Whitepaper

What is the added value of the Pactive Motion system for current health issues?

Physical inactivity is a widespread problem. Worldwide an increasing number of people spend their time inactively. We sit in our cars, sit during our office jobs, and sit while gaming, serving the internet or watching TV. Research has indicated that the average amount of time we spend sitting may vary between 6.4 and 10 hours per day.[1,2] After the break out of the COVID-19 crisis when most employees and students work and study from home and miss out on commuting and participation in sports clubs, this amount of sedentary time will only have increased. What does physical inactivity to our and physical and mental functioning? And how can passive activation technology help to alleviate the burden of inactivity?

The burden of physical inactivity

What does physical inactivity to our health?

Physical inactivity is related to several non-communicable diseases such as heart disease, diabetes and several forms of cancer. Worldwide, 1 out of 10 premature deaths are caused by physical inactivity.[3] In addition, physical inactivity is not only related to a decrement in physical functioning, but also to a decrement in mental functioning. It can increase stress related complaints and lead to decreased cognitive functioning. [3–5] Moreover, scientists have emphasized the fact that physical inactivity and obesity makes us more susceptible for infectious diseases such as COVID-19.[6,7] Many people think they can compensate a sedentary day by exercising in the evening or in the weekends. However, that is not true. Excessive, prolonged sitting time is an independent risk factor for the development of health problems.[4,5] Therefore, physical activity guidelines prescribe both to be physically active for at least 150 minutes per week at a moderate to vigorous level, and to breach sedentary time as much as possible.[5,8] Research has indicated that only about half of the Dutch population meets this guideline.[9]

Passive activation technology

What is passive activation technology?

Passive activation technology is a unique mix of robotics and virtual reality. The technology simulates several activities with synchronic movements, images, sounds and music. The user is set into motion during standing or sitting on a robotic chair or platform, while watching a corresponding video, for example of riding a horse, swimming with dolphins or walking in a zoo. This co-exists with the transmission of specific vibrations to the body of 0-100 Hz. Together this results in a multisensory stimulation of visual, auditive, tactile and proprioceptive stimuli. This multisensory stimulation activates the body and the brain, which leads to more activation and relaxation of the body and mind.
Our technology is based on scientific research and has been used for 10 years in the long-term care. By now, our company aims to introduce a newly developed robot disc into the market, which can also be used by private users.

Overview of the product line of Pactive Motion and the Pactive Motion robot disc

How does the Pactive Motion system work?

Cognitive functions and an enriched environment

Cognitive functions are brain functions with which we process information, learn, control impulses, think and act. These functions are crucial to function independently in daily living and for work and gaming performance.[10–12]

Cognitive functions can be stimulated at any age, due to the principle of neuroplasticity: the ability of brain cells to regenerate and make new connections.[10]

Stimulating neuroplasticity starts with a sufficient level of arousal. In an impoverished environment, with few stimuli and no physical activity, the level of arousal will be low. However, in an enriched environment where one is physically active and multiple senses are stimulated, arousal levels and subsequently cognitive performance will be optimized.[10]

A Multisensory stimulation

The Pactive Motion system offers the user an enriched environment, by stimulating multiple senses at the same time. This multisensory stimulation of images, sound and movement strengthen each other, creating a realistic and fun experience.

The following senses are stimulated:

- Proprioception (sense of position): Passive movements activate systems in the body associated with movement orientation and sensing the positioning of the body in space. [12,13]
- Vestibular (balance) system: A variety of passive movements/ activities activate the balance system, thereby training (trunk)balance and postural control. [14]
- Tactile sense: The Pactive Motion system integrates specific vibrations with multiple amplitudes and frequencies, that are transmitted to the body. Effects of those whole-body vibrations have been extensively studied on the human body and brain. [11,15]
- Vision: The Pactive Motion system uses real images that are known to activate the mirror neurons in our brain. These are the same neurons that are active when a certain movement is actually performed, and therefore enable motor learning without actually moving. [16] This is an important principle within neurorehabilitation, and can offer a solution in situations where the actual execution of movements is limited, such as in people with neurological disorders.[12,17]
- Auditory system: An indispensable part of the various simulations of the Pactive Motion are sounds and music. Sounds ensure recognition of a specific activity and encourage action. Music and rhythm also have a powerful influence on human movement. The acoustic cortex is very plastic, so is able to adapt after training.[12]

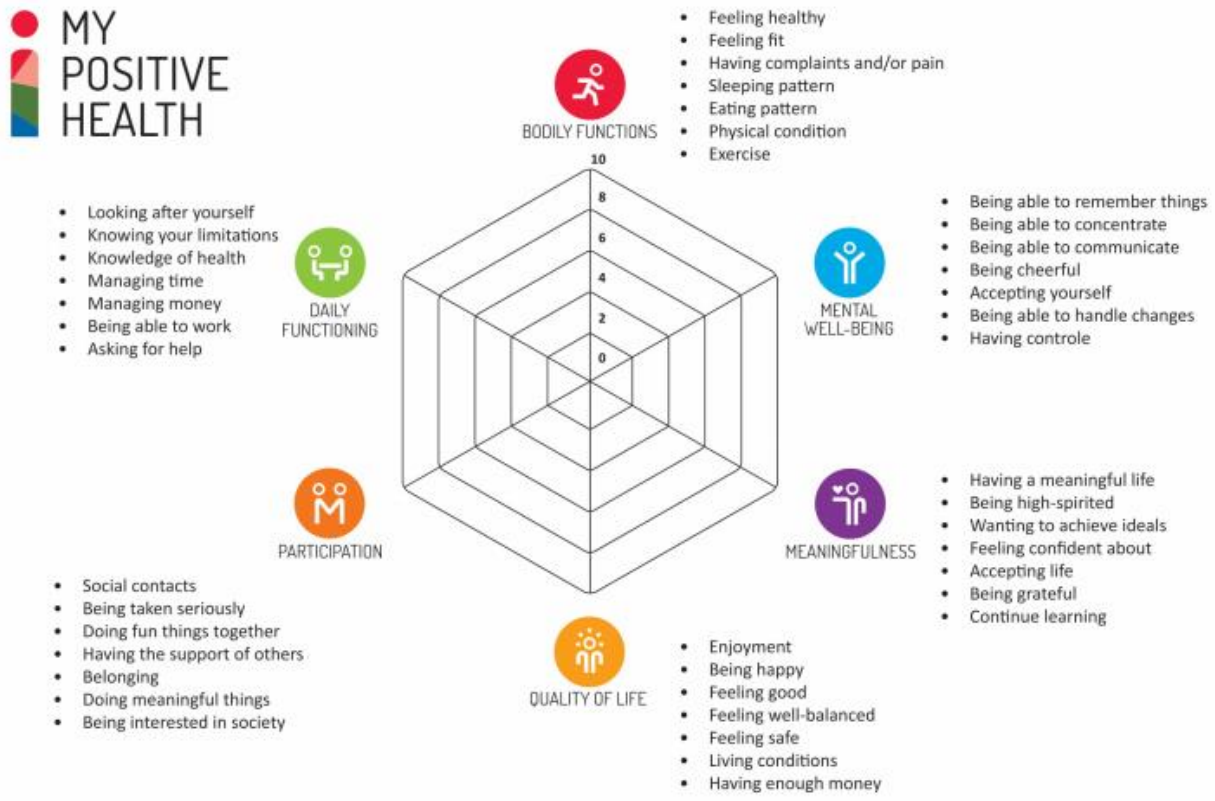
Goals

For which goals can the Pactive Motion system be used?

Three main areas that the Pactive Motion system can influence are the following:

- Improvement of physical functioning
- Improvement of relaxation
- Improvement of cognitive functioning

Overall, the system aims to increase general wellbeing and quality of life for a variety of people. This relates to the concept of Positive Health, that is broadly applied within Dutch healthcare. This concept emphasizes the importance of a broad view of health and healthcare: health is not the absence of disease, but the ability to adapt to physical, emotional and social challenges.[18] Table 1 provides a summary of the effects of the Pactive Motion system and relation to the domains of Positive Health.



The Positive Health Model

Table 1. Effects of the Pactive Motion system and relation to Positive Health.

Effects Pactive Motion system	Relation to Positive Health Model
Physical functioning - Breaches inactivity - Mobilization of the spine, decrement of pain - Blood flow - Muscle strength, balance and postural control	- Feeling healthy - Having complaints and/or pain - Feeling fit - Exercise 
Relaxation - Optimization of mood, joy - Optimization of rest and relaxation - Decrement of stress, agitation and stress related complaints	- Enjoyment - Being happy - Feeling good - Feeling safe 
Mental functioning - Improvement of brain functions such as alertness, concentration, focus and working memory - Improvement of inhibition (decreases irrelevant impulses) - Improvement of reaction speed	- Being able to remember things - Being able to concentrate 

Physical functioning

The Pactive Motion system has an effect on various physical functions. Overall, the system breaches inactivity by using multisensory stimulation. The movements that the system generates set the spine in motion. This ensures a mobilization of the spine and therefore a reduction in pain complaints caused by stiffness in the spine or increased muscle tension. In addition, the special movements combined with whole-body vibrations applied within the system have been shown to improve blood circulation, muscle flexibility, bone density, and postural control in various populations of healthy adults, elderly, and clinical populations.[19–22]

Moreover, The World Association of Vibration exercise experts (WAVex) has recently published a comprehensive review in which the use of passive vibrations is supported for the management of infected individuals with COVID-19. The use of these specific movements have shown to reduce inactivity-related declines in physical function in vulnerable people that are not able to move actively.[23] The integrated vibrations may also help people to release mucus in the lungs, which can relieve stuffiness that many COVID-19 infected individuals are suffering from.

For long-term care clients, the combination of movements and vibrations also stimulate the intestines, which results in an improved intestinal peristalsis and therefore a better digestion. This prevents these clients from being dependent of medication to keep digestion going.

Besides the passive activation while sitting, the Pactive Motion Balancer makes it possible to move passively while standing.

Being passively moved while standing appeals to the balance capacity and muscle strength. Research has shown that undergoing whole-body vibrations while standing leads to a significant increase in physical performance in the elderly.[24] If one also combines standing exercises (such as a squat) with these special movements, this leads to significantly more improvement in bone density, balance, muscle strength and functional mobility compared to exercising without these movements. [25,26] When using the Pactive Motion system, the user must constantly make postural adaptations, which, together with the integrated special movements is a great training for the balance capacity and overall functional capacity. This is of great importance to decrease the risk of falling in the elderly.
In patients with neurological disorders such as cerebral palsy, similar effects have been found of the application of vibrations, whether or not combined with exercises, in the

areas of gait function, functional mobility, postural control, balance and muscle strength. [27,28]

Moreover, when ones goal is to activate, the integrated and correct dosage of movements and vibrations in our system enhances heart rate and therefore impact metabolism.[29]

Relaxation

The motion simulations of the Pactive Motion system are experienced as a fun activity by our users. Fun relaxes and puts the user in a good mood. In this way, the system is very suitable for various people who experience stress or tension-related complaints.

Research has shown that applying whole-body vibrations and movements at a low frequency (6-10 Hz) while lying on a chair, after moderate to intensive exercise sessions, leads to a faster recovery compared to control groups that do not undergo these specific movements. After applying these movements, there is a significantly faster lowering of the heart rate, a faster recovery of heart rate variability, and a faster recovery of lactate levels in the blood and muscle fatigue.[30,31]

Good effects in the area of relaxation have also been observed in various healthcare institutions where the system is in use. In a department with various psychogeriatric clients, the system provided, among other things: [32]

- More relaxation, better mood, improvement of sleeping behavior
- Reduction of depressed, apathetic, restless and / or repetitive behavior
- Improvement of general well-being and quality of life

The system may also be applied for neurological patients with spasms, for example in people with Parkinson's disease, non-congenital brain damage or cerebral palsy. These people may benefit from using the system because relaxation can induce a reduction of spasms.[32] This is in accordance with research into the application of vibrations in patients with neurological disorders. It found indications for a reduction of spasms in the lower extremities after applying vibrations.[28]

Cognitive functioning

The Pactive Motion system stimulates various cognitive functions by stimulating multiple senses simultaneously and thus offering an enriched environment. The movement simulations with the integrated whole-body vibrations have a proven positive effect on various cognitive functions such as selective attention, inhibition control and visual working memory. This has been demonstrated in healthy subjects as well as in children and young adults with ADHD and adults with brain damage. [21,33,34] These effects enable people to perform cognitive tasks better after a simulation with specific vibrations. The effects on cognition have been shown for a short time immediately after applying these movements for two minutes (30 Hz, amplitude 0.5 mm) . [21,34] When the vibrations are applied more systematically, for a few minutes a day, several days a week, the effect is also visible after 24 hours and partly after 1 week. [15,34]

Different target groups can benefit from stimulating cognitive functions. For the elderly and various patient populations who stay in a care institution and suffer from moderate alertness regulation, the system means a disruption of the day, so that inactivity, drowsiness, boredom and restlessness are avoided. [35] Practice has often shown that the use of the Pactive Motion system improves alertness regulation for these target groups.

Which target groups do we serve?

Esports

With our new branch aimed at esports we are ready to conquer the esports market. Research in cooperation with the Breda University of Applied Sciences has shown that there is a need for a passive activation system that helps with recovery after prolonged periods of gaming, and helps to improve gaming performances.

Employees working at home or at the office

Healthy working has never been so important. Therefore, another important target group is employees with an office job. Employees benefit from alternation of prolonged sitting time by getting passively activated, in which they can choose between activating or relaxing activities in case of unhealthy stress while improving their skills.

Elderly living at home or at long-term care institutions

People who would benefit the most from physical activity are actually the least active. These are people in health care institutions, such as people with disability or people with dementia. Most of these people are not able to move properly anymore, making it impossible to meet physical activity guidelines. Here, the Pactive Motion system affords a great opportunity to activate these people and to reduce restlessness and boredom.

Experiences

How do people experience the Pactive Motion system?

Woman (84 years old) with peripheral motor and sensory neuropathy and hip osteoarthritis: *"Because of the exercises on the Pactive Motion Balancer, I no longer have groin pain and I no longer need surgery on my hip. My balance has improved. I want to remain independent as long as possible, that is my goal with the exercises with the Pactive Motion system."*

Man (65) with incomplete spinal cord injury at C4 level "*The system has brought me a lot of pleasure. My trunk balance has improved a lot; I am no longer afraid of falling forward from my wheelchair. I am also able to move much better; I can get out of bed independently again and walk independently with my walker. This makes me less dependent of other people."*

Care manager about a client: *"There was a boy who was testing the Pactive Motion system, who had a lot of trouble with his arm. Watching the video and experiencing the different activities made the pain in his arm much less at that time."*

Want to know more about how people experience Pactive Motion technology? Have a look at our website: www.pactivemotion.nl/historie/testimonials/

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