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XXIV Ciclo

Generating metasystem: how three years of life become an emergent system

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The emergent behavior of a system is due to the non-linearity.
The properties of a linear system are in fact additive:
the effect of a set of elements is the sum of the effects considered separately,
and they do not appear new properties that are not already present in the individual elements.
But if there are terms / elements combined, which are dependent on each other,
then the complex is different from the sum of its parts, and new effects appear.

PERCY BRIDGMAN (1927)
THE LOGIC OF MODERN PHYSICS

GENERATING METASYSTEM

HOW THREE YEARS OF LIFE BECOME AN EMERGENT SYSTEM

DOTT. MARCO IVALDI
PH.D. CANDIDATE

To Gioachino and all those who don't believe only in what is measurable.

To Epica, Mercuzio and Polpetta: my grand crew.

ABSTRACT

In the last three years, (in which I planning, studying, understanding and marveling), I have observed that basically the study of complex systems generates, in turn, a complex system. A small experiment of metatheater in which you can't use a linear way of thinking, but you need to use a system of analysis of distorted, inconsistent, computational and self-reflexive reality. The path of my Ph.D. course on complex systems has thus generated a complex system and I had to redefine the areas in which I had to work and on which I had to focus. This thesis is intended as a detailed report of all the situations that I faced, starting from the field of neuroscience, in which I began my job, continuing in the analysis of big data in the web, in the analysis of motor skills and finally monitoring pollutant parameters during sport activities. In the first period of my PhD course, I focused on the study of EEG signals taken from healthy subjects. I learned to use acquisition and visualization tools and to analyze signals. In the course of three years, I made two different data acquisition campaigns. One of these was to compare the signal from subject in different postural situations, the other one to compare the quantitative electroencephalographic signal picked up by wireless and wired devices designed and built with the cooperation of the company OTBiolettronica and comparing the same signal picked up by three different types of caps, one with a plastic sleeve, another with neoprene sleeve, and finally the third with an electrode-skin contact with electrodes made of felt. The construction of the wireless device has been done by working with the mentioned company, in particular seeking to improve EEG recording during movement. It is clear that a major problem in EEG analysis in relation to the movement was given by the limited range of motion caused by the presence of the cap-amplifier cable connection; the study concerning the comparison between the different types of headset has been done trying to understand which model could give the best result regarding to the reliability of the acquired signal and the minimal presence of noise and motion artifacts. The evolution of these studies would allow EEG signal analysis in complex motor situations without affecting the acquisition because of noise and artifacts. The two above-stated studies succeeded in obtaining two grants from the ISI Foundation (one for a period of 12 months and the second for a period of 18 months) which includes the acquisition of signals on subjects in different postural conditions, the development of the wireless amplifier with the software for data processing and the study of a innovative cup that will be patented. Besides my work on the mainstream project related EEG I have developed three other projects. In June of 2009 I began to follow the project We-Sport with the aim to create a social network connected to the sporting environment and to facilitate the practice of amateur sport and in particular related to sport with low diffusion. The OMS has established that sport and physical activity are one of the most important means of prevention of degenerative diseases; it is clear that one of the main reasons to stop the practice and sport is the lack of a partner with which to practice. We-Sport is based on a simple algorithm with the function to create a match of data based on the characteristics of sport players: sport, location, schedule, gender, age, skill. The system displays people who have the same characteristics and who want to play sports together. Today We-Sport is a spin-off of Motor Sciences Research Center, has a market value of 600,000 euro as the acquisition of shares by private company, has won 6 national and international awards and it was the finalists in the same number of cases. It is among the 7,000 most visited sites in Italy, the structure of We-Sport consists of approximately 120,000 lines of code and we have been released 280 different versions. Thanks to the work on We-Sport data base an oral report was presented at an international conference, a poster session at a national congress and finally a paper was submitted for a special issue on sports complex systems. We-Sports is a registered trademark at national office for patents and trademarks. The second side project that I have dealt with is the Touch Wall, a system for evaluating qualitative/quantitative analysis of motor skills through a multi-touch interface with IR-LLP (infrared laser light plane). The system was designed, developed (both for the hardware and the software part) in collaboration with the CSP-Innovation in ICT. A first set of data was collected from 100 subjects to validate the instrument and start the interpretation of the 92 analyzed parameters. Also the Touch Wall , that is part of a larger project from the Motor Science Research Center called MAC (Motor Activity Certification), is patent pending by the University of Turin. Finally, the last project I worked on was aGrisù, a portable device that can detect the presence of air pollutants and correlate their presence with some physiological and morphological parameters measured during outdoor or indoor physical activity. For this project a prototype was realized and in this case too, the request for patent was submitted to the patent office of Turin University.

KEYWORDS:

Complex system, emergent system, non linear thinking, electroencephalography and human motion, motor analysis certification, big data analysis, web, pollution and physical activities.

INTRODUCTION

Il trasloco del dottorando

Così anche questi tre anni sono passati. Si chiude il dottorato. Avrò bisogno ora di almeno tre mesi per riordinare tutto. Dopo questi tre anni.
Fare questo percorso per me è stato un po' come fare un trasloco (e non mi sono fatto mancare in realtà neanche quello, per davvero!).
Quando si decide di cambiare casa si parte che si ha tutto in ordine, tutto chiaro.
Poi si deve scombinare tutto questo ordine per crearne un altro fittizio, provvisorio. Si preparano le scatole.
Ecco, in questi tre anni io ero sul furgone, con tutte le scatole. Attento a non rompere i bicchieri di vetro e a non rovinare il divano nuovo.
Avevo deciso di cambiare casa a di destabilizzare ogni cosa.
Dopo aver distrutto il mio vecchio equilibrio e dopo aver messo tutte le mie cosette nelle scatole, dopo un viaggio lungo tre anni, ora sono arrivato.
Dovrò di nuovo mettermi al lavoro per capire dove vanno messe ora le cose vecchie, nel loro nuovo posto.
E capire cosa c'è da buttare che mi sono portato dietro. E cosa devo ancora comperare che mi manca?
La casa è più grande. Sicuro. Ed io durante il viaggio sono maturato. Certamente.
Ora, appunto, nei prossimi tre mesi credo proprio che avrò bisogno di disfare tutto e mettere a posto.
Ma cosa ho capito durante il mio percorso sul furgone? Ho capito cosa vuol dire fare il ricercatore. Prima non ne avevo così chiara l'idea. Ma sapevo che quella era la mia strada.
E come sempre faccio quando ho un obiettivo, me lo scrivo, in modo da creare la realtà.
La parola "ricercatore" me l'ero scritta in un posto impossibile da non avere continuamente sotto gli occhi. No, nulla di scabroso! Semplicemente sulla carta di identità.
Sapete che all'anagrafe potete dire quello che volete, sotto la voce professione: l'astronauta, il pompiere, il domatore di leoni.
E' un bel posto per creare le proprie realtà.
Io ci scrissi "ricercatore".
Quando appunto non sapevo realmente che mestiere fosse. Ma ne avevo sentito parlare bene …

Rabdomante fai da te? Hai Hai Hai...

Da cercatore a ricercatore c'è una differenza. Il primo va d'istinto, il secondo di cervello. E io che andavo e vado d'istinto mi sono ritrovato a dover capire cosa fosse il secondo …
E' un po' come la storia dei rabdomanti … Il rabdomante è un cercatore. Sa dove è l'acqua. Dice "è qui!", la sente. Non sa spiegare come e perché, ma la sente.
Il ricercatore invece fa una analisi statistica sulle possibilità di trovare l'acqua in quel determinato posto, in caso di esito positivo effettua una serie di carotaggi, quindi fa una analisi chimica dei campioni, calcola il costo della trivellazione ed il costo del pozzo e infine fa una stesura di un dettagliato report sulle probabilità di trovare l'acqua e sugli ipotetici costi dell'operazione.
Entrambi cercano qualcosa di cui non sanno realmente l'esistenza. Entrambi sondano l'ignoto. Chi con un metodo, chi con un altro.
Uno con qualche probabilità di trovare qualcosa, l'altro con molte meno (scegliete voi chi).
Dopo tre anni passati a capire cosa vuol dire fare e essere un ricercatore ho compreso che, comunque, la seconda strada non era quella giusta per me.
Io continuo a rimanere un cercatore.

La questione più problematica era dato dal fatto che, invece, mi trovavo nel luogo e con le persone che avevano ben chiaro quale fosse il ruolo del ricercatore.
Il ruolo che sfacciatamente avevo messo in bella evidenza sulla mia carta d'identità.
E qui sono incominciati i problemi. I primi due anni di dottorato fondamentalmente li ho passati a fare il rabdomante.
E a sentirmi a disagio quando incominciavano le trivellazioni da parte dei veri ricercatori.
Di fronte a due segnali non statisticamente significativi io mi fermavo a guardare il più bello.
Prendendomi anche un po' di insulti, perché "bello" non è una misura riconosciuta dal Sistema Metrico Internazionale.
Poi, magicamente, ho iniziato a scorgere timidi bagliori di luce. Ed ho finalmente compreso per la seconda volta nella mia vita che è inutile lottare, basta riuscire a comprendere.

Tutto un mondo intorno

Diverse volte ho frequentato corsi di alta formazione in cui ci si ritrovava tra dottorandi a disquisire sull'importanza di comunicare la ricerca, di trovare nuove vie per la scienza.
Ho in prima persona curato gli allestimenti per la notte dei ricercatori trovando sempre nuovi stimoli e nuove soddisfazioni.
Ma tutte le volte capivo che in qualche modo questo mondo e quell'altro, quello fatto di analisi e statistiche e articoli, dovevano collimare.
Lo scorso anno sono accaduti **due fatti** che mi hanno mostrato che altre persone provavano la stessa mia sensazione; e non erano pochi, anzi!
C'era tutto un mondo intorno che aveva bisogno di quelle persone, dei loro pensieri, delle loro sensazioni e dei loro bastoncini tremolanti.
Ho conosciuto persone come Leonardo Camiciotti, come Giuseppe Fresa, come Marco Asquini, Silvano Agosti o Alessandro Vespignani.
Ho conosciuto persone che avevano le mie stesse idee e si chiedevano come poterle far interagire con il resto del mondo scientifico e non.

Innovazione, chi era costui?

Uno di questi fatti è stata la partecipazione al corso di alta formazione in Gestione dell'Innovazione.
Durante il corso, a cui hanno accesso ogni anno 25 dottorandi provenienti da tutta Italia e di tutte le discipline, si è parlato di innovazione.
E per la prima volta (*sono uno sprovveduto, lo so*) ho sentito dire che capita che l'innovazione non vada a braccetto con la ricerca.
L'innovazione è uno che per vedere quanto è profondo un buco ci si butta dentro. L'innovazione non ha metriche, non si può misurare.
Perché è in divenire e non è ancora stato creato lo strumento che misura qualcosa che ci sarà domani.
E allora innovazione versus ricerca. Caspita! E io dove ero stato fino a quel momento? A pettinare le bambole?
Ma allora la mia domanda è: "c'è posto nella comunità scientifica per l'innovazione?"
Credo ce ne sia, dal momento che il direttore del MIT di Boston è uno dei più importanti artisti visuali al mondo.
Quindi avevo capito (*sono un po' tardo, lo so*) che ero su un versante semplicemente diverso, non fondamentalmente sbagliato.
E che quel lato, quello dell'innovazione, doveva dialogare con l'altro, quello della ricerca, senza farsi sopraffare (non lo permetterei mai, comunque).
Mi ero appuntato alcune frasi dette da Giuseppe Fresa. Diceva che un innovatore è come uno che ha la scrivania sempre in disordine.
Perché non può stare nell'ordine. E' dirompente. Questa è la sua forza e la sua utilità.
E' caotico, perché nel caos e nel disordine trova l'intuizione per fare il passo laddove altri non avevano immaginato si potesse andare.

Ma non si può poi rimproverargli di essere disordinato. Perché è un ossimoro. E di ossimori si può anche morire (questa è una aggiunta mia …).
In un'altra conferenza invece Alessandro Vespignani ha spiegato la sua visione di sistemi complessi: ovvero lo studio di sistemi in cui un gran numero di unità interagenti danno luogo a fenomeni cooperativi e dinamici che non possono semplicemente essere dedotti dall'analisi microscopica dei relativi fenomeni.
E questa visione era fortemente divergente rispetto alle prospettive microscopiche di molta della ricerca che vedevo intorno a me.

I bambini ci salveranno

Divergente. Già. **Ecco il secondo fatto**. Il secondo fatto è relativo ad un documentario prodotto da TED sul pensiero divergente, nel quale si spiega come la società si sia auto organizzata per far si che le persone abbiano un pensiero collettivamente convergente. Perché più ecologico ed efficiente. Ma efficiente non vuol dire efficace.
Efficiente è quando quello che esce è il più aderente possibile a quello che entra. Un'auto e efficiente se tutta la benzina che consuma è usata per spostarsi e non si disperde energia, termicamente, per esempio. Ma questa non è innovazione. Questo è perfezionamento.
Io vorrei essere efficace. Cioè utilizzare al meglio le mie risorse in funzione di obiettivi. Voglio arrivare in modo diverso da come sono partito. Voglio che la mia auto mi porti prima a destinazione, mi rada anche durante il viaggio e mi prepari il caffè. E pazienza se consuma un po' di più a parità di km fatti. Il mio pensiero deve essere divergente.
Nel documentario viene spiegato un test per il pensiero divergente, il test è stato condotto in modo rigorosamente scientifico su un vasto campione (ecco che innovazione e ricerca si incontrano). I risultati migliori sono stati ottenuti dai bambini più piccoli, prima della scuola elementare. Essendo questo studio condotto nel tempo si sono visti poi i risultati ottenuti dagli stessi bambini anni dopo. Bene, i risultati erano via via più bassi mano a mano che la scolarizzazione progrediva. Per quanto riguarda il pensiero divergente stavano regredendo.
Il sistema sociale ed il sistema scolastico tendevano ad armonizzare e quindi a livellare verso il basso le singole unità sociali.

Le esperienze avute durante l'ultimo anno di dottorato (compresi gli ultimi mesi passati soltanto a visionare, analizzare e descrivere dati, per concludere quella mole di lavori aperti e disordinatamente sparsi sulla scrivania), mi hanno fatto capire un mondo e l'altro.
Ora so in quale squadra gioco e voglio giocare, ma ho anche capito la fatica che è insita nell'essere un vero ricercatore e lo rispetto.
Non credo cambierò la professione scritta sulla mia carta d'identità (anche se è scaduta … e dovrei rinnovarla), non credo metterò la parola innovatore, né tanto meno inventore.
Non mi interessa più una etichetta né ho più sensazioni di disagio da gestire.
Alla fine del mio viaggio sul furgone ho imparato veramente cosa sono i sistemi complessi. Vivendoli fino in fondo.
Ma ho imparato anche cosa vuol dire cogliere una sfida che tanti grandi prima di me hanno accettato, pagandone anche le conseguenze.
Quando si viaggia fuoristrada, a volte, si prendono anche dei rami in faccia.
Ma non esiste strada asfaltata se non è mai stata percorsa da nessuno.

Sono quindi quasi arrivato nella mia nuova casa. Ho qui di fianco a me, sul sedile del passeggero, una scatola con alcuni libri. Sono libri a me cari.
La biografia di Leonardo, quella di Goethe, quella di Caravaggio e di Castaneda.
Ed un piccolo libro di Charles Fort. Nella copertina c'è scritto:

"Il destino di tutte le spiegazioni è quello di chiudere una porta solo per spalancarne un'altra."

EEG AND MOVEMENT INTENTION

Libet and colleagues studied a time relationship between activity brain and the conscious intention of doing a simple voluntary movement. [1]
Previously Kornhuber found that it was possible to observe immediately before voluntary movements a negative amplitude deflections of the EEG signal.[2] They call this "readiness potential" and they have their origin in a region of the cerebral cortex known as supplementary motor area (SMA), which is involved in the anticipation of the movement. Libet and colleagues found that the readiness potential began to manifest some tenths of a second before "*the feeling of wanting*" to become conscious.[3]
It is suggested therefore that the potential of readiness reveals the primary cortical area which the decision of the movement is made. The studies of Libet were held analyzing only the brain regions related to the movement, this factor is important because many other parts of the prefrontal cortex are frequently involved in situations of choice. A limitation of potential of readiness is that they manifest themselves only in a narrow time immediately prior to movement. Even prior to Libet experiments, it was noted that the prefrontal cortex prepare voluntary movements in a longer time than what emerges from the consideration of the potential readiness only.[4]
In another experiment, Libet and colleagues before [5], Soon and colleagues then[6], have been found
two brain regions that predict, before the conscious decision, if the subject is to choose one answer or another (in that case right or left), although the subject itself is not aware of his decision.
The first region is the frontopolar cortex (FPC), the area 10 of Brodmann. This predictive information, as measured with fMRI, in the case of actions with intention and not so sudden, is present already seven seconds before the decision of the subject. This first area is deputed to maintain the intentions even for long periods after they have reached the consciousness. [7]
The second predictive region is located in the parietal cortex, it extends itself from the posterior cingulated cortex and the precuneus.[8]

[1] Libet B, Gleason C A, Wright E W, Pearl D K. Time of conscious intention to act in relation to onset of cerebral activity (readiness potential): the unconscious initiation of a freely voluntary act. Brain 1983. 106: 623-42.

[2] Kornhuber H H, Deecke L. Hirnpotentialanderungen dei willkurbewegungen undpassiven bewegungen des menshen: bereitschaftpotential und reafferente potentiale. Pflugers archive 1965. 284: 1-17.

[3] Eccles J C. The initiation of voluntary movement by the supplementary motor area. European archives of psychiatry and clinical neuroscience 1982. 231: 423-41.

[4] Groll-Knapp E, Ganglberge J A, Haider M. Voluntary movement-related slow potentials in cortex and thalamus in man. Progress in clinical neurophysiology 1977. 1: 164-73.

[5] Libet B, Gleason C A, Wright E W, Pearl D K. Time of conscious intention to act in relation to onset of cerebral activity (readiness potential): the unconscious initiation of a freely voluntary act. Brain 1983. 106: 623-42.

[6] Soon C S, Brass M, Heinze H J, Haynes J-D. Unconscious determinants of free decision in the human brain. Nature neuroscience 2008. 11: 543-5.

[7] Haynes J-D, Sakai K, Rees G, et al. Reading hidden intentions in the human brain. Current biology 2007. 17: 323-8.

[8] De Caro M, Lavazza A, Sartori G. Siamo davvero liberi?: le neuroscienze e il mistero del libero arbitrio. pp.5-19

PREVIOUS EEG STUDIES

It is possible to some interesting studies of qEEG analysis in relation to motor tasks. Some of them analyze the behavior of the motor cortex relative to the fingers dexterity[9], others analyze the cortical electrical changes induced by Zen meditation[10].
Over the last 20 years have multiplied the studies that use qEEG to analyze the activity of the cerebral cortex, thanks to increasingly large possibility that the equipment hardware but especially software of data analysis can offer. [11][12]
From the literature reviewed, you may focus differences in the EEG signal recorded in subjects with eyes closed with respect to eyes open for the frequency band alpha (8-13 Hz)[13]: also in these studies it is assumed there could be a completely different use of audio feedback of a subject with eyes closed compared to the same subject with eyes open[14].
In this study we attempted to highlight the differences in EEG response between the subject sat with eyes open and subject sat with eyes closed in EEG spectral bands of alpha (8-13 Hz) and beta (13.5-30 Hz), in agreement with the literature previously analyzed.
A study of Del Percio[15] and colleagues on balance explains the decrease of the power density of the alpha band in the frequency range of the EEG signal in parietal area from subjects in the upright position with mono-podalic support, compared to the signal with both feet support.
We decided to investigate the exclusion of visual feedback in standing subject, we also investigated in addition the sitting position with eyes open (task OA) and eyes closed (task OC), the standing position with the support of both feet with eyes open (task BIPO) and eyes closed (task BIPOC). Finally, the standing position with the mono-podalic support with eyes open (task MONO) and eyes closed (Task MONOC).
The execution of monopodalic tasks is due to the will of studying the EEG signal on three different degrees of postural control: sitting and bipodalic monopodalic orthostatic standing, to which is the task that need greater postural control.

TESTING THE INSTRUMENTATION

This study was conducted in two separate times, the first test session was done almost a year after the second, due to problems with quality of the recorded signal. The amplifier and the headset have been improved following the conclusion of the first pilot study. The biggest problem was referred to the headset and the amplifier: in fact at the conclusion of the first measurement session data resulting from the analysis were affected by a significant amount of noise; it dues to hardware problems relate to the electrical grounding of the instrument and the manufacturing of the electrodes of the cup.
After replacing it with a more advanced model built on our request and with the improvement of the amplifier by the manufacturer, we was able to start the second measurement session, from which we collected data for further analysis.

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[9] Calmels C, Jarry G, Stam C J. Changes in local and distant EEG activities before, during and after the observation and execution of sequential finger movements. Neurophysiol Clin 2009; 39 (6): 303-12.

[10] Chiesa A. Zen meditation: an integration of current evidence. J Altern Complement Med 2009; 15 (5): 585-92.

[11] Friedman D, Cycowicz Y M, Gaeta H. The novelty P3: An event-related brain potential (ERP) sign of the brain's evaluation of novelty. Neuroscience & Biobehavioural Reviews 2001; 25: 355-73.

[12] Gevins A, Leong H, Smith M E, et al. Mapping cognitive brain function with modern high-resolution electroencephalography. Trends in Neuroscience 1995; 18: 429-36

[13] Thuraisingham R A, et al. Analysis of eyes open, eye closed EEG signals using second-order difference plot. Med Biol Eng Comput 2007; 45 (12): 1243-9.

[14] Pirini M, et al. EEG correlates of postural audio-biofeedback. Hum Mov Sci 2010.

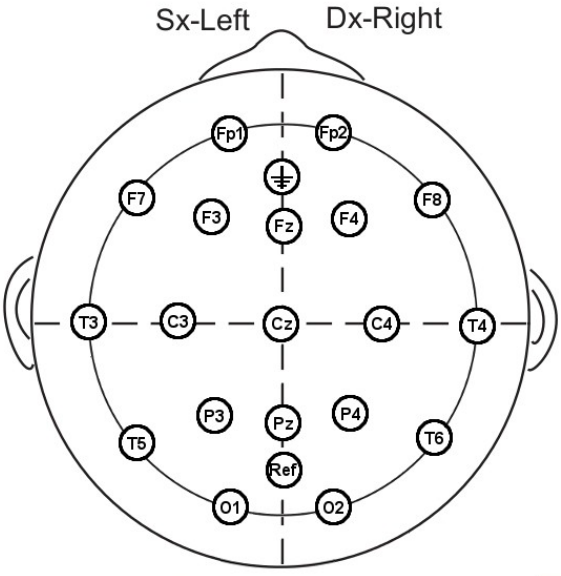
[15] Del Percio C, et al. "Neural efficiency" of athletes' brain for upright standing: A high-resolution EEG study. Brain Res Bull 2009; 79 (3-4): 193-200.

OT BIOELETTRONICA AMPLIFIER

This study used the Ot Bioelettronica EMG amplifiers No. USB2-W003, the instrument was originally an EMG amplifier, it was later adapted for EEG measurements by inserting two -8 channels- cards, with some circuit modifications introduced to properly acquire EEG signal. The sampling frequency is 512 Hz with 12 bit resolution each sample. The amplifier gain was set to 5000. The amplifier analyzes signal band from 3 Hz to 140 Hz, with a adjustable gain of 100, 200, 500, 1000, 2000, 5000, 10.000. The amplifier is connected to a personal computer that handles the display and export data.

SPES MEDICA HEADSET

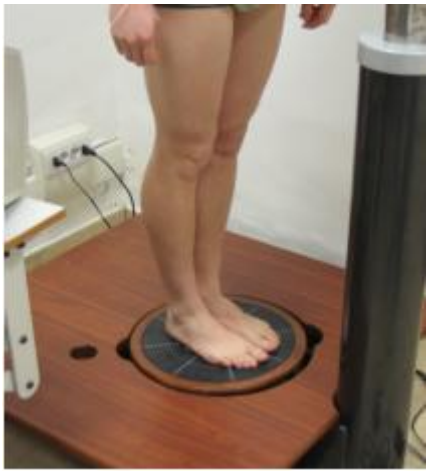
For this study have been used two types of headset in breathable elastic material, with two different types of electrodes. In the first the electrodes had a plastic structure. This type of electrodes had drawback due to the manipulation of the cup: the connecting cables between the monopolar connector and electrodes were cut because they didn't have any kind of protection. This drawback worsened the quality of the signal, necessitating the replacement of headset and the repetition of tests.
The new headset is structurally the same as the previous one, except for the shape of the electrodes consisting of two rings of neoprene with interposed the conductor ring connected to the cable, this time they had a protection against wear in the hub of the cable. This new type of sleeve reduces the problem of small scalp respect to plastic sleeve; this rubber material allows some little movement of the headset with the scalp without creating noise or interfering with the signal acquisition. In addition, another advantage of this new model is the improved wereability.
So the finally headset was the Spescup produced by Spes Medica in tin ring electrodes protected by a structure in neoprene; to ensure that the skin comes into contact with the electrode is necessary to fill the cavity with the conductive gel, for this purpose was used the elastic and conductive gel Neurogel also produced by Spes Medica, for the filling of electrodes has been used a syringe with a 1 mm thick with a blunt tip. The headset has 21 electrodes placed in accordance to the International System 10-20. The connection between headset and amplifier is provided by a cable length 150 cm with a special connector produced by OT Bioelectronics.



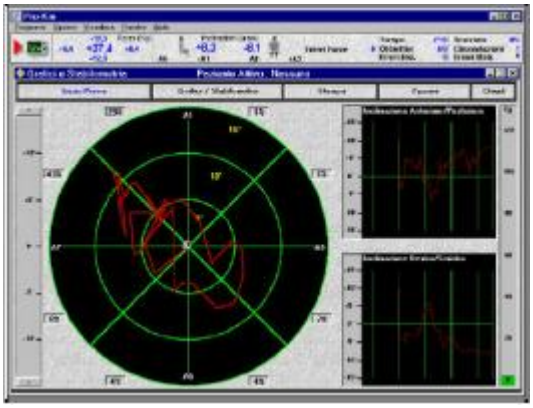
Map of electrodes on EEG Spes Medica headset (International System 10/20)

STABILOMETRIC PLATFORM AND SEAT

The subject was positioned for orthostatic task on the stabilometric platform Prokin PK 214 P (produced by TecnoBody, Bergamo, Italy). This instrument is able to acquire data of fluctuations of the center of pressure, not used for analysis in this study. The platform has a diameter of 40 cm and a maximum load capacity of 200 kg, each sensor has a maximum load of 70 kg with a maximum resolution of 50 g. The system is equipped with four load cells placed at 120° with respect to the transverse plane and placed diagonally to the two axes antero-posterior (AP) and medio-lateral (ML); the sample frequency is 20 Hz and their calibration is automatic. The software tool creates and analyzes the statokinesigram, the axial stabilometry, the Fourier transform of the oscillations, and the assessment of the trunk. The sitting task was made on a physiotherapy couch, Raminstar, 80 cm high, produced by Kinesport.



Bipodalic position on the platform



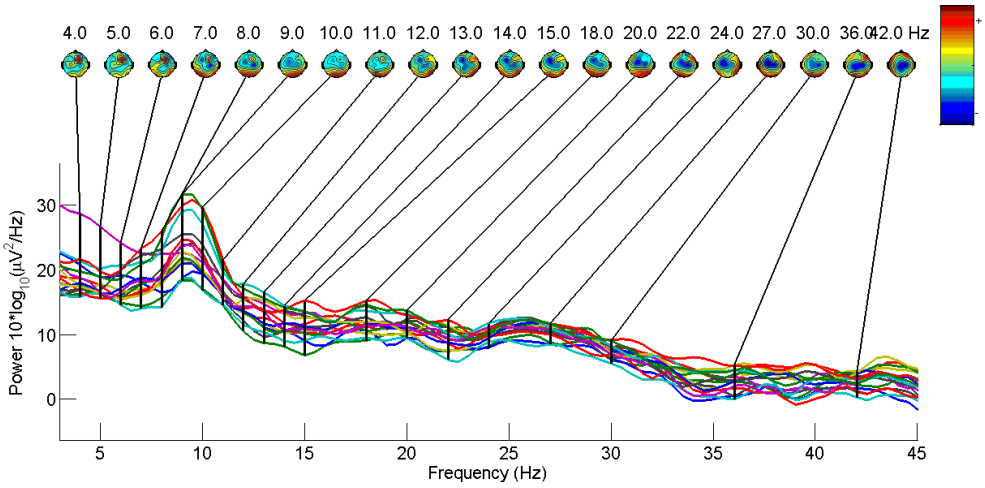
On the left an example of
Statokinesigram, on the right an example of
Axial stabilometry (A-D) and (M-L)

HARDWARE AND SOFTWARE EQUIPMENTS

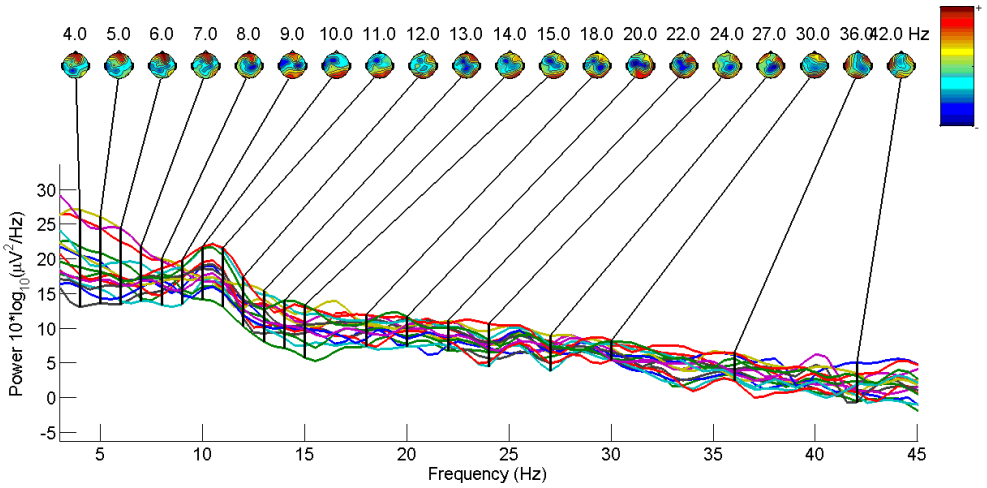
The personal computer used for data import had an AMD Athlon 701 MHz and equipped with 256 Mb of RAM, the OS is Windows XP Professional Service Pack 3. The real-time data acquisition and visualization of signal are performed using the software OTBiolab 1.2. Data processing was performed with the program Matlab 7.9.0.529 (R2009b) 32-bit MathWorks. The program Eeglab 8.0.3.4b, a tool of Matlab, was used to display the signal imported and the creation of the maps of brain activity. This program is open source and is was created by a group of developers of the Swartz Center for Computational Neuroscience. For statistical analysis we used the program GraphPad Prism to 5.
OTBiolab allows recording the signals measured by the amplifier; after completing the data sheet of the subject, screen appears displaying signals with indicators of the saturation of each signal.
Then is needed an assessment of the signal quality. The data backup has the extension .otb, a Compressed file (.zip) containing the data of the subject and the signal (.sig).

Eeglab allows you to view files coming from the amplifier, in order to successfully import the signals it's required a transformation of the file from .sig to ASCII. Through this program it is possible to view the spectrum of frequencies and compare the brain activity in spatial mode choosing frequency. This is useful to analyze what are the most active areas during a specific task. Unfortunately, the software generates chromatic maps with a relative scale, not quantitatively comparable to each other. The display function of the signal along the time has been used to visual selection of noise free part of the signal or with minimal artifacts disturbance as possible, these selections then were processed and used for statistical analysis.

Examples of visualization of EEG signal of a subject sitting with eyes open and eyes closed using Eeglab.



Frequency spectrum of the task: sitting, eyes closed (OC)



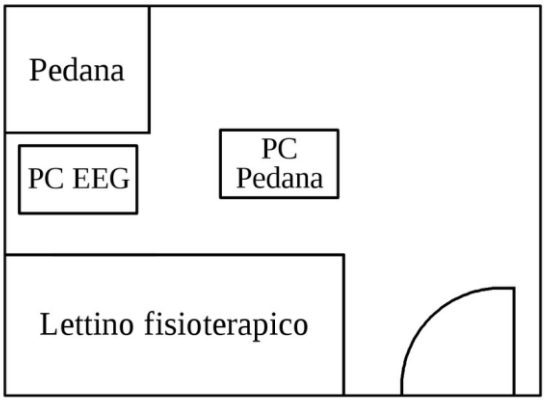
Frequency spectrum of the task: sitting, eyes open (OA)

EEG ROOM

A laboratory was set up specifically for the acquisition of the EEG at SUISM Motor Science Research Center; the ideal place should be without windows and be artificially lightened to ensure a constant light; this room should be free from noise sources and acoustically isolated from the outside.

We considered all noise sources as an integral part of the measure, since we wish to determine if the information is also removable from the noise.

The room has the physiotherapy couch at an angle, next to this there are the amplifier and the computer placed on a table with wheels adjacent to the wall, in addition there is the stabilometric platform which occupies the other corner of the room. The measurement platform is placed diagonally on the right front of the platform. On the wall opposite the platform was placed on a support which is drawn a point, that is placed at the height of the eyes of the subject.



Plan of the EEG signal acquisition room.

METHODS

One of the biggest problems in EEG analysis is the presence of artifacts, especially myoelectric; it is therefore necessary to avoid contraction of the muscles of the skull. Since a long time analysis recording, the isolate peaks of myoelectric activity are averaged over the entire length of the signal, so reducing the outcome influence of EMG on the analysis of EEG.
In this study we tried, using instrumentation built specifically, to replicate some previous studies in the literature, to check how EEG signal changes with eyes open or eyes closed, expanding the study with the investigation of EEG signal in subject in different postural conditions.
The aim of the study is to discriminate task with eyes closed, compared to the same with open eyes, and if is possible to discriminate the position of the subject, among the three proposed, and finally to check whether some areas behave in a particular way with respect to others.
We selected the central part of each recording task, allowing the stabilization of the signal. To avoid putting any kind of noise and artifact in the data analysis we took 5 seconds of each recording for each task analyzed (recordings of 30s and 60s total time). We analyzed the mean frequency, the median frequency of the power spectrum, the ARV (Average Rectified Value) and PSD (Power Spectral Density). As regards the PSD, the highest peak is extracted from the distribution of PSD for the various signal frequencies. We analyzed the differences between sitting position, standing with both feet, and standing with monopodalic support; with eyes open and eyes closed.
For statistical analysis we used GraphPad Prism and performed a Wilcoxon test on each pair of variables. We decided to perform Wilcoxon two-tailed test to see if all channels in the task involving the eyes closed has an average value greater than the same with open eyes.
In addition, we used a Friedman test to make a comparison between the three tasks to eyes closed and the three tasks with their eyes open, then the Dunn's Post Hoc analyzed the differences between tasks in the same group.

CHARACTERISTICS OF THE SAMPLE

We examined 10 male subjects, in apparent good health, with an average age of 29 years and 10 months (SD = 5 years and 1 months), none of whom suffer from any neurological, orthopedic or vestibular disease. All subjects preferred right limb in the test of the predominance. In the tasks in monopodalic orthostasis, subjects were on predominantly limb, maintaining the controlateral with the limb bended and approximately parallel to the floor of the platform.
The criteria for inclusion in the campaign is the absence of cognitive deficits and neurological diseases, other criterion is the length of the hair, focusing on subjects with short hair to facilitate the electrode placement contact.

PROTOCOL

The subject were settle in the laboratory where the test was performed, the time of confidence (10 min.) was necessary in order to prevent that objects in the room and the environment itself can influence the EEG. In this time the operator shows the equipment and explains the method of sampling EEG signal through the headset, the subject is ensured that the acquisition is not painful and does not involve any kind of damage. Before the subject is sitting on the couch, a test for identifying the dominant lower limb of the subject was conducted. This test consists of a boost by the operator, located behind the subject, while the subject is unaware of and placed on foot, the operator notes which limb was placed on the ground in the first step to regain balance. In the final phase the operator presents the protocol used for testing.
Then the operator places a sponge bracelet soaked in water to the right wrist of the subject, through a ground wire the bracelet is connected to the amplifier, the headset is applied to the head of the subject and the electrodes are filled with conductive gel by using a syringe with a blunt needle, then the connection is made between headset and amplifier.
The operator makes a visual inspection (using the software OtBiolab) of the signal obtained from the scalp directly on the monitor of the PC that is connected with the amplifier and check that

the indicators of saturation of the signal of each channel gives a negative result, as a result of this operation there is a check of the quality of the received signal, if it is not good, he checks the correct positioning of electrodes and adds additional conductive gel.
Once the assessment of signal quality, the operator explains the subject the actions that must be done during the signal acquisition. At this point begins the study protocol in which the EEG signal is recorded for each task, the acquisition is monopolar type and the reference is the median of the scalp (Cz).
The subject is seated on the couch watching in front of him, this task is called seated with eyes open (OA), 30s after the subject closes his eyes, this task is called sitting with eyes closed (OC) for 30s.
At this point, the subject moves on the platform, the operator check again the quality of EEG signal, and, if necessary, adds other gel in order to improve the contact between the electrode and the skin that may deteriorated with the movement; the subject is positioned with the feet together, parallel to the midline (anterior-posterior axis) of the platform, and in antero-posterior direction (medial-lateral axis), the subject need to see a dot positioned at his eye level applied two meters from the subject on the wall in front of the platform. The first task that the subject must do on the platform is to stand with both feet with eyes open (BIPOA) for 60s fixing the point. The second task is the same but with eyes closed (BIPOC), the next task
provides the monopodalic support of the dominant limb with the middle sagittal line of the platform (anterior-posterior axis) coinciding with the second finger and the center of the foot and heel. This task has a duration of 30s with eyes open (MONOA), then the last task involves the same position but with eyes closed (MONOC).
In the two tasks with monopodalic support is needed the intervention of the operator who holds the monopolar cable; as this motor task cause oscillations in the subject more than the previous task, to avoid noise due to collisions between connectors, the operator keeps the cable above the subject's head, allowing the braid of cable to move freely without contact among connectors, this operator must be "grounded" by a bracelet on you're the connected to the amplifier.
During MONOA and MONOC task, in the case of loss of balance, the subject can leaning with one hand to the support of the platform.

30 s	OA	Subject sitting with eyes open
30 s	OC	Subject sitting with eyes closed
60 s	BIPOA	Subject standing with bipodalic support, eyes open
60 s	BIPOC	Subject standing with bipodalic support, eyes closed
30 s	MONOA	Subject standing with monopodalic support, eyes open
30 s	MONOC	Subject standing with monopodalic support, eyes closed

Task description

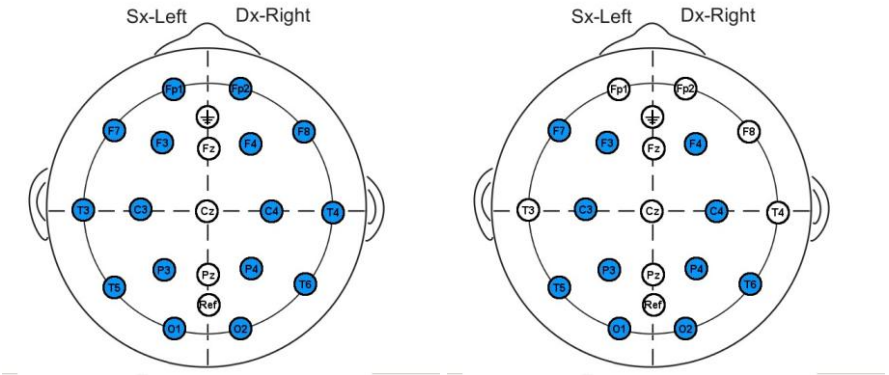
ANALYZING DATA

There is statistically significant difference between the two tasks on sitting position and the two tasks on standing position with bipodalic support both about ARV and PSD, as you can see from the table of significance, the differences expressed above are visible for the scalp. There is a higher statistically significant differences in the different tasks filtered by the alpha band than the band beta, when statistically significant differences showed higher values for the task with eyes closed. With regard to the orthostatic task with monopodalic support, the significance were noted only for rear area of the scalp.

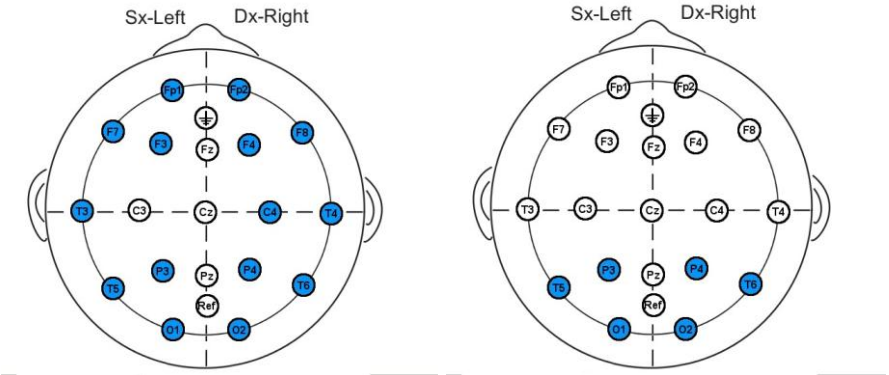
Variable	ARV						PSD					
Task	OA OC		BIPOA BIPOC		MONOA MONOC		OA OC		BIPOA BIPOC		MONOA MONOC	
Band	α	β	α	β	α	β	α	β	α	β	α	β
1 – Fp1	**		**				**		**			
2 – F3	**	**	*				**	*	**			
3 – C3	*	*										
4 – P3	**	*	*	*				*	*			
5 – Fp2	**		**				**		**			
6 – F4	*	**	*				**	**	**			
7 – C4	**	**	*				**	*				*
8 – P4	**	**	**	**			**	**	**	**	*	
9 – F7	*	*	**				**	*	*			
10 – T4	**		*				**		*			
11 – T5	**	*	**	*		*	**	**	**	**		
12 – F8	**		*				**		**			
13 – T4	**		**				**		**			
14 – T6	**	**	**	**			**	**	**	**		
15 – O1	**	**	**	**		**	*	**	**	*		**
16 – O2	**	**	**	**	*	**	*	**	**	**		**

Table of significance of the Wilcoxon test; every pairs of tasks with open eyes was compared with the same position with eyes closed.
*Legend: * = P <0.05*
*** = P <0.01*

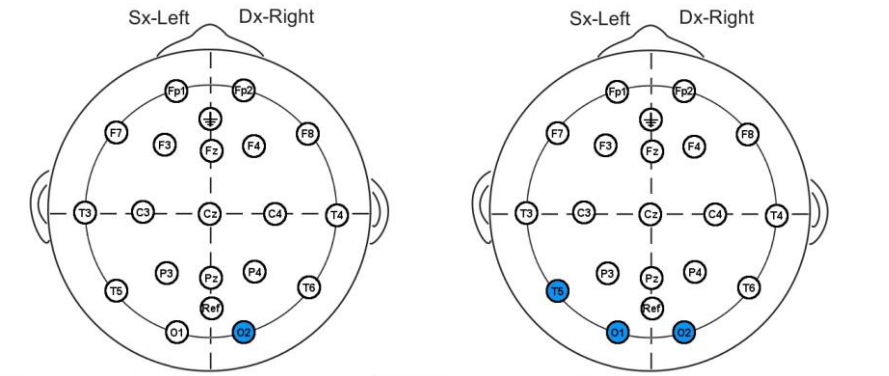
Statistically significant differences for ARV



Significance on ARV
for a band between OA and OC in the left
and for β band between OA and OC in the right

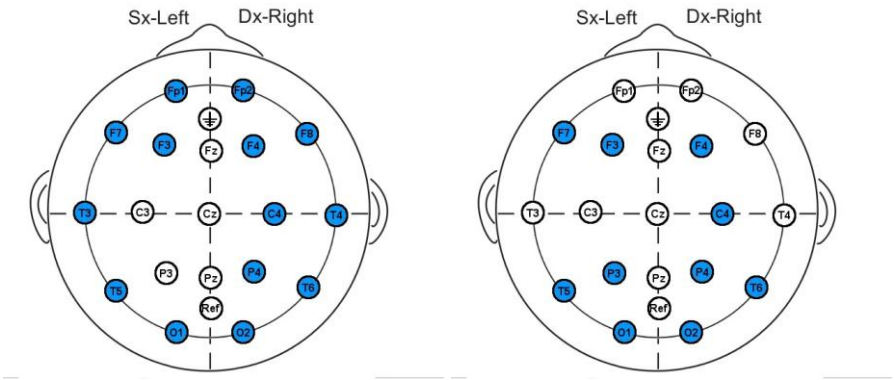


Significance on ARV
for a band between BIPOA and BIPOC in the left
and for β band between BIPOA and BIPOC in the right

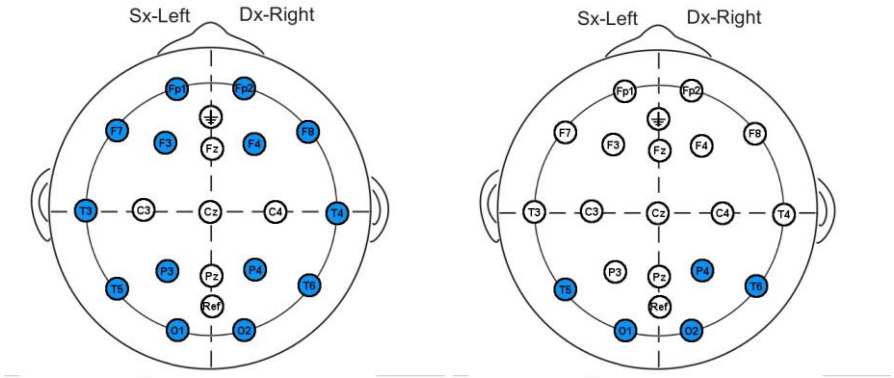


Significance on ARV
for a band between MONOA and MONOC in the left
and for β band between MONOA and MONOC in the right

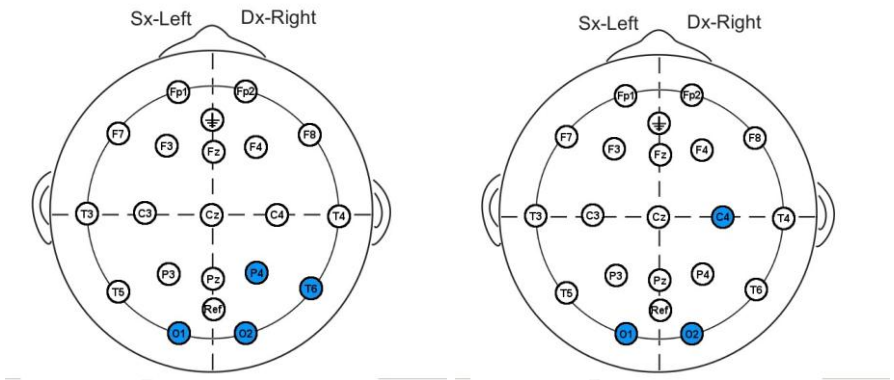
Statistically significant differences for PSD



Significance on PSD
for a band between OA and OC in the left
and for β band between OA and OC in the right

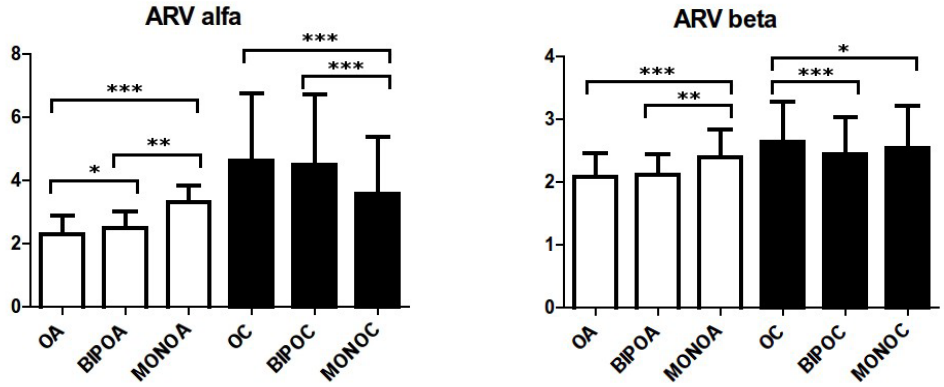


Significance on PSD
for a band between BIPOA and BIPOC in the left
and for β band between BIPOA and BIPOC in the right

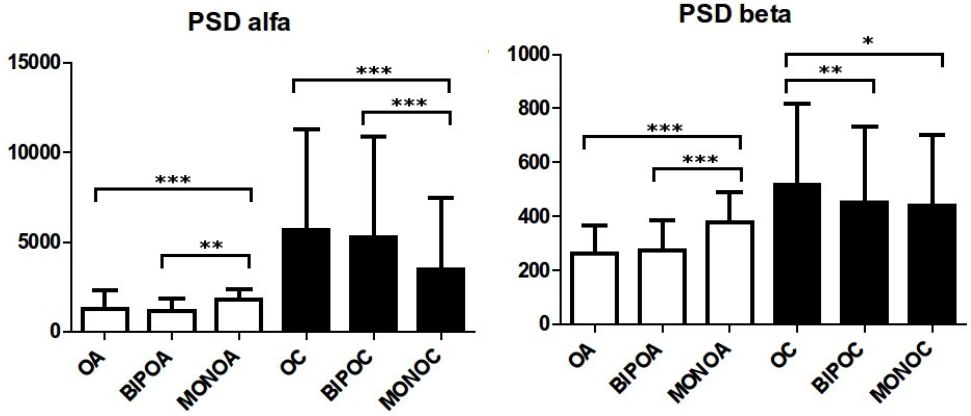


Significance on PSD
for a band between MONOA and MONOC in the left
and for β band between MONOA and MONOC in the right

Averaging ARVs and PSD on all channels, it is possible to obtain a value for each task that represents the average output power of all the scalp averaged over all subjects. From this analysis we can noted that in the alpha band tasks with closed eyes are always higher than the task with eyes open, both for ARV and PSD.
It may be noted that the values of the task with eyes closed decreases with increasing the difficulty of the task being performed.



Average ARV on all channels for a band on the left
and average ARV on all channels for β band on le right. Filled bars = OA and empty bars = OC



Average PSD on all channels for a band on the left
and average PSD on all channels for β band on le right. Filled bars = OA and empty bars = OC

DISCUSSION AND CONCLUSION

The myoelectric artifacts are the first potential source of error, because the contraction of mimic muscles, especially in the temporal, frontal and occipital areas, (e.g. the epicranic and auricular muscles) generate an electrical signal that is detected from the EEG amplifier, but that do not correspond to the cortical electrical signal.
To limit this factor is necessary applying a low pass filter at 45 Hz, to reduce part of the myoelectric reordered signal[16], the filter can be applied directly via hardware or later via software.
A further source of noise is related to the anatomical region of the scalp and it concerns the reciprocal movement of the skin with respect to the skull, due to the contraction of muscles. While that shift does not generate electrical artifacts, however it is evident in the EEG recording the presence of peak of amplitude of the signal due to slipping of the electrodes on the scalp (motion artifacts).
The positioning of the electrodes should follows a consistent and repeatable procedure, if the position is changed during the measurement, the signal will be recorded from areas that had a slight shift in proportion to movement. It is useful to remember that the electrode detects the electrical activity of cortical area from a circle with a diameter of about 10 mm larger the diameter of electrode itself. In addition, the shape of the cup in relation to the shape of the skull could generate small differences in the spatial acquisition of EEG signal[17].
We used an amplifier to amplify the EEG signal (EMG-USB2 OT Bioelectronics No. W003), which on the surface of the scalp the electric signal has a amplitude of few tens of microvolts; because of the strong amplification necessary to view the EEG signal (which can reach up to ten thousand times), the electromagnetic interference that are present in the environment were picked up the amplified and can become a source of noise.
The electrical network to which the equipment is connected (AC 240 V 50 Hz), interferes with the acquisition of EEG signal, the interference is evident in the analysis of the signal for the presence of a peak in the frequencies domain of 50 Hz; using the low pass filter this frequency is outside from the range of frequencies in the analysis.
Random sources of acoustic noise in recording room could disturb the test, they would reduce the reproducibility of the protocol by inducing in tested subject changes in the cortical output signal. these changes are distinguishable and will then be eliminated by looking at the track, but they can compromise the usefulness of the measurement of the task understudy. Thus the test should always be performed under the same conditions and it is therefore important to eliminate random noise and other forms of sensory disturbance.
To make the electrodes record the signal optimally, it is necessary to use conductive gel; if gel is lacking, the signal will be affected by a large amount of noise, but in the opposite case the acquisition of the signal may not be correct, because of the short circuit that would take place between neighboring electrodes. A final source of error is the uncorrected position of the electrode mass to the wrist of the subject: the strategy is to use a bracelet completely wet on the wrist of the subject tested. It is also recommended that the examiner has a ground in the same device.
In the evaluetion phase of quality signal reception, the experience of researcher is crucial for the recognition of the consistency of the signal. A signal with artifacts or spurious spikes, would generate a record useless for further analysis; the inclusion of indicators of saturation of the signal by the software does not facilitate the the operator job, because this indicator does not assess the quality of signal but only the saturation, so the visual analysis of signal at monitor remains essential. It is also important that the reference electrode (please note that during monopolar type acquisition, as used in this protocol, all electrodes have a single neutral reference,

[16] Weidong Z, Gotman J. Removal of EMG and ECG artifacts from EEG based on wavelet transform and ICA. Conf Proc IEEE Eng Med Biol Soc 2004; 1: 392-5.
[17] Please note that the cortical neurons are organized in clusters to form columnar oriented perpendicular to the surface of the cerebral cortex.

which by definition does not detect electrical activity) is located in an area of the scalp electrically silent; usually the reference electrode is placed in the interemisferic fissure in the apical region, in our case we chose the electrode Cz.
A superficial or a non-explanation of the experimental protocol is supposed to affect outcome on the electroencephalographic trace, as a subject unaware of what will happen during the study, will respond differently with respect to a subject properly trained. The manipulation of the cable between the headset and the amplifier during signal recording introduces a source of noise. To overcome this subject movements should be minimized during testing and the cable should be positioned without swinging and the operator should avoid touching the cable, because the parts generating most noise are the pin connections between the headset and monopolar connector pin of the amplifier.
The use of the device (EMG-USB2 No. W003 Bioelectronics OT) needs some adjustments; the software of real-time display and processing must be sufficiently known by the researcher, who must spend a learning period on the application of its use. The length of hairs can affect the measurements, with shorter hair we must use a larger amount of gel and we need to visually control that the connection is free from disturbances due to lack of contact. The hairs and scalp have a conductivity that varies with subjects, then the signal quality also depends on the subject. In this case a partial solution might be shaving the scalp to standardize the value of the length of the hair and applying a degreasing solution would eliminate some differences in the conduct power of the scalp.
Due to the shape of the skull the headset has some electrodes not sticked to the skin: this would affect the quality of signals picked up at these points.

For the alpha band of EEG signal we detected a statistically significant difference between the ARV and PSD in task with eyes open and eyes closed, also in the sitting task and in standing task with support for both feet with the exception of electrode C3 and P3, for all other electrodes we found statistically significant differences.
The reason for this behavior lies in the fact that the exclusion of the visual channel causes an increase of the signal amplitude in the alpha band, so we can highlight more statistically significant differences in this band.

In the analysis of standing tasks with monopodalic support we do not found the same number of statistically significant differences, however, we highlighted the significance in the occipital electrodes (O1 and O2) and surrounding areas. These differences were found for both the alpha and beta bands. One possible explanation is related to the non-relaxation induced by the elimination of visual feedback; in this type of support (monopodalic) the subject cannot find a state of relaxation, blocking the increase of the signal amplitude in the alpha band.
The electrodes O1 and O2 are placed on the occipital cortex, at 17-18-19 Brodmann areas, which represent the visual areas of the cortex; this is probably the reason because we can detect differences in all positions and all the analyzed bands. It is also possible that, due to the reduced spatial resolution, the signal recorded by the two electrodes contains some signal components from the cerebellum, which is responsible for execution control of movements.
For the beta band of EEG signals were detected minor significant differences between tasks with open eyes and closed eyes, the reason is found in the characteristic of beta waves. They are gradually wider as increasing brain activity, so fewer differences were found especially in tasks with monopodalic and bipodalic support in standing task.
The difference in brain activity between the task with eyes open and eyes closed in monopodalic support is of minor importance compared to the activity introduced by the task itself, also the increased level of attention, which occurs when rule out the view, produces greater brain activity and growing increase in instability. With regard to the standing position with as both feet, being less burdensome the task of maintaining the balance compared to monopodalic support positions are more differences between the tasks with the presence or absence of visual feedback, although the significance is related only to the rear the skull. In sitting tasks, or the reasons mentioned above, we highlighted a greater number of significance.
In all tasks analyzed for both bands, when test results are statistically significant, the values of ARV and PSD of task with eyes closed is higher than task with open eyes, this means that when

the subject has closed eyes, the signal emitted by cortical areas in which differences were found has greater amplitude.
In orthostatic task with monopodalic support the value of power density spectrum (PSD) of C4, filtered for the beta band, has an interesting behavior. The electrode scalp area is identified in the literature as Brodmann Area 4 on the primary motor cortex [18]. This area generates signal related to voluntary motor activity in the controlateral half of the body, in our case the left side. During the execution of standing task with monopodalic support to maintain the balance with eyes closed, the left limb works to maintain the balance. Since the Brodmann Area 4 is active in motor control of the right side of the skull, it's clear the significant electrical activity recorded by the electrode C4.
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[18] Zilles K, Amunts K. Centenary of Brodmann's map--conception and fate.Nat Rev Neurosci. 2010 Feb;11(2):139-45.

QEEG WIRELESS

PATENT BEING DRAFTED

TO COMPARE THE QUANTITATIVE ELECTROENCEPHALOGRAPHIC SIGNAL PICKED UP BY WIRELESS AND WIRED DEVICES AND COMPARING THE SAME SIGNAL PICKED UP BY THREE DIFFERENT TYPES OF HEADSET

AIM OF STUDY

The purpose of this study was to compare the signal received from three different types of EEG headset in order to establish whether there was a difference in the acquired and amplified signal. One of these headsets (which will be specified in detail below) using an innovative prototype sleeve for the electrodes and a saline solution as a conductive material between skin and the electrodes.
All signals were acquired through amplifiers prototype[19] built by Ot Bioelettronica (technical data will be provided later). The data obtained from the use of one of these three headsets were compared with those obtained from the same recorded with the wired EEG amplifier, in order to compare the signals recorded and amplified by the two instruments (taking into account electric dynamic, gain and high pass filter of two different amplifiers).
This study was focused to have scientific guarantees to obtain a patent (being drafted) on the headset prototype and the method of signal transmission. The amplifier wired used as a reference is the same used for the study described in the previous chapter.
Also in this study subjects performs tasks during the sampling of the signal (specific references in the PROTOCOL section with technical data of amplifiers and headphones) in order to

[19] Cammann R. Possibilities for the use of a wirelsss telemetric technic in electroencephalography. Psychiatr Neurol Med Psychol (Leipz). 1975 Dec;27(12):737-46. German.

Mohseni P, Najafi K, Eliades SJ, Wang X; Wireless multichannel biopotential recording using an integrated FM telemetry circuit. IEEE Trans Neural Syst Rehabil Eng. 2005 Sep;13(3):263-71.

Jun J, Mengsun Y, Yubin Z, Zhangrui J: A wireless EEG sensors system for computer assisted detection of alpha wave in sleep. . Conf Proc IEEE Eng Med Biol Soc. 2005;5:5351-3.

Berka C, Levendowski DJ, Lumicao MN, Yau A, Davis G, Zivkovic VT, Olmstead RE, Tremoulet PD, Craven PL; EEG correlates of task engagement and mental workload in vigilance, learning, and memory tasks. Aviat Space Environ Med. 2007 May;78(5 Suppl):B231-44.

Cosmanescu A, Miller B, Magno T, Ahmed A, Kremenic I; Design and implementation of a wireless (Bluetooth) four channel bio-instrumentation amplifier and digital data acquisition device with user-selectable gain, frequency, and driven reference. Conf Proc IEEE Eng Med Biol Soc. 2006;1:2053-6.

Lin CT, Ko LW, Chang MH, Duann JR, Chen JY, Su TP, Jung TP; Review of wireless and wearable electroencephalogram systems and brain-computer interfaces--a mini-review. Gerontology. 2010;56(1):112-9. Epub 2009 Jul 25. Review.

Gargiulo G, Calvo RA, Bifulco P, Cesarelli M, Jin C, Mohamed A, van Schaik A; A new EEG recording system for passive dry electrodes. Clin Neurophysiol. 2010 May;121(5):686-93. Epub 2010 Jan 25.

Penders J, Yazicioglu RF, van de Molengraft J, Patki S, Torfs T, Brown L, Van Hoof C ; Wireless EEG systems: increasing functionality, decreasing power. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:3441.

Brown L, van de Molengraft J, Yazicioglu RF, Torfs T, Penders J, Van Hoof C ; A low-power, wireless, 8-channel EEG monitoring headset. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:4197-200.

Bonfanti A, Ceravolo M, Zambra G, Gusmeroli R, Spinelli AS, Lacaita AL, Angotzi GN, Baranauskas G, Fadiga L. A multi-channel low-power system-on-chip for single-unit recording and narrowband wireless transmission of neural signal. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:1555-60.

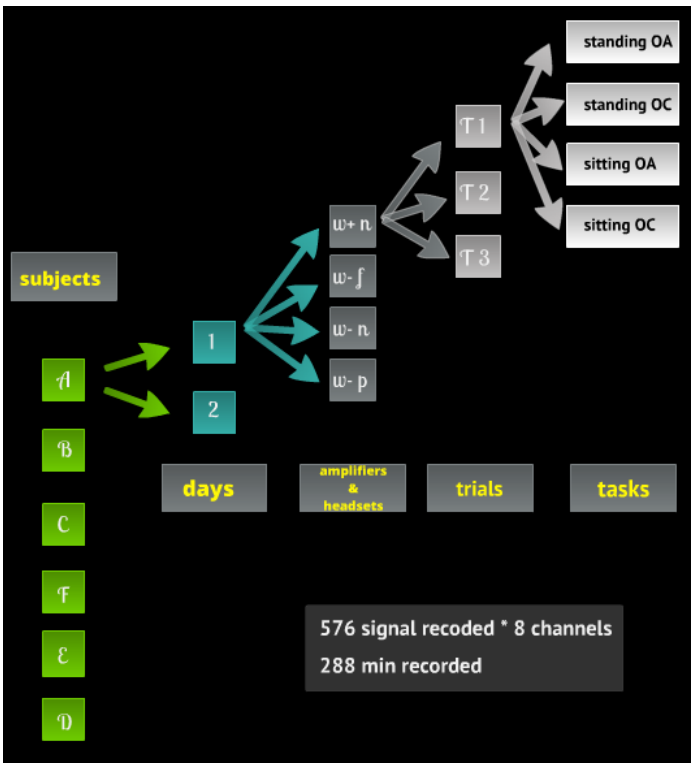
Filipe S, Charvet G, Foerster M, Porcherot J, Beche JF, Bonnet S, Audebert P, Regis G, Zongo B, Robinet S, Condemine C, Mestais C, Guillemaud R. A wireless multichannel EEG recording platform. Conf Proc IEEE Eng Med Biol Soc. 2011 Aug;2011:6319-22.

Dias NS, Carmo JP, Mendes PM, Correia JH ; Wireless instrumentation system based on dry electrodes for acquiring EEG signals. Med Eng Phys. 2011 Dec 5. [Epub ahead of print]

understand if it was possible to distinguish the EEG signal related to different tasks. Finally, EEG signals are analyzed to understand if there was differences of signal amplitude and signal frequency intra and inter subjects.

PROTOCOL

They were examined 6 healthy male subjects, with an average age of 27 ± 4 years, weight 75 ± 9 kg, height 178 ± 5 cm, without any neurological, orthopedic or vestibular disease. The inclusion criteria were the absence of cognitive deficits, neurological disease and the reduced length of the hair.
All subjects were examined in the EEG room (described in the previous chapter), in the Motor Science Research Centre. The subjects were tested for two days, three trials for each instrument and each headset, on postural and visual tasks: sitting with eyes closed (sitting OC), sitting with eyes open (sitting OA), standing with eyes closed (standing OC) and standing with eyes open (standing OA).
Two amplifiers and three headsets were used. The total number of signal tracks recorded was 576 lasted 30 seconds, a total recording time was 288 min and the number of epochs was 576 (one every 0.5 s); 8 electrodes were located along the perimeter line of the scalp (International Standard Position of Electrodes). The cranial sections analyzed, therefore, were 4: frontopolar, frontal, central and parietal. The reference was monopolar, in the center of the scalp with a grounding on the wrist of the subject through a strap moistened in water and on the earlobe of the subject through a pin with neuroconductive gel.
Signals were analyzed after a low pass filter of 45 Hz.



Protocol tree

AMPLIFIERS AND HEADSETS DATA SYNTHESIS

WIRED AMPLIFIER

8 channels recorded, gain 2K, sampling frequency 512 Hz and recorded band from 3 Hz to 120 Hz.

WIRELESS AMPLIFIER

8 channels recorded, gain 2K, sampling frequency 512 Hz and recorded band from 1 Hz to 120 Hz.

All instruments were made by Ot Bioelettronica

NEOPRENE HEADSET

This type of headset use a sleeve in neoprene, a soft and comfortable material, this kind of headset is still widespread and little-used in clinical setting.

PLASTIC HEADSET

This type of headset has a plastic sleeve. It is the most common headset employed in a clinical setting. The plastic material of the electrodes doesn't ensure great comfort and allows more mobility by electrodes on scalp.

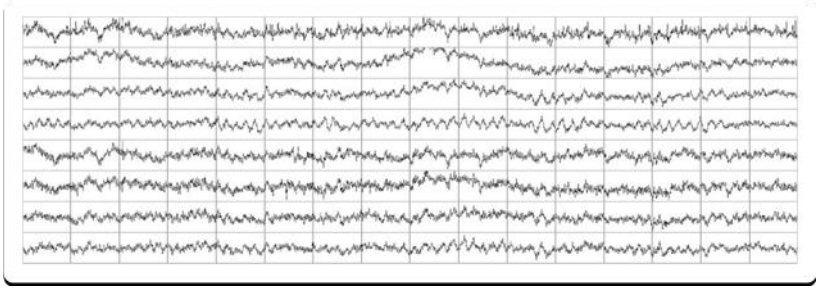
All this headsets work with conductive neurogel.

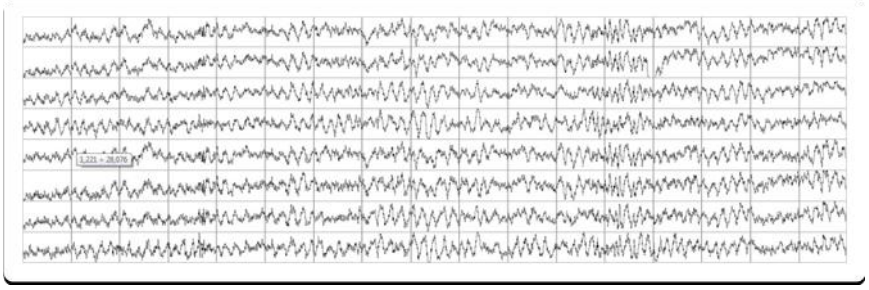
FELT HEADSET

This type of headset has a plastic ring sleeve but the contact between skin and electrode is given by a little thickness in felt. These type of headset is more comfortable and less expensive then the plastic one. Moreover the conductive material is a simple saline solution.

ANALYZING DATA

Each subject performed 6 recording sessions, divided into 2 days and 3 trials.
Each session involved the recording of signals from the wired and wireless amplifier and from three types of headsets for each task.
For each recorded trace (that contains 8 single electrode trace, see figure below) were made the following operations: sum of signals from all channels to obtain the total signal recorded on the scalp, FFT of the sum of channels, sum of signals from channels in reference to the areas of scalp (Fp, F, C, P), low-pass filter at 45 Hz to eliminate electrical noise, calculation of RMS and MDF (root mean square and median frequency) of each area of the scalp to obtain the average amplitude and the average frequency of the signal of each task lasted 30 s; it was also obtained in this way the mean, the standard deviation and the covariance of each analyzed variable.

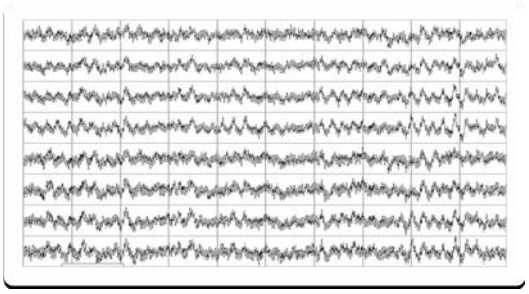




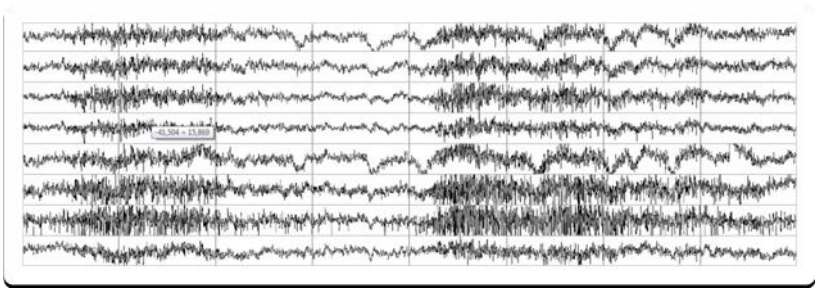
EEG recorded on standing task with eyes open, the first image, and with eyes close the second one.

THE PROBLEM OF NOISE IN EEG

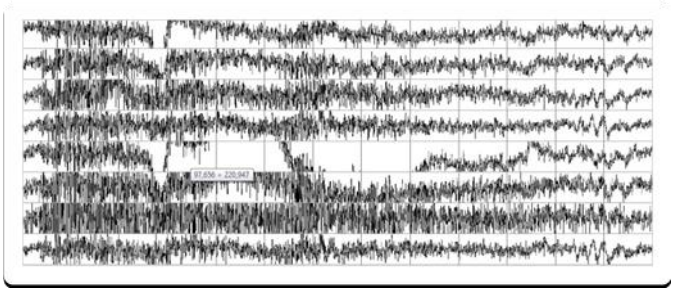
As it can be seen in the figures below the EEG signal can be affected by noise.
Much of this is given by 50 Hz and multiples, taken from the electric network, but some artifacts mainly refer to movements of the electrodes on the skin caused by coughing, sneezing or sudden movements by the subjects.
A further source of noise is given by the manipulation of wires, especially at the point of contact between the pins of the electrodes and the monopolar connector of the amplifier.
The low-pass filter was set at 45 Hz especially to eliminate noise at 50 Hz. International guidelines refer that signal must to be picked up at 70 Hz using a low pass filter at 70 Hz.
In spite of this we decided to use the low-pass filter at 45 Hz to avoid having to enter later a NOTCH filter. The EEG signal above 45 Hz is not considered in the International literature in normal adult subjects in significant densities, at least in reference to the tasks performed by subjects[20]. If the subject had produced artifacts that significantly altered signal acquisition, the test was repeated. All tasks were performed with eyes open, inviting the subject to keep his eyes open to avoid repeatedly slamming the lids (each task had a duration of 30 s). These artifacts, however, having an extremely limited duration and it had no effect on data obtained by averaging over the entire time period recorded.



Noise in raw signal (50 Hz)

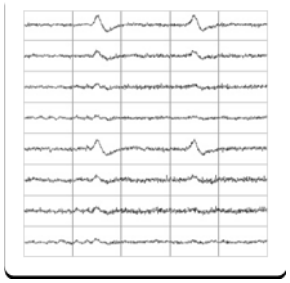


Signal with noise due to handling wiring and/or headset

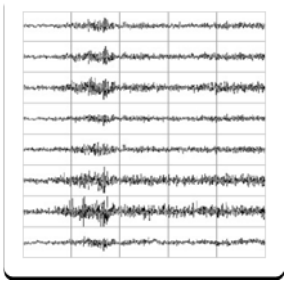


Signal with movement artifacts
and 50 Hz noise

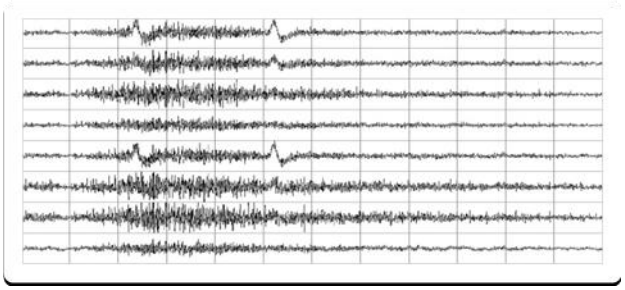
[20] Spyrou L, Sanei S; Source localization of event-related potentials incorporating spatial notch filters. IEEE Trans Biomed Eng. 2008 Sep;55(9):2232-9.



Example of blink artifact

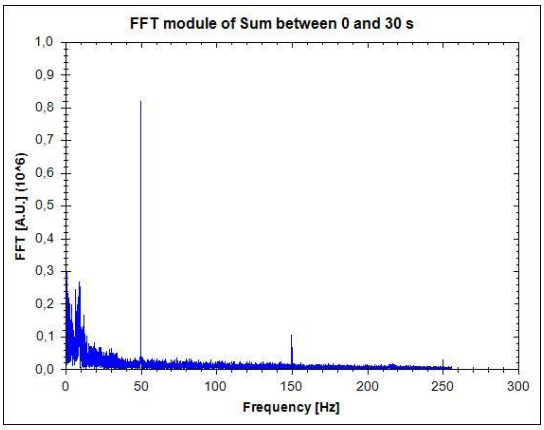


Example of cough artifact



Example of motion artifact

FFT



FFT of signal recorded from subject standing with eyes open (on the left).
Note the amount of 50 Hz noise

REPEATABILITY TEST

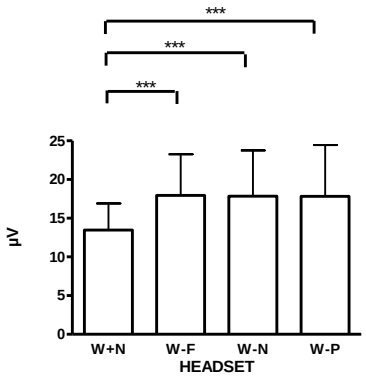
	subj	day	trial	SEM within	SEM between
mean RMS standing oa wired neoprene	68,07	2,97	28,96	4,01	6,85
mean RMS standing oa wireless felt	55,66	2,57	41,77	5,11	7,61
mean RMS standing oa wireless neoprene	35,84	44,60	19,56	5,84	7,58
mean RMS standing oa wireless plastic	76,33	3,20	20,47	4,69	9,76
mean MNF standing oa wired neoprene	13,97	74,55	39,43	9,62	6,60
mean MNF standing oa wireless felt	13,06	56,77	56,29	8,21	6,25
mean MNF standing oa wireless neoprene	12,29	97,55	14,74	8,46	6,86
mean MNF standing oa wireless plastic	16,33	54,96	28,71	5,78	5,71
mean RMS standing oc wired neoprene	76,52	11,37	12,11	4,09	8,53
mean RMS standing oc wireless felt	49,99	36,72	13,29	4,01	6,73
mean RMS standing oc wireless neoprene	62,76	27,53	9,71	5,26	11,76
mean RMS standing oc wireless plastic	43,40	28,47	28,13	4,84	6,44
mean MNF standing oc wired neoprene	35,05	34,24	30,71	6,81	9,20
mean MNF standing oc wireless felt	8,14	58,64	33,22	5,75	5,59
mean MNF standing oc wireless neoprene	32,31	106,42	25,89	7,14	4,39
mean MNF standing oc wireless plastic	18,90	33,53	47,58	6,35	5,39
mean RMS standing oa wired neoprene	12,57	4,82	82,60	7,83	7,28
mean RMS standing oa wireless felt	31,26	0,75	67,99	6,37	5,96
mean RMS standing oa wireless neoprene	30,67	23,85	45,47	5,75	5,99
mean RMS standing oa wireless plastic	48,76	-10,05	61,29	6,00	6,46
mean MNF standing oa wired neoprene	23,06	47,82	75,23	11,80	5,26
mean MNF standing oa wireless felt	28,02	48,78	23,20	7,12	11,06
mean MNF standing oa wireless neoprene	-1,91	73,98	27,93	9,07	8,15
mean MNF standing oa wireless plastic	12,86	50,84	36,30	6,27	6,88
mean RMS standing oc wired neoprene	86,84	6,05	7,10	3,41	9,91
mean RMS standing oc wireless felt	43,04	27,35	29,61	5,11	6,32
mean RMS standing oc wireless neoprene	65,51	1,96	32,53	6,26	10,34
mean RMS standing oc wireless plastic	57,98	-5,99	48,01	5,09	8,61
mean MNF standing oc wired neoprene	16,59	51,61	64,98	8,37	4,46
mean MNF standing oc wireless felt	61,56	12,19	26,25	3,80	6,08
mean MNF standing oc wireless neoprene	54,73	111,12	43,62	7,11	2,39
mean MNF standing oc wireless plastic	0,95	76,62	22,43	5,71	5,25

RESULTS AND DISCUSSION

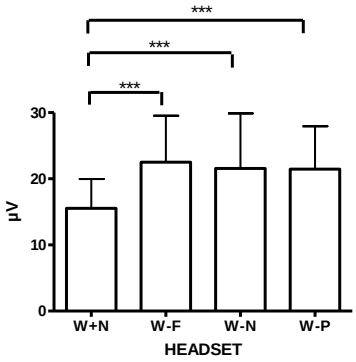
COMPARISON BETWEEN WIRED AND WIRELESS SIGNALS

All graphs below show the differences between signals for all trials, all subjects, all over the scalp, for each task. They show the mean values of RMS and MDF respectively for the amplitude and frequency of signal.
For the statistical analysis was used the ANOVA - Kruskal Wallis that showed a significant p value ($p<0.001$) between the signal recorded with the wired amplifier and the signal recorded with the wireless amplifier; only in two case there is a significant differences between the signal taken from different wireless headset. The Dunn's post hoc shows statistically significant differences between the amplifiers.

all subj all trial all section task:standing OA MEAN RMS

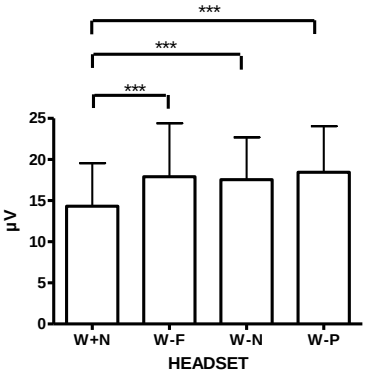


all subj all trial allsection task:standing OC MEAN RMS

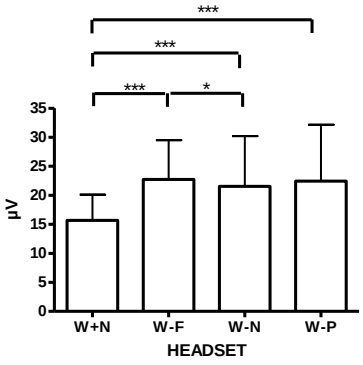


For this and next pictures:
W+ is the wired amplifier, W- the wireless;
N is the neoprene headset, F is the felt headset and P is the plastic one.
*Dunn's post hoc: *** for p<0,001, ** for p<0,01,* for p<0,05*

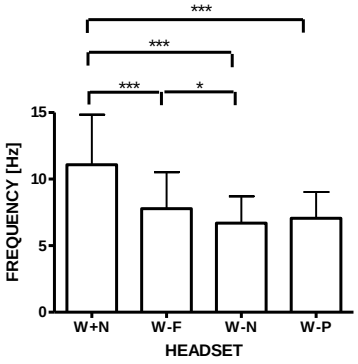
all subj all trial allsection task:sitting OA MEAN RMS



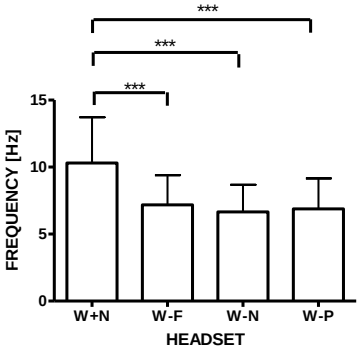
all subj all trial allsection task:sitting OC MEAN RMS



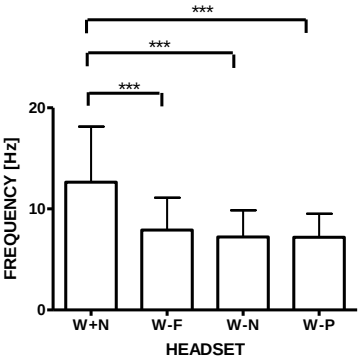
all subj all trial allsection task:standing OA MEAN MDF



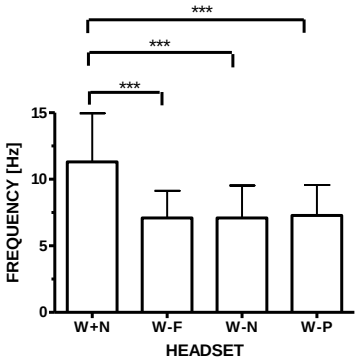
all subj all trial allsection task:standing OC MEAN MDF



all subj all trial allsection task:sitting OA MEAN MDF

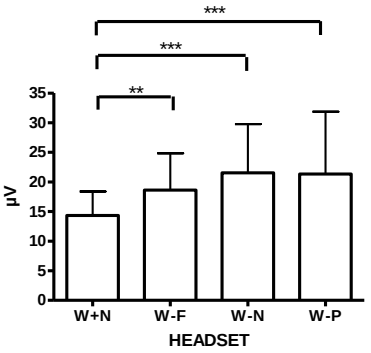


all subj all trial allsection task:sitting OC MEAN MDF

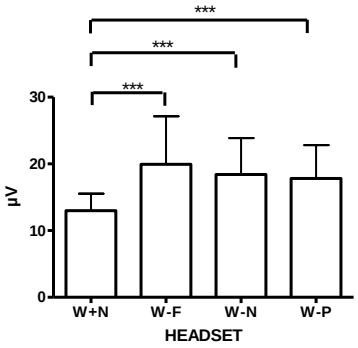


Analyzing the individual sections of the scalp, there are some differences respect to the entire scalp. The examples reported below show standing OA task analysis; so they show the differences between signals for all trial, all subjects, for each section of the scalp.
They show the mean values of RMS and MDF respectively for the amplitude and frequency of signal. It is possible to see that the most part of differences are between the wireless amplifier and wired amplifier. For the statistical analysis was used the ANOVA - Kruskal Wallis that showed a significant p value ($p < 0.0001$) between the signal recorded with the wired amplifier and the signal recorded with the wireless amplifier; but no statistically significant differences were reported for the signal taken from different wireless headsets. The Dunn's post hoc shows statistically significant differences between the amplifiers.

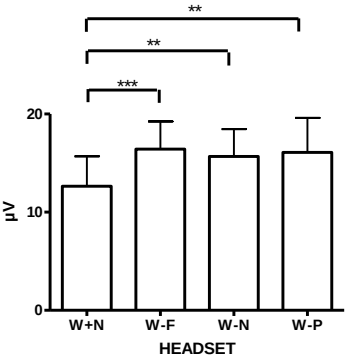
all subj all trial section fp task:standing OA MEAN RMS



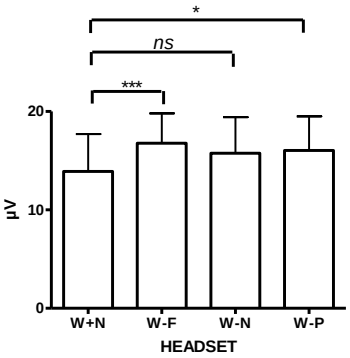
all subj all trial section f task:standing OA MEAN RMS



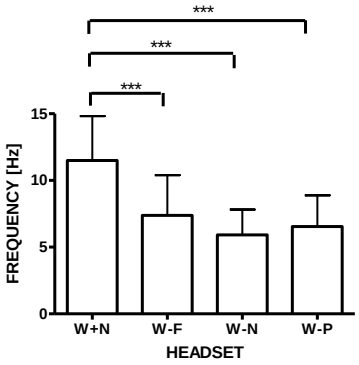
all subj all trial section c task:standing OA MEAN RMS



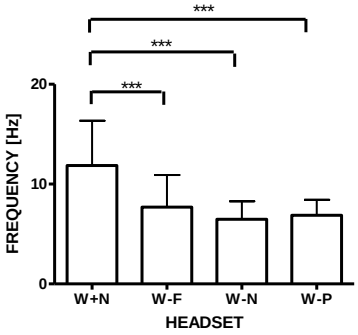
all subj all trial section p task:standing OA MEAN RMS

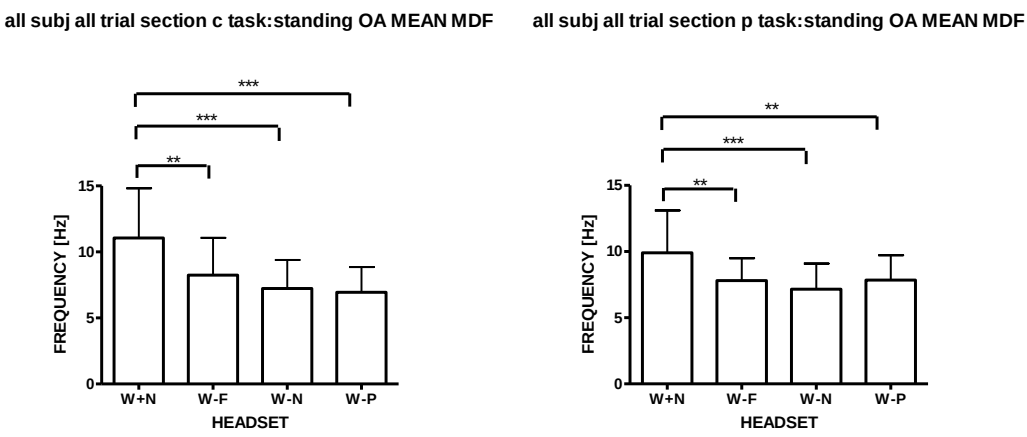


all subj all trial section fp task:standing OA MEAN MDF



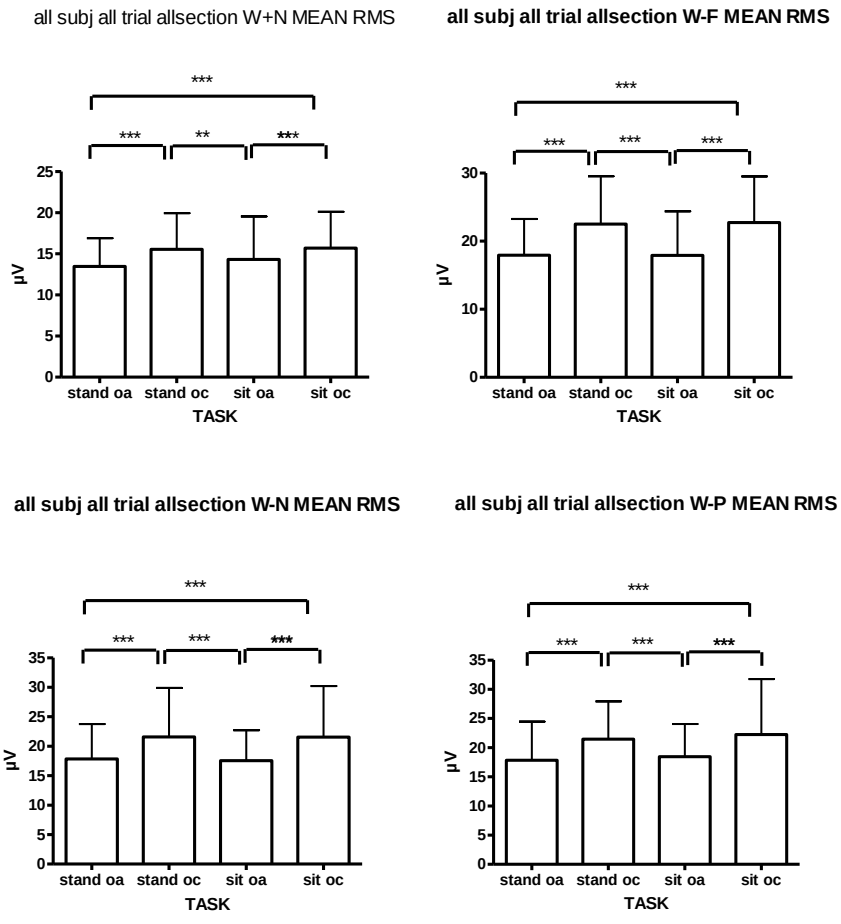
all subj all trial section f task:standing OA MEAN MDF

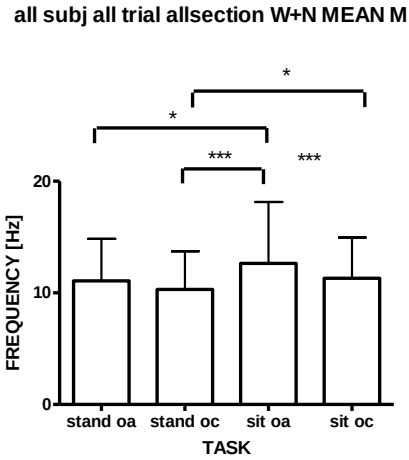




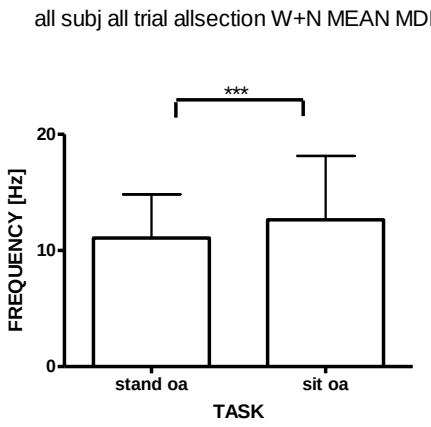
HIGHLIGHTING TASKS

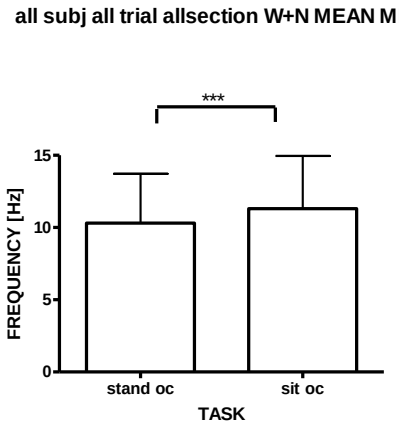
The following figures show the results of the statistical analysis for each task on each headset. The results are statistically significant for both the signal amplitude (RMS variable) and the frequency analysis (MDF). The instrumentations were able to distinguish between the same postural tasks but performed with different visual inputs (sitting eyes open vs sitting eyes closed and standing eyes open vs standing eyes closed; for the statistical analysis was used the ANOVA - Kruskal Wallis that showed a significant p value $p < 0.0001$) but not if it was performed in the same visual condition (sitting eyes open vs standing eyes open and sitting eyes closed vs standing eyes closed). The wired device, as shown in the last figure of the next series, is able to distinguish the different tasks even in the same visual condition, with regard to the variable MDF. The Dunn's post hoc shows statistically significant differences between the tasks.



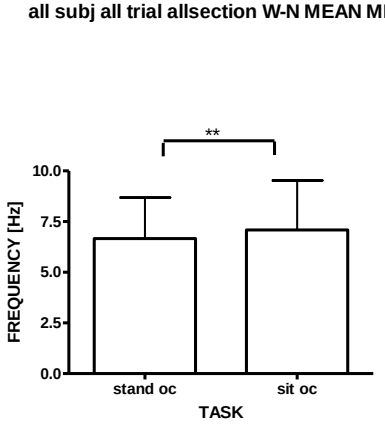


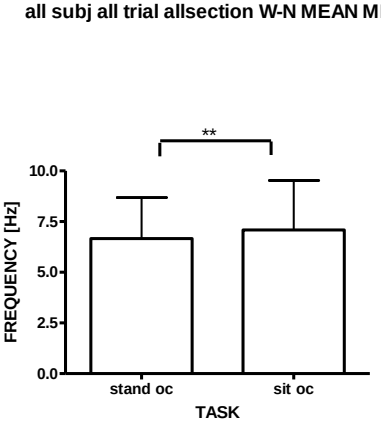
All graphs below show the differences in MDF variable between task with same visual condition all over the scalp. For the statistical analysis was used a Wilcoxon test that showed a significant p value ($p<0.001$) between the signal.

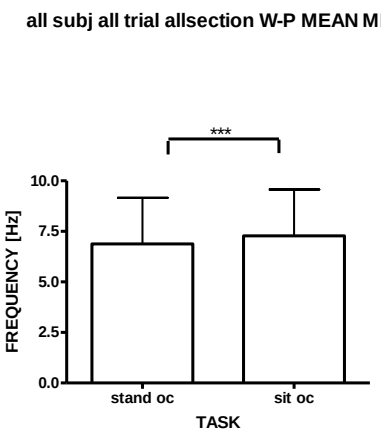




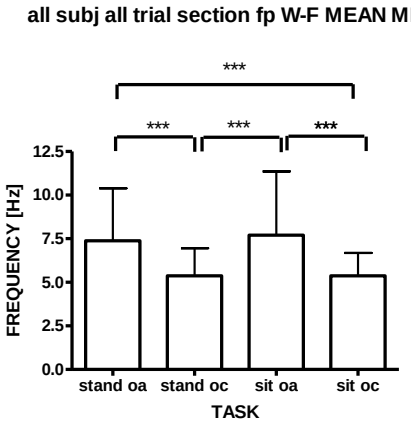
Using the Wilcoxon test for other types of headset (plastic and neoprene) with signal recorded by wireless amplifier, statistically significant differences ($p < 0,01$ and $p < 0,05$) were found between the different postural task in the same visual condition.







The headset with felt skin-electrode contact used with wireless amplifier did not show any statistically significant differences between the different tasks using the signal over the entire scalp for MDF. Then it was analyzed the individual scalp section and it was seen that the front-polar section showed statistically significant differences between tasks (ANOVA Kruskall Wallis $p < 0.001$). No statistically significant differences were found analyzing the other sections.

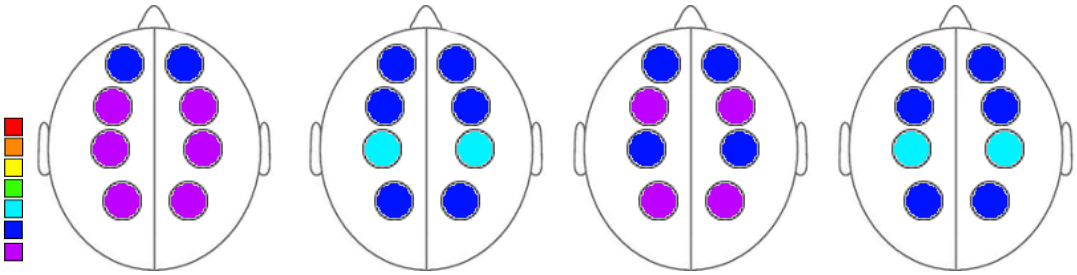


POST HOC SIGNIFICANCE TABLE

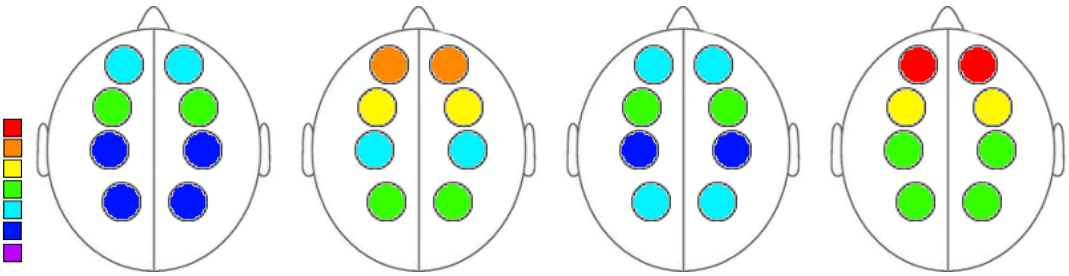
	RMS															
	standing OA				standing OC				sitting OA				sitting OC			
	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P
W+N		***	***	***		***	***	***		***	***	***		***	***	***
W-F	***				***				***				***		*	
W-N	***				***				***				***	*		
W-P	***				***				***				***			
	W+N				W-F				W-N				W-P			
	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC
st OA		***		***		***		***		***		***		***		***
st OC	***		**		***		***		***		***		***		***	
sit OA		**				***				***				***		
sit OC	***				***				***				***			

	MDF															
	standing OA				standing OC				sitting OA				sitting OC			
	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P	W+ N	W-F	W-N	W-P
W+N		***	***	***		***	***	***		***	***	***		***	***	***
W-F	***		*		***				***				***			
W-N	***	*			***				***				***			
W-P	***				***				***				***			
	W+N				W-F				W-N				W-P			
	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC	st OA	st OC	sit OA	sit OC
st OA			*													
st OC			***	*												
sit OA	*	***														
sit OC		*														

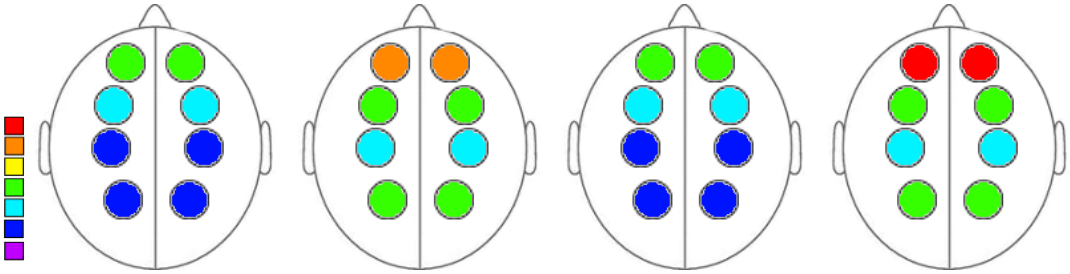
Analysis of differences between tasks for each type of headsets and amplifiers. It was used a chromatic scale weighted on the maximum value for the variable RMS (signal amplitude). Red is higher value, violet lower.



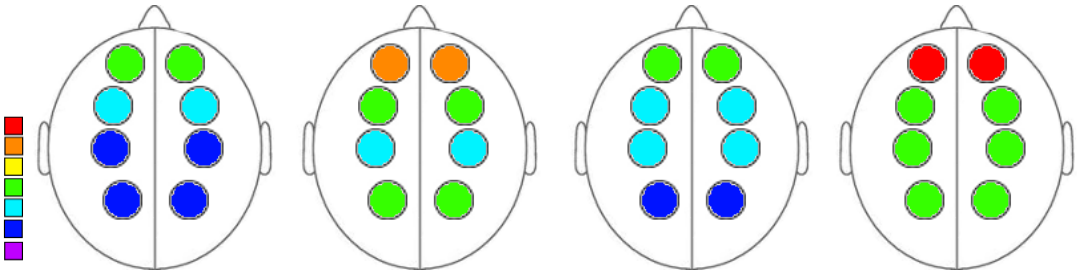
RMS for each section with Wired amplifier and Neoprene headset; from the left: sitting OA, sitting OC, standing OA, standing OC



RMS for each section with Wireless amplifier and Felt headset; from the left: sitting OA, sitting OC, standing OA, standing OC



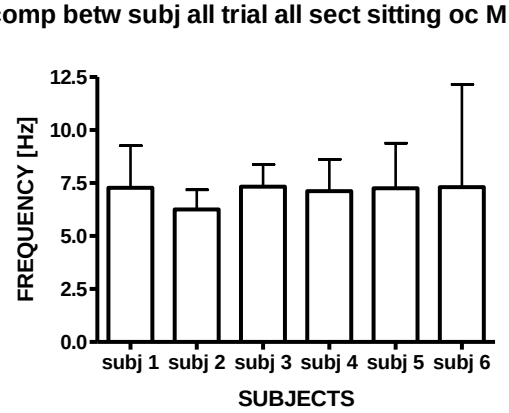
RMS for each section with Wireless amplifier and Neoprene headset; from the left: sitting OA, sitting OC, standing OA, standing OC



RMS for each section with Wireless amplifier and Plastic headset; from the left: sitting OA, sitting OC, standing OA, standing OC

DIFFERENCES BETWEEN SUBJECTS

How presumed differences between the subjects wearing the same headset, using the same amplifier and involving in the same task, with regard to the average amplitude of the signal (variable RMS) were in general statistically significant. This is mainly due to the different impedances of the subjects skin.
Concerning the signal frequency (MDF), it was generally less subject-dependent than the signal amplitude (RMS). Below is reported an example of signal recorded from neoprene headset, wireless amplifier, during a sitting eyes closed task.



CONCLUSION

The analysis of qEEG recorded from two different amplifiers and three headset established that there is no statistically significant differences between the headsets (except for some sporadic cases), but there is statistically significant differences between the amplifiers. The differences seem due to high-pass filter on hardware of the wired amplifier. The filter affects both the average amplitude and the average frequency, so the differences are only related to the bandwidth of the two different instruments: on the one hand the wireless recorded bandwidth is 1 Hz - 120 Hz, on the other the wired is 3 Hz - 120 Hz.
The choice of one headset instead another is given by the comfort (neoprene cup and felt cup are more comfortable) and the easiness of wearing (neoprene cup and felt cup are more easy to wear). But there are some other considerations: the felt cup has the possibility of losing the pads during the dressing and during signal acquisition, as the saline swells the electrodes, which protrude from their sleeve; there is also the possibility that the solutions spilling out on the scalp causing short circuits between the electrodes. The neoprene headset does not have the problem of felt headset, it is comfortable and without a lot of motion artifact but it uses the neurogel which is more difficult to clean than the saline solution and it is more expensive.
By analyzing task it was demonstrated that all amplifiers and all headsets show significant statistically difference between the visual task on RMS (amplitude).
By analyzing the MDF it was possible to show statistically significant differences between the postural tasks in the same visual condition. In particular the wired amplifier was able to find statistically significant different on MDF on the average all over the scalp; for the wireless amplifier it was necessary to do an analysis on sections of the scalp (in particular Fp).
Concerning the differences between subjects there are statistically significant difference for RMS between subjects. This results could be explained by the different skin impedance.
For MDF it was not found any consistent difference between subjects, as expected.

WE-SPORT

REGISTERED TRADEMARK / MSRS SPIN OFF

A WEB SOCIAL NETWORK CONNECTED TO THE SPORTING ENVIRONMENT TO FACILITATE THE PRACTICE OF AMATEUR SPORT, IN PARTICULAR RELATED TO SPORT WITH LOW DIFFUSION

INTRODUCTION

In June of 2009, thanks to the direct support of S.U.I.S.M. in Torino, We-Sport s.r.l. was born as a spin-off of the Motor Science Research Center, with the goal of developing and maintaining a vertical web social network (we-sport.com), capable of linking athletes through some significant sport parameters: Sport, Location, Schedule, Level, Age and Gender. In this way, one of the main problems of sports practice, i.e. the lack of a partner with which to practice one's favorite sport, could be solved by using a web tool. Two years after, the project We-Sport has won numerous national and international awards, it received private fundings and investments from capital ventures as well as made arrangements with the most important Italian institutions for sports promotion. Moreover, the information derived from the data obtained by individual users provides a large database to be used for further scientific purposes. One of the most interesting features of the project is to transfer information from web-world to real-world related to the practice, in this case, in sporting activities.

To date, We-Sport is close to the top 250000 websites on Earth and to the top of 5000 websites in Italy according to Alexa Rank statistics.[21] In January 2012 Netcraft survey received responses from 582,716,657 sites in the WWW. The total number of Active Sites now stands at 175 millions.[22]

COMPANY DESCRIPTION

We-Sport is the name of the first social network devoted entirely to sports. The project is within the Interfaculty School of Motor Sciences of Torino thanks to the initiative of three researchers: Marco Ivaldi, Marco Iacuniello, Vacariuc Aurelian.
The idea of creating a social network on sport comes from two findings: the need and pleasure for those who practice sport to get in touch with other people in the same geographical area, and the need on the part of industry to experiment with new ways of promoting the services offered. The social network We-Sport has the aim of facilitating access to sporting activities, linking athletes and sports enthusiasts, offering the opportunity to contact and book on-line structure where to perform the activity.

[21] At the time of writing respectively 250805 in the word and 5016 in Italy. Alexa Internet, Inc. is a California-based subsidiary company of Amazon.com that is known for Web traffic reporting, and considered to be the most reliable in the web world.
[22] Netcraft is an Internet Research Services company based in Bath, England, UK.

We-Sport has its own mission also in a social aim: to provide access to sport for all those who for various reasons, have difficulty in sports, such as the handicapped in general and those belonging to disadvantaged social groups. For this aim, a "social section" will be created.
The corporate **mission** of We-Sport is: "To allow all athletes to find the right partner for their training, their missing teammate for their game or just the right person to share their experiences and sports emotions with. Allow all companies operating in sports field, at all organizations for the sport promotion and sports organizations and sports federations and in general all those who gravitate around the sports world to get in touch directly with key users, customers, supporters".
The **vision** of We-Sport is: "To be the website benchmark for sports in the world".
Team aspirations are the development of the community worldwide, to facilitate the aggregation of those who play secondary sports and attract public and actors such as associations, government agencies, sports facilities, companies that organize events, professional, shops and sporting goods companies.
Risk appetite stands at high or medium levels as is the current management team will invest time and resources in this project. The **main advantage** of We-Sport appears to be the advantage of priority over any competitors' actions: We-Sport already has the technology and the platform and it's the first in Italy focuses on a service which embraces almost all the existing sports and is moving towards mobile applications. With regard to global competitors, We-Sport for the first focused on organizing events that relates to the individual athlete, rather than focusing on large mass events.

SOCIAL NETWORK DESCRIPTION

We-Sport is a social network made to the world of athletes. It allows them to organize meetings, training sessions and track their results in a personal profile, relating them through sport practiced and geolocation. The platform has been developed since May 15, 2009 and it is permanently available from 1 November 2009 at www.we-sport.com and apps.facebook.com/we-sport/, it is continually updated and maintained. We-Sports offers two types of accounts: simple user and professional user.
A **simple user**, once the application process is completed, can interact with all other community users, both stating his availability of time that the sports played. The platform will put him in relation with others, suggesting those related to sports, availability and geographically closer. It can also interact with **business users** (federations, facilities, companies, experts) who have access to customizable pages with which they can promote and manage their business.

PROBLEM AND SOLUTION

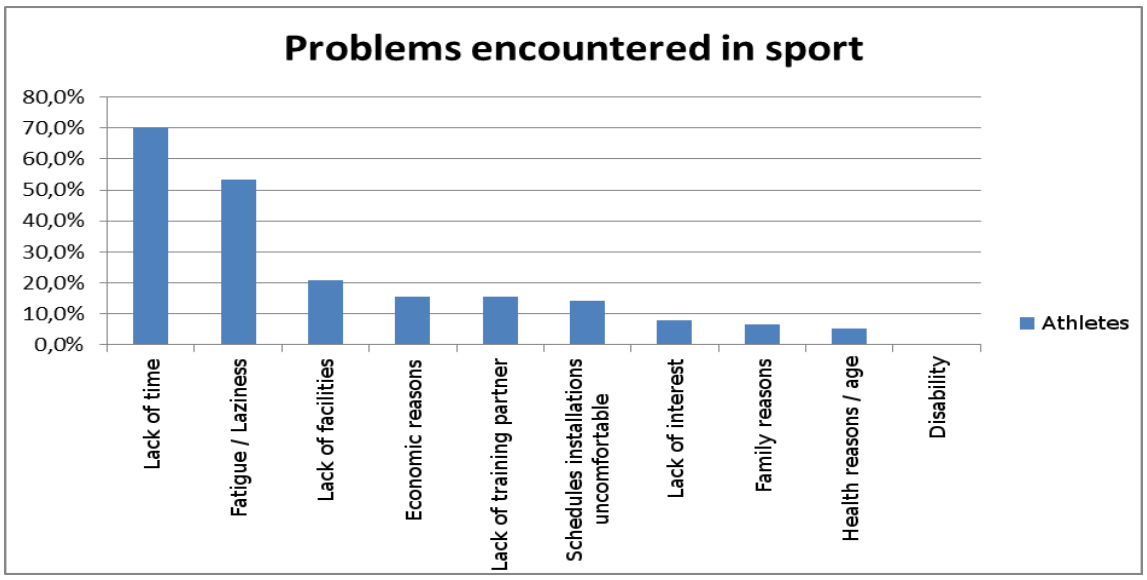
The social network for sports We-Sport will listen to needs that exist at different levels. First, in 70% of those who are involved in sports in general it is noted the demand for more opportunities for contact with other athletes of their own discipline in the same geographical area (source: primary research). It is apparent, especially in large cities, the difficulty of quickly locate facilities to practice sports, such as near your home and with skilled personnel. Furthermore, with increasing strength of the sports federations, sports facilities and centers, professionals working in the field of sport, feel the need to get to know and maintain the relationship with their members/customers (source: interviews with presidents of the Federation, facilities managers, trainers).
Finally, considering the social side of entrepreneurship in which We-Sport want to give great relief, it is estimated in industrialized countries, that for every person who practices sports, there are two who can't practice for barriers to entry of various kinds (economic, cultural, physical, etc...).

We-Sport offers a platform organized according to the structure and dynamics of social networks ables to relate to each other both athletes with athletes and athletes with the facilities to practice the activity, with the professionals (such as a personal trainer for improve their performance) and companies.

The platform allows athletes and sports fans to get in contact with other athletes of the same or other disciplines to choose from more than 300 sports including minor sports, and to identify thanks to geolocation athletes closer to their area; so it can realize the contact developed on the platform with the actual practice of the sport.
It's possible in a few steps to organize immediate, individual and team games, tournaments and leagues, sports meetings, training sessions. Sports fans can also keep track of their performance and share and compare them with those of other athletes.
Thanks to future implementations, users can check in real time the availability of playing fields and book them directly from the platform. Sports facilities, which will have the opportunity to fill a greater number of slot times, is also given the opportunity to send through the platform last minute on their fields and sports initiatives to target users in line with the offer.
We-Sport also provides job profiles for all companies and professionals (federations, sports facilities, individual professionals) that in this way can use the platform for promotional and experiential marketing campaigns easily reaching a target group of potential users / high-profile clients. An online shop will be the site of the platform where the industry can be sold, possibly at a discount because of the collective mode of purchase that the platform can generate, sports products and services. Also the user can benefit of it because he can find in the same "place", the social network We-Sport, all he need to enjoy his favorite sport.

AUDIENCE

The idea of developing a social network dedicated to sports fans to bring them into contact with each other and at the same time with sport facilities and technicians, stems from the fact that 20% of those who practice sports feel **the need to find more people to practice the same sport** (source: primary research) both for organizational reasons both for the **need of motivation**. It has therefore often difficult to find people who share the same passion for sports. Also, especially in big cities, it is useful to **quickly find a list** of possible sport facilities to achieve comfortable and to **find expert personnel** to practice in the best way their favorite sport. Furthermore, the need is growing by small federations and sports centers to be known and maintain the relationship with its members and the need by companies to promote their business (source: interviews with presidents of federation and managers of facilities).



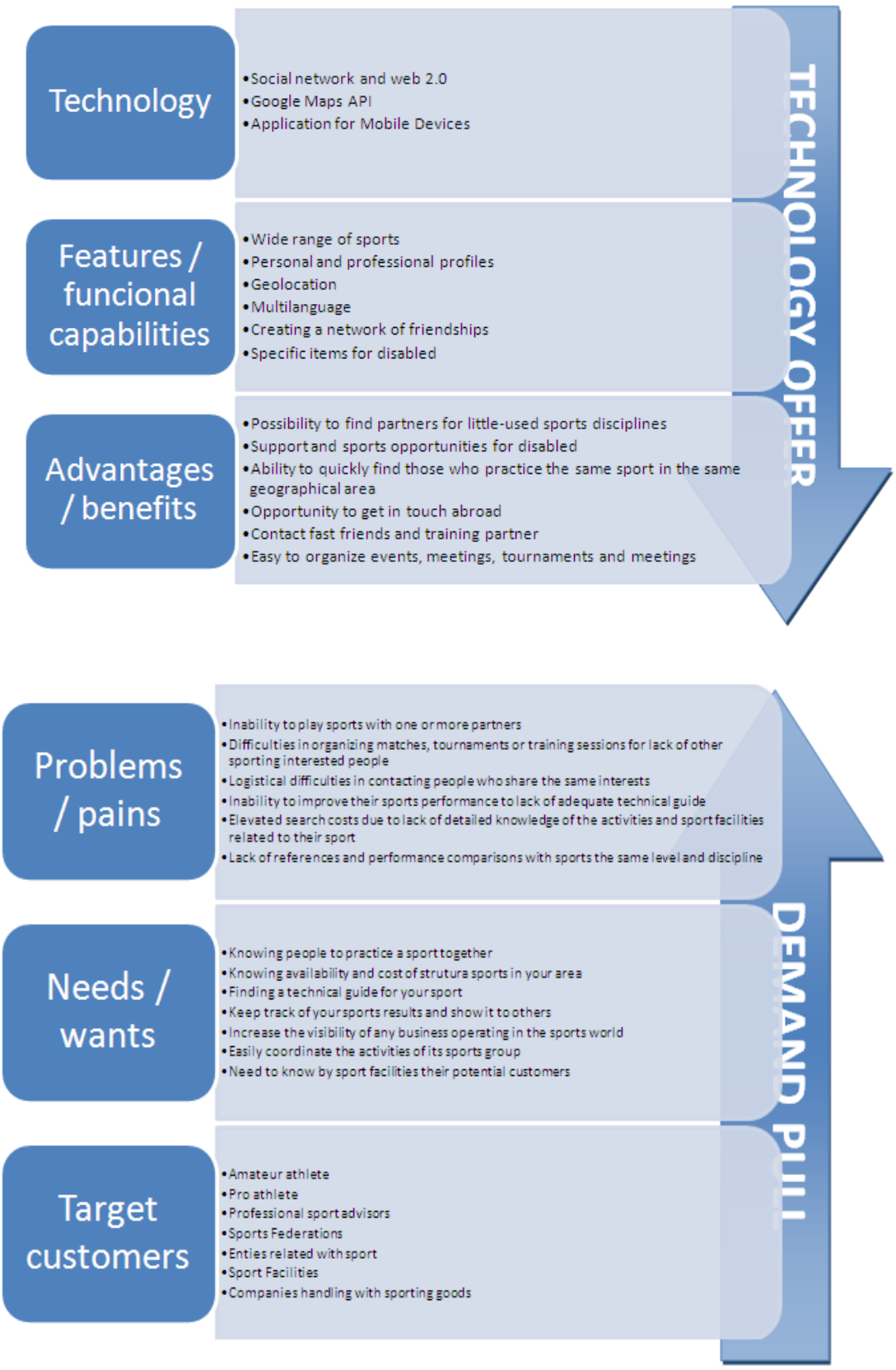
Problems in sport (source: primary search)

THE BENEFITS FOR THE USER

We-Sports offers a platform capable of **linking athletes and companies**, offering a **wide range of disciplines**, allowing you to contact those who share your same interests and that is located nearby you, with the help of **geolocation**. This allows you to easily organize games, rallies, training sessions, testing new products. We-Sport also allows the creation of pages and professional profiles, thereby facilitating the promotion activities by companies, associations and sport facilities that through the platform have access to a **highly segmented target**.

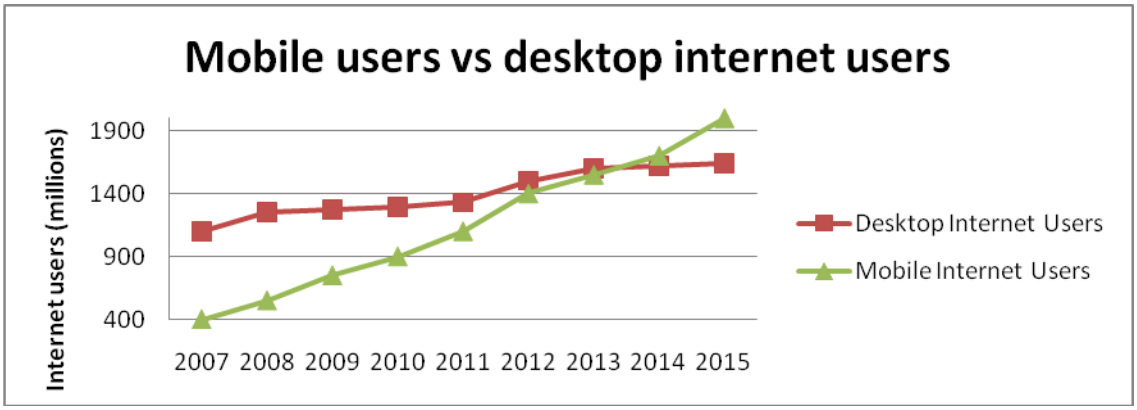
OVERVIEW ON SPORTS EQUIPMENT

European market for sports equipment in 2008 is estimated $ 21.2 billion and is growing significantly, it forecasts to 2013 lead to an increase of 10.9% compared to 2008, bringing the total valuation to $ 23.5 billion. Clothing and sports shoes have a large share 6.8% and generate revenues up to $ 1.4 billion.
Revenues of three major companies (Amer Sports Corporation, Adidas Ag, Head Nv) suggest that the shares for investment in advertising are very important. The team believes that the presence of a social network with a clear enough definition of sports can be attractive to these companies because it represents an alternative way to reach future consumers.


Technology
•Social network and web 2.0
•Google Maps API
•Application for Mobile Devices
Features / funcional capabilities
•Wide range of sports
•Personal and professional profiles
•Geolocation
•Multilanguage
•Creating a network of friendships
•Specific items for disabled
Advantages / benefits
•Possibility to find partners for little-used sports disciplines
•Support and sports opportunities for disabled
•Ability to quickly find those who practice the same sport in the same geographical area
•Opportunity to get in touch abroad
•Contact fast friends and training partner
•Easy to organize events, meetings, tournaments and meetings
TECHNOLOGY OFFER
Problems / pains
•Inability to play sports with one or more partners
•Difficulties in organizing matches, tournaments or training sessions for lack of other sporting interested people
•Logistical difficulties in contacting people who share the same interests
•Inability to improve their sports performance to lack of adequate technical guide
•Elevated search costs due to lack of detailed knowledge of the activities and sport facilities related to their sport
•Lack of references and performance comparisons with sports the same level and discipline
Needs / wants
•Knowing people to practice a sport together
•Knowing availability and cost of strutura sports in your area
•Finding a technical guide for your sport
•Keep track of your sports results and show it to others
•Increase the visibility of any business operating in the sports world
•Easily coordinate the activities of its sports group
•Need to know by sport facilities their potential customers
Target customers
•Amateur athlete
•Pro athlete
•Professional sport advisors
•Sports Federations
•Enties related with sport
•Sport Facilities
•Companies handling with sporting goods
DEMAND PULL

OVERVIEW ON INTERNET MOBILE

The spread of users who surf using mobile connections is a strong trend rising in the Internet world. The explosion of social networking combined with the iPhone, laptop or smartphone, or so-called mobile Internet devices (MID) is proving a decisive push for new usage scenarios of mobile Internet:



Evolution of Internet (Source: Morgan Stanley)

A study conducted by Mediascope and edited by the European Interactive Advertising Association show that in Europe alone more than 71 million people connect with a certain constancy from mobile networks, the average duration of access was estimated at little more than a hours a day and the age group includes people between 16 and 34 years. Italy is in second place on the continent for number of users. Under this light it is vital to a social network emerging immediately focusing on the development of dedicated applications for MID and more specifically for the iPhone, as We-Sport is doing.

POTENTIAL MARKET

The service can be used both by professional entities such as federations, sports clubs and sports organizations by identifying a structure **Business to Business (B2B),** both from a final user identifying a structure **Business to Consumer (B2C).** These structures appear to be of fundamental importance because they allow to derive economic benefits from their co-existence: the increase of users in one of two markets inevitably leads to greater attraction for each other which in turn increases the growing interest in new users:

Target market segments

THE SOCIAL SECTION

We-Sport with is Social Section wish to provide access to sporting opportunities to individuals who, for various reasons, have troubles to play sports (physical handicap, economic status, psychological distress and relational, etc ...).
The social section intends to bring together all the realities on the platform, first Italian and later European and international, who for various reasons dealing with the social function of sport, in order to make the most extensive and comprehensive as possible offer for the disadvantaged.
The platform will inform users about courses to free or reduced price, on the presence of social sports projects, will enable instructors to act as assistants or volunteers, will offer a "social place" for the exchange of experiences and initiatives and projects to set shared between institutions and structures that deal with social sport, will provide the user-specific features such as a car pooling service to facilitate travel to the sports facilities.
The social section is directly targeted at disadvantaged people but is of course open to all users in this way they will approach the world of sport in a totally new way with a particular attention to the social value of sport.

Briefly the social section will be structured around three main areas

- Pages describing the entity that deals with social sport;
- Pages describing the event and/or social project, with the ability for the entity that promotes the initiative organized to receive donations, to seek partnerships with other institutions of social networks, or to obtain sponsorship from companies/federations/etc .. adhering to the platform;
- "Social Square", with a showcase on major sporting events, with space for shared planning with support of the team of Sportiamo – Lo Sport che Unisce, and a corner "talk to the specialist" where you can deal with a team of specialists to the various problems that exist within the social sport.

The social section will be jointly created and managed by We-Sport Srl and by the association Sportiamo – Lo Sport che Unisce, association founded by a group of professionals working for years in the sport in particular in the social sphere.

AIM

We-Sport is aimed to:

- ✓ Athletes and anyone who wants to play sports (professional and amateur);
- ✓ Sports Federations;
- ✓ Company and Sports Associations (also amateur)
- ✓ Government and Foundations of the Third Sector;
- ✓ Sports Facilities;
- ✓ Professional of sport (dieticians, personal trainers, nutritionists, sports medicine, etc ...);
- ✓ Companies producing and selling sporting goods.

Referring to the year 2010 it was estimated[23] that 32.9% of Italians older than three years, (approximately 19.2 million), practice sports, of which 22.8% continuously and 10.2% intermittently (at least once a week). Those who have not practiced a sport but do light physical activity (i.e. a medium distance walks, swimming, cycling) are approximately 28.2% of the population equal to 16 million and a half.

[23] Source: ISTAT, Multipurpose Survey on families "Aspects of Daily Life", 2010

The temporal analysis reveals an increase in the propensity to sport of 1.8 percentage points last year (from 26.8 percent in 1997 to 32.9 percent in 2010).
In Italy, therefore, appears to be the catchment area of 35.2 million individuals. Considering only individuals falling in the age group that most uses the Internet, between 14 and 65 years of age, the basin narrows to 23.2 million individuals practicing physical activity.
Assuming that the percentages above may be used to estimate the number of practicing sports in the rest of the world, and considering that to date only 25% of the world's population access the Internet, we obtain the following data:

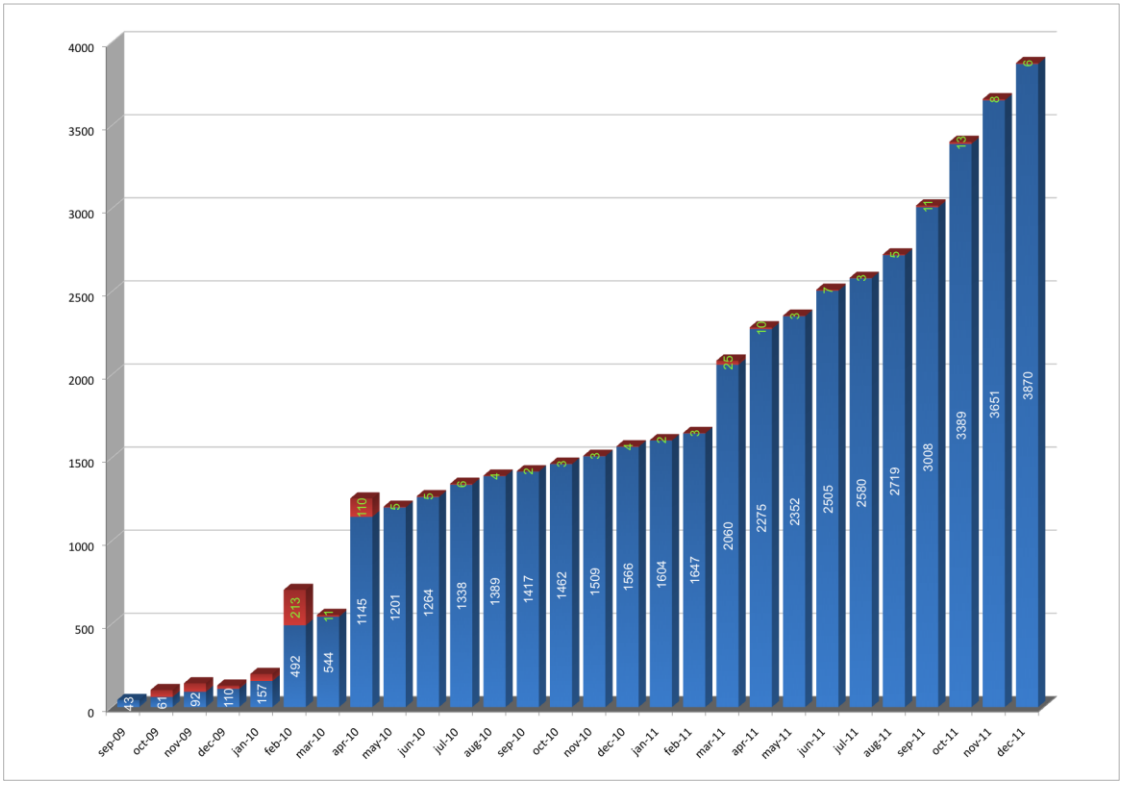
- ✓ Italy: 5.8 million practitioners of physical activity of 60.6 million inhabitants.
- ✓ Europe: 70 million practitioners of physical activity of 731 million inhabitants.
- ✓ World: 648.5 million practitioners of physical activity of 6,775 million inhabitants.

Target/Total Population	**Italy**	**Europe**	**World**
Athletes between 18 and 44 years using Internet	**5.8 mil** **60 mil**	**70.8 mil** **730 mil**	**330.5 mil** **6,829.3 mil**
Athletes between 18 and 44 years using Internet to communicate and social networks	**4.7 mil** **60 mil**	**57.3 mil** **730 mil**	**267.5 mil** **6,829.3 mil**

Potential World Market (source: ISTAT)

Taking these data as reference, the historical pattern of projecting members to We-Sport from November 2009 to date and considering reasonable reaching for at least 25% of the basin (whereas some regions have an Internet connection with bandwidth limited - only 60% of European households have a broadband connection - and that there is high competition in popular sports), we obtain the curve of adoption you will see in other page.

The expansion will be by-step: the marketing efforts will focus on the Italian area first and then move to the European with the release of new languages. Once established in Europe, We-Sport will be pushed on other countries worldwide.



Increase of we-sports members from 2009 to 2011
in red the percentage increase per month, in blue the total number

INDUSTRY ASSESSMENT E COMPETITORS

The sector is highly fragmented with a large number of players of different sizes.
The attractiveness of the sector stood at good levels, as demonstrated by the growth of Web advertising spending, which rose from € 871 million to € 1,027 million between 2009 and 2010. Fubles and Sportilia in Italy and Heia Heia in Europe are the main competitors.
The added value that We-Sport has on competitors is represented by the following competitive advantages:

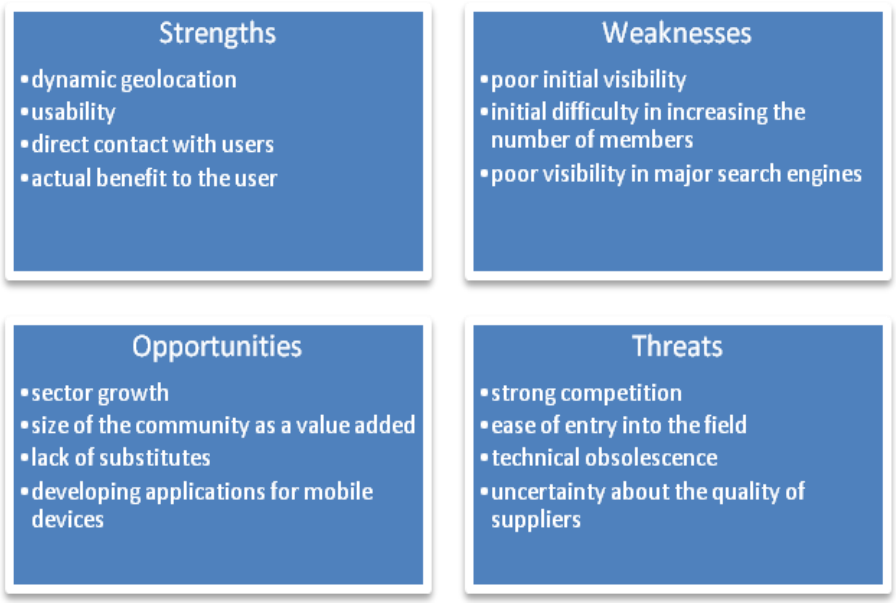
- The support of the University of Motor Sciences of Turin, a member of the project, which guarantees credibility to the initiative and privileged channels for the development of the project;
- Parmalat sponsorship and strategic partnerships with major industry players such as Cisalfa Group (the largest Italian brand of sports shops) and Radunisportivi srl (the main organizer of sports events on the beach);
- The area devoted to the sport's social platform, which distinguishes the social network We-Sport to all the other initiatives;
- First mover in terms of presence on Facebook, thanks to the development of a specific flash application;
- Highly qualified project team, with specific experience in the sports sector, which has achieved excellence in academic positions, managerial and information technology.

The growth of the sector in recent years shows that it is a very attractive area for potential new players. The sector also appears to be one of the most fragmented within the IT area. The **threat of entry** by new competitors (e.g. by the development of Facebook functions or specific applications for athletes) is extremely severe and caused mainly by the ease in which new players can enter the market. This is mainly due to lack of control of the distribution channel that in the case of a social network is the Internet, lack of control of raw materials (represented by users

carrier of information) and the difficulty of protecting with patent its own code. Nevertheless, we must consider that a larger and wider community (or the first to become stable) discourages the entry of new competitors. The **switching costs** for customers are also high especially if the social network reaches a number of members that make it difficult to surrender to it.

COMPETITOR ANALYSIS

Below is a list of leading industry players. At national level the two major possible competitors were identified in Calcetto Italiano (www.calcettoitaliano.it) and Fubles (www.fubles.it), although in reality both deal exclusively or almost exclusively with football.
At the international level we have identified Active (www.active.com) and Weplay (www.weplay.com). Active is a site that operates mainly in the United States and deals with all types of sports offering all kinds of information for those who practice a particular discipline, often the information comes from experts (trainers, doctors) and concerns both athletic training tips that closely engineers to improve their performance. Weplay is a U.S. site dedicated to young athletes, parents, coaches and youth teams.
The **strengths, weaknesses, opportunities and threats** for We-Sports are represented in the figure below.



S.W.O.T. analysis

Product development based on the concept of **continuous deployment** requires the identification of certain characteristics that are important to the success of the product and their classification in terms of priorities under even the hours per man available to the team. The development process then proceeds with the creation of a feature, the analysis of user feedback, the correction or deletion of features. The user feedback will be critical for determining priorities in developing the final features of the platform.
Alongside the development team will, through appropriate metrics and monitoring activities to verify customer satisfaction for existing features, improve and correct any bugs.
Here are some features currently identified for development:

Feature	Description
Mobile Geolocation	Interaction between the database of athletes currently maintained by We-Sport and mobile devices with GPS functionality (Satellite Positioning System). Planned to develop specific applications for iPhone and Android based devices.
Co-marketing	Collaboration with companies interested in promoting their products through interaction with the users of the site. These companies can offer users activities, meetings and challenges.
Profile for professional users pay	Available for event handlers and sports facilities and manufacturers of sports equipment. We will provide them tools to actively involve the end user.
Pages for business users do not pay	Available for professionals with different levels of interaction and tools than previous.
Support for additional languages	Will be able to appeal to more users. It is currently planned to add Spanish, French, Romanian, Albanian and German.
Integration with other social networks	Allow the user to interact inside the site with other social networks.
Customizing professional profiles	Allow you to customize your profile by style sheets (CSS).
Advertising	Allows better routing of promotional campaigns to specific targets.
Services for disabled people	Will be implemented specific services such as search filters.
Tracking and tracing activities biometric	Interaction of sport user with the website.
Upload photos and videos	Increased attention to social networking services.
Integration of sport newspapers	Allow the user to interact with leading sports newspapers.

Features to be implemented

BUSINESS MODEL

The strategic plan of We-sport is characterized by three elements:

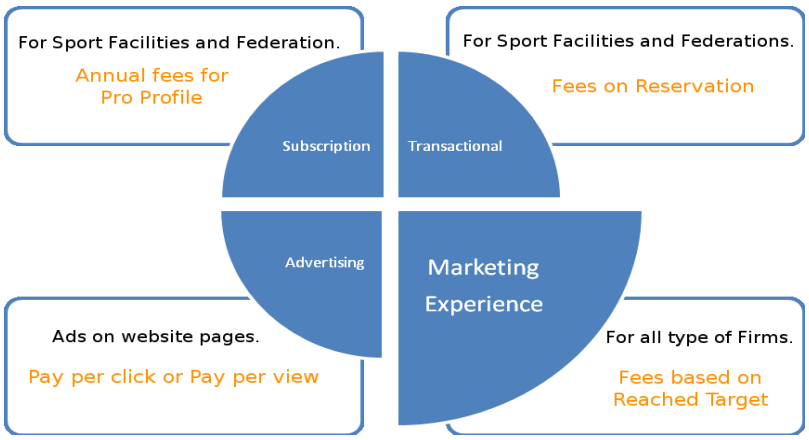
- The spread of the application is pursued with agreements with major networks. The promotion at the non-paying users will be primarily through online advertising, presence on major social networks, creating viral campaigns, spreading off-line at major universities and on-site at the sports facilities, and through participation in trade fairs conferences and industry to have direct contact with potential customers.

- Placement and the price of the platform is designed to be perceived by the market as more advantageous than the existing networks: high potential, specificity, ease of segmentation, low cost, ease of use.

- The platform will distinguish itself from competitors with outstanding operating characteristics that characterize it as a real tool for the recruitment of participants in sporting activities (non-paying users) and sales (business and sports / paying users).

As described will introduce the concept of diversification compared to its competitors, going to position the brand We-Sport apex of consumer preferences.

The business model proposed by We-Sport is based on the following models:



Business model

MARKETING STRATEGY

The marketing strategy aims to:

• Targeted Partnerships: We-Sports has partnered with Cisalfa Group, RaduniSportivi, CUS Torino, RAI Trade (in closing), CONI (in closing), Associazione Sportiva "Sportiamo – Lo sport che unisce", Association of Italian Municipalities.

• On-site activities: attendance at major sporting events, activities of viral and street marketing, presence at major Universities and sports facilities, participation in trade fairs and conventions industry.

• Activities on-line: presence in the major sports-related sites and blogs, digital PR activities to promote We-Sport at the online community of athletes and sports fans.

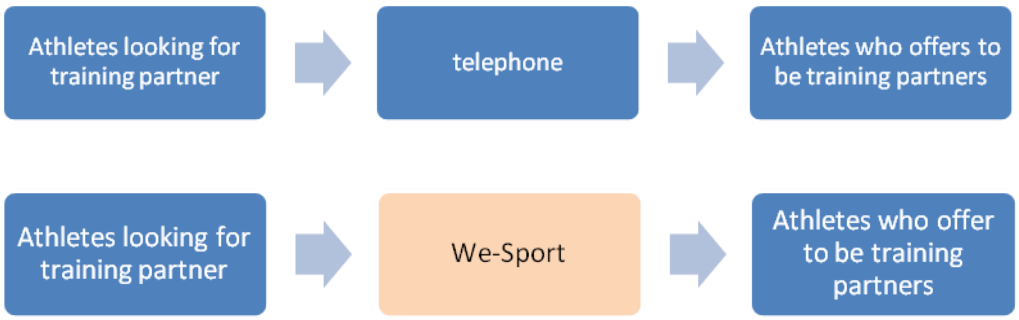
EXPERIENTIAL MARKETING

The strategy is targeted at companies, associations and sports clubs and relies heavily on the peculiarities of the athlete: **challenge and competition**.
The activities to be carried out include the interfacing of the companies with the athlete by organizing events with competitive nature: **"Launch challenge"**. The company partners sponsoring the event and is giving away prizes for the winners while We-Sport is responsible for promoting it on its website. In this We-Sport aims to act as a gateway between the Web's social networking and the real experience. This strategy focuses on working with companies on Italian territory in the first time, going to scale across Europe and the world after obtaining the necessary evaluation metrics including hierarchies and decision-making.
The cost for creating an event is totally free for businesses in the first two years to determine whether this business model is scalable and replicable, while the third year companies pay an ad hoc fee according to the number of users reached by the communication challenge.

COMPANY OPERATIONS

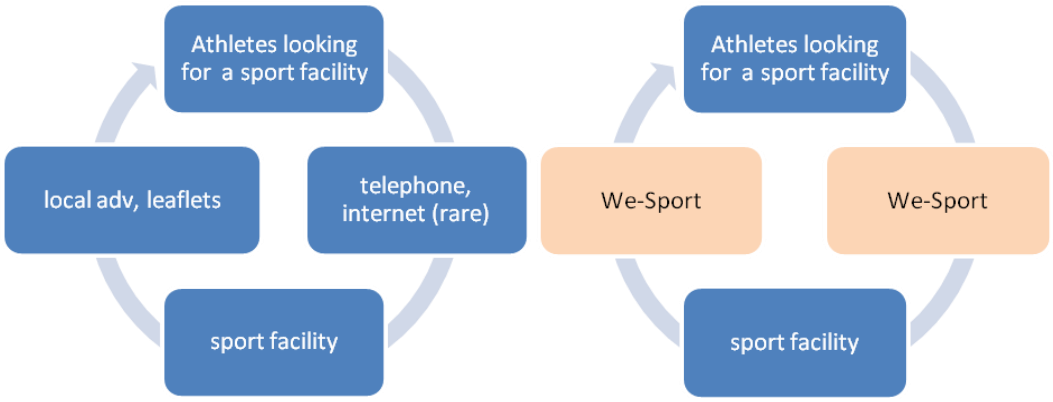
The actors involved along the value chain of We-Sport are:

- Athletes who use the platform to seek training partner or a sport facilities available to welcome them. We-Sport fits between these two categories, thus play the role of intermediary and facilitating the organization of meetings, introducing a savings in cost and time.



The role of We-Sport in the athlete's value chain

- The sport facilities that want to be known and to publicize their activities, which may use We-Sport as a marketing tool.



The role of We-Sport in the sport facility's value chain

- The federations and sports clubs, organizations, which use the platform proposed by We-Sports as a channel of promotion and communication with its members and the interested athletes.

The role of We-Sport in the federation's value chain

TEAM

- Marco Ivaldi, Co-Founder and Chief Technology Officer of We-Sport. He is a Clinical Kinesiology and PhD Candidate in medical physiopathology, he has always had its interests in sports and in the dissemination of a healthy lifestyle. He developed the idea of We-Sport and now he follows the evolution in terms of technical and product.

- Aurelian Vacariuc, Co-Founder and Chief Architect of We-Sport. Degree in Computer Science, Head of Software Development, is responsible for the architecture of the website in all its aspects.

- Marco Iacuaniello, Co-Founder and Chief Marketing Officer of We-Sport. Degree in Marketing and Business Administration and Management Company. Takes care of marketing and communications and is CEO of We-Sport.

MEDIA

Here are some reviews of We-Sport, which appeared on the main institutional and national information portals.

INFOSERVI.IT

"Trovo molto interessante il fatto che questo (social) network concentri l'attenzione sul dare la possibilità agli utenti di trovarsi all'interno dell'applicazione virtuale con lo scopo di incontrarsi poi nella vita reale e condividere insieme l'attività sportiva. Un bell'esempio a mio avviso di come le applicazioni virtuali possano diventare (e diventano) sempre più vicine e parallele alla vita reale delle persone. E così il network di amici virtuali trova il suo preciso scopo nel favorire l'incontro reale, nel contesto dell'attività sportiva."

LASTAMPA.IT

"[…]Tutti e quattro sarebbero ben felici di poter condividere quell'ora o poco più di attività fisica con qualcuno, giusto per non annoiarsi e - in compagnia - non perdere la voglia di allenarsi un po'. Adesso, se vogliono, un modo c'è. Si chiama We-Sport."

ILMESSAGGERO.IT

"La sezione "Percorsi dell'Innovazione: dall'idea al business" ha dato occasione di comunicazione e promozione a sette idee innovative presentate da nuove aziende, insieme al supporto della Camera di Commercio e Assessorato alle Attività Produttive di Roma Capitale. Le idee che abbiamo visto erano tutte interessanti, dal social network specializzato per chi fa sport di We-Sport.com […]"

CAMPUS.IT

"We-Sport, in definitiva, è un modo innovativo per condividere esperienze sportive, conoscere le persone che praticano lo stesso sport nella propria città, mettersi in contatto con chi condivide le medesime esperienze, organizzare incontri sportivi, tornei o gruppi di allenamento."

REGIONEPIEMONTE.IT

"Nasce We-Sport. Un progetto sostenuto e finanziato dal Centro Ricerche Scienze Motorie della SUISM, Scuola Universitaria Interfacoltà di Scienze Motorie di Torino. We-Sport ha vinto lo "Start-up hack" organizzato da Top-IX Piemonte per i progetti universitari sul web [...]"

"Prende vita il progetto We-Sport. L'innovativo social network per tutti quelli che praticano attività sportive. Il progetto è stato presentato dalla Scuola universitaria interfacoltà in Scienze motorie di Torino e dal Centro Ricerche Scienze motorie. Il social network ha come obiettivo quello di mettere in contatto tra loro gli utilizzatori sia attraverso l'attività sportiva praticata sia mediante la geo-localizzazione […]"

SCIENTIFIC PURPOSE

We-Sport is a vertical social network whose main aim is to link athletes through some sport parameters. Moreover, We-Sport can also be an important source of data of great interest for scientific purpose. This social network can be naturally described as a bipartite graph. Thus we use methods proposed for this class of graphs to detect the most important proprieties of the network such as the degree distribution, the modularity structure, the clustering coefficient and the assortativity. These results have an important interpretation that we discuss extensively. We use them to address some important questions like: how people aggregate across sports; how the different sexual genders behave, or how sports are different in the way they are chosen by athletes. In particular, we focus on the problem of sport classification. We check whether some classes of different sports have some affinity, and we try to detect if classes of sports are distinguishable by the topological structure of the network.
In this section I do not present the mathematical analysis section in toto but only those applicable to the sports world.
The research article from which this information is attached as annex.

In this study we intend to use a complex network approach in order to analyze the real web sport-community, transferring the results into real applications for the sport world. It represents an interesting example of multidisciplinary cross-fertilization between the physiology of exercise, movement science, mathematics, and computer science.
The analysis was made by photographing a precise historical moment of the social network, considering the sports with at least one participant. The number of considered practitioners was 1680. We took the data and information relating to the sports chosen by each individual user in the We-Sport database. Then, we classified the sports not according to theoretical parameters, but to practical situations, as the venue, the objective, instrumental characteristics (for more specific informations see the next subsection). Finally, we tried to understand how some sports classes have similarities with other classes in different categories. This analysis resulted in an interesting evidence of the proposed classification, based on the choices of users in the We-Sport database, validating this choices.

THE PROBLEM OF SPORT CLASSIFICATIONS

Classifying sports is, without any doubt, one of the most difficult and controversial approaches related to the sport world. Over the years, many authors have described various possibilities for sport classification, mainly related to the physiology of each exercise. Several ways were proposed to perform this classification by analyzing either the technical aspect only, or the physiological aspect, starting from Bellotti and coauthors in 1978, Meinel in 1984, Berger and Hauptman in 1985, Starosta in 1987, Merni in 1989 and again Dal Monte in 1999.

Most classifications finally related to the sport world are based on the fundamental objectives of the technical basis or on the physiology of the exercise.[24]
In this study we propose a fundamentally different and pragmatic approach that might be called bottom up. Instead of defining an a priori classification of sports on theoretical grounds, it analyzes the behavior of people to establish relationships between the different sports.

This approach attempts to classify sports according to the response to the eight fundamental questions of rhetoric (called circumstances or loci argumentorum[25]), namely:

1. QUIS: Who?

2. QUID: What?

3. QUANDO: When?

4. UBI: Where?

5. CUR: Why?

6. QUANTUM: How much?

7. QUOMODO: How?

8. QUIBUS AUXILIIS: With what kind of equipment?

The goal was to demonstrate that people choose the practice of sport not on a basis of technical or physiology, but on other features.
We have necessarily detailed the category that answers the question "Who?", with "With whom?". In this case, responding to the fact that a sport is played mostly in solitude, in pair or in team (with particular attention to the fact that sports that are practiced in groups can also be practiced in solitude, especially with regard to non-competitive practice; and, conversely, sports that can be done in solitude can also be enjoyed in company).
The questions "Where?" and "When?" were divided into three distinct categories. The first is related to the environment, seen either as an artificial sport facility (e.g. an hockey field), or a natural-but-human-modified environment (e.g. a golf pitch), or a wild or pristine one (with particular attention to the fact that if a sport can be practiced outdoors without special facilities, this does not mean that it cannot be practiced in specific structures). The second one is related to the type of field, e.g. air, water, land. etc. Finally, the category of a sport was linked to the season during which the sport is usually practiced, namely hot or cold season.
The question "Why?" took the form of the question "What is the goal?", whereas the question "How" relates to what neurophysiologic aspects are required for the athlete's performance.

[24] Committee on Sports Medicine. Recommendations for Participation in Competitive Sports. Pediatrics, 81(5):737-739, 1988. Chelladurai P; A classication of sport and physical activity services: implications for sport management. Journal of Sport Management, 6(1):38-51, 1992.

Mitchell J, Haskell W, Raven P; Classication of sports. Journal of the American College of Cardiology, 24(4):864-6, October 1994.

Mitchell J, Gunnar Blomqvist C, Haskell W, James F, Miller H, Miller W, Strong W; Classication of sports. Journal of the American College of Cardiology, 6(6):1198-1199, December 1985.

Riemer B, Visio M; Gender typing of sports: An investigation of metheny's classication. Research quarterly for exercise and sport, 74(2):193-204, 2003.

Scotton C; Verso una classicazione definitiva delle specialità sportive. New Athletics Research in Sport Sciences, XXXI(185):26-36, 2004.

[25] see Tommaso d'Aquino, Summa Theologiae, 1265-1274

Last, the question: "With which kind of equipment?" considers the necessary equipment to play the sport.
Finally we wanted to identify other specific aspects related to particular well-defined types of sports. The characteristics of the sports in the classification are obviously prevalent and not exclusive. In fact, this is a theoretical exercise and it is impossible to imagine a complete classification of features of sports thanks to their absolutely unique nature. What we propose is a classification according to objective features and not to those intrinsic of sporting gesture.
We are aware that every inclusion of a sport is questionable and worthy of further investigation. However, what we wish to propose is a first milestone, a foundation that will require further validation, improvements and additional specifications. Below is the classification we have adopted as described, with in brackets the names of the classes shown in the matrices and the number of sport included in each class:

Category: With whom?

Classes: Sports played in solitude (solo - 146), in couple (1vs1 - 34), in team (team - 58)

Category: Where?

Classes: Sports played in facilities (close - 95), outdoor but in artificial situation (open MOD - 62), outdoor in natural situation (open NAT -81)

Category: Environment

Classes: Sports played in air environment (air - 11), in water (water - 20), on ground (ground - 170), on snow or ice (ice-snow - 24), on beach or sand or sea (sea - 12), composite (composite -1)

Category: Season

Classes: Cold season (cold - 17), hot season (hot - 22), indifferent (indifferent - 200)

Category: Instrument

Classes: With specific equipments (specific equipments - 52), with a mean of locomotion (locomotion mean - 73), with balls or similar (balls - 53), with nothing (nothing - 60)

Category: Target

Classes: Time (time - 61), points (points - 72), individual and personal goal (individual target - 39), aesthetics (aesthetics - 46), physical defeat of the adversary (enemy defeat - 12), measure (measure - 7)

Category: Neurophysiologic aspects

Classes: Musculoskeletal and cardio resistance (resistance - 59), muscular strength (strength - 9), speed (velocity - 5), accuracy (precision - 21), acrobatics (acrobatics - 34), rapidity and reaction time (rapidity - 52), other aspects (others - 58)

Category: Other aspects

Classes: Martial arts and fighting (martial art - 14), dances (dance - 7), elitist sports (elitist - 10), intellective sports (brain - 5), gymnastics (gymnastic - 3), track and field sports (track and field - 7), composite sports (composite - 2), sports with animals (animals - 4), gym and related (ambient gym - 10), sports with vehicles (engine - 8), holistic gymnastics (holistic gym - 3)

NETWORK ANALYSIS OF WE-SPORT

We perform a number of analyses on a snapshot taken at a precise historical moment of the We-Sport social network, in order to explore if some features of the sport world could be deductible from the structure of the network only. In this section I will not report the mathematical analysis related to social networks, which will be readable in the specific annex.

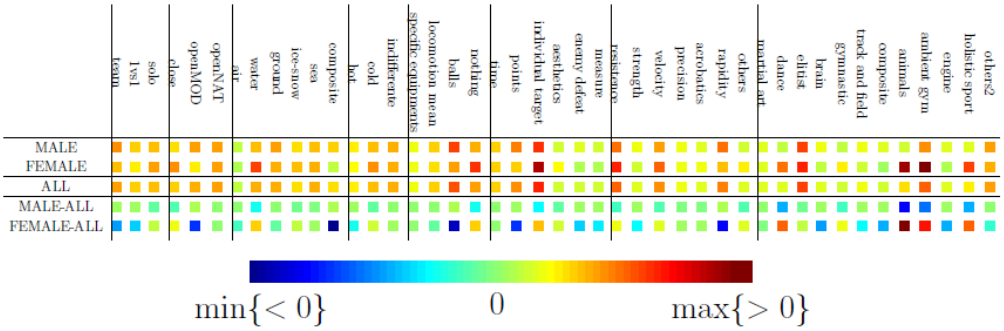
RESULTS AND DISCUSSION

Aware of the fact that the population and its behavior described by the We- Sport social network are not representative of the total real world population, i.e. people using we-sport social network are not a random sample of the entire population but an aggregation of people interested in technologies and web tools[26], we are able to conclude some results. It seems that athletes who practice few sports are associated with sports practiced by many athletes. This is also pointed out by the negative correlation: the more sports I play, the smaller is the number, on average, of practitioners of that sport. Also, it seems that sports with low diffusion are connected with athletes that, on average, play more different sports. It is possible to understand that there is a positive correlation, so athletes that choose a kind of sport have similar attendance with other athletes that have chosen the same sports. It is the same for people: people who play few sports are connected, through sports, with people that play few sports, and vice versa. Athletes who show a very unconventional behavior demonstrated multidisciplinary sport aptitude, while those with a more conformist behavior have a very focused sport attitude. Therefore, there is a kind of well-defined population, where those who choose unconventional sports tend to have similar behavior with other athletes who practice unconventional sports.

The practice of a lot of sports or a few more sports follows the same rules and creates subgroups of athletes with similar behavior among them. We could therefore postulate that sports with low diffusion have intrinsic characteristics that make them attractive for small groups of people just by their very low diffusion. The vicious circle is then fed from the fact that a sport with a low diffusion is chosen by the few players who appreciate the exclusivity present in such activities. Once that sport reaches high diffusion, it is elected by the people who like sports with high diffusion, while the group that chooses the sport with low diffusion will tend to replace it with another sport with characteristics similar to the lost one. Against these arguments, it's evidence that increasing the number of sports chosen by the subject makes it more difficult to find other users with the same characteristics with which to connect. It is also interesting to note that those who practice many sports have less propensity to find mates, but this is caused by the fact that as we have seen, people who choose a lot of sports tend to choose sports with low diffusion.

Figure in the next page shows the different preferences for gender on classes of sports. As it can be seen, boys prefer sports played in team and performed out- doors, played with balls, with target of a score or individual goals, and that have physiological aspects related to the muscular strength and speed and quickness. They also prefer sport related to gymnastic environment.

[26] Alexa audience demographics for we-sport.com identified that the average age of users of we-sport is in the range 25/34, users have high education, they have no children and they use we-sport at work.



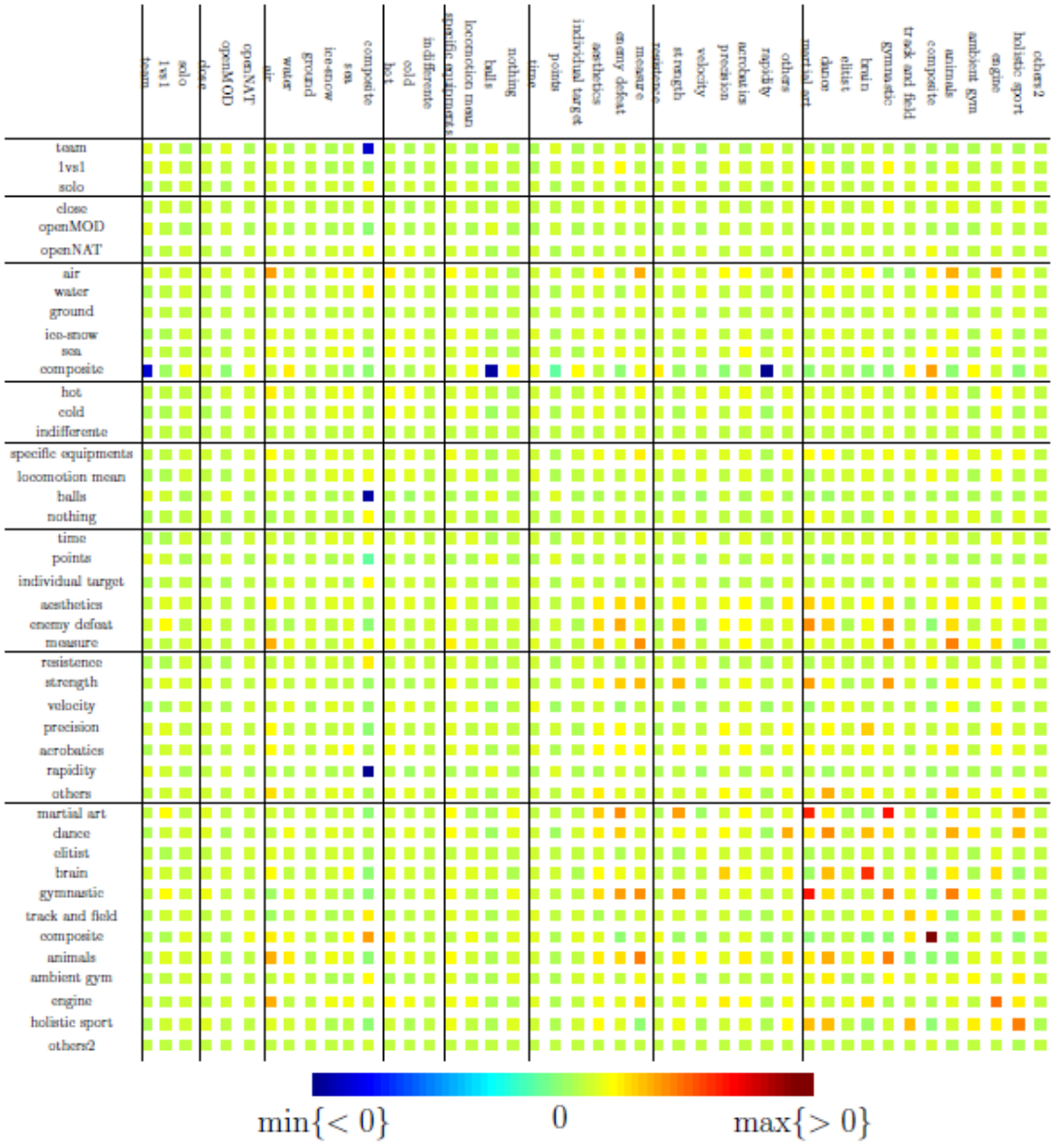
The connecting behavior of sexual gender among classes of sports. Last two rows show the same behavior compared to that of all athletes nodes. Colors range from dark blue for classes that are less connected than expected to dark red for classes that are more connected than expected. Green is for those couple that are connected as expected.

On the contrary, females show preferences for sports played alone, indoor, in water, without specific tools (such as running or swimming), and in many case related to the hot season, with a strong propensity for sports with individual goals linked to the resistance. Females also have a significant propensity to play sports in the dance and in the gymnastics world, in particular in relation to holistic gymnastic. They also show a preference for sports played with animals.

In general, the marked difference between genders is found in the fact that females have little tendency for sports played in team or played in pairs, for composite sports and for sports played with balls or similar and that have a score as a target, a measuring or defeat an opponent. They also have little affinity with sports related to the speed and with engines and for intellectual sport.

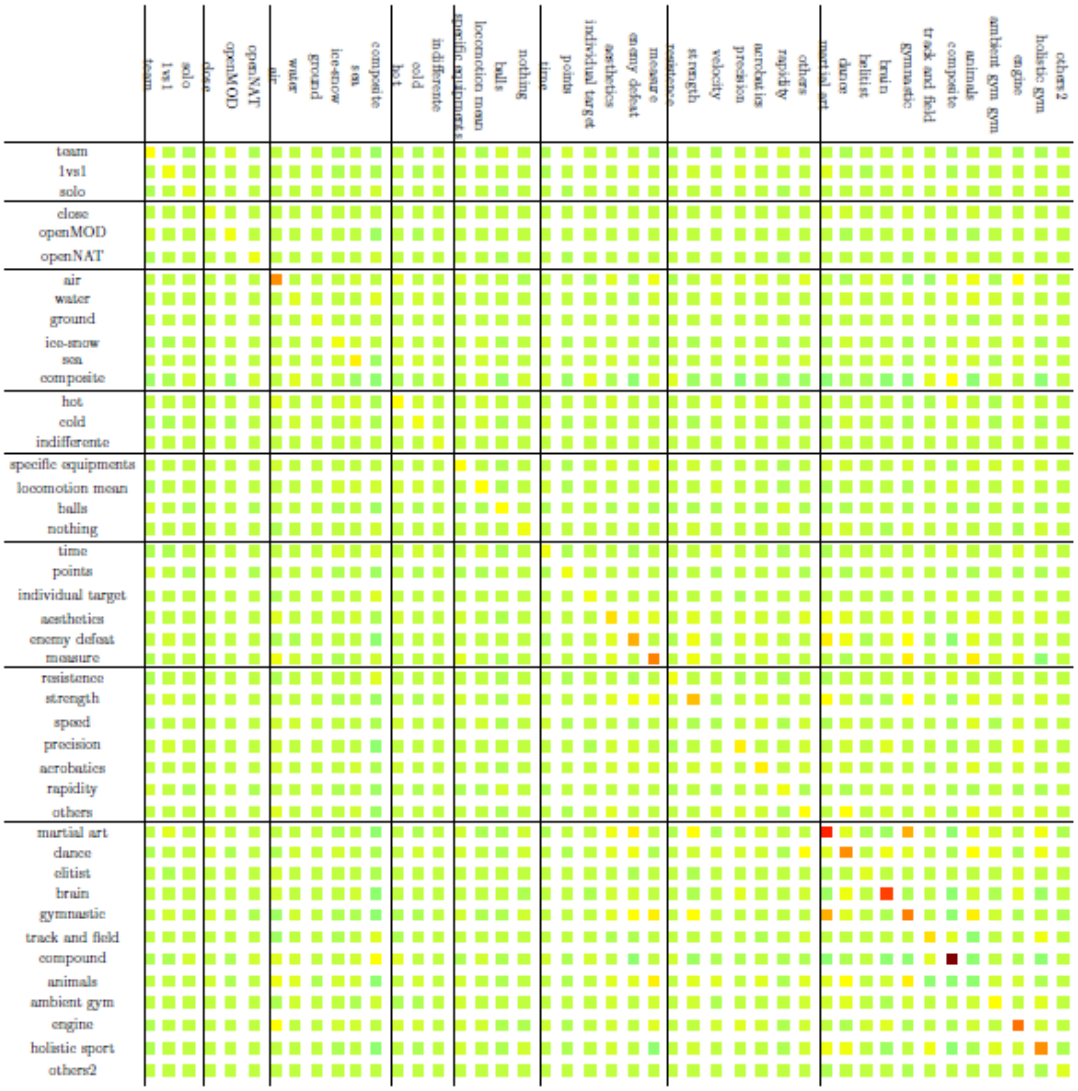
Conversely, men show more cross-cutting, and in general they do not like sports related to the dances, performed with the animals and with holistic world. They like sport in water environment less than women.

Figure in the next page shows the affinity of different classes of sports between them, as derived from the choice of athletes. Classifying the different parameters allowed us to point out where there are interesting relations between different classes of sports. The figure illustrates an example of how, by normalizing the value of the category according to the number of sports on each class, athletes who choose sports conducted in ambient "Air" in the category "Environment" have a higher than average affinity with class of sports with the goal "Measure" , targets in the category "Target", and with the class of "Animals" and the class of "Engine" in the "Other aspects" category. Another interesting correlation is between class of sport "Measure" in the category "Target" with the class of sport "Strength" in the category "Neurophysiological aspects" The most significant observation on this matrix consist in a correlation between the class of sports "Martial art" and the class "Gymnastic" in "Other aspects" category. This shows the high tendency of practicing martial activities in the gym facilities and the correlation between the two worlds. It 's simple, fun and certainly more effective to observe the matrix and find the most evident correlations directly observing the chromatic scale.



The figure shows how classes are connected each other. Colors range is the same of the first figure.

Finally, the last figure, again normalized by the number of sports on each class, shows the similarities between sports in the same category and in the same class. This is important to highlight the correct classification of sports. The choice of the classification of sports with parameters so different between them has created a risk of inaccuracy in the inclusion of a sport in a category. The diagonal highlighted in this matrix instead shows how the sports included in the same category, according to the different classes, have a high affinity between them. This supports the fact that sports were included in the same class with correct criteria, validating the proposed categorization.



The figure shows the probability for classes to be connected inde-pendently by the size of each class. Colors range from green for low probabilities to red for high probabilities.

TOUCH WALL

PATENT PENDING

A SYSTEM FOR EVALUATING QUALITATIVE/QUANTITATIVE ANALYSIS OF MOTOR SKILLS THROUGH A MULTI-TOUCH INTERFACE WITH IR-LLP (INFRARED LASER LIGHT PLANE)

INTRODUCTION

The Touch Wall is part of a diffuse project including tool for qualitative and quantitative analyzing of human motion aimed at maximum interaction between the subject and the tool of analysis, with specificities related to the low invasiveness and the marginal presence of the operator.
In September 2009, it was speculated to the development of some tools that can analyze noninvasively human motion. The Touch Wall is the realization of the first of these tools. The overall project is called M.A.C. (Motor Ability Certification) with the aim to provide the quantitative basis for certification of motor skills and motor ability. The construction of the Touch Wall, hardware and software part, had required 2 years of work by the CRSM and CSP (innovation in ICT).
A subject who uses the Touch Wall interacts with a evolved touch-screen interface capable, through a series of games specially developed, to analyze the motor ability of the subject and give feedbacks on various motor parameters that are analyzed during the execution of the games. The games are a playful excuse to avoid the commonly used standardized tests for motor analysis and allow the subject to deal with the system in the most natural way as possible.
The touch wall is therefore able to provide a quantitative analysis of motor skills in healthy subjects using a vertical multi-touch interface equipped with specific software.

These are the main objectives we wanted to achieve with the construction of Touch Wall:

- ✓ The need to provide reliable data related to measurement of quality parameters.
- ✓ Using a non-invasive approach in the analysis of healthy subjects.
- ✓ Possibility of obtaining a cross-sectional analysis of multiple parameters simultaneously.
- ✓ Possibility to monitor the change in motor skills over time.
- ✓ Possibility to compare the measurements before and after trauma or in temporary pathological condition[27].

Touch wall now is able to perform the following task:

- ✓ Provide a method to evaluate quantitatively and automatically some motor skills.
- ✓ Provide a method of analysis playful and non-invasive.
- ✓ Provide a reference to comparing people with different characteristics such as age, gender, motor and intellectual skills and normalize them in order to provide a certification of the motor skills characteristics of each people.
- ✓ Provide a tool for screening and monitoring over time with the aim of stimulating the attention to the care of motor skills before the deficits due to trauma or a disease.

[27] Lucca L. F., Virtual reality and motor rehabilitation of the upper limb stroke: a generation of progress?, J Rehabil Med 2009; 41: 1003–1006

PARTS OF THE INSTRUMENTS

The Touch Wall is composed of several parts:

- ✓ The iron structure on which is inserted a Plexiglas panel to which it applied a rear projection film, the panel receives direct contact with the user's hands.
- ✓ A projector used in rear-projection mode. The projector is used to project on the Plexiglas panel the software used to interface with the user.
- ✓ Eight infrared laser with a reshaping lens able to irradiate the entire surface of the Plexiglas panel.
- ✓ A specially adapted camera able to highlight the bright blob created by the contact between the Plexiglas and the user's fingers.
- ✓ A computer to process information about axial location of fingers contacts of the user, it provides a unique ID to every touch and manage the interface software.
- ✓ A computer dedicated to the recognition of the user via QR code.

Basic structures of Touch Wall:

- ✓ The hardware part consists of: structure (2.4 m wide x 2.6 m high x 1.1 m minor / 1.6 m major depth) - Plexiglas – projection film – 8 lasers - camera - projector - two computers - speakers
- ✓ The software part consists of software for interface with the user (created in Flash, the software specifications will be explained below), software of infrared camera, software for the recognition of subject using QR codes, software to detect blobs of light generated by the contact between the user's fingers and the matrix infrared and finally software for the data storage.

USE OF TOUCH WALL

The subject has his QR code (created on the basis of the fiscal code) to access the system through the recognition of the same by a camera. The application comes out stand-by mode and asks (through a typed command) to the user to perform a calibration on the screen using his anthropometric parameters (height, weight, maximum horizontal opening of the arms).
The database begins recording data. After the calibration, test phase begins, and at present, it consists of nine games related to specific tasks (motor, motor related to senses, motor related to logic and motor related to memory). Throughout the period of analysis there is no interaction with an operator, the instrument being completely independent in managing the relationship with the user. The system, once the test has finished, save the session data in the database and returns to standby mode.
At the end of the games the system generates a feedback on the data analyzed relative to the motor task, suggesting specific areas for improvement or those where it highlights the most critical results.
The operator can have a manual-mode access to repeat specific exercises, to improve motor skills in which the subject has produced below-average performance of the other users.

Motor skills and abilities are valued making games that do not have a specific bearing on the ability measured, in this way the user has the feeling of being in the play area; thus facilitates the collection of information.
The funny interaction is in particular useful in the analysis of the very young people, naturally inclined to the use of interactive environments and graphical interfaces. [28]The software, however,

[28] Dunne A., Do-Lenh S, O' Laighin G, Shen C, Bonato P, Upper extremity rehabilitation of children with cerebral palsy using accelerometer feedback on a multitouch display, Conf Proc IEEE Eng Med Biol Soc. 2010;2010:1751-4.

works with simple instructions and easy commands that appear on the touch wall before the test, in order to help users not accustomed to these environments (e.g. the elderly).
The entertainment aspect also amplifies the propensity to challenge; it creates the conditions for obtaining the data as close as possible to the real potential of the subject, providing feedback on abilities and motor skills in healthy subjects. It is also possible to reproduce the tests after physical injury in order to compare the performance pre-and post-accident or pre-and post-surgery or rehabilitation.

The total automation of the system allows to evaluate the subjects without the intervention of operator, so it is possible to eliminate all operator-dependent bias. The automation of the test provides reliable measurement of the qualitative motor parameters that in other contexts are strongly influenced by the presence and experience of the operator.

Authentication mode

The user, at the first access to the system, must provides the following information:
FIRST NAME - LAST NAME - DATE OF BIRTH - FISCAL CODE - GENDER - DOMINANT SIDE.
This information can be inserted through a standard personal computer from any location, not necessarily placed near the Touch Wall. The only prerequisite is that the personal computer needs to communicate with the database managed by the Touch Wall computer. At the end of the registration process the user has a card with the QR[29] code created from the fiscal code.

User is automatically logged in Touch Wall with immediate identification by the system, through the camera, of the QR code on the personal and private card. The system so is able to comes out from sleeping mode. In the absence of the QR code it is possible to access the application manually with the help of an operator by simply entering the fiscal code.

SOFTWARE SPECIFICS

The system is managed by five software.

The first (TouchWallAuth), previously described, identifies the user through the QR code. This operation does not require any direct input of information from the user, it is fair as any kind of information is directly visible without a decoding software and increases the feeling of interfacing with the system in a one to one relationship. The software was written in C # and needs. NET Framework 3.5.

The second software (CCV Community Core Vision 1-3) acknowledges the points of contact of the surface and the user's fingers. The contact create blobs of light interfering with the diffusion of light created by the infrared laser. Software assigns to every touch a unique ID characterized by Cartesian coordinates (x, y) on the wall, to be managed by next software. In this way it is able to manage multiple touches simultaneously and dragging virtual objects on the surface of the Plexiglas screen. In summary CCV makes possible the processing of images captured by the camera, the processing and its communication with the software SmartWall

The third software (Smart Wall) manages the games with which the characteristics of user are evaluate.. The application was written in Flash[30] and ActionScript 3 and requires the installation of Adobe AIR 1.5 or higher.

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[29] The QR Code is a two-dimensional bar code (or code 2D) matrix, composed of blacks modules arranged in a square pattern. It is used to store information that is generally intended to be read by a camera. Are contained in a single cryptogram 7,089 numeric and 4,296 alphanumeric characters.
The name is the short form for quick response (rapid response), by virtue of the fact that the code was developed to allow rapid decoding of its content.

[30] Adobe Systems Incorporated, 345 Park Avenue - San Jose, CA 95110-2704

The fourth software (MySQL Workbench 5.2.34) is used to access the database on which users data and held sessions are stored as well as the data obtained by different tests.

The fifth and last one is the proprietary software of infrared camera.

The software Smart Wall and TouchWallAuth are currently not released under any specific license.

HARDWARE SPECIFICS

The Touch Wall is composed of an iron structure that serves as a support for the Plexiglas panel, lasers and dark room for rear projection. The structure is closed on rear and lateral sides to prevent the penetration of light into the dark room, this drawback could affect the accuracy of the data of user touches. In the front bezel (1.5 meters high x 2 meters wide), along the perimeter of the Plexiglas, 8 infrared lasers are included placed at the four corners and in the half of the long sides.
Subsequent to the Plexiglas rear projection film is applied, the film can spread the rear projector brightness over the entire surface of the Plexiglas. On the sides of the structure are inserted two speakers required for auditory feedback.
Inside the structure are placed the projector with a fisheye short-range lens (see below), the infrared camera for the recognition of the bright blobs and the stabilized power supply for the lasers.
Outside the structure are placed two computers with two monitors, one for the management of the CCV and the software interface, the other for the database and for QR recognition.

LLP Specific technology:

LLP Technology (Laser Light Plane) is characterized by the use of laser sources to radiate the touch panel. The laser emits an infrared radiation that it generates a plane of light often about 1mm properly calibrated, so the laser is positioned immediately above the surface. When the finger intercepts the light on the table creates a blob that is recorded and managed as a "touch". Usually the laser sources are placed at the corners of the surface and each form uses a reshaping lens that turns the laser beam in a plane. These lenses have an angle ranging from 90 to 120 degrees. The wavelengths most often used are 780nm and 940nm.
The bright blob recognition is given to techniques of computer vision. In fact the system has a webcam, suitably modified to be sensitive to infrared light, with a sample frequency between 30 and 60 fps (frames per second) of the rear surface of the Plexiglas. These images are processed by filters that enhance the image and by algorithms that extract the features. When a user touches the surface, in fact, the point of contact is highlighted thanks to infrared light and the resulting image is processed to locate and to associate the Cartesian coordinates. Referencing between coordinate systems and touch point is made possible through a phase of calibration of system that combines the touch generated on screen with some already on the system.

Technical specifics

- ✓ Webcam: Sony PS3eye, modified with IR filter at 780 nm and 2.8 mm lens, 640x480 @ 60 fps.
- ✓ Projector Benq MP776ST, XGA (1024x768) Brightness of 3500 ANSI Lumens, 3500:1 Contrast, Ratio Diagonal / Projection Distance 0.61:1 (81 in @ 1m), Lens: F = 2.6, f = 6.9 mm
- ✓ Laser: 25mW power, frequency 780 nm, 120 ° reshaping lens
- ✓ Panel for rear projection: Plexiglas plate 1.5mm thick and rear projection film glued on the back of panel.
- ✓ Speakers N: 2 50 mm full-range, 80 dB SPL, response 180 Hz - 20 kHz (-10 dB), Signal to Noise Ratio @ 1 kHz, input: > 85 dB dimensions: 70 mm (width) x 121 mm (depth) x 94 (height)

GAMES DATA SPECIFIC

The touch wall, currently has 9 games. Each of these provides the following data are recorded during execution.

Quick Shot: ROM right and left, right and left touches percentage, accurate touch, wrong touch, more faster touch, more slower touch, average speed touch, amount of left touch, amount of right touch, the highest touches, radar diagram of correct touches[31].
Taping: errors, correct sequence of touches.
Bend Side: left corner, right corner, difference between angles.
Piano: right and left correct touches, total errors, more faster touch at right and at left, more slower touch at right and at left, average speed of touches at right and at left, total average speed, percentage of correct touches for each finger.
Flash: number of errors, more faster touch, more slower touch, average speed of touches.
Quick look: reaction speed of 8 touches (2 EAST 2 NORTH 2 SOUTH 2 WEST) distances in seconds and pixels from the central of visual plan.
Stereo: reaction times to all sound (difference for volume and frequency: low frequency, middle frequency and low volume, middle frequency and middle volume, middle frequency and high volume, high frequency), diagram of correct touch.
Grips: right and left rotation for both the hands and difference between intra and extra rotation angles.
Abaco: completion percentage, more faster side, average mean time at left and right with standard deviation, total time, total number of errors, more faster touch, more slower touch, mean time of total touches.

Games description

Quick Shot: some colored dots appear on the Touch Wall, within the calibration area. Users must touch the dot, being careful to touch those that appear in the right side of the screen with the right hand and vice versa. After a random colors dots, the user is invited to touch only those of a certain color (color discrimination). The system records the arms range of motion and the velocity.
Taping: users must reproduce four sequences of touches with right and left hand gradually more long. The system records the capacity of motor memory.[32]
Bend Side: users must flex the trunk while keeping both hands resting on a sign over the calibration area. The system evaluates the bend of the trunk.
Piano: users must place both hands on hand shapes and press each finger when the last phalanx of the fingers of shape glows. The system records the reaction speed and fine dexterity.[33]
Flash: users must touch the screen as fast as possible as soon as they see a flash appearance. After a series of indiscriminate flash they should touch only after seeing the flash of particular colors. The system records the speed of reaction with chromatic discrimination.
Quick look: users must fix a point at eyes level and they need touch the screen as soon as they see another point appearing, from any cardinal points. The system records the visual field.[34]

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[31] Lieberman J, Breazeal C, A robotic feedback suit: markers on the right arm indicate the joints that are regulated by the system. IEEE Transactions on Robotics, Vol. 23, No. 5, October 2007

[32] Godijn R, Theeuwes J., Overt is no better than covert when rehearsing visuo-spatial information in working memory, Mem Cognit. 2011 Jul 20

[33] Mendoza JE, Apostolos GT, Humphreys JD, Hanna-Pladdy B, O'Bryant SE., Coin rotation task (CRT): a new test of motor dexterity, Arch Clin Neuropsychol. 2009 May;24(3):287-92.

[34] Dufour A, Touzalin P., Improved visual sensitivity in the perihand space, Exp Brain Res. 2008 Sep;190(1):91-8. Epub 2008 Jun 14.

Stereo: user must touch the screen in the right side as they hear a sound from one of two speakers on either side of the touch wall. The system records the speed of reaction to a auditory stimulus and its spatial discrimination.
Grips: users need to put their hands on the screen and rotate the arm clockwise and counterclockwise. The system records the angle of rotation.[35]
Abaco: Users should touch a series of numbers in the correct order and tapping the right side of the screen with the right hand and left side with the left. The system records the motor speed connected to a logical-mathematical task.[36]

THE ABILITY AND MOTOR SKILLS TESTED:

- ✓ Speed of reaction to visual stimulus
- ✓ Speed of reaction to auditory stimulus
- ✓ Logical motor ability
- ✓ Memory related to movement
- ✓ Visual field and oculo-motor coordination
- ✓ Dexterity of fingers
- ✓ R.O.M. of the scapulo-humeral joint
- ✓ R.O.M. of lateral flexibility of trunk

FIRST STUDY

The Touch Wall provides useful data to the measurement of motor skills in healthy subjects. Its main use is thus inherent in the physiology of exercise in healthy subjects with special characteristics associated with low invasiveness and low dependence on the operator. The tool then is an analyzer of physiological characteristics linked to the movement and it returns feedback on the same characteristics so user can know which areas linked to its capacity are improvable and which ones are in line with the average parameters for the subjects of his\her age and gender. The benchmarks are constantly updated using the results recorded by a suitably developed algorithm.
The system, through monitoring motor skills in healthy subjects, is able to keep track historical of the characteristics of the user; in this way in case of an injury it's possible to compare the features of the subject over time: before the injury, post injury, post rehabilitation and re-education and ultimately in his\her return to daily activities. This highly innovative aspect of the clinical context allows to know the real characteristics of the subject and following a traumatic event it can compare this characteristics with no margin of assumption.
The tool also allows you to plot the characteristics of population groups by comparing the characteristics between both groups over time.

After a period of testing with some dozens of subjects to develop the system, it has begun the first study on the Touch Wall.
They were examined 76 healthy subjects, with a average age of 25 ± 2 years, 48 males and 28 females, 64 right-handed, 9 left-handed and 3 ambidextrous, without any neurological, orthopedic or vestibular disease.
The average age of the subjects was 172 ± 7 cm (male: 176 ± 6 cm, female: 166 ± 6 cm), with a average weight of 65 ± 10 kg (male: 70 ± 8 kg, female: 56 ± 6 kg), average IBM 21 ± 2 (male: 23 ± 3, female: 20 ± 1), average arm span 157 ± 14 cm (male: 162 ± 13 cm, female 149 ± 11 cm) and average maximum height 212 ± 12 cm (male: 217 ± 9, female 204 ± 10 cm).

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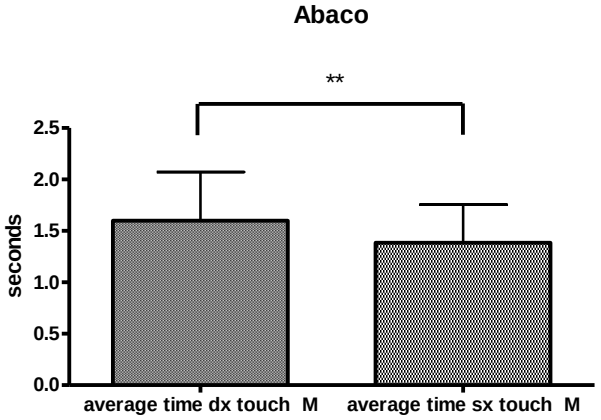
[35] Forthomme B, Dvir Z, Crielaard JM, Croisier JL., Isokinetic assessment of the shoulder rotators: a study of optimal test position, Clin Physiol Funct Imaging. 2011 May;31(3):227-32.

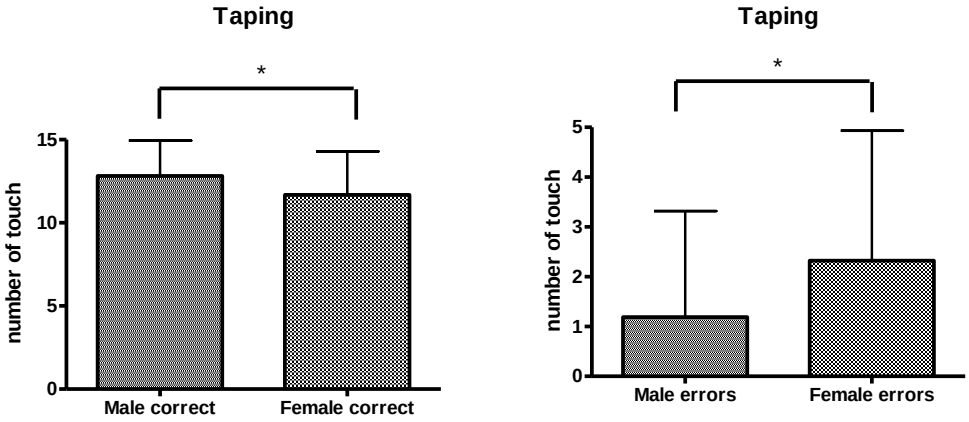
[36] Mounoud P, Dal pensiero all' azione, edizione NIS, 1995, pp. 51-68.
Abilità cognitive e motorie in una prospettiva di sviluppo.

AIM OF THE STUDY

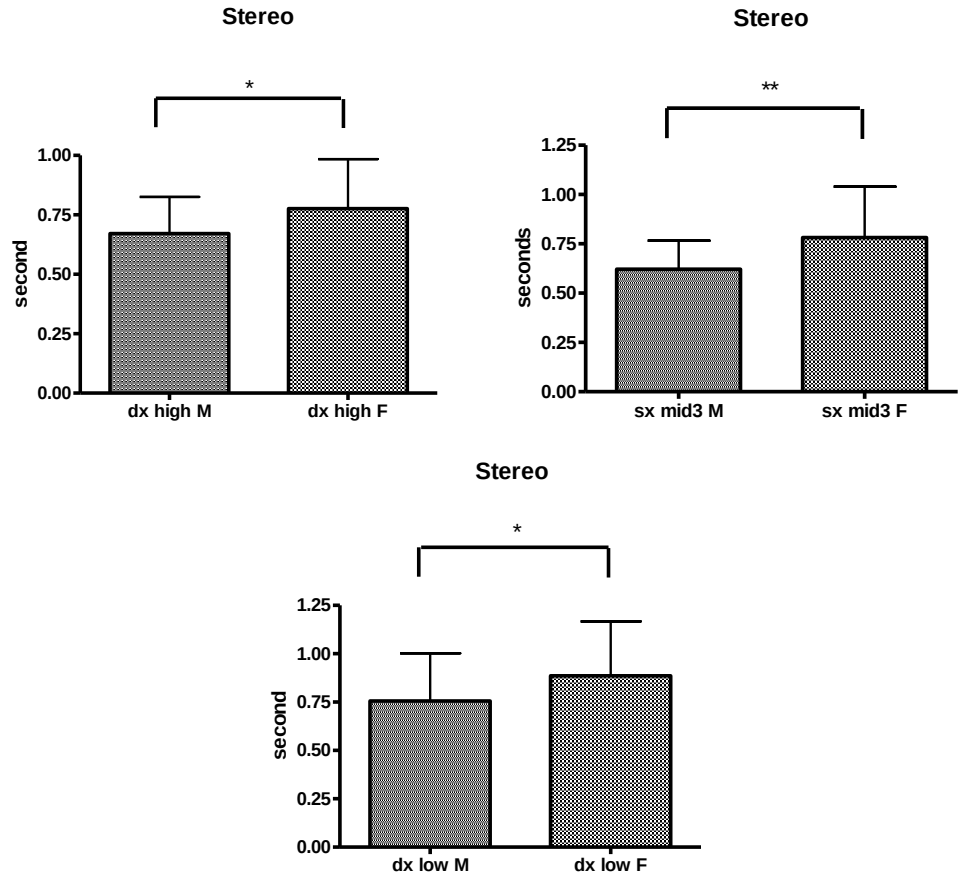
The purpose of this study is to test the correct operation of the Touch Wall, both from the point of view hardware and software, with his repeated use. The aim also is to ensure proper recording of data and start to find some evidence in the results on test subjects, in particular with respect to the gender of the subjects.
Those that follow are preliminary results, the analysis of data are still in progress.



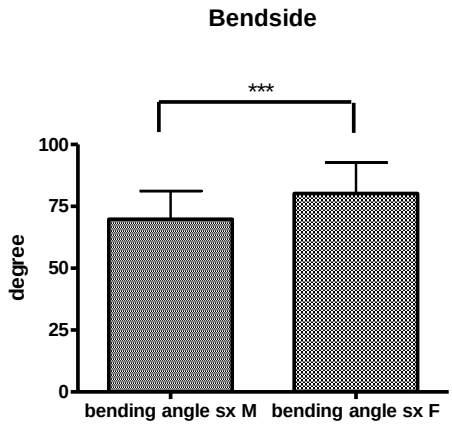
Parametric paired t test shows statistically significant differences ($p < 0,005$) between the average time on the right side and the left side in the ABACO game for male subjects

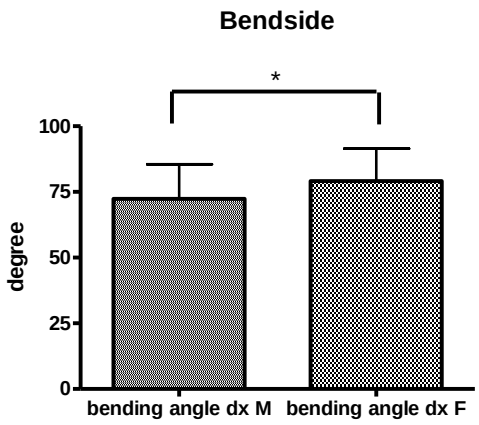


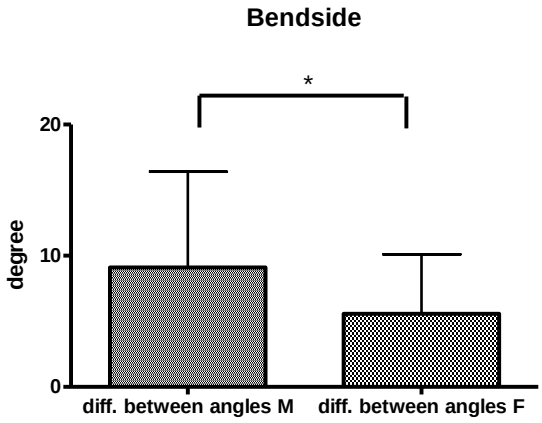
Parametric unpaired t test shows statistically significant differences (p = 0,04) of the average number of correct touch and average number of errors between genders in the TAPING game.



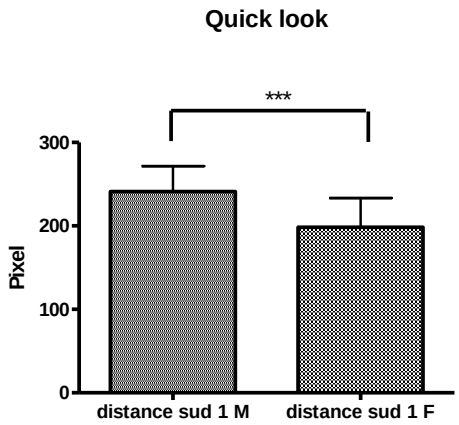
Parametric unpaired t test shows statistically significant differences (p = 0,001 for the first case, p = 0,039 for the second case and p = 0.0171 for the last one) of the average time of speed of reaction to a auditory stimulus between genders in the STEREO game.

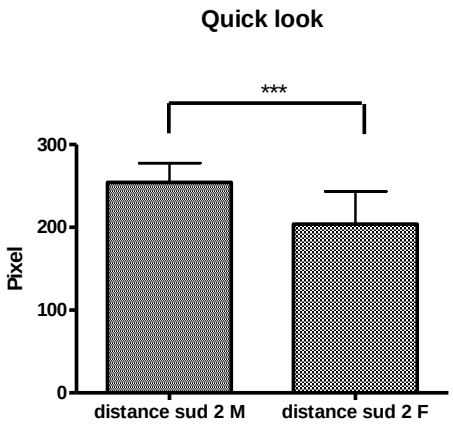






Parametric unpaired t test shows statistically significant differences (p = 0,0004 for the first case, p = 0,031 for the second case and p = 0.023 for the last one) of the degree of the bend of the trunk between genders in the BENDSIDE game.





Parametric unpaired t test shows statistically significant differences (p < 0,001) of the reaction time (calculated in pixel from the central of visual plan) between genders in the QUICK LOOK game.

DISCUSSION

Despite many data and many aspects are still in phase of analysis, from the early results is evident as Touch Wall is able to highlight statistically significant results between different populations with regard to motor skills. Other interesting features could result from the analysis of motor responses within the same population, with regard to the same motor task depending on the intensity of the stimulus or the type of stimulus. For example STEREO game can provide information on the reaction speed as a function of sounds in different frequency or at a different volume (same stimulus but different values). Also compare the speed of reaction to different stimuli (visual versus auditory) can provide scientific evidence on the different behavior of a population[37]. Very interesting is the work on the correlation between the results of the games: if a subject has good motor skills in a task, is possible that also have the same result in a game with similar tasks, or having negative values of other types of tests. The comparison between different populations also could provide information on the way in which some motor skills vary according to specific conditions (training, pathology) or in function of time.

[37] Sugano Y, Keetels M, Vroomen J, Adaptation to motor-visual and motor-auditory temporal lags transfer across modalities, Exp Brain Res. 2010 March; 201(3): 393–399.

A-GRISÙ

PATENT BEING DRAFTED / FUTURE MSRC SPIN OFF

A PORTABLE DEVICE FOR MONITORING ENVIRONMENTAL POLLUTANTS RELATED TO PHYSIOLOGICAL PARAMETERS DURING PHYSICAL ACTIVITIES AND SPORTS

INTRODUCTION

GRISU ' is a portable device able to detect the presence of atmospheric pollutants in the air and to relate their presence with some physiological parameters detected during the outdoors or indoors activity and with some morphological parameters set by the user .
In particular, the wearable device evidence the presence of different environmental pollutants and, through an algorithm, it puts in relation the quantity and type of pollutants detected with the physiological parameters detected during physical activity of the user (heart rate and ventilation) and with morphological parameters (height, weight, age, sex and BMI). So is possible to indicate whether the place is suitable or not for physical activities[38].
The device monitors the atmosphere in which is carried out physical activity suggesting the areas with a lower concentration of pollutants, in relation to the intensity and effort expressed, estimated in real time.
Today tools exist able to detect the physiological parameters described and portable instruments able to detect the presence of environmental pollutants, however there is no available tool able to relate these data in relation to the activity physical and/or sports practiced and focusing on correlation between physiological and environmental parameters.
At present, the project is a prototyped with a sensor and a wireless module for sending data to a monitor.

TECHNICAL DATA

The system allows to detect and correlate physiological and environmental information at the place where physical activity is taking place. Also evaluate the real-time effort to give a feedback output to the user.

[38] Kipen H, Rich D, Huang W, Zhu T, Wang G, Hu M., Lu S, Ohman-Strickland P, Zhu P, Wang Y, Zhang J; Measurement of inflammation and oxidative stress following drastic changes in air pollution during the Beijing Olympics: a panel study approach. Annals of the New York Academy of Sciences 2010; 1203 p. 160-7

Kargarfard M, Poursafa P, Rezanejad S, Mousavinasab F; Effects of exercise in polluted air on the aerobic power, serum lactate level and cell blood count of active individuals. International journal of preventive medicine 2011, 2 (3) p. 145-50

Branis M, Šafránek J; Characterization of coarse particulate matter in school gyms. Environmental Research Volume 111, Issue 4, May 2011, Pages 485–491

Sehlstedt M, Behndig A, Boman C., Blomberg A, Sandström T, Pourazar J; Airway inflammatory response to diesel exhaust generated at urban cycle running conditions. December 2010, Vol. 22, No. 14 , Pages 1144-1150

Environmental pollutants measured (hypothesis):

Carbon Monoxide (E)
Sulfur dioxide (SO2)
Metals (Lead, Arsenic, Cadmium, Nickel)
Benzene (C6H6)
Nitrogen dioxide (NO2)
Ozone (O3)

Physiological parameters:

Heart Rate
Pulmonary ventilation
O2 saturation

Morphological parameters:

Age
Weight
Height
Gender
Secondary parameter:

BMI
Instantaneous and total calorie consumption
Effectiveness of training

Environmental parameters

Humidity
Temperature
Altitude
Exposure to UV

Geographical parameters

Speed
Distance

A graphical rendering of a hypothetical final appearance of the device

SHORT AND LONG TERM AIMS

The project *a*Grisù was presented in a exhibit form (in a modified version compared to that final due to patent issues) during the fifth and sixth edition of the Night of Researcher. In this exhibit it was shown an ARDUINO control unit on which was mounted a O2sensor , a humidity and a temperature sensor and a module ZigBee for wireless transmission of data. The controller was placed inside a Plexiglas cube of 0.5 m^3. The control unit sending the data wirelessly to a laptop on which was installed the Lab View program, with a specially developed screen capable of displaying information from the controller.
In this way, after getting a person in the cube and after sealing the opening, it was possible to show how the human body was able to modify the environmental parameters (in this exhibit O^2 and CO^2, humidity and temperature).
The exhibit, however, was used to demonstrate that is possible to send the parameters by a control unit to another device. From this first work it was thought to build a receiver portable device able to withdraw information from wireless environmental control units. Then it was thought to integrate directly the sensors into the device, but correlating the values with physiological information and relating to physical activity.

Today the project aGrisù has been included from University of Turin incubator (2I3T) between projects worthy of funding for the creation of spin-off, even after the positive experience of we-sports. Today it is doing the analysis of the literature (see in references) in order to understand what studies have been done on the relationship between sport, performance and motor activity in the presence of environmental pollutants. It was requested from the Patent Office of the University of Turin a patent draft and the office has done the first analysis of the patent form. After several meetings between the teams that will develop the project it was decided to define the possible developments of the idea to only two directions: first by creating a portable device capable of receiving information via wireless from diffuse units that can monitor some environmental parameters (such as the project Fonera) and capable of relating it with the physiological information monitored; the second way is to build a portable device capable of interfacing (GPRS mode) with a server that handles big data provided by units already on the land and then capable of developing the information on the basis of the physiological parameters recorded during the activity. In both cases the core of the device will be the algorithm able to provide feedback related sporting activity practiced and the environmental information received.

The exhibit in the sixth edition of Night of the Researcher

OTHER INTERESTING THINGS

ANYTHING ELSE NOT ENOUGH IMPORTANT TO HAVE A CHAPTER,
BUT NOT ENOUGH TRIVIAL TO BE EXCLUDED

In these three years I did a lot of things.
Here is a list detailed enough. I think I just forgot nothing.

Projects

Mainstream Project:

- ✓ qEEG in different postural situations: to compare the signal from subject in different postural situations
- ✓ qEEG wireless: to compare the quantitative electroencephalographic signal picked up by wireless and wired amplifiers and comparing the same signal picked up by three different types of headset

Sub-projects:

- ✓ Touch Wall: a system for assessing qualitative / quantitative analysis of motor skills through a multi-touch interface with IR-LLP (infra-red laser light plane).
- ✓ We-Sport: a social network connected to the sporting environment to facilitate the practice of amateur sport, in particular related to sport with low diffusion.
- ✓ aGrisù: a portable device for monitoring environmental pollutants related to physiological parameters during physical activities and sports.
- ✓ Analysis of subcutaneous tissue with three different instrument: ultrasound, thick calliper and bodymetrix

Article:

Ferreri L., Daolio F., Ivaldi M., Giacobini M., Tomassini M., Rainoldi A.
A network approach to investigate the aggregation phenomena in sports
paper in submission for Special Issue on Complex Systems and Sports
Journal of Systems Science and Complexity

Chapters book translation:

Thomas JR, Neson JK, Silverman SJ
Research Methods in Physical Activity
Human Kinetics VI Edition
traduzione italiana a cura di P. Bellotti, A. Rainoldi,
Calzetti&Mariucci Editori, 2011

Abstract:

Ivaldi M., Ferreri L., Daolio F., Giacobini M.,Tomassini M., Rainoldi A.
We-Sport: from academic spin-off to data-base for complex network analysis; an innovative approach to a new technology.
J Sports Med and Phys Fitness Vol. 51- Suppl. 1 to issue No. 3

Congresses:

Formicola D., Pizzigalli L., Filippini A., Ivaldi M., Riba A., Rainoldi A.
Neuromechanical differences between "difficulty" and "boulder" climbers. A pilot study.
3rdInternational Congress "Mountain, Sport & Health"
12-14 November, 2009, Rovereto (TN), Italy
poster session

Formicola D., Gazzoni M., Pizzigalli L., Filippini A., Ivaldi M., Boccia G., Riba A., Rainoldi A.
Neuromechanical characterization of two different techniques of rock climbing.
XVIII ISEK Congress,
16-19 June, 2010, Aalborg, DK
poster session

Ferreri L., Ivaldi M., Daolio F., Giacobini M., Tomassini M., Rainoldi A.
A network approach to investigate the aggregation phenomena in sports
European Conference on Artificial Life: Complex Systems in Sports (satellite workshop),
12 August, 2011, Paris
oral presentation

Ivaldi M., Ferreri L., Daolio F., Giacobini M.,Tomassini M., Rainoldi A.
We-Sport: from academic spin-off to data-base for complex network analysis; an innovative approach to a new technology.
3rdSISMES National Congress, September 29 – October 1, 2011, Verona, Italy
poster session

Attended Seminars:

"Moodlemoot Italia 2009"
Seminars held by Science MFN Faculty - University of Turin
8/9 May 2009

"Health in sport and sport for health"
International workshop held by Faculty of Exercise and Sport Sciences - University of Bologna
30 May 2009

"I realize, the art of disruption"
Workshop held by Top-IX Piemonte
9-10 June 2009

"Science at the time of crisis"
National Summer School 2009 SCS (Science, Communication, Society)
held by Inter-University Agorà Science Centre of University of Turin
5-10 July 2009

"To the knowledge frontier"
Seminars held by Tamietto M., Berti A., Sinigaglia C. - Polytechnic University of Turin
27 July 2009

"17th EASM Student Seminar and Conference"
Seminar and Conference held by EASM - Amsterdam, The Nederlands
12-19 September 2009

"3rd Mountain, Sport and Health - updating study and research from laboratory to field"
International Congress held By CeBISM, University of Trento, University of Verona, University of Brescia - Rovereto,
12-14 November 2009

"Give and not just say security"
Interdisciplinary meeting of underwater sports and recreational
Turin 20 November 2009

" Internet evolved"
Vth National Conference held by Top-IX
10 December 2009

"Open Science - Research and Society"
National Summer School 2010 SCS (Science, Communication, Society)
held by Inter-University Agorà Science Centre of University of Turin
1-6 July 2010

"ESOF 2010"
Euroscience Open Forum, Turin
2-7 July 2010

"2rd SISMES"
National Congress of Motor and Sport Science Society, Torino
30 September - 2 October 2010

"Applied research for the inclusion of people with disabilities"
held by CRT Foundation
29 April 2011

"Science for the future. Innovation, sustainability, uncertainty"
National Summer School 2011 SCS (Science, Communication, Society)
held by Inter-University Agorà Science Centre of University of Turin
3-8 July 2011

"20th ECALL11"
European Conference of Artificial Life, Paris
8-12 August 2011

"3rd SISMES"
National Congress of Motor and Sport Science Society, Verona
29 September - 1 October 2011

"Management of Innovation"
High level training course, University of Turin
24-28 October 2011

"Fabermeeting"
held by Turin city
17-18-19 November 2011

" Internet evolved"
VIIth National Conference held by Top-IX
6 December 2011

Awards

The following awards were won by We-Sport Project:

Winning project @ the second edition of the Faber Meeting 2011: web projects
(November 2011)

Finalist Project @ Venture Contest in the Italian Venture Forum
(November 2011)

Winning project @ Smau Startupbusiness Innovation paths
(October 2011)

Company invited @ Startupbusiness Innovation paths of SMAU 2011: Rome - Milan

Semi-finalist Project @ Eurecan European Venture Contest
(November 2010)

Finalist @ Mind The Bridge Venture Camp c/o Corriere della Sera
(November 2010)

Selected among the 15 best ideas @ The Mind The Bridge Coaching
(October 2010)

Project selected @ Mind The Bridge Bootcamp
(September 2010)

Project selected @ Mind The Bridge Business Plan Competition
(June 2010)

Winning project @ Turin International contest
(March 2010)

Project winner @ I3P for tutoring and construction of business plan
(January 2010)

Winning project @ I Realize Start-Up Hack
(November 2009)

Winning project @ Management Game in the International Contest for Innovative Sports Management, Amsterdam
(September 2009)

Fundings

Ph.D. Scholarship from Lagrange project, ISI Foundation: Start up (12 months) - 15,000 €

Applied research grant from Lagrange Project, ISI foundation (18 months) - 24,000 €

Innovation Voucher from Regione Piemonte 20,000 €

Gain from selling some We-Sport Equity, SUISM still holds 5% of the equity - 25,000 €

Parmalat supporting for We-Sport - 100,000 €

European cross-border project ALCOTRA (funding not yet closed)

Teaching and Tutoring

Contract Professor:

Posture neurophysiology - Master's Degree in Sports Traumatology, 2010

Strategies and methods of motor learning - Degree of physical activities and sports sciences, 2011/2012

Assistant Professor and Tutoring in bachelor and master degree 2009/2010/2011:

Sport performance methodology, Bioengineering, Electronics and Computer Science, Technical of sports with adaptation to the environment, Theory and methodology of human movement, Research Methodology, Bases of human movement, Strategies and methods of motor learning Measurements and analysis, Measurement and analysis of the movement.

Lectures:

Laboratory of materials and models
Polytechnic of Turin

Patents and Trademarks

We-Sport.com is a trademark registered at Camera di Commercio di Torino

Touch Wall is a pending patents at patent and intellectual property office of University of Turin

aGrisù is a pending patents at patent and intellectual property office of University of Turin

Thesis

Thesis supervisor:

Cherubini R. The eutonic method for the homoeostasis of body functions, an analytical approach, Master's Degree in Sports Traumatology 2009/2010

Thesis co-supervisor:

Giacobini L. Quantitative electroencephalography. Cortical responses in different postural conditions, Master degree of physical activities and sports sciences (supervisor Prof. Rainoldi A.)

Thesis co-supervisor in writing:

Grignano S. Preliminary study by the data obtained from the Touch Wall (provisionally)

Internal held lessons

"What 's about N.I.R.S.?"

"What' s about the university system and regulation?"

Other Interesting Things!

Created exhibits and presentations for the following editions of "Night of the researchers": 4th edition September 2009, 5th edition September 2010, 6th edition September 2011

I held the workshop "I move to live - I live to move" @ "I realize, the art of disruption", 9-10 June 2009

I was the director of:
"SCIENTIFICA, we are still busy changing the word"
a national conference with 6 appointments to talk about the relationship between science and art with important people of art and science community.
SCIENTIFICA was funded by EDISU

I'm the contact person for SUISM @ SPORT INN,
a board for sport field and sport company of UnionCamere and Camera di Commercio of Turin

I'm the contact person for SUISM @ Youth Regional Council of Regione Piemonte

I create graphic and video presentation of the activities of Motor Science Research Center

I'm working closely with the staff of the councillor of sport of City of Turin for the projects: Gyms at open sky, We-Run Torino and for the drafting of the protocol between the City of Turin and SUISM.

…that's all

REFERENCES

INTRODUCTION

Fort C; The book of damned; Boni and Liveright 1917

qEEG AND POSTURE

Calmels C, Jarry G, Stam C J. Changes in local and distant EEG activities before, during and after the observation and execution of sequential finger movements. Neurophysiol Clin 2009; 39 (6): 303-12.69

Chiesa A. Zen meditation: an integration of current evidence. J Altern Complement Med 2009; 15 (5): 585-92. 70

Del Percio C, et al. "Neural efficiency" of athletes' brain for upright standing: A high-resolution EEG study. Brain Res Bull 2009; 79 (3-4): 193-200.

Eccles J C. The initiation of voluntary movement by the supplementary motor area. European archives of psychiatry and clinical neuroscience 1982. 231: 423-41.

Friedman D, Cycowicz Y M, Gaeta H. The novelty P3: An event-related brain potential (ERP) sign of the brain's evaluation of novelty. Neuroscience & Biobehavioural Reviews 2001; 25: 355-73.

Gevins A, Leong H, Smith M E, et al. Mapping cognitive brain function with modern high-resolution electroencephalography. Trends in Neuroscience 1995; 18: 429-36

Groll-Knapp E, Ganglberge J A, Haider M. Voluntary movement-related slow potentials in cortex and thalamus in man. Progress in clinical neurophysiology 1977. 1: 164-73.

Haynes J-D, Sakai K, Rees G, et al. Reading hidden intentions in the human brain. Current biology 2007. 17: 323-8

Kornhuber H H, Deecke L. Hirnpotentialanderungen dei willkurbewegungen undpassiven bewegungen des menshen: bereitschaftpotential und reafferente potentiale. Pflugers archiv 1965. 284: 1-17.

Libet B, Gleason C A, Wright E W, Pearl D K. Time of conscious intention to act in relation to onset of cerebral activity (readiness potential): the unconscious initiation of a freely voluntary act. Brain 1983. 106: 623-42.

Pirini M, et al. EEG correlates of postural audio-biofeedback. Hum Mov Sci 2010.

Soon C S, Brass M, Heinze H J, Haynes J-D. Unconscious determinants of free decision in the human brain. Nature neuroscience 2008. 11: 543-5.

Thuraisingham R A, et al. Analysis of eyes open, eye closed EEG signals using second-order difference plot. Med Biol Eng Comput 2007; 45 (12):1243-9.

Weidong Z, Gotman J. Removal of EMG and ECG artifacts from EEG based on wavelet transform and ICA. Conf Proc IEEE Eng Med Biol Soc 2004; 1: 392-5.71

Zilles K, Amunts K. Centenary of Brodmann's map--conception and fate.Nat Rev Neurosci. 2010 Feb;11(2):139-45.

QEEG WIRELESS

Berka C, Levendowski DJ, Lumicao MN, Yau A, Davis G, Zivkovic VT, Olmstead RE, Tremoulet PD, Craven PL. EEG correlates of task engagement and mental workload in vigilance, learning, and memory tasks. Aviat Space Environ Med. 2007 May;78(5 Suppl):B231-44.

Bonfanti A, Ceravolo M, Zambra G, Gusmeroli R, Spinelli AS, Lacaita AL, Angotzi GN, Baranauskas G, Fadiga L. A multi-channel low-power system-on-chip for single-unit recording and narrowband wireless transmission of neural signal. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:1555-60.

Brown L, van de Molengraft J, Yazicioglu RF, Torfs T, Penders J, Van Hoof C. A low-power, wireless, 8-channel EEG monitoring headset. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:4197-200.

Cammann R; Possibilities for the use of a wirelsss telemetric technic in electroencephalography. Psychiatr Neurol Med Psychol (Leipz). 1975 Dec;27(12):737-46. German.

Cosmanescu A, Miller B, Magno T, Ahmed A, Kremenic I. Design and implementation of a wireless (Bluetooth) four channel bio-instrumentation amplifier and digital data acquisition device with user-selectable gain, frequency, and driven reference. Conf Proc IEEE Eng Med Biol Soc. 2006;1:2053-6.

Dias NS, Carmo JP, Mendes PM, Correia JH.Wireless instrumentation system based on dry electrodes for acquiring EEG signals. Med Eng Phys. 2011 Dec 5. [Epub ahead of print]

Filipe S, Charvet G, Foerster M, Porcherot J, Beche JF, Bonnet S, Audebert P, Regis G, Zongo B, Robinet S, Condemine C, Mestais C, Guillemaud R.A wireless multichannel EEG recording platform. Conf Proc IEEE Eng Med Biol Soc. 2011 Aug;2011:6319-22.

Gargiulo G, Calvo RA, Bifulco P, Cesarelli M, Jin C, Mohamed A, van Schaik A. A new EEG recording system for passive dry electrodes. Clin Neurophysiol. 2010 May;121(5):686-93. Epub 2010 Jan 25.

Mohseni P, Najafi K, Eliades SJ, Wang X. Wireless multichannel biopotential recording using an integrated FM telemetry circuit. IEEE Trans Neural Syst Rehabil Eng. 2005 Sep;13(3):263-71.

Jun J, Mengsun Y, Yubin Z, Zhangrui J.A wireless EEG sensors system for computer assisted detection of alpha wave in sleep. Conf Proc IEEE Eng Med Biol Soc. 2005;5:5351-3.

Lin CT, Ko LW, Chang MH, Duann JR, Chen JY, Su TP, Jung TP. Review of wireless and wearable electroencephalogram systems and brain-computer interfaces--a mini-review. Gerontology. 2010;56(1):112-9. Epub 2009 Jul 25. Review.

Penders J, Yazicioglu RF, van de Molengraft J, Patki S, Torfs T, Brown L, Van Hoof C.Wireless EEG systems: increasing functionality, decreasing power. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:3441.

Spyrou L, Sanei S.Source localization of event-related potentials incorporating spatial notch filters. IEEE Trans Biomed Eng. 2008 Sep;55(9):2232-9.

WE-SPORT

Committee on Sports Medicine. Recommendations for Participation in Competitive Sports. Pediatrics, 81(5):737-739, 1988.

Chelladurai P; A classication of sport and physical activity services: implications for sport management. Journal of Sport Management, 6(1):38-51, 1992.

Mitchell J, Haskell W, Raven P; Classication of sports. Journal of the American College of Cardiology, 24(4):864-6, October 1994.

Mitchell J, Gunnar Blomqvist C, Haskell W, James F, Miller H, Miller W, Strong W; Classication of sports. Journal of the American College of Cardiology, 6(6):1198-1199, December 1985.

Riemer B, Visio M; Gender typing of sports: An investigation of metheny's classication. Research quarterly for exercise and sport, 74(2):193-204, 2003.

Scotton C; Verso una classicazione definitiva delle specialità sportive. New Athletics Research in Sport Sciences, XXXI(185):26-36, 2004.

TOUCH WALL

Dufour A, Touzalin P; Improved visual sensitivity in the perihand space; Exp Brain Res. 2008 Sep;190(1):91-8. Epub 2008 Jun 14.

Dunne A, Do-Lenh S, O' Laighin G, Shen C, Bonato P; Upper extremity rehabilitation of children with cerebral palsy using accelerometer feedback on a multitouch display, Conf Proc IEEE Eng Med Biol Soc. 2010;2010:1751-4.

Godijn R, Theeuwes J; Overt is no better than covert when rehearsing visuo-spatial information in working memory; Mem Cognit. 2011 Jul 20.

Hauert Cl- A; The relationship between motor function and cognition in the developmental perspective; Ital. J. Neurol. Sci., Suppl. 5/1986.

Lieberman J, Breazeal C; A robotic feedback suit: markers on the right arm indicate the joints that are regulated by the system;IEEE Transactions on Robotics, Vol. 23, No. 5, October 2007

Lucca L. F; Virtual reality and motor rehabilitation of the upper limb stroke: a generation of progress?; J Rehabil Med 2009; 41: 1003–1006

Mendoza JE, Apostolos GT, Humphreys JD, Hanna-Pladdy B, O'Bryant SE; Coin rotation task (CRT): a new test of motor dexterity; Arch Clin Neuropsychol. 2009 May;24(3):287-92.

Mounoud P,Dal pensiero all' azione, edizione NIS, 1995, pp. 51-68.

Sugano Y, Keetels M, Vroomen J; Adaptation to motor-visual and motor-auditory temporal lags transfer across modalities; Exp Brain Res. 2010 March; 201(3): 393–399.

AGRISÙ

Branis M, Šafránek J; Characterization of coarse particulate matter in school gyms. Environmental Research Volume 111, Issue 4, May 2011, Pages 485–491

Kipen H, Rich D, Huang W, Zhu T, Wang G, Hu M., Lu S, Ohman-Strickland P, Zhu P, Wang Y, Zhang J; Measurement of inflammation and oxidative stress following drastic changes in air pollution during the Beijing Olympics: a panel study approach. Annals of the New York Academy of Sciences 2010; 1203 p. 160-7

Kargarfard M, Poursafa P, Rezanejad S, Mousavinasab F; Effects of exercise in polluted air on the aerobic power, serum lactate level and cell blood count of active individuals. International journal of preventive medicine 2011, 2 (3) p. 145-50

Sehlstedt M, Behndig A, Boman C., Blomberg A, Sandström T, Pourazar J; Airway inflammatory response to diesel exhaust generated at urban cycle running conditions. December 2010, Vol. 22, No. 14 , Pages 1144-1150

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