The efficacy of attentional distraction and sensory monitoring in chronic pain patients: A meta-analysis

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ABSTRACT

Attentional strategies, such as distraction and sensory monitoring, are often offered to reduce pain and pain-related distress. However, evidence for their efficacy in chronic pain patients is equivocal. We report a meta-analysis on the efficacy of distraction and sensory monitoring in chronic pain patients, and explore possible methodological and theoretical moderators. The scientific literature was searched for relevant articles, which were coded for methodological quality and several theoretical and methodological moderator variables. Only 10 articles fulfilled the search criteria. Eight studies allowed us to compare distraction with a control condition, two studies to compare sensory monitoring with a control condition, and four studies to compare the effect of distraction with the effect of sensory monitoring. Overall, results indicate that distraction did not differ from control in altering pain experience (k=8; Hedges' g=0.10, *ns*) and distress (k=2; Hedges' g=0.549). Sensory monitoring did also not alter pain experience (k=2; Hedges' g=-.21, *ns*) and distress (k=1; Hedges' g=-0.191, *ns*). We found no evidence to support the superiority of distraction or sensory monitoring in altering pain compared to control conditions. We offer guidance for future theory-driven research to investigate distraction and sensory monitoring in this largely unexplored field, albeit one replete with methodological difficulties.

1. INTRODUCTION

Chronic pain is defined as pain that persists past normal healing time (Treede et al., 2015). Most often 'healing time' is judged to be between three to six months (Mersky & Bogdut, 1991). Chronic pain is a common problem, with a prevalence of between 10 and 20% of the general adult population (Blyth, March, Nicholas, & Cousins, 2003; Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006; Gureje, Von Korff, Simon, & Gater, 2008; Saastamoinen, Leino-Arjas, Laaksonen, & Lahelma, 2005; Toth, Lander, & Wiebe, 2009). Although common it is not trivial. Chronic pain often results in reduced quality of life, unemployment or early retirement, and incurs large societal and economic costs (Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Phillips, 2009). Poor pain management may further enlarge these costs because individuals with unresolved problems often remain in the healthcare system (McQuay, 2008). Given the high prevalence of chronic pain conditions and the physical, emotional, social and economic burden, optimizing chronic pain management is a goal of many healthcare organisations (Gereau et al., 2014).

A biopsychosocial perspective on pain is widely accepted as a heuristic framework to understand and manage pain. This view proposes that pain is a result of the interplay between physiological, psychological, and social factors. As such, pain and pain-related outcomes are not solely dependent on the physical pathology, but are influenced by a range of psychological and social factors (Gatchel et al., 2007). Cognitive factors underpin much of the literature on psychosocial interventions for chronic pain, from direct attempts to alter pain experience, memory for pain, reasoning and planning in pain, and acting in pain (Williams, Eccleston & Morley, 2012). But perhaps most researched as a mechanism for selection of pain over competing contextual demands, is the study of attention and pain (e.g., Eccleston & Crombez, 1999: Van Damme, Legrain, Vogt, & Crombez, 2010; Vlaeyen, Morley & Crombez, 2016).

The idea that one can control attention as a technique for the management of pain has a long track record in scientific research (Buhle & Wager, 2010; Cioffi, 1991; Legrain et al., 2009; McCaul & Mallot, 1984) and clinical practice (Bennett, Jones, Turk, Russell, & Matallana, 2007; Turk, Meichenbaum, & Genest, 1983). Today, the use of attention management is part of a range of multi-modal psychological treatments for chronic pain (Elomaa, Williams, & Kalso, 2009; Johnson, 2005; Morley, Shapiro, & Biggs, 2004; Mortensen, Kristensen, Brooks, & Brooks, 2015). Utkarsh and colleagues accordingly report that health providers increasingly employ attention management (in particular distraction-based interventions) for patients with chronic pain (Utkarsh, Starkweather, & Menzies, 2016). Distraction, defined as directing attention away from pain by engaging in a competing demand, is probably the most popular and commonly used attentional strategy because of its intuitive appeal (Elomaa et al., 2009; Leventhal, 1992; Verhoeven et al., 2012). A broad range of distraction strategies is available, from the simple (e.g., looking through distraction cards during blood draw; Inal & Kelleci, 2012) to the complex (such as virtual reality; Malloy & Milling, 2010). Sensory monitoring, i.e. directing attention away from the (negative) emotional valence of pain by directing attention towards its sensory features in an "objective" or "scientific" way (e.g., the pain is pricking), as sometimes described in the instructions, is less intuitive. Exemplifying this counter intuitiveness, Leventhal and colleagues reported difficulties in convincing pregnant women to use sensory monitoring. Even though monitoring proved to be the more effective analgesic, these women wanted to distract themselves from pain, not to monitor it (Leventhal, 1992). Despite its counter-intuitive character, focusing on the sensory characteristics of pain is also part of pain treatment programs (Forys & Dahlquist, 2007; Petter, McGrath, Chambers, & Dick, 2014).

Various theoretical frameworks have addressed the use of distraction and sensory monitoring to cope with pain. Sensory monitoring has been recommended as a coping strategy

within Leventhal's dual processing theory (Leventhal & Everhart, 1979; see also Cioffi, 1991). The dual processing theory proposes that individuals can use either a sensory–oriented processing or an emotional-oriented processing mode of pain. These two modes work in parallel, and are mutually exclusive. More specifically, Leventhal suggested that adopting an emotional-oriented schema activates an emotional-processing mode of pain, resulting in focusing attention on negative affective aspects of pain and, consequently, an amplification of pain-related distress. The adoption of a sensory-oriented schema would, however, only activate the sensation-processing mode. Focusing attention solely on the sensory aspects of pain would decrease one's experience of pain-related distress (Cioffi & Holloway, 1993; Leventhal & Everhart, 1979). Evidence for the efficacy of sensory monitoring has been found in experimental studies with students undergoing cold pressor pain (e.g., Ahles, Blanchard, & Leventhal, 1983; Roelofs, Peters, van der Zijden, & Vlaeyen 2004; Sullivan, Rouse, Bishop, & Johnston, 1997, but see also Thompson, Keogh, & French, 2011) and studies with individuals experiencing acute and/or procedural pain (e.g., Haythornthwaite, Lawrence, & Fauerbach, 2001; Logan, Baron, & Kohout, 1995).

Likewise, the use of distraction has been informed by various theoretical models explaining the interplay between attention and pain (e.g., McCaul & Mallot, 1984, see also Buhle & Wager, 2010). Dominant in many models is the idea of limited cognitive resources, in which pain is constructed as a demand for a scarce commodity of attention to be competitively allocated. More recently, functional and motivational accounts of attention and pain have repositioned pain as a motivating signal for action in the context of threat (Crombez, Eccleston, Van Damme, Vlaeyen, & Karoly, 2012; Eccleston & Crombez, 1999; Van Damme et al., 2010). In acute pain management, there is evidence for the efficacy of distraction to help people cope with pain and distress, most often related to medical procedures (e.g., Birnie et al., 2015; Carwile, Feldman, & Johnson, 2014; Fernandez & Turk, 1989; Hudson, Ogden, & Whiteley,

2015; Johnson, 2005; Malloy & Milling, 2010; McCaul & Mallot, 1984). However, research on the efficacy of attentional strategies in chronic pain patients remains inconclusive (Seminowicz & Davis, 2007; Van Damme et al., 2010). Several scholars have suggested that distraction may be less effective or even counterproductive for chronic pain patients (Snijders, Ramsey, Koerselman, & van Gijn, 2010; Van Damme et al., 2010). One possible reason may relate to the finding that chronic pain is associated with heightened awareness or vigilance for pain and/ or somatic sensations in general (Crombez et al., 2013; Vlaeyen, Morley, & Crombez, 2016). If pain demands attention, chronic pain might usefully be thought of itself as a chronic distraction by the threat of harm. In the context of alarm, and vigilance for alarm, distraction may be an unhelpful strategy. Other researchers suggested that patients witch chronic pain are characterized by problems of executive functioning, which could be due to a structural deficit or to the repeated presence of pain and/or negative emotions (Berryman et al., 2014; Moriarty, McGuire, & Finn, 2011). Low levels of executive functioning may then reduce the ability to control pain (Karsdorp, Geenen, & Vlaeyen, 2014; Legrain et al., 2009; Legrain, Crombez, Verhoeven, & Moureaux, 2011; Verhoeven et al., 2011). Some researchers have suggested that for chronic pain patients sensory monitoring may prove superior to distraction (Chan, Chan, Kwan, Ting, & Chui, 2012; Loewenstein, 2011; Verhoeven et al., 2010). In contrast, other scholars have doubted whether patients with chronic pain are actually able to focus exclusively on the sensory features of pain while ignoring its affective aspects (e.g., Michael & Burns, 2004). Perhaps the idea of separating the sensory from the affective, whilst helpful for acute pain, is less relevant for chronic pain as pain has become intimately associated with anxiety and distress.

Inconsistent findings on the efficacy of attentional strategies in chronic pain patients may however also be due to methodological issues. First, the efficacy of attentional strategies has been researched using various procedures (i.e., using different pain and/or distraction

strategies), some of which have been criticized for methodological and theoretical reasons (Eccleston, 1995; Johnson, 2005; Van Damme et al., 2010). For example, some studies instruct participants to judge the pain sensation (e.g., report pain threshold) during the distraction procedure, which creates a paradoxical situation (Eccleston, 1995; Johnson, 2005). Second, in contrast with research in healthy participants, most studies investigating attentional strategies in chronic pain patients have small sample sizes, prohibiting firm conclusions.

To overcome problems of small sample sizes and restrictions or peculiarities of any singular study we provide a meta-analytic synthesis combining all available evidence on the efficacy of distraction and sensory monitoring in chronic pain. Other reviews on this topic have been reported, but are now outdated (e.g., Jensen, Turner, Romano, & Karoly, 1991), focus on particular techniques (e.g., virtual reality; Malloy & Milling, 2010) or specific populations (e.g., children; Birnie et al., 2015) or discuss broad cognitive interventions of which distraction is only one of many treatment components (Utkarsh et al., 2016). In this review we have three aims: (1) to comprehensively review the literature and identify relevant studies, (2) to meta-analyse the data on the efficacy of attention strategies in chronic pain, and (3) to explore the methodological quality of available studies.

2. METHODS

2.1. Literature search and inclusion criteria

Studies were identified through a search of electronic databases (PubMed, PsychINFO, Web of Science), using the following keywords: *distraction, attention* focus*, attention* direct*, sensory focus*, monitoring (Only used in PsycINFO), attention* diver** intersected with *pain*. The following criteria were used to select studies for inclusion in the meta-analysis:

1. The study is a full report published in a peer-reviewed scientific journal
2. The study includes an adult sample (age 18 year or older).

3. The study includes a sample of patients experiencing chronic pain, defined as pain that lasts longer than three months (e.g., Crombez et al., 2013).
4. The study includes at least one *experimental attentional strategy* condition (i.e., distraction or sensory monitoring) and *a control condition*. A control condition can be a non-distraction condition with the same participants (within-subjects design, but excluded when not controlled for order-effects; e.g., Schreiber et al., 2014) or a non-distraction group (between-subjects condition, but only included when using random allocation to condition). To compare the effects of both coping strategies, a study is also included when *both experimental attentional strategy conditions* (i.e. distraction and sensory monitoring) and no control condition were included.
5. The study includes an experimental attentional strategy condition that is not part of a larger cognitive-behavioural treatment program spread over multiple sessions. Such treatment programs often include multiple components (e.g., goal setting) and, as such, do not allow the investigation of the specific effects of attentional strategies.
6. The study includes more than 10 participants in each arm at the point of analysis.
7. The study provides data in a format that allows for the computation of an effect size (Hedges' *g*). When insufficient information is available, attempts were made to recover information through other means, in particular by searching for related articles by citation and author contact.

Electronic databases were searched for references on the 26th March 2016 and resulted in 8505 unique references. A two-step procedure was then used. In a first step, two reviewers (DVR, NDC) independently screened a selection of the study abstracts for possible inclusion. Reviewers were not blind to authorship, institution, journal, or results. To check the inter-rater-reliability between both reviewers, 10% of all references was screened by both reviewers. There

were some disagreements between the reviewers (kappa =.84), but all disagreements were resolved by consensus. First screening resulted in 103 remaining references. In a second step, full copies of articles were obtained and read. After reading the full copies, 11 articles, reporting on a total of 11 independent studies, were considered eligible for the meta-analyses. Next, the lead author of each publication was contacted to provide additional data (if data were missing) and extra coding information (if information on the variables of interest for coding the articles was missing in the manuscript). For one study (Wiederhold, Gao, Sulea, & Wiederhold, 2014) insufficient information was available to calculate Hedges' g. Three attempts were made to contact the authors to provide additional data but they were uncontactable. Final analyses were performed on 10 articles, reporting on a total of 10 independent studies.

In addition, all authors were invited to comment on the coding and data extraction of their study. Additional provided information was taken into account throughout the manuscript and in the analysis. If the requested information on a variable could not be, or was not, provided, this was coded as 'unclear' and the study was not included when investigating this variable as a moderator. Figure 1. shows the flowchart for the selection of included studies in this meta-analysis, including reasons for excluding studies/articles at different stages.

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2.2. Coding system and coding decisions

We used a standard coding system, based on previous meta-analyses (e.g., Crombez et al., 2013), to code every study in terms of (1) study and sample characteristics, (2) methodological quality (Table 1) and (3) experimental procedure (Table 2). The coding system was developed in several steps. A first coding system was piloted using a random selection of

five articles investigating distraction/ sensory monitoring efficacy. Criteria of coding variables that appeared unclear were adapted via discussion and finalized by the authors.

2.3.1. Study characteristics

For study characteristics we coded journal name, year of publication, experimental design (i.e. within-subjects design (e.g., Goubert, Crombez, Eccleston, & Devulder, 2004), between-subjects design (e.g., Burns, 2006) and its category in the Web of Science database. For sample characteristics, we coded sample size used for analyses (*n*), mean age of the participants, and percentage females in each condition.

2.3.2. Methodological quality

The coding system for the methodological quality of the studies related to both (1) the extent to which a study allows for cause-effect inference (internal validity), and (2) the extent to which a study allows for a generalization of the findings to other relevant settings and samples (external validity). Because setting criteria for internal and external validity is often open to debate, we decided to base our assessment on the CONSORT-criteria. In line with the philosophy of CONSORT (Moher et al., 2012), we considered that authors should report the necessary information to report on the validity in the study. Although Consort criteria are guidelines for the conduct and reporting of randomized controlled trials, many of the biases they address are relevant for experimental studies. More specifically, we selected guidelines related to the internal and external validity, and, where necessary, adapted them to the specific context of the current review. Based on the CONSORT-criteria and to decrease the possible influence of a third confounding variable (e.g., habituation over time), studies were only included when they fulfilled the minimum criterion of random assignment to condition (for a between-subjects design) and/or controlling for order effects (for a within-subjects design). These criteria were as such not included in the calculation of internal methodological quality-index of the study.

Criteria for external validity were related to the description of the following features of the study: description of (1) eligibility criteria, (2) participant demographics, (3) pain experience of participants, (4) recruitment procedure, (5) setting and/or location, and (6) data cleaning. Criteria for internal validity were related to the description of the following features in the study: description of (1) engagement with the instructions of the experimental condition, (2) control for alternative pain coping strategies in a control condition, (3) report of objectives/ cover story to participants, (4) selective outcome reporting (i.e., report other or only a subset of the initially selected outcomes) and (5) blinding of participants and or assessors. The final coding scheme is available from the authors upon request.

2.3.3. Experimental procedures

The coding of the characteristics of the experimental procedures was based on available theoretical models or reviews discussing variables that may influence the interplay between attention and pain (e.g., Eccleston, 1995; Johnson, 2005; Van Damme et al., 2010). We first coded the type of attentional strategy that was used in the study (*Type of intervention*: distraction, sensory monitoring). Next we coded for *Type of target pain* (i.e., clinical pain [no noxious stimulus is induced] or experimental pain [a noxious stimulus is induced]). Although these categories are not mutually exclusive, we opted to categorize the target pain in one of these categories on the basis of the primary focus of the research. In case the study investigated the effect of an attentional strategy for an experimentally induced pain stimulus (e.g., cold pressor pain, electrocutaneous pain), the study was coded as 'experimental pain'. In case the attentional strategy was applied to cope with the person's own clinical pain (e.g., fibromyalgia pain, chronic low back pain) it was coded as 'clinical pain'. As the efficacy of the attentional strategy may also differ as a function of the outcome, we coded the *study outcome(s)* as primary outcome (pain intensity, pain tolerance, pain threshold, pain affect) and secondary outcome

(i.e., measure of distress; e.g., score on the Beck Anxiety Index). Indeed, it may well be that motivational aspects play a role in enduring pain for a longer duration and as such affect pain tolerance, whereas this is probably less important for pain threshold and reporting pain intensity.

Furthermore, several procedural aspects were coded that may have had an impact upon the efficacy of the attentional strategy. In particular, we coded the *presence of others* during the experimental manipulation (e.g., the presence of a medical doctor, partner, or experiment leader). Previous research has indicated that the presence of another person may influence the experience of pain (Krahé et al., 2015). We also coded the presence of a *positive expectancy* of the attentional strategy (i.e., information that distraction/sensory monitoring is an effective coping strategy is provided). Finally, we coded several characteristics that are specific for distraction, sensory monitoring and the control condition. For distraction, we coded the use of *paradoxical instructions* (i.e., instruct people to report pain experience whilst directing attention away from pain; Eccleston, 1995), the *type of distraction* used (i.e., directing attention to events in the environment [external; e.g., Snijders et al., 2010], or directing attention to thoughts different from pain [internal; e.g., Hadjistavropoulos, Hadjistavropoulos, & Quine, 2000]), the *valence of the distraction task* (positive, such as flowers in the environment; negative, such as negative memory; neutral, such as beep tones), whether participants had a *choice* concerning the stimuli used during the strategy (e.g., participants can choose their own music), and the *type of perceptual input* of the distraction task (e.g., visual, auditory, tactile, olfactory, taste). For *sensory monitoring*, we coded the *instructions* given to participants to induce sensory monitoring. For the *control condition* we coded the *instructions* given: a 'no instruction control condition' (e.g., no instructions, or instructions saying "do as you usually do") or an 'attention instruction control condition' (e.g., instructions to focus your attention on the pain, perform a task that makes one focus on the pain) (*Type of control condition*).

Some additional data-extraction and coding decisions were made. First, when studies reported a baseline outcome (pain/ distress) for the compared conditions in the manuscript (e.g., Fors & Götestam, 2000), we opted to use only the final scores (i.e., only post-test-data) over the change scores (difference between final scores and baseline scores). In doing so, reported effect-sizes for all studies are only based upon final scores (i.e., only post-test-data; Higgins & Green, 2011). This approach also reduces the risk of selective reporting as the choice of whether to report, or not report, the change or final values might depend upon the result. Second, when a study did not report the overall results for a group of interest, but reported results of subgroups (e.g., group of high and low health anxiety; Hadjistavropoulos et al., 2000), the first option was to contact the authors to provide overall results for a group of interest. If authors could not provide the data from the combined group, we first calculated the combined effect size using available formula in the Cochrane handbook (Higgins & Green, 2011) and imputed the pooled mean and standard deviation in the meta-analysis. Data-extraction and coding were conducted by two reviewers (DVR & SVD) using an Access form specifically designed for this meta-analysis. If necessary, a third reviewer (GC) was asked to resolve disagreements. The final coding reflects the consensus of the coding (see Table 1).

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2.3. Meta-analytic procedures

To address the research questions of this paper, we performed three separate sets of meta-analyses. A first set of analyses was performed to investigate the efficacy of distraction (i.e., comparison between distraction condition and control condition) and variables moderating this relationship. A second set of analyses was performed to investigate the efficacy of sensory monitoring (i.e. comparison between sensory monitoring condition and control condition) and

variables moderating this relationship. A third set of analyses was performed to directly compare the effect of distraction with sensory monitoring and variables moderating this relationship.

For all analyses, similar procedures were used. In particular, Hedges' g was applied to indicate effect sizes, correcting for small sample sizes, evident in this literature (Hedges & Olkin, 1985). Hedges' g was calculated as the mean difference between two conditions (i.e., distraction/sensory monitoring condition vs control condition or distraction condition vs sensory monitoring condition) divided by the pooled standard deviation, corrected for small sample bias (Hedges & Olkin, 1985). In case of a within–subject design, the correlation between the means of the two conditions was retrieved from the authors based upon the original data. For one study (Johnson et al., 1997), this correlation could not be retrieved and was set at 0.50. To investigate the impact, sensitivity analyses were performed with this correlation set lower (0.20) or higher (0.80) than the assumption of 0.50. In our meta-analyses, we took into account the sampling error of each sample. Effect sizes were weighted by the inverse of the estimated sampling variance of the corresponding effect, whereby high-precision effect sizes gain more weight than low-precision estimates. A random effects-model was chosen to combine effect-sizes of the studies. Furthermore, we applied Cochran's Q test to judge the degree of heterogeneity in effect sizes (Borenstein, Hedges, Higgins, & Rothstein, 2009). To address whether variations in effect sizes can be explained by categorical coded variables, we performed moderator analyses. For all moderator analyses, we chose a mixed-effects model. Due to the limited number of studies per condition, we opted to pool within-group estimates of tau-squared when performing moderator-analyses. For these moderator analyses, a group was only taken into account if at least three studies were available in the group. To maintain the independence of our data, whenever necessary, we averaged the effect sizes across conditions. Finally, for the continuous coded variables (e.g., study quality score), we performed meta-regressions using the

methods of moments procedure (Thompson & Higgins, 2002) with Knapp-Hartung correction, where the slope (β) and its *p*–value indicated the importance of this moderator in understanding linear changes in effect sizes. All analyses and computations were carried out using Comprehensive Meta-Analysis software, version 3.3.070 (Biostat Inc, Englewood, NJ, USA). Effect sizes of >=0.80 were considered large, >=0.50 were considered moderate and >=0.20 were small effects (Cohen, 1988).

3. RESULTS

3.1. Summary of included studies

To provide more details on the studies that investigated the efficacy of distraction and sensory monitoring in chronic pain patients, we provide a brief summary of the relevant information of each included study.

Johnson and Petrie (1997) were the first to experimentally investigate distraction in chronic pain patients. Participants were 20 chronic low back pain patients (M_{age}: 45 years; 12 females) who carried out a brief step-up exercise (resulting in increasing pain) and a cold pressor task; and 18 pain-free participants (M_{age}: 36 years; 9 females) who carried out a cold pressor task. All participants performed the pain induction task(s) with and without distraction (counterbalanced order). Distraction consisted of a shadowing task during which participants were asked to repeat aloud a series of neutral words presented at 30 words per minute. To increase the difficulty of the distraction task, participants viewed a video monitor during the shadowing task on which a pair of words appeared. Participants were instructed not to shadow these words. Results in chronic low back pain patients were inconclusive. For the brief step-up procedure, distraction resulted in increased pain tolerance, but there was no difference in pain intensity between the distraction and non-distraction group. There was no effect of distraction

upon pain experience and pain tolerance during the cold pressor task in chronic low back pain patients. In the healthy (pain-free) comparison group distraction did result in a 26% increase in tolerance time during the cold pressor task.

Hadjistavropoulos and colleagues (2000) investigated the role of individual differences in health anxiety upon the efficacy of distraction and sensory monitoring in chronic pain patients. Participants were a mixed group of 81 patients (M_{age}: 38.6 years; 34 females) who performed a 30-minute active, physiotherapy session. Participants were randomly divided into a distraction condition (n=25), a sensory monitoring condition (n=28) and a control condition (n=28). Participants in the distraction condition were instructed to think of anything other than physical sensations during the sessions. Participants in the sensory monitoring condition were instructed to pay close attention to the physical sensations while completing each exercise. Participants in the control condition were instructed to complete the physical therapy session as they normally did. Study findings indicated that the efficacy of coping strategy depended upon the level of health-anxiety of participants. In non-health-anxious patients, distraction was the better strategy as it reduced sensory and affective pain compared to the control condition, whereas monitoring resulted in more worrying about pain. In health anxious patients sensory monitoring resulted in less anxiety and pain, compared with the distraction and the control condition.

Fors and Götestam (2000) compared the efficacy of (1) a "guided imagery" programme (i.e., distraction instructions followed by a visualisation sequence/guided imaginary of pleasant nature), (2) a "patient education" programme (i.e., listening to an audio file which guided them on a tour in which they imagined the pain controlling mechanisms of the body) and (3) a control programme (i.e., talk freely about fibromyalgia problems) to modulate pain and anxiety. Fifty-eight patients with fibromyalgia (M_{age}: 45.7 years; all females) were randomly assigned to one of the three conditions ($N_{\text{Guided imaginary}} = 17$; $N_{\text{Patient education}} = 22$; $N_{\text{Control}} = 19$). Each intervention

had a duration of 30 minutes. Results indicated that patient education and guided imagery reduced the current pain and anxiety levels. No changes were found in the control condition where patients could talk freely about their fibromyalgia problems.

Goubert and colleagues (2004) investigated the effects of distraction during and after a pain-inducing lifting task in a sample of 52 chronic low back pain patients (27 females; M_{age}: 46.3 years). In this study, all patients performed a pain-inducing lifting task twice (once without and once with distraction; counterbalanced order). In the distraction condition participants performed a 'Random Interval Repetition' task (i.e., detection of tones with varying inter-tone-interval) during a 60 seconds lifting task. Results revealed that distraction had no effect upon self-reported pain during the lifting task. In contrast, a paradoxical effect of more pain immediately after the lifting task was found.

Michael and Burns (2004) examined the effects of focusing attention on sensory information, focusing attention on affective information, and distraction on the experience of cold pressor pain. A sample of 82 chronic musculoskeletal pain patients (36 females; M_{age}: 41.5 years) was recruited. Twenty-six patients received instructions to focus on the sensations they experienced when their hand was in the cold water while they read a list of sensation words aloud (sensory monitoring condition). Twenty-nine patients received instructions to focus on the emotions and feelings they experienced when their hand was in the cold water while they read a list of emotional words aloud (affective monitoring condition). Twenty-seven patients read aloud words from a list of 18 neutral words while their hand was in the cold water (distraction condition). No control condition was included in this study. Results indicated that, compared to baseline, pain threshold and tolerance were increased for participants who engaged in sensory monitoring. In the distraction condition, pain threshold also increased (yet less than in the sensory monitoring condition), but not patients' pain tolerance. Finally, none of the attentional strategies affected participants' level of self-reported pain intensity.

Roelofs and colleagues (2006) were the first researchers to investigate the effects of distraction on pain experience in daily life of patients with chronic low back pain. An experience sampling methodology was used to examine the effects of a manipulation of attention towards pain (i.e., control condition) or away from pain on pain intensity in daily life of pain patients. Thirty-eight patients with chronic low back pain (M_{age}: 46.4 years; 22 females) carried a small palmtop computer for two weeks. During this period, patients were 'beeped' eight times a day to complete diary questions. On certain days, participants received instructions to direct attention away from pain (i.e., pay close attention to positive things in your environment), whereas on other days participants received instructions to direct attention towards pain (i.e., 'pay close attention to your pain and other sensations today'). In contrast with the hypotheses, results indicated the distraction instructions did not result in decreased pain intensity.

Burns (2006) examined the effects of sensory monitoring, distraction, and suppression on pain experience during a cold-pressor task (duration = two times 90s; temperature between 0-3°C). Additionally, he investigated the delayed effects of using each of these coping strategies during pain experience upon physiological and self-report responses to a subsequent stressful event. In order to investigate immediate and delayed effects of these strategies 93 chronic low back pain patients (50 females, M_{age} = 46.0 years) were recruited and randomly assigned to a sensory monitoring (N=22; "think objectively about the sensations in your foot and hand. That is, concentrate on whether you feel coldness, wetness, tingling, or throbbing sensations. Stay objective and focus on the various sensations in your foot and hand"), a distraction (N=25; "think about your bedroom at home. Picture it as clearly as you can: the arrangement of furniture, your possessions, pictures on the wall, colours, and so forth") and a suppression condition (N=23; "try as hard as you can to not think about any sensations or distress you may be having. In other words, you should suppress any thoughts and feelings about your foot and hand"). The remaining participants took part in a control condition (N=23; "think about

anything you like. You might think about your foot and hand, or you might think of something else"). In addition, the authors also recruited a healthy comparison group of 105 individuals (56 females, M_{age} = 29.0; $N_{distraction}$=26; $N_{control}$=26; $N_{sensory\ monitoring}$=27; $N_{suppression}$=26). Results indicated that the immediate pain experience during the cold pressor task did not significantly differ as a function of the strategy used in both the chronic low back pain and the healthy comparison group.

Nouwen and colleagues (2006) examined the efficacy of sensory monitoring and distraction on the experience of a seven-minute during cold pressor pain in 41 chronic back pain patients (4 females; M_{age}= 45.6 years). No control condition was used in this study. In the sensory monitoring condition participants were instructed to describe aloud the sensations they felt in their forearm throughout the entire time their hand and forearm were in the water. In the distraction condition participants were instructed to name aloud the largest number of first names beginning with any letter of the alphabet that came to mind. Pain and discomfort ratings were assessed seven times. Results indicated that in the distraction condition, pain levels started low but continued to rise throughout the cold pressor immersion, whereas in the focused attention condition, pain levels started higher, rose less quickly, and then decreased from the middle of the task.

Snijders and colleagues (2010) investigated the effect of distraction in 16 patients (M_{age} = 47.5; 11 females) with chronic, unexplained pain and 16 matched control subjects (matched for age, gender and handedness). The authors assessed pain thresholds to electrocutaneous stimuli when participants' attention was directed towards or away from pain. Next, low intense pain stimuli were presented while attention was directed towards pain (by instructing people to count the number of applied stimuli in a block) or away from pain (via a computerized version of an oddball paradigm during which participants saw flashing dots of a certain diameter on a screen, heard tones of a certain frequency with varying inter-stimulus-intervals and needed to

press a button each time a target was presented). Pain was induced via a transcutaneous electrical nerve stimulator using short (0.5 - 1.0s) pulse trains (frequency 10 Hz). Results indicated that distraction increased thresholds for pain in chronic pain patients (although less than in healthy volunteers). Furthermore, VAS scores for painful stimuli were reduced during distraction in healthy controls, but increased the pain experience during distraction in participants with chronic, unexplained pain.

In a last study, Ellingson and colleagues (2012) investigated the relationship between both, physical activity and sustained sedentary behaviour, and attention modulation (i.e., distraction) in 11 women with fibromyalgia (M_{age} = 41.3 years). Distraction efficacy was investigated by comparing pain experience with and without simultaneous performance of a (in)congruent Stroop paradigm (presented in counterbalanced order). Both the congruent and incongruent Stroop version were used as it was expected that the incongruent Stroop task is more attention demanding than the congruent Stroop task. Pain was induced using heat stimuli that were experienced as "slightly intense". Results indicated that the performance of the congruent Stroop or the incongruent Stroop task while experiencing pain substantially decreased the pain experience in comparison with when experiencing pain without distraction. Furthermore, this study indicated that sedentary behaviour and the level of physical activity modulated participants' pain during the cognitive tasks.

3.1. The efficacy of distraction

3.1.1. Descriptive statistics and methodological quality

There were eight articles reporting eight studies fulfilling the inclusion criteria and including a distraction and control condition ($N_{distraction}$ = 204; $N_{control}$ = 207), which allowed us to calculate an effect size (Burns, 2006; Ellingson, Shields, Stegner, & Cook, 2012; Fors & Götestam, 2000; Goubert et al., 2004; Hadjistavropoulos et al., 2000; Johnson & Petrie, 1997; Roelofs, Peters,

Patijn, Schouten, & Vlaeyen, 2006; Snijders et al., 2010). All studies, except one (Fors, & Götestam, 2000), were published in a Web of Science category, i.e., ‘‘Anesthesiology’’ (*n* = 3), “Clinical Psychology’’ (*n* = 2), ‘‘Clinical Neurology’’ (*n* = 1) and “Experimental psychology” (*n* = 1). Most studies were published in the journals Pain, (*n* = 2) and The Journal of Pain (*n* = 2). The mean age (weighted for *N* per study) was 44.87 for the distraction condition and 44.80 for the control condition. Finally, the sex distribution was similar between the distraction condition and the control condition: respectively, 60.75% and 60.93% of females. On average, studies including a distraction condition and a control condition fulfilled 56% of the external validity criteria and 28% for the internal validity criteria. Table 1 shows the ratings of methodological quality for studies included in the meta-analysis.

-INSERT TABLE 2 HERE-

3.1.2. Overall findings

Analyses were performed with eight studies where a positive Hedges’ *g* indicates that the outcome favors the experimental condition, and a negative hedges’ *g* indicates that the outcome favors the control condition.

The effect size for the distraction efficacy upon the primary outcome (*k* = 8) was small and non-significant (Hedges’ *g* = 0.102, 95% CI -0.019: 0.223, *p* = .10), suggesting that the distraction and control condition do not differ (see Fig. 2). Although Cochran’s *Q* failed to reach significance (*Q*(7) = 10.63, ns), screening of Figure 2 shows substantial heterogeneity (Hedges’ *g* ranging between -0.077 and 1.036) warranting the relevance of moderator analyses. Sensitivity analyses showed that the effect did not change when the imputed correlation for the study of Johnson and colleagues (1997) was changed to 0.2 (Hedges’ *g* = 0.105) and 0.8

(Hedges' g = 0.092). Therefore, the correlation of this study was set at 0.5 for all following analyses.

The effect size for the distraction efficacy upon the secondary outcome (i.e., distress; k = 2) was moderate, but also non-significant due to a wide confidence interval (Hedges' g = 0.549, 95% CI -0.971: 2.068, ns; $Q(1) = 11.705$, $p < .01$).

-INSERT FIGURE 2 HERE-

3.1.3 moderation analysis

3.1.3.1 Study quality

We investigated whether the efficacy of distraction in chronic pain patients on the primary outcome varied as a function of the study quality. A meta-regression revealed that the effect size (Hedges' g) for distraction effectiveness was not influenced by study quality (point estimate of slope = -0.674, 95% CI -2.390: 1.042, ns).

3.1.3.2 Pain outcome

Most often studies have investigated the effect of distraction upon pain intensity and/or pain unpleasantness. Some studies have also investigated the influence of distraction on pain tolerance and/or pain threshold. Depending on the pain outcome findings may differ. A posteriori sub-analyses were performed to investigate distraction effects on different outcomes. Analyses indicated that Hedges' g was not significant for pain intensity (k = 8; Hedges' g = 0.048, 95% CI -0.088: 0.184, ns; $Q(7) = 13.590$, $p = .06$), pain unpleasantness (k = 2; Hedges' g = 0.214, 95% CI -0.190: 0.618, ns; $Q(1) = 0.963$, ns) and pain tolerance (k = 1; Hedges' g = 0.121, 95% CI -0.304: 0.547, ns). However, for pain threshold, results showed that the pain threshold was significantly higher during distraction (k = 1; Hedges' g = 0.274, 95% CI 0.145: 0.404, $p < .001$).

3.1.3.3 Type of target pain

Whereas some researchers investigated the effect of distraction with patients on their clinically relevant pain (*k*=4), other researchers have investigated distraction with chronic pain patients on experimentally induced pain (*k*=3). One study (Johnson et al., 1997), investigated the effect of distraction upon both, experimental induced pain (i.e., cold pressor pain) and clinical pain experience (i.e., chronic low back pain). Sub-analyses indicated that Hedges' *g* for distraction efficacy was not significant for experimentally induced pain (*k* = 4; Hedges' *g* = 0.094, 95% CI -0.064: 0.252, ns; *Q*(3) = 3.453, ns) and clinical pain (*k* = 5; Hedges' *g* = 0.115, 95% CI -0.083: 0.314, ns; *Q*(4) = 8.023, *p* = .09). No difference was found between distraction efficacy for both types of target pain (*Q*(1)= 0.103, ns). To maintain independence of the data (and because a lower number of studies induced experimental pain to investigate distraction efficacy), only experimental pain data of the study of Johnson and colleagues (1997) were taken into account to compare distraction efficacy for both types of target pain.

3.1.3.4 Type of control condition

Most studies used a control condition in which patients did not receive instructions, or received instructions to do as they usually do when experiencing pain (no instruction condition; *k* = 6). However, some studies compared the distraction condition with an attention focus condition where patients needed to focus on the pain experience. Comparing both conditions indicated that Hedges' *g* was of similar size when the control condition received no instructions on how to focus their attention (*k* = 6; Hedges' *g* = 0.156, 95% CI -0.110: 0.422, *ns*; *Q*(5) = 10.225, *p* = .07) as when the control condition needed to focus on the pain experience (*k* = 2; Hedges' *g* = 0.108, 95% CI 0.016 : 0.199, *p* < .05; *Q*(1) = 0.280, *ns*). However, distraction efficacy significantly differs from 0 when the control condition was asked to focus on pain, but not when the control condition is given no instructions or instructed to do as they would usually do.

3.1.3.5 Type of distraction task

Finally, we investigated the effect of the distraction task used. Since many of the characteristics of the distraction task were interrelated, analyses were restricted to the investigation of tasks that used external stimuli (e.g., visual or auditory stimuli) versus tasks that made use of internal stimuli (e.g., "imagine your bedroom"). Only two studies made use of internal stimuli to distract participants (k = 2; Hedges' g = -0.015, 95% CI -0.399: 0.370, ns; $Q(1)$ = 0.092, ns), whereas six studies used external stimuli to distract participants (k = 6; Hedges' g = 0.120, 95% CI -0.023: 0.264, p = .10; $Q(5)$ = 10.188, p = .07).

3.2. The efficacy of sensory monitoring

3.2.1. Descriptive statistics and methodological quality

Only two studies included a sensory monitoring condition and a control condition ($N_{\text{sensory monitoring}}$ = 50; N_{control} = 51) which allowed a calculation of an effect size of the efficacy of sensory monitoring in chronic pain patients (Burns, 2006; Hadjistavropoulos et al., 2000). Both articles were published in a Web of Science category, i.e., "Clinical Psychology'' (n = 1) and "Experimental psychology" (n = 1). Furthermore, the mean age (weighted for N per study) was 41.86 for the sensory monitoring condition and 41.94 for the control condition. Sex distribution was similar between the sensory monitoring condition and the control condition, respectively, 47.19% females and 47.32% females. On average, studies scored positive on 75% the external validity criteria and 20% for the internal validity criteria that are applicable for the study (see Table 2).

3.2.2. Overall findings

Analyses were performed with only two studies where a positive Hedges' g indicates that the outcome favours the experimental condition, and a negative hedges' g indicates that the

outcome favours the control condition. The effect size for the efficacy of sensory monitoring upon the primary outcome (*k*=2; Hedges' *g*= -0.214, 95% CI -1.160: 0.733, *ns*) indicated that, if anything, sensory monitoring had a worse outcome than the control condition in chronic pain patients (see Fig. 3). This finding did however not reach significance, due to a very wide confidence interval ranging from a moderate/large positive effect-size to a large negative effect-size. Results indicated substantial heterogeneity [Q(1) = 5.780, $p < 0.05$]. No further moderator analyses could be performed due to the limited number of studies reporting on the efficacy of sensory monitoring in chronic pain patients. The effect size for the efficacy of sensory monitoring upon the secondary outcome (i.e., distress) was only reported in one study (Hadjistavropoulos et al., 2000). Results indicated that sensory monitoring had no beneficial effect over the control condition in chronic pain patients (*k* = 1; Hedges' *g*= -0.191, 95% CI -0.709: 0.327, ns).

- INSERT FIGURE 3 HERE -

3.2. The efficacy of distraction compared with the efficacy of sensory monitoring

3.2.1. Descriptive statistics and methodological quality

There were four articles reporting on four studies fulfilling the inclusion criteria and including both a distraction and sensory monitoring condition ($N_{\text{distraction}} = 93$; $N_{\text{sensory monitoing}} = 86$), which allowed direct comparison between distraction and sensory monitoring (Burns, 2006; Hadjistavropoulos et al., 2000; Michael & Burns, 2004; Nouwen, Cloutier, Kappas, Warbrick, & Sheffield, 2006). All studies were published in a Web of Science category. Furthermore, the mean age (weighted for *N* per study) was 42.76 for the distraction condition and 41.20 for the sensory monitoring condition. Sex distribution was similar between the distraction condition and the sensory monitoring condition, respectively, 40.30% females and 42.03% of females.

On average, studies including a distraction condition and a sensory monitoring condition fulfilled 71% of the external validity criteria and only 16% for the internal validity criteria (See table 2).

3.2.2. Overall findings

Analyses were performed with four available studies. A positive Hedges' *g* indicates that the study favors distraction, whereas a negative hedges' *g* indicates that the study favors sensory monitoring. Combining all available information showed that the effect of distraction and sensory monitoring did not significantly differ from each other upon the primary outcome (*k*=4; Hedges' *g*= 0.236, 95% CI -0.240: 0.711, ns; see Fig. 4). Results, furthermore indicated possible heterogeneity [Q(3) = 7.542, *p* = 0.06]. Similarly, no difference was found between the effect of distraction and sensory monitoring for the secondary outcome (*k* = 1; Hedges' *g*= -0.072, 95% CI -0.603: 0.460, ns). No further moderator analyses were performed due to the small number of studies reporting on the primary outcome and secondary outcome.

-INSERT FIGURE 4 HERE-

4. DISCUSSION

Deliberately directing and maintaining attention when in pain might be one of the most commonly attempted psychological strategies to cope with pain. We try to distract ourselves by thinking about something else, or we try to alter its meaning, context, motivational relevance, or importance. Statements such as "Try not to focus on the pain all the time" or "Think of something positive" are perhaps the most common pieces of lay advice we ever give or receive when confronted with pain. When it comes to pain in chronic pain patients, however, there is no evidence that this strategy reduces pain or pain related-distress. In summary, current findings

show no overall benefit of the use of distraction (Hedges' g = 0.10) or sensory monitoring (Hedges' g = -0.21) to cope with pain in chronic pain patients. Additional moderator analyses could only be performed for distraction studies and showed that the efficacy of distraction only differed as a function of the investigated pain outcome and control condition. Interestingly, there was a small effect of distraction on pain threshold (Hedges' g = 0.27), but no effect on pain intensity, pain unpleasantness and pain tolerance. Finally, coding of the study quality showed that there is need for improvement of the internal validity of studies investigating the efficacy of attentional strategies.

Although attempting to control one's attention to chronic pain is thought to be a popular strategy, available evidence suggests it has no efficacy, and its harms have not been systematically assessed. Only one study reports on the putative 'rebound-effects' of distraction in chronic pain patients (in which pain increases after the termination of the experiment; Goubert et al., 2004; See also Cioffi & Holloway, 1993). In contrast with previous meta-analyses showing the efficacy of distraction to cope with acute or procedural pain (e.g., Birnie et al., 2015; Fernandez & Turk, 1989; Johnson, 2005; Malloy & Milling, 2010; McCaul & Mallot, 1984), distraction does not seem to be helpful for patients with chronic pain. Our meta-analysis indicates that this is the case for both the person's own clinical pain (e.g., fibromyalgia pain, chronic low back pain) and experimentally induced pain stimuli (e.g., cold pressor pain), suggesting that the reasons underlying the lack of efficacy of distraction in chronic pain patients are not specific for chronic pain. An exception to this broad claim might be for mild pain experiences.

Several underlying mechanisms have been proposed to explain why distraction in particular is unlikely to offer benefit. First, the persistent or repetitive interruption of attention by pain, alarming for possible harm, is thought to be a major risk factor for developing a vigilant attentional style for both pain (Snijders et al., 2014; Van Ryckeghem et al., 2013) and

somatosensory stimuli in general (Hollins et al., 2009; McDermid & Rollman, 1996). Selective or heightened levels of attention for pain may then result in the attentional prioritization of pain over competing information and, consequently, decrease distraction efficacy. Hypervigilance for pain may be due to high levels of pain-related fear often seen in chronic pain patients (Crombez et al., 2013; Vlaeyen et al 2016). Second, the central sensitization (Woolf, 2011) hypothesis suggests a neural basis for an amplified central signaling of pain signals. Both, ascending pathways (e.g., by a spinal mechanism in which repetitive noxious stimulation results in a slow temporal summation) and descending pathways, arising from the periaqueductal gray matter and the brainstem, may be altered (Roussel et al., 2013). In particular, the disruption of descending inhibitory pathways (compared to healthy volunteers) could explain the decreased efficacy of attention strategies, such as distraction, to attenuate pain. Third, it has been argued that one's level of executive functioning, such as working memory capacity and level of inhibition, influences the ability to control pain (Legrain et al., 2009; Legrain, Crombez, Verhoeven, & Moureaux, 2011; Verhoeven et al., 2011). The link between executive functioning and one's ability to control pain is of particular interest as a recent meta-analysis indicates that chronic pain patients often have reduced executive functioning abilities (Berryman et al., 2014). This may as such explain the absence of beneficial effects of distraction in chronic pain patients.

Follow-up moderator-analyses indicated that, although distraction does not influence most pain outcomes, it does result in an increased pain threshold. This finding is in line with the idea that at greater levels of intensity, pain can no longer be easily excluded from attention and distraction becomes ineffective (Eccleston & Crombez, 1999; McCaul & Mallott, 1984). However, this finding is based upon a single study. Future research is essential to confirm the finding that distraction does work with low intense, but not with moderate to high intense pain stimuli. Only few studies have addressed this issue with variable results (Romero, Straube,

Nitsch, Miltner, Weiss, 2013; Van Ryckeghem et al. 2013). This research has primarily been conducted with healthy volunteers. Investigating distraction efficacy in chronic pain patients using low and high intense stimuli may increase insight in earlier mentioned underlying mechanisms of distraction failure.

Some researchers have argued that sensory monitoring may be more fruitful for people who are anxious or catastrophizing about their pain (Heyneman, Fremouw, Gano, Kirkland, & Heiden, 1990; Roelofs, Peters, van der Zijden, & Vlaeyen, 2005; Verhoeven et al., 2010) and when pain is persistent (Loewenstein, 2011). Accordingly, it was suggested that sensory monitoring may be preferred above distraction to cope with pain in chronic pain patients (Nouwen et al., 2006). This suggestion is not substantiated by our findings. Sensory monitoring has no beneficial effect compared with the use of distraction as a strategy to cope with pain. This finding is surprising and contradicts previous recommendations (e.g., Cioffi, 1991; Leventhal & Evenhart, 1979; Van Damme et al., 2010). An inability of chronic pain patients to focus uniquely on the sensory aspects of experienced pain may explain the lack of efficacy of sensory monitoring. Indeed, in contrast with healthy participants, patients' pain schemata may predominantly consist of beliefs that pain is harmful and make it difficult to focus purely on the sensory quality of painful stimulation (Michael & Burns, 2004). Another explanation may relate to the finding that the concept (and instructions) of sensory monitoring are far more difficult to understand than the idea of distraction (Verhoeven, 2012). Of note is that the included studies have used minimal instructions to introduce the concept of sensory monitoring. In addition, it was found that it is sometimes difficult to motivate people to monitor pain sensations as a way to cope with pain (Leventhal, 1992). It may thus be that sensory monitoring is not successful because people do not understand well how to apply this strategy or are not motivated to perform sensory monitoring. Future research may be able to confirm or exclude these suggestions by asking people about the strategies they used, and why.

This review also indicates that, despite the fact that we set a minimum criterion of quality (i.e., we excluded studies of which the effect of the attentional strategy could be entangled with order-effects and non-random allocation of participants), studies investigating the efficacy of attentional monitoring are prone to methodological difficulties. For example, almost no study checked for the use of comparable coping strategies in the control condition. Thus, it may be that participants in the control condition use similar attentional strategies (e.g., imagination) or self-selected strategies that are equally effective as the strategies in the experimental condition. Distraction may be used in the control condition because of its intuitive appeal. The control condition should be well chosen and better documented. From a theoretical perspective one would like to know whether modulating attention for pain results in a reduction of pain, whereas from a clinical perspective one would like to know whether a particular distraction strategy has clinical benefits over one's usual coping strategy. The importance of a well-defined and documented control category is further substantiated by the finding that distraction is superior to the control condition in studies in which participants in the control condition needed to focus on the pain, but not when participants in the control conditions coped with pain as usual. Second, almost half of the studies did not check whether participants applied the attentional strategy as instructed and almost none of the studies actually determined whether effects differed when excluding participants who did not follow the instructions in the experimental condition. Furthermore, none of the studies reported whether participants and/or experimenters were blinded for the condition (attention strategy or control condition). This lack of blinding may bias study results (Moher et al., 2012), in particular for distraction because participants often strongly believe in the potency of distraction. In this context, Leventhal provocatively stated "I know distraction works even though it doesn't!" (Leventhal, 1992), suggesting that even though distraction may prove to be ineffective, people will keep believing that distraction works. While blinding of participants to study condition can be hard given the

nature of the psychological interventions, future research should try to make participants and researchers blind to hypotheses in order to avoid unwanted demand or expectancy effects. Due to a low number of studies, sub-analyses investigating the unique effect of each of these study characteristics were not possible. Nevertheless, we recommend that future research takes into account the above-mentioned methodological concerns as they will help to address and/or rule out alternative explanations or sources of noise in researching the efficacy of attentional strategies to cope with pain.

Current findings have clinical implications. This review indicates that, despite the intuitive character of distraction, the use of distraction (as proposed in the included studies) should not be promoted as a standard procedure to cope with pain in chronic pain patients. Available research in chronic pain patients shows that distraction has no efficacy and its harms remain largely unknown. Goubert and colleagues (2004) suggested that the use of distraction by chronic pain patients might result in increased pain on disengaging from distraction, while having no beneficial analgesic effects during its use.

This conclusion does however not exclude the idea that particular distraction techniques could have positive effects in particular contexts, but they have not yet been demonstrated. Indeed, distraction research in chronic pain has been dominated by an erroneous limited resource model of attentional competition, and methods that position a single cognitive strategy in competition with pain. Current thinking in pain presents attentional interruption by pain within a more affective-motivational, and action orientated functional model of pain (e.g., Eccleston & Crombez, 1999; Van Damme et al., 2010; Vlaeyen et al., 2016). Understanding which contextual demands are selected over pain, and how that selection is maintained, needs a better understanding of the context, purpose, and affective consequence of that choice (see also Birnie, Chambers, & Spellman, 2017). Accordingly, not only the cognitive demands of a task, but also emotional and motivational factors may increase or reduce the efficacy of

distraction. Optimizing distraction by using motivational relevant tasks or by first reducing the threat value could prove analgesic. In support of this suggestion, a study of Verhoeven and colleagues (2010) showed that distraction only worked in healthy people who catastrophize about pain when the used distraction task was motivationally relevant (see also Schrooten et al., 2012; Van Ryckeghem, Crombez, Van Hulle, & Van Damme, 2012). Furthermore, distraction paradigms could be optimized by using tasks that are more immersive. Wiederhold and colleagues (2007), for example, argued that the use of virtual reality may prove superior to other distraction techniques because of a high level of immersion. Immersion relates to how "present" a person feels in the world and how "real" the environment seems. Wiederhold and colleagues suggested that when immersion is high, the user has a strong focus on the virtual environment, resulting in less attention for the pain (Wiederhold & Wiederhold, 2007).

There are limitations to this study. First, most primary studies investigated the effect of attention strategies in small samples of patients. Second, we explored the possible moderating role of task characteristics on the efficacy of the attentional strategy, but it was not possible to examine the role of participant characteristics (e.g., catastrophic thinking). Third, the instructions used to induce sensory monitoring in some of the studies were not in line with the original sensory monitoring instructions (see table 3). For example, Michael and colleagues (2006) instructed people to focus on the sensations they would experience when their hand was in the water while they simultaneously read a list of sensation words aloud to help them concentrate on their sensations. Reading a list of sensation words could have resulted in distraction, rather than sensory monitoring. Sensitivity analyses indicated that exclusion of this study did not change our findings. Fourth, there are only 10 studies. To investigate whether results were driven by one study in particular, we performed additional analyses where each time one study was removed from the meta-analysis on distraction efficacy. Results indicated that the significance level varied from significant (p = .03) to completely non-significant (p =

.24), depending on which study was excluded, indicating the instability of the evidence base. Yet, most importantly, the effect size remained stable (ranging from 0.087 to 0.130) and small. The changing significance level was mainly due to the fact that the confidence interval largely increased dependent from which studies were included. Last, due to the limited number of studies, some of the anticipated analyses could not be performed. Systematic research addressing still lingering questions may help to answer these questions in future.

Despite these considerations, this review furthers our insight in the use and value of attentional coping strategies in chronic pain patients. There is no evidence for the efficacy of attention-based strategies in altering the pain reported by chronic pain patients. The harms of engaging in these strategies are unknown. This conclusion may be an artefact of the current evidence base, in particular the dominance of a structural theory of attention and the metaphor of resource sharing, or it may be due to the persistence of methodological problems, despite them being well documented (Eccleston, 1995), or it may be due to both. Alternatively, and more simply, attentional strategies may just not work in chronic pain patients. Further research would need to be based on a more sophisticated model of attention to pain. In this context it is helpful to think of the chronic pain patient as someone chronically interrupted by pain, interrupted by a motivational priority to avoid or escape harm (Eccleston & Crombez, 2017). We hope that current review may provide guidance for future research on attentional strategies in chronic pain patients.

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FIGURE CAPTIONS

Figure 1. Meta-analysis search flowchart

Figure 2. Forest plot of overall effect sizes comparing distraction condition and control condition for individual studies ordered by publication year.

Figure 3. Forest plot of overall effect sizes comparing sensory monitoring condition and control condition for individual studies ordered by publication year

Figure 4. Forest plot of overall effect sizes comparing distraction condition and sensory monitoring condition for individual studies ordered by publication year

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CONTRIBUTORS

All authors were involved in the design and development of the study protocol. D. M. L. Van Ryckeghem conducted the literature search. D. M. L. Van Ryckeghem and S. Van Damme coded the included articles. D. M. L. Van Ryckeghem conducted the statistical analysis and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

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Table 1. Ratings of methodological quality for each study included in the meta-analysis.

	M	Burns et al., 2006	Ellingson et al., 2012	Fors et al., 2000	Goubert et al., 2004	Hadjista-vropoulos et al., 2000	Johnson et al., 1997	Michael et al., 2004	Nouwen et al., 2006	Roelofs et al., 2006	Snijders et al., 2010
1. Eligibility criteria	**.80**	1	1	0	1	1	0	1	1	1	1
2. Demographics of participants	**.60**	1	0	1	1	1	0	1	0	0	1
3. Pain experience	**.80**	1	0	0	1	1	1	1	1	1	1
4. Recruitment procedure	**.30**	0	0	0	1	1	0	1	0	0	0
5. Setting and/or location of the study	**1.00**	1	1	1	1	1	1	1	1	1	1
6. data cleaning	**.00**	0	0	0	0	0	0	0	0	0	0
External validity*		**.67**	**.33**	**.33**	**.83**	**.83**	**.33**	**.83**	**.50**	**.50**	**.67**
1. Engagement in ESC	**.60**	0	0	0	1	1	1	1	0	1	1
2. Control for alternative strategies in CC	**.25**	0	0	0	0	1	0	NA	NA	1	0
3. Report of objectives/ cover story	**.40**	0	1	1	0	0	0	0	0	1	1
4. Selective outcome reporting	**.00**	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)
5. Blinding	**.00**	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)	Unclear (0)
Internal validity*		**.00**	**.20**	**.20**	**.20**	**.40**	**.20**	**.25**	**.00**	**.60**	**.40**

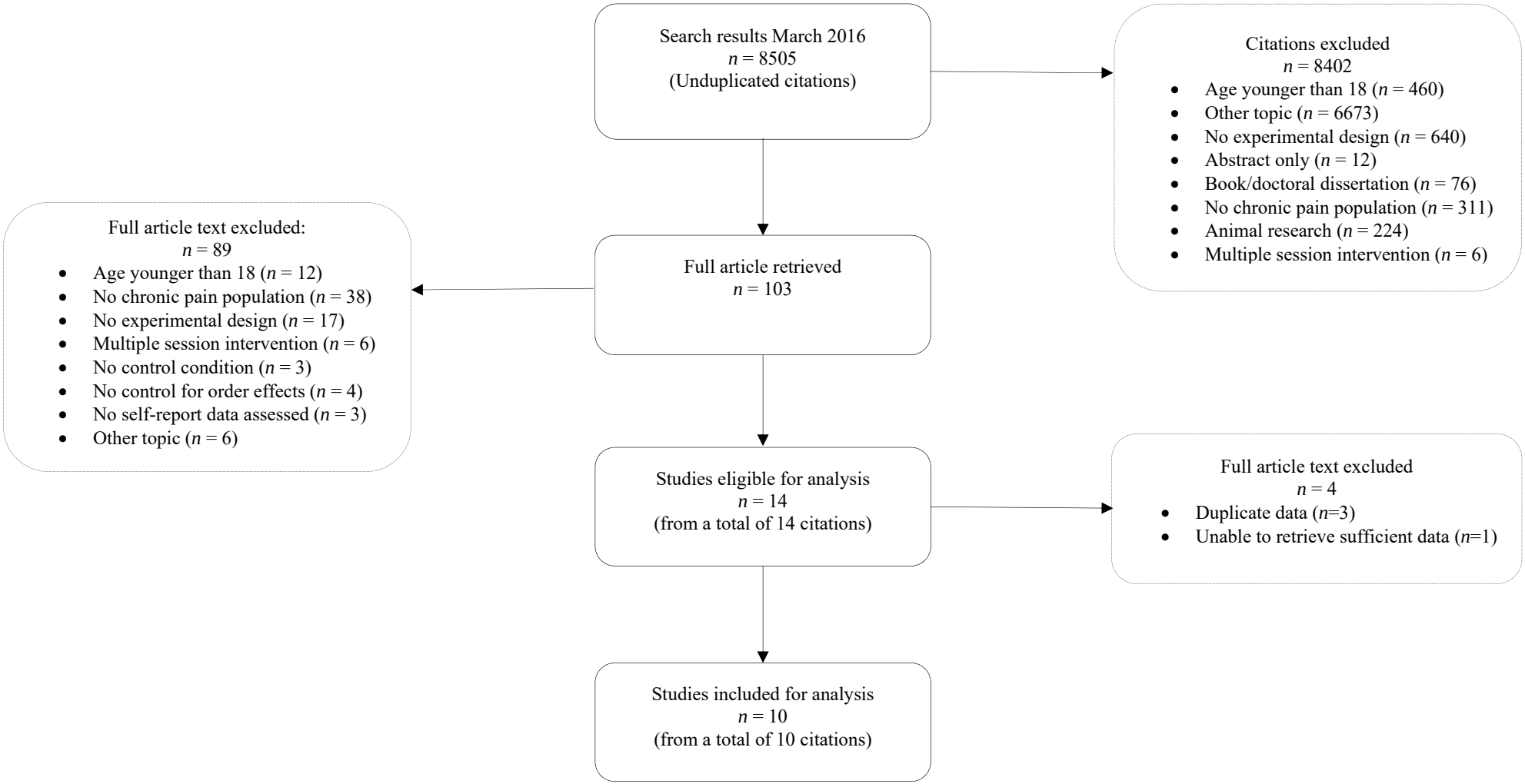
*Range: 0 = none of the applicable criteria are fulfilled; 1 = all applicable criteria are fulfilled; NA = Not applicable; ESC= Experimental strategy condition; CC= Control condition.

Table 2: Details on the experimental procedure of the studies included in the meta-analysis

	Type of conditions included (*n*)	Type of target pain	Outcome measure(s)	Presence of others	Induction of positive expectancy	Type of control condition
Burns et al., 2006	Distraction Sensory monitoring Control	Experimental pain – Cold pressor	Primary measure – Pain intensity	Unclear	No	No instruction control
Ellingson et al., 2012	Distraction Control	Experimental pain – Heat pain	Primary measure - Pain intensity; Primary measure - Pain unpleasantness	No	No	No instruction control
Fors et al., 2000	Distraction Control	Clinical pain – Whole body pain	Primary measure – Pain intensity; Secondary measure – Distress	Yes, for CC; No, for distraction condition	Yes	No instruction control
Goubert et al., 2004	Distraction Control	Clinical pain – Muscoskeletal pain	Primary measure - Pain intensity	Yes	No	No instruction control
Hadjistavropoulos et al., 2000	Distraction Sensory monitoring Control	Clinical pain – Mixed	Primary measure - Pain intensity; Primary measure - Pain unpleasantness; Secondary measure – Distress	Yes	No	No instruction control
Johnson et al., 1997	Distraction Control	Experimental pain- Cold pressor AND Clinical pain – Muskoskeletal pain	Primary measure – Pain tolerance Primary measure – Pain intensity	Unclear	Unclear	No instruction control
Micael et al. 2004	Distraction Sensory monitoring	Experimental pain – Cold pressor	Primary measure – Pain tolerance Primary measure – Pain threshold Primary measure – Pain intensity	Unclear	Unclear	/
Nouwen et al., 2006	Distraction Sensory monitoring	Experimental pain – Cold pressor	Primary measure - Pain intensity; Primary measure - Pain unpleasantness;	No	No	/
Roelofs et al., 2006	Distraction Control	Clinical pain – Muscoskeletal pain	Primary measure – Pain intensity	Unclear	No	Attention instruction control
Snijders et al., 2010	Distraction Control	Experimental pain – Electrocutane pain	Primary measure – Pain intensity; Primary measure – Pain threshold	Yes	No	Attention instruction control

Table 2: Details on the experimental procedure of the studies included in the meta-analysis (continued)

	Presence of paradoxical instructions	Type of distraction	Valence of distraction task	Choice of stimuli	Type of perceptual input	Type of response	Sensory monitoring instructions
Burns et al., 2006	No	Internal	Unclear	No	/	No overt response	"While your foot and hand are in the ice water, it is very important that you think objectively about the sensations in your foot and hand. That is, concentrate on whether you feel coldness, wetness, tingling, or throbbing sensations. Stay objective and focus on the various sensations in your foot and hand."
Ellingson et al., 2012	Yes	External	Neutral	No	Visual	Discrete choice response	NA
Fors et al., 2000	No	External	Positive	No	Auditory	No overt response	NA
Goubert et al., 2004	No	External	Neutral	No	Auditory	Discrete simple response	NA
Hadjistavropoulos et al., 2000	No	Internal	Unclear	Yes	/	No overt response	"Attend to and monitor all physical sensations (i.e. pay close attention to the physical sensations you are experiencing while completing each exercise)"
Johnson et al., 1997	No	External	Neutral	No	Visual & auditory	Continue response	NA
Micael et al. 2004	No / Yes	External	Neutral	No	Visual	Continue response	"Focus on the sensations you will experience when your hand is in the water as you read a list of sensation words aloud. The list will help you concentrate on these sensations."
Nouwen et al., 2006	Yes	Internal	Neutral	Yes	/	Continue response	During the time that your forearm is in the water, you will feel many sensations in your hand and forearm … While your forearm is in the water, describe aloud the sensations you are feeling in your forearm throughout the entire time your hand and forearm are in the water. You may, at times, feel similar sensations and you may have to repeat things that you have already said. This is perfectly all right."
Roelofs et al., 2006	No	External	Positive	Yes	Visual	Continue response	NA
Snijders et al., 2010	No / Yes	External	Neutral	No	Visual & auditory	Discrete choice response	NA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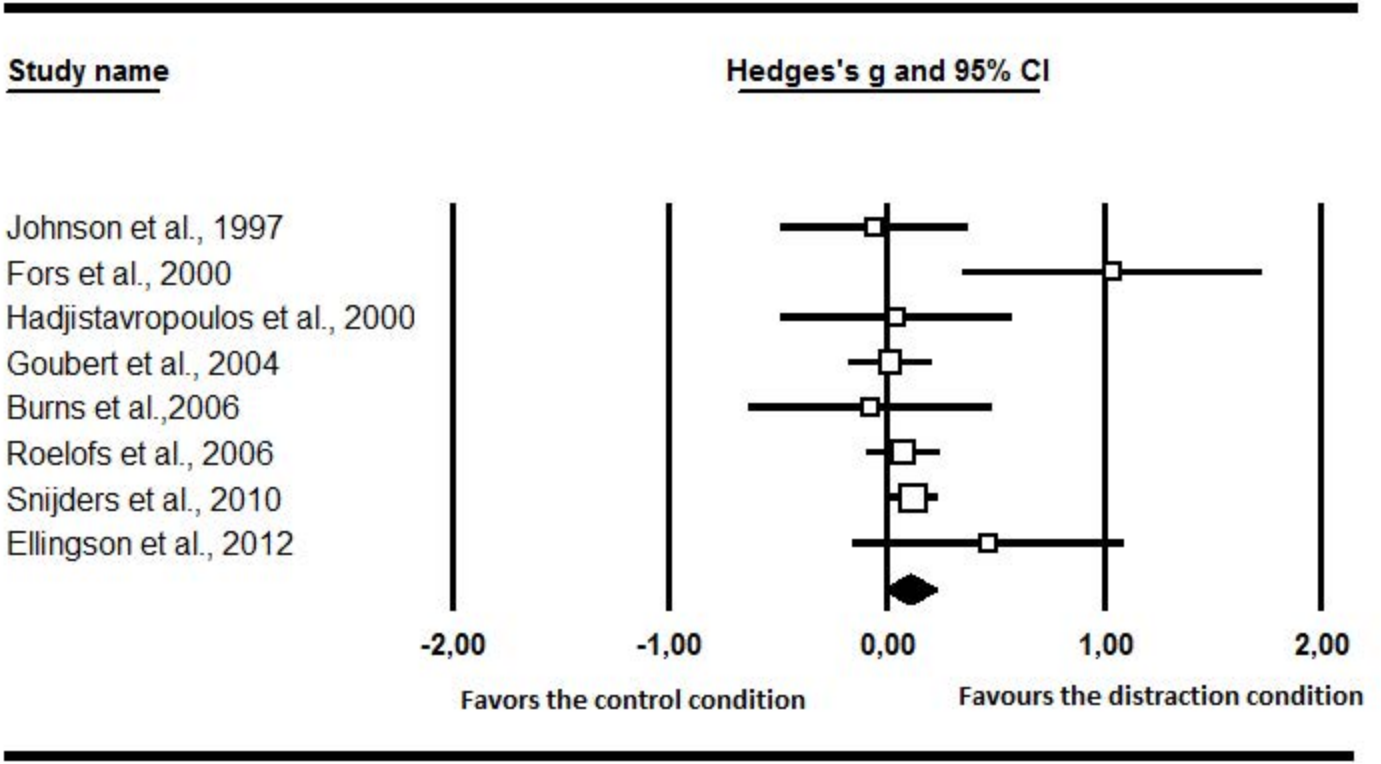
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Roelofs et al., 2006
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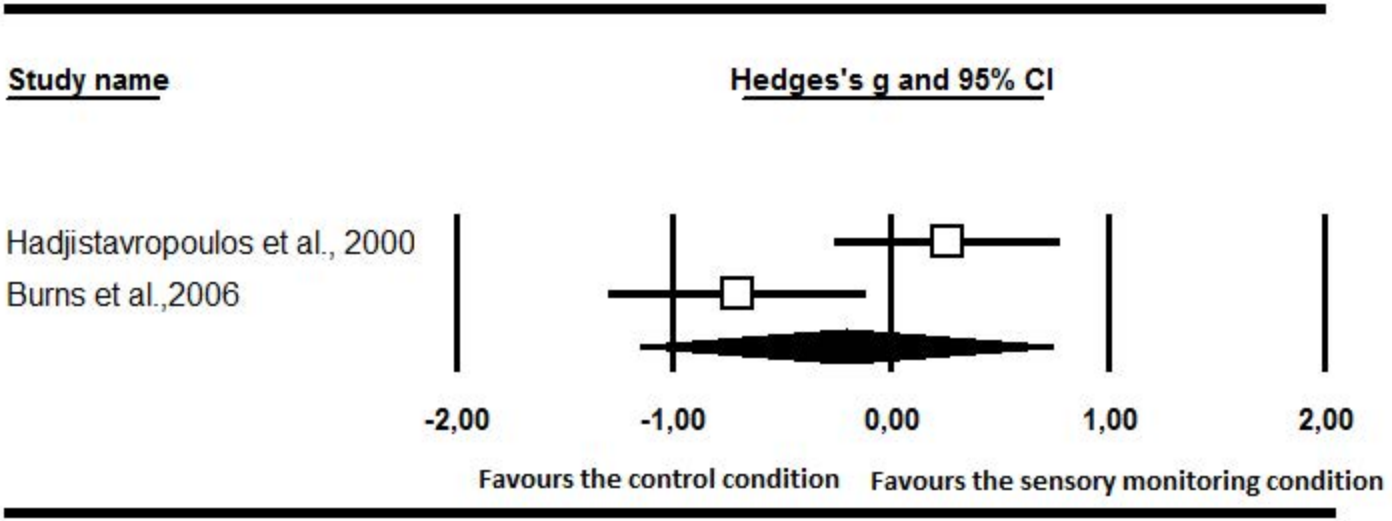
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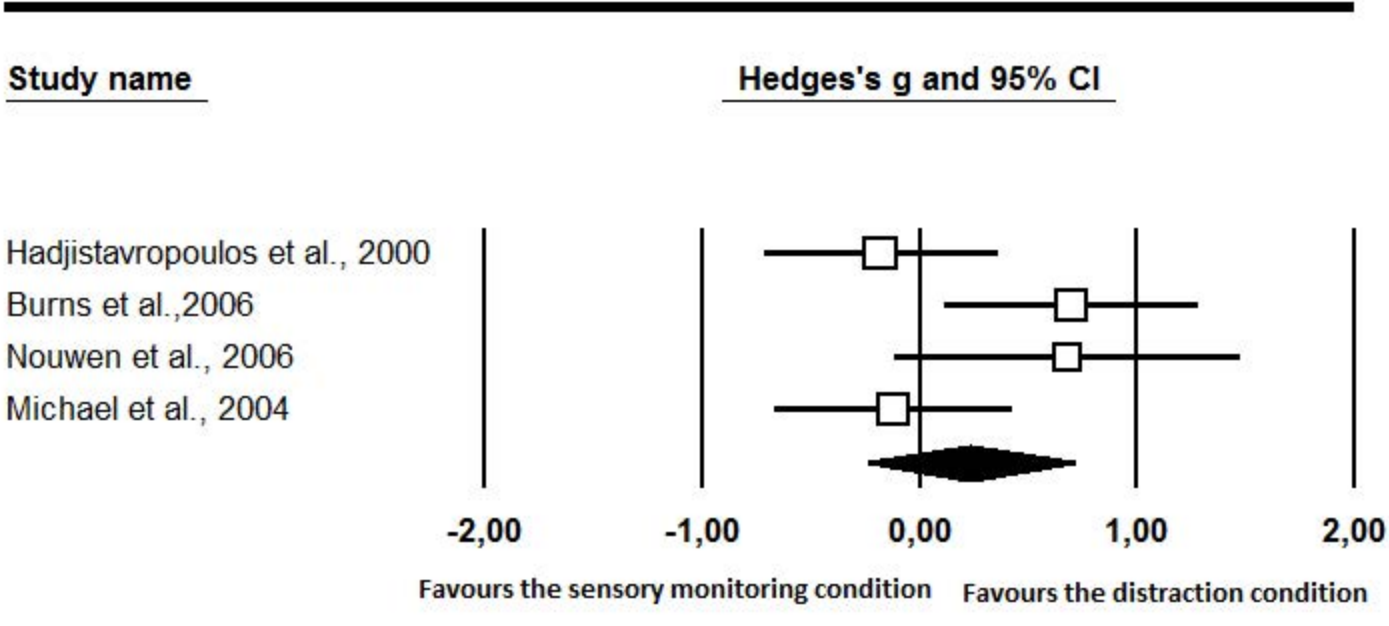
Favours the control condition
Favours the sensory monitoring condition


Study name
Hedges's g and 95% CI
Hadjistavropoulos et al., 2000
Burns et al.,2006
Nouwen et al., 2006
Michael et al., 2004
-2,00
-1,00
0,00
1,00
2,00
Favours the sensory monitoring condition
Favours the distraction condition