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Original

Validation of the Montreal Pain and Affective Face Clips (MPAFC): The role of sex and participants' pain status

Elena Robles, Carmelo Vazquez

Department of Clinical Psychology, Complutense University of Madrid, Spain

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A B S T R A C T

Background: The use of pain-related stimuli in experimental psychology studies has increased in the last few years. Consequently, various sets of stimuli have been created for this purpose. *Aims:* To analyze the validity of the pain faces of Montreal Pain and Affective Face Clips (MPAFC), in Spanish participants with and without pain. *Method:* A total of 291 participants completed psychological self-report and pain measures and were asked to rate the prototypicality and emotional intensity of the eight pain-related faces from the MPAFC by rating. The sample was divided into three groups depending on the participants' pain status (chronic, acute, or pain-free). *Results:* Three of the eight pain faces did not reach a higher rating than 5 (on a 0-10 points scale) in both dimensions. Regarding the pain status, there were no significant differences in the ratings between groups of participants. Female faces were rated as significantly more prototypical and emotionally intense than male faces. Limitations: As we used the last image of every clip, this study is based just on static images of the pain facial expression, which may be less representative of the emotion. *Conclusion:* Overall, the presence of pain in participants did not significantly affect their assessment of the faces. Female faces were significantly rated as more prototypical and more emotionally intense than male faces. From our results, we conclude that experimental studies about pain should explore and report the validity of the selected stimuli to optimize the adequacy of the stimuli.

Validación del set Montreal Pain and Affective Face Clips (MPAFC): rol del sexo y estado de dolor de los participantes

Palabras clave:
Expresiones faciales
Validez
Dolor
Estímulos emocionales

R E S U M E N

Antecedentes: El uso de estímulos relacionados con el dolor en los estudios de psicología experimental ha aumentado en los últimos años. En consecuencia, se ha creado una variedad de conjuntos de estímulos para este fin. *Objetivos:* Analizar la validez de las caras de dolor del Montreal Pain and Affective Face Clips (MPAFC), en participantes españoles con y sin dolor. *Método:* Un total de 291 participantes completaron medidas psicológicas de autoinforme y de dolor y valoraron la prototipicidad y la intensidad emocional de las ocho caras de dolor del MPAFC. La muestra se dividió en tres grupos en función del dolor de los participantes (crónico, agudo o sin dolor). *Resultados:* Tres de las ocho caras de dolor no alcanzaron una valoración superior a 5 (en una escala de 0-10 puntos) en ambas dimensiones. En cuanto al estado de dolor, no hubo diferencias significativas en las puntuaciones entre los grupos. Los rostros femeninos se calificaron como significativamente más prototípicos y emocionalmente más intensos que los masculinos. Limitaciones: Este estudio se basa sólo en imágenes estáticas de la expresión facial del dolor, que pueden ser menos representativas de la emoción. *Conclusiones:* En general, la presencia de dolor en los participantes no afectó significativamente a su valoración de los rostros. Los rostros femeninos fueron valorados significativamente como más prototípicos y más intensos emocionalmente que los masculinos. Como conclusión, los estudios experimentales sobre dolor deberían explorar e informar sobre la validez de los estímulos seleccionados para optimizar la adecuación de los estímulos.

* Corresponding author.
E-mail address: cvazquez@psi.ucm.es (C. Vazquez).

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Introduction

The study of visual attention has become a standard strategy to assess cognitive biases toward specific stimuli. A variety of experimental tasks (e.g., dot-probe, Stroop test, visual search, or free viewing tasks) have been developed to assess visual attentional biases in pain and healthy individuals. For instance, the dot-probe task, which has been one of the most applied methods to study attentional biases in emotional problems like depression (Winer & Salem, 2016) or social anxiety (Bantin et al., 2016), has also been used to analyze biases in chronic and acute pain (Todd et al., 2018).

Most of these traditional experimental approaches to studying attentional biases have been rooted in the analyses of reaction times, which has some limitations as the speed of response is not necessarily a direct measure of bias (Waechter & Stolz, 2015; Rodebaugh et al., 2016; Duque & Vazquez, 2018). Alternatively, attentional biases can be better explored with eye-tracking technology, which allows for analyzing eye movements in the presence of visual stimuli (Martínez-Conde et al., 2004). Using this approach, attentional biases have been widely studied in different disorders such as depression (Duque & Vazquez, 2015), anxiety (Günther et al., 2021), and eating disorders (Ralph-Nearman et al., 2019), among others.

Besides attentional biases towards pain-related visual stimuli, the experimental literature has found that other cognitive variables are also associated with pain conditions. For example, pain catastrophizing (i.e., the tendency to increase the threat value of the pain stimulus and to experience helplessness in the context of pain) has been associated not only with higher pain intensity levels (Severeijns et al., 2001) but also with attentional biases towards pain-related stimuli (Lee et al., 2018; Ranjbar et al., 2020). Anxiety sensitivity (i.e., the belief that anxiety symptoms or arousal can have harmful consequences) has also been associated with pain intensity and interference (Rogers et al., 2022), and with fearful appraisals of pain (Ocañez et al., 2010). In a study by Keogh and Cochrane (2002), it was found that participants with higher levels of anxiety sensitivity exhibited a greater interpretative bias and reported more negative pain experiences than participants with lower levels of anxiety sensitivity. Thus, these two cognitive aspects seem to have a key role in the perception of pain-related information and, consequently, were also assessed in the present validation study.

A variety of images, words, and faces sets have been validated and used as experimental stimuli to analyze the attentional biases toward emotional information. In the field of the study of pain, pain-related faces have been used to explore attentional biases. One of the most widely used sets of faces is the Montréal Pain and Affective Face Clips (MPAFC). It consists of a set of 64 standardized dynamic stimuli created by Simon et al., (2008), showing the facial change of eight models (4 male, 4 female) from a neutral state to a full expression of eight different emotions (including pain). The MPAFC has been used in different types of psychological problems and conditions, such as depression (Trapp et al., 2018), anxiety sensitivity (Schoth et al., 2016) or optimism (Peters et al., 2016), but has been also used in a variety of eye-tracking studies with chronic pain population (Liossi et al., 2014; Schoth et al., 2015; Priebe et al., 2021; Jones et al., 2021) as it also includes the emotion of pain.

Regarding differences in emotional recognition between men and women, previous studies (Proverbio, 2017; Plouffe-Demers et al., 2022) and meta-analyses (Thompson & Voyer, 2014) have observed that men and women show differences in the recognition and perception of emotional expressions. It has been found that women are faster and more accurate at recognizing facial expressions than male (Saylik et al., 2018; Wingenbach et al., 2018). However, although this superiority of women in terms of emotion recognition has been observed independently of the actor's sex (Thayer & Johnsen, 2000) other studies have found that women are better at recognizing female emotional expressions in comparison to male ones (Lewin & Herlitz, 2002). Given this controversy, we decided to incorporate an analysis of the effect of the sex of the model and participant in our study.

In summary, the present study aims to validate the pain faces of the Montréal Pain and Affective Face Clips (MPAFC) in the Spanish population. To carry out the study, individuals with and without chronic pain assessed all the pain-related images included in the database. Following previous studies (e.g., Sánchez & Vázquez, 2013), we assessed the prototypicality (or typicality, that is, the extent to which a specific face represents the category of pain) (Rosch, 1988) and the emotional intensity of every pain expression. To facilitate the assessment of each face in terms of prototypicality and intensity, we selected the anchor-point procedure (Sánchez & Vázquez, 2013). In this procedure, participants compare the pain face to a neutral face from the same actor or actress representing that emotion. Furthermore, as attentional biases toward pain information have been found not only in patients with chronic pain but also in patients suffering from acute pain (Haggman et al., 2010; Skinner et al., 2021), we decided to analyze possible differences in the assessment of faces in both samples of participants and healthy control individuals. The last objective of this study was to explore sex differences in the assessment of pain facial expressions but also the effect of the sex of the individual representing the emotion. We hypothesized that all eight pain faces of the MPAFC would reach values of prototypicality and intensity that make them adequate to be used in further experimental studies. We also hypothesized that participants suffering chronic or acute pain would perceive the pain faces as more prototypical of the pain emotion than healthy participants, as it has been considered that chronic and acute pain experiences are explained by different mechanisms and have different physical and emotional consequences (Cohen et al., 2021), which may affect the perception of emotional stimuli such as pain facial expressions. Finally, we explored whether the sex of participants was related to their respective assessments of prototypicality and intensity of male and female faces expressing pain. We hypothesized that women would perceive female faces as more representative and/or emotionally intense than male ones.

Method

Participants

A total of 291 participants took part voluntarily in the study. The sample was drawn from two main sources: 1) undergraduates who were recruited through messages at the Psychology School and 2) individuals from the general population, who were recruited through the Complutense Psychology School and Nirakara (an institute for research and training on mindfulness and cognitive sciences). Announcements in social networks were also used to recruit students and the general population. The only inclusion criteria to participate in the study were being older than 18 and being fluent in Spanish. The sample was composed of 221 women and 69 men (one participant preferred not to answer), with a mean age of 30.29 (*SD*=14.23).

Based on the *International Association for the Study of Pain* (IASP), which considers chronic pain to last longer than 3 months (Treede et al., 2015), the entire sample (including students and the general population from the research institute) was divided into three groups according to their pain status and duration: an acute pain group (with pain duration under 3 months), a chronic pain group (with pain duration over 3 months), and a current pain-free group. The demographic characteristics of the three groups are shown in Table 1. The pain-free group was composed of 188 participants (51 men and 137 women), with a mean age of 26.88 (*SD* =10.95; range=18-70 years). The acute pain group was composed of 35 participants (6 men, 28 women, and 1 person who preferred not to answer), with a mean age of 26.71 (*SD*=12.10, range=18-66 years). The chronic pain group was composed of 68 participants (12 men and 56 women), with a mean age of 41.53 (*SD*=17.31, range=18-75 years).

Stimuli

The Montréal Pain and Affective Face Clips (MPAFC) is a set of emotional face clips created by Simon et al., (2008). It consists of 64 one-second film clips of 4 men and 4 women who imitate prototypical facial expressions of pain, happiness, sadness, anger, disgust, fear, surprise, and neutral emotions. Figure 1 shows the eight individuals' neutral and pain faces included in the dataset which were included in our study. Due to the purpose of this study, only pain and neutral faces were included in the validation task.

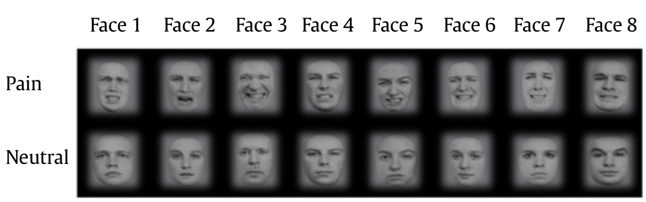

Figure 1. Neutral and pain-related facial expressions from the eight clips of the Montréal Pain and Affective Faces Clips (MPAFC).

As most experimental studies in the field of pain until now have employed static stimuli, all clips were converted to pictures of every face by selecting the final part of every clip, to explore between-groups differences (e.g., pain status, sex) in the perception of these types of stimuli. Furthermore, as in previous studies (Calvo & Lundqvist, 2008; Sanchez et al., 2013; Sanchez & Vazquez, 2013), the surrounding areas of the faces (including hair and neck) were darkened to remove irrelevant aspects of the faces that may affect the perception and assessment of each image.

Instruments

Before starting the validation task, participants were asked to answer the following psychological measures:

Pain-related questions. For participants suffering from pain, specific questions related to pain intensity, interference, and duration were included.

Mood Evaluation Scale (EVEA). It consists of 16 items assessing four current mood states (anxiety, anger-hostility, sadness-depression, and joy) with four items for each mood. Each item is scored by using an 11-point Likert scale from 0 (nothing) to 10 (a lot). For this study, the Spanish version of this scale was used (Sanz, 2001). We added four items to assess other processes that may occur when performing demanding experimental tasks (bored, tired, entertained, and curious). In our study, the EVEA showed high internal consistencies for the sadness-depression (α=0.86), anxiety (α=0.89), anger-hostility (α=0.92), and joy subscale (α=0.88).

Patient Health Questionnaire (PHQ-9). The PHQ-9 measures the severity of depression through the rating of the nine items included in the diagnosis of major depression (APA, 2013), from 0 ("not at all") to 3 ("nearly every day"). The PHQ-9 had good internal consistency in this study (α=.86).

Pain Catastrophizing Scale (PCS). This is a 13-item scale measuring three aspects of pain catastrophizing (rumination, magnification, and helplessness) and a total score (Sullivan et al., 1995). Participants are asked to rate their responses on a five-point Likert scale ranging from 0 (not at all) to 4 (always). The PCS showed good internal consistency for total PCS (α=.93), rumination (α=.91), magnification (α=.68), and helplessness (α=.88) in this study.

Anxiety Sensitivity Index (ASI-3). It is an 18-item scale assessing the consequences of symptoms associated with anxiety. Participants are asked to indicate their agreement with each item from 0 ("very little") to 4 ("very much"). Total scores range from 0 to 72. The ASI-3 contains three subscales related to social, physical, and psychological concerns, and it showed high internal consistency in this study (α=.91).

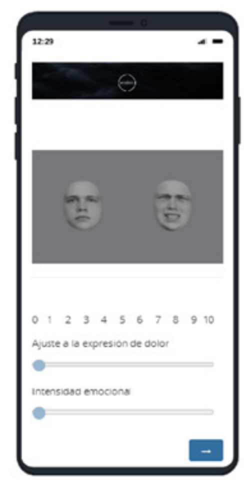

Figure 2. Example of a simultaneous presentation of neutral versus pain faces used in the validation task (i.e., anchor-point method).

Procedure

As in other similar validation studies (e.g., Duque et al., 2023), the study was conducted online through Qualtrics (Provo, UT, 2017). Before starting the task, the participants received a link with an invitation to take part in the study. Then, they filled in the informed consent and the set of self-report questionnaires. After that, the validation task started. Each trial started with a pair of pain-neutral faces that appeared on the screen. Participants were asked to rate two dimensions of every pain face (prototypicality and emotional intensity) by using two different Likert scales, with a range from 0 ("not at all") to 10 ("extremely"). Higher scores reflect that the pain face is highly prototypical and emotionally intense, while lower scores reflect that the pain face is not very prototypical and emotionally intense. Figure 2 shows an example of how the stimuli were presented in each trial. To minimize spatial location effects (Blanco, et al., 2021), each pair of pain-neutral faces was randomly presented twice (one with the emotional face on the left side and the other on the right side). The completion of the self-reported measures and the validation task lasted 15 minutes.

Table 1.
Demographic and clinical data of the groups.

	Pain-free (N= 188) Mean (SD)	Acute pain (N=34) Mean (SD)	Chronic pain (N=69) Mean (SD)	F	p
Age	26.88 (10.95)	25.88 (11.22)	41.73 (17.26)	35.92	<.001
	N (%)	N (%)	N (%)	χ^2	*p*
Women (%)	137 (72.9)	27 (81.8)	57 (82.6)	3.28	.19
Education				2.72	0.84
Primary school	9	1	6		
High school	67	14	22		
University graduate	82	13	29		
University post-graduate	30	6	12		
Race or ethnic group				16.17	0.18
White	172	31	67		
Black/African	1	1	0		
Asian	2	0	1		
North African	2	0	0		
Hispanic	8	0	0		
Romani	1	0	1		
Prefer not to answer	2	2	0		
Pain diagnosis	-			7.81	0.16
Musculoskeletal pain		13	43		
Headache	-	5	10		
Orofacial pain	-	4	2		
Stomachache	-	5	5		
Other types of pain	-	7	9		
Pain intensity	-			6.82	0.07
Mild		16	17		
Moderate	-	15	36		
Strong	-	3	13		
Unbearable	-	0	3		
Pain duration	-		-	103.00	<.001
Less than 1 month		26			
1-3 months	-	8	-		
3-12 months	-	-	3		
More than 1 year	-	-	66		
Interference				18.75	<.001
None	-	13	5		
A bit	-	17	38		
Quite	-	4	18		
Very much	-	0	8		

Data analyses

Firstly, means and standard deviations were calculated for the prototypicality and emotional intensity of every face for the entire sample (*N*=291). After that, means and standard deviations were calculated for the three subgroups of participants. Cronbach's alpha coefficient was calculated for prototypicality and emotional intensity to explore the reliability of the ratings.

Secondly, a series of one-way ANOVAs were carried out to explore differences between the three groups of participants on prototypicality and emotional intensity, followed by post hoc analyses using Bonferroni tests.

Thirdly, the effect of sex in the assessment of pain faces was analyzed following two strategies. On one hand, we analyzed the sex differences of participants on the mean scores in prototypicality and emotional intensity by using a series of t-tests. On the other hand, we also analyzed the interaction between the sex of the models and the participants using a 2x2 ANOVA on the prototypicality and intensity scores.

Finally, to explore the influence of psychological variables (e.g. pain catastrophizing) in the perception of the pain-related faces, correlational analyses were conducted. Furthermore, subgroups were created according to the levels of PCS, ASI-3, and PHQ-9 to explore differences in the stimuli ratings.

Results

Demographics and clinical status

Table 1 shows the demographics and self-reported clinical information of the sample. Groups were statistically different in age [$F(2, 291)=33.62$; $p<.001$]. Individuals in the chronic pain group were older than those in the pain-free and acute pain groups. Participants with chronic pain in general reported more severe levels of pain intensity, interference, and longer-lasting conditions than those in the acute pain group.

Table 2.
Means and standard deviations for psychological measures of all participant groups.

	Pain-free (N= 188)	Acute pain (N=35)	Chronic pain (N=68)		
	Mean (SD)	Mean (SD)	Mean (SD)	F	*p*
EVEA Sadness-Depression	2.57 (2.01)	5.02 (2.09)	3.65 (2.56)	21.16	<.001
EVEA Anxiety	3.31 (2.51)	4.19 (2.77)	4.50 (2.60)	6.06	0.003
EVEA Anger-hostility	1.54 (1.96)	2.92 (2.63)	3.09 (2.64)	14.95	<.001
EVEA Joy	5.43 (2.14)	3.97 (2.19)	4.36 (2.32)	10.32	<.001
PCS Rumination	10.73 (4.01)	9.82 (4.35)	10.53 (4.34)	0.70	0.49
PCS Magnification	6.97 (2.44)	7.05 (3.00)	6.92 (2.51)	0.03	0.97
PCS Helplessness	12.56 (4.84)	11.32 (5.03)	14.30 (5.62)	4.69	0.01
PCS Total	30.27 (10.17)	28.20 (11.08)	31.76 (11.40)	1.31	0.26
ASI Physical	7.51 (5.69)	7.50 (4.93)	8.50 (6.14)	0.79	0.45
ASI Cognitive	5.17 (5.18)	4.91 (5.54)	6.79 (6.45)	2.40	0.09
ASI Social	9.44 (6.04)	10.32 (4.99)	9.89 (6.29)	0.38	0.67
PHQ-9	8.82 (5.7)	10.61 (5.89)	12.08 (6.71)	7.83	<.001

Note. EVEA = Scale for Mood Assessment; PCS = Pain Catastrophizing Scale; ASI = Anxiety Sensitivity Index; PHQ-9 = Patient Health Questionnaire.

Psychological measures

Means and standard deviations for psychological measures are shown in Table 2. The three groups were similar in the level of rumination, magnification, and the three subscales of the ASI-3 (physical, psychological, and social concerns). However, they were statistically different in EVEA subscales: sadness-depression [$F(2, 291)=21.16$; $p<.001$], anxiety [$F(2, 291)=6.06$; $p=0.003$], anger-hostility [$F(2, 291)=14.95$; $p<.001$] and joy [$F(2, 291)=10.32$; $p<.001$]. The groups were also different in the helplessness subscale of PCS [$F(2, 291)=4.69$; $p=0.01$] and PHQ-9 score [$F(2, 291)=7.83$; $p<.001$]. Bonferroni post hoc analyses revealed that individuals with either acute pain or chronic pain showed higher levels of sadness-depression than the pain-free group. Furthermore, individuals with acute pain presented higher levels of sadness-depression than the chronic pain group. Regarding anxiety, the chronic pain group showed higher levels of anxiety than the pain-free group. Both the acute and chronic pain groups showed higher levels of anger-hostility and lower levels of joy than people without pain. Finally, the chronic pain group presented higher levels of helplessness than the other two groups and higher levels of depression symptoms, as assessed by the PHQ-9, than the pain-free group.

Validation of the pain-related faces

Firstly, the means and standard deviations for prototypicality and emotional intensity of all faces, for the entire sample ($N=291$), are shown in Figure 3. For the prototypicality dimension, only face 1 ($M=6.00$; $SD=1.98$), face 2 ($M=6.71$; $SD=1.99$), face 6 ($M=5.54$; $SD=2.28$), and face 7 ($M=5.82$; $SD=2.25$) were rated over 5 points out of 10. For emotional intensity, only face 1 ($M=5.33$; $SD=2.14$), face 2 ($M=6.12$; $SD=2.32$), face 3 ($M=5.59$; $SD=2.75$), face 6 ($M=5.19$; $SD=2.19$) and face 7 ($M=5.45$; $SD=2.36$) were rated over 5 points out of 10.

	Face 1	Face 2	Face 3	Face 4	Face 5	Face 6	Face 7	Face 8
Prototypicality	6.00 (1.98)	6.71 (1.99)	4.13 (3.14)	3.57 (3.05)	4.69 (2.12)	5.54 (2.28)	5.82 (2.25)	4.30 (2.21)
Intensity	5.33 (2.14)	6.12 (2.32)	5.59 (2.75)	3.16 (2.05)	4.33 (2.19)	5.19 (2.19)	5.45 (2.36)	3.80 (2.23)

Figure 3. Means and standard deviations for all pain faces from the MPAFC in the entire sample of participants.

Secondly, means and standard deviations for prototypicality and emotional intensity were calculated for the three groups (Table 3). To explore between-group differences, a series of one-way ANOVAs were conducted. Regarding the prototypicality of stimuli, there were no significant differences between groups for any face: face 1 [$F(2, 291)=0.54$; $p=0.57$], face 2 [$F(2, 291)=0.69$; $p=0.50$], face 3 [$F(2, 291)=0.48$; $p=0.61$]; face 4 [$F(2, 291)=1.52$; $p=0.22$], face 5 [$F(2, 291)=0.12$; $p=0.88$], face 6 [$F(2, 291)=0.82$; $p=0.43$], face 7 [$F(2, 291)=0.07$; $p=0.92$], and face 8 [$F(2, 291)=1.18$; $p=0.30$]. Concerning the emotional intensity, there were no significant differences between groups for any face: face 1 [$F(2, 291)=1.29$; $p=0.27$], face 2 [$F(2, 291)=0.10$; $p=0.90$], face 3 [$F(2, 291)=1.41$; $p=0.24$], face 4[$F(2, 291)=1.00$; $p=0.36$], face 5 [$F(2, 291)=0.28$; $p=0.75$], face 6 [$F(2, 291)=1.58$; $p=0.20$], face 7 [$F(2, 291)=0.45$; $p=0.63$], and face 8 [$F(2, 291)=0.85$; $p=0.42$].

Analyses were controlled for age and psychological measures, finding a significant effect of PHQ-9 on the prototypicality of pain faces [$F(2, 291) = 5.76$; $p = .017$], which indicates that individuals with higher PHQ-9 scores rated the pain faces as more prototypical of the pain emotion. For the rest of the variables, there were no significant effects.

To test the reliability of the anchor-point method used in our study, Cronbach's alpha values were calculated for prototypicality and emotional intensity. Excellent internal consistencies were found for prototypicality ($\alpha=0.90$) and emotional intensity ($\alpha=0.91$).

Sex differences

Table 4 shows the means and standard deviations for prototypicality and emotional intensity according to the participants' sex. A series of t-tests were used to analyze differences in prototypicality and emotional intensity ratings between male and female participants. For prototypicality, there were significant differences between groups in face 3 ($t=3.58$; $p<.001$) and face 5 ($t=2.15$; $p=0.03$). Men rated those two faces as being more prototypical of pain (Face 3: $M=5.26$, $SD=2.99$; Face 5: $M=5.18$, $SD=2.11$) than women (Face 3: $M=3.78$, $SD=3.11$; Face 5: $M=4.55$, $SD=2.11$). Regarding emotional intensity, there were significant differences between groups in face 1 ($t=-2.62$; $p=0.009$), face 2 ($t=-2.04$; $p=0.04$) and face 7 ($t=-2.23$; $p=0.02$). Women rated those faces as expressing more intense pain (Face 1: $M=5.52$, $SD=2.14$; Face 2: $M=6.27$, $SD=2.30$; Face 7: $M=5.62$, $SD=2.37$) than men (Face

Table 3.
Means and standard deviations for prototypicality and emotional intensity ratings of the participant groups.

	Pain-free		Acute Pain		Chronic Pain	
	Prototypicality Mean (SD)	Intensity Mean (SD)	Prototypicality Mean (SD)	Intensity Mean (SD)	Prototypicality Mean (SD)	Intensity Mean (SD)
FACE 1	5.92 (2.05)	5.22 (2.13)	6.29 (1.52)	5.20 (2.03)	6.06 (2.01)	5.69 (2.20)
FACE 2	6.62 (2.05)	6.11 (2.36)	7.02 (1.75)	5.97 (2.17)	6.81 (1.95)	6.19 (2.32)
FACE 3	4.22 (3.15)	5.76 (2.72)	3.64 (3.15)	4.94 (2.79)	4.11 (3.12)	5.46 (2.81)
FACE 4	3.43 (1.9)	3.11 (1.86)	3.63 (1.89)	2.86 (1.96)	3.93 (2.47)	3.43 (2.53)
FACE 5	4.73 (2.02)	4.3 (2.13)	4.54 (2.25)	4.16 (2.06)	4.65 (2.35)	4.58 (2.42)
FACE 6	5.61 (2.14)	5.3 (2.05)	5.07 (2.47)	4.57 (1.92)	5.59 (2.53)	5.20 (2.64)
FACE 7	5.84 (2.16)	5.52 (2.25)	5.89 (2.07)	5.10 (2.27)	5.73 (2.59)	5.43 (2.69)
FACE 8	4.22 (2.1)	3.74 (2.14)	4.05 (2.15)	3.55 (1.77)	4.65 (2.50)	4.09 (2.63)
TOTAL	5.07 (1.67)	4.88 (1.73)	5.02 (1.67)	4.54 (1.56)	5.19 (2.03)	5.00 (2.14)

1: *M*=4.75, *SD*=2.05; Face 2: *M*=5.62, *SD*=2.35; Face 7: *M*=4.89; *SD*=2.28).

To explore the interaction between the sex of the participants and the sex of the individuals expressing the emotion, a 2 (participants' sex) x 2 (model) ANOVA was conducted for both prototypicality and emotional intensity. For prototypicality, there were no main effects for participants' sex [$F(1, 290)= 1.06$; $p=0.30$], but there was a significant effect for model [$F(1, 290)= 172.97$; $p<0.001$], indicating that female faces (*M*=5.72; *SD*=0.13) were significantly judged as more prototypical of pain than male faces (*M*=4.62; *SD*=0.12). This significant main factor was qualified by a significant interaction effect [$F(1, 290)= 4.53$; $p=0.03$]. Bonferroni's post-hoc tests showed that both men and women rated the prototypicality of female faces higher than male ones. For emotional intensity, there were no main effects for the participant's sex [$F(1, 290)=2.22$; $p=0.13$) or the interaction effect [$F(1, 290)=0.07$; $p=0.78$]. However, a significant effect for the model [$F(1, 290)=95.55$; $p<0.001$], revealed that female faces (*M*=5.17; *SD*=0.13) were judged to reflect more pain intensity than male ones (*M*=4.38; *SD*=0.12).

Correlational Analysis

Correlational analyses were conducted to explore the association between both dimensions (prototypicality and emotional intensity) and psychological measures. There was a small but significant correlation between prototypicality and PCS Rumination (r = .12; p = .037) and ASI-3 total score (r = .11, p = .046). This result shows that irrespective of the pain status, individuals with higher levels of anxiety sensitivity and rumination rated the pain faces as more prototypical of the pain emotion than those with lower levels.

Regarding emotional intensity, it was significantly correlated with PCS Helplessness (r =.13; p =.018), which indicates that individuals with higher levels of helplessness rated the pain faces as more emotionally intense in comparison to those with lower levels of helplessness.

Influence of ASI-3, PCS, and PHQ-9 on facial perception

To explore the influence of some psychological variables in the perception of the pain faces, the entire sample was divided into two groups depending on their levels of pain catastrophizing, anxiety sensitivity, and depression, not finding significant between-groups differences in the prototypicality and emotional intensity scores. However, when comparing individuals with higher versus lower levels of pain catastrophizing, anxiety sensitivity, or depression in every group, it was found a significant effect of anxiety sensitivity in the pain-free group (t = -2.002; p = .04), which shows that healthy individuals with higher levels of anxiety sensitivity (*M* = 5.62; *SD* = 1.79) rated the pain faces as more prototypical than those with lower levels of anxiety sensitivity (*M* = 4.97; *SD* = 1.63). There was also a significant effect of pain catastrophizing in the chronic pain group (t = -2.17; p = .03), indicating that chronic pain individuals with higher levels of pain catastrophizing (*M* = 5.67; *SD* = 2.20) rated the pain faces as more prototypical than those with lower levels of pain catastrophizing (*M* = 4.78; *SD* = 1.79). There were no significant between-group differences for depression.

Table 4.
Means and standard deviations for prototypicality and emotional intensity ratings according to the participant's sex.

	Male participants		Female participants	
	Prototypicality Mean (SD)	Intensity Mean (SD)	Prototypicality Mean (SD)	Intensity Mean (SD)
FACE 1	5.85 (1.94)	4.75 (2.05)	6.06 (1.99)	5.52 (2.14)
FACE 2	6.60 (2.03)	5.62 (2.35)	6.76 (1.98)	6.27 (2.30)
FACE 3	5.26 (2.99)	5.10 (2.55)	3.78 (3.11)	5.75 (2.81)
FACE 4	3.76 (2.03)	3.38 (1.97)	3.52 (2.06)	3.09 (2.08)
FACE 5	5.18 (2.11)	4.18 (2.09)	4.55 (2.11)	4.37 (2.23)
FACE 6	5.71 (2.22)	5.18 (2.27)	5.50 (2.29)	5.19 (2.18)
FACE 7	5.54 (2.11)	4.89 (2.28)	5.92 (2.29)	5.62 (2.37)
FACE 8	4.47 (2.17)	3.59 (1.80)	4.26 (2.23)	3.87 (2.35)
TOTAL	5.29 (0.86)	4.58 (0.79)	5.04 (1.17)	4.96 (1.08)

Discussion

The main goal of this study was to validate the pain-related stimuli from the Montréal Pain and Affective Faces Clips (MPAFC) in Spanish samples with different conditions of pain. To that end, individuals from the general population were recruited and divided into three groups depending on the presence and characteristics of pain. All participants rated each face according to two dimensions (i.e., prototypicality and emotional intensity).

Regarding our first hypothesis on the overall adequacy of the pain faces from the MPAFC, not all the faces reached adequate values in the domains measured in our study. Although there is no golden criterion to quantitatively define the optimal values of prototypicality and intensity of the selected emotional faces, a conservative criterion could be that they should at least obtain a score of 5 (on a scale of 0 to 10) in both parameters (see Figure 3). Considering the mean scores of the faces in the total sample of participants, only four faces met this criterion. This low representativeness could be explained by the fact that although some facial actions accompany pain, such as raising the cheeks or wrinkling the nose (Craig, et al., 2011), the pain facial expression shares some similarities with other emotional facial expressions, such as disgust (Kunz et al., 2013), what may lead to less clear classifications compared to other emotional facial expressions. Our second hypothesis was not confirmed either, as there were no significant differences between groups (i.e., pain-free, acute pain, or chronic pain) in assessing the prototypicality and intensity of the faces.

Reliability analyses showed a high internal consistency for the two dimensions analyzed (prototypicality and emotional intensity). Previous studies using arousal, intensity, and valence ratings to validate the MPAFC found similar reliability levels (Simon et al., 2008).

Our third aim was to explore sex differences associated with the ratings of pain-related faces, which have not been sufficiently analyzed in the previous literature. Firstly, there were no significant differences in the overall ratings between male and female participants. However, previous studies which have used neutral faces taken from a web dataset to compare the ability to recognize facial expressions between men and women, found that female participants were more efficient in recognizing female neutral faces (Cellerino et al., 2004). Concerning the MPAFC, previous studies did not find sex differences in ratings (Simon et al., 2008). Secondly, although the three subgroups of participants rated female faces as more prototypical of the pain emotion than male faces, a significant interaction showed that female participants rated the expression of pain in men's faces particularly low. This result may be explained by the fact that women have been considered to be more emotionally expressive than men (Fischer & LaFrance, 2015; Wang et al., 2022). Furthermore, sociocultural beliefs about the expression of pain in men and women could be affecting the perception of pain facial expressions, as women tend to publicly show painful experiences more than men. Furthermore, pain has been more socially associated with women in comparison to men (Robinson et al., 2001). Due to this, it could be the case that female expressions of pain may be more credible and representative than male ones as they are more frequently exposed in public. However, regarding the generalizability of these results, it is important to take into account that the sample size was mostly composed of female participants, making it difficult to generalize the results to the male population. The subgroup size differences should be also taken into consideration, as the pain-free group size was larger than the acute and chronic pain group size.

Regarding the relationship between pain and other psychological problems, it has been shown that patients in primary care centers who endorse symptoms of muscle pain, headache, or stomach pain are approximately 2.5-10 times more likely to have a panic disorder, generalized anxiety disorder, or major depressive disorder (Means-Christensen et al., 2008). The experience of pain is directly connected with psychological suffering and factors traditionally associated with anxiety like catastrophizing, or negative anticipation (Todd et al., 2015). The use of facial expressions of pain has been used as stimuli to explore the connections between emotional and cognitive components. For instance, Ranjbar et al. (2020) showed that individuals with high pain catastrophizing had a poor capacity to disengage their attention towards painful faces. In our study, we found that stimuli scores are associated with anxiety sensitivity and pain catastrophizing. The more anxiety sensitivity or pain catastrophizing, the more representative of pain the faces are perceived. Furthermore, anxiety sensitivity seems to influence the perception of the pain faces in individuals without pain, as those with higher levels of anxiety sensitivity rated the faces as more prototypical. In addition, chronic pain individuals with high pain catastrophizing perceived the faces as more representative of the pain emotion compared to those with lower levels of pain catastrophizing. These findings are in line with the previous literature which has found a relationship between anxiety and self-perception of pain. For example, Keogh and Mansoor (2001) found, in a healthy female sample, that those with high anxiety sensitivity reported higher levels of pain during the cold pressor task, a widely used pain induction method. Metzger et al., (2022) found, in a healthy sample, that anxiety increased pain perception only in those individuals with clinical levels of anxiety sensitivity. Thus, anxiety sensitivity may be acting as a vulnerability factor in the origin, maintenance, and perception of pain. On the other hand, pain catastrophizing has also been frequently linked to an increase in pain perception in individuals with (Terry et al., 2016) and without chronic pain (Weissman-Fogel, et al., 2008; Campbell, et al., 2010). For instance, Kristiansen et al., (2014) found a positive correlation between pain catastrophizing and self-perception of pain on the cold pressor test. Furthermore, pain catastrophizing has been considered an explanatory mechanism of the relationship between positive traits and pain perception (Pulvers & Hoods, 2013).

In general, our results show that it is important to consider the sex factor (both of participants and models) in the validation of faces expressing pain. Similarly, other factors, like the race and age of the individuals expressing the emotion, may also affect the processing of facial expressions and rating decisions (Hirsh et al., 2008). It has been observed that young people are better at perceiving emotions compared to older adults (Isaacowitz et al., 2007). Although, in our study, sex differences in the assessment of prototypicality and intensity do not inform on the precision of these judgments, other studies have found a relationship between age and sex in the recognition of emotional faces, showing an advantage for women across the lifespan (Olderbak et al., 2019). In terms of race, it has been demonstrated that people tend to better recognize neutral and emotional expressions in individuals of their race (Elfenbein & Ambady, 2002; Hunter et al., 2009; Kang et al., 2019). However, aspects such as age and race are not usually included in the validation of face stimuli, as most of the facial stimuli are based on young or middle-aged Caucasian individuals thus contributing to a lack of more precise validation of the stimuli used in the literature and to general cultural and socioeconomic biases in psychological research (Henrich et al., 2010).

The main strength of this study is that stimuli have been validated not only by healthy individuals but also by individuals with different pain statuses (chronic or acute), with a variety of pain diagnoses, which has not been done before. Interestingly, our study did not find significant differences in perceiving pain-related stimuli between individuals with and without pain. One explanation for this finding is that the perception of pain facial expressions is not dependent on the pain status, but on other variables such as the sex, age, or race of the face (Wandner et al., 2012). Psychological aspects (e.g. anxiety sensitivity and pain catastrophizing) seem to be involved in the perception of pain as well. Besides, other cognitive variables (e.g., attentional and interpretational biases) as well as experimental task characteristics have shown to be linked to pain perception. It has been observed in previous studies that the personal relevance of stimuli is crucial to detecting attentional or interpretational biases towards pain-related stimuli in both healthy and chronic pain individuals (Dear et al., 2011; Traxler et al., 2019). These findings might be also applied to the perception of pain in others, being another possible reason why differences between healthy, acute, and chronic pain individuals are not found in this study.

Moreover, we analyzed not only the role of the participants' sex in rating the stimuli, which has only been explored in a few studies (Simon et al., 2008) but also the interaction of that factor with the sex of the actor/actress portraying the emotion which, as far as we know, has not been explored before. However, this study has some limitations. Firstly, as in the majority of published studies of emotional expressions, we used static images instead of dynamic ones (Liossi et al., 2014; Schoth et al., 2015; Jones et al., 2021). In our case, we selected the last image of the eight MPAFC clips which admittedly shows the highest level of intensity of pain, to focus on the pain facial expression from the first moment. Nevertheless, it has been found that dynamic emotional faces expressing happiness or disgust seem to be more representative of the emotion than static facial expressions (Trautmann et al., 2009). Recent evidence (Dildine et al., 2023) from computer-generated faces of pain, shows that the movement intensity of the faces was positively associated with higher rates of pain by the participants observing these images. Thus, it could be possible that, although we selected the highest peak of the expression of pain in each face from the MPAFC database, eliminating the sequence of movements might have reduced the perceived intensity of the pain and provided a more accurate approach to examining the attentional processing of emotional facial expressions (Biele & Grabowska, 2006; Fernandes-Magalhaes et al., 2022). Nevertheless, static images are still the most frequently used stimuli in experimental studies. Secondly, the sample of participants was mainly composed of Caucasian individuals, as well as the facial stimuli used in the study. Due to cultural differences, it may affect the generalizability of the results and their clinical applications to the general population.

In any case, our study indicates the need for validation of the stimuli to be used in experimental studies on pain. Likewise, it illuminates the convenience of considering different validation parameters (e.g., prototypicality and intensity) and analyzing the effect that central variables such as sex (both of participants and the models) have on the results. According to our results, female faces might be more representative of the pain emotion and, possibly, of other emotional facial expressions. Thus, female faces could be more useful and reliable for experimental investigation. Our findings suggest that other variables, such as age or race, should be more systematically explored and not taken for granted in similar validation studies. As we did not find differences between healthy and acute or chronic pain individuals, other cognitive aspects are likely involved in the perception of pain (in oneself or others). Thus, future experimental studies should explore the role of other psychological processes in pain perception and consider including facial expressions of different ages as well as different races and ethnic groups. It is also highly recommended for future studies to use dynamic and personally relevant stimuli for participants, as they would be more reliable and representative of every participant.

There is a vast literature using faces in the field of depression (e.g.), anxiety, and pain (e.g., Kunz et al., 2019) and our study contributes to this growing field of research. Analyses of the perception of emotional states (as those related to pain) are still of the utmost importance. Detecting when individuals have pain is socially and clinically important and facial expressions are one of the most commonly used indicators for casual observers and professionals. As a new avenue of research, the current interest in AI models to 'detect' faces of pain shows that this is still an interesting issue in psychological research. Interestingly, these models must 'learn' from real human faces and their ability to detect precise expressions of pain must be based on robust databases. In the case of the MPAFC, we have shown that even faces preselected as indicators of pain, are not perceived as such by the majority of our participants. Thus, our results also call for a note of caution regarding the validity of faces in databases, which should not be taken for granted (De Sario et al., 2023). Teaching to detect genuine expressions of pain is important and is often included in clinical assessments of specific populations (e.g., infants, nonverbal patients, or cognitively impaired individuals). Another potential implication for the field is that future studies using models (like the MPAFC database) or computer-generated images, should pay attention to the specific groups of muscles more directly involved in the expression of pain (i.e., contraction of the eyebrows, contraction of the muscles surrounding the eyes, nose wrinkle/lip raise, and opening of the mouth) (Kunz et al., 2019) and are not involved in the expression of emotions like fear (Dildine et al., 2023). Thus, future studies using actors or computer-generated images might improve the validity of the stimuli paying attention to these unique muscle features of facial expressions of pain.

Finally, it is possible that the low replicability of findings in some areas of pain research, such as the existence of attentional biases toward emotional stimuli (Chan et al., 2020), could be partly due to limitations in the validity of the stimuli used. The selection and validation of stimuli is a relatively neglected aspect of research, and we are convinced, based on our results, that more attention should be paid to these issues to make more substantial advances in the psychological literature on pain.

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