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Human body in motion Journal

ISSUE 1

Special congress : **From lab to practice**


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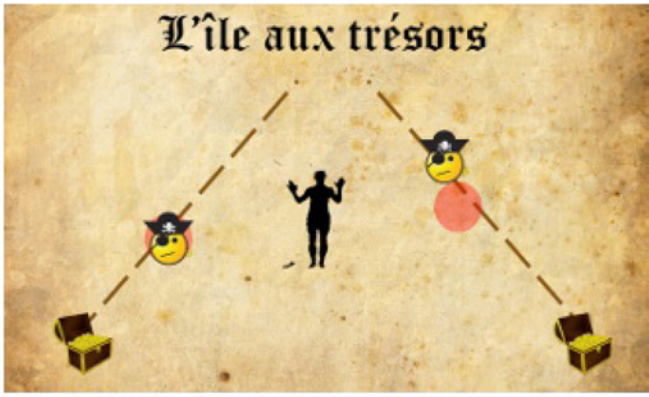
The therapies concerning the movements are evolving and new approaches are developing. The know-how concerning the patients' healthcare is therefore getting richer. the HBiM Journal will focus on the close links between quality healthcare and innovative research.The focus will be put on the exchange between the actors dealing with therapies concerning movements, such as physiotherapists, engineers, doctors, researchers...

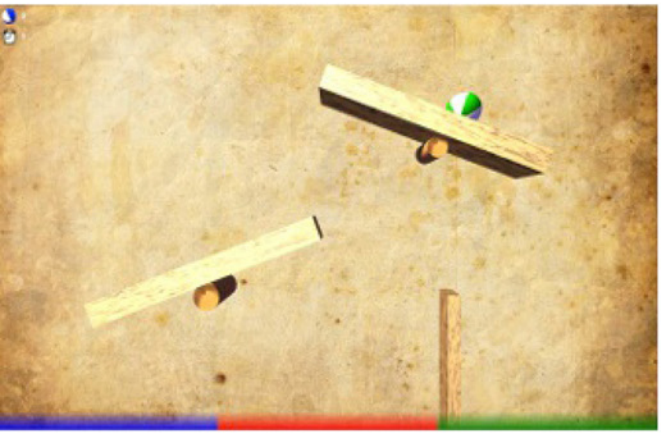
We will always have in mind to articulate fundamental science, applied science and "real" know-how. The idea is to create a true dialogue benefitting both the therapist on the field and the researcher.

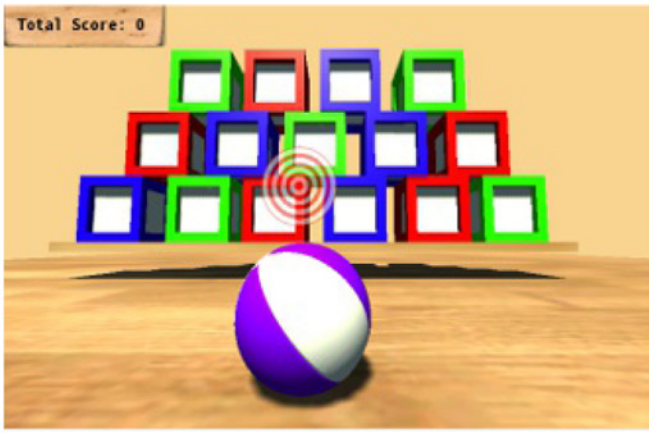
The Human Body In Motion Team:

Olivier Van Hove,
Bruno Bonnechère,
Julien Frenot,
Cédric Van Hove.

SUMMARY







Interview
Bruno Bonnechère

Serious-gaming, video games as a therapeutic approach for patients.

What is the topic of your research?

I am interested in the use and integration of new technologies in rehabilitation. This is a broad and emerging field. I am focusing on the use of commercial and specially developped video games. There are many ways to integrate the games in the conventional revalidation. We choose to work only with widely available and low cost material. Therefore the solutions that we are currently developing will be as accessible as possible for patients and clinicians. We are mainly working with the "Kinect" camera and the force plate Balance Board that have been developed by the video game industry. They are thus produced on a large scale and at reasonable cost (approximately one hundred euro for each device). One part of my thesis was to validate the use of this equipment to perform functional assessments of patients during rehabilitation exercises. Despite the low price of these devices, we get very satisfactory results in comparison to "gold standard" devices used in laboratory. We are currently working on a feedback system that corrects in real time the movements performed by the patient during the rehabilitation exercises, therefore there are sure to do them correctly. All the motion performed by the patients are recorded and reports are sent to the therapist to monitor the evolution of the patients during the full rehabilitation process.

What is the added value of serious games in the treatment?

There are several positive aspects related to the integration of serious games in the conventional treatment. The first point is that it allows more possibility in the treatment and more exercises for both patients and clinicians. The exercises that the patients have to perform in the games are the same as the one the patients have to perform during conventional rehabilitation exercises. But

the fact to perform those exercises in games provides new opportunities. From a motivational point of view it is obvious that games are a nice and positive solution to stimulate the patients. All studies agree on this positive effect. Another positive point is the fact that when patients are playing, they are less focusing on the movements they need to perform and can therefore performed more repetitions before getting tired of the exercises. Studies have shown that patients perform on average 10 times more repetitions within video games than during conventional rehabilitation. In rehabilitation it is well known that the number of repetitions is directly related to patient outcome (especially in neurological rehabilitation), we can easily understand the possibilities of this kind of intervention. But in order to be effective the exercises must be performed correctly. The use of video game coupled to a motion analysis system is also and added value. Clinician could check that patients are really performing their exercises at home but most important is that they can control if the motions are performed correctly! A last positive point is the fact that these games are close to double-task training. We know that this kind of exercises is a good way of developing new connections in the brain. Studies using functional MRI showed changes in the cerebral cortex before and after training using video game.

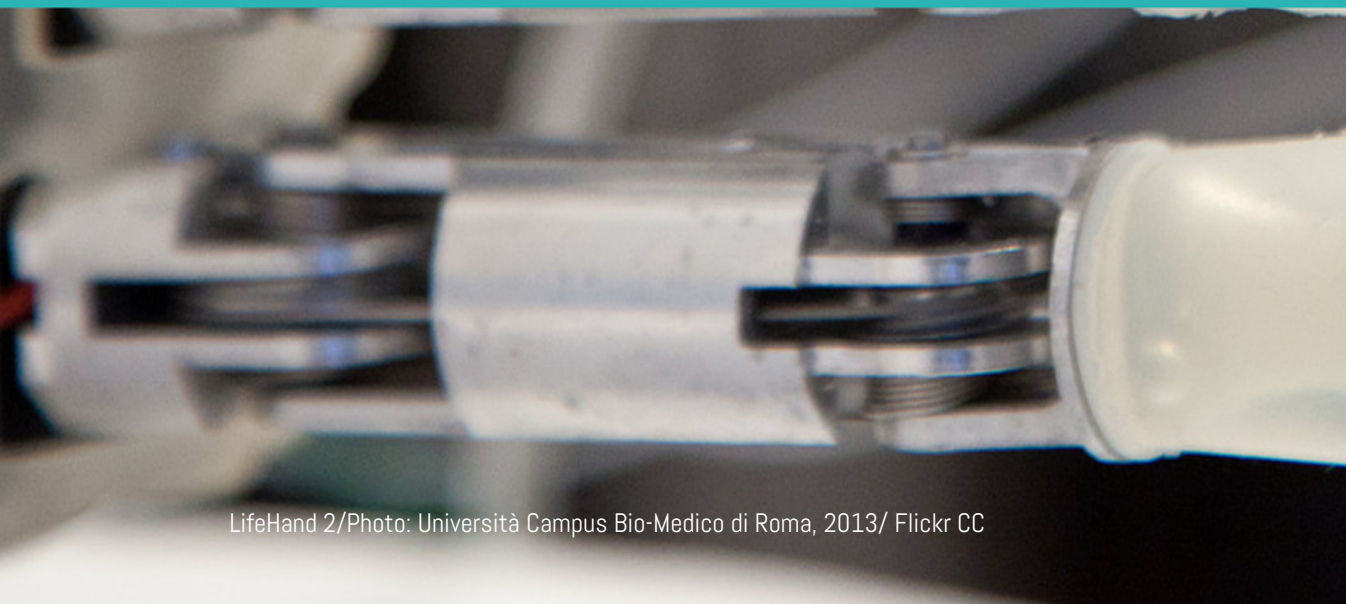
Some will argue that with this type of intervention (serious-gaming) the physiotherapist risks to loose their kwow-how. What would you answer to them?

Paradoxically, while we are living surrounded and helped by technology, some people are still reluctant and fearful about to use of new technology in their profession, especially in the healthcare system. In a way it is natural to have this sense of protectionism and to say and think that machines will never replace the know-how and human skills. Although I am convinced that it will happen one day, and it is in fact already the case in many domains, the debate is not there. The technology is definitely not an enemy but a precious help. If we take a look at the evolution of medicine over the last thirty years, it is clear that medical doctors are using more and more technology to provide precise diagnosis and improve the quality of patient's care. I think that nobody complains about the fact that we can obtain perfect pictures of coronary vessels in a few milliseconds without any risk for the patients, to perform most of the abdominal surgery using laparoscopic techniques or that it is possible to remove brain tumors without surgery... Technology is already used and will be more and more used in the future. Rehabilitation follows, slowly, and will follow this movement. Of course this does not mean that the clinician will lose their know-hows and knowledges. I think exactly the opposite! In fact, the new data coming from such kind of system must be interpreted and well understood by the clinicians. This will enable him to adapt the treatment based on those results but also based on his expertise, knowledges and clinical perceptions when he is working and performing exercises with the patient. It is also clear that the final decision of treatment will always be taken by the clinician, not by technology. Clinician is charge of the patients, technology is a help and a precious support to help clinician, he is free to do what he wants with this help!


A
B
A: Kinect
B: WII BlanceBoard

Nathanaël Jarrassé

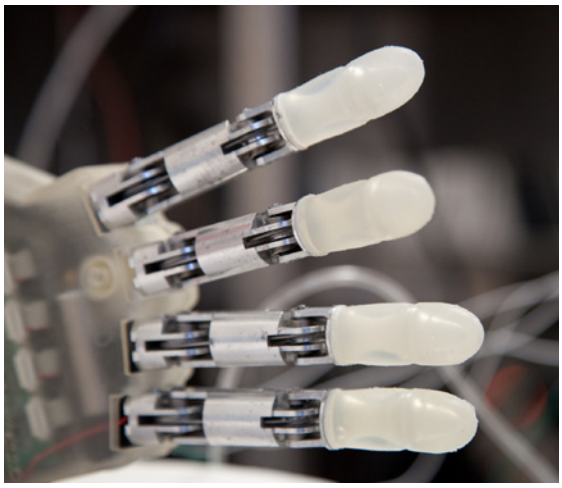
Robotic prostheses: what do they actually mean for the patient?



LifeHand 2/Photo: Università Campus Bio-Medico di Roma, 2013/ Flickr CC

Robotic prostheses

Prostheses have undergone an accelerated development over the past few years, triggered by, amongst others, the conflicts in Iraq and Afghanistan. Indeed, with their share of wounded and amputees, these conflicts will undoubtedly have made a strong contribution to, putting the spotlight on this niche field of research. The technological sophistication of robotic prostheses gives free rein to the imagination. But what is the reality on the ground? As we speak more and more of the augmented man and body-machine fusion, what does this all actually mean for the patient? To shed some light on this matter, we put our questions to Nathanaël Jarrassé, a CNRS researcher at the Institute of Intelligent Systems and Robotics at the Pierre and Marie Curie University in Paris.



LifeHand 2/Photo: Università Campus Bio-Medico di Roma, 2013/ Flickr CC

Between techno-utopianism and radical technocriticism:

To caricature the issue, commentators on robotic prostheses hover between techno-utopianism and radical technocriticism. For the former, technology represents a hope that reaches its climax in the form of augmented man. For the latter, this technology offers both the possibility of a qualitative leap forward for man but also a danger in the form of a change so radical that man would lose all resemblance to a human. For Nathanaël Jarrassé, even if these two positions seem to be contradictory, they both serve to build up the patients' hopes and their representations, while being «far removed from the reality of the patient and the scientific reality». For him, one of the most convincing examples is the rhetoric of some non-specialists on the technological risks.

"The problem is that even if the intentions are generally commendable and the issues are very much present, they sometimes construct a rhetoric on a perception of technologies and practices that are not at all based on a technical reality. It sustains myths, beliefs and a kind of ideology."

We often forget the hours of training necessary to use a prosthesis, the discouragement, the failures, the return to the good old mechanical or aesthetic prostheses.

Oscar Pistorius is held up as an example, but what they forget to say is that, to keep his balance, he has to hop on the spot, and that if he wants to swim or simply walk, he must change prosthesis. All this is a significant constraint. It's a world away from the adaptability of a human lower limb. Some predict that soon we will be amputating a limb in order to gain in physical performance but what about the damage to the body map and the pain of the phantom limb? What about the unrivalled versatility of our bodies?

Setting sites on Gold in 2012/Photo:The U.S. Army , 2009/ Flickr CC

He does not deny that this rhetoric is also generated by the scientists themselves. «It's actually a multi-scale problem. The relationship between technological innovation, the general public and the researchers who created it is influenced by numerous agents in the social, cultural and commercial fields, and among them, in particular, popularisation and mass scientific communication. Because popularising inevitably means simplifying. But there is so much content that, in the end, it becomes distorted.» According to Nathanaël Jarrassé, some researchers who are not technological specialists, government agencies, the media and the general public form a kind of ecosystem that contributes to the emergence of these myths. «For example, when government agencies make calls for funding, this is done through themes that, in actual fact, are influenced by cultural myths. Sometimes we'll find keywords or illustrations that are straight out of the realm of science fiction rather than a technological reality. "The researchers themselves"use this to sex up their research. They will cling to a certain cultural myth, they will make analogies with films». This is obviously not without perverse effects because researchers sometimes find themselves caught up in their own sexed-up rhetoric: «It may seem benign but reporting and transforming can ultimately put pressure on research. In fact, this gives the impression that there is a gap between research and its popularised version, eliciting reactions such as "you've only reached that point". The disappointment for the patient will also be significant.

It is, therefore, undeniable that researchers have their share of responsibility. «But in their defence, it is very difficult for researchers to talk to journalists about their research. It is a complex exercise. I think that, in the long run, we should have training in «communication». We have to realise that a word, if it has links with a cultural object or a myth, can trigger a train of thoughts in a journalist who is not a specialist in the field and put him on the wrong track."

Setting sites on Gold in 2012/Photo:The U.S. Army , 2009/ Flickr CC

Reflection on his research:

Even if there is truth in the criticisms that researchers have tunnel vision and do not think enough about their research, there is nevertheless a growing fringe of scientists who are aware of this need. For Nathanaël Jarrassé, this vision of the researcher can be put down to the over-representation of certain «spinners» such as Kevin Warwick or Hiroshi Ishiguro; the former who proclaimed himself «the first cyborg» while the latter makes robots in his effigy and that of his entire family. For Nathanaël Jarrassé, «they are anecdotal people who are media hungry but who are not at all representative of the community». It is important to note their significant presence in the media. The taste for sensationalism is undoubtedly the cause.

Nevertheless, the engineer pointed out another difficulty: «Researchers have a hard time publishing studies carried out in conjunction with anthropologists or sociologists.» While the research community is well aware of the need for reflection on their research, interdisciplinary work does not seem to go down well in scientific journals. And yet, it is only through this interdisciplinarity that we can ask ourselves the right questions. There is obviously no question of turning a physician or a physiotherapist into an engineer or an indeed an engineer into an anthropologist. No, however, there is a need to work together, to create so-called co-designs. But it isn't easy.

What should be done to promote interdisciplinarity? Nathanaël Jarrassé replies: «For example, by considering real funding that encourages these disciplinary combinations. The fact

is that, even if this type of research interests the researchers, they are forced back into their technical reality because they must publish in engineering journals. In order to raise substantial funding (spread over several years to finance equipment and human resources), they will have to work in truly technical fields. There is no guarantee of money being thrown at an interdisciplinary analysis that will obviously be slower. Thus, researchers are torn between research that is driven by slower ethical issues and a certain pressure that forces them to come up with the results.»

While medicine is making some headway in this field, it is also true that, in most cases, co-design is still a matter of wishful thinking. While, for example, a sociologist may be involved in a research project, this integration is rarely done upstream. If he intervenes, it will very often be after the fact and brought on board to work on its social acceptability. Obviously, this can only cause frustration for social scientists. Nevertheless, things are changing: "thanks to the CNRS (and its mission for interdisciplinarity) and recently to the ANR (French National Research Agency), we are working on the use of phantom signals for the control of prostheses. To do so, they have brought on board a clinical equipment centre, a neuroscience and neurophysiology laboratory, a robotics laboratory, a company that develops printed electrodes as well as a sociologist. This team has been put together to work around a product relating to the phantom limb. It's not easy and there are trade-offs to be made. When the experiments take place, everyone is there. The question is why would a sociologist attend the kinematics or electrophysiology measurements. In fact, the idea is to ask for everyone's opinion and discuss it afterwards and try to take it into account when defining a system. We are very fortunate to have been able to create this and we have many colleagues who would like to follow suit, but who do not always have the framework or the funding to make it happen."

There is indeed an ethical reflection on the development of therapeutic robots. The Allistene Digital Science and Technology Research Ethics Commission (CERNA http://cerna-ethics-allistene.org) has issued an ethics report for research in robotics. It is a first step that lays the foundation for a reflection on major problems: «The problem of defining the robot, the scientific communication of researchers with regard to the general public, the dangers of robotic links with the body and the links between robotics and vulnerable persons (elderly people, autistic people, etc.), the risk that may arise with robots that are involved in social interaction, the power that this can have on some vulnerable people. In fact, the community, at least in robotics, is aware of this and has been thinking about these kinds of issues for a while".

Patient integration and validation

The integration of the patient, moreover, upstream of the project, remains the major challenge. Nevertheless, the emphasis is increasingly on this component, to avoid hearing observations such as: «I sometimes have the impression of building houses on sand». Indeed, what the patient wants is sometimes far removed from what the researcher has planned for him. Comfort, the aesthetic aspect and discretion can sometimes override the functional aspect. This is why sitting down with the patient to discuss his expectations and life plan before the design of the finished product is paramount if he does not want it to end up in a cupboard. «Even if this represents one more step in the already long process of co-design».

But even before thinking about integrating the patient at the beginning of the project, another seemingly essential step also appears difficult to roll out in practice: the evaluation of what has been developed and the clinical tests carried out. Often, projects remain blocked at the «proof of concept» stage - in other words, at the scientific discovery stage. In general, the idea will be validated but the transfer to the patient, the development of something that will be useful for him and exploitable tends to be shelved". Lack of time and funding seems to be the cause. When Nathanaël Jarrassé is questioned about the waste that this can generate, he becomes rather impassioned: «When you see the lavish string of exoskeletal platforms created and developed

for the rehabilitation of the upper limb! There are around fifty worldwide, and this, of course, by different laboratories. In addition, if we look more closely at those that have been clinically or pre-clinically tested, there are no more than 8 to 10 in total. In fact, very often the device is only validated on healthy subjects but we rarely go on to the next stage". Funding policies should therefore take this validation step into account or allow improvements to already existing devices, especially in the medical field. Innovation is nothing if it is limited to proof of concept.

Did you forget to drop a bomb or a mine?/Photo: Alexandre Dulaunoy, 2015/ Flickr CC

Interview
Valentine Gourinat

Cybathlon/Photo: Simon Fraser University - University Communications , 2016/ Flickr CC

Prosthetics, between fantasy and reality

(PhD student in ethic and live science ;
Laboratoire Dynamiques Européennes
- UMR 7367
- Université de Strasbourg / CNRS ;
Faculté de Biologie et de Médecine
- Université de Lausanne)

Two competitions were held a short while ago: the Paralympic Games and the Cybathlon. What do you consider to be their similarities and differences?

I would say that the only thing that they have in common is their aim of catering to and highlighting a population group considered to be outside society's physical «norms», to allow people with disabilities to compete while taking into account theirspecific characteristics and adapting to them (via adapted events or even events which simply do not exist in able-bodied competitions), without making any judgement whatsoever. As for the differences (because, at the end of the day, they are very different competitions), I see two main ones:

1) As far as the Paralympics are concerned, the events are sports events (races, javelin, long jump, etc.). While the Cybathlon does not entail sporting events but situations of accessibility and adaptability to everyday life (climbing stairs, sitting on a soft chair, setting the table, opening a door, hanging out washing, etc.).

2) The Paralympics are hinged around the physical and bodily performances of athletes (strength, speed, precision, etc.). In the Cybathlon, the evaluation focuses on the technological performances (and their interaction with the person using these technologies, of course). An athlete at the Cybathlon may be in top physical shape, but if their device is less effective than that of their opponent, they will not necessarily win the event, as everything depends on the collaboration between the prosthetic device and its user.

Paralympic Marathon 2012/Photo: Paul Miller, 2012/ Flickr CC

Isn't the Cybathlon uniquely about performance?

I actually think it's the other way around. The way I see it, performance is more of an issue at the Paralympics. At the Cybathlon, the notion of performance seems almost secondary, coming after the notion of adapted use. The events are not tests of strength or speed, but tests of accuracy of use and adaptability to any situation: the winning athlete, in this case, will be the one who has succeeded in completing the various stages in a minimum of time, and the leaders can quickly change in the middle of the competition, depending on the type of obstacle encountered (a wheelchair that has been the fastest throughout the course can be outclassed when they come across stairs at the last stage of the race due to the fact that another chair may not boast the same "performance" but may be more adapted). Moreover, the results have often been counter-intuitive: for example, the upper limb prosthesis that won the first place was the only one not to use a robotic control device (and therefore the one with the lowest technological "performance", but the most effective in terms of use during the situations encountered). I think there is an implicit subtlety that goes far beyond the realm of performance in the case of the Cybathlon: we are dealing with the need for a fine-tuned compatibility between the device and its wearer, for controlled and precise use, while also having to navigate a multitude of complex and varied situations.

Isn't there a risk in the rhetoric and in the perceptions of switching from a status of "disability" to a status of "advantage"?

Yes, and this is already the case in some perceptions and in a certain rhetoric. Since Pistorius, the cat has been put among the pigeons and this leitmotiv of an augmented body brought about by the prostheses has become a nagging problem. Yet I see this as a truly limited and simplistic take on the technological possibilities and especially on the reality of life for a person with a disability. Technology does not solve everything, and overcoming the disability through an augmented body depends on the individual situation; it cannot be generalised or held up as a true paradigm, in my opinion. I am still convinced that this rhetoric and these perceptions are based above all on a partial or skewed knowledge of the reality on the ground (and in particular of all the dimensions an injured or disabled body implies) and a poor estimation of technological possibilities.

Cybathlon/Photo: Simon Fraser University - University Communications , 2016/ Flickr CC

What impact could this have on the patient? His identity, his sensitivity, his reality.

This already has some impact on the patient. In particular when it comes to his therapeutic journey. Showing patients with prostheses

who are achieving great things can skew the understanding that new patients have of the opportunities available to them.

A number will think that their prosthesis will allow them to recover their lost physical abilities effortlessly and that they will be able to go back to their old way of life. Unfortunately, their life will not be the same as before (it will not necessarily be worse or less rich, but will simply be different), they will not be able to recover all their previous physical abilities, and the prosthesis will not be able to deliver the answers they expect. This sometimes leads to major disappointments in the care pathways when patients realise how difficult, painful and limited the use of the prosthesis is, and this sometimes gives rise to a number of tensions with the healthcare team, which cannot come up with a satisfactory response to this frustration/disappointment (caregivers are not magicians). On the other hand, we must underline another positive impact: by giving a positive and «capable» image of this population, these perceptions help patients to better accept their condition in relation to the rest of the social group. They feel less «reduced», and know that they can be perceived as people capable of integration, or even as people who are able to achieve great things. These images can help patients regain their self-confidence, and accept themselves as they are. For example, more and more amputees are choosing to wear a visible prosthesis, whereas previously the vast majority of prostheses were hidden under flesh-coloured clothing or dressings. There is thus a clear evolution in the acceptance and appropriation of the image of the amputated body. And that can only be a good thing!

How do you feel about the term «augmented man»?

These terms leave me a bit dubious. What does it really mean? I mean concretely, apart from the philosophical meaning. How are we augmented, in relation to what? I feel that everything is always a matter of relativity, context, situations, the notion of augmentation is relatively fluctuating and not very significant... Augmented compared with the norm, yes ok, but in a specific field or in general? All this remains to be clarified before I can accept the idea of an augmented man. I am convinced that physical life is always a combination of augmentation and decrease in relation to the different people, situations, and conditions that we encounter. This notion, therefore, seems to me as variable as that of disability (it is the situation that creates the disability, there is no disability as such, so in my eyes there is no augmentation as such either, everything depends on what is being talked about, when, and in what context).

Do you think that your work, or that of your colleagues in the field, will feed prosthetic research upstream?

I don't think that studies in the humanities really feeds into the fundamental research into prostheses. In any case not in a tangible way. Prosthetic research is happening at another level, and for a large part of it, it is already working with the medical community and the patients themselves. As far as I know, studies in the humanities often reveal more about the results of these technologies, their uses, their applications in society or in the life of the patient, etc. We are more present in the

operational dimension, and not at the preliminary stage of this research. To make these studies meaningful for researchers working on future prostheses, they need to be firmly anchored in the field and have relevant elements to research, elements that could change the direction of this research, which is not necessarily the case. In my opinion, these studies have more relevance in the context of «post» research, that is to say, the use of the fruits of this research. But who knows, this can evolve, and perhaps some research laboratories will find interesting avenues of development based on the social science studies! On the other hand, this research in social science feeds into or can nurture medical practices, and have an impact on care processes. As I said earlier, at the operational level, collaboration between the health sciences and the humanities and social sciences is quite relevant and already exists at some levels (caregivers are increasingly interested in social science and take it into account in their professional practices).

Photo: Alexandre Dulaunoy, 2015/ Flickr CC

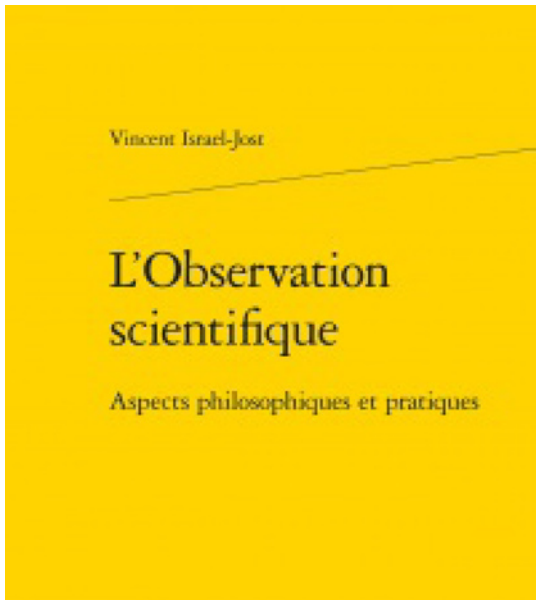
Interview
Vincent Israel-Jost

«Measure a thousand times, cut once»/Photo: Sonny Abesamis, 2014/ Flickr CC

Movement, its measurement, its data: a critical vision

Vincent Israel-Jost is a doctor of philosophy and researcher at the FNRS at the Higher Institute of Philosophy of the Catholic University of Louvain

"Since the instrument is used to characterise certain functions of life, I think that a fairly profound understanding is recommended, not only of the instrument but also of what it measures."



What does your research entail?

My research consists of exploring certain practices in the field of contemporary science and observing or detecting, or at any rate, formulating problems related to these practices. These problems may not strike the practitioners as very urgent, which is why they are left to the philosophers, but they can reveal very profound things, touching on the very foundations of a discipline. At the moment, I am looking into algorithmic processing of images or digital data. These are reconstructed images, such as a CT scan or an MRI, or even images that are denoised, deblurred, always by computerised means. Data-processing practitioners, mathematicians and computer scientists are busy with exciting tasks: developing methods to perform new tasks automatically and reliably. For my part, the questions that I explore in this area are, for example: with such a wide range of algorithms at their disposal, have scientists not developed a set of tools close to Photoshop? Are the scientific images that are produced, corrected, and improved, similar to photoshopped images that we know are disapproved of in photojournalism, for example? Another question that I find interesting is this: when algorithmic processing makes it possible to improve data, let us say by correcting an aberration, is it still useful to intervene materially on the instrument to correct this aberration? Or is it no longer of interest because the problem can be corrected by another means?

I won't dwell here on the treatment of these questions, but it seems to me in any case fundamental that the philosophy of science be inextricably linked, at every stage, with real science. In other words, it is important that problems arise from observed situations and not from collective mental constructions thought up by philosophers alone; but also that real examples support the arguments and that all of our work can be of interest to the scientists involved. Finally, as for researchers in the field of science (I was one before switching to philosophy), this research is intended to be published in the form of articles, books or chapters, and communicated at local conferences and international symposia.

Is it important to you that therapists take a critical look at the measuring instruments they are using?

The question is not as self-evident as it first appears. Of course, one is tempted to say: the therapist MUST look at the instruments being used and adopt a critical attitude. But at the same time, the aim is not to demand that therapists be distracted too much from the central focus of their expertise: the human body (or even the human per se). For example, I don't believe that it is necessary for therapists to have a detailed knowledge of the physical operating principles of their instruments to the point of being able to construct these instruments! On the other hand, since the instrument is used to characterise certain functions of life, I think that a fairly profound understanding is recommended, not only of the instrument, but also of what it measures. Only such an understanding will distinguish a therapist from a mere automaton who simply reads the measurement and then goes to look for the appropriate treatment in a textbook. A measurement can be interpreted in many ways! You have the instrument, which can react differently depending on the ranges of values, the measurement conditions that can influence matters, the patient's condition ... And finally, what this measure is, what this number represents, all the possible correlations. The "must", from my point of view, is to develop a rich vision of the discipline, to forge links between various types of knowledge, physical, technological and biological, for example, to be as holistic as possible to avoid the draining reductionism that sometimes exists, including in the medical field.

What is an objective measurement to you?

This is an issue that is at the heart of my current research. The objective is the opposite of the subjective, and something that is subjective is what the subject influences decisively. An approach is subjective if it leads to different results depending on the person who has undertaken it, whether due to different abilities or beliefs. In this perspective, to speak of an «objective measurement» is almost redundant. A measurement is a result given by an instrument, and that therefore does not rely on the particular perceptive capacities of an investigator. This instrument is used according to a certain well-established protocol, which does not leave much room for individual imagination. As for the reception of this measurement, it is very different from that of an X-ray image for example, which requires a certain expertise to find the noteworthy signs in this image. A measurement is thought of as something that is read without requiring any real interpretation. In short, the measurement is the most profound breakthrough made in the field of objectivity. Yet, as has been pointed out above, it is actually important for therapists to develop a good understanding of what the measurement is and what their instrument does. And if we have encouraged this curiosity among therapists, it is because we believed that it could make an effective difference. In other words, in spite of the effort of objectification represented by the measurement, there is no getting away from the individual qualities of the examiners. Again, a measurement can require corrections and always requires an understanding. A measuring device serves only to attenuate the differences between experimenters but does not entirely eliminate them. As such, a perfectly objective measurement does not exist.

Diving deeper into scuba...science

Practical and theoretical knowledge

Constantino Balestra
Peter Germonpré

Diving Deeper into SCUBA... Science

Practical and Theoretical Knowledge

- The editors and authors of this book are a cadre of scientists and physicians with broad experience and knowledge of diving physiology and decompression theory. As is often the case, it requires a group effort to succeed in advancing practical knowledge. The colloquialism "the whole is greater than the sum of its parts" is often true and the PHYPODE Research Group epitomizes this concept. By logically grouping the various elements of diving science and medicine with provocative "food for thought" sections the text offers valuable lessons to those interested in the current state of diving. Despite nearly 170 years of research, the fundamental nature of decompression stress remains elusive. As is well outlined in this book, great advances have been made to the practical elements allowing for safe diving. Nonetheless, there are glaring voids of knowledge related to the nature of bubble nucleation, its consequences and methods to ameliorate risk. The synergy exhibited in this text not only provides a foundation for what is known, it offers a glimpse of where research is taking us.

- --- Professor Stephen R. Thom, Dept. of Emergency Medicine, University of Maryland School of Medicine

- **Editors**: Costantino Balestra - Full-time Professor & Head of the Integrative Physiology Lab at the Haute Ecole Bruxelles-Brabant; and Peter Germonpré - Medical Director of the Centre for Hyperbaric Oxygen Therapy of the Military Hospital Brussels, Belgium.

  Co-editors: M. Rozloznik, P. Buzzacott, D. Madden. European Underwater and Baromedical Society

Interview

Dr. Vasileios Andrianopoulos

Computational Models of Partical Deposition in the Lung/Photo :
Pacific Northwest National Laboratory, 2013/Flickr CC

PHYSIOLOGY: Respiration-cognition

Vasileios Andrianopoulos is a clinical exercise physiologist working as postdoctoral research fellow at Schoen Klinik Berchtesgadener Land in Germany. He has his expertise in COPD pathophysiology, clinical exercise assessment and Pulmonary Rehabilitation programs for COPD patients. Devoting himself to research, he acquired experience in designing research protocols, analyzing data and writing manuscripts as well as in operating several clinical devices. He has numerous publications in healthy and patients with COPD and since 2014 is an active member of the European Respiratory Society (ERS) College of Experts. Recently (2016), he has been awarded with a prestigious Marie Skłodowska-Curie fellowship cofounded by the European Union and the European Respiratory Society (ERS) for his project about cognitive dysfunction in COPD.

Why are you interested in breath-cognition relationship? And how do you explain the current "craze" for cognition in physiology?

Almost all humans as getting older will exhibit some degree of cognitive capacity decline, which is sometimes evident after the age of 65 years old. Even though cognitive decline is a natural part of ageing, it makes older people to be more vulnerable to mild or more severe forms of cognitive impairment. Cognitive impairment in its primary level is an intermediate stage between the expected cognitive decline of normal aging and the more serious cognitive deficits that can involve serious problems with memory, language, thinking and judgment. In general population, the prevalence estimates of cognitive impairment range from 3% to 20%, with higher rates in older age groups, according to various studies. Therefore, the rising of life-expectancy requires a special focus on cognitive deterioration as the number of people over 65 years old will be globally increased and as a matter of course the health and social burden of cognitive impairment and dementia is expected to rise dramatically. This concern and also the fact that cognitive science is a very promising field may explain the current "craze" for cognition in physiology.

Cognitive impairment is a result of complex interactions between pathophysiological, genetic and environmental factors as well as related to chronic conditions such as diabetes, vascular disease and chronic obstructive pulmonary disease (COPD). Cognitive impairment that primarily affects memory is known as "amnestic", whereas when it affects thinking skills other than memory is known as «non-amnestic". The most common subtype of cognitive impairment is the amnestic in which memory loss is the main symptom. People who are cognitive impaired usually have limited occupational performance and participation as well as they present deficits in instrumental activities of daily living. Cognitive impairment is also associated with higher mortality, increased hospitalization and disability, and with a generally lower quality of life. Dealing with cognitive impairment is not easy only for patients but also for their relatives or loved-ones. Family members or loved-ones may need to take on new roles and responsibilities, such as helping with finances, to compensate for the memory loss or other cognitive decline and also may have difficulties coping emotionally with this difficult situation.

Regarding the breath-cognition relationship, it is observed that patients with COPD have a generally higher prevalence of cognitive impairment compared to healthy that is ranging from 12% to 61%, with an average of 36% among COPD patients presenting mild or more severe cognitive problems. A number of them will also progress from cognitive impairment to dementia. Indeed, this higher incident of cognitive impairment in COPD may indicate that there is a breath-cognition relationship that needs further investigation. Pathophysiology and consequences of respiratory insufficiency can result in lower oxygen levels in blood and also lower oxygen availability in the brain increasing the odds of cognitive impairment in COPD. In my opinion, investigating this breath-cognition relationship is very interesting from a scientific point of view and a real challenge as more negative consequences than hypoxemia in COPD may enhance the risk of cognitive deterioration. Unraveling this breath-cognition relationship may be of great clinical importance considering that cognitive impairment could be held responsible for insufficient adherence to therapeutic modalities, for increased mortality and hospitalization, and also could potentially reveal biomarkers of dementia.

Do you think that this parameter will be part of the treatment of respiratory insufficient?

As I mentioned before, pathophysiology and respiratory insufficiency may contribute to cognitive deterioration which is associated with lower quality of life, less adherence to therapeutic modalities and higher rates of mortality and hospitalization. On the bright side, cognitive impairment could also be considered as a potentially reversible state especially when it is mostly occurred due to medication side-effects, vitamin B12 or folic-acid deficiency, and depression or increased stress. It is also known that favorable factors for improving or even keeping cognition intact are physical activity, social participation and engagement, education and intellectual activity (i.e mind games such as crosswords or Sudoku) as well as a balanced diet.

In addition, effective treatments are developed to interrupt the neurodegenerative or cerebrovascular process and thereby improve outcomes. Therefore, cognitive impairment in some cases can be reversed or improved and this is something that should be considered. In any case, solutions including external memory aids, such as electronic calendars on a smart phone or computer; paper-based aids, like calendars, diaries, lists and pocket notebooks; and voice mail to leave messages as reminders, can be really helpful.

Cognitive impairment could be a limitation in patients with COPD and, therefore, potential cognitive deficits should be considered prior to health-care planning. This is because cognitive impairment may negatively affect the course of respiratory treatment. In my point of view, patients with COPD at higher risk for cognitive dysfunction (i.e. ≥65 years old with advanced COPD and/or hypoxemic, with symptoms of memory-loss reported from relatives) should be systematically assessed for cognitive impairment in order to detect coexisting cognitive deficits or an unusual decline of cognitive status. The process of diagnosing of cognitive impairment can include the assessment of independent function and daily activities, observations from family members or loved ones, cognitive screening tests, neurological examination, , laboratory tests, and neuropsychological testing to assess multiple types of cognitive skills. A combination of cognitive tests, which are usually easily administered and simple, can be often used to detect cognitive impairment. Preventive actions by early detection of cognitive impairment can be considered as optimal. Therefore, I want to believe that cognitive evaluation will become a part of the respiratory assessment. It would be also important and ideal, therapeutic care not only to deal with the patients but also with their family, who is struggling to understand and accept the cognitive/behavioral changes they are seeing in their loved-ones. Also, educational sessions about the self-management of the disease especially adapted for patients with cognitive deficits would be more than desired in the clinical settings (i.e. Pulmonary Rehabilitation).

For you what bring your research philosophically?

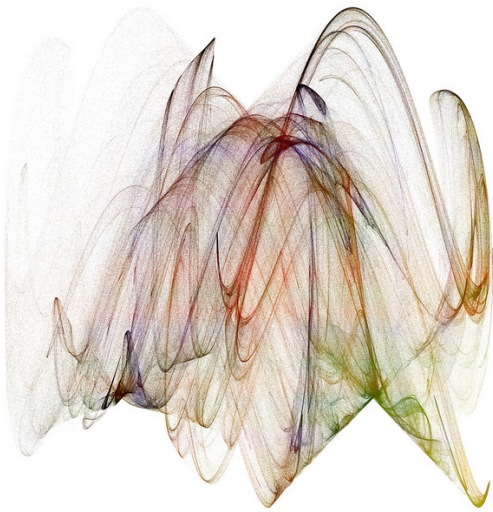
Honestly, it is very important and rewarding for me to have the opportunity to contribute to the clinical knowledge through my persistence and dedicated research work. Also, it very encouraging to see patients who benefit the most from new therapeutic approaches derived from recent research findings. In my point of view, research is a combination of science and art. Producing new knowledge as a result of intellectual activity and systematic study is the main outcome of research (science). On the other hand, starting from the design of figures for the visualization of research results and continuing to the design and the implementation of an experimental protocol until the turning of scientific research advances into clinical practices is a kind of art. It is a combination that doesn't leave a lot to be desired from an occupation. Herein, I would like to acknowledge the European Respiratory Society (ERS) for its crucial support to my research career as I was a holder of an ERS Long-Term Research Fellowship and currently awarded with an ERS/EU Marie Curie Post-doctoral Research fellowship (RESPIRE2). Briefly, I would like to finish off by saying a quote of double Nobel-Prize winner Dr. Frederick Sanger; "Scientific research is one of the most exciting and rewarding of occupations".

THE LUNG/Photo: Gilberto Santa Rosa, 2008/ Flickr CC

Interview
Christophe Lettelier

I have butterflies in my body; chaos theory and physiology

Christophe Letellier, professor at the University of Rouen, is a physicist, science historian and epistemologist. He is also what he calls a "chaotician", that is, he applies the «techniques of chaos» to physiology or to the treatment of cancer.
It is difficult to describe succinctly what these particular mathematics are. Henri Poincaré offers us a first explanation: «A very small cause, which escapes us, determines a considerable effect which we cannot fail to see. We say that this effect is due to chance». This is what others call the «butterfly effect»
We asked Christophe Letellier how these theories contribute to the understanding of the human body and its therapies. It will also therefore touch on pluridisciplinarity.



strange attractor vectors/
Photo: parameter_bond, 2016/ Flickr CC

You no longer define yourself as a physicist but as a «chaotician», can you tell us what this means?

As a physicist, the aim is to come up with an explanatory description of phenomena. As a «chaotician», it's a little different because the approach is a little more holistic. We are interested in «everything». We are less inclined to dissect the individual phenomena, but their dynamics is at the heart of our work. This changes the perceptive. In fact, you don't need to know all the principles underlying a phenomenon to characterise its dynamics and possibly to control it.

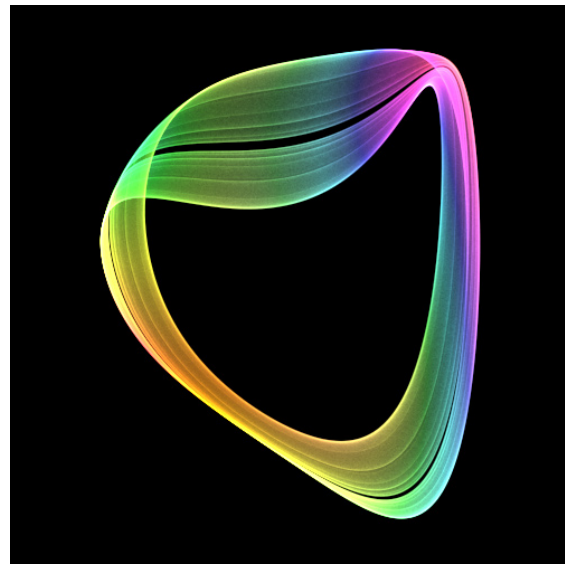
How has this notion of chaos been introduced to the field of medicine? As it may not be that self-evident in an environment where one tries to understand "everything":

In fact, it was introduced somewhat coincidentally via physiology. Everything that tends to be repeated cyclically, but with a certain variability, offers fertile ground for the «techniques» of chaos. Physiology is exactly that: heart rate, breathing, brain activity. This is actually how it started for me since I started off exploring breathing with a pulmonologist. We studied together the difficulties of patient-machine synchronisation during artificial respiration. It is typically problems such as phase synchronisation that are addressed by chaos theory.

There is therefore an overlap between chaos theory and medicine. But that doesn't mean that introducing these theories into medicine is easy. Indeed, within this framework, there are two pitfalls. The first is historical, especially in cardiology. There have been many attempts to introduce «chaos theories" in this area, but with totally inadequate tools. Many studies have proved unsuccessful, especially in the early 1990s. As a result, many doctors and physiologists have preconceived ideas that «chaos theory serves no purpose». When we address these people today, there is a whole lot of deconstruction to be carried out to have any hope of starting on new foundations. There are also very conservative points of view: how can non-physicians understand physiology or pathologies?

What are the advantages of applying such a theory in therapy or physiology?

The problem, and physics also comes up against it, is that the human body is a very complex system. And if we want to study a phenomenon by isolating an organ, we don't understand much. Indeed, the isolated organ behaves in a completely different way when it is not integrated into the body. It is exactly the same with tumours: if you take the tumour cells out and put them in a Petri dish, they do not behave at all in the same way as in the body. In fact, you do not really have access to what the disease does or what the organ does in the body. So, schematically, what we do with chaos is: we start off by trying to understand what happens in general, and only then do we break it down again. The schema of classical science, which is to explain the underlying phenomena and then come back to the general vision, is not that effective, including in medicine.



Lorenz-84-3/Photo: Marc de Ruijter, 2004/ Flickr CC

Do these «chaos theories» lead us to a personalised medicine?

Absolutely! When it comes to oncology, that's what we're working on. Beyond the marketing effect, for me, this is the only way forward in oncology. Each cancer is unique. If you apply a treatment based on statistical studies, it may work, but sometimes it won't. While if you have a really individualised diagnosis and an equally individualised treatment, chances are that it works better. This is what we are doing with the oncologist, Fabrice Denis, and it is proving effective. But there is still much work to be done.

Interview
Lara Muralt

What is the topic of your research?

For my medical doctor thesis I have focused on the stability of stance at altitude in patients with COPD. The impairment in postural control is a possible adverse effect of the hypobaric hypoxia at altitude. We assessed the body sway during quiet standing at 760 m and 3200 m with a Wii-Balance board.

Why did you focus your research on COPD patient and the altitude?

COPD is worldwide one of the major health problems. Due to an increased geographic mobility also persons with a lung disease can ascend to altitudes for leisure activity or for work and they might be exposed to hypobaric hypoxia during air travel. But little is known about postural control in patients with chronic obstructive pulmonary disease (COPD) travelling to altitude. Patients with COPD travelling to altitude are at greater risks of experiencing severe hypoxia than healthy people and they may therefore experience more altitude related problems. Furthermore they have a higher tendency of falling due to impaired postural control1.
To make reliable recommendation for patients with COPD travelling to altitude in terms of health risks, the literature must be extended.

Does your research have some application for «the valley»?

Knowledge about the tolerance of hypoxia in patients with lung disease helps to make reliable recommendation concerning an altitude sojourn. Understanding the pathophysiological mechanisms of the effect of hypoxia is also of interest for various diseases associated with hypoxemia at lowland. For example, studies in patients with obstructive sleep apnea at lowlands have shown an impaired postural control similar to what healthy subjects experience at altitude.

What is the contribution of physiology in extreme conditions compared to the classical physiology?

In extreme condition additional factors are present, like the hypoxia at altitude. It allows studying the effect of hypoxia on the human body in healthy individuals as well as in patients. Many settlements and working places are located above 3000 m. Better understanding the negative consequence on health and working performance might help to prevent adverse effects and identify therapeutic targets.

Hypoxia can occur also at lowland so that the altitude can serve as a model for other hypoxic condition, like in lung or cardiovascular diseases.

1) Porto, E. F., A. A. Castro, V. G. Schmidt, H. M. Rabelo, C. Kumpel, O. A. Nascimento and J. R. Jardim (2015). «Postural control in chronic obstructive pulmonary disease: a systematic review.» Int J Chron Obstruct Pulmon Dis 10: 1233-1239.

Slack Liners/ Photo: Joseph, 31/12/2013/ Flickr CC

Interview
Fabrice Bertile

Brooks Lodge/Photo: Max Goldberg, 27/06/2015/Flic

How to preserve the muscle mass during immobilization? ask the bear!

Fabrice Bertile biologist and chemist at IPH

-What Is the current state of your research and what are your hopes?

Our main objective is to understand the molecular and physiological mechanisms that allow the brown bear to maintain its mass and muscle strength during hibernation. Indeed such kind of conditions (5 to 7 month of physical inactivity and fasting) are absolutely deleterious for humans.

We have been collecting several samples (blood, muscle, fat tissues) of brown bears living in the wild state in Sweden during two periods: winter time (hibernation) and summer (active period), since 2012. Few animals are sampled each year (maximum 5-7) and biopsies are very small (only 300 mg per animal).

After 4 years of follow up and analysis, we are known able to understand some physiological mechanisms in favor of muscle «preservation»: a special regulation of metabolic networks, a reduction of oxidative stress, and a possible recycling of nitrogen that could be linked to the intestinal microbiota of the bear during the winter period.

Beyond those molecular mechanisms that explains muscle preservation, one of our major finding and probably the most promising is the proof of the existence of circulating factors that could modify the resistance of muscle atrophy of the bear. This or those factors are also able to crossing the species barrier: they indeed induce muscle hypertrophy of muscle cells in vitro. The aim of our studies is to try to isolate those factors in order to create innovative preventive and therapeutic treatments to fight against human muscular atrophy.

Why did you study the bear? (There are many other hibernating animals)

There are indeed numerous other hibernating animals such as: reptiles, amphibians, wasps and mammals including woodchucks, hedgehogs, several rodents, bats and of course the bear. We study the bear because it has some characteristic that make it unique:

-While many hibernating species wake up occasionally to find some food, the bears sleep for several months without eating, drinking, urinating, or defecating.

The preservation of muscle mass during hibernation of the bears is outside the norm: they only loose about 20% of muscle mass during the first month but this loss remains stable during the other months.

-This "muscle preservation» is a paradoxe in the bear: the body temperature and metabolic rate are only slightly reduced during hibernation. This is different from other hibernating animals.

-The bear is a «big animal», thus the sample, even though there are restricted, are not going to disturb the animals, and are sufficient to perform many analysis.

-We are lucky to work with the teams of the "Scandinavian Brown Bear Research Project".

They follow and capture wild bears for over 20 years. So we have easily access to samples. This is the largest consortium studying the lives of wild carnivores such as bears in the world.

What does it evoke for you the bio-inspiration and biomimicry? How do you explain the current enthusiasm for this search.

I am a former biologist and after I specialized into analytical chemistry. This is very close to the world of engineering. Biomimicry and bio-inspiration therefore represent for me a bridge between the two domains. Analyzing and observe the living world and take inspiration form it to try to solve human problems is not really new! For exemple the flying machines designed by Leonardo da Vinci was inspired by birds and bats.oday, technological advances allow us to go one step further, and bio-inspiration opens the way to a new industrial revolution (renewable energies, new materials, new ways of transport). All this in a context of sustainable development and economy. Bio-inspiration is also the source of innovations in the Tbiomedical field: bionics, new drugs...

Biomimicry or bio-inspiration enriches not only engineering but also of human health and medical care. What the Nature has been developed over billions of years of evolution and contains some solutions to promote life and survival of man in harmony with nature and environment.

As a biologist what connections do you have with the medicine?

I have plenty of exchanges with medical doctors: they ask us for example to find new biomarkers for particular disease (i.e. an oncologist is part of our team since a few years). For the study of the bear we have a highly multidisciplinary team included veterinarians, oncologists, cardiologists, endocrinologists, diabetologists (bears do not suffer from cardiovascular or metabolic disorders despite the weight change during hibernation).Thanks to these collaborations I learned that even if the point of view of the biologist and medical doctor may seems different there are if fact complementary and the interpretation of the acquired data are strengthened and therefore more relevant thanks to those collaborative works

Interview
Amandine Aftalion

Running: Everything is mathematical?

A. AFTALION

Amandine Aftalion is mathematician (CNRS and researcher laboratoire de mathématiques de Versailles.)

"Galilean" Promise: the Nature is a book written in mathematical language. Therefore could the acuity of the mathematical equations allow us to understand everything, to optimize everything? This vision is probably a little too idealistic but it is sure that mathematics are a «beautiful toolbox» as Amandine Aftalion says. Even for physiology? Even to improve training of athletes? If, at first glance, physiology and mathematics seem almost diametrically opposed, this couple once formed can prove to be the happiest and more efficient. Of course, a bunch of equations is daily used in the laboratories of physiology but Amandine Aftalion goes further, much further. Nevertheless she assures that «these equations do not reach a phenomenal complexity level».

-In 2014 and 2016 you have published articles presenting a possibility to optimize the running by means of differential equation. Could you briefly explain that?

The idea of the model is based on two fondamental physics principle: the conservation of energy and the law of motion also called Newton's second law. The aim is, once a distance is fixed, to determine the instaneous velocity (the velocity at each time) to run this distance in the shortest time, given one' physiology. So the result is to tell you when to speed up and when to slow down to run your best race.

As a first step, assume that you have a magic way to know someone's maximal oxygen uptake, maximal force of propulsion, his total anaerobic energy, his friction coefficient, then the equations will yield the evolution of the velocity, anaerobic energy and propulsive force at each time to produce the shortest time to run a fixed distance. The interest of the model is also to show you, how, if you improve one of your physiological parameters by x%, how it will change your performance and your way of running.

The second step is of course to determine one's physiological parameters. This requires a good value of the maximal oxygen uptake, but the other parameters are computed using timesplits of a good run. This relies on the model and works well on the examples we have produced (champions on 100m, 400m, 800m and 1500m and intermediate runners on various distances).

[Health & Fitness/Photo: Liam Matthews, 2017/airsoftpal.com

-This research has changed your vision of the body and these abilities. If so, how?

My idea is that a lot of phenomena can be explained by equations.Concerning running, I do not have a specific vision of the body. I tried to understand by reading books and articles of physiology what were the most important componentsthat matter to describe the running. For example I understood that the mathematical models of maximal oxygen consumption (VO2) were not adequate. Then, using the physical principles that govern movement and energy, I tried to put all those elements into equations, taking into account the phenomena of feedback. It turns out that in the end the matching of the numerical results with the reality proves that the model is good.

-Do you think that everything is mathematical?

I do not know what you mean by everything and what you have in mind. But i do believe that good mathematical models can well describe a lot oh phenomena around us.

I am trying to include at the moment a system of two runners and the influence of the psychology. I do believe that it can be put into the equations.

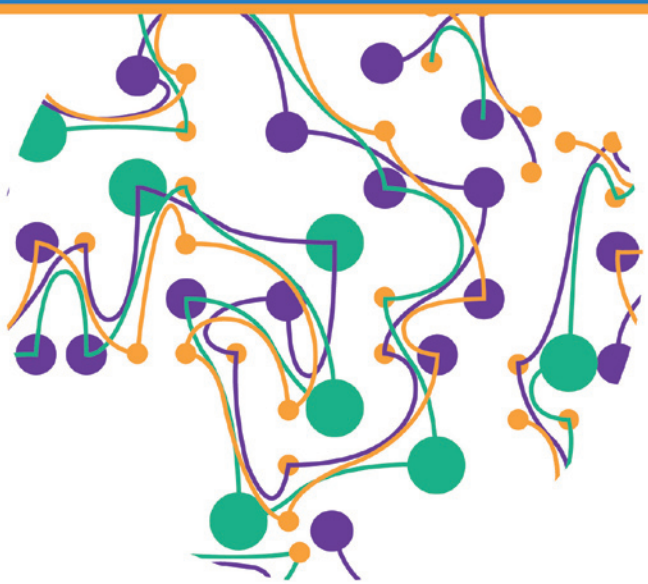
-For you the researchs in human physiology should automatically integrate mathematicians?

I often use a metaphor to answer this question: when you look at your table, in front of you, it does not move, though it is full of atoms and electrons and microscopic movement., but you do not care about all the atoms to understand that your table does not move. Concerning the movement of the runner, it is similar : you can analyze it using psychology, using bio mechanics, using physiology, and each of this science will help you understand some parts of the moment. From what i have seen up to now, research focus on very specific points: the gait, the way the foot is put on the floor, anaerobic energy, oxygen uptake. But in order to understand performance, you have to take all into account, and only mathematics can allow you to have this global view, at the right mesoscopic scale.

Health & Fitness/Photo: Liam Matthews, 2017/airsoftpal.com

FROM LAB TO PRACTICE

How to close the gap between research and patients?



From Lab to Practice

S. GOLDMAN

Head of Nuclear Medicine, Erasme Hospital, Brussels, Belgium

When dealing with disorders of movements and action, two different therapeutic approaches are often considered. They are usually presented as opposite, because the first one aims at the cure of the disorder at the origin of the dysfunctions (causal medical treatment) and the other essentially tends to alleviate the consequences of the disorder, whatever their cause might be (symptomatic functional treatment). In this dichotomous view, the medical treatment of motion dysfunction by pharmaceutical agents and the rehabilitation of the motion deficits appear independent. For a long time, the development of these two types of therapies has appeared to follow different routes. The pharmaceutical agents — either chemical, biological or cellular —are developed following the global rules of the pharmaceutical domain, starting from theoretical biological concepts, going to preclinical testing in academic or industrial laboratories, and ending with clinical evaluation and implementation in case of success. In the field of motion disorders, such a pipeline has led, for instance, to innovative and efficient immunotherapy for multiple sclerosis. Rehabilitation, on the other hand, seems to be developed on the field, by testing the immediate and long-term effects of physical procedures that emerge from the experience acquired. This dual representation of therapies for motion disorders has changed over the last years, mostly thanks to two types of bridges between the medical and the rehabilitation fields. First, both therapeutic approaches have adopted the use of "devices" for the treatment of motion dysfunction. When an electrode is introduced in the brain to modulate local and global brain activity, obviously we are in the medical domain since it involves a surgical intervention. But what about using an external stimulator? When the device is positioned on a muscle, it intervenes in a physical procedure, but when it is positioned on the scalp to stimulate or inhibit the activity of brain regions, how should it be considered? This ambiguity proves that the medical and rehabilitation worlds are now profoundly interfaced, in particular because sophisticated "devices" follow developments that resembles those of classical medical agents. These developments require theoretical frames, preclinical experimentation that deciphers and dissects modes of action, and structured validation in a controlled clinical set up. The increasing implication of the industry in the rehabilitation world — by introducing various types of devices and robots —, has prompted novel type of interactions of this world with academic and industrial laboratories. A second bridge between the medical and the rehabilitation worlds has been established by the use of common concepts and experimental supports for the development of their respective therapeutic methods. In particular, the extraordinary development of functional neuroimaging methods has modified our view on how diseases cause motion disorders. But neuroimaging methods also provide a better understanding of the functional consequences of these diseases, with direct effects on the recent evolution of rehabilitation methodologies.

Cognitive training in the real world: Research and application with mobile apps

E. MISIRLISOY

Games are fast becoming the best way to engage participants in online behavioural experiments and interventions. The challenge for scientists and clinicians is to develop cognitive tasks that are enjoyable and motivating for users. Outside of the lab, failure with this mission leads to high drop-out rates and low quality data. The best partnerships are often between industry and academia: applying academic principles behind cognitive interventions to industry-standard game development. This produces fun games that patients can use in at-home cognitive remediation and also attracts participants for large scale online studies or real world experiments. Peak (www.peak.net) are a company who develop cognitive training games. In this presentation, I will discuss the challenges and advantages of our approach to building a mass market mobile app inspired by the latest scientific work. I will describe how we use evidence in developing new games, and highlight some of our existing collaborations with academics around the world.

Figure 1: A: The 8 games used in this study. *(A)* Babble bots, *(B)* Word pair, *(C)* Memory sweep, *(D)* Size count, *(E)* Square number, *(F)* Must sort, *(G)* Unique, *(H)* Rush back

Cognitive impairment, a multifactorial problem screaming for attention, and the role of respiration in cognitive function

V. ANDRIANOPOULOS

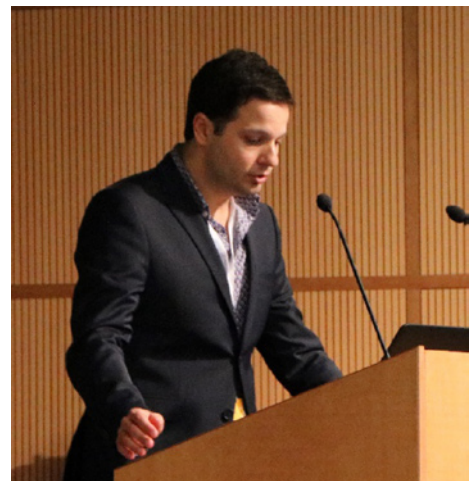
Department of Respiratory Medicine and Pulmonary Rehabilitation;
Schoen Klinik Berchtesgadener Land - Schoenau am Koenigssee , Germany

Cognitive impairment (CI) is a prevalent extrapulmonary manifestation in COPD. Potential disturbances in cerebral circulation and oxygen delivery due to reduced ventilatory efficiency and ventilatory drive may be associated with higher rates of CI. We assessed cerebral tissue oxygen index (TOI) and cerebral hemodynamics at exertion in COPD patient with and without CI.

52 COPD patients (aged: 68±8yrs; FEV1: 45±14%; 40%women) underwent a comprehensive cognitive assessment. Patients were assigned to "CI" and "non-CI" groups according to Montreal Cognitive Assessment (MoCA) cutoff score ≤25points. Patients performed cycle endurance test (CET) at 75% of peak work rate while transcutaneous carbon-dioxide partialpressure (TCPCO2), cerebral tissue oxygen index (TOI) and hemoglobin responses were recorded by SenTec and Portalite systems, respectively

23 patients (44%) presented evidences of CI (MoCA≤25) with also lower scores in other cognitive tests (all p <0.001). A correlation between TCPCO2 and cerebral oxygenated hemoglobin (O2Hb), and total hemoglobin (tHb) at the end of CET was detected (r:0.34, p=0.021; r:0.34 p=0.023, respectively). Oxygen saturation (SpO2) at the end of CET was not related with cerebral deoxygenated hemoglobin (HHb) and tHb. Patient with CI developed similar cerebral hemodynamic pattern and TOI compared to non-CI during CET.

COPD patients have the capacity to autoregulate cerebral cortex blood flow in response to hypercapnia and hypoxemia, at least during exercise, and thus to normalize cerebral tissue oxygenation. These findings suggest that exercise is safe and can be beneficial regarding to cognitive function in COPD.



From extreme environmental physiology to critical care

M. TIPTON

Professor of Human & Applied Physiology
Extreme Environments Laboratory
Department of Sport & Exercise Science University of Portsmout

Humans are air breathing, low altitude, 1 g, tropical animals. All but 15 % of the surface of planet Earth is water, mountain, permafrost or ice. Most of the planet is in constant darkness. Thus, despite our perception, most of Earth represents a hostile environment for humans. In order to visit or inhabit areas outside of the tropics humans have had to endure stresses, as well as physiologically and technologically adapt.

The investigation of the responses of healthy humans to extreme environments provides information on the physiological, pathophysiological and psychological impact of, and adaptation to, such environments. The same information can also provide insights into mechanisms that might help protect individuals when the threat to the body is trauma or disease rather than environmental stress. These mechanisms may then be deliberately evoked to help save lives or, at the very least, explain the variation in outcome between individuals in otherwise similar conditions in intensive care.

In his presentation Professor Tipton will briefly look at the response of the body to two conditions: drowning and altitude. He will examine the link between the responses to these stresses and possible interventions to avoid brain damage in conditions such as circulatory arrest and stroke. He will also discuss how an understanding of the response of healthy humans to altitude can help explain the variation seen in the response to pathology-induced hypoxia on intensive care.

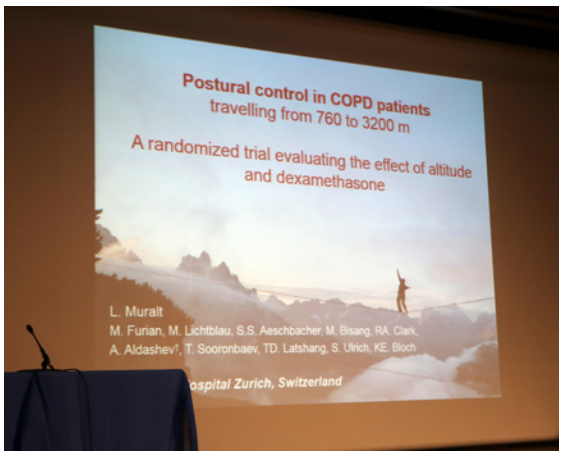
Reference
Tipton, M. J. (2015) GL Brown Lecture: "Extreme Threats" Environmental extremes: origins, consequences and amelioration. Experimental Physiology. http://onlinelibrary.wiley.com/doi/10.1113/EP085362/full

Postural control at high altitude in patients with COPD

L. MURALT

Departement of Pneumology ; UniversitätsSpital Zürich, University of Zurich

The ability to stand safely is essential at high altitude. Posture control requires the central nervous system and the sensory system and has been shown to be impaired with hypoxia in healthy people. Patients with chronic obstructive lung disease are at risk to experience more severe hypoxemia at altitude. The aim of this study was to evaluate effects of acute altitude exposure and of dexamethasone treatment on postural control in patients with COPD



Methods : 104 lowlanders with COPD, GOLD 1-2, age 20-75 y, living near Bishkek (760 m), were randomized to receive either dexamethasone (2x4 mg/d p.o.) or placebo on the day before ascent and during a 3-day sojourn at Tuja-Ashu (3200 m), Kyrgyz Republic. Postural control was assessed at 760 m and one day after arrival at 3200 m by letting patients stand on a WiiBalance BoardTM recording the center of pressure path length (PL) during 5 trials of 30 s.

Results : Ascending from 760 to 3200 m increased the PL in the placebo group from median (quartiles) 29.2 (25.8;38.2) to 31.5 (27.3;39.3) cm ($P<0.04$); in the dexamethasone group the change from 28.8 (22.8;34.5) to 29.9 (25.2;37.0) cm was nonsignificant ($P=0.10$). The mean difference between groups in altitude-induced PL change (treatment effect) was -0.3 cm (95% CI -3.2 to 2.5 cm, $P=041$). Regression analysis controlling for potential confounders confirmed an increase in the PL at altitude (coefficient 1.6, 95% CI 0.16 to 30.8, $P=0.03$) but no effect of the dexamethasone treatment on the postural control was found. (coefficient 0.01, 95% CI -3.8 to 3.8, $P=1.00$). PL changes were related mostly to antero-posterior sway. 22 of 104 patients had an increase in antero- posterior sway velocity of >25%, what is associated with a two-fold risk of falls in previous studies.

Conclusions In lowlanders with COPD traveling to altitude (3200 m) postural control was impaired 24h after arriving and this was not prevented by dexamethasone.

Research in Extreme Sports Medicine

F. FELETI

Hospital of Ravenna, Italy

This presentation on medicine as applied to extreme sports offers broad coverage of the field extending well beyond the usual focus on major trauma and acute injuries. In addition to the injuries and diseases associated with individual extreme sports, this book also addresses the topics of psychology, dermatology, ophthalmology, infectious diseases, physiology, nutrition, training, injury prevention strategies, rehabilitation, doping, treatment in hostile environments, and legal aspects. Innovative and less frequently considered topics are also discussed, such as recent advances in protective equipment and materials, the effects of exposure on whole-body vibration, and cold exposure risk management

Bio-inspired design of lower-limb prostheses

R. RONSSE

Center for Research in Mechatronics,
Institute of Mechanics, Materials and Civil Engineering (IMMC),
Insitute of Neuroscience, Université Catholique de Louvaint

Nature has always been a source of inspiration for man-made designs, so is it in medical robotics. In this talk, I will review several research projects being currently conducted at UCLouvain in the field of bio-inspired design for rehab and assistive robotics. The first focus will be put on the design of prostheses for the lower-limb. Human legs are actuated by muscles and some of these muscles span across several joints. Multi-articular muscles show the potential interest of transferring mechanical energy across joints during the different gait phases. We are developing a transfemoral (i.e. above-knee) prosthesis with a specific mechanism – based on a continuously variable transmission – to store and release mechanical energy during walking, and to optimally distribute this energy across the leg joints. Bio-inspiration is also of potential interest for the prosthesis controller. Copying the neuro-mechanical principles governing locomotion to an artificial device is expected to make it more intuitive to use for the patient, the artificial leg behaving like a biological one! Next, we will explore similar ideas for the assistance of the intact limb, i.e. through exoskeletons. Finally, we will discuss how similar concepts can be developed to support post-stroke rehabilitation for the upper-limb, in the particular context of rhythmic movement execution.

Sustainable development and motion therapy

C. ZAOUI

Biotechnologies & Environmental Sustainability Consultant
- Visiting Researcher at Université Catholique de Louvain

The biomimetic approach is a multidisciplinary design approach that relies on the observation and understanding of living systems' functioning principles to tackle environmental and social challenges. The expected outcome of this design methodology is the generation of innovative yet sustainable and regenerative solutions that remain compatible with the biosphere's mode of functioning. This general presentation aims at illustrating how the biomimetic approach could provide responsible innovations in the health sector by putting into context the three pillars of the approach: innovation, sustainability and reconnexion. More specifically, innovation will be illustrates via the latest biomimetic examples in "red" biotechnologies, sustainability will be addressed through the issue of the life cycle of healthcare materials and devices, and the reconnexion pillar will seek to provide the audience with an outlook about biophilia, its links to well-being and thus its possible use in therapy.

After the completion of an academic curriculum in Life Science (PhD in Microbiology from the Hannover Medical School in Germany), Caroline Zaoui is now working on biomimicry R&D projects in the environmental sector, previously as a work package leader within the FP7 CO2SolStock project at Greenloop's (Brussels) and now as co-founder of the start-up Novobiom for the development of bio-inspired environmental technologies. She is also co-founder of the asbl Biomimicry Belgium, which aim is to map and consolidate the network of biomimicry professionals in the academic and private sectors in Belgium.

BIOMIMICRY Belgium

The physiology of « exotic species »: When bio-inspiration helps to better understand human metabolic diseases

F. BERTILE

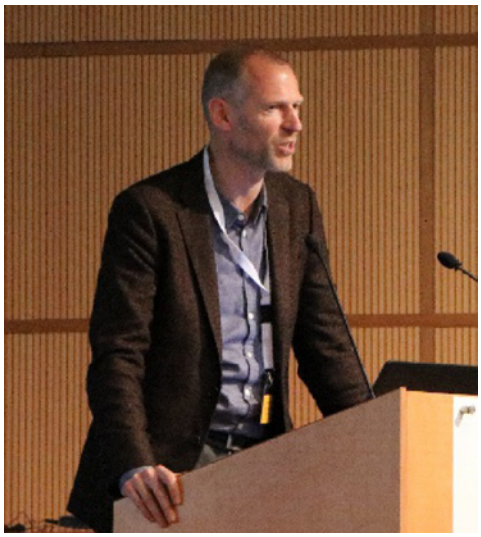
Université de Strasbourg, CNRS, Institut Pluridisciplinaire Hubert Curien, UMR 7178, Strasbourg, France

There is currently an increasing biomedical interest in translational approaches 'from wild animal adaptations to human therapeutics'. Biodiversity indeed offers numerous 'exotic' animal models that allow not only understanding new mechanisms that permit wildlife to succeed where humans would fail, but also identifying new therapeutic strategies for humans. Examplesencompass the study of ageing mechanisms in bats and ants, cancer-resistance in mole rats, obesity reversibility in the grey mouse lemur and anti-obesity mechanisms in voles, and discovery of new antimicrobial molecules in Antarctic penguins. Of the main modern pathologies affecting human health, muscle atrophy is not only observed as a consequence of ageing and disuse, but it is also associated with fasting and several diseases. Although basic knowledge regarding the underlying mechanisms of muscle wasting is continuously growing thanks to studies in laboratory rodents and clinical trials, there are still no efficient therapeutic strategies for its prevention and treatment. Hibernating bears are a model of choice for bioinspired strategies to fight human muscle atrophy. They exhibit a strong and unique ability to preserve muscle mass in conditions (fasting and physical inactivity) where muscle atrophy is observed in humans. From the study of metabolic networks regulation, oxidative stress, and nitrogen recycling in winter versus summer bears, we have identified a series of mechanisms that contribute to muscle sparing in bears. We have recently shown that the bear blood contains still unknown factors that are able to control protein balance in human muscles, thus crossing the species barrier. Using a combination of large scale (transcriptomics, proteomics) and targeted (enzymatic activities, signalling pathways) approaches, we notably found that winter bear serum induces molecular events in human myotubes that all mimic those that are elicited in bear muscles during hibernation, including regulation of protein content, substrate and energy metabolism, and tissue remodelling. By inducing a hibernation-like phenotype in human muscle cells, winter bear serum thereforeholds potential for developing new tools to fight human muscle atrophy and related metabolic disorders. Our next step focuses on bear serum composition, with the aim to identify circulating factor(s) specifically present or enriched in winter bear serum that could be involved in the observed effects.

REVAL Research Center (UHasselt)

Technologically-supported rehabilitation in neurological and musculo-skeletal fields

P. FEYS



Within all domains, research questions can be situated on the level of applied clinical research, closely related to clinical practice, and on the level of underlying mechanisms (immunological, neurophysiological, anatomical, motor learning, metabolic). Besides, REVAL includes biomechanical and health psychological research supporting the domains listed above. REVAL is an European leading center in MS physical rehabilitation as well as cardiometabolic and COPD rehabilitation. It is involved in the relevant European organizations in these listed domains. REVAL is also recognised for its methodological expertise in non-invasive brain stimulation, this resulted in bilateral cooperation with international experts in this field and is also known for research on imitation in autism. More recently, REVAL is having an increased (inter)national reputation in technology-supported physical rehabilitation, also thanks to thecollaboration with EDM and Eindhoven University of Technology. Due to demographic changes, and an increase in chronic health conditions, there is an increasing need for efficient and motivating treatment strategies. This lecture summarizes the potential of technological applications for motor learning andautonomous exercise, and for improving the function, activities and participation levels during musculoskeletal and neurological rehabilitation. Effectiveness studies also chart the effects of rehabilitation with the various technological applications.

MOBILAB
@THOMAS MORE

Applied Rehabilitation & Orthopedic research in Mobilab

L. DE MAESSCHALCK

This lecture will highlight the working of Mobilab. Mobilab is a multidisciplinary centre of expertise, that conducts human-centered, leading and innovative applied research into wellbeing and technology. Our activities create a socially relevant synergy between research, education and practice, aimed at improving quality of life and wellbeing. Mobilab conducts research, starting from a multidisciplinary approach. We aim to make connections between technology and health, working closely together with the field. The applications of our research are aimed at quality of life, specific needs in sports, care and rehabilitation, and the development of diagnostic and therapeutic tools. Therefore, Mobilab conducts research into thefollowing fields:

1. Biomedical technology: aimed at long-term and comfortable monitoring of physiological parameters.
2. Sports- and rehabilitation technology: aimed at smart adaptive aids, assessment tools, compliance and tele-rehabilitation.
3. Orthopaedic technology: research into the improvement of ortheses and prostheses, by means of e.g. modeling and mechanical testing
4. Ageing in place: focused on the implementation of technology in domestic situations.

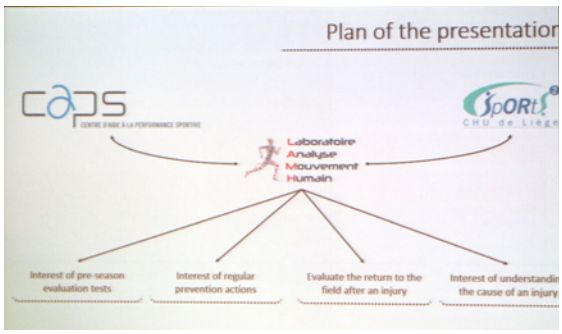
Our gait lab allows for extensive motion and gait analyses within several domains such as sports, ergonomics, orthopaedics and rehabilitation, and in clinical and pathological research. There is a line-up for motion and gait analysis, in which subjects can be filmed at high speed by 4 high speed cameras from different angles. Dynamic 3D-scanning of the foot is also possible at our gait lab. We have a system to measure contact pressure, e.g. to measure the contact pressure between stump and socket of a prosthesis. End of 2014, we purchased the Diers Formetric 4D, which is used to measure the human back, spine included, optically. Our robotic gait simulator, to conclude with, has been developed specifically to test prostheses or shoes.

LAMH

The motion analysis: a prevention tool

C. SCHWARTZ

The Laboratory of Human Motion Analysis (LAMH) is a multi-disciplinary entity including physiotherapists, physical trainers and engineers. One of our main topic of interest concerns the prevention in sports. The LAMH has a strong relationship with the university hospital of Liège. The LAMH is also involved in the evaluation of various high level athletes of the Belgium French community (including tennis, football, ski and athletics) and is a member of the interuniversity association "Centre d'Aide à la Performance Sportive". Because of our implication in these two « field » entities, the LAMH has a strong will to transfer our researches from the lab to the field. The LAMH has an expertise in the quantification of various biomechanical parameters including 3D kinematic analysis of the complete body, muscle activity, maximal muscular strength quantification.



Among others, the neuro-muscular and kinematic factors can have a strong role in the injury risk of athletes. On Friday, the presentation will focus on four applications of motion evaluations for prevention:
1) the interest of pre-season tests,
2) the interest of regular prevention actions,
3) the interest of an evaluation before returning to the field after an injury
4) the interest of understanding the cause of an injury

Laboratoire
Analyse
Mouvement
Humain

BRUBOTICS

Improving quality of life through Human-Centered Robotics

D. LEFEBER

BruBotics is a multidisciplinary consortium of 8 research groups of the Vrije Universiteit Brussel (VUB), performing research on Human Robotic technology. Funded by the Flemish Industrial Research Fund (IOF), BruBotics aims to stimulate cross-disciplinary research and bridge the gap between academia and industry and society. Together these research groups have the goal and vision to develop Human Robotic Technology to improve the quality of life and working conditions of people.
By combining over 80 scientists from disciplines as diverse as ageing studies, robotics, social studies, human physiology, artificial intelligence, neurological rehabilitation, eHealth, mechatronics,...working on topics as wide as exoskeletons, collaborative robots, social robots, actuation, bionic prostheses, self-learning systems and many others, BruBotics is able to go much further in fulfilling its vision.

With over 35 European H2020 and FP7 projects, an ERC grant and dozens of Belgian FWO, Brussels Innoviris and Flemish SBO's and ICON projects running, the BruBotics research groups have a strong track record of performing top-notch research at the highest level.

LABO

Clinical and research activities in fonctional evaluation

S. VAN SINT JAN

Functional evaluation is closely related to physical rehabilitation since patient follow up is compulsory to guarantee an organisation of the therapy schemes according the individual needs of the patients.

However, two problems coexist in Clinics:
1- many functional evaluation methods do not reach daily clinical practise despite important efforts by researchers in the field because of a lack of practical knowledge;
2 - many clinicians shows limited interest for true scientifical methods because of a lack of time or understanding of the tools values to increase the quality of therapies.

The problem is clearly provoked by a lack of communication between researchers and clinicians. Without proper communication, definition of a common ground and experience sharing, the gap between both communities will persist.

It is however in the interest of both parties to make an effort to increase such communication. This will allow researchers to develop methods properly answering real clinical needs, while clinicians will have access to methods and access that are well-suited for their daily practice.

This presentation will present the LABO experience in this context and will call upon more communication between researchers (in need of clinical problems to solve) and clinicians (in need of solutions for their clinical problems). This win-win situation will entirely benefit the patient's progresses.

LABO ULB

EOPL

From Breath-hold diving to the patient's bed: the normobaric oxygen paradox

C. BALESTRA

Using intermittent hyperoxia to stimulate EPO has been coined the "normobaric oxygen paradox". First described after breath-hold diving, hypoxia as a trigger was questioned sincesuch short deep dives were not hypoxic enough to trigger EPO production.

The maximal pressure reached was 5 ATA, or 1 ATA of Oxygen the same amount of oxygen was administred in laboratory conditions to measure whether the return back from the increased oxygen partial pressure was considered by the body as a drop of oxygen in the tissues and thus leading to an increase in EPO.

Being both a hormone and a cytokine the actual action for EPO are complex; it's clinical utility has been postulated for neuroprotection and cardioprotection as a preoperative treatment as well as in the treatment of sepsis patients.

The repetition of this simple stimulus has been used to increase hemoglobin and reticulocytes in anemic patients.

Under normoxic conditions, the hypoxia Inducible Factor 1 alpha, (HIF-1 alpha) is hydroxylated by prolyl-hydroxylase. This results in ubiquitylation by the Von Hippel Lindau tumour suppressing Protein (VHLp) and finally in the degradation of HIF-1 alpha in the proteasome. In case of limited availability or absence of reactive oxygen species, the HIF-1 alpha will not link with VHLp and thus can be dimerized with the HIF-1 beta. This HIF complex can thus bind to target promoters known as hypoxia responsive elements leading to the transcription of the erythropoietin gene as well as many other genes involved in cellular metabolism.

Increasing the level of oxygen breathed by the patient will enhance the production of protective agents against oxygen reactive species (ROS); this will be achieved by increasing the glutathione synthethase enzyme activity.

This enhanced activity will thus increase the glutathione production and subsequently ROS scavenging. During the hyperoxygenation period, an increased stock of reduced glutathione (GSH) will be formed. After cessation of hyperoxygenation, this increased stock of GSH, together with the (slow) reduction of GSSG to GSH, produces an excess of this complex and allows the enhanced scavenging of ROS to last longer after oxygen level reduction with concomitant reduction of ROS availability reaching "hypoxic" like levels.

Louvain BIONICS

UCL center of interdisciplinary expertise

B. HERMAN

Louvain Bionics is an interdisciplinary center of expertise created in 2014 thanks to the legacy of Pierre De Merre through the Fondation Louvain. The objective of Louvain Bionics is to unite the talents of UCL researchers from the three sectors – science and technology, medical sciences and humanities sciences – who are interested in questions of movement and robotic assistance, to enhance knowledge and skills in areas such as surgical assistance, and diagnosis and rehabilitation. The ambition of Louvain Bionics is to allow the patient to benefit from the best research advances in robotics science and technology, and more generally, bionics. For this, the role of Louvain Bionics is to identify, encourage and develop innovative collaborative projects that address a variety of issues relating to health. Louvain Bionics brings together multidisciplinary research teams (engineers, medical doctors, physiotherapists, neuropsychologists, philosophers etc.) responsible for the design and validation of prototypes. Furthermore, it aims to provide, in close collaboration with the OpenHub, a laboratory for the orientation and training of both designers (engineers) and users(clinicians, academics, scientists), in order to develop innovative know-how in medical practice, using the available devices.19 The main advantage provided by Louvain Bionics within a comprehensive university such asthe UCL is to investigate andvalidate medical devices «from bench to bedside», that is to say, from the laboratory to bedside, by a process of translational and multidisciplinary research based on constant interaction between designers and users. The devices can then be improved based on practice in the field and customized by taking into account the specific needs of patients and clinicians

LOUVAIN BIONICS
center of interdisciplinary expertise

Serious gaming platform for physical rehabilitation

O. LUBOS

FeasyMotion is a potential spin-off company from ULB and VUB on a comprehensive toolset for improving physical rehabilitation, targeting individual patients, therapists, rehabilitation centers and clinical trials with methods for low cost motion capture and analysis and game based rehabilitation tools.

Ambulatory system for gait analysis

M. BOUTAAYAMOU

We describe the principle and use of a wireless, 3-axis accelerometer-based ambulatory system that records acceleration signals and automatically analyses them to characterize normal and pathological gait. The associated algorithm is versatile enough to detect, on a stride-by-stride basis, refined gait parameters that quantify subtle gait disturbances in, e.g., in Parkinson's disease in a rater-independent way. The experimental results show the potential of the developed accelerometer-based technique to be used in neurology (e.g., characterization of Parkinsonian gait: slowness, shuffling, short steps, freezing of gait, asymmetries in gait), rehabilitation, geriatrics (ex. monitoring activity parameters in the elderly), orthopedics and sport..

An intelligent knee brace to monitor knee angles of users during physical activities, such as sports or rehabilitation exercices

R. SELS

Mobilab will demonstrate a validated intelligent textile which is capable of measuring knee angles of users during physical activities, such as sports or rehabilitation exercises. The smart textile is equipped with sensors and embedded electronics to condition the signal and transmit data wirelessly to a smartphone app. The smartphone app delivers direct feedback to the user about the quantity and performance of the exercises. It will also send the information to a central cloud solution, which is accessible for coaches and medical experts.

MOBILAB
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Hypoxic conditioning : a new therapeutic opportunity?

S. VERGES

While hypoxia is a well know deleterious mechanisms involved in many pathological conditions, some data suggest that repetitive exposure to moderate hypoxia (i.e. simulated altitude) may induce cardiovascular, metabolic and neurological adaptations and represent a new preventive or therapeutic strategy for several diseases. This presentation will describe the current knowledge and practical modalities for hypoxic conditioning strategies.

Producing prosthetic and orthotic devices with the additive manufacturing techniques: tips and tricks

V. CREYLMAN

Making patient-specific orthopaedic products (e.g. foot orthoses, ankle-foot orthoses, prostheses and braces) involves several steps: collection of patient-specific properties, designing the orthopaedic device and producing the device. Mobilab will present tips and tricks on how "new" techniques like 3D-scanning and additive manufacturing can be applied in orthopaedics to improve reproducibility, reduce production time, improve mechanical properties and increase design freedom.

MOBILAB
@THOMAS MORE

Just a new health

J. HARFOUCHE

Just a New health is the owner of the PeriKit (Belgian patent and worldwide patent pending) and the inventor is Dr. Joseph Harfouche. This device is designed to take accurate and reproducible measurements (circumferences) on the limbs. It can be used in different fields: medical (neurology and lymphology), health (sport and diet) to assess the evolution and to define programs accordingly. Compared to other measurements tools used on the market, PeriKit is able to take, accurate and reproducible measures thanks to its patented elements, and being affordable at the same time. Taking measurements in the treatment of lymphedema is fully part of the treatment because it helps monitoring and assessing the edema in order to adapt the treatment, follow up the results and provide information to healthcare insurance. The measurements can be saved, using the PeriKit App and then compared to the previous ones and displayed in a graphic showing the evolution. Thanks to the PeriKit, the patient /sportsman... is from now on able to monitor his limb dimensions and can send info to his therapist / coach that can help him taking the good decision depending on the result Besides, the digital version of Perikit can improve the time needed to take the measurements asit records them automatically in the app or on the computer.

PeriKit

Personalised support for remobilising the body

M. TELLER

Initially born out of research in algology, Arturo has evolved into a solution to help physiotherapists follow up their treatments and their patients' progress in an easy and userfriendly way. Because everybody knows each patient is unique, Arturo fits your patients exercise programs, comfortably.

The moveup digitam coach for personalised hip/knee rehabilitation

C.-E. WINANDY

moveUP offers a fully personalized tele-rehabilitation solution for patients and their stakeholders, offering higher satisfaction, better outcome, lower costs and quicker rehab. Based on data collected pre-surgery (baseline measurements, personal and medical profile of the patient) and perioperative (type of implant, complications, anaesthesia, ...), the solution sets out the ideal rehabilitation path. During the rehabilitation, data is provided by a smart wristband and by the patient (via PROMS). Based on these, the software automatically proposes a certain type and level of exercises / activities

Cognitive training

E. MISIRLISOY

Our mission here at Peak is to make lifelong progress enjoyable. We believe there's always a little room for improvement, and we should strive to better ourselves bit by bit. That's why we use a combination of neuroscience, technology and fun to get those little grey cells active and striding purposefully towards their full potential.

HBIM
Posters

Matti: an interactive rehabilitation mat

J. LERNOU [1], P. MAES [2], J. JOUNDI [2], F. WYFFELS [1],
S. VERSTOCKT [1], J. SALDIEN [2]

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Rehabilitation exercises can be very demanding for children and traditional techniques/ tools are often passive elements which are not adapted to them and difficult to control. Therefore we introduce Matti, an interactive gaming mat used in the context of rehabilitation at the physiotherapist. Our main goal is to increase the motivation of the child by linking exercises with digital games. In this way, therapy becomes more fun and the motivation and performance of exercising during rehabilitation increases. Furthermore by making the mat open-ended, the exercises can be adapted to the patient needs. Afterwards, it is also possible to analyze the results of the exercises.

As demonstrated in [1] the key areas for improvement in rehabilitation are motivation, customization and independence. By implementing gamification during practice it is possible to stimulate desired behaviors and raise motivation [2]. During practice it is important to do different workouts that will be supported by various games. By giving kids a clear goal in a computer game and a tactile, adaptive interface on a mat used as a controller, they understand the purpose of their exercises and know how to interact with the gaming mat. In this way the children are motivated to do their best.

Because of the variations in ergonomics, each series of exercises will be dependent on the user. For this reason, we support customization of the mat to the specific training needs of the patients, i.e., the physiotherapist can easily set up the game so the exercises are done correctly (in a controlled or independent way). Similar open input setups are discussed in [3]. Furthermore, by logging all the locations and pressure levels, feedback is displayed to the patient during the exercise and the physiotherapist can subsequently analyze these data and adapt the practice on these results. This interactive infrastructure ensures the physiotherapist can continuously monitor their patients and follow their progression.

1] A. J. Bongers et al.,Interactive Infrastructures: Physical Rehabilitation Modules for Pervasive Healthcare Technology, Pervasive Health: State-of-the-art and Beyond, pp. 229–254, 2014.
[2] K. Harman et al., Scholarly interest in gamification: a citation network analysis. Industrial Management & Data Systems, 114(9), pp. 1438–1452, 2014.
[3] A. Hochstenbach-Waelen et al., Tag-exercise creator: towards end-user development for tangible interaction in rehabilitation training. 4th ACM SIGCHI symposium on Engineering interactive computing systems, 2012.

An explorative study regarding attitudes towards the use of robots by physiotherapists

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Introduction: Although robot technology is increasingly being implemented in rehabilitation, only few studies focus on patients' perspectives of robot-assisted therapy1,2 and studies investigating physiotherapists' opinions are even more limited3,4. A better understanding of physiotherapists' views and concerns could, nevertheless, improve the care process and the outcomes of robot-assisted therapy. This study contributes to the limited existing research by further exploring attitudes towards the use of robots in physiotherapy.

Materials and Methods: Ninety-two participants (35.0±13.4 years old; 44.6% male) completed a survey with 18 questions. 25.0% were physiotherapy students (54.6% masters), others were physiotherapists with varying amounts of work experiences (35.9% > 15 year) and working in different settings (65.2% in private practices). The objective of the survey was to collect background information prior to the interviews about their attitudes and experiences regarding the use of robots at work[5]. Purposeful sampling was used to recruit participants with varying degrees of work experience. SPSS 24 was used for data analysis.

Results: 14.1% of the participants had used a robot at work before, 20.7% had used one at home, and about 2/3 (65.2%) had never used a robot before (neither at work nor at home). 83.7% of the participants had a positive idea about robots in general, but 55.4% believes that a robot will not be capable of doing a physiotherapist's work in the future (20.0% of the students and 69.8% of the physiotherapists). Nevertheless, 39.1% thought a robot could partially do their job as a physiotherapist (70.0% of the students and 30.2% of the physiotherapists). These percentages were significantly different between students and physiotherapists (Chi2 test $p<.001$).

Conclusion: The results suggest that (future) physiotherapists generally have a positive view of robots. However, physiotherapists in the field are more critical towards robots performing physiotherapy activities. In future work, we will analyse the interviews to understand the perceived benefits and concerns of the use of robots in physiotherapy.

1. Vanmulken et al. Spinal Cord, 53(7); 547-551, 2015
2. Phelan et al. Disabil Rehabil, 37(24): 2272-2281, 2015
3. Swinnen et al. Topics in Stroke Rehabilitation, 2016
4. Kang et al. J Phys Ther Sci; 28(1): 202-206, 2016
5. Special Eurobarometer 427 / Wave EB82.4 - Autonomous systems, 2015

Reproducibility of the evolution of stride biomechanics during exhaustive runs

G. MARTENS [1,2], D. DEFLANDRE [2], C. SCHWARTZ [2,3], T. BURY [2]

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3 Laboratory of Human Motion Analysis - LAMH, University of Liège, Liège, Belgium

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Introduction: Running biomechanics and its evolution through intensive trials is widely studied. However fewer studies focused on the reproducibility of the stride evolution in these runs. The purpose of this investigation was thus to assess the reproducibility of biomechanical parameters evolution during exhaustive runs, using three-dimensional analysis.

Materials and Methods: Ten male athletes (age: 23 ± 4 years; maximal oxygen consumption: 57.5 ± 44 mL02.min-1.Kg-1; maximal aerobic speed: 19.3 ± 0.8 km.h-1) achieved a maximal exercise protocol. Three to 10 days later, 3 time-to-exhaustion trials, spaced by 7 days, were performed at 90% of the individual maximal aerobic speed. During these trials, 8 biomechanical variables (i.e.: swing duration, stance duration, stride frequency, step length, reactivity, foot orientation, vertical and lateral amplitudes of the center of mass) were recorded for 20 seconds every 4 minutes, until the runner's exhaustion. The evolution of a parameter over a trial was represented as the slope of the linear regression of these parameters over time. The reproducibility was assessed by intraclass correlation coefficients (ICC). Variability of these measurements was quantified by standard error of measurement (SEM).

Results: Five out of the 8 variables' evolution (swing duration, stride frequency, step length, center of mass vertical and lateral amplitudes) showed moderate to good reproducibility ($048 \leq ICC \leq 0.72$) while the evolutions of stance duration, reactivity and foot orientation showed poor reproducibility ($-0.71 \leq ICC \leq 0.04$). The SEMs were relatively low regarding the mean values of each parameter but were higher when converting these values into slopes.

Conclusion: Evolution with fatigue of stride biomechanics does not show an extensive reproducibility but appears to benefit of a satisfying stability regarding swing duration, stride frequency, step length and center of mass motion.

IntoAction: Insole tools for active learning and prevention

K. CUPPENS, M. BROECKX, T. SAEY, E. DE RAEVE, I. VAN DEN HERREWEGEN, L. MURARU, V. CREYLMAN

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Introduction: The design and production of custom made foot orthoses requires an extensive expertise. Building this expertise takes time, mostly by treating patients in practice. In recent years, clinical studies provide more insight and give recommendations for the design of orthoses for specific pathologies. This scientific information is only transferred to the orthopedic field at a relatively slow pace. Non-sedentary employees often have to deal with a high loading on their locomotor system. They are more prone to overuse injuries, or other pathologies where custom made foot orthoses can help. The link between the health issue and therapy is not always clear, and they are not always identified at an early stage.

Materials and methods: We propose two tools that support the foot experts to design foot orthoses, and the patients for the screening of pathologies related to the locomotor system.
In the first tool, the foot expert will be able to select a pathology, where he gets an overview of the current state-of-the-art in the scientific literature and common practice. This helps the less-experienced, starting clinician to gain more insight in which adjustments to make to the custom made foot orthosis, but it also helps the experienced foot expert to critically evaluate his design, and compare it to what his peers are doing, and what is proposed in literature or what (international) guidelines propose.
In the second tool, an employee is screened in different stages. In the first stage, he fills out a questionnaire assessing factors that lead to a higher risk of having health issues related to the locomotor system. When an increased risk is identified, he is forwarded to the company doctor, who performs a more thorough analysis.

Results: We focus on two specific pathologies, namely plantar fasciitis, and lower back pain. Literature shows that there is evidence that the use of foot orthoses can help in the treatment of plantar fasciitis [1]. We are developing the two tools as an app that is working on a tablet of smartphone. The screening tool will be tested in companies with non-sedentary employees such as warehousing or manufacturing companies. This will happen in collaboration with external prevention services companies, who have expertise in occupational health.

Conclusion: We propose two tools that are under development to aid the starting clinician in building expertise, and get more insight in de scientific advancements, and a second one to screen non-sedentary employees for health issues where the application of foot orthoses can help.

[1] Martin, R. L, et. al. Journal of Orthopaedic & Sports Physical Therapy. 44 (11), p A3 – p A33 (2014)

Endurance testing of additive manufactured orthotic and prosthetic appliances

L. MURARU, T. SAEY, E. DE RAEVE, M. BROECKX, K. CUPPENS, V. CREYLMAN

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lintroduction: Although the advancements and benefits of additive manufacturing (AM) for custom orthoses and prostheses are now well documented [1], technological aspects of the manufacturing process and clinical implications of the implementation process need to be addressed for full-scale integration of AM in a service system fo custom orthoses and prostheses. Mechanical testing of such devices is an important step prior to clinical testing to assure mechanical requirements are met. The aim of this abstract is to present protocols for bench testing of additive manufactured ankle foot orthoses (AFOs), prosthetic sockets for transtibial amputees and foot orthoses (FOs).

Materials and methods: Rigidity and endurance assessment of one printed AFO was performed within a static and dynamic test bench, respectively. AFO rigidity was estimated by measuring deflection of the shank under loading with different standard loads. In the dynamic rig, the AFO was attached to a prosthetic limb, tailored to the size of the test subject's leg. The ankle was rotated to 10° dorsiflexion and 15° plantarflexion for 5 000 000 cycles. After every 500 000 cycles the AFO was tested in the static rig, to measure the stiffness. Endurance testing of one printed transtibial socket was performed with a robotic gait simulator. The robot was programmed to mimic gait of transtibial amputees as measured in the gait lab [2]. The socket was attached to the robotic arm through an artificial stump and loaded for 1 000 000 cycles. Compression stiffness and endurance of FOs were quantified with a texture analyser and with the robotic gait simulator, respectively. Certain displacements were applied with the texture analyser on the surface of the foot orthosis in different points of interest, with known speed, while the applied loading was measured. Furthermore, the FOs were loaded for 210 000 steps in the robotic gait simulator while simulating gait of a healthy subject.

Results: For now, durability of one printed ankle foot orthosis and of one printed socket were verified and properties of one pair FOs were quantified. The AFO sustained 5 000 000 cycles and showed limited variation of rigidity over the tested period. The transtibial socket sustained 1 000 000 cycles. The FOs sustained 210 000 cycles; variability of compression stiffness over the tested period is now being analysed.

Conclusion: Protocols for bench testing of additive manufactured orthotics and prosthetics appliances are presented in this abstract. Positive (preliminary) results demonstrate valuable properties of the printed devices.

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Smart Clothing for Heart Rate Variability Measures in Military

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Variations in heart rate can be evaluated by several methods and measurements instruments. Smart clothing offers the opportunity to monitoring soldier's physiological status in an intrusive and ecological approach. Intensive military training, missions, fatigue can create Post Traumatic Stress Disorders (PTSD) and Physical Exhaustion (FPE) on soldier's performances.

Heart rate variability (HRV) is a physiological measurement of the autonomic activity of the heart. The autonomic nervous system actively compensates for injury or fatigue by modulating the balance between parasympathetic and sympathetic cardiovascular control mechanisms.

The collaboration between the Politecnico di Milano, the Belgian Royal Military Academy and the Military hospital Queen Astrid aims at developing a smart cloth for monitoring soldier's physiological status based on a wearable textile electrodes ("textrode") technology for ECG measurements.

Heart rate variability measurements in time and in frequency domain were extrapolated through a MATLAB algorithm that works offline on time intervals between successive heartbeats from electrocardiographical (ECG) recording collected by the two textrodes embedded on the cloth.

The innovative marks of the study stem not only from the ability to optimize the evaluation in terms of human resources and in a non-invasive way for humans but also from the possibility to implement a new assessment for the evaluation of soldier's physiological status.

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