The balance of power

IMPACT PARAGRAPH

I do believe that every scientific piece of work has value in itself if the research underlying it is conducted following good scientific practice and rigorous methods. This value lies in the knowledge that is gained through experimentation, and in how it can eventually be used to develop new tools that are able to solve specific problems. In this regard, the aim of this section is to highlight both the scientific impact and the societal impact of the work presented in this thesis. The studies reported in this dissertation can be related to both aspects, delivering knowledge that enriches our understanding of the human brain, as well as having the potential to directly influence and improve people's lives.

The objectives of this thesis revolve around understanding how the brain is able to deploy attention in visual space. To achieve such understanding, we developed innovative methodologies in terms of experimental design, data analysis and brain stimulation approaches. We provided evidence of how the fronto-parietal dorsal attention network works in the healthy brain, further elucidating the role of its core nodes and their interactions when attention deployment takes place. Furthermore, we employed a novel TMS approach that is able to simultaneously interact with multiple nodes of a given brain network in a safe manner. This approach has been proven more effective than the more conventional approaches that are usually employed, being able to induce stronger and more consistent inhibitory effects. This positive evidence, though, needs to be supported by further investigation and developments, which are needed to fully discover the beneficial effects this approach might yield. The results obtained in these studies were presented at different international conferences, and successfully led to publications in international peer-reviewed journals. Thus, by fully embracing the principle of sharing knowledge and open science, the scientific impact of these studies is immediately clear.

Discovering these dynamics about brain function not only gave a direct and substantial contribution to the scientific community, but has also a huge influence in terms of societal relevance. Even though these studies mostly dealt with the discovery of fundamental principles underlying human cognition, and therefore fall under the umbrella of basic rather than applied science, the insights we gained through our experiments have the potential to influence people's lives in a tangible manner. In fact, having a deep knowledge of how the brain is capable of carrying out attention is necessary in order to treat and improve possible deficits when brain damage occurs to the regions responsible for such function. A frequent consequence observed after stroke is having attention-related symptoms such as unilateral spatial neglect. This syndrome appears after lesions to regions of the attention system in either hemisphere, but it is more commonly observed and in a more severe form after damage of the right hemisphere. People suffering from this syndrome show difficulties in reporting and attending to stimuli presented on the contralesional side of visual space. Even though these patients usually show spontaneous recovery, ahead they have a long journey

made of daily life difficulties. In order to recover and improve from these symptoms, it is necessary to know how the attention system works in the healthy brain. Only then we can guide clinical interventions toward the right direction, aiming to reestablish the brain function as it once was. Still today, though, many pieces of this puzzle are missing, with treatment and recovery outcomes of such syndrome being consequently often uncertain. Thus, revealing information about how the attention system works is extremely relevant and has crucial implications for cognitive rehabilitation strategies, potentially allowing the implementation of informed interventions, which would in turn lead to a faster and more successful recovery after the loss of function. The same principle holds for our innovative network-based TMS approach. More reliable (in terms of efficiency) brain stimulation protocols can have direct impact for the recovery of stroke patients after the occurrence of brain damage, being more able to enhance cognitive functions and improve stroke-induced cognitive impairments than what conventional protocols currently do.

In this context, the team I am part of started a parallel research line dedicated to bring this knowledge into clinical practice. By establishing nationwide collaborations with several rehabilitation centers, we have now the possibility to translate these insights into the development of innovative brain stimulation protocols based (also) on alpha entrainment, and test their possible beneficial effects on this clinical population. Preliminary results are promising, and this work will (hopefully) soon demonstrate its potential in a concrete manner. The progress in terms of our understanding of the mechanisms underlying attention and methodologies could eventually result in a more efficient patient care, making patients' perspective much brighter than it currently is. Moreover, not only these protocols are suitable for attention related deficits, but also for an innumerous variety of network-based pathologies, offering a new avenue of experimentation and treatment. The challenge now is to integrate this knowledge in a meaningful way, embedding it into existent theoretical frameworks and together with a multidisciplinary endeavor translating it into practical implementations. Reconciling all these aspects is the key to improving the quality of life of these patients, who could eventually benefit from these developments.