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RESPONSE EXPECTANCIES: A PSYCHOLOGICAL MECHANISM OF SUGGESTED AND PLACEBO ANALGESIA

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Abstract

Response expectancies, or the expectation of one's own non-volitional reactions to situational cues, are hypothesized to be a psychological mechanism of both hypnotic and placebo responding (Kirsch, 1990). In this study, response expectancies were evaluated as a mediator of suggested and placebo analgesia using Baron and Kenny's (1986) classic method of testing mediation. One hundred and seventy-two volunteers were randomly assigned to hypnotic analgesia suggestion, imaginative analgesia suggestion, placebo analgesia, or no-treatment control conditions. The hypnotic, imaginative and placebo treatments were more effective than the no-treatment control condition in relieving finger pressure pain. The hypnotic treatment was also more effective than the placebo. Each of the three treatments was partially mediated by response expectancies, although the percentage of mediation varied across the hypnotic (25%), imaginative (29%) and placebo (41%) conditions. The findings support the position that response expectancies are one of the major psychological mechanisms of suggested and placebo analgesia.

Key words: hypnosis, pain, placebos, response expectancies, suggestions

Hypnosis has proven to be a potent tool for relieving pain. For example, in a meta-analysis of research on hypnotically-induced analgesia, Montgomery, DuHamel and Redd (2000) calculated 41 effect sizes from 18 studies and obtained a moderate to large effect (D = .67) for hypnosis. These scholars determined that the average participant treated with hypnosis achieved more pain reduction than 75% of individuals in standard treatment and no-treatment control conditions. Similarly, important qualitative reviews of the use of hypnosis for treating clinical pain recently concluded that hypnosis is effective for alleviating both acute and chronic pain conditions (Patterson and Jensen, 2003; Jensen and Patterson, 2006).

A hypnotic suggestion consists of a hypnotic induction, followed by a suggestion in which the person is invited to experience some imaginary state of affairs. When such suggestions are provided without an induction, they have been termed 'waking' or imaginative suggestions (see Kirsch, 1997a). Studies comparing the effectiveness of imaginative and hypnotic suggestions for pain reduction have yielded contradictory results. Some research indicates that there is no difference between imaginative and hypnotic analgesia suggestions (Houle, McGrath, Moran and Garrett, 1988; Milling, Kirsch, Allen and Reutenauer, 2005; Spanos and Katsanis, 1989; Spanos, Radtke-Bodorik, Ferguson and Jones, 1979). Other studies find that hypnotic suggestions are

more effective than imaginative suggestions in reducing pain (Tripp and Marks, 1986; Van Gorp, Meyer and Dunbar, 1985). Another investigation suggests that when participants receive both kinds of suggestions in a within-subjects design, differences are a function of order (Stam and Spanos, 1980). A fourth set of studies shows that individuals scoring in the low range of hypnotic suggestibility benefit as much from imaginative suggestions for analgesia as highly suggestible individuals do from either hypnotic or imaginative suggestions (Spanos, Perlini, Patrick, Bell and Gwynn, 1990; Spanos, Perlini and Robertson, 1989). To add to this small literature, the first purpose of this study is to compare the effectiveness of imaginative and hypnotic suggestions for relieving pain.

As is the case with hypnosis, there is substantial evidence that placebos can produce significant pain relief (see Price and Barrell, 1999 for a review). A placebo is a chemically inert substance which a person believes is an active drug, but does not have the chemical properties attributed to it (Kirsch, 1985). Placebos have been shown to reduce both clinical and experimental pain (Liberman, 1964; Graceley, Dubner, Wolskee, and Deeter, 1983; Grevert, Albert, and Goldstein, 1983; Levine and Gordon, 1984). Indeed, pain may be particularly responsive to the influence of placebos. For example, a recent review of 130 clinical trials in which medical patients were assigned to either a placebo intervention or a no-treatment control condition demonstrated that pain was the only medical complaint that reliably responded to a placebo (Hrobjartsson and Gotzsche, 2001).

Response expectancies

What are some of the psychological mechanisms that account for the pain-reducing effects of analgesia suggestions and placebos? Response expectancies, defined as the expectation of one's own non-volitional reactions to situational cues, may be one of the key variables (Kirsch, 1990). Kirsch's (1985) response expectancy theory is an extension of Rotter's (1954) social learning theory (SLT). According to SLT, the probability that a behaviour will occur is a function of the expectation that the behaviour will lead to a particular reinforcement and the strength of that reinforcement. Social learning theory predicts the occurrence of goal-directed or choice (i.e. voluntary) behaviours. For example, social learning theory might be useful for predicting whether people would choose to invest money in the stock market or in a savings account. As such, in social learning theory, expectancies are said to be *outcome expectancies*. In contrast, response expectancies predict the occurrence of involuntary behaviours, such as pain sensations.

Additionally, response expectancies are different from outcome expectancies because they are directly self-confirming (Kirsch, 1997b). Unlike outcome expectancies, response expectancies for particular experiences directly generate those experiences. For example, deciding to invest money in a conservative savings account because one expected the stock market to decline might affect the investment decision, but it would not determine the amount of interest produced by the savings account. In contrast, if one expects to become more alert from drinking a cup of coffee, drinking the coffee will cause one to feel more aroused, even if the coffee is decaffeinated (Kirsch and Weixel, 1988). Thus, a response expectancy directly determines the anticipated automatic response.

It has been proposed that hypnosis and placebos both operate via the mechanism of response expectancies (Kirsch, 1997b). That is, hypnosis and placebos are said to achieve their effects by altering a person's expectancies for non-volitional responding. In fact, hypnosis sometimes has been described as a non-deceptive placebo (Kirsch, 1999). With regard to treatments for pain, response expectancies may function by creating a

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cognitive set in which a patient or research participant anticipates pain reduction (Kirsch, 1990).

However, relatively few studies of placebo analgesia have directly assessed the role of expectancy in pain reduction (Price and Fields, 1997). Some studies have manipulated expectancies (e.g. provided information to participants that they will receive treatments of different 'strengths'), but not measured resulting changes in pain expectancies (e.g. Klinger, Soost, Floor and Worm, 2007). Indeed, research on the various mechanisms by which placebos generate analgesia is in a somewhat early stage. Global mechanisms of action, such as the release of endogenous opiods (Levine, Gordon and Fields, 1978) or decreased levels of anxiety (Sternbach, 1968), may explain some forms of placebo analgesia, although they would not account for the observation that placebo analgesia can be localized to particular regions of the body (Montgomery and Kirsch, 1996).

One prominent explanation of the action of placebos is based on classical conditioning (Wickramasekera, 1980; Voudouris, Peck and Coleman, 1985). Accordingly, active drugs are unconditioned stimuli that become paired with the tablets, salves and syringes in which they are provided. Eventually, these mediums begin to function as conditioned stimuli capable of eliciting analgesia even in the absence of active drugs. However, classical conditioning does not explain why people show a placebo response to medications they have never experienced. Also, when expectations are inconsistent with past experience, classical conditioning does not explain why people sometimes respond to a placebo in a way that matches their expectancies rather than their experience (Montgomery and Kirsch, 1997). Indeed, a small literature argues that expectancy rather than classical conditioning may best account for placebo analgesia and that the primary role of conditioning is to help individuals acquire the expectation that a particular medical treatment will lead to pain relief (see Price and Barrell, 1999).

Unfortunately, few studies have actually measured changes in pain expectancies resulting from treatment with a placebo analgesic. Even fewer studies have conducted the appropriate mediator analyses (see Baron and Kenny, 1986) that would provide support for the position that response expectancies are a mechanism of placebo pain reduction. Of note, however, Montgomery and Kirsch (1997) reported that response expectancies fully mediated the effect of a placebo analgesic on iontophoretic pain. In view of the very limited size of the literature in this area, a second purpose of this study is to evaluate whether response expectancies mediate the effects of a placebo analgesia treatment using Baron and Kenny's (1986) classic method of testing mediation.

Like placebo analgesia, a variety of psychological mechanisms have been offered to account for the phenomenon of hypnotic analgesia. Perhaps the greatest controversy in the field of hypnosis is whether there is an altered state of consciousness that increases responding to suggestion (see Kirsch and Lynn, 1995), which would include suggestions for analgesia. Other hypothesized psychological mechanisms of hypnosis include dissociation (Hilgard, 1986), imaginative involvements (J. Hilgard, 1974), role theory (Sarbin, 1950), and compliance (Wagstaff, 1991). A small, but growing literature suggests that response expectancies may help to explain how hypnosis reduces pain.

For example, Montgomery, Weltz, Seltz and Bovbjerg (2002) reported that response expectancies partially mediated the effect of hypnosis on breast biopsy pain. Similarly, Milling, Reardon and Carosella (2006) found that expectancies partially mediated the effect of a variety of hypnotic and cognitive-behavioural treatments on experimental pain. However, in the latter study, expectancies were shown to mediate a cluster of hypnotic and cognitive-behavioural treatments and were not localized to hypnosis. Therefore, a third purpose of this study is to evaluate whether response expectancies

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mediate the effects of a hypnotic analgesia treatment using Baron and Kenny's (1986) method of testing mediation. This is one of the first studies to pinpoint the role of response expectancies as a mediator of hypnotic, imaginative and placebo analgesia using Baron and Kenny's (1986) approach to evaluating mediation and it is the first study to report the percentage of mediation produced by expectancies in each of these three treatments.

The current study

A hypnotic analgesia treatment, an imaginative analgesia treatment, and a placebo analgesia treatment were compared with a no-treatment control condition in reducing finger pressure pain. To evaluate whether response expectancies mediated pain reduction, participants were asked to rate the relief they expected to obtain from treatment. To isolate the mediator function of response expectancies in each treatment, a large sample of data was collected, making it possible to compare each of the three treatments in turn with the no-treatment control condition using Baron and Kenny's (1986) method of testing mediation. Response expectancies were predicted to mediate the effect of each of the three treatments on pain.

Method

Participants

Participants were 68 male and 104 female introductory psychology students who took part in the experiment to satisfy a course requirement. These individuals were recruited to participate in a study comparing the effectiveness of an experimental topical analgesic with several different psychological pain interventions. To prevent a *hold-back effect*, no mention was made in recruitment that the study involved hypnosis. In a hold-back effect, participants exaggerate reports of pain during the pretreatment trial to leave room for improvement resulting from hypnosis on the posttreatment trial (Zamansky, Scharf and Brightbill, 1964). Eligible participants could not have a medical condition that affected the sensitivity of their left index finger.

Instruments

Pain intensity rating

Pain intensity was measured on an 11-point graphic rating scale ranging from 0 (no pain at all) to 10 (pain as intense as one can imagine). A display showing an 18-cm line with the eleven numbers and verbal anchors was positioned in front of participants. After placing their left index finger in the pain stimulator, an audiotape prompted participants to report a whole number indicating pain intensity every 20 s for one min. The sum of these ratings provided an index of overall intensity ranging from 0 to 30. Baseline intensity ratings were made prior to treatment and postintensity ratings were made while participants underwent a pain intervention. Cronbach's alpha was .96 for baseline ratings and .95 for post intensity ratings.

Pain expectancy rating

Expected pain intensity was rated using the same 11-point scale utilized in the intensity ratings. These ratings consisted of a single whole number ranging from 0 to 10. The baseline expectancy rating was made immediately after the baseline intensity rating and

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indicated what participants expected the pain to be like if they were again to put their finger in the stimulator for 1 min without intervention. The postexpectancy rating was made immediately after experiencing a pain control intervention (but without putting a finger in the stimulator) and indicated what participants expected the pain would be like while using the pain intervention they had just experienced. Participants in the no-treatment control condition made baseline and postexpectancy ratings indicating expected pain without intervention.

Carleton University Responsiveness to Suggestion Scale (CURSS; Spanos, Radtke, Hodgins, Stam and Bertrand, 1983). The CURSS consists of a hypnotic induction and seven test suggestions. After responding to the test suggestions, participants fill out a booklet in which they indicate much they responded to each suggestion. The CURSS measures three dimensions of suggestibility. 'Objective suggestibility' reflects what participants think an observer would have seen them do in response to each suggestion. 'Subjective suggestibility' indicates participants' internal experience of each suggestion. 'Involuntariness' assesses the extent to which participants experienced each suggestion as occurring automatically and without a feeling of effort. Spanos, Radtke, Hodgins, Bertrand, Stam and Dubreuil (1983) report test-retest reliability coefficients of .67 to .76 for the three indices. The validity of the CURSS is suggested by high correlations with other measures of suggestibility (Spanos, Radtke, Hodgins, Bertrand, Stam and Moretti, 1983). The Comey and Kirsch (1999) version of the CURSS used in this study replaces goal-directed fantasies with repetition of suggestions, thereby producing a more normal distribution of scores.

Apparatus

A Forgione-Barber Strain Gauge Pain Stimulator (Forgione and Barber, 1971) was used to administer finger pressure pain. This device consists of a doughnut-shaped weight (900g), which is attached to a bar (231g) that pivots from a hinged support stand at the far end. The participant's index finger is placed on a 5 cm stand in the middle of the stimulator and the other fingers rest on a platform between the support stand and the finger stand. The moveable bar is about 2 mm wide where it contacts the index finger. The bar is generates 2,041 g of force when it is lowered on the finger.

Treatment conditions

The treatments were delivered in two phases. During the 'preparation phase', participants heard information about pain management and were given an opportunity to experience a pain intervention without placing their finger in the stimulator. Participants then made an expectancy rating indicating what they thought the pain would be like while using the intervention they had just experienced. Then, during the 'intervention phase', experimenters worked live from a treatment manual to administer the pain intervention while participants placed their finger in the stimulator and made intensity ratings. The experimenters consisted of ten advanced undergraduate students who were trained and monitored by the author.

Hypnotic analgesia condition

During the preparation phase, the 17 males and 29 females assigned to this condition listened to an audiotape presenting: (a) information from Kirsch, Lynn and Rhue (1993) intended to correct misconceptions about hypnosis; (b) the hypnotic induction from the CURSS; (c) information about hypnotic analgesia; and (d) an opportunity to experience a 45-sec glove analgesia suggestion adapted from Spanos et al. (1989). During the inter-

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vention phase, an experimenter worked live from the treatment manual to deliver the glove analgesia suggestion during the postintensity trial.

Imaginative analgesia condition

The 18 male and 25 female participants assigned to this condition experienced the same glove analgesia suggestion used in the hypnotic analgesia condition, but without the hypnotic induction or information designed to correct misconceptions about hypnosis. Instead, the glove analgesia suggestion was framed as guided imagery. During the preparation phase, participants first heard information about the use of guided imagery for reducing pain and were then instructed to use their imagination to experience the glove analgesia suggestion. During the intervention phase, an experimenter worked live from the treatment manual to deliver the glove analgesia suggestion during the postintensity trial.

Placebo condition

The placebo consisted of an inert solution presented as an experimental, local, topical analgesic. The solution was actually composed of oil of thyme and povo-iodine, producing a brown liquid with a medicinal smell. The solution was placed in a pharmaceutical bottle labelled 'Trivaricaine: Approved for Research Purposes Only'.

During the preparation phase, the 15 males and 26 females assigned to this condition heard information about the nature of medical analgesics. To convey the impression that the placebo was a powerful analgesic, the following manipulation was adapted from Baker and Kirsch (1993). The experimenter drew a small circular test spot on the participant's forearm and pricked it with the sharp end of a sewing pin. The Trivaricaine was then applied to the test spot and to the participant's left index finger. When applying the solution, experimenters wore latex examination gloves so they would not come in direct contact with the 'powerful' analgesic. After allowing the solution to 'work' for a few seconds, the experimenter surreptitiously rotated the pin and pricked the test spot with the dull end of the pin, creating the illusion that the analgesic had reduced sensitivity in the test spot. During the intervention phase, participants placed their left index finger, with Trivaricaine applied, in the stimulator and made intensity ratings.

No-treatment control condition

After making baseline intensity and expectancy ratings, the 18 males and 24 female participants assigned to the no-treatment control condition waited for the same amount of time that participants in the other conditions underwent preparation for treatment. Thereafter, these individuals provided a second (i.e. post) expectancy rating indicating what they expected the pain would be like if they again placed their finger in the stimulator without pain intervention. Then, these participants placed their finger in the stimulator for 1 minute and made postintensity ratings.

Procedure

Participants were recruited to take part in a study comparing an experimental topical analgesic with several different psychological pain control methods. Participants were randomly assigned in blocks to one of the four experimental conditions such that each condition had equal proportions of males and females. Before beginning the experiment, participants provided written informed consent and completed a medical screening form. Eligible participants could not have a medical condition that affected the sensitivity of their left index finger.

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Participants assigned to the hypnotic analgesia condition were not told the experiment involved hypnosis until after the baseline pain assessment to prevent a hold-back effect. Participants assigned to the other conditions were not told the experiment involved hypnosis until the hypnotic suggestibility assessment to prevent them from mistakenly concluding they were being hypnotized when this was not true. To further reduce the possibility that participants might incorrectly assume they were being hypnotized when this was not the case, all cues associated with hypnosis (e.g. books, journals) were removed from the treatment room. Also, in the imaginative analgesia condition, experimenters delivered the glove analgesia suggestion with a soothing voice quality, but without the unique tone and cadence associated with hypnosis.

Each participant was run through the experiment individually by two experimenters. One experimenter delivered the treatments and the other experimenter conducted the hypnotic suggestibility assessment. This was done to reduce the *demand* on participants to respond consistently across these two parts of the experiment. Each experimenter was blind to information collected during the part of the study he or she had not run. The treatment portion of the study was sequenced before the hypnotic suggestibility assessment so that subjects would not be aware the experiment involved hypnosis until just before they were about to be hypnotized.

In the initial part of the study, the first experimenter met with the participant to provide treatment. During the baseline pain assessment, participants placed their left index finger in the stimulator and made baseline intensity ratings every 20 seconds for one minute. Participants then made a baseline expectancy ratings indicating what they expected the pain would be like if they were to place the same finger back in the stimulator for one minute.

Participants were randomly assigned in blocks to one of the four treatment conditions. During the preparation phase of treatment, participants were given an opportunity to experience a treatment without putting their finger in the stimulator. Afterwards, they made postexpectancy ratings in which they indicated what they expected the pain would be like if they placed their finger in the stimulator while using the intervention they had just experienced. Thereafter, participants put the finger in the stimulator and made postintensity ratings every 20 seconds for one minute while using the intervention to reduce the pain. Participants in the no-treatment control condition made postexpectancy and postintensity ratings reflecting expected and actual pain without intervention.

At this point, the first experimenter left the room and the second experimenter entered to conduct the hypnotic suggestibility assessment using the CURSS.

Results

Preliminary analyses

The CURSS produced mean scores of 2.59 (*SD* = 1.96, range = 0–7) on the objective dimension, 6.66 (*SD* = 4.19, range = 0–19) on the subjective dimension, and 5.03 (*SD* = 4.13, range = 0–19) on the involuntariness dimension. The frequency of objective scores was 0 (16%), 1 (19%), 2 (19%), 3 (17%), 4 (8%), 5 (14%), 6 (5%), and 7 (4%). Pain expectancy ratings yielded mean scores of 5.50 (SD = 2.36; range = 0–10) at baseline and 3.58 (SD = 2.21; range = 0–10) at posttreatment. Pain intensity ratings yielded mean scores of 13.27 (SD = 6.28; range = 1–28) at baseline and 10.10 (SD = 6.08; range = 0–29) at posttreatment. Means and standard deviations for baseline and posttreatment ratings of pain intensity and expectancy by treatment condition are shown in Table 1.

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Table 1. Means and standard deviations for baseline and post pain intensity and expectancy ratings by condition

	Pain intensity				Pain expectancy			
	Baseline		Post		Baseline		Post	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hypnotic analgesia suggestion[a]	12.43	6.03	7.50	5.53	5.15	2.16	3.20	1.82
Imaginative analgesia suggestion[b]	13.09	5.90	8.79	5.19	5.67	2.32	3.53	1.89
Placebo control[c]	13.56	6.36	10.98	5.51	5.46	2.29	2.68	1.72
No-treatment control[d]	14.10	6.92	13.45	6.47	5.69	2.69	4.93	2.71

[a]$n = 46$. [b]$n = 43$. [c]$n = 41$. [d]$n = 42$.

A series of one-way analyses of variance on objective, subjective and involuntariness suggestibility scores, as well as baseline intensity and expectancy ratings did not produce a significant effect for treatment condition, thereby suggesting the comparability of the groups on these variables.

Reduction of pain intensity

A one-way analysis of covariance on postintensity ratings, with baseline intensity ratings as the covariate, produced a significant main effect for treatment condition, F (3,167) = 16.84, $p < .001$, $\text{eta}^2 = .23$. A least significant difference test on estimated marginal means with a Bonferroni adjustment for the number of statistical comparisons revealed that participants in the no-treatment control condition reported more intense pain (adjusted mean = 12.85, *SD* = 6.83) than those in the placebo (adjusted mean = 10.77, *SD* = 6.90), imaginative analgesia (adjusted mean = 8.92, *SD* = 6.74), and hypnotic analgesia (adjusted mean = 8.11, *SD* = 6.53) conditions. Additionally, participants in the placebo condition reported significantly more intense pain than those in hypnotic analgesia condition. The difference between the imaginative analgesia condition and the placebo condition approached significance (p = .079). The remaining pairwise comparisons were nonsignificant.

Reduction of expected pain

A one-way analysis of covariance on postexpectancy ratings, with baseline expectancy ratings as the covariate, produced a significant main effect for treatment condition, F (3,167) = 15.21, $p < .001$, $\text{eta}^2 = .22$. A least significant difference test on estimated marginal means with a Bonferroni adjustment for the number of statistical comparisons revealed that participants in the no-treatment control condition (adjusted mean = 4.80, *SD* = 2.95) expected more pain than those in the hypnotic analgesia (adjusted mean = 3.41, *SD* = 2.83), imaginative analgesia (adjusted mean = 3.42, *SD* = 2.92), and placebo (adjusted mean = 2.70, *SD* = 2.99) conditions. All of the other pairwise comparisons were nonsignificant.

Mediator analysis of response expectancies

Response expectancies were hypothesized to mediate the effects of the hypnotic, imaginative and placebo treatments on pain. Accordingly, three separate sets of mediator

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analyses were performed in which the no-treatment control condition was contrasted in turn with each of these treatments. Performing the analyses in this way isolated the mediator function of response expectancies in each treatment. Each mediator analysis used Baron and Kenny's (1986) method of testing mediation, in which three regression equations were estimated.

In the first set of analyses, the hypnotic analgesia treatment was contrasted with the no-treatment control condition. The results of the simultaneous regressions are shown in Table 2. In the first regression, postexpectancy was regressed on baseline expectancy and treatment condition. After baseline expectancy was controlled, treatment condition predicted postexpectancy. This demonstrates an association between the independent variable (i.e. treatment condition) and the hypothesized mediator variable (i.e. expected change in pain intensity).

In the second regression, postintensity was regressed on baseline intensity and treatment condition. After controlling for baseline intensity, treatment condition predicted postintensity. This demonstrates an association between the dependent variable (i.e. posttreatment intensity) and the independent variable (i.e. treatment condition) when the covariate (i.e. pretreatment intensity) was controlled.

In the third regression, baseline intensity, baseline expectancy, postexpectancy and treatment condition were regressed on postintensity. After controlling for baseline intensity and baseline expectancy, postexpectancy and treatment condition predicted postintensity. Reduction of expected pain was directly related to reduction of pain intensity (*Beta* = .33, $p = .002$). A Sobel test revealed that the indirect effect of treatment on pain intensity via response expectancy was significant ($z = 2.55$, $p = .011$). At the same time, the effect of treatment on intensity remained significant despite the inclusion of response expectancy in the third regression equation. These results indicate that the effect of the hypnotic analgesia treatment on pain intensity was partially mediated by response expectancy.

The percentage of mediation was calculated as 1-(c'/c) where c is the effect (i.e. the Beta) for the independent variable in predicting the dependent variable in the second regression and c' is the effect (i.e. the Beta) of the independent variable in predicting the dependent variable with the mediator variable controlled in the third regression. The

Table 2. Simultaneous regressions testing mediation of effects of hypnotic analgesia treatment on pain intensity by pain expectancy

Criterion and predictor	*F*	*p* <	*Beta*	Eta^2
Postexpectancy				
Baseline expectancy	112.83	.001	.71	.57
Treatment condition	17.37	.001	−.29	.17
Postintensity				
Baseline intensity	148.45	.001	.72	.64
Treatment condition	36.36	.001	−.36	.30
Postintensity				
Baseline intensity	25.05	.001	.58	.23
Baseline expectancy	1.27	.262	−.12	.02
Postexpectancy	10.48	.002	.33	.11
Treatment condition	19.00	.001	−.27	.19

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Table 3. Simultaneous regressions testing mediation of effects of imaginative analgesia treatment on pain intensity by pain expectancy

Criterion and predictor	*F*	*p* <	*Beta*	Eta^2
Postexpectancy				
Baseline expectancy	76.64	.001	.67	.48
Treatment condition	14.29	.001	–.29	.15
Postintensity				
Baseline intensity	198.77	.001	.78	.71
Treatment condition	31.49	.001	–.31	.28
Postintensity				
Baseline intensity	23.99	.001	.52	.23
Baseline expectancy	0.18	.673	–.04	.00
Postexpectancy	22.19	.001	.39	.22
Treatment condition	16.51	.001	–.22	.17

percentage of mediation of the hypnotic analgesia treatment by response expectancy was 25%.

In the second set of analyses, the imaginative analgesia treatment was compared with the no-treatment control condition. The results of these simultaneous regressions are shown in Table 3. In the first regression, postexpectancy was regressed on baseline expectancy and treatment condition. After baseline expectancy was controlled, treatment condition predicted postexpectancy. In the second regression, postintensity was regressed on baseline intensity and treatment condition. After baseline intensity was controlled, treatment condition predicted postintensity.

In the third regression, baseline intensity, baseline expectancy, postexpectancy and treatment cluster were regressed on postintensity. After controlling for baseline intensity and baseline expectancy, postexpectancy and treatment condition predicted postintensity. Reduction of expected pain was directly related to reduction of pain intensity (*Beta* = .39, $p = .001$). A Sobel test showed that the indirect effect of treatment on pain intensity via response expectancy was significant ($z = 2.95$, $p = .003$). However, the effect of treatment on intensity remained significant despite including response expectancy in the third regression equation. These findings indicate that the effect of the imaginative analgesia suggestion on intensity was partially mediated by response expectancy. The percentage of mediation of the imaginative analgesia treatment by response expectancy was 29%.

In the third set of analyses, the placebo analgesic was contrasted with the no-treatment control condition. The results of these simultaneous regressions are shown in Table 4. In the first regression, postexpectancy was regressed on baseline expectancy and treatment condition. After baseline expectancy was controlled, treatment condition predicted postexpectancy. In the second regression, postintensity was regressed on baseline intensity and treatment condition. After baseline intensity was controlled, treatment condition predicted postintensity.

In the third regression, baseline intensity, baseline expectancy, postexpectancy and treatment cluster were regressed on postintensity. After controlling for baseline intensity and baseline expectancy, only postexpectancy predicted postintensity. The effect of treatment condition was not significant. Reduction of expected pain was directly related to reduction of pain intensity (*Beta* = .18, $p < .041$). A Sobel test showed that the indirect

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Table 4. Simultaneous regressions testing mediation of effects of placebo analgesic treatment on pain intensity by pain expectancy

Criterion and predictor	*F*	*p* <	*Beta*	Eta^2
Postexpectancy				
Baseline expectancy	102.97	.001	.67	.56
Treatment condition	39.46	.001	−.42	.33
Postintensity				
Baseline intensity	394.31	.001	.89	.83
Treatment condition	13.89	.001	−.17	.15
Postintensity				
Baseline intensity	47.06	.001	.80	.34
Baseline expectancy	0.15	.698	−.04	.00
Postexpectancy	4.33	.041	.18	.05
Treatment condition	2.80	.099	−.10	.04

effect of treatment on pain intensity via response expectancy was significant ($z = 1.98$, $p = .048$). Although treatment condition did not significantly predict postintensity, the Beta for treatment (*Beta* = −.10, $p < .099$) was not 0. These findings indicate that the effects of the placebo analgesic on intensity were partially mediated by response expectancy. The percentage of mediation of the placebo by response expectancy was 41%.

In sum, these mediator analyses indicated that the effect of each of the three treatment conditions on pain intensity was partially mediated by response expectancies. The extent of mediation by response expectancies appeared to be greater in the placebo condition than in the hypnotic and imaginative analgesia conditions.

Supplementary analyses

Conceptually, one would expect that hypnotic suggestibility might predict the amount of pain reduction produced by a hypnotic analgesia treatment. To test this hypothesis, Baron and Kenny's (1986) method of testing moderation was used to examine whether there was an interaction between the hypothesized moderator and the independent variable. Accordingly, the effect of the hypnotic analgesia treatment was contrasted with the no-treatment control condition in simultaneous regression to evaluate whether there was an interaction between suggestibility and treatment condition. Separate regressions were performed for each of the three dimensions of suggestibility measured by the CURSS.

Table 5 presents the results of these regressions. In each analysis, postintensity was regressed on baseline intensity, hypnotic suggestibility, treatment condition and the interaction of suggestibility and treatment condition. The regression for the objective dimension shows that after controlling for baseline intensity, postintensity was predicted only by hypnotic suggestibility. The effect for the condition x suggestibility interaction approached significance ($p < .075$).

The regression for the subjective dimension shows that after controlling for baseline intensity, postintensity was predicted by hypnotic suggestibility, as well as the interaction of suggestibility and condition, thereby indicating a moderator effect. Figure 1 summarizes the interaction of the subjective dimension with treatment condition in the regression. Residualized change scores in pain intensity were generated by regressing postintensity on baseline intensity. A scatterplot of residualized change scores and hyp-

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Table 5. Simultaneous regressions testing moderation of hypnotic analgesia treatment by hypnotic suggestibility

Suggestibility dimension	*F*	*p* <	*Beta*	*Eta*^{2}
Objective				
Baseline intensity	168.60	.001	.74	.67
Hypnotic suggestibility (HS)	8.56	.004	−.06	.09
Treatment condition (TC)	3.55	.063	−.19	.04
TC × HS	3.25	.075	−.22	.04
Subjective				
Baseline intensity	190.93	.001	.77	.70
Hypnotic suggestibility (HS)	12.58	.001	−.05	.13
Treatment condition (TC)	0.84	.361	−.10	.01
TC × HS	7.40	.008	−.32	.08
Involuntariness				
Baseline intensity	220.94	.001	.78	.73
Hypnotic suggestibility (HS)	19.72	.001	−.06	.19
Treatment condition (TC)	1.55	.217	−.10	.02
TC × HS	10.70	.002	−.34	.12

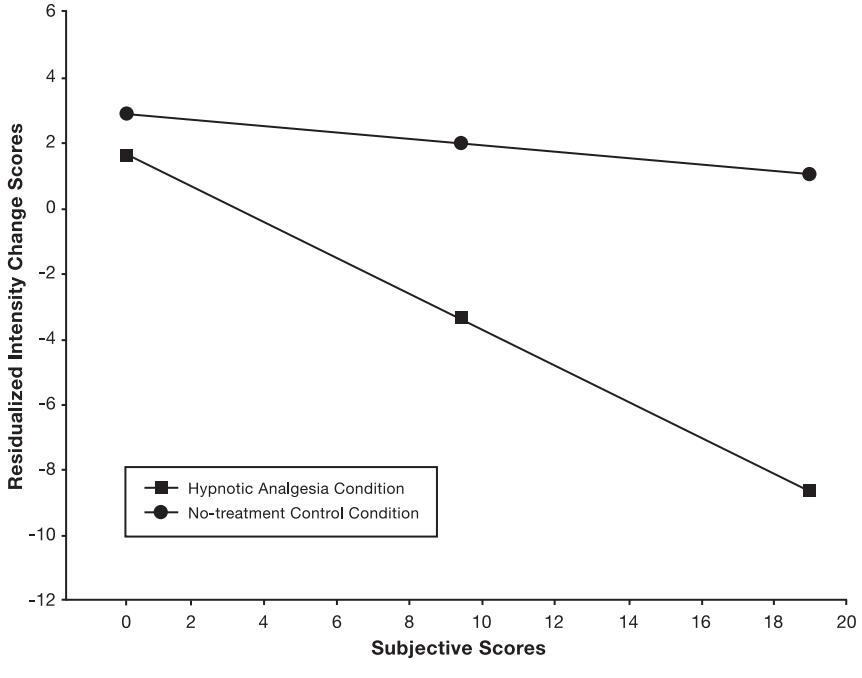

Figure 1. Interaction of Subjective Suggestibility and Treatment Condition on Residualized Intensity Change Scores.

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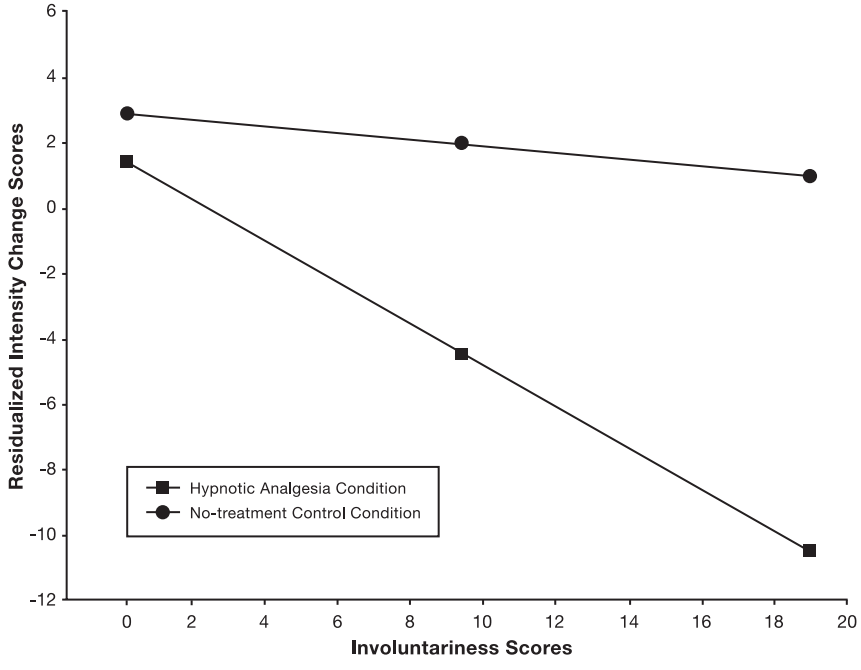

Figure 2. Interaction of Involuntariness Suggestibility and Treatment Condition on Residualized Intensity Change Scores.

notic suggestibility was created, and a regression line was generated for the hypnotic analgesia condition and the no-treatment control condition. Figure 1 shows that higher levels of subjective suggestibility were associated with more pain reduction in the hypnotic analgesia treatment, but not in the no-treatment control condition.

Similarly, the regression on the involuntariness dimension shows that after controlling for baseline intensity, postintensity was predicted by suggestibility, as well as the suggestibility x condition interaction, thus indicating a moderator effect. Figure 2 summarizes the interaction of involuntariness and treatment condition in the regression. Once again, residualized change scores in pain intensity were generated by regressing postintensity on baseline intensity. A scatterplot of residualized change scores and hypnotic suggestibility was created, and a regression line was generated for the hypnotic analgesia condition and the no-treatment control condition. Figure 2 shows that higher levels of involuntariness were associated with more pain reduction in the hypnotic analgesia treatment, but not in the no-treatment control condition.

To summarize, the subjective and involuntariness dimensions of hypnotic suggestibility moderated the effect of the hypnotic analgesia treatment.

Discussion

The hypnotic, imaginative, and placebo analgesia treatments used in this study were more effective than a no-treatment control condition in reducing pain. The hypnotic treatment also produced more pain reduction than the placebo, but there was no difference in effectiveness between the hypnotic and imaginative analgesia suggestions. Com-

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pared with the no-treatment control condition, each of the three treatments produced significant reductions in expected pain. These changes in expected pain partially mediated the effect of each of the three treatments on ratings of pain intensity.

Using Baron and Kenny's (1986) classic method of testing mediation, this study showed that the hypnotic and imaginative analgesia treatments were partially mediated by response expectancies. These results corroborate the findings of Montgomery et al. (2002) and together suggest that response expectancies are a psychological mechanism specific to hypnotic analgesia. However, in the current study and also in Montgomery et al., the effect of suggestion was significant even when expectancy was controlled. This indicates that the pain-reducing effects of suggestion were partially accounted for by variables other than expectancy. Indeed, Milling, Shores, Coursen, Menario and Farris (2007) reported that response expectancies and credibility of treatment rationale independently mediated the effect of a cluster of hypnotic and cognitive-behavioural interventions on pain. Thus, response expectancies may be one of several psychological mechanisms of hypnotic pain reduction.

Compared with the hypnotic and imaginative analgesia suggestions, a somewhat different pattern of mediation was obtained for the placebo analgesic. When response expectancies were controlled, the effect of the placebo on pain was no longer significant. In the past, such a result might have been interpreted as evidence of full mediation. However, the presence or absence of significant effects for an independent variable in a mediator analysis can be a function of statistical power rather than mediation per se (see MacKinnon, Lockwood, Hoffman, West and Sheets, 2002; and Mallinckrodt, Abraham, Wei and Russell, 2006). To claim full mediation, the Beta must be 0 or near 0 (Kenny, Kashy and Bolger, 1998). When expectancy was controlled in the third regression, the Beta for the placebo approached, but was not quite near 0 (*Beta* = –.10). Thus, the result is correctly interpreted as partial mediation. On the other hand, the percentage of mediation by expectancy was somewhat greater in the placebo condition (41%) than it was in the hypnotic (25%) and imaginative (29%) analgesia conditions. This introduces the possibility that response expectancies may account for placebo analgesia to a greater extent than they account for hypnotic or imaginative analgesia.

Although research comparing hypnotic and imaginative analgesia suggestions has produced contradictory findings, about half of the studies have not shown any difference in effectiveness (Spanos et al., 1979; Houle et al., 1988; Spanos and Katsanis, 1989; Milling et al., 2005). The results of the current investigation were consistent with this pattern. It is not possible to prove the null hypothesis. However, power analysis permits an estimation of the probability that an effect of a given size is not present in the population. Utilizing the same experimental paradigm, and three of the conditions used in this study, Milling et al. (2006) obtained an effect size (f) of .59 for the main effect of condition. With 4 groups, a sample size of 172, and alpha set at .05, an effect size of .59 in a 3 degree of freedom F test on means in an analysis of variance produces a power coefficient of 1.00. Statistical power indicates the probability of rejecting the null hypothesis when the alternative hypothesis is true. Therefore, it seems unlikely that a difference between the hypnotic and imaginative analgesia suggestion would have gone undetected in the current study if it were to actually exist in this treatment paradigm.

Consequently, this study suggests that, on average, there is no difference in effectiveness between hypnotic and imaginative analgesia suggestions. This may have important clinical implications. Braffman and Kirsch (1999) found that when they administered a standardized hypnotic suggestibility scale both hypnotically and nonhypnotically, some people responded more strongly to the test suggestions when they were delivered in

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hypnosis, others responded more strongly to the suggestions when delivered outside of hypnosis, and still others responded equally strongly to the two sets of suggestions. Indeed, these investigators reported that 25% of a large sample of 173 subjects achieved higher scores on the scale when it was administered nonhypnotically. This suggests that for a substantial minority of patients, delivering an analgesia suggestion outside of hypnosis may actually be more effective than delivering it hypnotically.

Several important limitations of this study should be noted. It is unclear how much the findings of a study of experimental pain might generalize to clinical pain. Experimental pain is relatively mild, time-limited, and has no health implications. In contrast, clinical pain can be much more intense and may have serious health repercussions. Also, the representativeness of the treatments used in this study is open to question. In particular, the placebo condition employed a relatively simple manipulation with what amounted to a single conditioning trial. A logical progression in this area of inquiry would involve determining the percentage of mediation produced by response expectancies in a placebo study that uses a sophisticated manipulation of the pain experience (e.g. surreptitious lowering of the intensity of the pain stimulus) across multiple conditioning trials.

In sum, this study substantiates that response expectancies are an important mechanism of hypnotic, imaginative and placebo analgesia. The findings corroborated the view that the effect of hypnosis on pain is partially mediated by response expectancies. The results also showed that the effect of a placebo on pain was largely, but not completely, mediated by response expectancies. This leaves room for other explanations of placebo analgesia, such as classical conditioning. Of course, response expectancies and classical conditioning are not incompatible mechanisms of placebo responding. The percentage of mediation by response expectancies of the hypnotic (25%), imaginative (29%), and placebo (41%) treatments used in this study leaves room for only one or two other possible explanatory mechanisms of greater magnitude. Thus, although the results of this study do not suggest that response expectancies are the final common pathway to pain relief, they do indicate that response expectancies are one of the major psychological mechanisms of suggested and placebo analgesia.

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