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My Brain Reads Pain in Your Face, Before Knowing Your Gender

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Abstract: Humans are expert at recognizing facial features whether they are variable (emotions) or unchangeable (gender). Because of its huge communicative value, pain might be detected faster in faces than unchangeable features. Based on this assumption, we aimed to find a presentation time that enables subliminal discrimination of pain facial expression without permitting gender discrimination. For 80 individuals, we compared the time needed (50, 100, 150, or 200 milliseconds) to discriminate masked static pain faces among anger and neutral faces with the time needed to discriminate male from female faces. Whether these discriminations were associated with conscious reportability was tested with confidence measures on 40 other individuals. The results showed that, at 100 milliseconds, 75% of participants discriminated pain above chance level, whereas only 20% of participants discriminated the gender. Moreover, this pain discrimination appeared to be subliminal. This priority of pain over gender might exist because, even if pain faces are complex stimuli encoding both the sensory and the affective component of pain, they signal a danger. This supports the evolution theory relating to the necessity of quickly reading aversive emotions to ensure survival but might also be at the basis of altruistic behavior such as help and compassion.

***Perspective:** This study shows that pain facial expression can be processed subliminally after brief presentation times, which might be helpful for critical emergency situations in clinical settings.*

***Key words:** Masked facial features, pain facial expression, reportability, sensitivity, area under the receiver operating characteristic curve.*

The intensity and unpleasantness of pain experienced by an individual can be measured only through self-assessment, most commonly using self-report scales (eg, visual analog scale). However, there can be discrepancies between nonverbal behavior and the patients' level of pain assessed by such scales, particularly in patients with chronic pain.[26,78] Moreover, such assessments are impossible in non-communicative patients or patients with dementia[49] and are suggested to be unsuitable for children younger than 8 years.[9,72,73] To overcome these limits, one method is to examine behavioral features of the sufferer. Among the different behavioral markers of pain, facial expression is one of the most reliable and specific.[14] Facial expression of pain has been shown to encode both the affective (unpleasantness) and the sensory (intensity) dimensions of pain[46] and can communicate both a warning signal of threat and a plea to elicit altruistic behavior such as help or compassion.[83]

The recognition of a face is a complex process that requires the extraction of specific components, involving the changeable aspects (including expressions and eye or lip movements) on the one hand, and the invariant aspects (including identity, familiarity, gender, and ethnicity) on the other hand.[12,36] Some arguments in the literature converge on the hypothesis that these two classes of facial attributes could be processed separately,[20,25,37,60] but this is still a matter of debate.

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Facial emotional features can be analyzed outside awareness[1,56,85,86] and trigger preattentive capture of attention.[56,81] Data from behavioral and functional brain imaging studies suggest that emotional information can be extracted from a face and can affect neural activity, even when faces are presented at levels thought to be below consciousness.[3,4,80,84]

A quick and unambiguous discrimination of others' pain facial expressions signaling dangerous situations might also be useful for real-time measurement of pain during physical examination in clinical settings.[65]

In this study, we aimed to assess 1) if the face presentation time (from 50 to 200 milliseconds) needed to discriminate pain versus another negative emotion is shorter than that needed to discriminate an invariant facial feature (gender) using a forward-backward masking paradigm known to block the conscious representation access of the visual stimulus[15,19,33,38,41,42,44]; and 2) whether for this minimal time slot needed for pain signal extraction, this pain discrimination is a subliminal process according to Dehaene taxonomy,[18] by evaluating participants' subjective reports.

Methods

Participants and General Procedure

One hundred and twenty healthy students (60 men and 60 women; mean age = 23.77 ± 5.08 years) were recruited from the University of Lyon 2, France. All participants were volunteers, provided written informed consent, and were not paid for their participation. The ethics of this study were approved by the ad hoc committees of the Neurosciences and Cognition Doctoral School (Lyon 1 University) and the Institute of Psychology (Lyon 2 University). None of the participants reported any neurologic or psychiatric history and none were taking any medication such as antidepressant or analgesic drugs. Medical students were excluded because it has been documented that expertise with pain can modulate pain perception in others.[13] All participants had normal or corrected-to-normal visual acuity and were naive to the stimuli used.

Among these participants, 80 performed the tasks designed to evaluate the presentation time needed to discriminate pain expression and gender from a face. We evaluated the Empathy Quotient (EQ) of our participants by the validated French version[8] of the EQ questionnaire (score range = 0–80) to evaluate if our population of participants had no trouble in their empathic behavior that could have biased their perception of emotional faces. The average score was 39.33 (standard deviation [SD] = 10.08), which is generally thought to represent people who know how to treat people with care and sensitivity.[5] The 40 other participants participated in the reportability testing.

The experiments were conducted individually in a softly lit and soundproof experimental room and the images were presented using an ASUSTeK laptop (Asus; Taipei, Taiwan; 43-cm [17-in] color screen; 6.00 GB RAM; Intel HD 4000 Graphics Card). Participants were sitting on a chair and their eyes were positioned 90 cm from the screen so that the stimulus angular size was 6°. The images were displayed at the center of a uniform black background. The refresh rate of the screen was set at 50 Hz. Stimuli were displayed and responses were recorded using Presentation software (version 16.3; Neurobehavioral Systems).

Pain and Gender Discrimination Experiment

Design and Procedure

Participants had to perform 2 forced-choice tasks, a pain discrimination task (PDT) and a gender discrimination task (GDT), in a counterbalanced order, separated by completion of the interference part of the Stroop test[79] as a distraction task. For both PDT and GDT, the pictures appeared on the screen for 50, 100, 150, or 200 milliseconds, using a backward and forward visual masking paradigm.[41,43] The range of presentation time was determined after a pilot study (N = 23) showing that participants discriminated the signal at chance level for 50 milliseconds of presentation and above chance level for 200 milliseconds of presentation. The masks were always presented 200 milliseconds before and after the picture to be discriminated (ie, the signal), whatever the presentation time. To avoid any possible learning process that could ameliorate participants' performances during each discrimination task, the block of pictures was presented only once to each participant. Each set of stimuli (mask-picture-mask) was preceded and followed by a fixation cross on a black screen, the duration of which varied randomly between 1600 and 1900 milliseconds (see Fig 1 for the sequence of events). Participants were randomly assigned to 4 experimental groups (n = 20 for each group, corresponding to the 4 different durations of the signal).

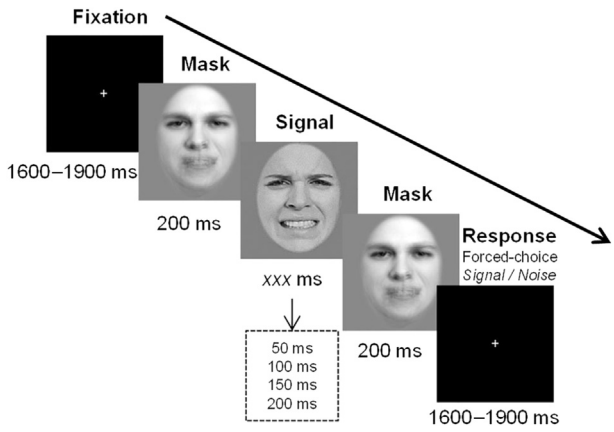

Figure 1. Experimental paradigm for the forced-choice PDT in which pain faces (signal) are presented for different durations. Presentation times for the cross-fixation and the masks were fixed. The GDT paradigm was the same but with male faces as the signal. The picture used for this illustration is from the database developed by Frederic Gosselin and colleagues[68,69] freely available on the Internet (http://www.mapageweb.umontreal.ca/gosselif/sroyetal_sub.pdf) and is reproduced with permission of the authors.