Hypnotic relaxation results in elevated thresholds of sensory detection but not of pain detection

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Somatosensory changes during hypnotic relaxation

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The element of relaxation has been assumed to play a major role in hypnotic analgesia. So far it is unknown whether hypnotic relaxation unfolds genuine analgesic effects on the sensory
perception of pain or whether the clinically observed pain relief is caused by the effect of relaxation on the affective aspects of pain.

This investigation evaluated the influence of hypnosis on somatosensory detection and pain thresholds. No effects on pain thresholds were observed.
Abstract

Background: The element of relaxation plays an important role in hypnotic analgesia. This study was designed to evaluate the effects of hypnotic relaxation suggestion on different somatosensory detection and pain thresholds.

Methods: Quantitative sensory testing (QST) measurements were performed in twenty-three healthy subjects on the dorsum of the right hand. Paired t-test was used to compare threshold changes before and during hypnosis. The influence of hypnotic susceptibility was evaluated by calculating correlation coefficients for threshold changes and hypnotic susceptibility (Harvard group scale).

Results: During hypnosis significantly changed somatosensory thresholds (reduced function) were observed for the following sensory detection thresholds: Cold Detection Threshold (CDT), Warm Detection Threshold (WDT), Thermal Sensory Limen (TSL) and Mechanical Detection Threshold (MDT). The only unchanged sensory detection threshold was Vibration Detection Threshold (VDT). No significant changes were observed for the determined pain detection thresholds (Cold Pain Thresholds, Heat Pain Thresholds, Mechanical Pain Sensitivity, Dynamic Mechanical Allodynia, Wind-up Ratio and Pressure Pain Threshold). No correlation of hypnotic susceptibility and threshold changes were detected.

Conclusion: Hypnotic relaxation without a specific analgesic suggestion results in sensory, but not pain threshold changes. We thus conclude that a relaxation suggestion has no genuine effect on sensory pain thresholds.
Introduction

Hypnosis is one of the oldest treatment forms of pain. There is an increasing evidence of its effectiveness in the therapy of acute and chronic pain [1-6]. The question has been raised whether hypnotic analgesia is a unique pain reduction strategy or whether different behavioral and cognitive elements are involved [7]. As the most common hypnotic techniques in pain therapy are focused analgesia (e.g. a glove of numbness being pulled over the painful extremity) and pleasant imagery relaxation suggestions (e.g. the visualization of peaceful scenery), it has been postulated that the element of relaxation might at least form a part of the analgesic effect of hypnosis [7, 8]. The techniques of relaxation suggestions and specific analgesic suggestions are often combined in clinical investigations and in the daily routine. This complicates a differentiation of the specific effects of the various suggestions on pain reduction. Indeed, the findings of studies focusing on this question are inconclusive: Some studies found hypnotic relaxation to be equally effective as analgesic suggestions [9], whereas others showed that analgesic suggestions are more effective [7, 10, 11]. This discrepancy can be caused by a number of reasons. One might be the fact that investigations on experimental pain often examine the reaction towards one single type of painful stimulus. However, not every type of stimulus can be modulated by hypnotic suggestions to the same degree as others [12]. An investigation of the effect of a hypnotic suggestion on different types of somatosensory stimuli could help to enlighten that theory. Quantitative sensory testing is a well-established, standardized protocol evaluating different thermal and mechanical detection and pain thresholds [13, 14]. It is therefore the ideal testing procedure to answer the question if the different hypnotic suggestions have a differential effect on somatosensory stimuli.

Another factor influencing the effect of hypnotic analgesia is the individual hypnotic susceptibility. A number of investigations could show that pain reduction was more effective in high than in low hypnotizable subjects [7, 15, 16]. Therefore we assessed the susceptibility
score for each subject to evaluate whether the observed effects depend on the hypnotic susceptibility.

In summary this study addresses the following questions:

1. A relaxation suggestion after the hypnotic induction often forms the basis for further hypnotic interventions, but it is unclear if it unfolds analgesic effects itself. It was therefore evaluated whether a suggestion of hypnotic relaxation without a specific analgesic component shows an influence on different somatosensory detection and pain thresholds, as assessed by quantitative sensory testing.

2. It was further evaluated whether that influence depends on the individual hypnotic susceptibility assessed by the Harvard Group Scale of Hypnotic Susceptibility.
Methods

Subjects

Twenty-three healthy subjects aged 31.7 ± 2.8 (mean ± sem; 10 male, 13 female) participated in this study. All subjects participated voluntarily and gave written informed consent. The study was carried out according to the Helsinki Declaration, and was approved by the local ethics committee.

Excluded from the study were subjects with a history of major psychiatric disease, substance abuse, severe systemic, metabolic or neurological disease capable of influencing quantitative sensory testing.

Design

In a single group pretest posttest design the effects of the hypnotic state on sensory parameters (quantitative sensory testing (QST)) were assessed. Hypnotic susceptibility was tested in all subjects before participation in the QST measurements. QST measurements were performed on the back of the right hand proximal to DII and DIII before and during hypnosis.

Hypnosis and hypnotic susceptibility

Hypnosis and testing for hypnotic susceptibility were performed by a trained hypnotherapist. All Participants were tested for hypnotic susceptibility following the German norms of the Harvard Group Scale of Hypnotic Susceptibility, Form A [17, 18], before participation in the QST measurements. Twenty-three subjects were selected out of forty-nine that were screened. Neither the participants nor the QST examiner, nor the hypnotherapist were informed about the results of the susceptibility testing.

Hypnosis was verbally induced using the fixation method. The induction phase of the hypnotic state was standardized in its wording for all individuals. After a suggestion of palpebral catalepsy, the participants were asked to try to open their eyes as a manipulation
check. If they stated that this was not possible, the hypnotherapist asked them to focus their attention on imagining an individual situation of well-being and calmness they had described before hypnosis. They were asked to imagine visual, auditory and tactile stimuli associated with the image in detail. The hypnotherapist then inquired about the situation and place the participants had reached in order to once more verify the hypnotic state. This individual part of hypnotic suggestion was repeated after the thermal testing of QST.

**Quantitative sensory testing (QST)**

QST was performed following the protocol developed by the German Research Network on Neuropathic Pain (DFNS) to improve the diagnostic value of QST and provide a broad basis of reproducible results [13, 14].

**Thermal thresholds**

Thermal testing was performed using a Peltier-based computerized thermal stimulator (TSA II; Medoc Inc., Ramat Ishai, Israel), with a 3 x 3 cm contact probe. All thresholds were measured using ramped stimuli (1 °C/s) with a baseline temperature of 32°C. Cut-off temperatures were 0 °C and 50 °C. Cold and warm detection thresholds (CDT, WDT) were assessed, as well as paradoxical heat sensations (PHS) during thermal sensory limen procedure (TSL) of alternating warm and cold stimuli. Afterwards, cold and heat pain thresholds (CPT, HPT) were obtained.

**Mechanical detection thresholds**

Mechanical detection thresholds (MDT) were assessed with a set of standardized von Frey filaments with forces two from 0.25 mN to 512 mN (Marstock-nervtest Ltd., Marburg, Germany). Using the “method of limits”, five ascending and five descending series of stimuli were applied (1 s duration per stimulus).
Mechanical pain thresholds

Mechanical pain thresholds (MPT) were measured with pinprick stimulators (non-injuring tip with a diameter of 0.2 mm) with fixed stimulus intensities from 8 mN to 512 mN (Department of Physiology and Pathophysiology, Mainz, Germany) [19]. Thresholds were calculated as the geometric mean of ascending/descending stimulus forces until the first perception/loss of sharpness.

Stimulus-/Response-Function (SRF): Mechanical Pain Sensitivity and Dynamic Mechanical Allodynia

In a separate test, a stimulus-response function for the mechanical pain sensitivity (MPS) was determined using the same pinpricks already described to activate \( \text{A}_\delta \)-nociceptors [19-21]. Pain in response to light touch (dynamic mechanical allodynia; ALL) was tested by light stroking with a cotton wisp (3 mN), a cotton wool tip fixed to an elastic strip (100 mN) and a brush (200-400 mN). Each of the seven intensities of pinpricks and three intensities of light stroking was applied five times in a randomized sequence. The subjects were asked to rate pain on a numerical rating scale (NRS; 0 = no pain, 100 = maximal imaginable pain). The mechanical pain sensitivity was calculated as the geometric mean of all pain ratings for pinprick stimuli. Dynamic mechanical allodynia was quantified as the geometric mean of all numerical pain ratings after light touch stimuli.

The wind-up ratio (WUR) was examined using ten repetitive pinprick stimuli (1 Hz) compared to a single pinprick stimulus with a force of 256 mN. Wind-up ratio was calculated as the mean pain rating of five series of repetitive pinprick stimuli divided by the mean pain rating of five single stimuli.

Vibration detection thresholds

Vibration detection thresholds (VDT) were examined with a Rydel-Seiffer tuning fork (64 Hz) that has a graded readout of vibration amplitude (from 0 to 8). Vibration detection thresholds were assessed by three series of descending stimulus intensities.
Pressure Pain Thresholds

Pressure pain thresholds (PPT) were measured using a pressure algometer (FDK20, Wagner Instruments, Greenwich, CT, USA) with a range between 2 and 20 kg. The algometer had a rubber tip with a contact area of 1 cm$^2$. The algometer was pressed to the skin with an increasing ramp of 0.5 kg/s, and the patient was asked to respond verbally as soon as the pressure became painful. This procedure was performed three times.

Data analysis

All data are presented as raw data (mean ± SEM). For statistical analysis several QST variables (CDT, WDT, TSL, MDT, MPS, ALL, WUR and PPT) were transformed logarithmically as recommended by Rolke et al., 2006b[14] resulting in normally distributed variables. To prevent the loss of zero values, 0.001 was added to zero before the data transformation. Hence, the pre-post comparison was performed by a paired sample t-test. Because of the variety of QST measures an α-adjustment for multiple testing according to Bonferroni was carried out with a p-value < 0.0041 regarded as statistically significant.

The identification of possible outcome differences depending on the hypnotic susceptibility was calculated by an ANCOVA as suggested by Vickers [22]. Data preparation and all calculations were performed by using the statistical package for social sciences (IBM SPSS 19 for Windows).
Results

Quantitative sensory testing results from the dorsum of the right hand from twenty-two healthy subjects before and during hypnosis were compared. For one subject vibration detection thresholds had to be excluded from analysis because of falling asleep at the end of QST procedure.

Somatosensory Profile

Results of quantitative sensory testing are shown in table 1 and figure 1. Cold detection thresholds (CDT) were significantly lowered, warm detection thresholds (WDT) were significantly elevated during hypnosis compared to the measurements before hypnosis. Accordingly, Thermal sensory limen (TSL), assessed by alternating CDTs and WDTs, were significantly elevated. No Paradoxical heat sensations (PHS) (assessed during TSL procedure) were observed before or during hypnosis. Cold pain thresholds (CPT) and Heat pain thresholds (HPT) did not show significant changes.

Mechanical detection thresholds (MDT) were significantly increased during hypnosis. Mechanical pain thresholds (MPT) and Mechanical pain sensitivity (MPS) showed a trend towards an increased threshold, that did not reach statistical significance due to the lowered significance level after Bonferroni-adjustment for multiple testing (p=0.0045). Dynamic mechanical allodynia (DMA), Wind-up ratio (WUR), Vibration detection thresholds (VDT) and Pressure pain thresholds (PPT) did not show significant changes.

No significant influence of hypnotic susceptibility on sensory thresholds changes was observed (figure 2).
Discussion

It was the aim of the present study to evaluate the influence of hypnotic relaxation without a specific analgesic suggestion on different somatosensory detection and pain thresholds, as assessed by quantitative sensory testing (QST). It was a further aim to examine whether the observed changes depend on the individual hypnotic susceptibility [Harvard test [17]].

We observed a significant change (reduced function) of different sensory detection thresholds (WDT, CDT, TSL, MDT) during hypnosis estimated by QST. Vibration detection and all pain thresholds did not show statistically significant changes. A correlation of sensory threshold changes to the determined hypnotic susceptibility score could not be demonstrated.

To our knowledge this investigation is the first to evaluate the effect of hypnosis on somatosensory detection and pain perception thresholds in a battery of standardized sensory tests such as QST. This comprehensive testing provides the opportunity to assess which kind of sensory qualities are the main focus of a hypnotic suggestion. Most previous investigations concentrated on evaluating the analgesic effect of a hypnotic suggestion on a certain type of pain stimulus. However, there are three investigations that can partly be compared to our approach:

DePascalis et al. [23] compared the effects of three different suggestions and placebo on painful electric stimuli. The detection and pain thresholds in DePascalis` investigation could correspond to the mechanical detection threshold (MDT) and the mechanical pain threshold (MPT) in our study, only the source of the stimulus was different (electric pain stimulus). Our results confirm DePascalis` observation that pain thresholds were not significantly altered by relaxation suggestions. But in contrast to our results they did not observe a significant effect of relaxation on detection thresholds. The discrepancy might be caused by the different type of stimulus. This underlines the importance of investigating the effects of hypnotic suggestions on different stimuli: Obviously there is no generalizability of hypnotic analgesia...
for different types of pain and differences in the effectiveness of hypnosis on different pain stimuli have been observed before [12].

Langlade et al [24] measured thermal detection, heat pain and heat pain-tolerance thresholds in fifteen healthy volunteers on the upper extremity (hand) after a suggestion of anesthesia of the right hand. During hypnotic suggestion they found a significant increase in heat detection and heat pain thresholds whereas changes in cold detection and heat pain-tolerance did not reach statistical significance. They did not assess the hypnotic susceptibility of the subjects.

Benhaiem et al [15] measured thermal thresholds in 32 healthy volunteers on the upper and lower extremity after a foot analgesia suggestion. During hypnosis they found significant local (foot) and remote (hand) alterations of heat pain thresholds depending on each subject`s susceptibility score. They further found significant local and remote alterations of warm and cold detection thresholds not correlated to hypnotic susceptibility. They therefore concluded that the modifications on thermal detection thresholds were less specific than those on thermal pain thresholds.

Our findings partly confirm the results of Benhaiem et al and of Langlade et al. In contrast to the two previous studies we did not observe threshold changes regarding thermal pain detection, but only change of thermal detection thresholds. In our opinion the most likely reason for the discrepancies between their findings and ours is the type of hypnotic suggestion: Both investigations employed a specific analgesic suggestion in contrast to the relaxation suggestion that was used in our investigation. It has been shown previously that rather the type of hypnotic suggestions than hypnosis itself influences the perception and processing of sensory and pain stimuli [16] with an advantage of a specific analgesic suggestion regarding pain relief [23, 25].

In this context future studies should concentrate on comparing the effect of different suggestions. The reasons for our decision to focus on the evaluation of hypnotic relaxation was the consideration that in clinical practice hypnotic relaxation often follows the induction
as a basis for further suggestions. Hypnotic relaxation could thus be referred to as “neutral hypnosis” [7, 11]. It was intention of this study to evaluate whether this basis alone already modulates sensory pain thresholds.

The observed reduced functions in sensory detection thresholds are difficult to discuss at the current state of knowledge, but we believe that they are mainly caused by distraction. Out of all somatosensory detection thresholds evaluated in our study, only vibration detection thresholds (VDT) showed no changes during hypnosis. To our knowledge there are no other investigations assessing hypnotic effects on mechanical perception thresholds apart from pain perception. Therefore these results are hard to interpret. A simple explanation might be that VDT is the only threshold in QST which is determined by a stimulus starting with full intensity decreasing to zero instead of a stimulus starting at zero with increasing intensity. The proband is more likely to immediately focus on a full intensity stimulus than on a stimulus that slowly reaches the individual perception threshold. This context once more suggests that distraction plays a role in our observations.

In summary, our findings indicate that a hypnotic relaxation suggestion does not unfold a specific analgesic effect (no influence on pain perception thresholds was observed). This finding is in contrast to the observation that hypnotic relaxation has an analgesic effect in a clinical setting [8, 26]. However, it has been shown that hypnosis in general, but especially hypnotic relaxation influences the affective aspect of pain perception to a larger extend than the sensory [25]. QST aims at the sensory component of perception rather than on affective aspects. Therefore our results are in line with these findings. Nevertheless future studies might need to introduce a parameter to assess affective aspects in addition to evaluating sensory thresholds.

A correlation of the individual hypnotic susceptibility with the analgesic effect has been described for a specific analgesic suggestion [15, 27, 28]. For unspecific remote effects the individual susceptibility does not seem to be of importance [15]. This was the case for our
observations as well. The fact that we did not find a correlation of the susceptibility score and the sensory changes is probably due to the more general relaxation suggestion. However, this observation in the context of our findings has an important implication for the clinical practice: Even if a relaxation suggestion has no genuine analgesic effect it might still be effective in a clinical setting, due to a modulation of the affective component of pain. Future studies should focus on the influence of different suggestions on somatosensory threshold changes as a function of hypnotic susceptibility and the proportion of sensory/ affective components of pain.

**Conclusion:**

In summary our findings indicate that the induction of a hypnotic state without special analgesic suggestions leads to an increase in sensory detection thresholds that does not depend on hypnotic susceptibility and has no effects on pain perception thresholds. The clinical implication of these findings is that a differential hypnosis should be adjusted to the patient’s individual requirements: Therapy of pain should be accomplished by a specific analgesic suggestion. However, the intensity of pain relief can depend on the individual susceptibility as can the analgesic effect of specific suggestions. Further investigations should compare the effect of different suggestions on somatosensory thresholds according to the hypnotic susceptibility.

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The authors are justifiably credited with authorship, according to the authorship criteria. In detail: SK – conception, design, acquisition, QST measurements, analysis and interpretation of data, drafting of the manuscript, final approval given; RZ – conception, design, acquisition, hypnosis, final approval given; MS – statistical analysis and interpretation of data, critical revision of manuscript, final approval given; LR – QST measurements, critical revision of manuscript, final approval given; DI- conception, design and interpretation of data, drafting of the manuscript, final approval given.
Reference List:


Figure 1
Figure 2
Additional files provided with this submission:

Additional file 1: Kramer_Sensory thresholds_during_hypnotic relaxation_table_1.doc, 40K
http://www.biomedcentral.com/imedia/1617731777948527/supp1.doc