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MEDIATION AND MODERATION OF HYPNOTIC AND COGNITIVE-BEHAVIOURAL PAIN REDUCTION

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Abstract

The mediator function of response expectancies and the moderator function of *hypnotic* and *non-hypnotic imaginative* suggestibility were evaluated in the analogue treatment of pain. One hundred and sixty-seven participants previously assessed for hypnotic and imaginative suggestibility were randomly assigned to distraction, cognitive-behavioural package (i.e., Stress Inoculation Training), hypnotic cognitive-behavioural package, hypnotic analgesia suggestion, placebo control, or no-treatment control conditions. The four 'active' treatments reduced pain more than the no-treatment control condition. There was no statistical difference in effectiveness between these four treatments, but only the cognitive-behavioural package reduced pain more than the placebo control condition. Response expectancies partially mediated the effects of treatment on pain. Imaginative suggestibility, defined as a generalized tendency to respond to imaginative suggestions delivered outside of hypnosis, moderated the effects of the cognitive-behavioural package. Contrary to prediction, neither hypnotic suggestibility, nor *hypnotizability* (operationalized as hypnotic suggestibility with imaginative suggestibility statistically controlled) moderated the effects of the hypnotic treatments.

Key words: pain, analogue treatment, hypnosis, cognitive-behavioural interventions, mediation, moderation

Mediation and moderation of hypnotic and cognitive-behavioural pain reduction

What prospects for relief can psychology offer to people who suffer from pain owing to disease, injury, or invasive medical procedures? A wide range of psychological interventions is commonly used to help those experiencing acute, recurrent, or chronic pain including simple distraction, more complex cognitive-behavioural procedures, and hypnosis. Simple distraction techniques, such as controlled breathing, do not require much training on the part of the patient. More complex cognitive-behavioural interventions are designed to divert attention from pain using such methods as relaxation and imagery, or to alter appraisals of pain employing skills like coping self-statements. Sometimes, individual cognitive-behavioural procedures are combined into sophisticated multi-component treatment packages such as Stress Inoculation Training (see Turk, Meichenbaum and Genest, 1983). Classically, hypnotic pain treatment involves direct suggestions for symptom reduction in which it is suggested that the affected body part is

numb and lacks feeling (see Chaves, 1993, and Hilgard and Hilgard, 1994). In contrast, some contemporary clinical hypnotists de-emphasize the role of direct suggestions and are more likely to provide established cognitive-behavioural procedures in a hypnotic context (see Kirsch, Montgomery and Sapirstein, 1995).

What does empirical research say about the efficacy of these interventions? Both simple distraction and more complex cognitive-behavioural procedures have been shown to be helpful in relieving clinical and experimental pain (see Milling, Kirsch, Meunier and Levine, 2002b for a review). Similarly, there is considerable evidence that hypnosis can be useful in reducing pain encountered in the laboratory and in clinical settings (see Montgomery, DuHamel and Redd, 2000 for a meta-analysis). Although there has been some research evaluating the effects of hypnotic and non-hypnotic analgesia suggestions (e.g. Spanos, Perlini and Robertson, 1989), there have been very few studies comparing hypnotic and cognitive-behavioural interventions for pain and none of these investigations have been placebo controlled (reviewed in Milling et al., 2002b). This is the first placebo-controlled pain treatment study comparing analogue versions of hypnotic and cognitive-behavioural pain interventions.

Mediator function of response expectancies

Response expectancies are defined as the expectation of one's own automatic, non-volitional reactions to situational cues (Kirsch, 1990). Response expectancies have been found to play a key role in a range of behavioural phenomena (see Kirsch, 1999), including response to psychotherapy (reviewed in Weinberger and Eig, 1999). In what has become a classic paper on the nature of mediator and moderator variables, Baron and Kenny (1986) describe a mediator as 'a generative mechanism through which the focal independent variable is able to influence the dependent variable of interest' (p. 1173). Response expectancies have been characterized as a generative mechanism through which various forms of treatment produce behaviour change (Kirsch, 1990). In pain treatment, response expectancies may generate relief by creating a cognitive set in which a person anticipates analgesia.

However, very few pain studies have performed the necessary regression analyses to determine whether expectancy actually mediates the effect of pain treatments (see Baron and Kenny, 1986). Specifically, Baker and Kirsch (1993) reported that expected pain reduction fully mediated the effects of hypnotic and placebo analgesia, whereas several other studies showed that the pain reducing effects of hypnosis and cognitive-behavioural interventions were partially mediated by expectancy (Milling et al., 2002b; Milling, Levine and Meunier in press; Montgomery, Weltz, Seltz and Bovbjerg, 2002). In view of the small size of this literature, a main purpose of this study was to evaluate the mediator function of response expectancies in hypnotic and cognitive-behavioural pain treatments.

Moderator function of suggestibility and hypnotizability

Baron and Kenny (1986) assert that a moderator 'partitions a focal independent variable into subgroups that establish its domains of maximal effectiveness in regard to a given dependent variable' (p. 1173). There is considerable evidence that hypnotic suggestibility, defined as a generalized tendency to respond to hypnotic suggestions, moderates the effect of hypnotic pain treatments (see Montgomery et al., 2000). In contrast, there has been little research on the moderator function of non-hypnotic

imaginative suggestibility, defined as the tendency to respond to imaginative suggestions delivered outside of hypnosis (see Braffman and and Kirsch, 1999 for a review). A third and related concept of interest is hypnotizability, which can be conceptualized as the change in suggestibility due to hypnosis (Weitzenhoffer, 1980).

Recently, Kirsch and Braffman (1999) proposed that hypnotizability can be operationalized as hypnotic suggestibility with imaginative suggestibility statistically controlled, and measured by administering hypnotic and non-hypnotic versions of the same suggestibility scale. These investigators reported that hypnotizability was associated with expectancy and motivation (Braffman and Kirsch, 1999), as well as reaction time (Braffman and Kirsch, 2001). Assessed in this manner, only one other study has examined the role of hypnotizability in predicting hypnotic behaviour. Milling, Kirsch, Allen and Reutenauer (2002a) failed to show an association between suggestibility or hypnotizability and the relief produced by hypnotic and non-hypnotic analgesia suggestions. A main purpose of the current study was to test the moderator function of hypnotic suggestibility, imaginative suggestibility and hypnotizability for hypnotic and cognitive-behavioural pain treatments. This is one of the first studies to assess whether imaginative suggestibility and hypnotizability moderate psychological pain reduction.

The current study

To assess the efficacy of hypnotic and cognitive-behavioural pain interventions, we compared analogue versions of two common cognitive-behavioural treatments (i.e., distraction and a multi-component cognitive-behavioural package) and two common hypnotic interventions (i.e., direct hypnotic suggestions for pain reduction and a multi-component cognitive-behavioural package delivered in a hypnotic context) against placebo and no-treatment control conditions in reducing finger pressure pain. To evaluate the mediator function of response expectancies in these interventions, participants rated the relief they expected to obtain from treatment, and mediation was tested in regression analysis using the analytic approach recommended by Baron and Kenny (1986). Finally, to examine the moderator function of hypnotic suggestibility, imaginative suggestibility, and hypnotizability (i.e., hypnotic suggestibility with imaginative suggestibility controlled) in hypnotic and cognitive-behavioural pain treatment, we measured imaginative and hypnotic suggestibility and tested their interaction with treatment condition in regression according to the Baron and Kenny (1986) analytic strategy. We predicted that hypnotic suggestibility and hypnotizability would moderate the effect of the two hypnotic pain interventions, whereas imaginative suggestibility would moderate response to a cognitive-behavioural intervention with a strong imaginative component (i.e., the multi-component cognitive-behavioural package).

Method

Participants

Sixty-two males and 105 females participated in the main study to earn credits satisfying a course requirement. These individuals were recruited from a group of approximately 1100 introductory psychology students previously screened for hypnotic and non-hypnotic imaginative suggestibility using a modified version of the Carleton University Responsiveness to Suggestion Scale (CURSS; Spanos, Radtke, Hodgins, Stam and Bertrand, 1983a) administered in the guise of a separate experiment.

The CURSS consists of a hypnotic induction and seven test suggestions. Participants complete a booklet in which they indicate whether they made the response called for by each suggestion (0 = no and 1 = yes). Objective suggestibility is measured as the sum of scores on the seven suggestions. A test-retest reliability coefficient of 0.67 has been reported for CURSS objective scores (Spanos, Radtke, Hodgins, Bertrand, Stam and Dubreuil, 1983b). The validity of the CURSS is suggested by correlations with other measures of suggestibility (Spanos, Radtke, Hodgins, Bertrand, Stam and Moretti, 1983c).

In this study, the CURSS was modified in two ways. First, instructions for goal-directed fantasies were replaced by repetition of suggestions (Comey and Kirsch, 1999). This produces a more normal distribution of response scores. Second, the seven test suggestions were administered twice using a procedure developed by Braffman and Kirsch (1999). In the first administration, a hypnotic induction was not employed. Instead, participants were asked to use their imagination to experience the seven test suggestions. Afterwards, participants completed a response booklet, thereby producing an index of non-hypnotic imaginative suggestibility (Braffman and Kirsch, 1999). During the second administration, the standard CURSS procedure was followed. After listening to the usual hypnotic induction, participants responded to the seven test suggestions and then completed another response booklet. This produces a measure of hypnotic suggestibility. According to Braffman and Kirsch (1999), the non-hypnotic version must always be administered before the hypnotic version to prevent diminished non-hypnotic responding resulting from a 'hold-back effect' (Zamansky, Scharf and Brightbill, 1964).

Apparatus

Finger pressure pain was administered using a Forgione-Barber Strain Gauge Pain Stimulator (Forgione and Barber, 1971). This device consists of a doughnut-shaped weight (900g) attached to a bar (231g) that pivots from a support stand at the far end. The participant's index finger is placed on top of a 5.1 cm stand in the middle of the stimulator. The other fingers rest on a platform between the finger stand and the support stand. The moveable bar is about 2 mm wide where it contacts the finger. The bar is gently lowered onto the finger, producing 2041 g of force at the contact point.

Instruments

Pain intensity rating

Pain intensity was measured on an 11-point scale anchored at 'pain as intense as one can imagine' (10) and 'no pain at all' (0). A placard mounted on the wall in front of participants displayed an 18 cm line with the verbal anchors and 11 numbers. After placing their finger in the stimulator, participants heard an audiotape prompting them to report an integer reflecting pain intensity every 20 seconds for one minute. The total of these three reports yielded an index of overall intensity ranging from 0 to 30. Baseline intensity ratings were made before treatment. Post-intensity ratings were obtained while participants were helped to utilize the pain control techniques they had learned as part of treatment. Cronbach's alpha was 0.93 for the three baseline intensity ratings and for the three post-intensity ratings.

Pain expectancy rating

Expected pain was measured using the same 11-point scale employed in the pain intensity ratings. Participants made a single numerical rating ranging from 0 to 10. The

baseline expectancy rating was obtained immediately after the baseline intensity rating and indicated what participants thought the pain would be like if they were to place their finger in the stimulator again for one minute without pain control techniques. The post-expectancy rating was obtained immediately after training in a pain control technique (but without placing a finger in the stimulator) and indicated what participants believed the pain would be like while using the techniques they had just experienced. Baseline and post-expectancy ratings made by participants in the no-treatment control condition reflected expected pain without pain reduction techniques.

Analogue treatments

The analogue treatments were delivered in two phases. During the preparation phase, participants heard an audiotape presenting information about pain control and providing an opportunity to experience a pain control technique without placing a finger in the stimulator. Next, participants made an expectancy rating reflecting what they thought the pain would be like if they were to use the pain control technique just experienced while placing their finger in the stimulator. Finally, during the intervention phase, experimenters worked live from a script in a treatment manual to administer the pain control technique to participants while they placed their finger in the stimulator and made post-intensity ratings. The analogue treatments were directly adapted from published materials describing each procedure and structured to be as ecologically valid as possible based on the senior author's experience in providing pain management in a variety of clinical settings (e.g. burn unit, bone marrow transplant unit). The experimenters consisted of five advanced undergraduate students who were trained and monitored by the senior author.

Distraction condition (D)

This treatment was adapted from an external distraction intervention developed by Spanos, McNeil, Gwynn and Stam (1984) in which subjects 'shadowed' monosyllabic words to divert their attention from a pain stimulus. During the preparation phase, the 11 male and 17 female participants in this condition listened to an audiotape providing instruction and practice in distraction. The tape began by presenting information on how distraction to external stimuli can be used to reduce painful sensations. Participants were then trained in an external distraction technique where they practised shadowing words presented on an audiotape. One-syllable words were presented at the rate of 74 words per minute and the participant had approximately one half second to repeat back each word. During practice, a total of 74 words were shadowed. Then, post-expectancy ratings were made.

Thereafter, during the intervention phase, participants were told to again shadow words presented on tape. Participants shadowed words for about two minutes (148 words). At this point, participants were helped to place their finger in the stimulator and then immediately resumed word shadowing while making post-pain ratings. The word shadowing was continued throughout the time the participant's finger was in the stimulator. After the third pain rating, the participant's finger was removed from the stimulator and the word shadowing ended.

Cognitive-behavioural package condition (CB)

This treatment was adapted from a version of Stress Inoculation Training developed for pain (SIT; Turk et al., 1983). SIT is a multi-component, cognitive-behavioural package whose core elements include educational information, progressive muscle relaxation,

attention diversion through imagery, and coping self-statements. This treatment was taken almost in its entirety verbatim from Turk et al. (1983). During the preparation phase, the 10 male and 18 female participants in this condition listened to an audiotape providing instruction and practice in SIT. First, the tape described the Melzack and Wall gate-control theory of pain. Then, information about progressive muscle relaxation was presented, followed by an opportunity to practise Jacobsonian muscle relaxation using instructions adapted from Goldfried and Davison (1976) in which participants were instructed to tense and relax all of the muscle groups in their body, one group at a time. Next, the tape described attention diversion through guided imagery. This was followed by an opportunity to practise imagery in which participants imagined themselves at a lake on a summer day. Finally, participants were trained in the use of coping self-statements (for example, 'I'll control the pain using the techniques I have learned'). When the tape ended, participants were told to sit with their eyes closed and to remain relaxed. Thereafter, post-expectancy ratings were made.

Then, during the intervention phase, participants were told to become even more relaxed and to generate a coping self-statement that could be used during the post-pain assessment. Next, working live from the treatment manual, the experimenter administered the same muscle relaxation and imagery instructions practised during training. After experiencing the relaxation and while engaged in the imagery, the participant's left index finger was guided into the stimulator and post-intensity ratings were obtained. The imagery instructions were continued throughout the time the participant's finger was in the stimulator. After intensity ratings were made, the participant's finger was removed from the stimulator and the imagery was concluded.

Hypnotic cognitive-behavioural package condition (HCB)

This treatment paralleled the cognitive-behavioural package treatment. However, each of the specific techniques was framed as hypnotic in nature. During the preparation phase, the 10 male and 17 female participants in this condition listened to an audiotape presenting information from Kirsch, Lynn and Rhue (1993) designed to correct misconceptions about hypnosis. This was followed by the hypnotic induction from the CURSS (Spanos et al., 1983a). After entering hypnosis, participants heard information about the Melzack and Wall gate-control theory, progressive muscle relaxation, imagery, and coping self-statements. These techniques were described as hypnotic relaxation, hypnotic imagery, and hypnotic self-suggestions (for example, 'The pain is there...but it becomes less and less noticeable as my concentration is directed more and more to something else'). After the tape described each pain control technique, it provided an opportunity to practise that technique. When the tape ended, participants were instructed to keep their eyes closed and to remain in hypnosis. Then, post-expectancy ratings were made.

Thereafter, during the intervention phase, participants were told to go deeper into hypnosis and to generate a coping self-suggestion. Then, working from the treatment manual, the experimenter delivered instructions for hypnotic relaxation and imagery. While engaged in the imagery, participants placed their left index finger in the stimulator and provided post-intensity ratings. The experimenter continued the imagery throughout the time the participant's finger was in the stimulator. Thereafter, the finger was removed from the stimulator, the imagery was ended, and the participant was brought out of hypnosis.

Hypnotic analgesia suggestion condition (HA)

During the preparation phase, the 10 male and 18 female participants in this condition listened to an audiotape providing instruction and practice in hypnotic analgesia. First,

the tape presented the information from Kirsch et al. (1993) designed to correct misconceptions about hypnosis. Next, participants heard the hypnotic induction from the CURSS, followed by educational information about hypnotic analgesia. Then, participants experienced a 45-second glove analgesia suggestion adapted from Spanos et al. (1989). The tape concluded with cancellation of the glove analgesia suggestion, but participants were told to sit with their eyes closed and to remain in hypnosis. Finally, a pain-expectancy rating was made.

Subsequently, during the intervention phase, an experimenter working from the treatment manual made suggestions for the participant to go deeper into hypnosis and then administered the glove analgesia suggestion. After that, the participant's finger was guided into the stimulator and intensity ratings were provided. The glove analgesia suggestion was continued throughout the time the participant's finger was in the stimulator. After making the ratings, the participant's finger was removed from the stimulator, the analgesia suggestion was cancelled, and the participant was brought out of hypnosis.

Placebo control condition

An inert solution described as an experimental, local, topical analgesic served as the basis of this condition. The solution consisted of a mixture of povo-iodine and oil of thyme that produced a brown liquid with a medicinal smell. The solution was contained in a medicinal bottle labelled, 'Trivaricaine: approved for research purposes only'. This solution has been shown in several investigations to be a credible topical analgesic placebo capable of reducing experimental pain (for example, Montgomery and Kirsch, 1996).

During the preparation phase, the experimenter presented basic information about the nature of medical analgesics to the 10 male and 18 female participants in this condition. Thereafter, the placebo solution was applied to the top of the middle digit of the participant's index finger (i.e., the area where the bar of the stimulator contacts the finger) with a cotton swab. The solution was allowed to 'work' for 30 seconds and then post-expectancy ratings were obtained. Thereafter, during the intervention phase, participants placed their finger in the stimulator and the bar was lowered on the middle digit, now covered with Trivaricaine, and intensity ratings were obtained. After the third intensity rating, participants withdrew their finger and the solution was removed with alcohol.

Procedure

Individuals who previously had been screened for hypnotic and imaginative suggestibility using the modified CURSS were contacted by telephone and invited to participate in a study comparing the effectiveness of an experimental topical analgesic against several different psychological pain control techniques. No selection criteria were used in recruiting participants for the main study. Participants were randomly assigned to one of the six experimental conditions in blocks so that each condition had equal proportions of males and females. Experimenters were blind to participants' suggestibility scores. Participants were run through the procedure individually.

To prevent a hold-back effect in which participants might hold back their responses (i.e., exaggerate the pain) during the baseline assessment to 'leave room' for improvement on the post assessment due to the effects of hypnosis (Zamansky et al., 1964), individuals assigned to the HCB and HA conditions were not informed that the study involved hypnosis until after the baseline assessment. To prevent participants assigned to the CB, D, placebo control and no-treatment control conditions from

mistakenly concluding they were somehow being hypnotized, no mention was made of hypnosis until the debriefing.

To further reduce the possibility that participants might infer the experiment involved hypnosis unless and until they actually received a hypnotic treatment, the modified CURSS was administered in the guise of an unrelated investigation by a separate group of experimenters using a different location on campus. Also, all cues associated with hypnosis (for example, journals, books) were removed from the treatment room. Finally, in the CB condition, the relaxation and imagery instructions were delivered without the unique cadence and tone of hypnosis. Consequently, participants in this condition had no more reason to believe they were being hypnotized than would a person taking part in any study involving relaxation and imagery.

There were some differences in the duration of the analogue treatments due to the natural length of the specific techniques. For example, the glove analgesia suggestion used in the hypnotic analgesia condition is relatively brief, whereas the progressive muscle relaxation technique employed in the cognitive-behavioural and hypnotic cognitive-behavioural conditions is quite lengthy. To equalize the amount of time spent in the experiment, participants assigned to certain conditions read magazines or completed a filler questionnaire during a waiting period between the end of the baseline assessment and beginning of the preparation phase of treatment. As a result, individuals in all conditions spent 90 minutes participating in the study.

The 11 male and 17 female participants in the no-treatment control condition waited 60 minutes after making baseline intensity and expectancy ratings. After that, these individuals provided a second (i.e., post-) expectancy rating reflecting what they expected the pain would be like if they placed their finger in the stimulator without pain reduction techniques. Then, control participants placed their finger in the stimulator for one minute and made post-intensity ratings.

Results

Preliminary analyses

On the CURSS, mean objective suggestibility scores were 1.93 (SD = 1.61; range = 0–7) on the hypnotic version and 2.05 (SD = 1.50; range = 0–6) on the non-hypnotic version. On the hypnotic version of the CURSS, a one-way analysis of variance (ANOVA) on objective scores failed to show a significant main effect for condition, thereby indicating that the treatment groups did not differ on hypnotic suggestibility. Likewise, on the non-hypnotic version of the CURSS, a one-way analysis of variance (ANOVA) on objective scores failed to show a significant main effect for condition, thus suggesting the treatment groups did not differ on imaginative suggestibility. Hypnotic and imaginative suggestibility scores were significantly correlated ($r = 0.59$, $p < 0.001$).

Means and standard deviations for baseline and post measures of pain intensity and expectancy are shown in Table 1. As would be expected, one-way analysis of variance (ANOVA) on baseline ratings failed to show a significant main effect for condition on either pain intensity or expectancy ratings. Differences among the five experimenters were evaluated using a 5 x 6 (experimenter x condition) analysis of covariance (ANCOVA) on post ratings of pain intensity and expectancy, with the corresponding baseline scores as the covariate. This analysis failed to show a significant main effect for experimenter or interaction between experimenter and treatment condition for either pain intensity or expectancy.

Table 1. Means and standard deviations (in parenthesis) for baseline and post-pain intensity and expectancy ratings by condition

	Pain intensity		Pain expectancy	
	Baseline	Post	Baseline	Post
Condition	Mean SD	Mean SD	Mean SD	Mean SD
Hypnotic cognitive-behavioural[a]	10.44(6.40)	8.44(6.20)	3.89(2.12)	2.89(2.04)
Cognitive-behavioural[b]	11.36(3.43)	7.79(3.51)	4.43(1.79)	2.89(1.29)
Hypnotic analgesia suggestion[b]	13.25(5.92)	10.36(5.07)	4.82(2.20)	3.71(1.65)
Distraction[b]	13.50(5.76)	10.86(5.27)	5.21(2.11)	3.46(1.84)
Placebo control[b]	14.07(6.30)	13.61(7.00)	5.29(2.40)	3.79(2.22)
No-treatment control[b]	12.21(4.25)	12.89(4.54)	4.75(1.48)	4.46(1.40)

[a]n = 0 27, [b]n = 0 28

Pain expectancy

A one-way analysis of covariance (ANCOVA) on post-expectancy ratings, with baseline expectancy ratings as the covariate, produced a significant main effect for treatment condition, F (6160) = 5.13, $p < 0.001$, eta^2 = 0.16. A Least Significant Difference test (LSD) on estimated marginal means with a Bonferroni adjustment ($p < 0.05$) for the number of statistical comparisons revealed that participants in the no-treatment control condition expected more pain (adjusted mean = 4.46) than those in the CB (adjusted mean = 3.10), HCB (adjusted mean = 3.47), D (adjusted mean = 3.14), and placebo control (adjusted mean = 3.41) conditions. There was no significant difference between pain expected by participants in the no-treatment control condition and those in the HA condition (adjusted mean = 3.66). All of the other pairwise comparisons were non-significant.

Pain intensity

A one-way analysis of covariance (ANCOVA) on post-intensity ratings, with baseline intensity ratings as the covariate, yielded a significant main effect for treatment condition, F (6160) = 5.98, $p < 0.001$, eta^2 = 0.18. A Least Significant Difference test (LSD) on estimated marginal means with a Bonferroni adjustment ($p < 0.05$) for the number of statistical comparisons revealed that participants in the no-treatment control condition reported more intense pain (adjusted mean = 13.10) than those in the CB (adjusted mean = 8.64), HCB (adjusted mean = 9.99), HA (adjusted mean = 9.78), and D (adjusted mean = 10.09) conditions. Also, participants in the placebo control condition (adjusted mean = 12.41) reported more intense pain than those in the CB condition. All of the other pairwise comparisons were non-significant.

Expectancy as a mediator of pain reduction

Change in expected pain was hypothesized as a mediator of the effect of treatment on pain intensity. According to Baron and Kenny (1986), 'to test for mediation, one should estimate the three following regression equations: first, regressing the mediator on the independent variable; second, regressing the dependent variable on the independent

variable; and third, regressing the dependent variable on both the independent variable and the mediator' (p. 1177).

Table 2 presents the results of these three hierarchical regressions. In the first regression, post-expectancy was regressed on baseline expectancy and treatment condition. After baseline expectancy was controlled, condition significantly predicted post-expectancy. This indicates that treatment was associated with changes in expectancy, thereby demonstrating a linkage between the independent variable and the hypothesized mediator.

Table 2. Hierarchical regressions testing mediation of effects of treatment condition on pain intensity by pain expectancy

Criterion predictor	F	p <	Eta^2
Post-expectancy			
Baseline expectancy	2012.57	0.001	0.93
Treatment condition	5.13	0.001	0.16
Post-intensity			
Baseline intensity	1847.30	0.001	0.92
Treatment condition	5.98	0.001	0.18
Post-intensity			
Baseline intensity	2016.26	0.001	0.93
Baseline expectancy	7.15	0.008	0.04
Post-expectancy	24.61	0.001	0.14
Treatment condition	4.00	0.001	0.13

In the second regression, post-intensity was regressed on baseline intensity and treatment condition. Condition predicted post-intensity with baseline intensity controlled. This indicates that treatment was associated with changes in pain intensity, thereby signifying a linkage between the independent variable and the dependent variable.

In the third regression, baseline intensity, baseline expectancy, post-expectancy, and treatment condition were regressed on post-intensity. After controlling for baseline intensity and baseline expectancy, post-expectancy and treatment condition both predicted post-intensity. This indicates that changes in pain intensity were associated with changes in expected pain and treatment. Expected pain reduction was directly related to reduction of pain intensity (*Beta* = 0.35, $p < 0.001$). The effect of treatment on intensity was less when entered together with expectancy in the third regression ($eta^2 = 0.13$) than when entered without expectancy in the second regression ($eta^2 = 0.18$). Together, these findings indicate that the effect of treatment condition on pain intensity was partially mediated by changes in expected pain.

Suggestibility and hypnotizability as moderators of pain reduction

According to Baron and Kenny (1986), 'a basic moderator effect can be represented as an interaction between a focal independent variable and a factor that specifies the appropriate conditions for its operation' (p. 1174). In this study, the focal independent variable was treatment condition and the potential moderating variables were imaginative

suggestibility, hypnotic suggestibility and hypnotizability. Consequently, we performed hierarchical regression analyses and tested the interaction of suggestibility and hypnotizability with treatment condition in predicting pain reduction.

Conceptually, one would expect the response to a non-hypnotic intervention with a substantial imaginative component (i.e., CB) would be associated with imaginative suggestibility, defined as the general tendency to respond to non-hypnotic, imaginative suggestions and measured in this investigation as scores on the CURSS administered without a hypnotic induction. Furthermore, one would anticipate that the response to hypnotic interventions for pain (i.e., HA and HCB) would be related to hypnotic suggestibility, defined as the general tendency to respond to hypnotic suggestions and measured in this investigation as scores on the CURSS administered with a hypnotic induction, as well as to hypnotizability, defined as the change in suggestibility resulting from the addition of hypnosis and measured herein as hypnotic suggestibility with imaginative suggestibility statistically controlled. Finally, one might predict that a non-hypnotic intervention lacking an imaginative component (i.e., D and placebo control) would be unrelated to either hypnotic or imaginative suggestibility.

Table 3 presents the results of a hierarchical regression of post-pain intensity on baseline intensity, imaginative suggestibility, hypnotic suggestibility, treatment condition, and all possible two-way and three-way interactions of condition, imaginative suggestibility, and hypnotic suggestibility. The regression showed that after the effects of baseline intensity had been controlled, post-intensity was predicted by treatment condition and the three-way interaction of condition, imaginative suggestibility, and hypnotic suggestibility. This indicates that pain reduction was predicted by treatment condition, but not by imaginative suggestibility, hypnotizability, or by a two-way interaction of any of these variables. However, the significant three-way interaction suggests that the pain reducing effects of some treatments were moderated by a combination of imaginative and hypnotic suggestibility.

By entering hypnotic suggestibility into the regression after imaginative suggestibility, the statistical effect of hypnotic suggestibility indicates the influence of hypnotizability. To measure the influence of hypnotic suggestibility, this regression was repeated without imaginative suggestibility included as a main effect or interaction term. Here, only treatment condition predicted pain reduction. This suggests that removing the variability associated with imaginative suggestibility from post-intensity in the original

Table 3. Hierarchical regression of post-intensity on baseline intensity, imaginative suggestibility, hypnotic suggestibility, and treatment condition

Predictor	F	p <	Eta^2
Baseline intensity	1935.40	0.001	0.93
Imaginative suggestibility (IS)	0.10	0.75	0.01
Hypnotic suggestibility (HS)	1.84	0.18	0.01
Treatment condition (TC)	6.16	0.001	0.21
TC x IS	1.45	0.21	0.05
TC x HS	0.49	0.79	0.02
IS x HS	1.56	0.21	0.01
TC x IS x HS	2.61	0.03	0.08

regression equation did not account for the failure of hypnotic suggestibility to predict pain reduction as a main effect or in the interaction with treatment condition.

To further evaluate the significant interaction of treatment condition with suggestibility, a series of hierarchical regressions were performed separately for each of the analogue treatments in which post-pain intensity was regressed on baseline intensity, imaginative suggestibility, and hypnotic suggestibility. Consistent with hypothesis, in the D and placebo control conditions, post-pain intensity was predicted by baseline intensity, but not by imaginative suggestibility or hypnotic suggestibility. Contrary to hypothesis, in the HCB and HA conditions, after the effects of baseline pain had been controlled, neither hypnotic suggestibility nor hypnotizability predicted post-intensity (nor did imaginative suggestibility predict post-intensity in these analyses).

Table 4 presents the results of the hierarchical regression of post-intensity on baseline intensity, imaginative suggestibility, and hypnotic suggestibility for the CB condition. The regression showed that after baseline intensity had been controlled, post-intensity was predicted only by imaginative suggestibility. Consistent with hypothesis, this finding indicates that more pain reduction was associated with higher imaginative suggestibility (Beta = -0.41, $p < 0.03$) and suggests that the effects of the CB condition were moderated by imaginative suggestibility. When the regression was repeated without imaginative suggestibility, hypnotic suggestibility still failed to predict pain reduction.

Table 4. Hierarchical regression of post-intensity on baseline intensity, imaginative suggestibility and hypnotic suggestibility for the cognitive-behavioural package treatment

Predictor	F	p <	Eta^2
Baseline intensity	294.42	0.001	0.92
Imaginative suggestibility (IS)	6.03	0.02	0.20
Hypnotic suggestibility (HS)	0.11	0.74	0.01

Discussion

The findings of this study showed that participants receiving the cognitive-behavioural package, hypnotic cognitive-behavioural package, hypnotic analgesia suggestion, distraction, and placebo control treatments expected less pain than those in the no-treatment control condition. These decreases in expected pain were partially mirrored by decreases in pain intensity. Each of the four 'active' treatments (but not the placebo control condition) reduced actual finger pressure pain more than the no-treatment control condition. However, there was no difference between the four 'active' treatments in pain reduction.

Our results are consistent with those of several past investigations in which we employed the same paradigm and some of the same treatments (Milling et al., 2002b; Milling et al., in press). These earlier studies showed that each of our hypnotic and non-hypnotic analogue treatments were more effective than a no-treatment control condition in reducing pain, but there was no difference between the treatments. Similarly, several other investigators failed to detect a difference between hypnotic analgesia and simple

distraction (Spanos et al., 1984; Tenenbaum, Kurtz and Bienias, 1990) or Stress Inoculation Training (Miller and Bowers, 1993; Spanos, Ollerhead and Gwynn, 1985–1986) in reducing cold pressor pain.

However, none of these past studies utilized a placebo control condition. In the current investigation, we incorporated a placebo that proved to be no different from the 'active' treatments in its ability to reduce expected pain and superior to no-treatment. Of the four 'active' treatments, only the cognitive-behavioural package was more effective than the placebo in reducing pain intensity. Noting the important caveat that there were no significant differences among our four 'active' treatments, this finding may raise the question of an advantage in pain reduction for Stress Inoculation Training (SIT). Unlike our cognitive-behavioural package, which is a brief analogue of SIT, the original version of SIT was designed to involve multiple practice sessions incorporating exposure to increasingly severe approximations of the threat stimulus. Implemented in this manner SIT might be even more effective than our cognitive-behavioural package in providing relief. Future research might usefully evaluate whether delivering SIT in this way provides greater benefit than a single session of training.

On the other hand, in certain circumstances, any advantage in pain reduction enjoyed by SIT may be offset by the amount of preparation required. We deemed that our 60-minute cognitive-behavioural package incorporated the minimum amount of training needed to produce a reasonably faithful SIT analogue. In contrast, our hypnotic analgesia treatment, designed to represent a faithful analogue of how clinicians might employ direct hypnotic suggestions for pain reduction, required only 20 minutes of preparation and the distraction analogue involved slightly less time. In treating clinical pain, it may not always be possible to provide the extensive patient preparation recommended by SIT. Consequently, in clinical situations where rapid intervention is required or where extensive preparation is not possible, distraction or direct hypnotic suggestions for analgesia may be the treatment of choice.

Despite the burgeoning interest in response expectancies, few studies have appropriately evaluated their function as a mediator of hypnotic and cognitive-behavioural pain treatments using the Baron and Kenny (1986) analytic strategy. Our results showed that expectancy partially mediated the effects of the analogue treatments on pain. This finding is consistent with those of two previous investigations in which we compared a variety of hypnotic and non-hypnotic analogue pain treatments (Milling et al., 2002b; Milling et al., in press), as well as those of a study of the effects of hypnosis on breast biopsy pain (Montgomery et al., 2002). These studies suggest that response expectancies may be a common factor in hypnotic and cognitive-behavioural pain treatments. However, in each of these investigations, treatment condition predicted pain reduction even when expectancy was statistically controlled. Thus, some other common factor (e.g. therapeutic relationship, motivation) or some factor(s) specific to at least some of the treatments were partially responsible for pain reduction.

Only one other pain treatment study has evaluated the mediator function of expectancy using the Baron and Kenny (1986) analytic strategy. Baker and Kirsch (1993) reported that expectancy fully mediated the effect of one hypnotic and two placebo pain interventions. This discrepancy from the pattern of partial mediation noted in our research and in that of Montgomery et al. (2002) suggests the possibility that placebo analgesia may be fully mediated by response expectancies, whereas hypnotic and cognitive-behavioural treatments may be only partially mediated by expectancy. Consistent with this proposition, Montgomery and Kirsch (1997) reported that expectancy fully mediated the effect of conditioning trials on placebo analgesia.

Continued study of the role of response expectancies as a mediator of various pain reduction methods employing the Baron and Kenny (1986) analytic approach would seem to be needed.

There are two predominant paradigms of hypnotic pain reduction. According to Hilgard and Hilgard's neodissociation model (1994), hypnotic pain reduction is explained by a division of consciousness in which pain is dissociated behind an amnesic barrier. Hence, more pain reduction would be experienced by those higher in hypnotic suggestibility. A response expectancy explanation of hypnotic analgesia would be consistent with the neodissociation model in that individuals may generate expectancies for hypnotic pain reduction in part based on perceptions of their general responsiveness to hypnosis. That is, response expectancies may partially mediate the relationship between hypnotic suggestibility and hypnotic pain reduction (see Council, 1999). A second influential perspective is offered by Spanos (1986). His socio-cognitive model uses the constructs of social psychology, including expectancy, to explain hypnotic behaviour. Thus, partial mediation of hypnotic pain reduction by response expectancies would seem to be compatible with both major paradigms of hypnotic pain reduction.

This study is the first to show that non-hypnotic imaginative suggestibility moderates the effect of a cognitive-behavioural pain treatment. Our cognitive-behavioural package was closely adapted from SIT, which features imagery as a core element. During the time participants in this condition had their finger in the pain stimulator, they were helped to imagine being at a lake on a summer day. Participants evidencing greater imaginative tendencies were able to use this imagery more effectively to reduce pain. Our results suggest that imaginative suggestibility may be a better predictor of responding to non-hypnotic pain treatments that incorporate a major imaginative component than of responding to hypnotic pain interventions. As such, our findings are consistent with the proposition that there may be a variety of types of suggestibility, each with a distinct nomological network (for example, see Gudjonsson, 1989, for a discussion of interrogative suggestibility).

Also consistent with prediction was the finding that suggestibility and hypnotizability did not moderate the distraction and placebo treatments, neither of which incorporate hypnotic or imaginative elements. Contrary to prediction, our hypnotic cognitive-behavioural package and hypnotic analgesia suggestion analogues were not moderated by hypnotic suggestibility or hypnotizability. In the only other pain treatment study to evaluate hypnotizability as operationalized herein, Milling et al. (2002a) found that neither suggestibility nor hypnotizability moderated the effects of the same hypnotic analgesia suggestion treatment used in this study or a non-hypnotic version of the same suggestion. The failure of hypnotic suggestibility to predict hypnotic pain reduction in Milling et al. (2002a) and in this study is puzzling considering how often this relationship has been reported in other research (see Montgomery et al., 2000).

There are several possible explanations for this failure. First, unlike most pain treatment investigations, in the current study and in Milling et al. (2002a), suggestibility and pain reduction were measured in the guise of two separate experiments. Spanos (1986) has argued that the relationship between hypnotic suggestibility and responding to hypnotic pain treatments tends to break down when measured in separate experimental contexts.

Second, responding to the suggestions delivered outside of hypnosis during the first part of the suggestibility screening may have altered participants' reactions to the same suggestions administered in hypnosis immediately afterwards. During the second portion of the screening, participants likely remembered their earlier, non-hypnotic responses

and were cued by the Braffman and Kirsch (1999) instructions as to the intent of the assessment (i.e., 'In this second part of the study, we want to assess your ability to experience the same suggestions, only this time we will ask you to experience them with hypnosis', p. 579). Equipped with this information, participants may have responded to the second set of suggestions reactively.

Some additional measurement artifacts may have influenced the accuracy of the hypnotizability scores. First, there may be subtle ceiling and floor effects when using the CURSS to measure hypnotizability. On the CURSS, objective scores range along a 0 to 7 scale. Thus, there is not be much room for those who score towards the high end on the non-hypnotic CURSS to increase their score on the hypnotic version, nor is there much room for those who score towards the low end of the non-hypnotic CURSS to decrease their score on the hypnotic version. That is to say, the CURSS may be insensitive to positive hypnotizability among individuals who score in the high range of imaginative suggestibility and to negative hypnotizability among those who score in the low range of imaginative suggestibility.

A second problem in measuring hypnotizability with the CURSS concerns the standard error of measurement (SEM) of this instrument. The SEM reflects the amount an observed score is expected to fluctuate around a true score. This statistic is calculated as SEM = SD ($\sqrt{1-r_{xy}}$ where SD is the scale standard deviation and r_{xy} is the reliability of the scale. Braffman and Kirsch (1999; Experiment 2) reported standard deviations of 1.56 on the non-hypnotic version of the CURSS and 1.92 on the hypnotic version. The test-retest reliability of the CURSS objective scores is reported to be 0.67 (Spanos, Radtke, Hodgins et al., 1983b). These estimates produce an SEM of 0.89 for the non-hypnotic version and 1.09 for the hypnotic version. Accordingly, 32% of the time, true scores will vary from observed scores by at least 0.89 on the non-hypnotic version and by at least 1.09 on the hypnotic version. This amount of random fluctuation on both the non-hypnotic and hypnotic versions of CURSS is likely to make it difficult to measure hypnotizability with accuracy. In sum, the Kirsch and Braffman (1999) approach to operationalizing hypnotizability (i.e., hypnotic suggestibility with imaginative suggestibility controlled) has the potential to be a useful conceptualization, but back-to-back administrations of non-hypnotic and hypnotic versions of the CURSS may not provide the optimal method of measuring this construct.

We used an experimental pain paradigm to evaluate analogue versions of four common hypnotic and cognitive-behavioural procedures for treating clinical pain. Because experimental and clinical pain can be quite different, it is unclear how well our findings generalize to clinical pain. Indeed, not all forms of clinical pain are alike. Our results may generalize best to acute clinical pain that is predictable and relatively mild in intensity, perhaps the kind associated with a less invasive medical procedure (e.g. venipuncture). Our results may generalize less well to the pain associated with a highly invasive medical procedure (e.g. a bone marrow aspiration) or to pain that is recurrent and unpredictable (e.g. sickle cell disease) or chronic in nature (e.g. unremitting lower back pain). Also, there may be key differences between some of our analogue treatments and the actual interventions upon which they were based. Future research might usefully evaluate the effectiveness of our analogue treatments for reducing acute clinical pain.

On the other hand, in the laboratory it is possible to standardize the treatments and pain stimulus in a way that is not usually possible in clinical settings. Our results would seem to suggest that in the treatment of relatively mild acute pain, a range of the most common hypnotic and cognitive-behavioural interventions may be fairly comparable in efficacy. Response expectancies may explain how, in part, these pain treatments work,

and non-hypnotic imaginative suggestibility may help to predict who will benefit most from cognitive-behavioural interventions possessing a substantial imaginative component.

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References

Baker SL, Kirsch I (1993) Hypnotic and placebo analgesia: Order effects and the placebo label. Contemporary Hypnosis 10: 117–26.

Baron RM, Kenny DA (1986) The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology 51: 1173–82.

Braffman W, Kirsch I (1999) Imaginative suggestibility and hypnotizability: An empirical analysis. Journal of Personality and Social Psychology 77: 578–87.

Braffman W, Kirsch I (2001) Reaction time as a predictor of imaginative suggestibility and hypnotizability. Contemporary Hypnosis 18: 107–19.

Chaves, JF (1993) Pain management. In: JW Rhue, SJ Lynn and I Kirsch (eds) Handbook of Clinical Hypnosis. Washington, DC: American Psychological Association, 511–32.

Comey G, Kirsch I (1999) Intentional and spontaneous imagery in hypnosis: The phenomenology of hypnotic responding. International Journal of Clinical and Experimental Hypnosis 47: 65–85.

Council JR (1999) Hypnosis and response expectancies. In: I Kirsch (ed.) How Expectancies Shape Experience. Washington, DC: American Psychological Association, 383–401.

Forgione AG, Barber, TX (1971) A strain-gauge pain stimulator. Psychophysiology 8: 102–6.

Goldfried MR, Davison, GC (1976) Clinical Behaviour Therapy. New York: Holt, Rinehart and Winston.

Gudjonsson GH (1989) Compliance in an interrogative situation: A new scale. Personality and Individual Differences 10: 535–40.

Hilgard ER, Hilgard JR (1994) Hypnosis in the Relief of Pain, revised edition. New York: Brunner/Mazel.

Kirsch I (1990) Changing Expectations: A Key to Effective Psychotherapy. Pacific Grove, CA: Brooks Cole.

Kirsch I (1999) How Expectancies Shape Experience. Washington, DC: American Psychological Association.

Kirsch I, Braffman W (1999) Correlates of hypnotizability: The first empirical study. Contemporary Hypnosis 16: 224–30.

Kirsch I, Lynn SJ, and Rhue JW (1993) Introduction to clinical hypnosis. In: J Rhue, SJ Lynn, I Kirsch (eds) Handbook of Clinical Hypnosis. Washington, DC: American Psychological Association, 3–22.

Kirsch I, Montgomery G, Sapirstein G (1995) Hypnosis as an adjunct to cognitive-behavioural psychotherapy: A meta-analysis. Journal of Consulting and Clinical Psychology 63: 214–20.

Miller ME, Bowers KS (1993) Hypnotic analgesia: Dissociated experience or dissociated control? Journal of Abnormal Psychology 102: 29–38.

Milling LS, Kirsch I, Allen GJ, Reutenauer EL (2002a) The effects of hypnotic and non-hypnotic suggestion on pain. Paper presented at the 53rd annual meeting of the Society of Clinical and Experimental Hypnosis, Boston, MA, November.

Milling LS, Kirsch I, Meunier SA, Levine MR (2002b) Hypnotic analgesia and Stress Inoculation Training: Individual and combined effects in analog treatment of experimental pain. Cognitive Therapy and Research 26: 355–71.

Milling LS, Levine MR, Meunier SA (in press) Hypnotic enhancement of cognitive-behavioral interventions for pain: An analogue treatment study. Health Psychology.

Montgomery GH, DuHamel KN, Redd, WH (2000) A meta-analysis of hypnotically induced analgesia: How effective is hypnosis? International Journal of Clinical and Experimental Hypnosis 48: 138–53.

Montgomery GH, Kirsch I (1996). Mechanisms of placebo pain reduction: An empirical investigation. Psychological Science 7: 174–6.

Montgomery GH, Kirsch, I (1997) Classical conditioning and the placebo effect. Pain 72: 107–13.

Montgomery, GH, Weltz CH, Seltz M, Bovbjerg DH (2002) Brief presurgery hypnosis reduces distress and pain in excisional breast biopsy patients. International Journal of Clinical and Experimental Hypnosis 50: 17–32.

Spanos NP (1986) Hypnotic behavior: A social-psychological interpretation of amnesia, analgesia, and 'trance logic'. The Behavioral and Brain Sciences 9: 449–502.

Spanos NP, McNeil C, Gwynn, MI, Stam, HJ (1984) Effects of suggestion and distraction on reported pain in subjects high and low on hypnotic susceptibility. Journal of Abnormal Psychology 93: 277–84.

Spanos NP, Ollerhead VG, Gwynn MI (1985–1986) The effects of three instructional treatments on pain magnitude and pain tolerance: Implications for theories of hypnotic analgesia. Imagination, Cognition, and Personality 5: 321–37.

Spanos NP, Perlini AH, Robertson LA (1989) Hypnosis, suggestion, and placebo in the reduction of experimental pain. Journal of Abnormal Psychology 98: 285–93.

Spanos NP, Radtke HL, Hodgins DC, Bertrand LD, Stam HJ, Dubreuil DL (1983b) The Carleton University Responsiveness to Suggestion Scale: Stability, reliability, and relationships with expectancy, and 'hypnotic experiences'. Psychological Reports 53: 555–63.

Spanos NP, Radtke, HL, Hodgins, DC, Bertrand, LD, Stam HJ, Moretti P (1983c) The Carleton University Responsiveness to Suggestion Scale: Relationships with other measures of susceptibility, expectancies and absorption. Psychological Reports 53: 723–34.

Spanos NP, Radtke HL, Hodgins DC, Stam HJ, Bertrand LD (1983a) The Carleton University Responsiveness to Suggestion Scale: Normative data and psychometric properties. Psychological Reports 53: 523–35.

Tenenbaum SJ, Kurtz RM, Bienias, JL (1990) Hypnotic susceptibility and experimental pain reduction. Journal of Abnormal Psychology 33: 40–9.

Turk DC, Meichenbaum D, Genest M (1983) Pain and Behavioral Medicine: A Cognitive-Behavioral Perspective. New York: Guilford Press.

Weinberger J, Eig A (1999) Expectancies: The ignored common factor in psychotherapy. In: I Kirsch (ed.) How Expectancies Shape Experience. Washington, DC: American Psychological Association, 357–82.

Weitzenhoffer AM (1980) Hypnotic susceptibility revisited. American Journal of Clinical Hypnosis 22: 130–46.

Zamansky HS, Scharf B, Brightbill R (1964) The effect of expectancy for hypnosis on prehypnotic performance. Journal of Personality 32: 236–48.

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