

# Move to the beat of the music

- ★ There is a strong link between music and movement, which can be used to both boost sporting performance and aid the rehabilitation of patients with Parkinson's disease. The BeatHealth project aims to exploit this close link by creating an intelligent technological architecture, as project coordinator **Professor Benoît Bardy** and scientific manager **Professor Simone Dalla Bella** explain

**There is known** to be a very strong link between music and movement. Music compels us to move, and as such can be used to both aid rehabilitation and boost sporting performance, areas that the BeatHealth project is exploring. "The ultimate goal of the BeatHealth project is to create an intelligent technological architecture, in the form of a downloadable app delivering rhythmic music to boost or improve movement. The app is connected to sensors and sends data over the cloud. We want the functions of this app to be 'science-driven', meaning that they exploits the natural link between movement and music in a way that is validated by science," says Professor Benoît Bardy, the project's scientific coordinator. Researchers are investigating why music has these beneficial effects, and how they

can be harnessed. "The usual way to answer this question is to say that music acts as a distractor, from pain or effort. Secondly, it is thought to be motivational," explains Professor Bardy. "So it's motivational to run to music or to walk to music, whether a person is suffering from Parkinson's disease or is training for an athletic event. However, we believe they are not the only reasons. The main reason is that music acts as a natural synchroniser."

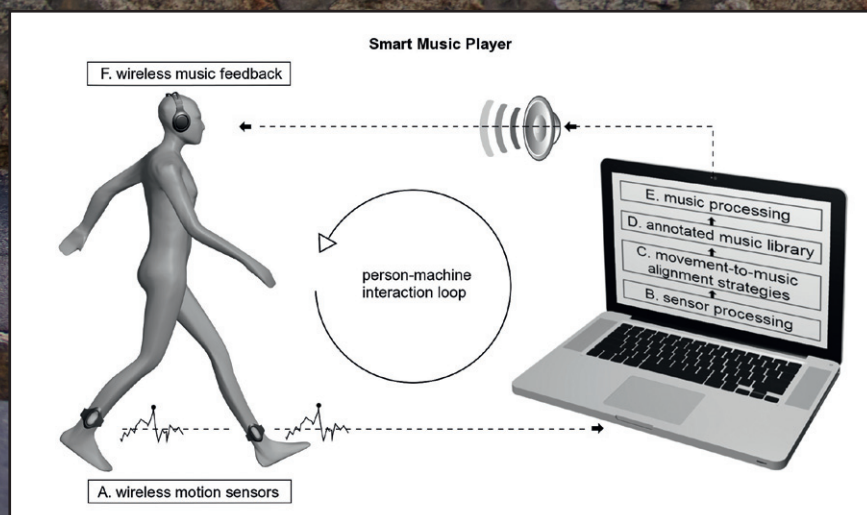
## Biological systems

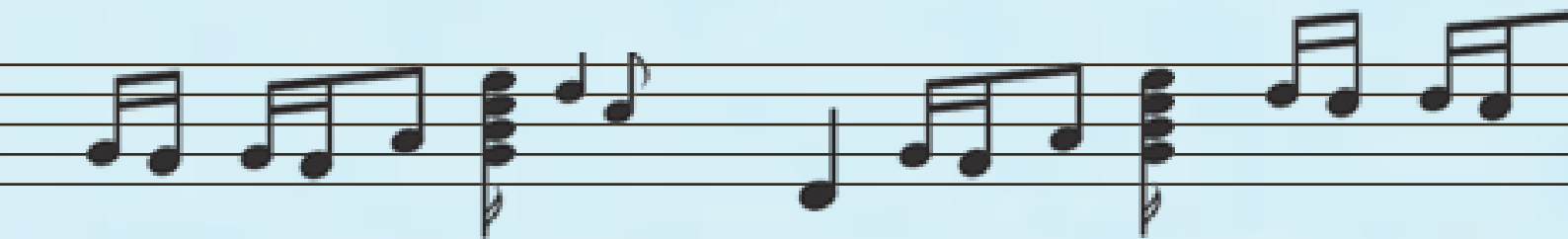
This is a key concept in the BeatHealth project. Professor Bardy says that if music can be used to synchronise the rhythm of different biological systems, such as breathing and running, then a range of potential health applications are opened up. "We say; if this is true, then music can stabilise the way you walk,

and the way you run. So we can exploit this link, which is hard-wired in our neurology, in both performance and rehabilitation," he explains. The intensity of exercise varies widely though, so it can be difficult to maintain synchronisation between different systems. "Take cycling – when you start cycling uphill you change your frequency and you lose the music," points out Professor Bardy. "When this happens, then instead of stabilising and acting as a synchroniser between biological systems, the music acts as a de-synchroniser between systems. Instead of stabilising the system it starts unbalancing the system. This is why some runners, cyclists and rowers do not like to listen to music. There is this changing regime all the time during which you either gain or lose synchrony."

The project aims to overcome this

The current BeatHealth architecture (image by Ghent University).





challenge by further developing existing technologies – such as the D-Jogger system originally conceived at Ghent University in Belgium, a project partner – which adapt the rhythm of the music to different physiological rhythms, whether an individual is walking, cycling or running. The goal is to maintain constant synchrony, within a certain beats per minute (BPM) range. “You cannot move rapidly from 50 BPM to 200 BPM for example. The system basically has a 10-20 percent signal alignment, in order to maintain the synchrony,” outlines Professor Bardy. In the case of running, the technology detects when the individual’s foot is on the ground, which it uses to align the music to their BPM; the system also gathers and uses other information to maintain synchronisation. “The architecture will gather a limited amount of information on an individual, for example on their physiological status, heart rate and movement dynamics. This information will be used to adapt the music in a specific way in order to maximize walking or running efficiency and hence treat movement disorders,” continues Professor Bardy.

### Parkinson's disease

This research also has significant implications for the treatment of Parkinson's disease, particularly in improving gait, which is typically slow and unstable, thereby reducing the number of falls and their deleterious consequences such as fractures and hospitalization. Professor Simone Dalla Bella underscores that these gait disorders are very debilitating for the

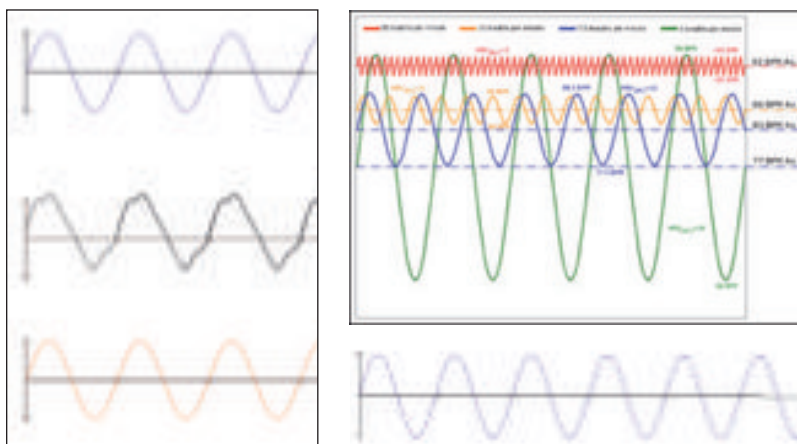
area though, and studies are ongoing. “We are interested in understanding the relationship between rhythmic stimulation – such as music – and the pathology of Parkinson's disease, including the brain mechanisms underlying the beneficial effects of rhythm on movement,” says Professor Dalla Bella. “There are important connections between sensory and motor areas in the brain. So music, by tapping

If music does act as a synchroniser of our biological rhythms then it can stabilise the way we walk or run, and improve movement efficiency. So we can exploit **the link between rhythm and movement, which is hard-wired in our neurology**, in both performance and rehabilitation.

patient. “Patients typically walk slowly, making small steps, and their risk of falling is heightened; in more severe forms of Parkinson's disease, they have to have people around them to support them,” he explains. Music can be used to stabilise an individual's walking rhythm, thus increasing mobility, preventing falling and reducing the associated anxiety; this is a complex

into the auditory system in the brain, also activates the motor system. We are interested in this connection between brain regions that are positively affected by music.”

The project is performing clinical studies to look at the effects of the BeatHealth architecture on rehabilitation. In a first experiment a group of 20 patients have been recruited at the





Montpellier Academic Hospital, one partner of the BeatHealth consortium, and are undergoing clinical evaluations three days a week, which will give researchers valuable information on the development of the technology. “The patients do these evaluations with the music, either adapted to the frequency of their steps or not. We follow that with a set of questionnaires to get their views on the technology,” outlines Professor Dalla Bella. Many Parkinson’s patients are elderly, and likely to be less comfortable with technology than younger people, so Professor Dalla Bella says it’s important to take their needs into account. “We have to develop a specific technology for the patients that will be different from the technology developed for healthy people. Maybe a tablet for the first group and a smartphone for the second. We are trying to understand the fundamentals of music and movement, in terms of neuroscience, and to see whether the BeatHealth architecture has positive effects,” he continues.

### Beneficial effects

These effects are mainly short-term in nature, with the wider goal being to delay the progress of the pathology in Parkinson’s disease patients. The beneficial effects of music on these patients are fairly well-known, but the BeatHealth project is the first to look at adapting the beat, and researchers will also look at the longitudinal effects of their approach. “The patients are now undergoing the first experiments, and the final part of the project will consist of a six-month evaluation period to see whether the architecture is really improving the way they walk around,” outlines Professor Bardy. Researchers – also including one group from the National University of Maynooth in Ireland and one group from the TECNALIA foundation in Spain – are also looking to improve the architecture further, using the individualized data they have gathered on both runners and Parkinson’s disease patients. “We want to use that data to extract what we call

movement signatures. This is a personalised signature of the way people run, move and walk, in synchrony – or not – with music, which will allow a personalized music-based treatment,” says Professor Bardy.

The project’s more immediate objectives are to bring together the work of the different partners and develop an integrated prototype of the architecture. This could in future potentially be used on other neurological conditions as well as Parkinson’s disease. “We are rhythmical biological systems, and music is generally rhythmical. So pathologies that have a rhythmic disorder can be aided by music and could potentially be targeted by BeatHealth,” says Professor Bardy. The project is progressing well, and Professors Bardy and Dalla Bella are keen to pursue further research with the team, including the development of more effective long-term strategies for delaying motor and cognitive decline in Parkinson’s disease.



# Q&A

**EU Researcher:** Is the project looking at the effects of music on the brain?

**Professor Benoît Bardy:** We conduct research in the project in order to validate the stabilising effect of music, as a synchroniser between biological systems. We develop the sensors and we develop the architecture.

The architecture is basically this software, this module that will be available in the app. We send the data collected over the cloud for coaches, doctors, families, social networks, so they can get access to an individual's degree of synchronisation.

For example a Parkinson's patient could walk down the street with friends, and then at the end of the day look online and see that they've walked 2,000 steps, and 70 percent of them have been synchronised with the music. As a consequence you have been able to walk in a more stable way and for a longer time.

Music can also be beneficial for runners. Did you know that MP3 players are banned in international competition?

**EUR:** Are they seen almost as technological doping?

**BB:** Yes, the IAAF usually say; 'we consider that technological doping, as it increases performance. The reason is that it distracts from pain and it's motivational.' The fact that it's motivational is not the only reason though. We are pretty sure that when you run in synchrony with the music you run in a much more stable way. And consequently your running pattern is more efficient.

**EUR:** And this could have a big impact on performance?

**BB:** If you run in synchrony with your favourite BPM, or a kind of modulated BPM, then we think you can gain several

minutes on a marathon.

So we think the key reason why MP3 players are forbidden in competition is that they improve performance.

In BEAT-HEALTH we are trying to understand the fundamentals of music and movement, in terms of neuroscience, and to assess whether we have positive effects.

**EUR:** Those positive effects, would they be halting the progression of Parkinson's disease?

**BB:** That's a good question and we can't answer it now. The effects we're looking at are short-term effects, but the pathology has already been declared. We're trying to use details to delay or slow down the progress of the pathology, that's the ultimate goal.

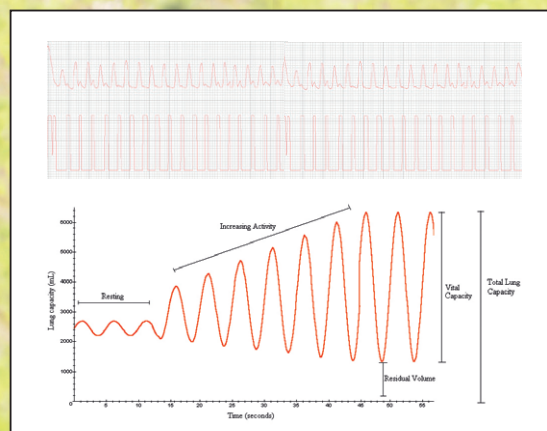
This is not the first time people have conducted research with music on Parkinson's patients, and looked at the way music stabilises walking. But this is the first time we have taken this adaptive, detailed approach.

**EUR:** And you are looking at the longitudinal effect of using music?

**BB:** Yes, so patients are coming now for the first experiments, and at the end of the project they will be tested for six months. So the final part of the project is a six-month evaluation with the patients, three days a week, to see whether these effects are really improving the way they walk around.

There will also be some retention at the end – so you stop the treatment, they come back a few months later, and we see whether the effect is still there. So that's to assess the durability of the treatment.

So we are at year 1 now, the final evaluation time will be in two-and-a-half years time.



## At a glance

### Full Project Title

Health and Wellness on the Beat (BeatHealth)

### Project Objectives

In BeatHealth, we exploit the compelling link between music and movement. We conduct fundamental research to clarify information in music that maximize the beneficial effects on movement kinematics and physiology. In addition, we create an intelligent technological architecture, which deliver embodied, flexible, and efficient rhythmical stimulation adapted to the individual's skills. The beneficial effects of BeatHealth are evaluated in patients with movement disorders (i.e., Parkinson's disease), and in healthy citizens of various ages with moderate physical activity.

### Project Funding

Total €3,83 M / EU funding €2,94 M

### Project Partners

Montpellier 1 University (UM1), France • Ghent University (UGent), Belgium • National University of Ireland, Maynooth (NUIM), Ireland • Fundación TECNALIA Research & Innovation (TECNALIA), Spain • Montpellier Academic Hospital (CHRU), France  
[www.euromov.eu/beathealth/beathealth-partners](http://www.euromov.eu/beathealth/beathealth-partners)

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Professor Benoît Bardy (left)  
Professor Simone Dalla Bella (right)



Benoît Bardy is Professor of Movement Sciences at Montpellier-1 University and a senior member of the Institut Universitaire de France. His research addresses problems of coordination and control of human movements, exploiting virtual and augmented realities, modelling, and simulation techniques. He is the founder and director of EuroMov, a new European research and innovation centre located in Montpellier, France.

Simone Dalla Bella is Professor of Movement Sciences at Montpellier-1 University, a junior member of the Institut Universitaire de France, and an associate member of the International Laboratory of Brain, Music and Sounds Research (BRAMS, Montreal). His research concerns the relations between music, cognition and the brain, and in particular the effects of music on motor behavior (e.g. for the purposes of motor rehabilitation).

**BeatHealth**  
Health & Wellness on the Beat