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Dispositional factors affecting the analgesic response to imagery and mindfulness suggestions during hypnosis

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ABSTRACT

Medical hypnosis combined with mindfulness suggestions may improve pain management, but individual benefits are difficult to predict. This study compared the effects of hypnotic induction suggestions and different hypnotic suggestions for analgesia on acute experimental pain, considering hypnotic susceptibility (SHSS:A) and five mindfulness facets (FFMQ). Thirty-four healthy participants were administered phasic electrical stimulations during a Baseline condition, a Hypnotic induction alone condition, and experimental hypnosis conditions involving Imagery and Mindfulness-like suggestions of analgesia. Results showed significant pain reduction to all three hypnotic conditions compared to Baseline (*EMMs* = 18.98 to 23.76; $p < 0.0001$) and highlighted the moderating role of dispositional factors. Imagery suggestions were more effective than Hypnotic induction (*EMMs* = 3.14, $p < 0.001$) and Mindfulness (*EMMs* = 4.78, $p < 0.0001$) but Mindfulness suggestions did not provide benefits over Hypnotic induction (*EMMs* = 1.64, $p =$ 0.25). Individuals with higher hypnotic susceptibility (SHSS:A) and lower scores on the FFMQ's non-reactivity subscale reported significantly more analgesia (p's < 0.01). FFMQ's Non-judgement score positively predicted hypoanalgesia in Hypnotic induction suggestions ($p <$ 0.01), FFMQ's Description score positively moderated Hypnotic induction and Mindfulness suggestions effects (p's < 0.01) and FFMQ's Awareness score was a negative moderator of mindfulness's hypoalgesia suggestions ($p < 0.001$). These findings confirm that mindfulness-like suggestions can be integrated to hypnotic interventions but indicate that they may not provide additional effect on acute pain responses, beyond standard hypnotic induction techniques. Importantly, different mindfulness dispositional characteristics may sustain or reduce the potential benefits of hypnosis interventions.

1. Introduction

Hypnosis and mindfulness have been proposed as useful psychological interventions to alleviate pain (Milling et al., 2021; Thompson et al., 2019; Taylor et al., 2018; Zeidan et al., 2011). Recent studies comparing possible mechanisms by which hypnosis and

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mindfulness operate are multiplying (Lush & Dienes, 2019; De Benedittis, 2021; Penazzi, & De Pisapia, 2022), while interventions aimed at their practical integration are becoming more common (Gloede et al., 2021; Patterson & Mendoza, 2024). Nonetheless, direct experimental comparisons of their mechanisms remain scarce. This study was designed to provide a better understanding of the individual factors underpinning the effectiveness of these interventions and the ones which might support their possible integration. It also aimed to better distinguish the roles of specific verbal suggestions (Jensen et al., 2017).

Hypnosis is an intervention that aims to affect perceptual, cognitive, ideomotor or emotional processes. Hypnotic suggestions are usually used to induce changes in the subjective experience of the person (Kihlstrom, 2008), and individual quantitative differences in responses to hypnosis have long been documented (Weitzenhoffer & Hilgard, 1959). Hypnosis is an effective intervention to reduce clinical pain (Milling et al., 2021), and experimental research demonstrates that optimal hypnoanalgesia is generally obtained with direct analgesic suggestions administered to individuals scoring higher on hypnotic susceptibility measures (Thompson et al., 2019), such as the Stanford Hypnotic Susceptibility Scale (SHSS) (Milling et al., 2021; Montgomery et al., 2011; Weitzenhoffer & Hilgard, 1959). Higher suggestibility may reflect a greater tendency toward dissociation or imagery (Terhune et al., 2011). During hypnosis, focused or imagery-based suggestions are generally most effective in highly susceptible individuals (De Pascalis et al., 1999, 2004). Yet, this effect is not explained by imagery ability (Zachariae & Bjerring, 1994), and non-imagery suggestions can be equally effective (Hargadon et al., 1995), indicating that hypnotic responsiveness does not rely solely on imagery processes.

As available evidence supporting the use of hypnosis in pain management grows, new questions have emerged about its possible integration with other mind–body approaches (Berna et al., 2023). Mindfulness is a state of observing one's own immediate and ongoing experience, allowing for deliberate attention to the present moment, without judgment (Kabat-Zinn, 1990). The many benefits of mindfulness generally emerge from practice and the development of expertise (Cahn & Polich, 2006; Davidson et al., 2003; Jha et al., 2007; Kozhevnikov et al., 2009; Moore & Malinowski, 2009; Zeidan et al., 2010), but individuals may also display predispositions to this type of experience, as measured with self-report instruments, such as the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006).

Experienced meditators derive benefits from their practice when it comes to attenuating the impact of aversive conditioning related to acute pain (Taylor et al., 2018). Observation and Non-Reactivity mindfulness traits (FFMQ) have also been shown to mitigate pain in trained meditators (Grant & Rainville, 2009; Mischkowski et al., 2021). Even brief mindfulness training can significantly reduce pain in novices (Zeidan et al., 2011). Even though it is possible to induce mindfulness in non-meditators in order to change a person's experience (Miller et al., 2021; Petrovic et al., 2022), much remains to be done to understand who benefits most from this type of intervention in the non-practicing population.

Though often framed in opposition to hypnosis, mindfulness is a psychological approach that some equate with a similar application of suggestions, although a different set of these (Yapko, 2020). Part of the difference in the content of hypnotic and mindfulness suggestions may lie in the idea that different semantic contents may prime different experiences. Measuring this contextual influence more directly may be possible by embedding mindfulness suggestions into a hypnosis framework (Gloede et al., 2021; Robin et al., 2005).

1.1. Developing suggestions for imagery and for mindful hypnosis

While the effectiveness of mindfulness generally depends on a certain level of expertise in the practice, hypnosis has the advantage of offering an immediate effect on responders. There has been some support in the clinical and in the scientific literature for combining hypnosis and mindfulness (Lynn et al., 2000; Otani, 2016, 2020; Simpkins & Simpkins, 2012; Casula, 2018; Elkins et al., 2018; Slonena and Elkins, 2021; Yapko, 2020; Williams et al., 2022; Patterson & Mendoza, 2024). The efficacy of hypnosis as an adjuvant therapy (Lynn et al., 2000; Jensen et al., 2020; Ramondo et al., 2021) may help facilitate the induction of a mindful posture in the face of adversity. The few attempts at combining them have emphasized that mindfulness concepts can be used as suggestions (Elkins et al., 2018; Shenefelt, 2018), to integrate them into therapeutic work (Patterson & Mendoza, 2024). However, some thoughts need to be given to how their predispositional moderators might differ. Indeed, comparing the dispositional traits, Grover and colleagues (2018) report that hypnotically susceptible people could display a tendency to be less predisposed to mindfulness, as "Observe" and "Non-Reactivity" factors of the FFMQ were found to be inversely correlated with the hypnotic susceptibility score. In a clinical study, a different pattern was found where FFMQ measures did not correlate significantly with non-hypnotic direct verbal suggestibility (Millman et al., 2022). As these practices are intended to produce a psychological change in pain perception, their similarities and differences should be considered as they relate to the role that predisposition to one or the other plays in their implementation.

In some regards, hypnosis and mindfulness seem to involve opposing processes, even though they share some neurophysiological and phenomenological features (Bauer et al., 2022; De Benedittis, 2021; McGeown, 2016; Penazzi & De Pisapia, 2022). The practices of hypnosis and mindfulness are both anchored in suggestions concerning attention and intentions (whether overt or covert; (Lifshitz and Raz, 2012; Lifshitz et al., 2012; Yapko, 2020), but they promote fundamentally different psychological stances (Simpkins & Simpkins, 2012). Hypnosis intervention typically fosters a reinterpretation of one's experience, while mindfulness encourages direct observation of immediate experience without elaboration or judgment (De Benedittis, 2021). Accordingly, hypnosis and mindfulness may differ in the engagement of metacognitive processes and in the subjective experience they produce (Lush et al., 2016; Lush & Dienes, 2019). Hypnosis may involve a suspension of meta-awareness of one's own mental states and self-agency, whereas mindfulness meditation aims at cultivating such meta-awareness (Semmens-Wheeler & Dienes, 2012). This difference is consistent with the general intentions communicated through hypnotic and mindful suggestions, where the focus of hypnotic suggestions is usually to imagine being somewhere else (e.g., a safe space) or to transform the experience itself (e.g., focused suggestion to reinterpret the experience), whereas, in sharp contrast, the focus of mindfulness is to acknowledge the experience while changing the way one relates to it, based on moment-to-moment presence (Penazzi & De Pisapia, 2022; Grover et al., 2018). The experience of focused attention and absorption into the process is common to both practices, and it is possible that the suggestions from one could be integrated into the other, such as the possibility of a hypnosis intervention that relies on suggestions relating to presence, rather than imagery. In that way, verbal suggestions for either "typical" hypnosis or for mindfulness-like hypnosis could promote different focal points for the same goal, and their effectiveness may vary between individuals according to different dispositional factors.

The aim of this experimental study was to examine the responses to different types of hypnotic suggestions for pain modulation, according to individual predispositions to hypnosis and mindfulness. It is expected that hypnotic mindfulness-like and imagery suggestions will have a hypoalgesic effect, compared to control conditions. It is also expected that individuals with greater hypnotic susceptibility will show greater hypoalgesia in response to imagery suggestions, and that individuals with a greater predisposition to mindfulness will show greater hypoalgesia in response to mindfulness-like suggestions.

2. Method

2.1. Participants

2.1.1. Participants

Thirty-five healthy adults were recruited through posters at the research centre of the Institut universitaire de gériatrie de Montréal (CRIUGM) and via social media ads. The title on the recruitment posters referred to the effects of "psychological states" on pain perception to minimize expectations about hypnosis or mindfulness. To be eligible, volunteers had to (1) be at least 18 years old, and exclusion criteria included (2) chronic pain, (3) diabetes, (4) neurological or psychiatric diagnosis, (5) psychotropic medication, and (6) daily consumption of recreational drugs. Participants completed a preliminary questionnaire to ensure their eligibility. The participants gave written consent and were compensated at a rate of $15 per hour for their time. One subject was unable to comply with the instructions during the first session and was excluded from the study. Thus, the data from thirty-four volunteers were analyzed. All procedures were approved in 2020 by the CRIUGM Research Ethics Board (CER VN 19-20-35).

2.2. Measures

2.2.1. Hypnotic susceptibility scale

The Stanford Hypnotic Susceptibility Scale (SHSS) is a standardized and validated measure of individual differences in hypnotic responses (Weitzenhoffer & Hilgard, 1959). For this study, the French version of Form A (SHSS:A) was used (Bourassa & Leclerc, 1991), as in previous studies (Rainville, Duncan, Price, Carrier, & Bushnell, 1997; Rainville, Bao, & Chretien, 2005; Rainville, Carrier, Hofbauer, Bushnell, & Duncan, 1999; Rainville, Hofbauer, Bushnell, Duncan, & Price, 2002; Rainville et al., 1999; Desmarteaux et al, 2021). The SHSS:A (Hilgard et al., 1961) demonstrated good psychometric properties in the original validation. Internal consistency was adequate (Kuder-Richardson KR-20 = 0.83), and test–retest reliability was strong (r = 0.83; Goss & Morosko, 1968). Following a standardized hypnotic induction, a series of twelve motor and cognitive suggestions were administered. Each item performed according to the suggestion counts for one point, resulting in a score ranging from 0 to 12. To minimize physical proximity with the participants in the context of the COVID-19 pandemic, the first item of the SHSS:A (falling backwards) was replaced with the first item of the Harvard Group Scale of Hypnotic Susceptibility (head falling) (Shor et al., 1962).

2.2.2. Mindfulness predisposition scale

The Five Facet Mindfulness Questionnaire assesses an individual's predisposition to adopting a mindful stance (Baer et al., 2006). The FFMQ allows for a description of the five aspects of the mindfulness predisposition: (1) *Observation* refers to being aware and focused on the experience even when it is aversive, (2) *Description* refers to describing and expressing the inner experience in words, (3) *Aware of Actions* means paying active attention from moment to moment, (4) *Non-Judgment* refers to the absence of any comments on inner thoughts and emotions, and (5) *Non-Reactivity* refers to allowing thoughts and emotions to exist without reacting to them automatically (Baer et al., 2006). A subject with a high score on this questionnaire is considered to be strongly predisposed to mindfulness. The validated French version was used (Heeren et al., 2011), and participants completed the questionnaire online before the first session. The FFMQ tends to show excellent internal consistency (Baer et al., 2006), though non-reactivity tends to display the lowest (Observing: $\alpha = 0.83$, Describing: $\alpha = 0.91$, Acting with awareness: $\alpha = 0.87$, Non-judging of inner experience: $\alpha = 0.87$, Non-reactivity to inner experience: $\alpha = 0.75$). For the French validation, Heeren and colleagues (2011) found psychometric properties and a structural validity similar to the initial version, acceptable test–retest reliability and reported similar observations about internal consistency (Observing: $\alpha = 0.78$, Describing: $\alpha = 0.88$, Acting with awareness: $\alpha = 0.89$, Non-judging of inner experience: $\alpha = 0.89$, Non-reactivity to inner experience: $\alpha = 0.76$). The FFMQ offers strong construct validity (Park et al., 2013). Its scores increase following mindfulness training (Khoury et al., 2013; Visted et al., 2015; Quaglia et al., 2016), and although its structure varies between meditators and non-meditators, it remains largely stable within each group (Gu et al., 2016).

2.2.3. Pain ratings

After each stimulation, participants reported the pain intensity (INT) and the unpleasantness (UNP) of the pain felt on two numeric rating scales (0: No pain to 100: Extremely intense and 0: Not at all unpleasant to 100: Extremely unpleasant) (Rainville et al., 1992). Each scale consists of a graduated vertical bar, explained to every subject at the beginning of every session. The difference between INT and UNP has been explored by Price and colleagues (Price et al., 1983, 1987). The study also involved several psychophysiological measurements, described in a separate report (Amrane et al., 2023).

2.2.4. Additional questionnaires

In addition to the SHSS:A and the FFMQ completed to address the main hypotheses, participants completed the following questionnaires, before the testing session, to explore future questions: the Pain Catastrophizing Scale (PCS; French et al., 2005; Sullivan et al., 1995), the Beck's Depression Inventory (BDI; Beck et al., 1988 Bourque & Beaudette, 1982), the Gender Role Expectations of Pain Questionnaire (GREP; Alabas et al., 2012; Robinson et al., 2001), the State-Trait Anxiety Inventory (STAI; Bergeron et al., 1976; Spielberger & Gorsuch, 1983), Metacognition Questionnaire (MCQ-30, Heeren et al., 2011) and the Beck Cognitive Insight Scale (BCIS; Favrod et al., 2008). These questionnaires are not discussed further in this paper.

2.3. Procedures

The experiment took place over two sessions, each lasting approximately 1.5 h. Before the first session, participants were informed of all relevant details related to their involvement and completed several questionnaires online. As proposed in the presentation of the SHSS:A (French version by Bourassa & Leclerc, 1991), minimal information was offered on the effectiveness of hypnosis, including its clinical use, but participants were encouraged to be open to what they might experience. Questions about the goal of the study were answered, acknowledging if necessary that we studied different types of suggestions, without divulging our hypothesis about moderation effects.

2.3.1. Protocol setting

During the first session, preliminary testing was conducted to assess individual pain thresholds and to test hypnotic susceptibility (see Fig. 1A). The main experiment took place during the second session, comparing pain responses across conditions (see Fig. 1B). In

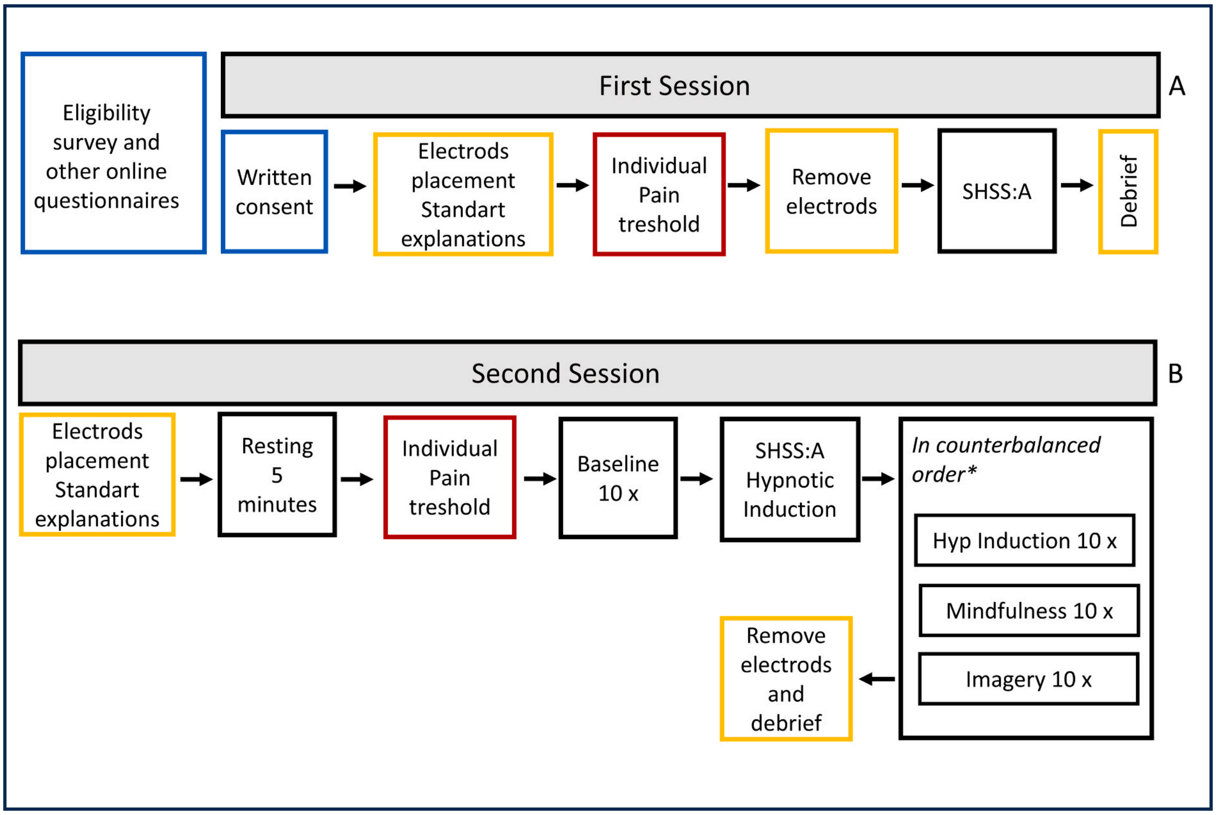

Fig. 1. Study procedures. A) After confirming their eligibility, participants completed online questionnaires before coming to the lab. During the first session, following electrode placement and general standardized explanations, the pain protocol was administered to determine the individual's moderate pain level. Following each stimulation, participants rated the pain on the INT and UNP scales. After removing the electrodes, the hypnotic suggestibility test was completed, followed by a debriefing. B) The second session began with electrode placement and general explanations. Participants were then asked to remain in a resting state for 5 min ("to do nothing in particular"), before undergoing the individual threshold calibration followed by the Baseline condition, where they received 10 electrical stimulations. Following hypnotic induction, participants underwent the three experimental conditions in counterbalanced order. Participants were then guided into an awake state. The session ended with a debriefing.

both sessions, participants were first prepped for the electrophysiological recordings and the pain calibration protocol, which was then conducted to determine the individual stimulation intensity to administer.

The second session started with a 5-min resting state, followed by the Baseline control condition and the Hypnotic Induction procedure. Each of the following three hypnotic conditions was then administered in counterbalanced order: Hypnotic Induction, Mindfulness and Imagery. Hypnosis was briefly re-induced at the beginning of each of these condition. Participants received and rated 10 painful stimuli in every condition, including the pre-hypnotic Baseline. After each rating, the next stimulation was triggered by the experimenter and delivered after a variable delay of 6 to 10 s to reduce temporal predictability. Following the last hypnotic condition, subjects were instructed to return to a normal waking state, and the session ended with a debriefing.

2.3.2. Experimental pain

Acute pain was produced by transcutaneous electrical stimulation controlled by a BIOPAC MP150 system and delivered using a Digitimer DS7A constant current stimulator via two reusable 8 mm2 surface electrodes (EL258RT; BIOPAC Systems Inc., USA). First, areas of the participant's skin were shaved with a disposable razor, exfoliated with NuPrep gel and cleansed with alcohol swabs. Stimulating electrodes were positioned over the retromalleolar path of the sural nerve on the participant's left ankle. The electrical stimulation consisted of 5*1 ms pulses delivered in trains of 20 ms, at 250 Hz, with an inter-train interval of at least 6 s, following established methods (de Willer, 1977; Lee & Yoon, 2017; Rhudy & France, 2011).

2.3.3. Individual pain threshold and calibration

The threshold of the nociceptive flexion reflex (NFR) was first determined using the staircase method (de Willer, 1977) to determine the smallest stimulus intensity, producing a reflex response in at least 50 % of the trials (NFR threshold). The calibration procedure involved 30–40 stimuli over about 15 min and determined the intensity to use in the experimental phase during the second session. After each stimulus, participants had to evaluate pain magnitude on both INT and UNP scales (see below). At the beginning of the second session, a few stimuli were administered for recalibration purposes. Then the intensity of the stimulus was increased to 130 % of the NFR threshold or until the subject reported pain in the range of 40–70 on the pain rating scale, defined as the moderate pain level. Following this calibration procedure, the intensity of the stimuli remained constant across all conditions (*mean* $\pm$ *sd*: 18.2 $\pm$ 8.4 mAmps).

2.3.4. Conditions

For every participant, pain and the NFR were assessed first in the Baseline condition. Three experimental conditions were then explored using a within-subject design (order counterbalanced across participants): (1) Hypnotic Induction suggestions (Hyp Induction), (2) Imagery suggestions (Imagery), and (3) Mindfulness-like suggestions (Mindfulness). These terms (Baseline, Hyp Induction, Imagery, Mindfulness- marked by a capital letter) will always refer to conditions that include specific hypnotic suggestions, as described below. These three hypnotic conditions were developed by a certified hypnotherapist through pilot testing and were written to match each other as much as possible in length and syntax (See Verbatim in Supplementary material). Suggestions were scripted to be similar but contained different indications regarding expectations of pain.

In the ***Hypnotic Induction condition***, participants received suggestions to experience the hypnotic state throughout pain stimulation. As an active control, the Hyp Induction condition did not include any explicit or direct suggestion to modulate pain perception. However, suggestions did encourage participants to acknowledge their "comfortable" hypnotic state and to feel stimulation "normally" while remaining in this state.

In the ***Imagery condition***, participants received suggestions to direct their attention internally and imagine being in a secure and comfortable place of their choice. In this condition, specific suggestions were also made to integrate and transform sensations evoked by the electrical stimulation of the ankle (focused imagery). Suggestions were designed to mentally evoke the sensations of the imagined environment and to transform the sensation of pain into a pleasant experience through reinterpretation. Direct and indirect suggestions were made to encourage the individual to disconnect from the present experience (dissociative imagery) and focus on their mental imagery.

In the ***Mindfulness condition***, participants received suggestions to observe their experience and to stay in the present moment. These mindfulness-like suggestions were designed to integrate specific terms that correspond to the five conceptual dimensions of the FFMQ. Suggestions were made to help participants focus their attention on bodily perception, with specific suggestions to be aware, to observe, to describe, but not to react or judge. Direct analgesic suggestions were made to encourage the individual to observe the sensation of pain stimulation without distress or anticipation.

2.4. Data analysis

The analysis plan of the study was preregistered on OSF (*https://osf.io/82jfd/*). Pre-registered statistical analysis included the General Linear Model to assess the effects of Mindfulness and Imagery suggestions on pain ratings and moderation analysis to test the impact of FFMQ and SHSS:A scores on pain modulation. Analyses were conducted using R (version 4.3.1) and supervised by a biostatistician who was blind to experimental conditions and hypotheses. All skewness and kurtosis indices of the distributions are between -1 and $+1$, for SHSS, FFMQ and pain reports, confirming normality.

First, descriptive analyses were performed (percentages, means and standard deviations for each of the variables of interest). Preliminary analyses were done to assess correlations between SHSS:A and FFMQ scores and between INT and UNP across the 34 participants. Pain ratings (INT and UNP) were analyzed using linear mixed-effects models, including Condition (Baseline, Hyp

Induction, Imagery, Mindfulness), and trial order (continuous, trial-by-trial covariate). To account for the repeated-measures structure (40 pain stimuli per participant across 4 conditions), we included a random intercept and a random slope of trial order within participant, allowing the baseline level of pain and the effect of trial progression to vary across individuals. For each model, the significance of fixed effects was tested using Wald χ^2 tests (type II ANOVA). Post hoc pairwise comparisons of estimated marginal means (EMMs) were conducted using the emmeans package (Lenth, 2023; 1.8.8), with Sidak correction for multiple comparisons.

The influence of SHSS:A and FFMQ scores on the differences in pain reports (INT and UNP) observed between experimental and control conditions was examined using a simple moderation analysis (Hayes, 2022). Conceptually, this analysis explored the effect of SHSS:A and FFMQ factors on the analgesic responses produced by the experimental conditions (see Fig. 2). Condition × SHSS:A (or Condition × FFMQ) interactions were included in the model, with participants as a clustering factor and trial order as a covariate of no interest. Null (intercept-only) models were also estimated to verify that models including condition and trait predictors explained significantly more variance than models with only random intercepts. The conditional R^2-change (ΔR^2) is reported in the results to characterize the impact of the simple moderation model (effect of X on Y at different levels of standard deviation (sd) of M; Fig. 2). Correction for multiple comparisons was carried out using the Bonferroni correction, accounting for the number of moderators tested (p-corrected = 0.05/6 = 0.008). The analysis was performed using the bruceR::PROCESS function as implemented in the bruceR package (Bao, 2021; Hayes, 2022; 4.3.1). A sensitivity analysis was conducted using closed-form power equations to determine the minimal detectable effects given the available sample of 1,360 observations. The study was adequately powered to detect small-to-moderate effects in pairwise condition contrasts (d ≈ 0.17–0.20) and very small effects for moderation ($\Delta R^2 \approx 0.006$; consistent with the addition of a single predictor in a regression framework, with the given sample size).

Moderation model in which either SHSS:A or one subscale of the FFMQ is considered as moderator (M) in the relationship between the change of condition (X) and the amount of pain reduction (Y).

3. Results

3.1. Preliminary Check

3.1.1. Study sample

The sample is composed of 34 people (M = 16, W = 18) ranging from eighteen to eighty-three years old (*mean* = 36, *sd* = 17). The education level of the majority is equivalent to a university degree (82 % of the sample).

3.1.2. Individual dispositions

The relationship between SHSS:A and FFMQ subscales was evaluated using Pearson's-r correlation (Table 1).

3.1.3. Pain reporting

Given the high correlation between INT and UNP ($r = 0.89$, $p < 0.0001$), only INT is reported systematically in the results. UNP is reported only when results differ from those for INT.

3.2. Pain modulation

3.2.1. Pain across conditions

All hypnotic conditions had a significant hypoalgesic effect relative to Baseline (all *ps* < 0.0001; Fig. 3). From Baseline (*M* = 57.11 *sd* = 18.63), pain was reported as lower in Hyp Induction (*M* = 36.43, *sd* = 20.17), Imagery (*M* = 33.29, *sd* = 19.64) and Mindfulness (*M* = 38.07, *sd* = 20.54). The average INT was significantly reduced in Hyp Induction (*EMMs* = 20.63), as well as following suggestions for Imagery (EMMs = 23.76) and for Mindfulness (*EMMs* = 18.98). The analgesic effect of Imagery was significantly greater than that

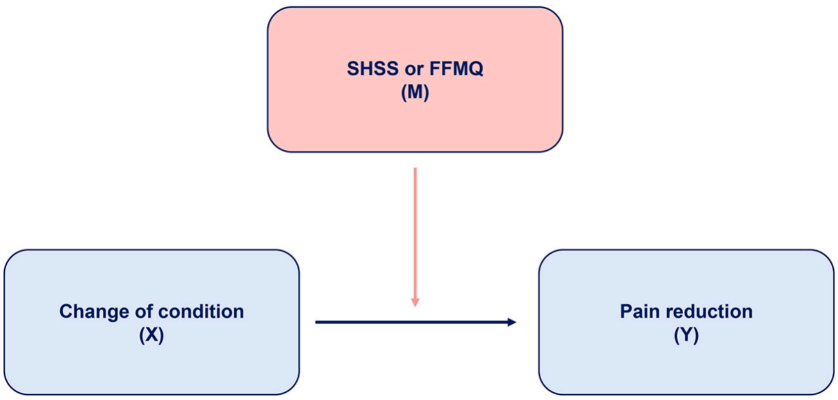

Fig. 2. Simple moderation model.

Table 1
Correlation between SHSS:A and FFMQ factors.

	SHSS:A	Non-Judgment	Observe	Description	Non-reactivity	Awareness
SHSS:A		0.40*	0.17	0.25	−0.05	−0.05
Non-Judgment			−0.05	0.21	−0.03	0.27
Observe				0.36*	−0,3	0.03
Description					−0.22	0.17
Non-Reactivity						−0.32

* $p < 0.05$, uncorrected; No significant relationship remained after applying a Bonferroni correction.

of Hyp Induction ($EMMs = 3.14, p < 0.001$) and of Mindfulness ($EMMs = 4.78, p < 0.0001$), whereas the Mindfulness condition did not significantly differ from Hyp Induction ($EMMs = 1.64, p = 0.25$).

3.3. Effect of predispositions on analgesia

3.3.1. Moderation effects

The results of the moderators corrected for multiple analyses were significant for SHSS:A and for certain FFMQ factors (Table 2).

3.3.2. Moderation effect of hypnotic susceptibility

The interaction between SHSS:A score and the change in condition (from Baseline) was statistically significant in predicting INT outcomes in each condition ($p < 0.001$; Fig. 4). The SHSS:A score positively moderated the relationship between the change of condition and INT (Table 2; Fig. 4). Hypnotic susceptibility positively moderated analgesia from Baseline to the Hyp Induction condition ($F = 14.37$, $p < 0.001$, $\Delta R^2 = 0.011$), to Imagery ($F = 14.21, p < 0.001, \Delta R^2 = 0.009$) and to Mindfulness ($F = 48.81, p < 0.001, \Delta R^2 = 0.022$). The SHSS:A score did not significantly moderate the difference in analgesia between Hyp Induction and Imagery ($p = 0.84$), but did so for the difference between Hyp Induction and Mindfulness ($F = 9.52, p = 0.002, \Delta R^2 = 0.006$). The SHSS:A score also significantly moderated the difference in analgesia between Mindfulness and Imagery ($F = 12.57, p < 0.001, \Delta R^2 = 0.007$). Individuals with higher hypnotic susceptibility displayed more hypoalgesia in all hypnotic conditions. The larger moderating effect was observed in Mindfulness, mainly reflecting the weaker hypoalgesic effect of Mindfulness suggestions in individuals with low SHSS:A score (Table 2; Fig. 4).

3.3.3. Moderation effect of predisposition to mindfulness.

The interaction between Non-Reactivity (FFMQ) and the change of condition (from Baseline) was statistically significant in predicting some INT outcomes ($p < 0.05$; Fig. 5). The Non-Reactivity score (FFMQ) negatively moderated the relationship between change of condition and INT (Fig. 5; Table 2). The Non-Reactivity score (FFMQ) negatively moderated the analgesia effect from Baseline to Hyp Induction ($F = 17.26, p < 0.001, \Delta R^2 = 0.011$) to Imagery ($F = 15.22$, $p < 0.001$, $\Delta R^2 = 0.008$) and to Mindfulness ($F = 32.90, p < 0.001, \Delta R^2 = 0.015$). The larger moderating effects in the Mindfulness condition reflect the weaker hypoalgesic effect of mindfulness-

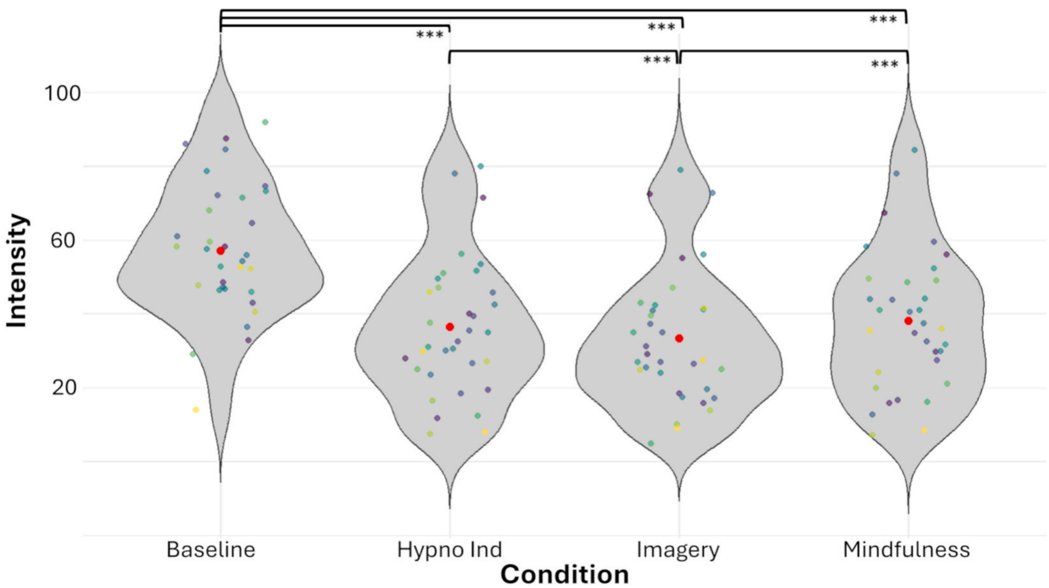

Fig. 3. Pain Reporting in Each condition. Each colored dot represents the average pain ratings of a subject across ten trials in each condition. The red dot represents mean INT for each condition. *** $p < 0.001$.

Table 2
Moderation effect of predisposition to mindfulness and to hypnotic susceptibility.

	Baseline > Hyp Induction	Baseline > Imagery	Baseline > Mindfulness	Hyp Induction > Imagery	Hyp Induction > Mindfulness	Mindfulness > Imagery
SHSS:A	**$p < 0.001$, $F = 14.37$**	**$p < 0.001$, $F = 14.21$**	**$p < 0.001$, $F = 48.81$**	$p = 0.837$, $F = 0.04$	**$p = 0.002$, $F = 9.52$**	**$p < 0.001$, $F = 12.57$**
Observe	$p = 0.441$, $F = 0.59$	$p = 0.912$, $F = 0.01$	$p = 0.825$, $F = 0.05$	$p = 0.232$, $F = 1.43$	$p = 0.477$, $F = 0.51$	$p = 0.666$, $F = 0.19$
Non-Reactivity	**$p < 0.001$, $F = 17.26$**	**$p < 0.001$, $F = 15.22$**	**$p < 0.001$, $F = 32.90$**	$p = 0.617$, $F = 0.25$	$p = 0.189$, $F = 1.73$	$p = 0.055$, $F = 3.70$
Description	**$p = 0.003$, $F = 9.04$**	$p = 0.012$, $F = 6.31$	**$p < 0.001$, $F = 19.66$**	$p = 0.443$, $F = 0.59$	$p = 0.196$, $F = 1.68$	$p = 0.03$, $F = 4.73$
Non-Judgment	**$p = 0.008$, $F = 6.99$**	$p = 0.246$, $F = 1.35$	$p = 0.022$, $F = 5.30$	$p = 0.041$, $F = 4.21$	$p = 0.514$, $F = 0.43$	$p = 0.178$, $F = 1.81$
Awareness	$p = 0.056$, $F = 3.66$	$p = 0.782$, $F = 0.08$	$p = 0.22$, $F = 1.51$	$p = 0.029$, $F = 4.80$	**$p < 0.001$, $F = 14.55$**	$p = 0.059$, $F = 3.59$

Results in bold are significant at p-uncorrected $< =0.008$ (p-corrected $< = 0.05$ Bonferroni corrected for 6 tests – each change score is tested with 6 moderators).

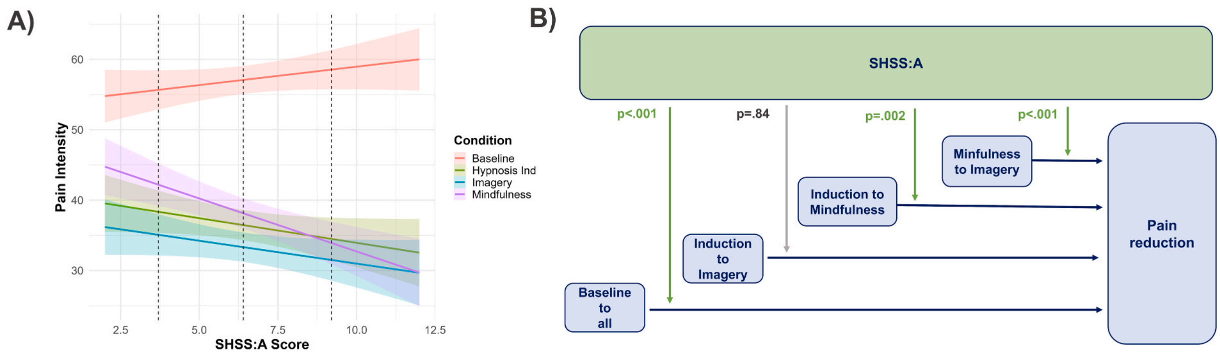

Fig. 4. Effect of Hypnotic Susceptibility (SHSS:A). A) Pain intensity (y axis) and SHSS:A score (x axis) for each condition (colors). Dashed lines: Mean report of pain Intensity in each condition at −1 sd (SHSS = 3,7), at a mean score (SHSS = 6.4) and at +1 sd (SHSS = 9.2). B) Significance of the moderation effect of SHSS:A score on the relationship between the change of condition and the amount of pain reduction.

like suggestions in individuals with higher Non-Reactivity scores.

The interaction between Description (FFMQ) and the change of condition (from Baseline) was statistically significant in predicting some INT outcomes ($p < 0.05$; Fig. 6). The Description score (FFMQ) positively moderated the analgesic effect from Baseline to Hyp Induction ($F = 9.04$, $p < 0.01$, $\Delta R^2 = 0.018$) and to Mindfulness ($F = 19.66$, $p < 0.001$, $\Delta R^2 = 0.012$). Once corrected for multiple comparisons, the moderation was not significant from Baseline to Imagery ($p = 0.012$) and from Mindfulness to Imagery ($p = 0.03$).

The simple moderation analysis showed that the interaction between Non-Judgment (FFMQ) and the change of condition (from Baseline) was statistically significant in predicting some INT outcomes ($p < 0.05$; Fig. 7). The Non-Judgment score (FFMQ) positively moderated the analgesic effect from Baseline to Hyp Induction for INT ($F = 6.99$, $p = 0.008$, $\Delta R^2 = 0.007$), but not for UNP ($p = 0.084$). The change from Baseline to Mindfulness (p = 0.022) and from Hyp Induction to Imagery ($p = 0.041$) were not significant when correcting for multiple comparisons.

The simple moderation analysis showed that the interaction between Awareness (FFMQ) and the change of condition (from Baseline) was statistically significant in predicting INT outcomes ($p < 0.01$; Fig. 8). As the Awareness score (FFMQ) increased, so did the analgesic effect, from Baseline to Imagery and Hyp Induction, while an inverse trend was observed for Mindfulness suggestions. The Awareness score (FFMQ) only negatively moderated the analgesic effect from Hyp Induction to Mindfulness ($F = 14.55$, $p < 0.001$, $\Delta R^2 = 0.01$; Table 2, Fig. 8).

4. Discussion

The present study arose out of the premise that intentions promoted by suggestions generally used in hypnosis and mindfulness practices differ from each other. While both experimental conditions primed analgesia, they did so by suggesting different attentional and experiential foci. Our hypothesis was that this difference would be reflected in the moderating effect of their predisposing traits on the analgesic effects of these suggestions during hypnosis. Overall, this study supports the efficacy of hypnoanalgesia, while adding nuances to the effectiveness of specific suggestions. We found a greater effect of imagery suggestions over mindfulness-like suggestions, as the latter did not exceed the analgesic effect of simple hypnotic induction. This may be explained by differential mechanisms needed to sustain the suggestion-specific analgesia for each. A novelty of this study was to explore the effect of dispositional traits on

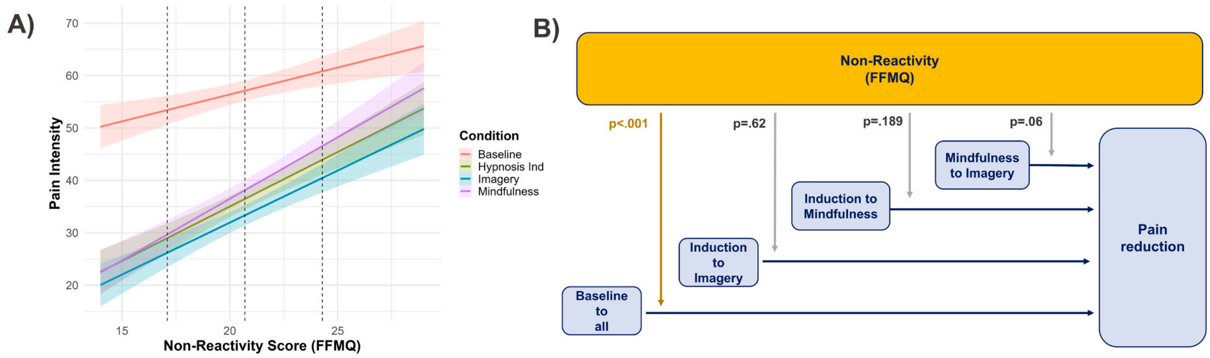

Fig. 5. Effect of Non-Reactivity (FFMQ). A) Pain intensity (y axis) and FFMQ Non-Reactivity score (x axis) for each condition (colors). Dashed lines: Mean report of Intensity in each condition at −1 *sd* (Non-Reactivity = 17.1), at a mean score (Non-Reactivity = 20.7) and at +1 *sd* (Non-Reactivity = 24.29). B) Significance of the moderation effect of Non-Reactivity score on the relationship between the change of condition and the amount of pain reduction.

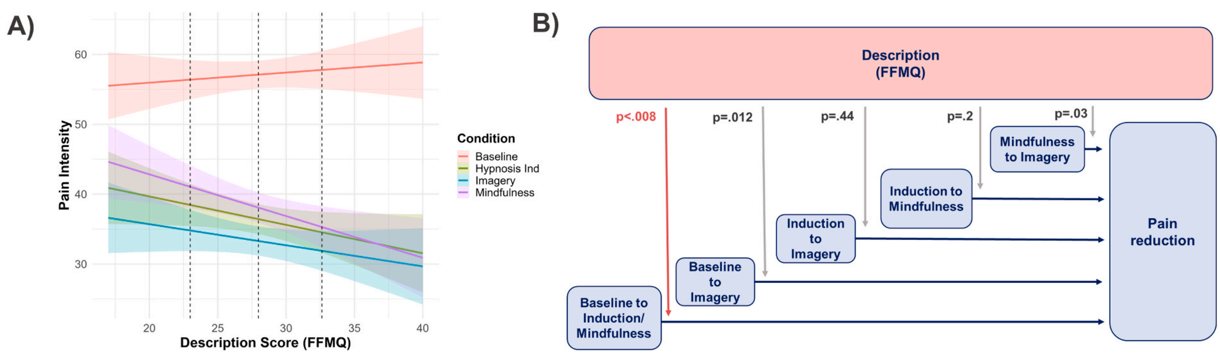

Fig. 6. Effect of Description (FFMQ). A) Pain intensity (y axis) and FFMQ Description score (x axis) for each condition (colors). Dashed lines: Mean report of Intensity in each condition at −1 sd (Description = 22.98), at a mean score (Description = 27.97) and at +1 sd (Description = 32.9). B) Significance of the moderation effect of Description score on the relationship between the change of condition and the amount of pain reduction.

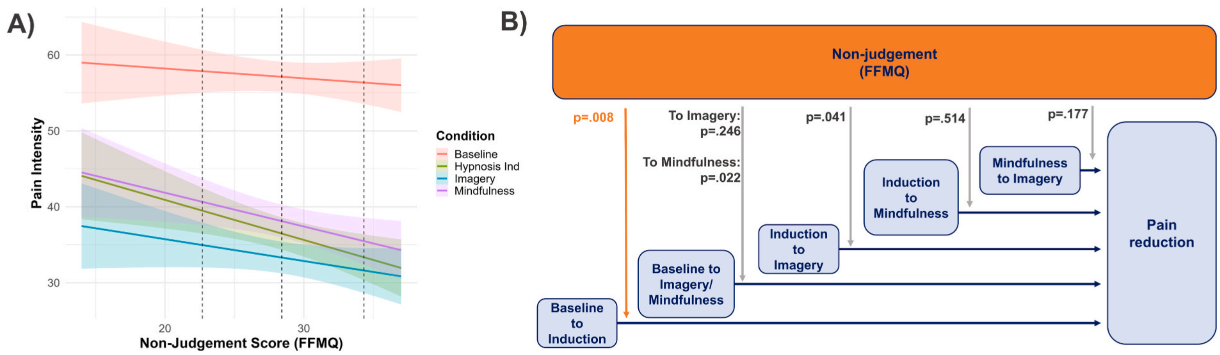

Fig. 7. Effect of Non-Judgment (FFMQ). A) Pain intensity (y axis) and FFMQ Non-Judgment score (x axis) for each condition (colors). Dashed lines: Mean report of Intensity in each condition at −1 *sd* (Non-Judgment = 22.69), at a mean score (Non-Judgment = 28.51) and at +1 *sd* (Non-Judgment = 34.32). B) Significance of the moderation effect of Non-Judgment score on the relationship between the change of condition and the amount of pain reduction.

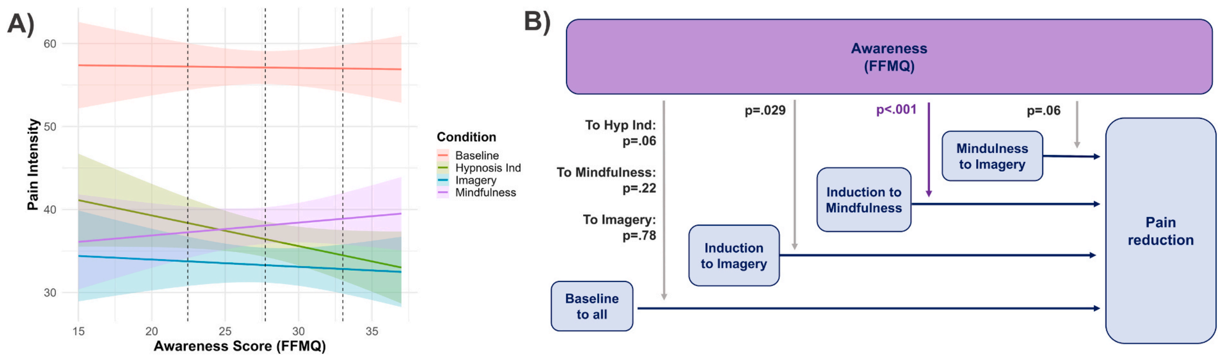

Fig. 8. Effect of Awareness (FFMQ). A) Pain intensity (y axis) and FFMQ Awareness score (x axis) for each condition (colors). Dashed lines: Mean report of Intensity in each condition at −1 sd (Awareness = 22.45), at a mean score (Awareness = 27.73) and at +1 sd (Awareness = 33.01). B) Significance of the moderation effect of Awareness score in the relationship between the change of condition and the amount of pain reduction.

these significant interactions (Table 2). In the present results, more susceptible (higher SHSS:A score) and more reactive people (i.e., low Non-Reactivity score on FFMQ) experienced less pain following a hypnotic induction. The negative relation trend between hypnotic susceptibility and non-reactivity (non significant) is coherent with past work, where hypnotic susceptibility scores and non-reactivity traits (FFMQ) were inversely correlated (Grover et al., 2018). Hypnotic susceptibility did not explain the supplementary effect of imagery suggestions over induction alone, although it did moderate the difference between imagery suggestions and mindfulness-like suggestions. Both higher SHSS:A and lower Awareness scores (FFMQ) moderated the somewhat superior effect of induction alone over mindfulness suggestions (even though the results for analgesia from both conditions did not significantly differ across the group). The lesser analgesic effects of mindfulness suggestions seem to be mainly related to the lower effect of mindfulness-like suggestions in individuals with lower SHSS:A scores (see Fig. 4) and the highest awareness scores (FFMQ; see Fig. 8). The Description score (FFMQ) predicted greater hypoalgesia following induction and mindfulness-like suggestions. The Non-Judgment score (FFMQ) moderated the effect of the hypnotic induction suggestions compared to Baseline. The Observe score (FFMQ) had no effect on any hypnotic conditions tested here.

The following will first go into more detail about the hypnoanalgesic effect found in the results. The specificity of suggestion and disposition in our results will be explored. Moreover, the superiority of imagery suggestions will be considered in relation to predictive coding theories of hypnosis (Zahedi et al., 2024) and language embodiment (Shapiro, 2019).

4.1. Mechanisms of hypnoanalgesic suggestions

The intervention had the desired effect, as participants reported significantly less pain under hypnosis conditions, compared to the Baseline condition. This intervention effect was moderated by SHSS:A score, a standard measure of hypnotic susceptibility generally associated with the effectiveness of a hypnotic intervention on pain (Thompson et al., 2019). Since one cannot avoid the order effect without risking the *carry-over* effects of hypnotic induction, the Baseline condition always preceded the hypnotic conditions. In this regard, the fact that hypnotic susceptibility leads to greater pain reduction in the hypnotic conditions compared to Baseline is evidence that the effect is related to hypnosis (Kekecs et al., 2024) or, at least, to verbal suggestions used following an induction labelled as hypnotic (Montgomery et al., 2022). In short, more susceptible individuals generally experience less pain following hypnotic induction and analgesic suggestions.

This raises the question of the mechanism at play. Even without direct suggestions for pain modulation, the suggestions of calmness and comfort could contribute to reducing pain in the hypnotic induction condition (De Pascalis et al., 1999). Even though the Hypnotic Induction condition did not explicitly suggest analgesia (while Imagery and Mindfulness suggestions did so), some suggestions described the hypnotic state as “comfortable” in this condition. Given that pain is inherently uncomfortable—as reflected by the strong correlation between subjective intensity and unpleasantness (Pearson-r = 0.89)—it is possible that susceptible participants interpreted the suggestions as analgesic in this condition. The induction effect alone is also explained by the participant’s ability to adopt a non-evaluative (or less critical) stance toward one’s experience (Non-Judgment score [FFMQ]). Mattes’s meta-analysis (2019) found that among the five facets of the FFMQ, Non-Judgment has the greatest association with the absence of undesirable outcomes. Such generalized protective effect may contribute to the benefits produced by Hypnotic Induction.

There was a supplementary effect from imagery suggestions, where direct analgesic suggestions anchored in imagery produced a significantly greater degree of analgesia than hypnotic induction suggestions and mindfulness suggestions. This is consistent with previous reports of the greater analgesic efficacy of direct suggestions (Thompson et al., 2019) and imagery suggestions (Bhatt et al., 2017; Braboszcz et al., 2017; De Pascalis et al., 1999, 2004; Zachariae and Bjerring, 1994). Widely used in research and clinical settings, suggestions for dissociative imagery (e.g., imagining being elsewhere, not feeling physical sensations as one’s own, etc.) are also particularly effective for pain modulation in experimental settings (De Pascalis et al., 1999, 2004). Zahedi and colleagues (2024) proposed that the act of imagination promoted in hypnosis effectively interferes with sensory input. They suggest that when individuals engage in vivid mental imagery, the brain’s predictive mechanisms prioritize these internal representations over external sensory information. This prioritization leads to a reduced impact of incoming sensory stimuli (i.e., pain) on the ongoing imaginative process, allowing the individual to maintain a consistent and immersive experience. In this regard, benefits from using hypnotic imagery suggestions may be explained by the very nature of the brain’s ability to generate and engage with internally sensorimotor experiences, as explored by the embodied cognition paradigm (Shapiro, 2019).

Being anchored in an embodied sensorimotor representation, imagery-based suggestions may be implemented through the use of verbal suggestions that contextualize ulterior pain stimuli and reduce the corresponding pain-related brain responses (Desmarteaux et al., 2021). This aligns with the idea that semantic content related to bodily experiences (e.g. verbal suggestions to imagine an alternative somatic experience) can influence the balance of intenal/external attentional focus, in favor of top-down processes to affect how physical stimuli are perceived (Markmann et al., 2023). Moreover, hypnosis is associated with a general feeling of absorption in the experience described in the suggestion (Penazzi & De Pisapia, 2022). If the focus of the suggestion is pleasant imagery, this is the experience that will be enhanced during hypnosis. Altogether, this idea is coherent with the main idea of a predictive brain theory (Friston, 2010, 2011) from which the concepts of language embodiment (Shapiro, 2019) may offer an integrative perspective: sensorimotor verbal suggestions are efficient during hypnosis, as the brain evolved to use language to anticipate and interpret ascending signals.

The lack of a supplementary effect from mindfulness-like suggestions over the simple induction of hypnosis may be attributable to the possibility that these suggestions enhance non-conceptual awareness of bottom-up first-order processes, such as sensory perception, bodily sensations, or emotional experiences before cognitive reappraisal (Vago and Silbersweig, 2012; Farb et al., 2013; Mukerji, Househam & Josipovic, 2015). While being delivered in hypnosis, mindfulness-like suggestions prompted attention and experience differently, by encouraging the individual to process the stimuli without reaction or judgment. In this regard, mindfulness suggestions could be conceived as “awareness suggestions.” These could have heightened attention to the ascending nociceptive signals, at the expense of the expectations set by the analgesic suggestions. While experienced meditators learn to change the way they relate to the pain they acknowledge (Grover et al., 2018; Baer et al., 2006), suggestions to observe the pain sensation could increase apprehension in non-experts or non-meditators (Baer, 2019). This could explain why there was a moderating trend in mindfulness suggestions, where more awareness and lower hypnotic susceptibility were associated with less analgesia to mindfulness-like suggestions. In the same vein, a previous reports observed an increase in pain following concentration suggestions in non-meditators (Grant & Rainville, 2009), while diverting attention may provide greater comfort compared to engaging in cognitive reappraisal in the normal population (Robinson et al., 2021).

The idea that a less mindful person (i.e., low Non-Reactivity score in FFMQ) benefits more from hypnosis may be somewhat counterintuitive. A possible explanation is that participants more predisposed to engage with their thoughts (to react) benefited more from the induction's analgesic effect. Accordingly, Grover et al. (2018) postulated that hypnotic responsiveness tends to involve a willingness to engage with and change an experience, whereas a high Non-Reactivity score in the FFMQ emphasizes accepting experience without altering it. Results support this notion that engagement in one's own thoughts might be a process that facilitates hypnoanalgesic effects.

This ability may relate to previous interpretations that hypnotic phenomena are derived from an absorptive capacity that helps hypnotized individuals focus on mental objects in a way that engages executive neurocognitive processes (Landry et al., 2017). On this account, the inverse of non-reactivity (i.e., the ability to mentally engage) may relate to a capacity to become absorbed in the suggested experience generally reported in hypnosis (Penazzi & De Pisapia, 2022). In that sense, this experiential absorption might partly mediate the relationship between suggestibility and the impulsivity/compulsivity domain, corresponding to the tendency to act without self-regulation (Acunzo et al., 2022), consistent with non-reactivity items of the FFMQ questionnaire. This dispositional characteristic may also pertain to the alteration of meta-awareness, inherent to hypnosis (Semmens-Wheeler & Dienes, 2012). This reactivity may reflect a predispositional characteristic that facilitates involvement in hypnotic intervention, without self-supervision and with greater engagement in imagery. This interpretation should be seen as speculative, as more experimental research is needed to assess the relation between those constructs.

Contrary to expectations, the supplementary imagery suggestion effect on pain (vs. Induction) could not be explained by hypnotic susceptibility. It is plausible that imagery suggestions operate through mechanisms at least partly distinct from those of hypnosis (Faymonville et al., 2003; Hargadon et al., 1995), while simultaneously enhancing its efficacy. This could pertain to the preceding idea that the integration of a verbal suggestion is a natural process in predictive and embodied cognition, which hypnosis taps into, without being fully dependent on hypnotic susceptibility (Zahedi et al., 2024; Montgomery et al., 2022).

Hypnotic susceptibility did, however, moderate the difference between mindfulness and imagery suggestions. Low-hypnotizable individuals may be less likely to internalize or engage with suggestions, including mindfulness-focused ones, as suggestibility plays a crucial role in both states (Penazzi and De Pisapia, 2022; Yapko, 2020). Hypnotic susceptibility may be even more important in a situation where suggestions do not offer an alternative sensorimotor context (beyond the induction effect), such as the one promoted in hypnotic imagery.

Less susceptible individuals were particularly less prone to the analgesic effect of the mindfulness condition (Fig. 4). This could be related to the idea that mindfulness suggestions encourage a form of detachment, such as observing thoughts while still being aware of the sensation. The need to disengage from the normal expectation of pain, while still observing it, would also call for cognitive flexibility (Gazik et al., 2024). Individuals with lower susceptibility tend to be less flexible (Enea & Dafinoiu, 2013; Crawford & Allen, 1983), which could make mindfulness suggestions more difficult to apply. Low-hypnotizable individuals may find it more challenging to disengage from their usual patterns of thought and behavior in order to respond to mindfulness analgesic suggestions.

In response to this challenge, it could be argued that, in mindfulness hypnotic suggestions, hypnoanalgesia may still be driven by verbal processing ability. Indeed, the FFMQ's Description score predicted the efficacy of mindfulness suggestions. This is consistent with prior literature suggesting that verbally labelling experiences can modulate brain responses to distressing stimuli (Hariri, Bookheimer, & Mazziotta, 2000; Lieberman et al., 2007). Thus, the ability to use verbal labels to categorize and alter the experience in a top-down fashion seems to be even more important to achieve the analgesic effect induced by mindfulness-like suggestions during hypnosis.

The effects of significant moderators were small and the present results should be considered a preliminary attempt to characterize the interaction between dispositional traits and types of suggestions, warranting further replication and refinement. Hypnotic susceptibility moderated all types of intervention except for the supplemental effect of imagery suggestions. The supplementary effect of imagery suggestions may not be due to verbal suggestibility. Propensity to engage with an experience may be associated with a higher capacity for experiential absorption, which, without *meta*-awareness fostered by a mindfulness practice (Semmens-Wheeler & Dienes, 2012), would mostly benefit from focusing on alternate imagery, rather than on the pain experience itself (Grant & Rainville, 2009). Suggestions to adopt a mindful approach during hypnosis may not provide additional benefits on acute pain regulation for all individuals, and could even potentially intensify attention to the distressing stimulus. Ultimately, if one must proceed with hypnotic mindfulness-like suggestions, the present results suggest that this may help those with higher hypnotic susceptibility as well as those with a greater predisposition for verbal labelling, but low awareness and non-reactivity (FFMQ). The main difference between imagery and mindfulness-like suggestions may reside in the fact that imagery helps create an alternative internal model to contextualize incoming sensory signals (nociception), while mindfulness-like suggestions encourage a suspension of interpretative and value-based processes in favor of a bottom-up transmission of ascending signals, reducing both facilitatory and inhibitory processes. According to this view, the benefits of mindfulness suggestions might essentially be to partly neutralize cognitive and affective processes that normally have pain-enhancing effects.

A number of limitations must be raised to inspire further improvements beyond this initial exploration. FFMQ factors have been associated with different tendencies among meditators and non-meditators (Baer, 2019). Further research may consider the degree of meditation expertise to better describe the relationship between individual disposition toward mindfulness and experiential induction through mindfulness suggestions. Moreover, the sample of this study is small, and a cautious interpretation is indicated. The use of a within-subject design comes with certain risks, as participants might have reported higher pain in the Baseline condition, thereby increasing the amplitude modulatory effects in the experimental conditions. Furthermore, the verbal suggestions used in the three experimental conditions may differ beyond the key concepts targeted, potentially introducing uncontrolled confounding factors. Finally, the study used the SHSS:A, which includes few cognitive-perceptual suggestions, and had few highly suggestible participants, which could make the results somewhat less sensitive to hypnoanalgesic and moderation effects (Woody et al., 2005). Negative results should therefore be interpreted with caution.

5. Conclusion

Aimed at understanding the differential and mutual effects of various interventions relying on verbal suggestion, this study provides further support for the notion that effective hypnoanalgesia varies based on the types of suggestions used and the relevant individual dispositions. Results confirm previous findings that participants generally benefit more from imagery suggestions than from hypnotic induction alone, even though this supplementary analgesic effect was not found to be moderated by hypnotic susceptibility. Hypnotic suggestions promoting mindfulness were effective in reducing pain, but it did not yield a greater degree of analgesia than suggestions for hypnotic induction. The induction effect alone can alleviate pain, which could have been facilitated by a non-judgmental stance. The superiority of imagery over mindfulness suggestions was moderated by the level of hypnotic susceptibility. The exploration of dispositional traits revealed that people who are more susceptible to hypnosis (higher SHSS:A score), more reactive (low Non-Reactivity score in FFMQ), and more able to describe their experience (high Description score in the FFMQ) tend to report less pain following hypnotic induction. Moreover, the novelty of the proposal that more reactivity (inverse of the Non-Reactivity facet of the FFMQ) may be a dispositional trait that facilitates engagement with hypnotic pain modulation merits further research. The attempt to reconcile this dispositional trait with the concept of absorption, even if conceptually plausible, has never been assessed. A predisposition for verbal labelling and a greater proneness to reduced self-agency and increased automaticity may also contribute to the potential benefits of hypnotic mindfulness suggestions.

These findings constitute advances consistent with the literature on hypnoanalgesia and offer new considerations on the integration of mindfulness-like hypnotic suggestions. This proposition contributes to the conversation about hypnosis and mindfulness being suggestion-based interventions (Yapko, 2020) which would benefit from being studied in the light of verbal processing (Montgomery & Kirsch, 2022) and embodied language cognition (Shapiro, 2019). We hope that further research will shed light on the potential relationships, differences and similarities of suggestion-centered interventions. Future work should also consider the impact of expertise as part of a more comprehensive model of factors contributing to the response to specific suggestions.

6. Other contributions

AF wrote the statistical analysis script (Bruce R) and DO provided feedback on the paper.

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8. Author statement

Given their role as authors and co-authors, Carolane Desmarteaux, Émilie Giguère, Mouni Amrane, Mathieu Piché, Arnaud Saj and Pierre Rainville had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to the journal editor.

The authors declare that they have no conflicts of interest related to this work.

The manuscript has not been published previously and is not under consideration elsewhere.

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Credit authorship contribution statement

Carolane Desmarteaux: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Émilie Giguère:** . **Mouni Amrane:** . **Mathieu Piché:** . **Arnaud Saj:** . **Pierre Rainville:** . Ali Filali and David Ogez collaborated to the paper. Mr Filali wrote the statistical analysis script (Bruce R) and David Ogez provided feedback on the paper, as credited.

Acknowledgements

CD, EG and PR conceived the study. CD planned the experiment, performed the hypnotic induction, and assessed the suggestibility of each subject individually. EG acquired data, helped by MP. CD, EG, MA and PR analyzed the data. EG updated the literature review and wrote part of the introduction, while MA wrote part of the method. CD, EG, PR and AS contributed to the interpretation of the results. CD wrote the final version of the paper. All authors provided feedback on the final version of the manuscript. AF wrote the statistical analysis script (Bruce R) and DO provided feedback on the paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2026.103993.

Data availability

Data can be found at: https://osf.io/82jfd/

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