

Task interference and distraction efficacy in patients with fibromyalgia: an experimental investigation

Dimitri M.L. Van Ryckegehem^{a,b,*}, Silke Rost^a, Ama Kissi^b, Claus Vögele^a, Geert Crombez^{b,c}

Abstract

Pain has the capacity to interfere with daily tasks. Although task interference by pain is largely unintentional, it can be controlled to a certain extent. Such top-down control over pain has been believed to be reduced in patients with fibromyalgia (FM). In this study, we investigated task interference and distraction efficacy in patients with FM and a matched healthy control group. Forty-nine patients with FM and 49 healthy volunteers performed as quickly as possible (1) a visual localization task in the presence of nonpainful vibrating or painful electric somatic stimuli, and (2) a somatosensory localization task (using nonpainful or painful stimuli). Participants reported on their experience of the somatic stimuli on some of the trials during both localisation tasks. Results indicated that pain interferes with performance of the visual task, in both patients with FM and healthy individuals. Furthermore, participants experienced the pain stimulus as less intense when directing attention away from the pain than when focusing on the pain. Overall, task performance of patients with FM was slower compared with the task performance in the healthy control group. In contrast to our hypotheses, patients with FM and healthy volunteers did not differ in the magnitude of the interference effect and distraction efficacy. In conclusion, current study provides support for contemporary theories claiming that attention modulates the experience of pain and vice versa. However, no evidence was found for an altered attentional processing of pain in patients with FM. Furthermore, results indicate that task interference and distraction efficacy are not just 2 sides of the same coin.

Keywords: Task interference, Distraction, Fibromyalgia, Attention

1. Introduction

A key feature of pain is its ability to demand attention.^{15,57} In acute pain, this feature is adaptive because it urges a person to escape from bodily threat.¹⁵ In the long term, however, this ability may become maladaptive because pain interferes with the capability to fulfil daily tasks and goal pursuit.^{16,18,49} The interference of pain with task performance has been documented in healthy individuals experiencing acute pain^{3,6,9,35} as well as in those with chronic pain.^{14,37} Although the capture of attention by pain may be largely unintentional, it can be controlled to some extent. Indeed, several studies have shown that directing attention away from pain by engaging in a task unrelated to pain (ie, attentional distraction) reduces acute pain and related distress.^{5,7,17,23,24,33}

The answers to the questions “How and when does pain interfere with ongoing tasks” (task interference), and “how and when does directing attention away from pain diminishes pain (distraction efficacy)” are often grounded in similar theoretical

frameworks.^{10,15,29} Nevertheless, only few studies have simultaneously investigated task interference and distraction efficacy (see Ref. 42 for an exception). Furthermore, these frameworks often (implicitly or explicitly) assume that the magnitude of both phenomena is altered in people with chronic pain.^{19,29,37} Research comparing task interference and/or distraction efficacy between healthy participants and patients with chronic pain is, however, largely lacking. The need for further research comparing both phenomena has been emphasised in a recent meta-analysis, summarizing available work on the effects of distraction in patients with chronic pain.⁵⁴ In contrast to research in healthy volunteers, available research in patients with chronic pain suggests that directing attention away from pain does not reduce pain and distress. Notwithstanding, more research study is needed because the available evidence consisted largely of studies that did not include healthy control groups, used small samples, and suffered from methodological shortcomings (eg, no control for alternative coping strategies in the control condition). If proven, distraction inefficacy in patients with chronic pain may point at the presence of (1) heightened levels of vigilance for pain and/or somatic sensations in general^{11,12,57} or (2) problems of executive functioning in patients with chronic pain.^{4,37} Both explanations have been put forward to explain the failure of distraction in patients with chronic pain.^{25,28,56}

In the current study, we investigated, both, task interference and distraction efficacy in a sample of patients with fibromyalgia (FM) and a matched healthy control group. Patients with FM were selected because previous research suggests that they are prone to impairments of attention and show reduced levels of executive functions.⁴⁷ We hypothesized that (1) pain would interfere with task performance in healthy participants and

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

^a Institute for Health and Behaviour, INSIDE, University of Luxembourg, Esch-sur-Alzette, Luxembourg, ^b Department of Experimental Clinical and Health Psychology, Ghent University, Ghent, Belgium, ^c Centre for Pain Research, University of Bath, Bath, United Kingdom

*Corresponding author. Address: Maison des Sciences Humaines, Université du Luxembourg, Porte des Sciences 11, L-4366 Esch-sur-Alzette, Luxembourg. Tel.: +35 (0) 4666449241. E-mail address: Dimitri.VanRyckegehem@uni.lu (D.M.L. Van Ryckegehem).

PAIN 159 (2018) 1119–1126

© 2018 International Association for the Study of Pain

<http://dx.doi.org/10.1097/j.pain.0000000000001196>

patients with FM, albeit to a larger extent in patients with FM; (2) directing attention away from pain would reduce the experience of pain in healthy volunteers, but not or to a lesser extent in patients with FM; and (3) pain intensity would affect the magnitude of task interference and distraction efficacy. For exploratory purposes, we also examined the relationship between distraction efficacy, task interference, and their relationship with other constructs presumed to play a role in both phenomena.

2. Method

2.1. Participants

The study sample (N = 98) consisted of patients with FM (N = 49) and healthy volunteers (N = 49) aged between 18 and 65 years, who were recruited for the ASEF-I-project. Within the ASEF-I-project, a group of patients with FM and a matched group of healthy participants were recruited to investigate attention and self-regulatory processes. The full project protocol, detailing the study design and flow can be retrieved through the following link: <http://hdl.handle.net/1854/LU-5686902>. Recruitment of participants took place between January and March 2014. Participants were only included if they (1) had sufficient knowledge of the Dutch language; (2) did not suffer from a neurological condition; (3) could use both index fingers; (4) did not report abnormal sensations in the arms; (5) had a normal or corrected-to-normal (eg, by glasses) eyesight; (6) were not pregnant; and (7) did not have a pacemaker. In addition, patients with FM were only included if they had received an FM diagnosis and fulfilled the American College of Rheumatology (ACR)-2010-criteria,⁵⁸ and healthy participants if they did not report a current pain problem. Patients with FM and healthy participants were matched at group level for age, sex, and educational level. Patients with FM were recruited in the Multidisciplinary Pain Clinic of Ghent University Hospital. They were informed about the study through a poster in the waiting room of the hospital. Patients who were interested in taking part left their contact details. The healthy control group was recruited through advertisements in a local newspaper, flyers, and the university website. Healthy participants who fulfilled the eligibility criteria were contacted by telephone and informed about the study. For participants who agreed to participate, an appointment was scheduled for a laboratory session. A flow chart indicating the exact number and reasons of nonparticipation of participants can be found in the full study protocol of the ASEF-I-project. The study was approved by the medical ethics committee of the University Hospital of Ghent (registration number: 2013/1016).

2.2. Apparatus and somatosensory stimuli

Somatosensory stimuli consisted of painful and nonpainful stimuli. Nonpainful stimuli were tactile stimuli (frequency = 200 Hz; duration = 300 ms; and intensity = 0.07 W) and presented with 2 resonant-type factors (C-2 TACTOR; Engineering Acoustics, Inc, Casselberry, FL) consisting of a box of 3.05 cm diameter and 0.79 cm height, with a skin contactor of 0.76 cm diameter. Painful stimuli were electrocutaneous stimuli (bipolar; 50 Hz; 300 ms; instantaneous rise and fall time) delivered by a constant current stimulator (DS5; Digitimer Ltd, Hertfordshire, United Kingdom). All somatosensory stimuli were delivered in the region of the medial cutaneous nerve of the left forearm (close to the wrist or close to the elbow; **Fig. 1**).

2.3. Self-report measures

Fibromyalgia symptoms were assessed using the widespread pain index (WPI) score, which represents a number of whole-body pain areas (max score = 19), and the symptom severity (SS) score that quantifies SS on a 0 to 12 scale by scoring problems with fatigue, cognitive dysfunction, and unrefreshed sleep over the past week. In line with the 2010 ACR criteria,⁵⁸ participants satisfied the FM criteria if they had a (1) WPI score greater than or equal to 7 and an SS score greater than or equal to 5 or (2) a WPI score ranging from 3 to 6 and an SS score greater than or equal to 9.

Pain severity was assessed with the pain severity subscale of the Multidimensional Pain Inventory (MPI^{26,31}). The MPI (part 1) consists of 5 subscales assessing the impact of pain on a 7-point Likert scale ranging from 0 to 6. Pain severity was assessed with 2 items (ie, “Rate the level of your pain at the present moment” and “On average, how severe has your pain been during the last week?”). In line with previous studies, the third item (“How much suffering do you experience because of your pain?”) of the pain severity subscale was not taken into account given that its content relates to suffering rather than pain severity (see also Refs. 40 and 53). The MPI has shown good reliability and validity.⁴³ In this study, Cronbach’s alpha of the MPI severity subscale was 0.84.

Pain-related disability was measured with the Pain Disability Index (PDI⁴¹) which assesses the level of restriction in participation in 7 life domains (eg, family) on a scale ranging from 0 (no disability) to 10 (total disability). Participants were asked to evaluate the overall impact of pain (not just when pain is at its worst) on each of the 7 life domains, on a scale from 0 to 70. Cronbach’s alpha of the PDI was 0.82.

Depressive mood, anxiety, and stress during the past week were assessed using the Depression Anxiety Stress Scales (DASS³²). Each subscale contains 14 items (eg, “I found it hard to wind down” and “I felt I was pretty worthless”), which were rated on a 4-point Likert scale ranging from 0 (“did not apply to me at all”) to 3 (“applied to me very much, or most of the time”). In this study, Cronbach’s alpha for the depression, anxiety, and stress subscales were, respectively, 0.96, 0.91, and 0.95.

Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS⁴⁶). This scale contains 13 items that measure catastrophic thoughts about pain in both clinical and nonclinical samples. To answer these items, participants are required to think about past painful experiences and indicate on a 5-point scale (ranging from 0 [“not at all”] to 4 [“always”]) the degree to which they experienced each of the 13 thoughts or feelings (ie, “When I’m in pain it’s terrible and I think it’s never going to get any better”). Research has shown that the PCS is valid and reliable.⁴⁸ In this study, Cronbach’s alpha of the total PCS score was 0.95.

Vigilance for bodily symptoms was measured using the Body Vigilance Scale (BVS⁴⁴). The BVS is a 4-item questionnaire measuring vigilance for bodily symptoms on an 11-point numerical rating scale (eg, “I am very sensitive to changes in my internal body sensations”). The last item is an average of the awareness scores of 15 nonspecific body symptoms (eg, “rate how much attention you pay to each of the following sensations [eg, heart palpitations, tingling, and nausea]”). Cronbach’s alpha of the 4 BVS items in this study was 0.73.

2.4. Experimental task

The experimental task was programmed and presented using INQUISIT Millisecond software package (Inquisit 3; Millisecond

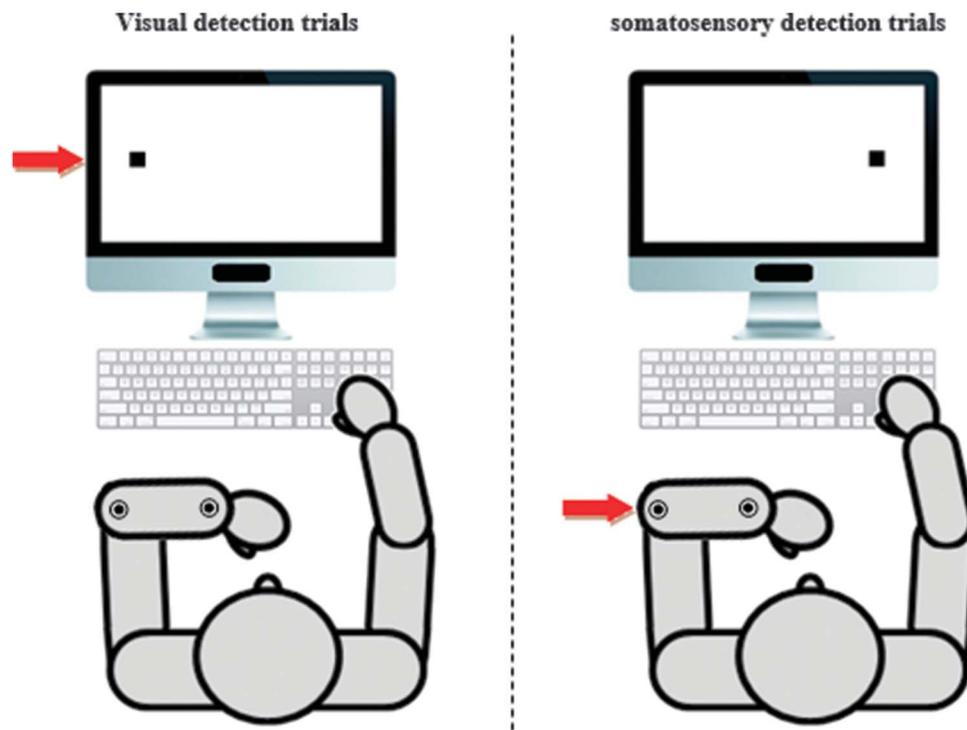


Figure 1. Schematic illustration of the experimental set-up.

Software, Seattle, WA) on a Dell computer (Intel Core2 Duo P8600, 4096 MB) with a 60-Hz, 17-inch colour CRT monitor. The experiment consisted of localizing either the somatosensory stimuli (nonpainful, low painful, and moderately painful) during a somatosensory localisation task (somatosensory focus task), or the visual stimuli during a visual localisation task (visual focus task = distraction task). Somatosensory and visual stimuli were simultaneously presented during each trial. In 50% of the trials, participants were instructed to localize as quickly as possible whether the visual stimulus (ie, 1×1 cm black square) was presented to the left or right side of the screen (visual focus trials). On the remaining trials, participants were instructed to localize as quickly as possible whether the somatosensory stimulus was presented to the left (close to the elbow) or right (close to the wrist) location on the left arm (somatosensory focus trials). Each trial started with a visual cue consisting of a full coloured circle (either blue or yellow; 1000 ms duration) in the centre of the screen that indicated which modality was relevant and needed to be attended to. Somatosensory and visual stimuli were presented the same number of times at the left and right location. A total of 256 trials were presented. In 192 (75%) trials, the somatosensory stimulus consisted of nonpainful tactile stimuli. In the other 64 (25%) trials, the somatosensory stimulus consisted of painful electrocutaneous stimuli (32 trials with low intense pain and 32 trials with moderately intense pain). Furthermore, 25% of the nonpainful trials (ie, 48 trials) and 75% of the painful trials (ie, 48 trials) were followed by 2 visual analogue scales (VAS) (“How intense was the last somatosensory stimulus” [0 = totally not intense; 10 = very intense]; “How unpleasant was the last somatosensory stimulus” [0 = totally not unpleasant; 10 = very unpleasant]) that probed the intensity and the unpleasantness of the experienced pain. Trials with vibrotactile stimuli were implemented for several reasons. First, somatosensory trials were included as a control category to investigate the magnitude of task interference by

pain. Second, the inclusion of somatosensory trials reduced the overall percentage of trials that were followed by a pain rating. Hence, the possibility that participants attended to the somatosensory stimuli during visual modality trials because they expected to rate the somatosensory stimuli was kept low (see also Ref. 51). This resulted in 6 trial types: (1) nonpainful somatosensory focus trials, (2) low painful somatosensory focus trials, (3) moderately painful somatosensory focus trials, (4) nonpainful visual focus trials, (5) low painful visual focus trials, and (6) moderately painful visual focus trials. Each trial type was presented “equi-probably” and randomly at the left and right location. Participants indicated the location of the stimuli using the right hand on the keyboard (4 = left; 6 = right) (see Fig. 1 for a schematic presentation of the study set-up).

2.5. Procedure

Before the experimental session (ie, before scheduling the laboratory session and providing general study information), all participants were asked to complete a number of questionnaires at home (including the MPI, DASS, PDI, BVS, PCS, and demographic information), either online (through LimeSurvey) or on paper. On arrival, all participants received additional information about the study and signed an informed consent form. Thereafter, all participants performed several experimental tasks as part of the ASEF-I-project. The experimental task described in the current study was the first (after ACR-criteria assessment and a 10-minute resting period during which heart rate was monitored) that people performed. Before starting the experimental task, participants filled out how intense the pain was (VAS ranging from 0 = no pain to 100 = worst imaginable pain) and how much fatigue (VAS ranging from 0 = not at all to 100 = very much) they experienced at that moment. Furthermore, participants received the following information “During this task,

nonpainful and painful stimuli will be administered. The intensity of the stimuli may differ more or less from each other.” After receiving this information, the left arm of the participants was scrubbed and 2 lubricated Technomed Europe surface electrodes (Maastricht, the Netherlands; 1 cm diameter) and 2 resonant-type factors (C-2 TACTOR; Engineering Acoustics, Inc) were attached at 2 locations of the left forearm (close to the wrist or the elbow) situated in the medial cutaneous nerve area. Next, the intensity of the electrocutaneous stimuli was individually determined for each participant by administering electrocutaneous stimuli of increasing intensity at both locations of the arm (starting with 0.5 mA) and increasing with steps of 0.5 mA. During the calibration phase, participants were instructed to pay close attention to the pain stimulus when judging its intensity. The intensity of the electrocutaneous stimulus increased until participants reported that the pain stimulus they received was of moderate pain (on a scale ranging from “no pain,” “little pain,” “moderate pain,” “intense pain,” “enormous pain,” and “unbearable pain”). This moderately intense pain stimulus was then used during the experimental task. A so-called “low intense pain” stimulus was derived from the moderately intense pain stimulus using the formula provided by Arntz and Lousberg.² This procedure resulted in an overall mean objective stimulus intensity of 3.79 mA (SD = 2.02) and 3.56 mA (SD = 1.97) for the left and right moderately intense pain stimulus, respectively, and an overall mean objective stimulus intensity of 3.38 mA (SD = 1.82) and 3.18 mA (SD = 1.78) for the left and right low intense pain stimulus. The objective stimulus intensity did not differ significantly between locations (All $F_{(1, 96)} < 2.35$ ns), but did differ between groups (moderately intense pain stimulus: $F_{(1, 96)} < 28.25$, $P < 0.001$; low intense pain stimulus: $F_{(1, 96)} < 28.03$, $P < 0.001$), indicating that the objective intensity of the pain stimulus was lower for patients with FM (moderately intense pain stimulus: $M = 2.79$ mA, $SD = 1.35$; low intense pain stimulus: $M = 2.49$ mA, $SD = 1.22$) than for healthy controls (moderately intense pain stimulus: $M = 4.56$ mA, $SD = 1.89$; low intense pain stimulus: $M = 4.07$ mA, $SD = 1.71$).

2.6. Data analyses

Statistical analyses were performed with SPSS statistical software, version 24.0 for Windows (SPSS Inc, Chicago, IL). Analyses investigating task interference by pain in healthy participants and patients with FM were performed on the response latencies of distraction (ie, performance of the visual task) trials only, using a repeated-measures analysis of variance (ANOVA) with somatosensory stimulus (nonpainful vs low painful vs moderately painful) and group (healthy controls vs patients with FM) as a between-group factor. Contrast analyses were used to investigate the effect of pain intensity on the magnitude of task interference. Analyses investigating distraction efficacy in healthy participants and patients with FM were performed on pain intensity and unpleasantness ratings of the painful stimuli only. Pain intensity and unpleasantness ratings of the vibrotactile stimuli were not analyzed (see above). For each dependent variable (pain intensity and unpleasantness), a repeated-measures ANOVA with Pain Stimulus (low painful vs moderately painful) and Modality Relevance (somatosensory relevant vs visual relevant) as within-subject factors and Group (healthy controls vs patients with FM) as between-group factor was conducted. When appropriate, contrast analyses were used.

For all analyses, Greenhouse–Geisser corrections (with adjusted degrees of freedom) were performed whenever the sphericity assumption was violated (Mauchly test of sphericity

was $P < 0.05$). Furthermore, the cutoff for statistical significance was set at $P < 0.05$, and effect sizes were reported using the partial eta squared index (η_p^2) and when appropriate Cohen's d (see also Refs. 8, 27, and 39).

3. Results

3.1. Descriptives

Mean age of participants was 45.30 years (SD = 10.74; range 22–65 years), and 81 of them were female (82.7%) (Table 1). The majority of the participants was married or living together (55.1%). Almost half of the sample graduated from high school or university (45.9%). For patients with FM, the mean pain duration was 186.36 months (SD = 115.14). The 2 groups did not differ in terms of age, sex distribution, or educational level (see Table 2 for an overview). Patients with FM reported a mean pain severity level (MPI) of 3.62 (SD = 1.07) and mean level of restrictions in participation (PDI) of 41.80 (SD = 10.39). All patients with FM fulfilled the 2010 ACR criteria⁵⁸ with a mean WPI score of 11.84 (SD = 3.33) and mean SS score of 8.96 (SD = 1.63). Most commonly reported pain locations were the neck (95.9%), shoulder (left side: 89.8%, right side: 91.8%), and back (upper back: 91.8%, lower back: 93.9%).

3.2. Task interference by pain

Before performing reaction time analyses, errors (2.7%) and outliers were removed. Data with response latencies shorter than 200 ms (anticipations) or 3 SDs above the individual mean reaction times of correct responses for each trial type were considered outliers and excluded from further analyses (1.6%). Next, a 3 (somatosensory stimulus: nonpainful vs low painful vs moderately painful) \times 2 (Group: patients with FM vs healthy controls) repeated-measures ANOVA was performed. Results showed a main effect for somatosensory stimulus ($F_{(1.78, 170.83)} = 53.50$, $P < 0.001$, $\eta_p^2 = 0.358$) and Group ($F_{(1, 96)} = 8.07$, $P < 0.01$, $\eta_p^2 = 0.078$). There was no interaction effect ($F_{(1.78, 170.83)} = 1.60$ ns; Figure 2). Planned contrasts showed that participants were significantly slower in performing the visual tasks when receiving moderately ($M = 735.89$, $SD = 260.24$) compared with low intense painful stimuli ($M = 712.36$, $SD = 234.04$; $F_{(1, 96)} = 5.43$, $P < 0.05$, $\eta_p^2 = 0.054$, $d_{rm} = 0.09$, confidence interval [CI] = 0.01–0.17). Participants were also significantly slower to perform the visual tasks when receiving low intense pain stimuli ($M = 712.36$, $SD = 234.04$) compared with nonpainful stimuli ($M = 620.53$, $SD = 176.35$; $F_{(1,96)} = 65.08$, $P < 0.001$, $\eta_p^2 = 0.404$, $d_{rm} = 0.39$, CI = 0.29–0.49). For follow-up correlations (section correlational analyses), an overall pain interference index was calculated by subtracting the average reaction time on nonpainful trials from the mean of the average reaction times of low and moderately painful trials. A positive index indicated a delayed response because of the presence of pain, whereas a negative index indicated a speeded response because of the presence of pain.

3.3. Distraction efficacy

Analyses concerning distraction efficacy were performed on the ratings of all correctly answered pain trials (ie, 94.1% of all possible pain trial ratings). A 2 (Modality Relevance: somatosensory relevance vs visual relevance) \times 2 (Pain Stimulus: low painful vs moderately painful) \times 2 (Group: patients with FM vs healthy controls) repeated-measures ANOVA was performed for pain intensity and unpleasantness. For pain intensity, a main effect

Table 1
Descriptive statistics per group (patients with FM and control group).

| | Healthy controls (n = 49) | Patients with FM (n = 49) | Group difference statistics |
|---|---------------------------|---------------------------|-------------------------------------|
| Sex (females/males) | 40/9 | 41/8 | $\chi^2_{(1)} = 0.07$ ns |
| Age | 45.39 (12.07) | 45.20 (9.35) | $t_{(90,34)} = 0.08$ ns |
| Education level (primary/lower secondary/higher secondary/higher education) | 2/2/19/26 | 2/7/21/19 | $\chi^2_{(3)} = 3.97$ ns |
| Pain intensity (test moment) | 2.10 (4.59) | 44.08 (21.06) | $t_{(52,56)} = 13.64$, $P < 0.001$ |
| PCS | 9.88 (9.76) | 21.90 (10.77) | $t_{(96)} = 5.79$, $P < 0.001$ |
| DASS-A | 2.84 (3.48) | 11.41 (7.42) | $t_{(68,21)} = 7.32$, $P < 0.001$ |
| DASS-D | 5.61 (6.25) | 13.41 (10.72) | $t_{(77,27)} = 4.40$, $P < 0.001$ |
| DASS-S | 7.76 (7.24) | 15.55 (7.81) | $t_{(96)} = 5.12$, $P < 0.001$ |
| BVS | 14.19 (6.81) | 18.59 (6.71) | $t_{(96)} = 3.22$, $P < 0.01$ |

BVS, Body Vigilance Scale; DASS, Depression Anxiety Stress Scale; FM, fibromyalgia; PCS, Pain Catastrophizing Scale.

was found for Pain Stimulus ($F_{(1, 96)} = 66.46$, $P < 0.001$, $\eta_p^2 = 0.409$, $d_{rm} = 0.13$, $CI = 0.10-0.16$) indicating that participants experienced the moderately intense pain stimulus ($M = 42.79$, $SD = 23.73$) as more painful than the low intense pain stimulus ($M = 39.66$, $SD = 22.64$). Also, a main effect was found for Modality Relevance ($F_{(1, 96)} = 31.31$, $P < 0.001$, $\eta_p^2 = 0.25$, $d_{rm} = 0.08$, $CI = 0.05-0.11$), in that participants experienced less pain during visual modality trials ($M = 40.29$, $SD = 23.00$) than during somatosensory modality trials ($M = 42.15$, $SD = 23.33$). In contrast to our expectation, there was no interaction effect between Group and Modality Relevance ($F_{(1, 96)} < 1$ ns). No other main effects or interaction effects were significant (all $F_s > 1.79$). Results for pain unpleasantness were similar such that there was a main effect of Pain Stimulus ($F_{(1, 96)} = 87.98$, $P < 0.001$, $\eta_p^2 = 0.478$, $d_{rm} = 0.16$, $CI = 0.12-0.19$), indicating that participants experienced the moderately intense pain stimulus ($M = 41.63$, $SD = 23.55$) as more unpleasant than the low intense pain stimulus ($M = 37.92$, $SD = 22.53$). In addition, we found a main effect for Modality Relevance ($F_{(1, 96)} = 30.91$, $P < 0.001$, $\eta_p^2 = 0.244$, $d_{rm} = 0.09$, $CI = 0.06-0.12$), indicating that pain was perceived as less unpleasant during visual modality trials ($M = 38.71$, $SD = 22.71$) than during somatosensory modality trials ($M = 40.84$, $SD = 23.37$). Again, in contrast to our expectation, no interaction effect was found between Group and Modality Relevance ($F_{(1, 96)} < 1$ ns). No other main effects or interaction effects were significant (all $F_s > 1$). For follow-up correlations (section correlational analyses), a distraction efficacy index was calculated by subtracting the mean of the average ratings on low and moderately painful visual focus trials from that of the low and moderately painful somatosensory focus trials for pain intensity and unpleasantness ratings, respectively. Given that the distraction efficacy indices for pain intensity and unpleasantness were highly correlated, an overall pain distraction efficacy was calculated by averaging both indexes.

3.4. Correlational analyses

In a final exploratory step, we investigated whether task interference by pain and distraction efficacy were related. In addition, we explored their relationship with individual difference variables (eg, anxiety and pain intensity). For variables measured in both groups, that is, patients with FM and healthy controls, partial correlations were performed to control for the impact of Group. For the variables that were only measured in the FM patient group, Pearson correlations were performed. Correlation analyses showed that the magnitude of distraction efficacy and task interference by pain did not correlate ($r = 0.06$ ns). Distraction efficacy was, however, negatively related to anxiety (DASS-A, $r = -0.18$, $P = 0.09$), pain catastrophizing (PCS, $r = -0.18$, $P = 0.08$), pain severity (MPI-ps, $r = -0.26$, $P = 0.07$), and fatigue at the moment of testing (fatigue, $r = -0.25$, $P = 0.01$), suggesting that distraction is most effective in people who are less anxious, are low catastrophizing about pain, report less severe pain, or are less fatigued, respectively. By contrast, task interference by pain was not related to any of the investigated individual difference variables (Table 2).

4. Discussion

This study investigated task interference and distraction efficacy in patients with FM, and in a matched healthy control group. The results can be readily summarised. First, we found that pain interferes with task performance in patients with FM as well as healthy individuals. Second, participants experienced the pain stimulus as less intense when directing attention away from the pain stimulus (ie, when performing a visual task) than when focusing on the pain. In contrast to our hypothesis, no difference was found in the magnitude of the interference effect and distraction efficacy between patients with FM and healthy controls. Finally, our findings indicate that the indices of task

Table 2
Partial correlations controlled for group (patients with FM vs control group).

| | Group | Dis. eff. | DASS-A | DASS-D | DASS-S | MPI-ps | PCS | PDI | BVS | State PI | State fatigue |
|--------------------|-----------|-----------|--------------------|--------|--------|--------------------|--------------------|-------|-------|----------|---------------|
| Task interference | <i>r</i> | 0.06 | 0.08 | 0.02 | -0.03 | -0.09 | -0.01 | -0.19 | -0.01 | -0.11 | -0.12 |
| | <i>df</i> | 95 | 95 | 95 | 95 | 47 | 95 | 47 | 95 | 95 | 95 |
| Distraction effect | <i>r</i> | — | -0.18 ^t | -0.10 | -0.01 | -0.26 ^t | -0.18 ^t | -0.19 | -0.10 | -0.14 | -0.25* |
| | <i>df</i> | — | 95 | 95 | 95 | 47 | 95 | 47 | 95 | 95 | 95 |

For the MPI and PDI which were only assessed in the patient with FM sample, Pearson correlations are reported ^t $p < .10$; * $p < .05$.

BVS, Body Vigilance Scale; DASS, Depression Anxiety Stress Scale; FM, fibromyalgia; MPI-ps, Multidimensional Pain Inventory pain severity; PCS, Pain Catastrophizing Scale, PDI, Pain Disability Index; PI, pain intensity.

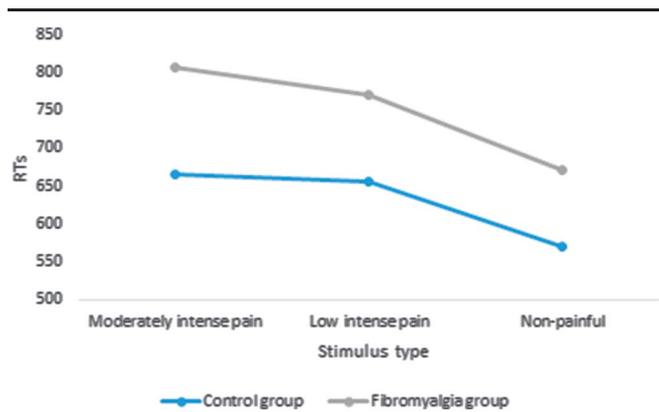


Figure 2. Task interference effect per group (patients with FM vs control group). FM, fibromyalgia.

interference and distraction efficacy are not related to each other, suggesting that they are not 2 sides of the same coin.

In line with previous research, the current findings show that pain interferes with task performance in both healthy participants^{35,36} and patients with chronic pain.¹⁴ Indeed, participants' performance on a visual detection task was significantly slowed when receiving a painful in comparison with a nonpainful tactile stimulus. Furthermore, to the best of our knowledge, the current study is one of the first to show that the interference effect increases with the intensity of the pain stimulus. This finding is in line with earlier theories that state that salient stimuli—that is, stimuli which are more intense, more threatening, more novel, or less predictable—are more likely to capture attention.^{15,29}

Furthermore, the findings of the current study indicate that distraction from pain may result in reduced experience of a low to moderately intense pain stimulus. Yet, the efficacy of the distraction task was not dependent on the intensity of the pain stimulus. This finding seems to be in contrast with research suggesting that distraction is more effective for less intense pain.^{33,54} It is, however, possible that the difference in the intensity of the pain stimuli (low vs moderately painful) was too small to show the impact of pain intensity on distraction efficacy. It may also be that there is no linear relationship between pain intensity and distraction efficacy, but that distraction is successful until pain intensity exceeds a certain level of intensity.⁵² Contrary to our expectations, groups did not differ in the magnitude of the pain interference effect and distraction efficacy. Although the overall performance of patients with FM was slowed, the interference effect of low and moderately intense pain stimuli did not differ from the interference effect in healthy controls. This finding challenges the idea that painful stimuli more easily demand attention in patients with FM than in healthy people. Instead, our results suggest that patients with FM and healthy volunteers may have similar difficulties performing a primary task when experiencing pain. We did observe a general slowing in task performance in patients with FM compared with healthy participants. This is in line with previous research revealing slower reaction times in patients with chronic pain than in healthy controls.⁵⁵ There may be several reasons for this slowed performance. First, the slowed performance may reflect impaired mental processing speed.^{20,30} Second, it is possible that the slower reaction times can be attributed to motor slowing. Indeed, performing the visual detection task required also a motor response (button press). Slowed motor responses may, for example, be due to the use of medication (or medication history)

or reduced general physical fitness levels.¹³ Unfortunately, the current study does not enable us to draw firm conclusions about whether the slow response times were due to problems in mental processing or motor speed, or both.

The current findings suggest that distraction is as effective in patients with FM as it is in healthy people. This finding contradicts some earlier findings (for an overview⁵⁴) indicating that distraction is not effective or to a lesser extent in patients with chronic pain compared with healthy controls. A number of reasons may explain this discrepancy. First, in contrast to most distraction studies in patients with chronic pain,²² the experimental pain stimulus was of a short duration and of low to moderate intensity. It may well be that patients with FM are able to increase their effort in a distraction task for a short timespan when pain is not too intense (see also Ref. 54). Second, our control condition did not instruct participants to cope with pain as usual, often the case in previous distraction research in patients with chronic pain, allowing for large variability in used strategies^{21,22} (but see also Ref. 45 for an exception). Instead, participants were instructed to focus their attention on the pain stimuli (ie, perform a somatosensory detection task). The fact that the difference in control condition could explain these diverging findings is in line with subanalyses of a recent meta-analysis.⁵⁴ Results of this meta-analysis showed that, although distraction shows to be ineffective when compared with a no-instruction control condition, it does result in a pain reduction when being compared with a condition in which attention is focused on pain. A potential avenue for research is then to investigate to what extent patients with FM spontaneously make use of distraction strategies, and the possible reasons for not doing so. All in all, this finding points at the importance of well thought control conditions in distraction research. Third, it should be noted that although all participants experienced the pain stimuli as moderately painful, the stimulus intensity was substantially lower in patients with FM compared with their healthy counterparts. This finding is in line with the central sensitisation hypothesis, which suggests that the responsiveness of central neurons to input from unimodal and polymodal receptors is augmented in patients with FM, and results in generalized or widespread hypersensitivity.^{34,38} The procedure followed in the current study, to determine individual pain thresholds, differs from most previous distraction studies in patients with chronic pain, in that they mostly used a fixed stimulus intensity for all participants.²¹ It may thus be that in current study, distraction was equally effective in patients with FM and healthy controls because during the calibration phase, we identified in each individual the intensity that was experienced as moderately painful. Therefore, at the start of the study, the self-reported intensity of the stimulus was not different between the FM and healthy controls. This approach was deliberate. When using a stimulus of fixed intensity,^{21,22} experienced pain may be higher in patients with FM than in healthy controls because of differences in low level processes involved in peripheral or central sensitisation. During the calibration phase, we instructed participants to pay close attention to the stimulus. That way, we reasoned that attention to pain was kept constant, and potential differences in the way participants habitually pay attention to pain were ruled out.¹ Future work should further explore this assumption. Finally, we found that the magnitude of task interference by pain is not related to distraction efficacy. This finding suggests that distraction efficacy is not just the counterpart of task interference by pain.⁵⁰ Distraction efficacy is based on self-report of pain and may be more prone to expectations of people and/or reporting or reflection biases. This may also explain why only distraction efficacy, and not task

interference, was related to self-report measures of pain experience, catastrophizing, anxiety, and levels of fatigue in patients with FM.

In addition to these theoretical implications, the current findings also have clinical implications. On the one hand, our results indicate that under specific conditions, distraction may be useful in patients with FM. That is, when pain is not intense and of short duration. It should be noted that our cognitive distraction task only resulted in a small reduction in self-reported pain. As such, the use of distraction strategies should be well considered. On the other hand, our results also show that distraction may be less effective for patients with FM who experience more intense chronic pain, catastrophize about their pain, and are more anxious or more fatigued.

This study has some limitations. First, the current study was performed in the laboratory using experimental pain stimuli. Although the use of experimental pain stimuli increases experimental control, it may be difficult to generalize findings to the everyday life of patients with FM. Second, we opted to tailor the intensity of the experimental pain stimulus to an experience of moderate pain. This resulted in the presentation of pain stimuli, which differed in their (objective) intensity. Other studies have most often used a fixed intensity procedure. Our results may differ from these studies because of this dissimilarity. Third, we did not assess whether the tactile stimulus was perceived as painful by the patients with FM. This is, however, unlikely because no patient mentioned that the tactile stimulus was perceived as painful and unpleasantness ratings of the tactile stimulus were low. There was also no difference in the unpleasantness ratings between patients with FM and healthy participants. Fourth, the difference between low intensity and moderate intensity pain stimuli was relatively small. This may have reduced the chances to find an impact on distraction efficacy. Future research may opt to increase the difference between the intensity levels of pain stimuli.

Conflict of interest statement

The authors have no conflict of interest to declare.

Preparation of this article was partly supported by Grant BOF/GOA2006/001 of Ghent University and FWO project G.017807. This project has received further funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No 706475.

Article history:

Received 22 November 2017

Received in revised form 13 February 2018

Accepted 22 February 2018

Available online 6 March 2018

References

- [1] Allport A. Attention and integration. In: Mole C, Smithies D, Wu W, editors. *Attention: philosophical and psychological essays*. New York: Oxford University Press, 2011. p. 24–59.
- [2] Arntz A, Lousberg R. The effects of underestimated pain and their relationship to habituation. *Behav Res Ther* 1990;28:15–28.
- [3] Attridge N, Eccleston C, Noonan D, Wainwright E, Keogh E. Headache impairs attentional performance: a conceptual replication and extension. *J Pain* 2017;18:29–41.
- [4] Berrymann C, Stanton TR, Bowering KJ, Tabor A, McFarlane A, Moseley GL. Do people with chronic pain have impaired executive function? A meta-analytical review. *Clin Psych Rev* 2014;34:563–79.
- [5] Birnie KA, Noel M, Parker JA, Chambers CT, Uman LS, Kisely SR, McGrath PJ. Systematic review and meta-analysis of distraction and hypnosis for needle-related pain and distress in children and adolescents. *J Pediatr Psychol* 2014;39:783–808.
- [6] Buhle J, Wager W. Performance-dependent inhibition of pain by an executive working memory task. *PAIN* 2010;149:19–26.
- [7] Carwile JL, Feldman S, Johnson NR. Use of a simple visual distraction to reduce pain and anxiety in patients undergoing colposcopy. *J Low Genit Tract Dis* 2014;18:317–21.
- [8] Cohen J. *Statistical power analysis for the behavioral sciences*. Hillsdale: Lawrence Erlbaum Associates, 1988.
- [9] Crombez G, Eccleston C, Baeyens F, Eelen P. Attentional disruption is enhanced by the threat of pain. *Behav Res Ther* 1998;36:195–204.
- [10] Crombez G, Eccleston C, Van Damme S, Vlaeyen JWS, Karoly P. Fear-avoidance model of chronic pain: the next generation. *Clin J Pain* 2012;28:475–83.
- [11] Crombez G, Van Damme S, Eccleston C. Hypervigilance to pain: an experimental and clinical analysis. *PAIN* 2005;116:4–7.
- [12] Crombez G, Van Ryckeghem DML, Eccleston C, Van Damme S. Attentional bias to pain-related information: a meta-analysis. *PAIN* 2013;154:497–510.
- [13] De Bruijn ST, van Wijck AJ, Geenen R, Snijders TJ, van der Meulen WJ, Jacobs JW, Veldhuijzen DS. Relevance of physical fitness levels and exercise-related beliefs for self-reported and experimental pain in fibromyalgia: an explorative study. *J Clin Rheumatol* 2011;17:295–301.
- [14] Eccleston C. Chronic pain and attention: a cognitive approach. *Br J Clin Psychol* 1994;33:535–47.
- [15] Eccleston C, Crombez G. Pain demands attention: a cognitive-affective model on the interruptive function of pain. *Psychol Bull* 1999;125:356–66.
- [16] Eccleston C, Crombez G. Advancing psychological therapies for chronic pain. *F1000Res* 2017;6:461.
- [17] Fernandez E, Turk DC. Review article. The utility of cognitive coping strategies for altering pain perception: a meta-analysis. *PAIN* 1989;38:123–35.
- [18] Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychol Bull* 2007;133:581–624.
- [19] Glass JM. Review of cognitive dysfunction in fibromyalgia: a convergence on working memory and attentional control impairments. *Rheum Dis Clin North Am* 2009;35:299–311.
- [20] González JL, Mercado F, Barjola P, Carretero I, López-López A, Bullones MA, Fernández-Sánchez M, Alonso M. Generalized hypervigilance in fibromyalgia patients: an experimental analysis with the emotional Stroop paradigm. *J Psychosom Res* 2010;69:279–87.
- [21] Goubert L, Crombez G, Eccleston C, Devulder J. Distraction from chronic pain during a pain-inducing activity is associated with greater post-activity pain. *PAIN* 2004;110:220–7.
- [22] Hadjistavropoulos HD, Hadjistavropoulos T, Quine A. Health anxiety moderates the effects of distraction versus attention to pain. *Behav Res Ther* 2000;38:425–38.
- [23] Hudson BF, Ogden J, Whiteley MS. Randomized controlled trial to compare the effect of simple distraction interventions on pain and anxiety experienced during conscious surgery. *Eur J Pain* 2015;19:1447–55.
- [24] Johnson MH. How does distraction work in the management of pain? *Curr Pain Headache Rep* 2005;9:90–5.
- [25] Karsdorp PA, Geenen R, Vlaeyen JW. Response inhibition predicts painful task duration and performance in healthy individuals performing a cold pressor task in a motivational context. *Eur J Pain* 2014;18:92–100.
- [26] Kerns RD, Turk DC, Rudy TE. The West Haven-Yale multidimensional Pain Inventory. *PAIN* 1985;23:345–56.
- [27] Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front Psychol* 2013;4:863.
- [28] Legrain V, Crombez G, Verhoeven K, Moureaux A. The role of working memory in the attentional control of pain. *PAIN* 2011;152:453–9.
- [29] Legrain V, Van Damme S, Eccleston C, Davis KD, Seminowicz DA, Crombez G. A neurocognitive model of attention to pain: behavioural and neuroimaging evidence. *PAIN* 2009;144:230–2.
- [30] Leavitt F, Katz RS. Speed of mental operations in fibromyalgia—a selective naming speed deficit. *J Clin Rheumatol* 2008;14:214–18.
- [31] Lousberg R, Van Breukelen GJP, Groenman NH, Schmidt AJM, Arntz A, Winter FAM. Psychometric properties of the Multidimensional Pain Inventory, Dutch language version (MPI-DLV). *Behav Res Ther* 1999;37:167–82.
- [32] Lovibond SH, Lovibond PF. *Manual for the Depression Anxiety Stress Scales*. 2nd ed. Sydney: Psychology Foundation, 1995 (Available from The Psychology Foundation, Room 1005 Mathews Building, University of New South Wales, NSW 2052, Australia).
- [33] McCaul KD, Malott JM. Distraction and coping with pain. *Psychol Bull* 1984;95:516–33.

- [34] Meyer RA, Campbell JN, Raja SN. Peripheral neural mechanisms of nociception. In: Wall PD, Melzack R, editors. *Textbook of pain*. 3rd ed. Edinburgh: Churchill Livingstone, 1995. p. 13–44.
- [35] Moore DJ, Keogh E, Eccleston C. The interruptive effect of pain on attention. *Q J Exp Psychol (Hove)* 2012;65:565–86.
- [36] Moore DJ, Keogh E, Eccleston C. Headache impairs attentional performance. *PAIN* 2013;154:1840–5.
- [37] Moriarty O, McGuire BE, Finn DP. The effect of pain on cognitive function: a review of clinical and preclinical research. *Prog Neurobiol* 2011;93:385–404.
- [38] Nijs J, van Wilgen PC, Van Oosterwijck J, van Ittersum M, Meeus M. How to explain central sensitization to patients with “unexplained” chronic musculoskeletal pain: practice guidelines. *Man Ther* 2011;16:413–18.
- [39] Olejnik S, Algina J. Measures of effect size for comparative studies: applications, interpretations, and limitations. *Contemp Educ Psychol* 2000;25:241–86.
- [40] Parenteau SC, Haythornthwaite JA. Assessment of functioning and disability in pain syndromes. In: Ebert MH, Kerns RD, editors. *Behavioral and psychopharmacologic pain management*. New York: Cambridge University Press, 2011. p. 67–81.
- [41] Pollard CA. Preliminary validity study of the Pain Disability Index. *Percept Mot Skills* 1984;59:974.
- [42] Romero YR, Straube T, Nitsch A, Miltner WH, Weiss T. Interaction between stimulus intensity and perceptual load in the attentional control of pain. *PAIN* 2013;154:135–40.
- [43] Rudy TE. Multiaxial assessment of pain. *Multidimensional Pain Inventory. User’s manual*. Pittsburgh: Departments of Anaesthesiology and Psychiatry and Pain Evaluation and Treatment Institute, University of Pittsburgh School of Medicine, 1989.
- [44] Schmidt NB, Lerew DR, Trakowski JH. Body vigilance in panic disorder: evaluating attention to bodily perturbations. *J Consult Clin Psychol* 1997;65:214–20.
- [45] Snijders TJ, Ramsey NF, Koerselman F, van Gijn J. Attentional modulation fails to attenuate the subjective pain experience in chronic, unexplained pain. *Eur J Pain* 2010;14:282–92.
- [46] Sullivan MJL, Bishop S, Pivik J. The Pain Catastrophizing Scale: development and validation. *Psychol Assess* 1995;7:524–32.
- [47] Tesio V, Torta DME, Colonna F, Leombruni P, Ghiggia A, Fusaro E, Geminiani GC, Torta R, Castelli L. Are fibromyalgia patients cognitively impaired? Objective and subjective neuropsychological evidence. *Arthritis Care Res* 2015;67:143–50.
- [48] Van Damme S, Crombez G, Bijttebier P, Goubert L, Van Houdenhove B. A confirmatory factor analysis of the Pain Catastrophizing Scale: invariant factor structure across clinical and non-clinical populations. *PAIN* 2002;96:319–24.
- [49] Van Damme S, Legrain V, Vogt J, Crombez G. Keeping pain in mind: a motivational account of attention to pain. *Neurosci Biobehav Rev* 2010;34:204–13.
- [50] Van Ryckeghem DML, Crombez G. Pain and attention: towards a motivational account. In: KarolyP, CrombezG, editors. *Motivational perspectives on chronic pain: theory, research, and practice*. New York: Oxford University Press, 2018.
- [51] Van Ryckeghem DML, Crombez G, Eccleston C, Legrain V, Van Damme S. Keeping pain out of your mind: the role of attentional set in pain. *Eur J Pain* 2013;17:402–11.
- [52] Van Ryckeghem DML, Crombez G, Van Hulle L, Van Damme S. Attentional bias towards pain-related information diminishes the efficacy of distraction. *PAIN* 2012;153:2345–51.
- [53] Van Ryckeghem DML, De Houwer J, Van Bockstaele B, Van Damme S, De Schryver M, Crombez G. Implicit associations between pain and self-schema in chronic pain patients. *PAIN* 2013;154:2700–6.
- [54] Van Ryckeghem DML, Van Damme S, Eccleston C, Crombez G. Distraction-effectiveness in chronic pain patients: a meta-analysis. *Clin Psychol Rev* 2018;59:16–29.
- [55] Veldhuijzen DS, Sondaal SF, Oosterman JM. Intact cognitive inhibition in patients with fibromyalgia but evidence of declined processing speed. *J Pain* 2012;13:507–15.
- [56] Verhoeven K, Van Damme S, Eccleston C, Van Ryckeghem DML, Legrain V, Crombez G. Distraction from pain and executive functioning: an experimental investigation of the role of inhibition, task switching and working memory. *Eur J Pain* 2011;15:866–73.
- [57] Vlaeyen JWS, Morley S, Crombez G. The experimental analysis of the interruptive, interfering, and identity-distorting effects of chronic pain. *Behav Res Ther* 2016;86:23–34.
- [58] Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P, Russell AS, Russell IJ, Winfield JB, Yunus MB. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care Res (Hoboken)* 2010;62:600–10.