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Social chronic pain: the affective response to social exclusion

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Abstract

Background Social exclusion, whether due to physical isolation or the subjective perception of being ignored and unwanted, threatens the fundamental human need for social belonging and is experienced as social pain. While its detrimental effects on mood disorders are well documented, its impact on individuals living with chronic pain remains largely unexplored. This study investigates emotional responses to social exclusion in individuals with chronic pain (CPs) compared to healthy controls (HCs), considering the role of comorbid mood disturbances. It also examines whether behavioral and social functioning, across cognitive and psychological domains, modulate the experience and impact of social exclusion.

Methods We recruited 38 CPs and 38 HCs, grouped according to validated cut-offs on the Hospital Anxiety and Depression Scale as follow: 22 Normal-CPs (G1), 16 Altered-CPs (G2), 22 Normal-HCs (G3) and 16 Altered-HCs (G4). All participants completed the Cyberball task, a virtual ball-tossing game designed to simulate social inclusion (control condition) and exclusion (ostracism condition) by manipulating the distribution of ball tosses. After each condition, participants reported their mood, emotional state, and perceived threat to psychological needs. Additional assessments included pain intensity, coping strategies, social functioning, and social cognition.

Results All groups were matched for age, sex, education, and cognitive efficiency. Participants with mood alterations (G2 and G4) reported higher levels of loneliness than the other groups. All CPs showed higher levels of catastrophizing compared to HCs. In the Cyberball task, all participants felt more excluded in the exclusion condition than in the inclusion condition, indicating decreased well-being following ostracism. Notably, only Altered-CPs exhibited blunted emotional reactivity after exclusion. Compared to HCs, Altered-CPs reported lower self-esteem, reduced happiness, and greater negative affect even during the inclusion condition. Correlation analyses revealed that psychological responses to social exclusion in CPs were associated with mood symptoms, catastrophizing, loneliness, and perceived social isolation.

Conclusion These findings suggest that chronic pain, particularly when accompanied by mood disorders, alters emotional processing and increases sensitivity to social context, even in neutral or positive social situations. Addressing social functioning may be crucial for developing personalized and effective treatment strategies for chronic pain.

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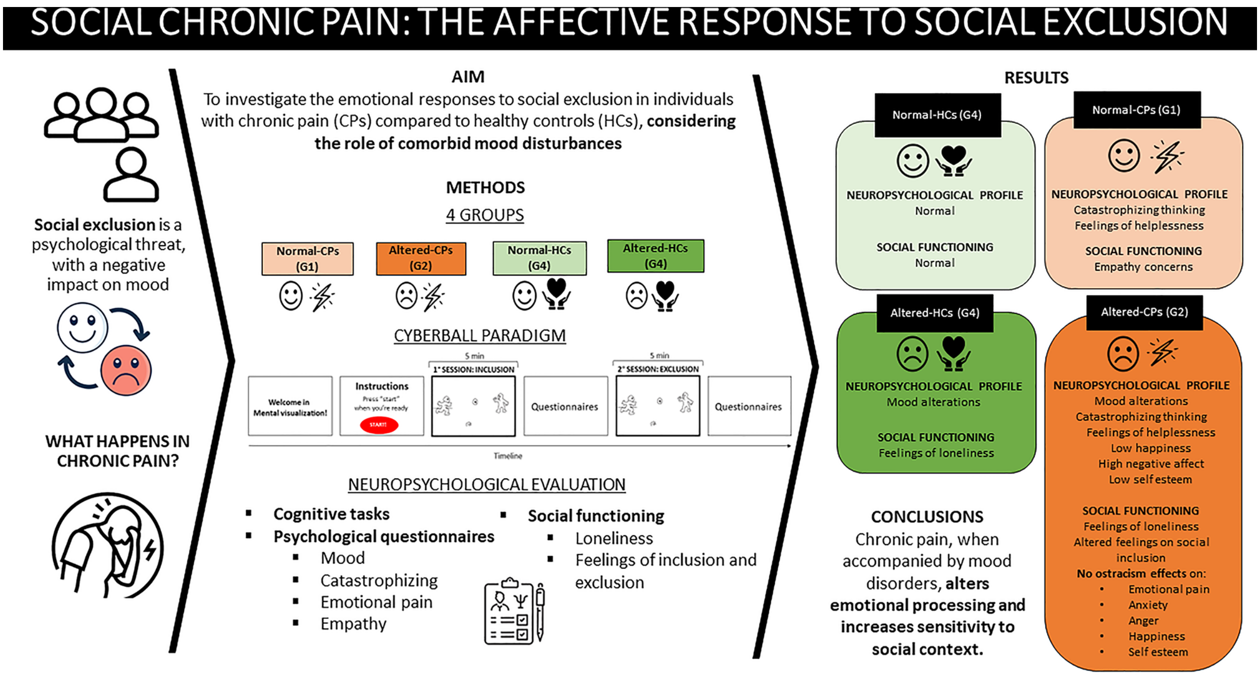
Keywords Social pain, Ostracism, Chronic pain, Cyberball, Mood

Graphical Abstract



Background

Social exclusion is one of the most detrimental threats to the need for social belonging [1]. It affects individuals who are deliberately marginalized either physically, through social isolation, or psychologically, by being ignored or made to feel unwanted [2, 3]. Often conceptualized as a form of social pain, it can, like chronic physical pain, impair cognitive functioning and mental health. Studies show that social exclusion impairs logical reasoning tasks [4, 5], thwarts social information processing [6, 7], lowers self-esteem and emotional regulation, and hampers psychological well-being [1, 8–10]. Moreover, it is also associated with an increased risk of psychiatric disturbances conditions, including depression [11]. While several studies explored the shared neural and behavioral mechanisms of social and physical pain [12, 13], fewer have examined the contribution of social factors to chronic pain. Social isolation and loneliness [14] can increase the risk of chronic pain [15] and worsen outcomes like pain interference and disability [16, 17].

Cyberball, a virtual ball-tossing game in which participants believe they are interacting with real individuals online while the game is controlled by an algorithm, is a well-established tool for experimentally simulating conditions of social inclusion and exclusion in a controlled environment [2]. Studies using the Cyberball paradigm have demonstrated that even brief experiences of social exclusion can elicit strong negative emotional and cognitive responses [18–20]. Cyberball has been used to test the effects of social exclusion in a wide range of clinical conditions, revealing that individual responses are modulated by psychiatric symptoms, illness duration, and underlying emotional distress [21, 22]. Conversely, this paradigm has not yet been used to investigate the impact of social exclusion in the contest of chronic pain. Our study aims to bridge this gap by comparing the emotional responses to social exclusion between chronic pain patients and healthy individuals taking into account comorbid mood disturbances. Additionally, we explored whether behavioral and social functioning, encompassing cognitive and psychological domains, influence the experience and outcome of social exclusion.

Materials and methods

We performed a cross-sectional study to examine the individual responses to social exclusion in a cohort of chronic pain patients with and without mood disorders. Additionally, we investigated whether proxies of social well-being, such as feelings of loneliness and social network size, influenced the responses to the Cyberball paradigm. This study was approved by the Ethical Committee of the Fondazione IRCCS Istituto Neurologico "Carlo Besta", Milano. Data were collected from January 2022 to February 2023.

Participants

Native Italian-speaking individuals aged between 18 and 80 years including patients meeting the criteria for Chronic Pain (CPs) [23] and healthy controls (HCs) with no previous or concomitant chronic pain diagnosis were invited to participate in the study. Exclusion criteria for both the groups were comorbidities with other neurological conditions (e.g., head injuries, hydrocephalus, cerebrovascular disease), drug or alcohol abuse, neurocognitive developmental disorder, primary psychiatric disorders (e.g., bipolar disorder, major depression), and dementia. Patients were allowed to continue their ongoing pharmacological treatment.

All participants were enrolled after giving written informed consent. Participant's consent was obtained according to the Declaration of Helsinki. The database was anonymized according to the Italian law for the protection of privacy. The study was approved by the local Ethic Committee.

Clinical and neuropsychological assessment

Demographical and clinical data, including diagnosis, disease duration and medication use were collected through a structured clinical interview and neurological examination. Pain intensity at the time of the assessment was recorded using the Numerical Rating Scale (NRS), ranging from 0 ("no pain") to 10 ("the worst imaginable pain").

All participants performed a neuropsychological assessment which included evaluation of the global cognitive functioning with the Italian-Version of the Montreal Cognitive Assessment (MoCA) [24]. MoCA is a screening instrument developed to detect early signs of cognitive decline through an assessment of cognitive abilities, including memory, language, visuo-spatial skills, executive functions, and orientation. It typically takes around 10 min to administer. Psychological profile was assessed through structured clinical interview and questionnaires. Mood alterations were assessed using the Hospital Anxiety Depression Scale (HADS) [25], a self-administered questionnaire in which participants reported how they have felt in the past week. It consists of 14 items, 7 addressing anxiety (HADS-A) and 7 addressing depression (HADS-D). The catastrophizing believes, namely helplessness, magnification, and rumination, were measured with the Pain Catastrophizing Scale (PCS) – Italian Version [26]. Higher scores indicate more frequent use of the coping strategies in each category.

Social functioning was assessed using a combination of self-administered questionnaires and cognitive tasks targeting (i) social well-being, and (ii) social cognition, specifically the ability to attribute mental states to others. Consistently we employed (i) the 3-item UCLA Loneliness Scale (UCLA-3 L) [27], a widely used tool consisting of three key questions that are designed to quickly evaluate an individual's sense of social isolation or loneliness, and the Lubben Social Network Scale (LSNS-6) [28] to measure the size, closeness, and frequency of contact with an individual's social network, including both family and friends. This scale is designed to identify individuals who may be at risk of social isolation, which is a significant factor in overall well-being. Then, (ii) social cognition abilities were assessed with the Story-Based Empathy Task (SET) [29] and the Ekman-60 faces test (Ekman-60 F) [30, 31]. The SET comprises three subscales evaluating individuals' ability to infer others' intentions (intention attribution – SET-IA) and emotions (emotion attribution – SET-EA), and individual ability to infer physical causality, which can be considered a control condition (causal inferences – SET-CI). Each subscale consists of six vignettes, requiring selecting the correct ending of a comic strip, which has an upper row containing the story, and a lower row with three options representing the possible conclusions. Each subscale has a maximum score of 6 points, with higher scores indicating a better performance. The Ekman-60 F [30, 31] consists of a computerized 60 black-and-white pictures of 4 males and 6 females, each displaying the six basic emotions: anger, surprise, fear, disgust, happiness, and sadness. Each stimulus was presented at the center of the screen for 5 s, after that participants choose the correct answer picking from the six basic emotions labels appearing at the bottom of the screen. Participants' accuracy was recorded.

Social exclusion paradigm

To manipulate social pain, we used the "Cyberball" social exclusion paradigm [2]. Participants were seated at 50 cm of distance from the screen (14 inches, 31 × 17 cm), on which a fictitious name of the game, namely "Mentalizing game" appeared. They were told that the aim was to measure their mental visualization abilities, therefore they would be asked to play the "Mentalizing game", a simple virtual game with basic graphics and a simple task, during which they had to imagine in details the place, the context and the people with whom they would play afterwards, in order to answer questions about how they felt during the session. This cover story was needed to not create any bias in participants, and the real intended aim was revealed at the end of the game. Subsequently, a simulated internet connection to the virtual online game and the instructions on the task appeared on the screen. Participants, using an avatar named "Me", would play with two other players, virtually connected with the nicknames of "Player 1" and "Player 2". Each time the participant received the ball, he/she had to decide which of the two players to throw it to. After reading the instructions, participants clicked on the “Play” button and the game started (Fig. 1). Cyberball was programmed to run two sessions, lasting 5 min, always presented in the same fixed order: the first was the inclusion condition (INC), in which they received the ball for 33% of the total tosses (~ 11 out of 30 throws), and the second was the exclusion condition (EXC), during which they received only two throws at the beginning of the game, and then never more.

Assessment of psychological effects of social exclusion

To evaluate the psychological impact of Cyberball, we employed questionnaires validated in the literature [2, 3]. We primarily adopted the Italian versions used by previous studies [32, 33], which featured a 7-point Likert scale ranging from 1 (‘not at all’) to 7 (‘very much’). Specifically, after each session of the experimental paradigm, participants completed the Need Threat Scale (NTS), which is the appropriate questionnaire to evaluate the Cyberball effects [2]. The NTS assess the level of satisfaction on the four fundamental needs, namely self-esteem (i.e., self-attributions that constitute the value that each person has for himself/herself), sense of belonging (i.e., the feeling of being connected to a group or another individual), control (i.e., the feeling of having control over one’s social environment) and meaningful existence (i.e., the feeling of being recognized for existing and being worthy of attention) [34]. Cyberball-related feelings of anxiety (3 items), emotional pain (3 items), sadness (3 items), anger (3 items), happiness (3 items), and rejection (3 items) were also assessed with proper self-administered questions [32, 33]. Then, we used the Pain Face scale [35] to measure how participants felt during the session, and the Other in Self scale (OIS) [36] to assess the feeling of social connection with the other two players. A manipulation check question (1 item) on the percentage of tosses that participants perceived to have received during the game session was also administered. Finally, a four-item manipulation check questionnaire was administered to assess the degree of involvement in the Cyberball game. Appendix 1 in the supplemental materials provides the complete set of Cyberball-related questionnaires and items.

Classification of participants

CPs and HCs were divided based on mood alteration. To deliver an estimate of clinically meaningful mood changes, benchmarks were derived based on established cut-offs [37]. Consistently, each participant with HADS-A and/or HADS-D score higher or equal to 8 was considered altered. Four groups were then obtained: CPs with normal mood (Normal-CPs, G1), CPs with altered mood (Altered-CPs, G2), HCs with normal mood (Normal-HCs, G3) and HCs with altered mood (Altered-HCs, G4).

Statistical analyses

The sample size was estimated using statistical power analysis conducted with G*Power software [38]. An a priori analysis was performed for a repeated measures ANOVA model with a within-between factor structure, assuming an effect size (F) of 0.25, an α error probability of 0.05, and a statistical power (1-β) of 0.95, with a minimum correlation between measurements of 0.5. The analysis indicated a required total sample size of 76 participants, with 19 per group.

Demographic, clinical, and neuropsychological data of group participants were compared using parametric and non-parametric analysis of variance (ANOVA), according to data distribution, with Mann-Whitney or Kruskal-Wallis methods and the Fisher’s exact test or Chi-squared test. For each group, Cyberball outcomes (listed in appendix 1) were analyzed by means of the non-parametric repeated measure ANOVA (rmANOVA) with the “*Cyberball condition*” (INC Vs. EXC) as the within-subject factor. Additionally, to test between-group differences of the Cyberball outcomes of the INC and the EXC conditions, we performed the Kruskal-Wallis test with the Dwass-Steel-Critchlow-Fligner correction for post-hoc analyses. To measure the magnitude of the Cyberball effect, the difference between Cyberball outcomes in EXC and INC conditions was computed (Δ = EXC – INC) and used for between-group analyses. Finally, Spearman’s

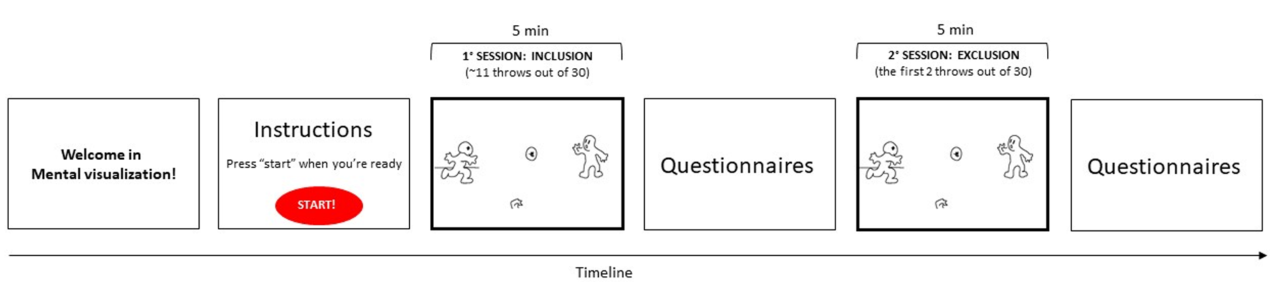


Fig. 1 The timeline shows the Cyberball task flow. After listening to the cover story by the experimenter (“Mental visualization”), and reading the instructions on the screen, participants pressed “play” and the game started. They completed two sessions in a fixed order: first inclusion, then exclusion, each lasting about five minutes. Following each session, participants completed the same questionnaires assessing Cyberball psychological effects

rho correlations were run to explore any potential associations between Cyberball outcomes and NRS, mood (HADS-A and HADS-D), social cognition (SET task and Ekman-60 F), social well-being (UCLA-3 L and LSNS-6), catastrophizing (PCS) and age separately from HCs and all CPs.

Statistical analysis was conducted using jamovi 2.4.11 [39], and no analysis code was used.

Results

Seventy-eight participants underwent the experimental procedure and the neuropsychological evaluation, but two HCs interrupted the Cyberball game, therefore they were excluded from the analyses. The final sample included 38 HCs and 38 CPs, of whom 28 diagnosed with neuropathic pain and 10 with orofacial pain. Both CPs and HCs were grouped based on the HADS scores as follow: 22 Normal-CPs (G1), 16 Altered-CPs (G2), 22 Normal-HCs (G3) and 16 Altered-HCs (G4). Table 1 shows the details on demographics and clinical data of included participants. Age, education, and sex distribution did not differ between groups. Supplementary Table S1 displays descriptive statistics for demographic and clinical variables in male and female subsamples.

Patients with orofacial pain and neuropathic pain were equally distributed across the subgroups. As expected, CPs reported higher pain intensity than HCs. The two CP groups did not differ significantly in pain intensity (W=-0.355, $p = 0.994$) or disease duration (U = 147, $p = 0.328$). None of the HCs were taking psychoactive drugs at the time of the study. Within the CP sample, no significant difference in the medication intake was found ($\chi^2_{(14)} = 14.3$, $p = 0.42$), only four Altered-CPs and three Normal-CPs were not taking psychoactive drugs (see Supplementary Table S2 for details).

Neuropsychological assessment

Significant differences between groups are illustrated in Fig. 2, while descriptive statistics and between-group comparisons for the neuropsychological assessment are provided in Supplementary Table S3. Post-hoc analyses showed that Altered-CPs had higher scores of catastrophizing thinking (PCS total score: W=-5.798, $p < 0.001$), rumination (W=-5.006, $p = 0.002$) and feelings of

Table 1 Descriptive analysis and differences between groups in demographical and clinical data

	Groups	No.	Mean	SD	Min	Max	Between-group analysis Statistical test (*p* value)
Demographic data							
Gender (F / M)	Normal-CPs (G1)	22	14 / 8	-	-	-	$\chi^2 = 2.91$ (0.406)
	Altered-CPs (G2)	16	12 / 4	-	-	-	
	Normal-HCs (G3)	22	17 / 5	-	-	-	
	Altered-HCs (G4)	16	14 / 2	-	-	-	
Age	Normal-CPs (G1)	22	46.81	11.15	28	76	$\chi^2 = 3.93$ (0.270)
	Altered-CPs (G2)	16	47.93	15.75	26	70	
	Normal-HCs (G3)	22	50.54	11.30	29	66	
	Altered-HCs (G4)	16	43.68	10.23	25	57	
Years of education	Normal-CPs (G1)	22	14.52	4.17	5	24	$\chi^2 = 1.42$ (0.701)
	Altered-CPs (G2)	16	14.43	4.61	3	21	
	Normal-HCs (G3)	22	14.40	2.92	8	20	
	Altered-HCs (G4)	16	16.12	4.03	10	23	
Clinical data							
Diagnosis (NP/ OP)	Normal-CPs (G1)	22	16 / 6	-	-	-	$\chi^2 = 0.024$ (0.875)
	Altered-CPs (G2)	16	12 / 4	-	-	-	
Disease duration (months)	Normal-CPs (G1)	22	92.63	77.65	9	243	U = 0.165 (0.745)
	Altered-CPs (G2)	16	124.0	132.81	4	444	
Pain intensity (NRS)	Normal-CPs (G1)	22	4.341	2.36	0	10	$\chi^2 = 28.70$ (< 0.001)
	Altered-CPs (G2)	16	4.862	2.10	1	9	G1 > G3*** and G4*;
	Normal-HCs (G3)	19	1.053	1.39	0	4	G2 > G3*** and G4**
	Altered-HCs (G4)	16	1.750	2.51	0	8	G1 = G2; G3 = G4s
Mood (HADS total score)	Normal-CPs (G1)	22	6.818	3.660	0	12	$\chi^2 = 50.1\ 4$ (< 0.001)
	Altered-CPs (G2)	16	17.063	6.875	11	32	G1 < G2*** and G4***;
	Normal-HCs (G3)	22	6.318	3.510	1	14	G3 < G2 and G4***
	Altered-HCs (G4)	16	16.000	3.521	10	22	G1 = G3; G2 = G4
MoCA (Total score)	Normal-CPs (G1)	22	24.9	2.94	19	29	$\chi^2 = 5.53$ (0.137)
	Altered-CPs (G2)	16	25.0	3.31	17	30	
	Normal-HCs (G3)	22	25.9	2.14	22	30	
	Altered-HCs (G4)	16	27.1	2.14	24	30	

Notes: HADS = Hospital Anxiety and Depression Scale; NP = Neuropathic pain; NRS = Numeric Rating Scale; MoCA = Montreal Cognitive Assessment; OP: Orofacial Pain; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

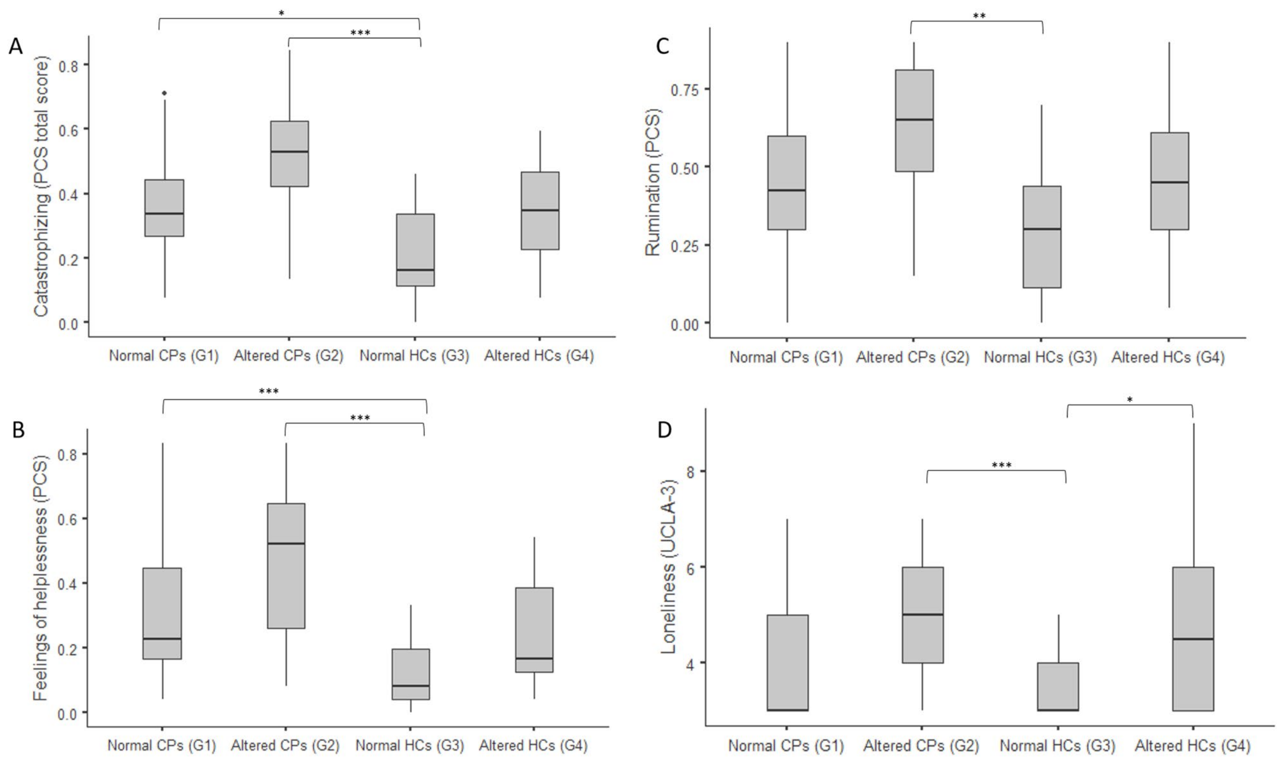


Fig. 2 The box plots show the mean psychological scale scores that differed significantly between the groups: (**A**) catastrophizing; (**B**) rumination; (**C**) helplessness; (**D**) loneliness (* $p<0.05$; ** $p<0.01$; *** $p<0.001$)

helplessness (W=-6.08, $p<0.001$) compared to Normal-HCs. Moreover, Altered-CPs showed higher feelings of loneliness (W=-5.608, $p<0.001$) than Normal-HCs. HCs with altered mood felt lonelier than those with normal mood (W = 3.691, $p=0.045$). Notably, the comparisons between CPs and HCs with normal mood showed that CPs consistently reported significantly higher levels of catastrophizing (W=-3.974, $p=0.026$) and feelings of helplessness (W=-5.42, $p<0.001$) than HCs.

Significant group differences also emerged in both the tasks assessing social cognition: the Ekman-60 F test (χ^2 = 9.15, $p<0.027$) and the SET total score (χ^2 = 8.22, $p=0.042$). However, post-hoc comparisons indicated that only the SET revealed a statistically significant difference, with Normal-CPs performing worse than Normal-HCs (W = 4.001, $p=0.024$).

Cyberball outcomes

Descriptive statistics of Cyberball outcomes are reported in Table 2. In line with the hypotheses, all participants correctly perceived the experimental manipulation induced by the Cyberball paradigm across all measured variables. Specifically, with few exceptions, all participants felt more excluded in the social EXC condition compared to the INC condition. Scores on the NTS basic needs scales and the Cyberball-related measures were significantly different between the two conditions ($p<0.001$), indicating decreased well-being and increased feeling of exclusion in the EXC condition (Supplementary Table S4). Exceptions emerged within the CP sample. Specifically, Altered-CPs did not perceive any difference between the two conditions for the outcomes addressing emotional pain (χ^2 =2.09, $p=0.054$), anxiety (χ^2 =1.69, $p=0.111$), anger (χ^2 =1.07, $p=0.300$), happiness (χ^2 =1.58, $p=0.136$), and self-esteem (χ^2 =0.565, $p=0.582$).

Results of the between-group analyses performed for each Cyberball outcome, separately for INC and EXC conditions, are reported in Supplementary Table S5. Interestingly, we found between-group differences for INC outcomes addressing self-esteem (χ^2=13.91; $p=0.003$), happiness (χ^2=9.574; $p=0.023$) and negative affect (χ^2=9.612; $p=0.022$). Post-hoc analyses highlighted that Altered-CPs had lower self-esteem than Normal-HCs (W = 4.858, $p=0.003$). Interestingly, compared to Normal-CPs, Altered-CPs also reported lower levels of happiness (W=-3.49, $p=0.027$) and higher negative affect scores (W = 4.147, $p=0.018$), despite the two patient groups having similar demographical, clinical, cognitive and behavioral profiles (Supplementary Table S3).

The magnitude of the Cyberball effect, measured by subtracting each EXC outcome from the corresponding INC outcome (Δ Cyberball), was similar in all groups, except for the OIS scale (χ^2 = 8.117, $p=0.044$) and self-esteem scale (W = 8.575, $p=0.036$). Post-hoc analyses

Table 2 Mean (and standard deviation) of cyberball outcomes measured in all subgroups for inclusion (INC) and exclusion (EXC) conditions

	CPs Normal (G1)	CPs Altered (G2)	HCs Normal (G3)	HCs Altered (G4)
Pain Face test	*INC*: 1.36 (0.902)	*INC*: 1.81 (1.223)	*INC*:1.41 (1.008)	*INC*: 1.13 (1.025)
	EXC: 3.32 (1.171)	*EXC*: 3.50 (0.816)	*EXC*: 3.18 (1.140)	*EXC*: 3.13 (0.957)
	Δ: 1.955 (1.214)	*Δ*: 1.688 (0.946)	*Δ*: 1.773 (1.193)	*Δ*: 2.000 (1.633)
Other in self scale	*INC*: 4.23 (2.069)	*INC*: 3.00 (2.000)	*INC*:4.36 (2.060)	*INC*:4.38 (1.628)
	EXC: 1.59 (1.403)	*EXC*: 1.94 (1.652)	*EXC*: 1.55 (1.057)	*EXC*: 1.38 (1.025)
	Δ: -2.636 (1.989)	**Δ**: **-1.063 (2.594)**[i]	*Δ*: -2.818 (1.943)	**Δ**: **-3.000 (1.713)**[i]
Anxiety	*INC*: 4.18 (2.239)	***INC***: ***5.06 (3.415)***[a]	*INC*:4.41 (1.968)	*INC*: 4.00 (1.751)
	EXC: 6.82(3.231)	***EXC***: ***7.31 (3.361)***[a]	*EXC*: 7.68 (3.138)	*EXC*: 5.88 (2.553)
	Δ: 2.636 (3.064)	*Δ*: 2.250 (5.079)	*Δ*: 3.273 (3.058)	*Δ*: 1.875 (2.802)
Anger	*INC*: 3.59 (1.368)	***INC***: ***5.56 (4.195)***[b]	*INC*: 3.45 (1.299)	*INC*:3.44 (1.209)
	EXC: 8.00 (4.701)	***EXC***: ***6.50 (4.487)***[b]	*EXC*: 6.82 (5.086)	*EXC*: 5.69 (3.860)
	Δ: 4.409 (4.905)	*Δ*: 0.938 (2.886)	*Δ*: 3.364 (4.766)	*Δ*: 2.250 (3.454)
Sadness	*INC*: 3.55 (1.535)	*INC*: 4.19 (2.482)	*INC*: 3.59 (1.297)	*INC*: 3.31 (0.873)
	EXC: 5.95 (3.579)	*EXC*: 5.44 (2.707)	*EXC*: 6.32 (3.400)	*EXC*: 6.00 (3.055)
	Δ: 2.409 (4.306)	*Δ*: 1.250 (1.807)	*Δ*: 2.727 (3.535)	*Δ*: 2.688 (3.321)
Pain	*INC*: 3.36 (1.329)	**INC**: **3.63 (0.957)**[c]	*INC*:3.27 (1.077)	*INC*:3.25 (0.775)
	EXC: 6.09 (4.730)	**EXC**: **5.31 (3.381)**[c]	*EXC*: 5.36 (3.619)	*EXC*: 5.63 (3.304)
	Δ: 2.727 (5.035)	*Δ*: 1.688 (3.198)	*Δ*: 2.091 (3.069)	*Δ*: 2.375 (3.462)
Happiness	*INC*:11.74 (4.112)	***INC***: ***7.19 (5.115)***[d, g]	**INC**: **11.59 (5.771)**[g]	*INC*:9.13 (5.058)
	EXC: 7.09 (5.442)	***EXC***: ***5.38 (2.964)***[d]	*EXC*: 6.59 (3.003)	*EXC*: 4.63 (2.125)
	Δ: -4.273 (5.881)	*Δ*: -1.813 (4.875)	*Δ*: -5.000 (4.129)	*Δ*: -4.500 (4.590)
Rejection	*INC*8.27 (3.239)	*INC*: 8.38 (3.263)	*INC*: 7.00 (3.729)	*INC*:8.50 (4.258)
	EXC: 16.55 (4.490)	*EXC*: 17.25 (3.715)	*EXC*: 16.64 (3.983)	*EXC*: 16.81 (2.536)
	Δ: 8.273 (6.467)	*Δ*: 8.875 (3.222)	*Δ*: 9.636 (4.943)	*Δ*: 8.313 (4.729)
Negative affect	*INC*: 21.0 (5.678)	**INC**: **28.6 (10.138)**[h]	**INC**: **20.9 (7.723)**[h]	*INC*: 22.6 (6.850)
	EXC: 34.7 (13.950)	*EXC*: 34.9 (8.601)	*EXC*: 35.20 (10.876)	*EXC*: 33.9 (8.606)
	Δ: 13.727 (15.532)	*Δ*: 6.250 (10.116)	*Δ*: 14.364 (11.329)	*Δ*: 11.313 (10.606)
Belongingness (NTS subscale)	*INC*: 6.36 (1.529)	*INC*: 5.88 (1.784)	*INC*:6.73 (0.767)	*INC*: 6.31(1.138)
	EXC: 3.32 (2.297)	*EXC*: 3.69 (2.243)	*EXC*: 3.91 (2.266)	*EXC*: 2.94 (1.436)
	Δ: -3.045 (2.836)	*Δ*: -2.188 (3.103)	*Δ*: -2.818 (2.322)	*Δ*: -3.375 (1.962)
Meaningful existence (NTS subscale)	*INC*: 6.64 (0.727)	*INC*: 6.56 (0.892)	*INC*:6.41 (1.260)	*INC*:6.19 (1.328)
	EXC: 3.36 (2.083)	*EXC*: 3.69 (2.152)	*EXC*: 3.91 (2.408)	*EXC*: 3.13 (1.668)
	Δ: -3.273 (2.229)	*Δ*: -2.875 (2.062)	*Δ*: -2.500 (2.133)	*Δ*: -3.063 (2.016)
Self-esteem (NTS subscale)	*INC*: 4.36 (2.060)	**INC**: **3.06 (1.526)**[e, f]	**INC**: **5.41 (2.153)**[f]	*INC*:4.25 (1.915)
	EXC: 3.36 (2.216)	**EXC**: **3.81 (1.759)**[e]	*EXC*:4.18 (2.322)	*EXC*: 3.06 (1.731)
	Δ: -1.000 (2.743)	*Δ*: 0.750 (2.049) [j]	*Δ*: -1.227 (2.114)	**Δ**: **-1.188 (1.424)**[j]
Control (NTS subscale)	*INC*: 5.73 (2.164)	*INC*: 6.19 (1.642)	*INC*: 5.95 (1.812)	*INC*:4.56 (2.581)
	EXC: 1.36 (0.790)	*EXC*: 1.06 (0.250)	*EXC*: 1.41 (0.854)	*EXC*: 1.19 (0.403)
	Δ: -4.364 (2.460)	*Δ*: -5.125 (1.628)	*Δ*: -4.545 (1.792)	*Δ*: -3.375 (2.500)

Notes: NTS = Need threat scale; INC = inclusion; EXC = exclusion; Δ = the Cyberball effect, measured by subtracting each EXC outcome from the corresponding INC outcome; **a**, **b**, **c**, **d**, **e** = within-group comparisons showing no significant differences ($p > 0.05$); **f**, **g**, **h** = between-group comparisons showing significant differences ($p < 0.05$); **i**, **j** = between-group comparisons showing trend toward significant differences ($p < 0.06$). Values in bold highlight the most relevant findings

documented trends of statistical significance toward differences between the Altered-CPs group and the Altered-HCs (Δ OIS: W = 3.61, $p = 0.052$; Δ self-esteem: W = 3.544, $p = 0.059$). See Supplementary Table S6 for details.

Figure 3 provides a graphical representation of the main findings from the analyses, highlighting the distinguishing cognitive, psychological and Cyberball-related features of the different study groups.

Correlation analyses

Explorative correlations between each Cyberball outcomes, pain intensity, mood, social functioning and age revealed different patterns of correlations for CPs

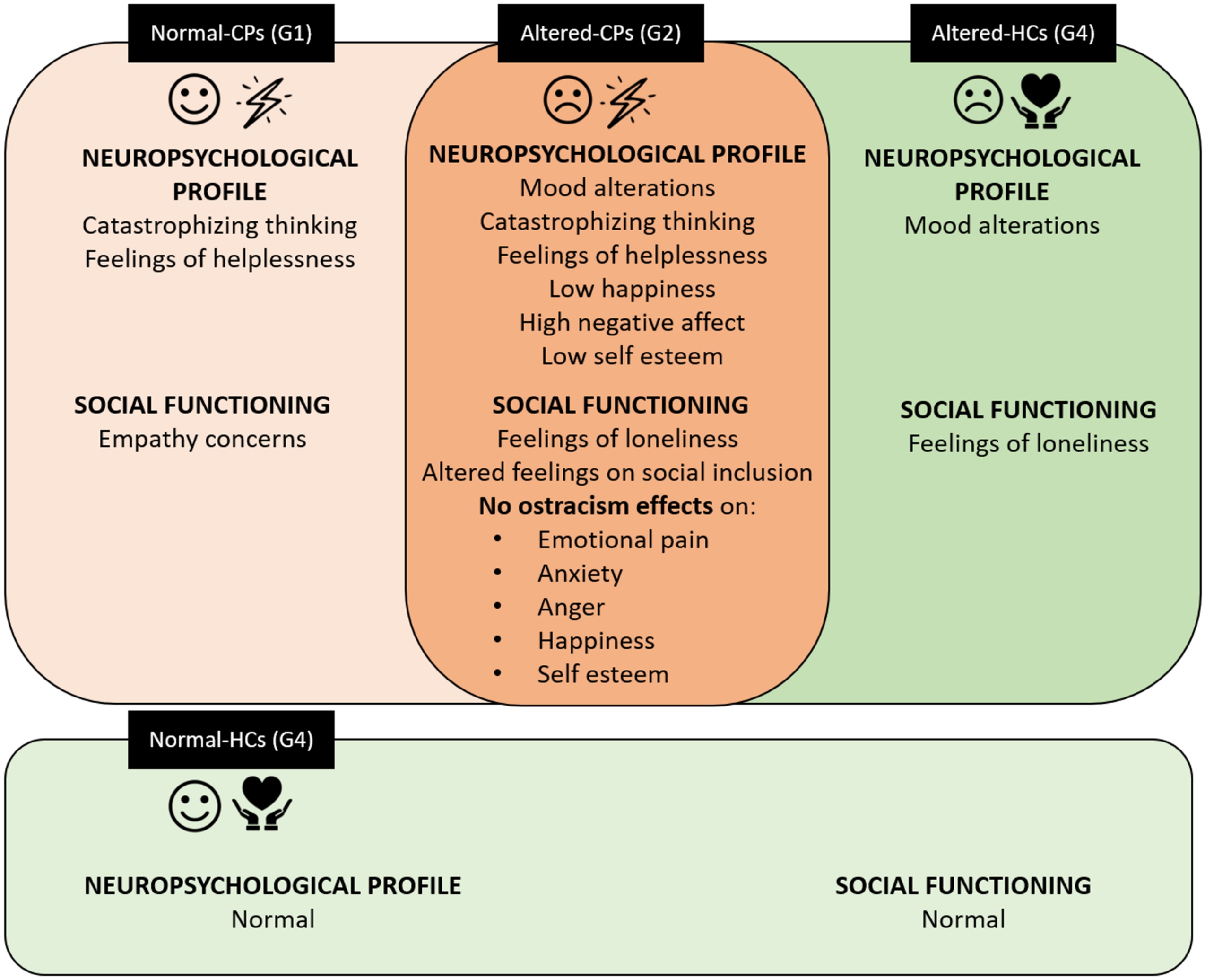


Fig. 3 A graphical representation of the main findings from the analyses, illustrating the distinguishing features of the different study groups is provided

Table 3 Spearman's Rho coefficients of significant correlations between cyberball outcomes measured after the exclusion condition and neuropsychological variables in CPs and HCs (in brackets)

EXC Outcomes	HADS-A	HADS-D	UCLA-3 L	LSNS-6	Ekman test	PCS	Age
Pain Face	-	-	-	-	-	0.430**	0.388*
Other in self-scale	-	(-0.331*)	-	-	0.364*	-	(0.337*)
Anxiety	-	0.436**	-	-	-	-	-
Sadness	-	-	-	-	-	0.395*	-
Emotional pain	-	-	-	-	-	0.334*	-
Happiness	-0.323*	-	-	-	-	-	-
Rejection	-	-	0.332*	-	-	-	-
Negative affect	-	0.351*	-	-	-	-	-
Belongingness	-	-	-	-0.354*	-	-	-
Control	-	-	-	0.331*	-	-	-

Notes: CPs = Chronic Pain subjects; EXC = Exclusion condition of the Cyberball paradigm; HADS-A = Hospital Anxiety and Depression Scale – Anxiety subscale; HADS-D = Hospital Anxiety and Depression Scale – Depression subscale; INC = Inclusion condition of the Cyberball paradigm; LSNS-6 = Lubben Social Network Scale; UCLA-3 L = UCLA 3 items Loneliness Scale; * $p < 0.05$; ** $p < 0.01$

(Supplementary Table S7) and HCs (Supplementary Table S8). Interestingly, only in CPs, measures assessing the psychological response to social exclusion were found to be associated with mood alterations, catastrophizing thoughts, and feelings of loneliness and social isolation (Table 3). Among CPs, age showed only a weak positive correlation with negative feelings in the EXC condition. In contrast, among HCs, older age was associated with a greater sense of control in the INC condition and with higher perceived connectedness (IOS scale) in the EXC condition.

Discussions

This study aimed to explore the responses to the Cyberball paradigm of experimental social exclusion in individuals suffering from chronic pain and to what extend mood disorders shaped their responses, a research topic that has received limited attention. As expected, all participants accurately detected the experimental manipulation, as they reported receiving fewer ball tosses during the exclusion condition compared to the inclusion condition, along with an overall decrease of well-being and increase of feelings of exclusion. These results confirm the effectiveness of the Cyberball paradigm in reliably eliciting experiences of social ostracism.

The detrimental impact of the comorbidity between chronic pain and mood disorders on emotional and social functioning

Only CP patients with mood disturbances (Altered-CPs) did not report increased anger or anxiety, neither showed a reduction in happiness or self-esteem following social exclusion, unlike the CP patients without mood disorder (Normal-CPs) and both the healthy control groups [18, 34, 40]. This suggests that chronic pain and mood may modulate sensitivity to social exclusion. We also found that Altered-CPs showed a specific blunting of social connectedness (low IOS effect) compared to Altered-HCs. This suggests that individuals with both chronic pain and altered mood may be even less sensitive to ostracism induced by the Cyberball task. However, this diminished sense of belonging in Altered-CPs may not be attributable solely to mood alterations; it could also reflect an underlying impairment in social cognitive abilities. Supporting this, a specific association emerged between reduced feelings of social connectedness and deficits in emotion recognition in CPs. An alternative non-mutually exclusive hypothesis is that in Altered-CPs, who exhibited greater rumination than Normal-HCs, the ruminative component fosters an internal attentional focus [41]. By concentrating on their own pain, Altered-CPs tend to ruminate and worry more, thereby thus being less sensitive to external environment factors.

Notably, patients classified as Altered-CPs exhibited atypical emotional responsiveness to external social cues, even in neutral or positive contexts such as social inclusion. This pattern may reflect emotional blunting, disengagement, or reliance on dysfunctional coping mechanisms. Consistently, compared to Normal-CPs, Altered-CPs reported lower levels of happiness and higher negative affect following the Cyberball inclusion session. Importantly, this altered emotional reactivity cannot be attributed to more severe clinical, cognitive, or behavioral impairments, as the two groups did not differ in pain intensity, illness duration, cognitive efficiency, coping strategies, or medication use. This corroborates the hypothesis of a potential affective blunting in individuals experiencing chronic pain and mood disorders in comorbidity. This pattern has been observed in other clinical populations, such as individuals with borderline personality disorder (BPD) [33, 42, 43]. In BPD, patients feel "socially satisfied" only when they are highly included, receiving more attention than others [42–44], indicating that for BPD patients social cues may be interpreted primarily through a self-focused lens, highlight the impact of psychopathology on perceived social well-being [45, 46]. Therefore, mood disturbances in chronic pain may exert a pervasive influence on emotional experience, even in favorable and inclusive social contexts.

Supporting this hypothesis, comparisons between Normal-CPs and healthy controls with normal mood (Normal-HCs), as well as between healthy controls with mood alterations (Altered-HCs) and Normal-HCs, revealed similar emotional responses across all Cyberball conditions. This suggests that chronic pain and mood disturbances alone cannot significantly influence emotional reactions to experimentally induced social inclusion and exclusion.

The impact of chronic pain on emotional and social functioning

The well-documented detrimental effects of chronic pain on psychological functioning are highlighted by the comparison of measures of Normal-CPs and Normal-HCs obtained by the neuropsychological assessment performed prior to the Cyberball game. Normal-CP patients displayed higher levels of catastrophizing and a stronger sense of hopelessness than controls, suggesting that chronic pain may contribute to dysfunctional cognitive processes such as catastrophizing. We could not exclude that the use of maladaptive coping strategies, particularly catastrophizing, may also be associated with a reduced sense of social connection experienced during the Cyberball exclusion session. Among all HCs, higher levels of catastrophizing were linked to a diminished sense of belonging, while, in all CPs, catastrophizing was associated with heightened experiences of social pain and sadness following ostracism. Furthermore, among participants with normal mood, patients demonstrated poorer performance than controls on the SET task, which assesses metacognitive abilities and theory of mind. This aligns with existing literature highlighting the psychological difficulties commonly observed in individuals with chronic pain, namely, depressive symptoms, maladaptive coping mechanisms, difficulty in identifying one's own emotions [47–51], and cognitive impairments, particularly in executive functioning and social cognition [52–55].

The impact of mood alterations and loneliness on emotional and social functioning

Finally, another emerging finding concerns the role of mood in shaping the perception of social isolation: in our sample, participants with mood disturbances, both Altered-CPs and Altered-HCs, reported significantly higher levels of loneliness. This finding contributes to the growing body of evidence supporting that mood alterations may alter the emotional impact of social exclusion, potentially intensifying feelings of social disconnection [56, 57]. Correlation analyses further supported this interpretation: patients reporting greater loneliness also reported to feel more rejected after Cyberball exclusion session, while those with smaller social networks experienced reduced feelings of belonging. However, the role of loneliness on healthy status is still controversial [58]. In our healthy sample, we did not find a linear relationship between loneliness and key Cyberball outcomes measured after the exclusion condition. Nonetheless, a moderate association emerged between the perceived sense of control over the game, after the inclusion condition, and their perception of social inclusion, suggesting that the feelings of agency may buffer against negative emotional effects. Specifically, older HCs reported feeling more in control after the fair-inclusion condition and more connected to other players even after exclusion. In contrast, older CPs experienced greater discomfort following exclusion. Future studies should further investigate the impact of aging on social inclusion, although a recent meta-analysis indicated that age is not a significant predictor of Cyberball outcomes [19]. Overall, these findings are in line with observations from the COVID-19 pandemic, where patients with chronic illnesses were particularly vulnerable to the psychological burden imposed by this abrupt social disruption [59, 60], and individuals across the globe who experienced forced social isolation and a marked loss of control had increased levels of stress, anxiety, depression, sleep disturbances, and other mental health challenges [61].

Limitations

The main limitation of this study is the small sample size which prevented a sub-classification of the CPs based on pain etiology or gender. A larger sample would allow for stratification into more clinically distinct subtypes of chronic pain, potentially revealing specific correlations between pain characteristics and social or emotional outcomes, as well as accounting for gender-specific responses. Indeed, the literature on this topic is controversial, with some reports suggesting that women exhibit stronger physiological and behavioral reactions to ostracism than men [62, 63]. However, a recent meta-analysis of 120 studies using the Cyberball paradigm found that sex is not a significant predictor of psychological outcomes [19]. Another limitation is the absence of measurements in response to ostracism, such as aggressiveness or prosocial behavior [32, 64–66]. Given that this is the first study to investigate social pain within the context of chronic physical pain, we focused exclusively on psychological outcomes and contributed to the emerging literature on Cyberball use in clinical populations (see Reinhard et al., 2019 and Telesca et al., 2024 for systematic reviews [20, 44]). The effect of drugs should be further assessed. Although no significant differences were found among CP subgroups, we cannot exclude the possibility that certain medications, such as opioid, may influence the experience of social pain. For example, opioid use may temporarily reduce social pain by mimicking the effects of endogenous opioids [67]; however, prolonged use can suppress the natural opioid system, potentially exacerbating social isolation and intensifying the perception of social pain [68]. The small sample size and heterogeneity of medications taken, with only five patients using opioid drugs, make it impossible to draw reliable inferences regarding the impact of specific medication types.

Future studies should explore the effects of ostracism in chronic pain populations more comprehensively, including the use of neuroimaging or neurophysiological methods. These techniques could reveal differences in how individuals with chronic pain process social contexts, thereby offering a deeper understanding of the altered emotional responses observed in the present study, contributing to the ongoing debate on the overlap between social and physical pain.

Conclusions

This study is the first to investigate the effects of social pain, elicited through social exclusion, in individuals with chronic physical pain, addressing a long-standing gap in the literature on the overlap between physical and social pain. Our findings highlighted the complex interplay between chronic pain, mood disturbances, and social exclusion. Specifically, individuals with chronic pain and comorbid mood alterations exhibited diminished emotional responses to social ostracism and reduced feelings of connectedness, even in inclusive contexts. These individuals also reported higher loneliness, poorer emotion recognition abilities, and greater reliance on maladaptive coping strategies, such as catastrophizing. Together, these findings suggest a possible emotional blunting or disengagement from social cues, likely influenced by both affective and neuropsychological factors. These results have important clinical implications, given the frequent co-occurrence of mood disturbances, social cognition deficits, and reduced quality of life in chronic pain populations.

Addressing these psychosocial dimensions may enhance care by supporting more personalized and effective treatment approaches.

Abbreviations

CPs	Chronic Pain patients
EXC	Exclusion Condition of the Cyberball task
G1	Chronic Pain Patients with Normal Mood
G2	Chronic Pain Patients with Altered Mood
G3	Healthy Controls with Normal Mood
G4	Healthy Controls with Altered Mood
HADS	Hospital Anxiety Depression Scale
HCs	Healthy Controls
INC	Inclusion condition of the Cyberball task
LSNS-6	Lubben Social Network Scale
MoCA	Montreal Cognitive Assessment
NRS	Numerical Rating Scale
NTS	Need Threat Scale
OIS	Other in Self scale
PCS	Pain Catastrophizing Scale
SET	Story-based Empathy Task
UCLA-3L	Three-items Loneliness Scale of the University of California, Los Angeles

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s10194-025-02238-2.

Supplementary Material 1

Supplementary Material 2

Author contributions

Substantial contributions to the conception or design of the work: AT, MC, and GiL. Substantial contributions to the acquisition, analysis, or interpretation of data for the work: AT, MC, ES, AF, VF, EDB, SU, LiG, and LJRL. Drafting the work: AT and MC. Reviewing the work critically for important intellectual content: AT, MC, ES, AF, SU, LiG, LJRL, and GiL. All authors read and approved the final manuscript.

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Data availability

The data that support the findings of this study are available at https://doi.org/10.5281/zenodo.17153289.

Declarations

Ethics approval and consent to participate

All participants provided written informed consent prior to enrollment. Consent procedures adhered to the principles outlined in the Declaration of Helsinki. The dataset was anonymized in compliance with Italian privacy legislation. The study received approval from the local Ethics Committee.

Competing interests

The authors declare no competing interests.

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