
Pain-catcher: Experiencing Pain in the Future

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Abstract

We developed a concept of a future pain detection and manipulation device, based on receiving and blocking of pain signals transmitted through the spinal cord to the brain. The proposed design is a system of two wearables called *Pain-catcher*—a patch and a wrist wearable which are connected to each other. In order to materialize our concept, we built a physical prototype that demonstrates the functions of transmitting and receiving signals between the wearables. Subsequently we created a video prototype to highlight our design implications and to demonstrate how the concept could be set within a used case.

Author Keywords

Pain; wearable; pain signal transmission; bodily experience.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction

Many people around the globe experience pain. Statistics show that 20% of adults suffer from pain globally and 10% are newly diagnosed with chronic pain each year [2]. Pain effects can cause high public healthcare costs, low worker productivity, and put

people in personal, emotional and financial crisis. As much as we would like to avoid it, it's a part of our lives and we are used to experience and manipulate it in a variety of ways.

Although pain is perceived as something negative in most cases, it is a vital function of the nervous system in the body. It helps individuals to avoid future harm and protect oneself from an imminent injury. Hence, it acts as an alarm that warns us of danger.

Considering these circumstances, we decided to construct a conceptual vision of how pain could be manipulated in the future, at the time of Sal's grandchildren [8]. Keeping in mind the notion of the "magical mundane" [6] we ended up with an idea of a two-part-wearable system called Pain-catcher.

Theoretical background

International Association for the study of Pain defines pain as "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" [9]. Nociceptors—receptors at the end of a sensory neuron's axon—respond to potentially damaging stimuli by transmitting information to the spinal cord and from there, it continues to the brainstem and the cerebral cortex where the perception of pain is produced, as it is shown in Figure 1.

Pain is an unpleasant experience, but at the same time pain is useful for survival. Leknes and Bastian [3] point out as well that one of the benefits of pain derives from its ability to inhibit other unpleasant experiences and to elicit empathy and social support. They further state that the experience of pain can benefit our defense

systems, since pain enhances motivation to accumulate resources.

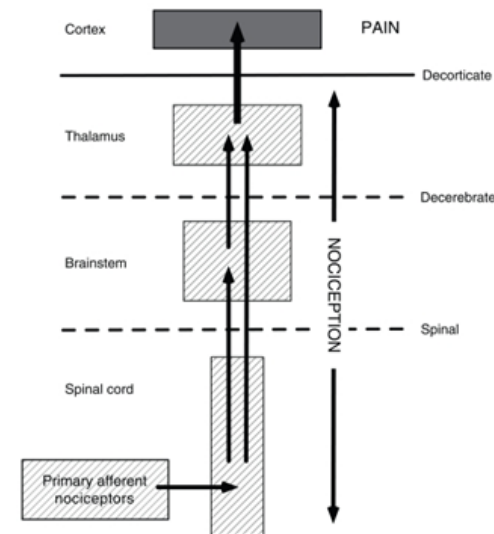


Figure 1. Anatomical distribution of nociception and pain as showed in [5]

Nowadays, plenty of treatments exist that are intended to manipulate and treat pain—different kind of medications, therapies, mind-body techniques (distraction, relaxation, meditation, yoga), strategies like cognitive-behavioral therapy and more. The latest treatments we found inspiring for our design, include direct stimulation or blocking of certain pain-sensing attention networks by drugs. Kathleen Vincent et al. discovered that pain can be controlled more effectively by targeting nerve cell's interior [7]. Dryden describes the conclusions researchers came to: "Blocking pain receptors in the nucleus of spinal nerve cells could

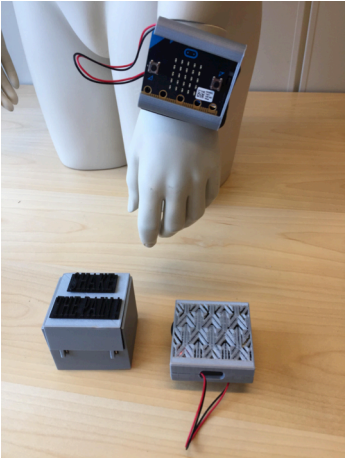


Figure 2. Physical prototype of the patch, wrist wearable and pain signal simulator

control pain more effectively than interfering with the same type of receptors located on cell surfaces...” [1]. The researches focused primarily on nerve cells in the spinal cord, which is a crucial area for transmitting pain signals coming from different parts of the body.

Design description

The Pain-catcher system consists of two wearables—a patch and a wrist wearable with a display. Both wearables are placed on a human body and function in connection to each other. The patch is placed on the back of the user's neck and catches the nerve signals that transport pain alerts through the spinal cord to the brain. From the patch the signal information is sent to the wearable on the user's wrist. With the wrist wearable the user is able to see the pain alert and projection of the pain location, block the pain signal if he/she wants so, and see the data analytics on the pain signals received.

The Pain-catcher is designed to:

- partially replace medication used nowadays for pain treatment,
- make the user more aware of pain processes in his/her body,
- empower the user to manipulate pain.

We are aware that there can be some complications while using the proposed solution - it can be misused and “painless experience” can lead to negative outcomes. That is why we underline, that control and awareness from the user is essential while using the product. The user should understand, that despite being unpleasant, pain is an important, and in some

cases useful, part of our life. It can't be shut down completely. But in many cases, lack of it can change the user's experiences completely and make life easier and more enjoyable, e.g. cases of chronic pain, specific pain after a traumatic treatment, such as chemotherapy, and certain types of acute pain, such as headaches or menstruation pain.

In order not to misuse the Pain-catcher it could be possible to connect the wrist wearable to the hospital or polyclinics systems, to send pain data gathered, so the user's pain patterns and manipulations could be monitored by professionals.

Method

To investigate, visualize and communicate our concept, we have built a prototype which shows the basic communication between two wearables—transmitting and receiving messages, using sound and graphical representations. To design a prototype several approaches were used; one was 3D printing and the other coding with micro:bits [4]. Working with new materials gave us insights and helped us to project our design process into the future, where 3D printers would be as mundane as Xerox printing machines were in 1990s.

Micro:bits were used to design both wearables - the patch and the wrist wearable screen. They were programmed to communicate with each other by means of a radio chip located in each micro:bit. The speaker was attached to the micro:bit representing the patch in order to reproduce sound signals transmitted between the wearables. The third micro:bit was used to simulate the pain signal and trigger the process of transmitting and receiving messages. The patch, the wrist wearable



Figure 3. Extract from the video prototype

and the cover for the pain simulator were printed out with an Ultimaker 2+ 3D printer. We provide the visual characteristics of the prototype in Figure 2.

With our prototype we depict three important steps of the pain blocking process:

1. The pain signal sent to the brain (in our case simulated with the help of the moving sensor placed in the micro:bit No 1—pain signal simulator) is caught by the micro:bit No 2—patch. It is affirmed with a short sound output.
2. The signal caught with the patch is sent to the wrist wearable (micro:bit No 3) where it is graphically presented to the user in the shape of exclamation mark. After that the patch shows the message to the user “Block (the pain)?”
3. If the user chooses to block the pain, he/she presses the A-button and the signal is sent to the patch to block the pain signal, which is confirmed with a longer sound output.

In our video prototype we put our design concept into a future context (Figure 3), gave our physical prototype a proper graphical shape and showed it in action. We chose to present a minimalistic design of the wearables, because we believe that a clean and neutral design can better communicate the message to the users. A restricted and strong palette and refined forms do not draw too much unnecessary attention and help the user to focus on the functionality of the product.

Result and discussion

While developing a design concept of the Pain-catcher we kept theoretical backgrounds about the journey of pain signals in the body and pain management and benefits of pain in mind. We built a physical prototype to examine the communication between two wearables and tested it by simulating a pain signal which would trigger the signal transmission and receiving. We also proposed our aesthetic vision for the concept in a form of neutral and minimalistic design presented in the video prototype. All parts of the project (including this article, and the physical and video prototypes) built up a more holistic representation of the proposed design concept.

We also want to underline that our proposed design is an attempt to delve into the future of pain management where pain will still be experienced, but the user will be more aware of pain processes in his/her body and be empowered to control pain to some extent. It could bring us closer to a world where we benefit from the protection of pain as a warning signal for danger, but at the same time “give pain a break” when we don't want to suffer anymore. We think that in the case of pain management there is not yet a rush to give all the control into the hands of technology which can decide everything and customize preferable conditions for the user, but instead to work in collaboration with it, to progressively come to better results and solutions. Pain is an essential process in our bodies and a very personal experience, which make us feel and make us humans and no one or nothing else yet can know it better than we do.

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