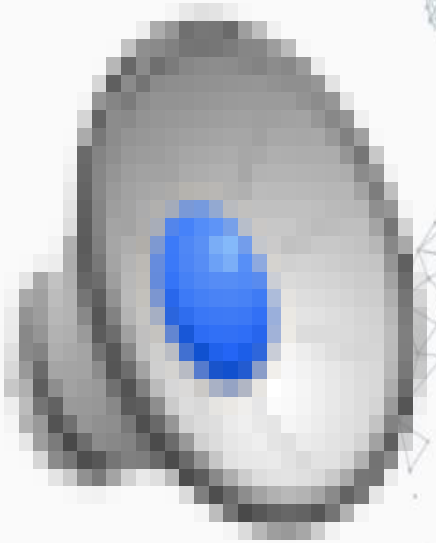
Textile electrodes use **sweat** to improve electrochemical coupling at the electrode-skin interface → Improving performances improve along time


Embedded Electronics
Textile Electrodes
Ag/AgCl Electrodes
Elastic Belt
10:36
SEWviewer
Attività: Coricato Passi al minuto: 0
Ritmo cardiaco: 0 Qualità del segnale ECG: 0%
ECG
Respire

Final wearable system for Horses

FEEL-ING - Largo Lucio Lazzarino, 1 - 56122 Pisa, Italy

Working phase



Experimental protocol

- Neutral Phase (P1)
- Visual and Olfactor Contact (P2)
- Physical Contact (P3)

Experimental protocol

Example of P2 phase

Results

- **Statistics**

feat	P_1 vs. P_2	P_1 vs. P_3	P_2 vs. P_3
MSC	0.032 (")	0.0029 (#)	0.0029 (#)
MPC	0.83 (-)	0.014 (#)	0.0029 (#)
DTW	0.57 (-)	0.036 (")	0.036 (")

Classification →Confusion Matrix

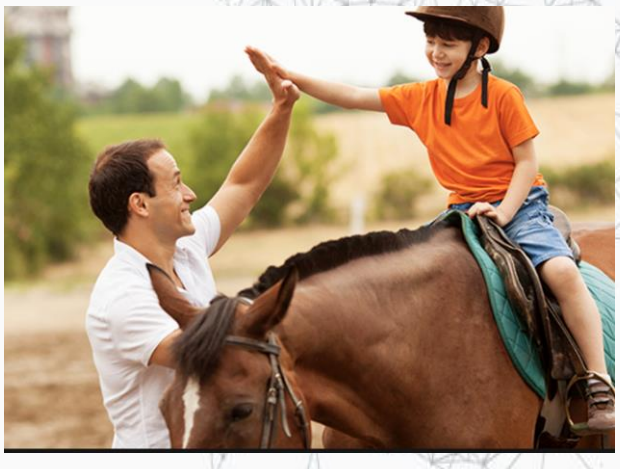
SVM CONFUSION MATRIX (MEAN ± STANDARD DEVIATION) RESULTED BY THE LOSO CROSS-VALIDATION TECHNIQUE.

	P_1	P_2	P_3
P_1	**90.90**	0.00	9.10
P_2	0.00	**100.00**	0.00
P_3	9.10	9.10	**81.80**

P_1: resting state, P_2: visual and olfactory interaction, P_3: brushing

Applications

- **Equine assisted therapy and psycho-therapy**

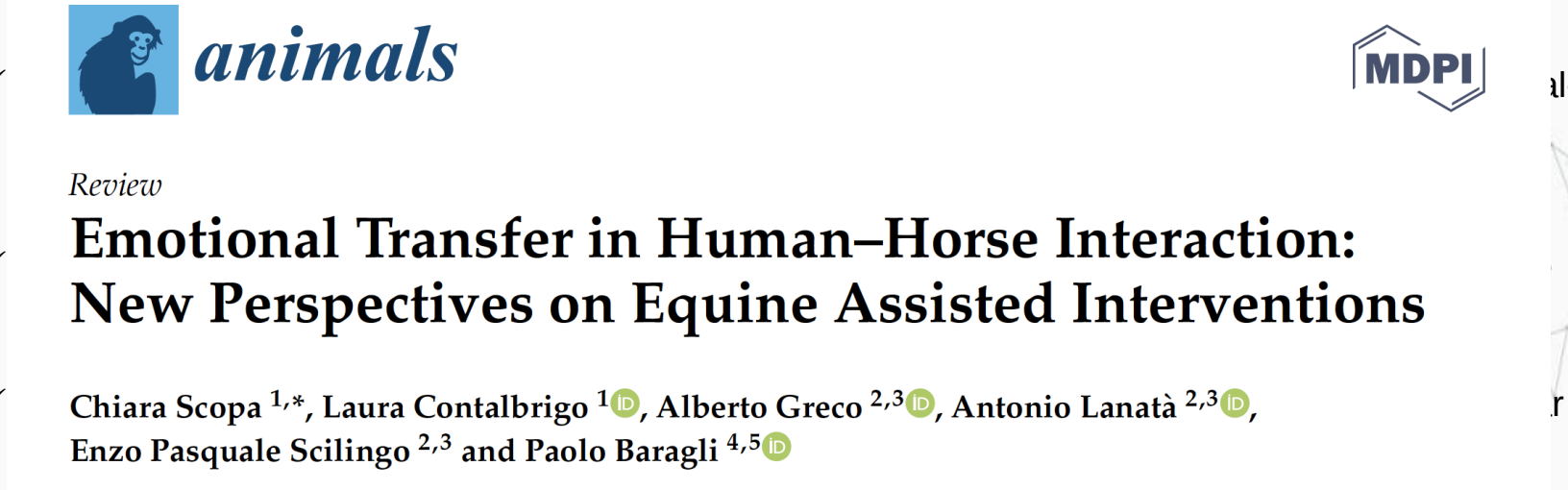


Horse Training

Human horse sensing

Publications

- ✓ Lanata, A., Nardelli, M., Valenza, G., Baragli, P., D'Aniello, B., Alterisio, A., Scandurra, A., Semin, G.R. and Scilingo, E.P., 2018, July. A case for the interspecies transfer of emotions: a preliminary investigation on how humans odors modify reactions of the autonomic nervous system in horses.



Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 1320-1323). IEEE.

- ✓ Guidi, A., Lanata, A., Baragli, P., Valenza, G. and Scilingo, E., 2016. A wearable system for the evaluation of the human-horse interaction: A preliminary study. *Electronics*, *5*(4), p.63.
- ✓ Lanata, A., Guidi, A., Valenza, G., Baragli, P. and Scilingo, E.P., 2016, August. Quantitative heartbeat coupling measures in human-horse interaction. In *2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)* (pp. 2696-2699). IEEE.
- ✓ Lanata, A., Guidi, A., Baragli, P., Valenza, G. and Scilingo, E.P., 2015. A novel algorithm for movement artifact removal in ecg signals acquired from wearable systems applied to horses. *PloS one*, *10*(10), p.e0140783.

Issue on Horses and people

shutterstock.com

A Smart Future for Saddlery

by Cristina Wilkins, Editor

Imagine buying a rug that predicts when your mare will foal, a saddlecloth that records and stores heart and respiration rate changes during your exercise sessions, or can tell you if your horse is stressed. What about a girth that beeps if it is too loose or a noseband that changes colour when it is done up too tight?

We are talking about a future where horse gear will be made with built-in smart fibres and electronics, but is made to look like 'regular' gear (no wires or bulky battery packs). Gear that can light up, flash or send readings of your horse's body temperature and other vital signs. It can even take an electrocardiogram (ECG) and send the readings to your mobile device.

Textiles made with conductive fibres woven into the fabric may sound futuristic, but they are nothing new. Royal gowns have been embroidered with gold and silver threads for many centuries. However, the innovation has been integrating these fibres with wearable electronic devices.

Although Europeans can already buy jackets that monitor body temperature and have a built-in mp3 player, most of these products are still 'first generation' and very expensive, so don't go looking in the saddlery catalogues just yet... The horse world is not quite there. Nevertheless, a team from the University of Pisa, Italy, have already tested textile platforms in horses, which have shown promising results.

Nevertheless, an Italian research team composed of veterinarians from the Department of Veterinary Sciences (www.vet.unipi.it) and bioengineers from the Bioengineering and Robotic Research Center 'E. Piaggio' from the University of Pisa, Italy, (www.centropiaggio.unipi.it), as well as engineers from the research company Smartex srl (www.smartex.it), have already developed and tested textile platforms in horses, with promising results.

Veterinarian and researcher Paolo Baragli presented, on behalf of the research team, the preliminary results at the 10th International Equitation Science Conference in Denmark. The Italian team has tested smart fabrics as a replacement for the standard electrodes used for electrocardiogram (ECG) - a test that checks for problems with the electrical activity of the heart, translating that activity into line tracings on paper or screen.

For this project, patches of smart fabric made with stainless steel yarn combined with elastane were sewn to the underside of a regular saddlecloth and connected to a very small transmitter that sent readings wirelessly to a tablet. The equipment could be used with a saddle and a rider. The project was focussed on comparing textile electrodes with standard electrodes to evaluate the performance and artefacts (reading errors that normally occur as a result of body movement) of both platforms.

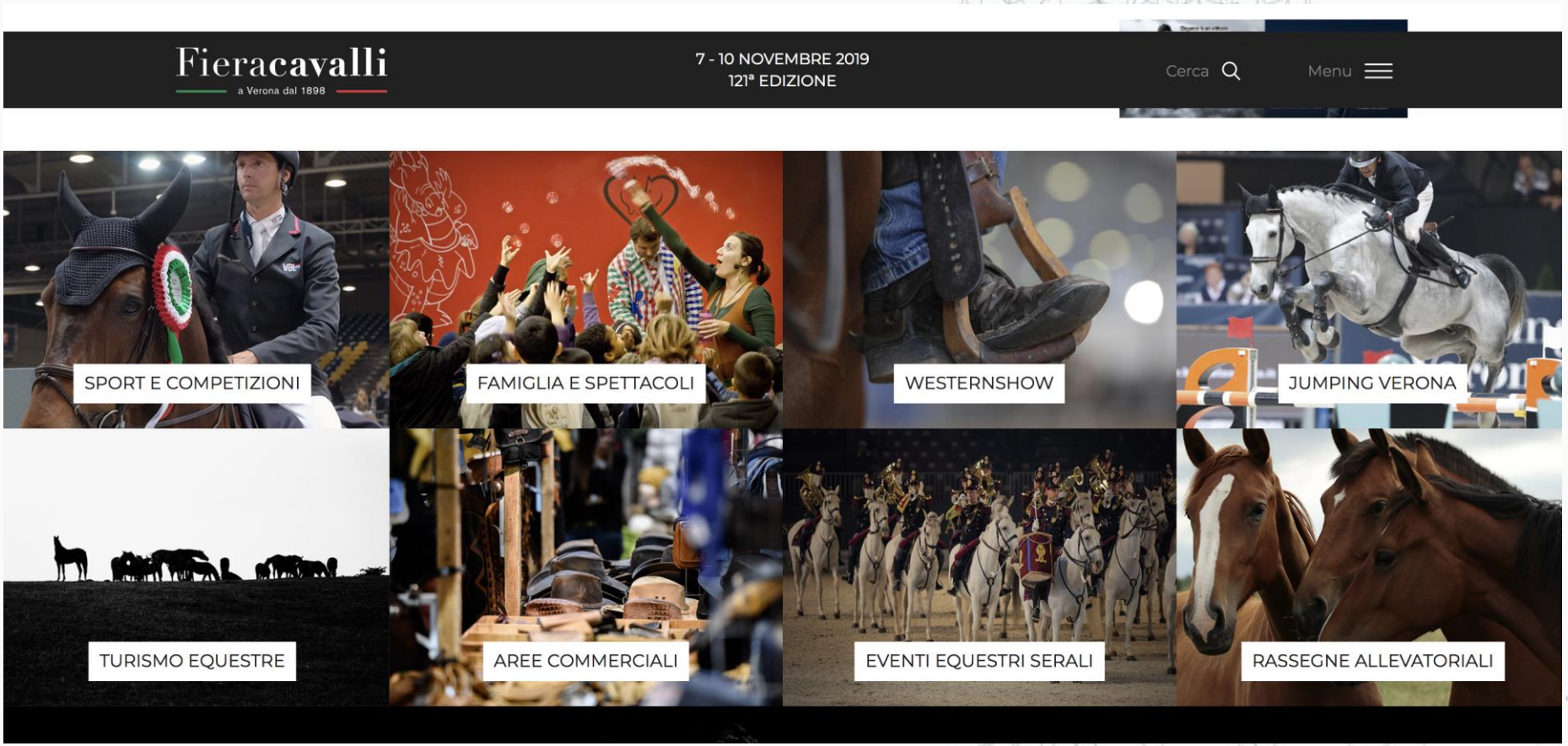
"Our results showed that as well as the well-known advantages of comfort and simplicity in using, the smart textiles showed better technical performances than the standard electrodes," Baragli says. "Although preliminary, these good results indicate that smart textiles can be profitably employed to collect short-term ECG in horses, both during rest and light physical activity."

There is still plenty of work to do because detection of each parameter requires an appropriate validation process. "After proper 'gold standard' validation, textile platforms could be easily adopted in horses to collect parameters related to the Autonomic Nervous System activity," he explains. "For example, heart rate variability (one of the important measures for stress), respiratory rate, peripheral measures of cardiovascular and respiratory functioning, electro-dermal response and skin secretion of stress-related hormones."

It seems that the sky is the limit when it comes to the future of smart textiles. The race is on in all corners of the world for (equitation) scientists and the textile industry to explore their full potential, and make that potential a reality to help us do the best for our horses.

Researchers from the University of Pisa, Italy have tested textile platforms to conduct ECG in horses with promising results. Photos courtesy Paolo Baragli.

Partecipazione a Fieracavalli a Verona



Festival della robotica 2018

Festival Internazionale della Robotica

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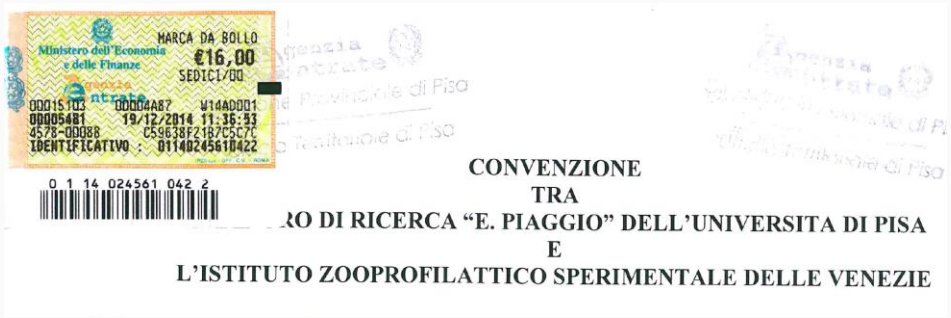
Progetti di ricerca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CONVENZIONE
TRA
...RO DI RICERCA "E. PIAGGIO" DELL'UNIVERSITA DI PISA
E
L'ISTITUTO ZOOPROFILATTICO SPERIMENTALE DELLE VENEZIE

PROGETTI DI RICERCA CORRENTE 2017

N. identificativo progetto: IZS VE 15/17 RC

Progetto presentato da:

ISTITUTO ZOOPROFILATTICO SPERIMENTALE DELLE VENEZIE

Area tematica: Benessere animale

Titolo del progetto:

Interazione emotiva tra cavallo e uomo negli IAA: componenti fisiologiche e comportamentali

Odori umani e feromoni

ISPA INSTITUTO UNIVERSITÁRIO

universidade de aveiro

Università degli Studi di Napoli Federico II

LabEC
Laboratorio di Etologia Canina
Prof. Biagio D'Aniello


POT ON

Consortium

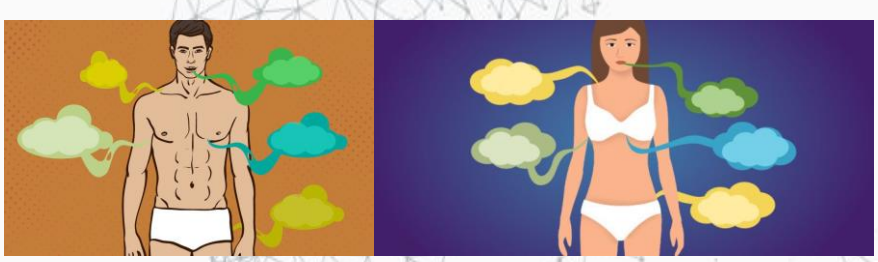
Participant Number	Participant organisation name	Country
1-University (coordinator)	Università di Pisa (UNIPI)	Italy
2-University	ISPA - Instituto Universitário (ISPA)	Portugal
3-University	Karolinska Institutet (KI)	Sweden
4-SME	SRA Instrumentation (SRA)	France
5- University	Polytechnic University of Valencia (UPV)	Spain
6-University	University of Essex (UESSEX)	UK
7-University	Università di Padova (UNIPD)	Italy
8-SME	Inventya Ventures (EU) Ltd. (INV)	Ireland
9-University	KU LEUVEN Centre for IT and IP law (KUL)	Belgium
10-SME	Feel-Ing S.r.l. (F-ING)	Italy
11-University*	Massachusetts Institute of Technology (MIT)	USA
12-University*	University College London (UCL)	UK
13-LE*	Agilent Technologies (AGI)	Italy
14-University*	Uppsala University (UPP)	Sweden
15- University*	Nencki Institute of Experimental Biology (NIEB)	Poland
16- University*	Scuola Internazionale Superiore di Studi Avanzati (SISSA)	Italy

* Advisory board institutions

Main objectives

POTION aims to study the **human capacity to transmit emotions and influence social behaviour through body odour**: chemosignals.

When we feel emotions such as happiness and fear, the human body produces chemosignals which are released through sweat and which could be emotionally contagious the moment they are perceived by others.



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Thank you for your attention!

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Enzo.scilingo@unipi.it

Computational Physiology & Biomedical Instruments Group

Centro E. Piaggio
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