Hypnosis and Distraction Differ in Their Effects on Cold Pressor Pain

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On the bases of Hilgard’s neodissociation theory and Spano’s (1982) socio-cognitive theory, volunteers stringently selected for high (N=10) and low (N=10) hypnotizability were exposed to a cold pressor pain test during counterbalanced conditions of waking relaxation, distraction, and hypnosis. To better discriminate between hypnosis and distraction conditions, a new distraction procedure was developed involving the memorization of a sequence of colored lights. High hypnotizables showed significantly greater pain relief for hypnosis versus distraction or waking relaxation conditions. High hypnotizables also demonstrated significantly greater pain relief than low hypnotizables in response to hypnosis. Quantitative electroencephalographic (EEG) findings showed significantly greater high theta (5.5 – 7.5 Hz) activity for highs as compared to lows at parietal (P3) and occipital (O1) sites during both hypnosis and waking relaxation conditions. The findings fail to support the socio-cognitive conceptualization of hypnotic behavior while providing additional evidence supporting the neo-dissociation theory and state based theories of hypnosis in general.

The primary purpose of this study was to test Hilgard’s (1977) neodissociation theory of hypnosis, which predicts both state specific and trait differences in hypnotic responding in comparison with Spano’s (1982) socio-cognitive theory, which proposes that hypnosis does not involve dissociation but simple attentional distraction. Our intention was to determine whether highly hypnotizable participants differ from low hypnotizables in perceived pain and neocortical electrical activity in three conditions: waking relaxation, distraction, and hypnotic analgesia. It was hypothesized that distinctions would be found between groups in both the experience of pain and in neocortical activity in the hypnotic analgesic condition.

Neo-dissociation theory (Hilgard, 1997, 1978) holds that hypnotic dissociation occurs when attention is effortlessly focused. “It is appropriate to describe activities as dissociated when one of them goes on automatically, with little conscious effort, as the other is carried out with attention focused on it” (Hilgard & LeBaron, 1982, p.4). The managing director of the attentional system is the “executive ego” which can turn one’s system to meet the environmental demands. The proposition that the dissociation that occurs in hypnosis is

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partial and thus functional has been clearly supported by a series of EEG hypnosis investigations using event related potentials, time locked to hypnotic events with fully controlled research designs (see Barabasz, Barabasz, Jensen, Calvin, Trevisan & Warner, 1999). The data reveals robust physiological markers of the trance state. The hypnotized individual remains in control of the situation, able to leave hypnosis or reject a hypnotic suggestion (Hilgard, 1984).

Cognitive social psychological theory (Spanos, 1982) holds that hypnosis does not involve dissociation but simple attentional distraction. Spanos believed that anyone can reduce pain through distraction by doing anything they can do with much conscious effort or by engaging in unrelated tasks (Devine & Spanos, 1990).

Hypnosis has been shown to be useful in the significant reduction of pain in both experimental (Barabasz & Barabasz, 1989; Hilgard, 1978; Miller, Barabasz, & Barabasz, 1991) and clinical (Anssil, 1990; Barabasz & Barabasz, 1989; Smith, Barabasz & Barabasz, 1996) settings. The investigation of pain responses between high and low hypnotizable groups has been studied using 60-second exposures to standard cold pressor pain, a method that has been reliably shown to relate to medical pains experienced by patients (Hardy, Wolff, & Goodell, 1940, 1952; Hilgard & Hilgard, 1975; Hilgard, Ruch, Lange, Lenox, Morgan, & Sachs, 1974). High hypnotizables reported lower pain scores in the hypnotic analgesic condition as compared to the waking relaxation and distraction conditions at both 30-second and 60-second data gathering points. Highs also reported significantly lower pain scores than low hypnotizables in the hypnotic analgesic condition. Low hypnotizables produced nearly identical pain scores in all conditions at both 30 and 60-second data points. The mean pain scores for both groups were nearly identical in the waking relaxation condition.

The present study also addressed potential theta EEG correlates of hypnotic responding. Historically, the electrocortical correlates of hypnotizability, hypnosis, and hypnotic analgesia have been difficult to identify, but recent findings have implicated the theta (3.5 – 7.5 Hz) bandwidth (Crawford & Gruzelier, 1992). The division of the traditional theta frequency range into low (3.5 - 5.5 Hz) and high (5.5 – 7.5 Hz) bandwidths has also yielded some findings potentially explicative of hypnotic responding (Crawford, 1990, 1991a; Sabourin, Cutcomb, Crawford, & Pribram, 1990). These studies showed significant difference between high and low hypnotizables in high theta at frontal, temporal, parietal, and occipital locations in both hemispheres, in an eyes closed resting condition. Graffin, Ray & Lundy (1995) have demonstrated that high hypnotizables show significantly more theta activity in frontal and temporal areas in comparison to low hypnotizables in baseline measurements. The same study also suggests that during hypnotic performance high hypnotizables demonstrate an attentional component related to the production of theta that differentiates them from low hypnotizables. A recent study by Barabasz, Stevens, and Genthe (1999) found that children with Attention-Deficit Disorder (ADD) were more hypnotizable than children without ADD and produced more theta activity in frontal, central, and posterior regions. The present study tested both low theta (3.5 – 5.5 Hz) and high theta (5.5 – 7.5 Hz) in high and low hypnotizability participants in an attempt to shed further light on potential EEG substrates of hypnotic responding.

We employed a new type of distraction procedure designed by the first author. Cognitive distraction has often been used as a comparative experimental condition to a hypnotic analgesic suggestion in pain studies. The types of distraction conditions used by many previous researchers appear flawed. Typically, participants have been instructed to imagine a pleasant scene (Tenenbaum, Kurtz, & Bienias, 1990); Turk, Meichenbaum, & Gnest, 1984), to “do whatever you can to reduce your pain” (Spanos, Kennedy, & Gwynn, 1984),
to imagine being in a desert, or to imagine an instructor giving a lecture (Spanos, Horton, & Chaves, 1975). Barabasz (1982) theorized that highly hypnotizable participants may spontaneously become involved with internally generated imagery, consistent with J. R. Hilgard’s (1979) theory of imaginative involvement. This suggests that the typical “distraction” conditions employed by previous researchers are likely to produce actual hypnotic responding via dissociation, thus misleading the socio-cognitive researcher to interpret pain relief as merely due to distraction when, in fact, the relief was produced by the induced hypnotic state. The improved distraction treatment introduced in this study was intended to capture the essence of Spanos’ socio-cognitive point of view and to minimize the likelihood that highly hypnotizable participants would spontaneously dissociate hypnotically in the distraction condition.

To shed light on this issue Smith, Barabasz, and Barabasz (1996) employed a sample of severely ill hypnotizable and low hypnotizable children (N = 27) who were undergoing a series of painful medical procedures in two different hospitals. Both hospitals had a program in place that used distraction methods (blowing-counting, pop-up toys with loud sounds, etc.) consistent with Divine and Spanos (1990). All of the research assistants, blind to children’s hypnotizability, expected the best results from the distraction condition while being skeptical or unconvinced that the hypnosis intervention could be effective. The hypnosis condition involved a “favorite place” induction where the parent and child go on an imaginary journey. Parent-child training times and adherence procedures were identical for both distraction and hypnotic procedures. The medical procedures were video taped, and skin conductance served as a physiological measure to confirm the autonomic arousal produced by a painful stimulus. Several standardized measures of pain perceptions were used. Consistent with the conceptualization of hypnosis as a special state of consciousness, the hypnotizable children showed significantly lower pain, anxiety, and distress scores in response to hypnosis, in contrast to the low hypnotizable children. The distraction condition with expectation for effect produced a significant effect only for the non-hypnotizables and only on the observer rated distress scale. Distraction and expectation failed to significantly alleviate pain or anxiety for either hypnotizable or non-hypnotizable children.

Method

Participants

Consistent with Barabasz and Barabasz (1992), pre-experimental training designed to maximize hypnotizability consisted of three phases. All participants were exposed to rapport building, education about hypnosis, and repeated inductions during the tests of hypnotizability. Volunteers (N > 200) from a large rural university community were initially assessed for hypnotizability using the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A) (Shor & Orne, 1962) in small groups of 7-12 participants. Highs (scores 9 and above out of a possible 12) and lows (3 and below) were scheduled for further hypnotic experiences. Selected participants were then administered the Stanford Hypnotic Susceptibility Scale, Form C (SHSS:C) (Weitzenhoffer & Hilgard, 1962). A minimum score of 9 on the 12-point scale was necessary for inclusion in the high group (N = 10, M = 10.9, SD = 1.00) and a maximum of 4 was the criterion for classification as a low hypnotizable (N = 10, M = 1.3, SD = 2.46). The final groups were gender-balanced (5 males and 5 females). All participants who completed the experimental procedures were paid $10.00.

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Apparatus

Quantitative EEG data were obtained using the Lexicor Medical Technology (Boulder, Colorado) Lexigraph-2400 and NeuroSearch 24 software\(^1\). A 21 electrode stretchable lycra cap (Electro-Cap Corp.) using 19 active monopolar sites was positioned to assure compliance with the international 10-20 placement method. Monopolar recordings were obtained from the 19 active electrode sites, including frontal pole (FP1, FP2), frontal (F3, F4, F7, F8), central (C3, C4), temporal (T3, T4, T5, T6), parietal (P3, P4), occipital (O1, O2), and the midline (FZ, CZ, PZ) sites. Resistances were kept below 4000 ohms with no more than 400 ohms between matched sites. The EEG signals were amplified using the Lexicor Neurosearch 24 system (gain setting 32K; 0.5 – 64 Hz). Standard RADIX2 Fast Fourier transform analyses were used to obtain peak-to-peak spectral magnitudes.

The distraction apparatus, created by the first author, consisted of a rubber kitchen-style storage box measuring 25 centimeters wide, 15 centimeters tall, and 15 centimeters deep. The front of the box was covered with translucent white plexiglass. Inside the box, mounted through the back wall, were three light bulbs colored red, blue, and green. Light bulb color changes were controlled manually by the experimenter.

Standard cold pressor pain procedures (Hilgard & Hilgard, 1975) were used for the administration of the pain stimulus. The cold pressor apparatus consisted of a basin filled with ice and water and a lever-operated carriage on which the participant’s arm rested. The ice was separated from the immersion area by a wire mesh. A pump circulated the water to ensure consistent temperature dispersion. Water temperature was maintained at 2 degrees Celsius (+ 1 degree C).

Procedure

Each participant experienced three 60-second cold-water immersions. Each immersion involved simultaneous pain reports and EEG monitoring. Using standardized procedure (Hilgard & Hilgard, 1975), pain reports were solicited at 30 seconds and 60 seconds. EEG monitoring was continuous. The first immersion for all participants was in the waking relaxation condition. This treatment served as a pretest baseline condition. Each participant was instructed that during the 60-second arm immersion that he/she was to (a) keep his/her eyes open looking forward, (b) not clench the immersed hand, and (c) report pain as previously instructed. All participants then received, in counterbalanced order, either the light array distraction condition, or the hypnotic analgesia condition.

During the distraction condition, the color on the screen changed two times. To avoid interference with the 30 and 60-second solicited pain reports, these intervals were staggered and occurred at the 15 and 45 second points. This required participants to report a three-color sequence. To help assure adherence to the essence of the Spanos conceptualization, instructions for the distraction condition were as follows:

During the following 60-second immersion of your arm, I want you to attend closely to the screen in front of you on the table. I’d like you to identify the color changes you see now…”red”…”green”…”blue”. During the 60 seconds your arm is in the water these colors will change several times. At the end of the 60 seconds, after I remove your arm from the water, I will ask you to tell me what sequence of colors you observed. As before, you will also be asked to report your pain when you hear “report” near the midpoint of the 60 seconds and again, after the immersion, I’ll ask you to report the maximum pain you felt. As before, it is very important that you remain still and relaxed during the monitoring period. Do you have any

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The hypnotic induction used for the hypnotic analgesic condition was the standard, eyes-closed induction from the Stanford Hypnotic Clinical Scale (SHCS) (Hilgard & Hilgard, 1975, p.213). It was presented to subjects in audiotaped format. The induction included instructions to progressively relax muscles starting from the feet and working toward the head. This induction was followed immediately by a hypnotic analgesia suggestion. These instructions were also presented in audio taped format. They included the suggestions that the “left arm was numb” and that, as it was lowered into the tank, they would “feel little or no sensation.” At the conclusion of the hypnotic analgesic suggestion and before the arm was immersed, participants were instructed to open their eyes and keep them open during the remainder of the procedure.

A minimum five-minute interval (typically 5 – 6.5 minutes) between arm immersions allowed participants’ arms to recover to normal temperature. Participants were also asked to verify if their arm felt normal prior to administration of another arm immersion.

Pain reports were taken using standardized procedures (Barabasz & Barabasz, 1989; Hilgard & Hilgard, 1975; Miller, Barabasz & Barabasz, 1991). Participants were asked to report their pain at the 30-second point of each arm immersion by assigning a numerical value to their pain experience on an open-ended scale where 0 represented no pain and 10 represented the pain level at which they “would very much like to remove the arm from the water.” Pain reports could exceed 10 because, upon reaching the anchoring level of 10, participants were encouraged to continue reporting. They were asked to report a second time immediately following the removal of their arm from the water. In this second report, participants were told to report the maximum pain they felt during the 60 seconds. During the recovery period after each arm immersion, each participant was asked to describe what, if anything, they had done to reduce the pain they felt. This inquiry was intended to provide qualitative information concerning the strategies employed by the participants.

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<td>x = high hypnotizables</td>
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Figure 1: 30 second mean pain scores.
To assess potential experimental demand characteristics, expectancy, and honesty of pain reports, an independent post-experimental inquiry was completed with each participant after the experiment. The interview consisted of three questions: (a) did you know what the experiment was about in terms of the ultimate objective? (b) Did you report your pain as you honestly felt it? and (c) Did you feel obligated to report your pain differently in any of the conditions?

Results

Pain Self Reports

The pain data were analyzed by two 2 X 3 between-within analyses of variance (ANOVA) (2 groups, high and low hypnotizability X 3 conditions, waking relaxation, distraction, and hypnotic analgesia) for 30-second and 60-second mean pain scores. A significant group X condition interaction effect, F (2, 36) = 17.58, p < .001 was found for the 30-second scores (Figure 1). The 60-second mean pain scores (Figure 2) also yielded a significant group X condition interaction effect, F (2, 36) = 13.59, p < .001. Post hoc analysis using Tukey’s HSD test indicated that 30 and 60-second mean pain scores showed that high hypnotizables reported significantly (p < .001) lower pain scores in the hypnotic analgesic condition as compared to waking relaxation and distraction conditions and that highs also reported significantly (p < .001) lower pain scores than low hypnotizables in the hypnotic analgesic condition. Low hypnotizables did not report significantly different pain scores in any of these conditions.

EEG

Analysis of the EEG data were performed by a series of 2 X 3 ANOVAs (2 groups, high and low hypnotizability X 3 conditions, waking relaxation, distraction, and hypnotic analgesia)
conducted on the dependent variables (high theta and low theta) at each of the 19 active monitoring sites (F7, F8, T3, T4, T5, T6, FP1, FP2, F3, F4, C3, C4, P3, P4, O1, O2, FZ, CZ, PZ). The results of a 2 X 3 ANOVA on high theta magnitude at the P3 (left parietal) site produced a significant interaction effect $F(2, 36) = 2.46, p = .10$. Following the suggestions of several hypnosis researchers (for reviews, see Barabasz & Barabasz, 1992; Orne & Scheibe, 1964), this study used an alpha level of .10. Post hoc analysis using Tukey’s HSD test showed that high hypnotizables produced significantly ($p < .10$) more high theta magnitude than low hypnotizables in the hypnotic analgesic condition and the waking relaxation condition at the P3 site.

The results of the 2 X 3 ANOVA performed on high theta magnitude at the O1 (left occipital) site also showed a significant interaction effect, $F(2, 36) = 2.55, p = .09$. Post hoc analysis using Tukey’s HSD test indicated that high hypnotizable participants showed significantly more ($p < .10$) high theta magnitude than low hypnotizables in the hypnotic analgesic condition and the waking relaxation condition at the O1 site. No differences were found in the low theta range for the waking relaxation or hypnotic analgesic conditions.

The results of a 2 X 3 ANOVA performed on low theta magnitude at the T4 site yielded a significant interaction effect $F(2, 36) = 5.09, p = .01$, and main effect for treatment condition $F(2, 36) = 3.52, p = .04$. Post Hoc analysis indicated that the low hypnotizables produced significantly more low theta in the distraction condition at the T4 site than at the same site in either waking relaxation or hypnotic analgesia. No significant differences were found between highs and lows in the low theta range within the waking relaxation, distraction, or hypnotic analgesic conditions.

**Figure 3:** High theta magnitude at the P3 site for three experimental conditions.
Qualitative Findings

Two supplemental inquiries were conducted to provide additional data concerning the subjective experiences of participants in the study. The following question was asked immediately after each participant removed his/her arm from the cold pressor tank in each
treatment condition: “What, if anything, did you do to reduce the pain?” This generated valuable information concerning expectancy and the coping strategies utilized by the participants (Barabasz & Barabasz, 1992).

First, high hypnotizables showed a spontaneous preference for strategies that appear to be more dissociative or imaginative than strategies described by low hypnotizables in the non-hypnotic (waking relaxation and distraction) conditions. Examples of high hypnotizable responses in the waking relaxation and distraction conditions include: “I associated the colors with warmth (red), sky (blue), and a meadow (green);” “I thought of warm water;” and “I paid more attention to a spot on the screen than to the pain.” In contrast, the low hypnotizables noted: “I counted numbers;” “I told myself it would be over soon;” or “I tried to ignore the pain.” The second qualitative finding indicated a difference between highs and lows in the hypnotic analgesic condition. In the hypnotic analgesic condition, eight of the ten high hypnotizable participants reported using no specific strategy to reduce the pain. These eight participants unanimously reported that the arm simply felt numb or less painful than in the other conditions, and they found no need to make any effort whatsoever to reduce the pain. There was no identifiable change in coping strategy for the lows across the three conditions. There was no discernible difference in expectancies for treatment effects between high and low hypnotizables.

Next was the post-experimental inquiry. At the end of the experimental procedures all participants were asked to complete a written survey consisting of three questions: (a) Did you know what the experiment was about in terms of the ultimate objective? (b) Did you report your pain as you honestly felt it? (c) Did you feel obligated to report your pain differently in any of these conditions? This inquiry confirmed that most participants had a general sense of what the experiment was designed to study. Fifteen of the twenty participants correctly reported that they believed the study to be concerned with pain control, EEG responses, and hypnosis. Five reported no such understanding. This independently gathered data revealed that all participants indicated that they had honestly reported their perceived pain in all of the experimental conditions and did not feel obligated to report differently in any of the conditions.

Discussion

The findings of this research fail to support the socio-cognitive (Spanos, 1982) perspective of hypnotic behavior while lending further support for the neo-dissociation theory of hypnosis. Our findings, obtained in the stringently controlled laboratory setting with adults, are entirely consistent with those of Smith, et al. (1996) which tested distraction and hypnosis with a clinical sample of 27 children undergoing painful medical procedures. Neither the findings in our study nor the previous study can be accounted for by expectancy. In the Smith study, expectancies on the part of both the research assistants, hospital staff, and patients’ parents favored the distraction procedure while in the present study no differences in expectancies between the treatment of high-low hypnotizable groups were revealed in the post-experimental inquires.

This research generated several findings of interest concerning the nature of hypnotic analgesia, hypnotizability, and associated neurocortical responses. High hypnotizables demonstrated significantly lower pain scores in the hypnotic analgesic condition in contrast to their performance in either waking relaxation or distraction, and in contrast to the lows in the hypnotic analgesic condition. Lows demonstrated no differences in pain scores among the three conditions.

The production of high theta (5.5 – 7.5 Hz) activity in the left parietal-occipital (P3, O1)
region was identified as a primary area of differentiation between high and low hypnotizables as well as for analgesic responsiveness to the hypnotic condition. The P3 and O1 sites are adjacent and located over the left hemisphere parietal-temporal-occipital association cortex. This area of the brain is believed to regulate the integration and association of somatic perceptions (P3) and control the processing of visual imagery (O1) (Kandel, Schwartz, & Jessell, 1991). This finding may indicate this region of the brain is central to the successful hypnotic alteration of afferent somatic perceptions in the process of cognitive-based pain control and that high hypnotizables may possess the ability to generate enhanced focused attention (or disattenttion) regarding information and activity controlled by these cerebral areas (Crawford, 1991b; Yamamoto & Matsuoka, 1990).

All EEG findings in this study, related to pain reduction, were found in the high theta range. These findings are consistent with the theory of Vogel, Broverman, and Klaiber (1968) concerning Class I and II inhibition of slow cortical activity. This theory postulates that two types of behavioral inhibition may be associated with theta range cortical activity, drowsiness (Class I) and more efficient attentional performance (Class II). Thus, the low range of theta activity (3.5 - 5.5 Hz) may truly be more closely related to the behaviors associated with the delta (0.1 - 3.5 Hz) bandwidth commonly associated with sleep and drowsiness (Kandel, Schwartz, & Jessell, 1991). The high end of the traditional theta range may be more accurately related behaviorally to low arousal with simultaneous abilities for focusing of attentional processes and accomplishment of cognitive tasks (Yamamoto & Matsuoka, 1990). This distinction may explain why the theta frequency band has commonly been associated with such a wide range of behavioral correlates (for review, see Schacter, 1977; Vogel & Broverman, 1964). These behaviors often appear contradictory (drowsy vs. focused attention). Analysis of both high and low theta activity appears useful in differentiating such behaviors in EEG studies. Investigation of the low range (7.5 – 9.5 Hz) of the traditional alpha bandwidth (7.5 – 12.5 Hz) is also warranted.

The findings of the study concerning the low theta range are remarkable in their absence. Only the T4 site demonstrated a significant difference for low hypnotizables in the distraction condition. As this difference was not accompanied by any difference in pain reports, it is difficult to interpret this finding. What is notable is that this lower half of the theta range contributes little to the electrocortical differentiation of high and low hypnotizable participants.

The new distraction techniques used in this study seemed to be particularly appropriate because it did not have hypnotic elements such as imaginative activity. Contrary to Spanos’ conceptualization, the high hypnotizables were apparently unable to utilize their hypnotic talents to reduce pain by distraction. This finding supports the results of Smith et al. (1996), which also failed to support Spanos’ socio-cognitive theory using distraction techniques.

References


