Demonstration of Pain masking by contextual modification in VR/AR environments

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Abstract— **XR experiences are recognized as effective tools for pain management. However, most XR-based pain reduction methods work by distracting attention from the pain source, and these approaches are not effective for individuals who struggle to shift their attention. A new approach, called "pain masking by contextual modification," is proposed. This technique alters the appearance of the pain source. A visual stimulus is presented at the same time as an external pain stimulus, giving the impression that the pain comes from a different source. The visual stimuli are designed to appear less unpleasant, thereby reducing perceived pain. An example of this method is demonstrated in an AR environment to explore its potential use in everyday life.**

Keywords— *AR, contextual modification, Pain, Stimulus, VR*

I. INTRODUCTION

Extended reality (XR) has demonstrated effectiveness as a tool for managing pain [1]. One method involves presenting visual stimuli within the XR space to redirect the user's attention to a different location at the moment of pain stimulus application. This redirection of cognitive resources away from the pain source contributes to a reduction in perceived pain [2]. Despite its benefits, this approach is less effective for individuals who exhibit heightened fear of pain stimuli and experience difficulty shifting attention from the pain source [3].

This study proposes a method called pain masking by contextual modification, which alters the appearance of the pain source without diverting the user's attention from the pain stimulus. The technique works by presenting visual stimuli that appear to originate from a different source at the same moment the user experiences the pain. Replacing the original cause with content that is generally perceived as less unpleasant can reduce the sensation of pain. In this experiment, electrical stimuli served as the original pain source, while cat scratches were used as the alternative stimulus. The procedure was conducted in an AR environment with potential applications for everyday settings.

II. SYSTEM

The system includes a head-mounted display (Quest3, Meta) and an electrotactile device. The device was attached to the right wrist, as illustrated in Fig. 1. The headset uses a pass-through function to create an augmented reality (AR) environment. A 3D cat model was introduced as a contextual element meant to be perceived as a new source of the pain stimulus. The electrotactile device, which consists of 64 electrodes, delivered electrical stimulation to produce the pain. In this configuration, the pain originally generated by the device was reinterpreted as scratching from the cat, which led to a reduction in the perceived pain.

Fig. 1. Setup of this experience.

III. DEMO EXPERIENCE

This demonstration illustrates how contextual modification can reduce the discomfort associated with pain. Using the experimental setup described in Chapter II, an electrical stimulus produced by the stimulator is presented as a pain-inducing input. The perception of this input is subsequently recontextualized as a cat scratch.

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