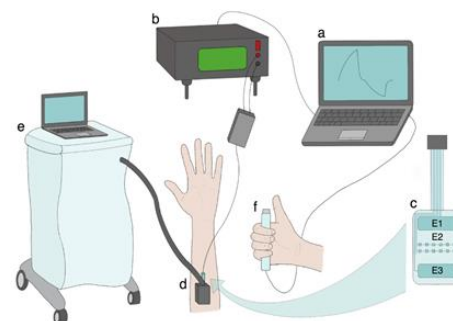


## ANNUAL HIGHLIGHTS IN CNAP

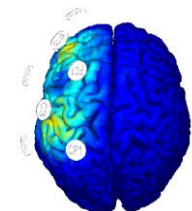
CNAP's ambition is to be the leading research centre focusing on neuroplasticity and pain. We base our research on a concept of "Provoking, Probing, Modulating" pain neuroplasticity and build our organisation on the keywords "Interdisciplinarity, Internationalisation, and Training".

**Research Highlights:** Unique and standardised provocation of nerve fibres (nociceptors) mediating the information about a peripheral painful event to the brain is crucial for developing models of pain neuroplasticity. Computational experiments showed that nerve fibres mediating mechanical sensation accommodate to slowly increasing electrical stimulation, while nociceptive fibres do not. This was used to improve the standard model for induction of long-term potentiation of pain perception (neuroplasticity) by high-frequency electrical stimulation and adding a low intensity slowly increasing electrical stimulation prior to the high-frequency stimulation. The experimental results proved that pain neuroplasticity is better induced by the new stimulation technique.



Exposure to extensive repetitive movements is an important factor for inducing long-term use-dependent brain neuroplasticity. However, it is also considered a main risk factor for developing pain and neuroplasticity. CNAP studies have explored the underpinnings linking extensive repetitive movements to abnormal nociceptive processing. Individuals with extensive training (musicians) had enhanced nociceptive brain responses compared with non-musicians. Such findings unveil how use-dependent neuroplasticity may shape brain processes translating nociceptive stimuli.

Brain neuroplasticity may involve efficient communication between many brain regions, rather than a single area. Functional connectivity is a measure that assesses the amount of this communication between brain regions. Novel CNAP studies investigated the effect of prolonged pain on connectivity in a network of brain regions often shown to be altered during pain. The results showed that connectivity was reduced by pain, but different regions are involved if the network is occupied by other processing (eyes closed and eyes open). This is the first time such findings have been demonstrated and it may open a window for modulating such effects with the perspective of interrupting conditions of neuroplasticity.



Earlier CNAP studies using transcranial direct current stimulation on one or more specific brain areas demonstrated limited modulation of the pain system. However, new initiatives were taken to address the same question in systems exposed to prolonged pain and thus potentially with neuroplastic changes. Brain responses to pain provocations were recorded after transcranial stimulation of the brain targeting selected regions while pain developed over 24 hrs. After 50 mins. of pain, the brain responses were reduced, but interestingly the brain stimulation modulated the response towards the normal situation after one day.

A CNAP research focus has been on epigenetic modifications, which may confer susceptibility to pain neuroplasticity in long-term pain conditions. The involvement of epigenetic modifications and provoked pain was further evaluated in a collaboration with external collaborators. This study showed a correlation between epigenetic modifications and brain responses after laser stimulation to the skin, suggesting that such mechanisms could be involved in the abnormal brain responses in some chronic pain conditions.

**Publications and Public Outreach:** CNAP published 55+ peer-reviewed papers in 2020, several of them in high-impact journals. One was selected as paper for the Global Year Against Pain series. Researchers participated in popular science events, e.g. the event "Girls' Day in Science".

**Congresses and Events:** 2020 was a year of virtual events. CNAP presented at the virtual World Congress on Pain and participated in the educational online programme of the European Pain Federation EFIC. Both the annual CNAP research seminar and some of the CNAP Round Table Meetings went virtual. Just before the first lockdown, CNAP hosted a seminar ("Midterm perspectives") discussing the progression and future perspectives within pain research. Other highlights at CNAP in 2020 were the PhD defences with three of them taking place within the same week.

**Internationalisation, Interdisciplinarity, and Training:** In 2020, 37 researchers of very diverse backgrounds, e.g. biomedical engineering, psychology, and physiotherapy were affiliated to CNAP. They came from 16 different countries and made up an equal gender balance. 23 of them were in training positions as PhD students or postdocs.