DOCTORAL DERBY

FINALS

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ABSTRACTS
Brain stimulation to improve motor learning in Parkinson's disease.

Visualize this: one day, you try to get out of bed and you notice that you have to deliberately think about how to get out. It doesn’t go automatically anymore, as it did before.

Most of our daily activities are in fact performed automatically, such as getting up in the morning or walking to work. These activities consist of multiple single movements that are performed in a specific order. Getting out of bed, for example, requires you to roll over, lower your legs off the side and push up to a seated position.

In Parkinson's disease – the fastest growing neurological disorder in the world – this skill is impaired. Hence, we want to improve this skill by applying a very mild electrical current to the scalp, by means of a superficial and quite easily applicable brain stimulation technique. We are yet to discover whether optimal effects are achieved by more specific or more generalized stimulation of the brain.

We hope to reveal the most effective brain stimulation protocols to improve the automaticity of movement in Parkinson’s. On the long-term, we want to incorporate these protocols in rehabilitational settings, ultimately enabling these individuals to continue their daily activities with less problems.
Imagine yourself walking through the city you were born in and suddenly noticing immense changes: street names changing, swastikas appearing, soldiers marching, aggressive songs sounding and vibrating, people staring, screaming, yelling. Your hometown is transformed and becomes threatening. These feelings of alienation are omnipresent in German-Jewish diaries and autobiographies written during the Third Reich and the unfolding Second World War. How did Jewish people reflect upon and write about this situation? Were they able to find places of refuge in a world marked by persecution and destruction?

These are some questions my research delves into in order to study the urban experience of Breslau. Such a specific focus on Jewish life in the city promises to offer new insights, since research has mostly looked into life in ghettos and concentration camps. The urban situation however remains unexplored territory. Moreover, the city of Breslau offers a unique case, since it did not only undergo massive changes during the period of 1933-1945. After World War II, the city came under Polish rule and is known as Wroclaw today. This only added to the sense of estrangement of returning survivors who tried to travel ‘home’ and were confronted with a new political reality, where all traces of a rich German-Jewish past seemed lost forever.
What data protection can do for you

Why should we care about data protection? At first glance, protecting personal data can appear bothersome and time-consuming. For example, we are constantly asked to agree to terms and conditions online and have to remember ever-more complicated passwords. But is this all there is? My research is not about what you can do to protect your data, but what data protection can do for you.

All of us in the EU have certain rights towards our own personal data granted by data protection laws, such as the General Data Protection Regulation. These rights build a relationship between us and our personal data that is supposed to let us participate in how decisions are made about them.

Reality however seems to prevent any such participation. Data are spread across the globe, and we do not know where they are nor how they are being used.

In my research I demonstrate that this is not an acceptable status quo from the perspective of EU data protection law. The rights we have towards our own data have to be and can be made a reality. Data protection law was designed to work for us. It is in our hands to ensure it does.
Let’s take a (virtual) walk

Imagine this: you are walking on a treadmill, but you are surrounded by a completely different world. Instead of walking in a bare room, you are taking a walk in the park or you are competing against avatars in a race. Is this some new game in the arcade or a new hype among gamers, you might think?

No. You are someone who had a stroke, and you need to learn to walk again. A stroke is a brain injury that frequently affects a patient’s walking function. Since walking disabilities can greatly influence someone’s daily activities, participation in social activities and quality of life, regaining the ability to walk has high priority.

In recent years, a new tool emerged in the field of rehabilitation: the use of virtual reality. Today, virtual reality is much more than just a gaming tool. It can provide safe, interactive and enriched environments in which different tasks, like walking, can be practiced. To find out how to implement this new tool in rehabilitation, I let people with a stroke walk on a treadmill while wearing virtual reality glasses. I’m committed to unravel the effect virtual reality has on walking in this population.
You and I probably enjoy spending time with our friends and family. But millions of people can’t do this because their entire body is in pain all the time or because they get ill after a small effort like washing their hair. These people have chronic widespread pain or ME/CFS, often even both. However, we can’t treat these patients because the biology of these diseases remains a mystery to scientists worldwide.

We try to solve this mystery by looking at epigenetics. These are the ‘paperclips’ of our body that regulate which parts of our DNA can be read. Our DNA is the instruction manual of our body and tells every cell what it needs to do. Paperclips can hide certain pages of this manual, which could have serious consequences for the functioning of our entire body. We already know that patients with chronic widespread pain and ME/CFS have more of such paperclips on certain parts of their DNA than healthy people. Could this paperclip discrepancy between patients and healthy people be the answer to the mystery?

That’s the question we will try to answer in the following years. The results of our research will increase our understanding about the biology of chronic widespread pain and ME/CFS. This will help us to work towards our ultimate goal: developing new therapies and helping the ones we still can’t help today.
Driving the CAR to the cure

In the human body, T cells are specialized in recognizing and killing diseased cells; for example cells infected with harmful invaders such as viruses or bacteria (‘pathogens’). Due to the presence of this invader, T cells can distinguish diseased from healthy cells. Cancer cells are also diseased cells, but because they do not contain a pathogen, they are more difficult to distinguish from healthy cells and easily escape T cell attacks. That is why scientists are trying to fight cancer by training the T cells to recognize and kill cancer cells. One way to do this is, is by inserting a specific molecule into the T cells, a so-called Chimeric Antigen Receptor (CAR). This CAR can activate T cells after recognizing a pattern on a cell; a pattern that you as a researcher can choose yourself. So, if you can find out how cancer cells differ from healthy cells, you can teach T cells to recognize them. Simple enough, right? However, nature is outsmarting us. The natural way in which a T cell recognizes a diseased cell is very sophisticated and difficult to imitate. That is why my research revolves around determining which parameters are important to activate the T cells in a correct and optimal way.
Are electric vehicles safe with new semiconductor technologies? Let Digital Twin decide.

Introducing Electric vehicles (EVs) has been a trending solution for transportation sectors to achieve net-zero carbon emission goals. However, the user’s tendency to adopt EVs is still far from expectations due to safety issues and driving range anxiety. Here comes the good news: applying new semiconductor technologies in EV electronics components can mitigate current drawbacks. Thanks to their smaller size, they could offer large space allocation for more powerful batteries. Yet the main confusion remains: are EVs sufficiently reliable in the presence of newly emerging semiconductor technologies?

Reliability is an important performance metric, which needs to be accurately estimated. Unfortunately, most researchers rely on historical datasets found in the old lifetime handbooks for the reliability assessment. These datasets are outdated for the latest semiconductor technologies and lead to less accuracy. Alternatively, for accuracy, researchers depend on physical tests, which are time-consuming and expensive. Our research develops an accurate virtual model known as the digital twin of the actual EV components model. The twin allows us to estimate the vehicle’s reliability in real scenarios based on virtual testing. Hence, our research brings an inexpensive, fast, and accurate solution and answers the doubts about the actual EVs reliability with new semiconductor technologies.
Production of super plastics by heat-loving bacteria

No one can imagine a life without using plastics. Despite the suitable properties of petroleum-based plastics, they have severe drawbacks as they contribute to global warming and take hundreds of years to be biodegraded.

During the last decades scientists worked on finding a sustainable alternative to conventional plastics. Fortunately, their research led to a breakthrough finding of bioplastics that can be produced by bacteria. Numerous species of bacteria can produce bioplastics as particles inside their cells according to presence of certain nutrients. The properties of these bioplastics are comparable to conventional plastics and most importantly they are completely biodegradable without producing any toxic substances.

Despite their convenient properties, their industrialization is still limited due to high production costs. Aiming at decreasing these costs, I focus in my research on the production of bioplastics by heat-loving bacteria which grow optimally at high temperatures. This would help in saving energy costs and avoiding contamination. Better understanding of the bioproduction process of bioplastics will lead to an increase in the production with better properties. Together with the reduction of energy consumption we aim to obtain competent industrial bioplastics producers. My work will be a step forward towards industrialization of a high-quality bioplastics.
Glass fibres as thin as human hair will make airplanes safer and eco-friendlier

New generations of airplanes will be safer and eco-friendlier thanks to smart materials with networks of glass fibres. These glass fibres are as thin as a human hair and are typically used to guide light for telecommunication. They can however also be used for measuring pressure or temperature. Imagine a wire as thin as a human hair with hundreds of sensors inside. That will save a lot on cabling and weight compared to hundreds of electrical sensors, right!

The airplanes of today are increasingly made from new composite materials. These materials combine tough plastics with strong reinforcements, which makes them stronger and lighter than aluminium. The newest plane from Airbus for example is made of more than 50% of these composites. Being complex materials they regretfully also have a weakness: impacts. A plane can get hit by several things during operation: think of birds, lightning, a stone from the runway, … Although you would imagine that the initial damage of such an impact is small, it can grow when the plane is in use. Lots of time and money is therefore invested to detect and repair possible damage as soon as possible.

We developed a method that uses glass fibre sensors as a permanent nervous network for composite materials to sense this damage as soon as it occurs. This will ensure safer airplanes and save maintenance time and costs. By needing less materials and weight to prevent this kind of damage, the planes can fly further with less fuel and less pollution.