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Painful Stimulation and Transient Blocking of Nerve Transduction Due to Local Anesthesia Evoke Perceptual Distortions of the Face in Healthy Volunteers

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Abstract: Anecdotally, orofacial pain patients sometimes report that the painful face area feels "swollen." Because there are no clinical signs of swelling, such illusions may represent perceptual distortions. In this study, we examine whether nociceptive stimulation can lead to perceptual distortion of the face in a way similar to that of local anesthesia. Sixteen healthy participants received injections of .4 mL hypertonic saline to induce short-term nociceptive stimulation, .4 mL mepivacaine (local anesthetic) to transiently block nerve transduction, and .4 mL isotonic saline as a control condition. Injections were administered in both the infraorbital and the mental nerve regions. Perceptual distortions were conceptualized as perceived changes in magnitude of the injected areas and the lips, and they were measured using 1) a verbal subjective rating scale and 2) a warping procedure. Prior to the study, participants filled in several psychological questionnaires. This study shows that both nociceptive stimulation ($P < .05$) and transient blocking of nerve transduction ($P < .05$) can lead to perceptual distortion of the face. A test-retest experiment including 9 new healthy subjects supported the results. Perceptual distortions were positively correlated with the psychological variable of dissociation in several conditions ($P < .05$). Perceptual distortions may therefore be influenced by somatosensory changes and psychological mechanisms.

***Perspective:** Knowledge of the factors that influence the perception of the face is important to understand the possible implications of perceptual distortions in orofacial pain disorders (and possibly other chronic pain states). Such information may ultimately open up new avenues of treatment for persistent orofacial pain.*

***Key words:** Dissociation, local anesthesia, orofacial pain, painful stimulation, perceptual distortions of the face.*

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Seventeen to 26% of the population report having orofacial pain, and for 7 to 11%, the pain is persistent and thus substantially impacts the patients' quality of life.[4] Although most acute facial pain conditions can be managed efficiently, treatment of persistent orofacial pain remains insufficient.[7]

Anecdotally, patients suffering from persistent orofacial pain due to damage of nerve fibers sometimes report that the painful face area feels "swollen" or "different." As there are no clinical signs to support this, these reports may represent a kind of disrupted body image or a "perceptual distortion of the

face,"[14,22,24,37] and it can be speculated whether such phenomena may contribute to the maintenance of orofacial pain. Phrases such as "perceptual distortions" and "body image disruptions" have been used interchangeably and cover somewhat different phenomena. However, common to such phenomena is a kind of disturbance in the way an individual *perceives* his/her body.[14,24,37]

Perceptual distortions have been described following local anesthesia (LA), for example, the feeling of a "swollen lip" after dental treatment.[14,24,37] Such phenomena have been related to cortical reorganization. This theory is justified by studies showing that transient blocking of nerve transduction due to LA can cause functional reorganization of the primary somatosensory cortex (S1).[6,28] At present, no studies have systematically investigated perceptual distortions in orofacial pain patients. Nevertheless, perceptual distortions or body image disruptions have been observed in chronic pain states such as chronic back pain[21] and complex regional pain syndrome,[18,20] where patients perceive the painful area differently from what it really looks like. It is unknown, however, which factors mediate such perceptual distortions. We speculate that these pain-related perceptual distortions involve nociceptive stimulation. Therefore, this study tests whether nociceptive stimulation can cause perceptual distortions.

As psychological processes are also known to influence chronic pain,[16,35] it is relevant to test whether psychological phenomena such as dissociation,[5] pain catastrophizing,[31] somatosensory amplification,[2] depression,[3] and anxiety[30] also contribute to perceptual distortion of the face in a top-down manner.

This is the first controlled study to test whether nociceptive stimulation can entail perceptual distortions of the face in a way similar to that of local anesthetics. Sixteen healthy subjects were exposed to experimental pain to stimulate nociceptive receptors, LA to transiently block nerve transduction, and isotonic saline (ISO) injection as a control condition. Injections were performed in the infraorbital and mental nerve regions of the face. Nine additional healthy subjects participated in a test-retest experiment. The study was explorative, and perceptual distortions were measured via verbal subjective reports and a warping procedure. In addition, participants filled in a set of standardized psychological questionnaires in order to investigate if psychological variables interfered with the findings. Knowledge of factors that influence the perception of the face is important in order to understand the possible relation between orofacial pain and perceptual distortions. The following hypotheses were tested:

1. Nociceptive stimulation can lead to perceptual distortions of the face in a way similar to that of transient blocking of nerve transduction.
2. Psychological processes contribute to perceptual distortions of the face.

Methods

Participants

Sixteen healthy and pain-free participants were recruited to the main study (8 men and 8 women) (mean age = 22.9 years, standard deviation = 1.8) after they had given written informed consent. In a test-retest experiment, 9 additional healthy subjects were included (1 man and 8 women) (mean age = 23.4 years, standard deviation = 2.8). All participants were compensated with 750 Danish kroner for their participation. The study was approved by the local ethical committee of the Central Denmark Region (ESDH 1-10-72-139-12) and conformed to the Declaration of Helsinki.

Injections

In each session, participants were given an injection of either .4 mL hypertonic saline (HS; pH value 7.4) to evoke medium- to high-intensity pain for approximately 5 minutes, .4 mL LA (mepivacaine 10 mg/mL without vasoconstrictor [short duration]) to transiently block nerve transduction, or .4 mL ISO as a control condition. Although HS has frequently been injected into jaw muscles to induce experimental pain,[32] this is, to our knowledge, the first study to apply this procedure close to the trigeminal nerves.

Injection and Rating Sites

Injections were always administered on the right side of the face in the infraorbital nerve region (close to the infraorbital foramen) and the mental nerve region (close to the mental foramen). Injections followed the clinical guidelines for an infraorbital and mental nerve block.[23] These injection sites were selected because pilot testing had demonstrated that perceptual distortions could occur in these regions.

For injections in the infraorbital nerve region, participants were asked to evaluate perceptual distortions in both the infraorbital nerve region and the upper lip. Likewise, when injections were given in the mental nerve region, participants were asked to estimate perceptual distortions in the mental nerve region and the lower lip. This division was based on pilot testing and nerve anatomy, as the infraorbital nerve innervates the upper lip and the mental nerve innervates the lower lip. In practice, this meant that participants were instructed to focus on 2 different regions of the face when evaluating perceptual distortions following all injections.

Pain Measures

In all conditions, participants rated their pain intensity on a 0 (no pain) to 10 (worst imaginable pain) numerical rating scale.[15] Pain intensity measures relate to the painful sensations experienced in the test side of the face (the side that received the injections); thus, only 1 pain measure was obtained for each injection.