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Original experimental

Effect of expectation on pain assessment of lower- and higher-intensity stimuli

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HIGHLIGHTS

- Expectation can have prolonged effect on pain perception.
- When expecting lower-intensity stimuli, participants underestimated pain intensity.
- When expecting higher-intensity stimuli, participants overestimated pain intensity.
- The effect size is moderate to large for both lower- and higher-intensity stimuli.

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ABSTRACT

Background and aims: Pain modulation via expectation is a well-documented phenomenon. So far it has been shown that expectations about effectiveness of a certain treatment enhance the effectiveness of different analgesics and of drug-free pain treatments. Also, studies demonstrate that people assess same-intensity stimuli differently, depending on the experimentally induced expectations regarding the characteristics of the stimuli. Prolonged effect of expectation on pain perception and possible symmetry in conditions of lower- and higher-intensity stimuli is yet to be studied. Aim of this study is to determine the effect of expectation on the perception of pain experimentally induced by the series of higher- and lower-intensity stimuli.

Methods: 192 healthy participants were assigned to four experimental groups differing by expectations regarding the intensity of painful stimuli series. Expectations of two groups were congruent with actual stimuli; one group expected and received lower-intensity stimuli and the other expected and received higher-intensity stimuli. Expectations of the remaining two groups were not congruent with actual stimuli; one group expected higher-intensity stimuli, but actually received lower-intensity stimuli while the other group expected lower-intensity stimuli, but in fact received higher-intensity ones. Each group received a series of 24 varied-intensity electrical stimuli rated by the participants on a 30° intensity scale.

Results: Expectation manipulation had statistically significant effect on pain intensity assessment. When expecting lower-intensity stimuli, the participants underestimated pain intensity and when expecting higher-intensity stimuli, they overestimated pain intensity. The effect size of expectations upon pain intensity assessment was equal for both lower- and higher-intensity stimuli.

Conclusion: The obtained results imply that expectation manipulation can achieve the desired effect of decreasing or increasing both slight and more severe pain for a longer period of time. Manipulation via expectation before the stimuli series was proven to be effective for pain modulation in the entire series of stimuli which lasted around 10 min. The results suggest a potential benefit of manipulating expectations to alleviate emerging pain, since the obtained effects are moderate to large.

Implications: It seems that expectation effect is strong enough to "overcome" even the direct effect of stimulus intensity (at least in the low to moderate intensity range), which suggests potential benefits of verbal instructions even in rather painful stimuli.

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1. Introduction

The role of expectation in pain modulation is studied within several research categories. The first category refers to the placebo effect. For the analgesic effect of some inactive substance to appear it is important that a person experience the matching (conditioning) of real and placebo treatment [1,2]. The placebo effect is significantly greater and more stable if conditioning is accompanied by expectations of positive outcome [3,4], but mere manipulation of expectation also leads to the placebo effect [5–8]. A positive correlation was found between strength of expectations and the size of the placebo effect [9], and between the direction of expectation and the direction of placebo/nocebo effect [10]. The effect sizes of placebo analgesia are found to be greater in experimental than in clinical studies [11] which is attributed to more detailed instructions in clinical setting and therefore more specific and stronger expectations of a certain treatment [12], thus showing the importance of expectations in placebo analgesia.

The second research category refers to the open or hidden manner of drug administration. Unlike hidden drug administration, open administration is accompanied by verbal suggestions regarding its effectiveness. Open administration and verbal suggestions can double the analgesic effect of the drug [13,14], but can also completely annul its effect (if the suggestions are negative) [15]. Expectations formed during open drug administration lead to greater drug effectiveness in patients suffering from pain, anxiety or Parkinsons' disease [16], and influence the effectiveness of different drug-free pain treatments, e.g. acupuncture [17].

The third research category refers to the examination of the effect of expectation upon the experience of pain, without combining it with either placebo or actual treatment. These studies are mostly experimental, demonstrating that people assess same-intensity stimuli differently, depending on the experimentally induced expectations regarding the characteristics of the stimuli. When expecting a weak, non-painful stimulus, a person's assessment of the received stimulus is lower than when expecting stimulus to be painful [18–21]. Also, when participants are informed about the incoming stimulus intensity, they assess it as less intense or unpleasant [22–24].

Results within all three categories clearly illustrate the role of expectations as a cognitive modulator of pain and suggest practical implications of expectation-based pain modulation for people suffering from acute or chronic pain. Diversity of possible usage of expectations in research and practice makes expectations relevant for further investigation. This was also the reason why we conducted the present study. Between studies in the third research category, dominant are those that manipulate expectations by introducing a signal that suggests the quality of the following stimulus thus leading to the forming of expectation regarding the following stimulus. Those designs are especially eligible when testing the possible physiological basis of the expectation manipulation effect [25,26] because of the possibility for the exact determination of time frames for the expected stimulus. There is, however, a deficiency of research which manipulates expectations for a longer period of time. If such an effect were found to be true, this would provide the basis for the usage of expectation in different pain treatments such as medical procedures with more than one short pain episode or prolonged pain that varies over time.

2. Methods

2.1. Participants

A total of 192 healthy participants (133 female) aged 18–51 ($M = 22.97$, $SD = 4.55$) volunteered to participate in the study. Participants were students and adults that answered adds on social networks or were recommended by other participants. Students got credits for their participation in the study and, after the data collection was over, all participant received written explanation of their results and general results of the study.

Table 1
Design of the study.

Applied intensity of stimulation	Manipulated expectation	
	Expectation of lower-intensity stimuli	Expectation of higher-intensity stimuli
Series of lower-intensity stimuli (range: 1.96–3.36 mA)	Group 1 $n = 48$ (15)	Group 2 $n = 49$ (15)
Series of higher-intensity stimuli (range: 2.76–4.16 mA)	Group 3 $n = 48$ (14)	Group 4 $n = 47$ (15)

In groups (1 and 4) expectations were congruent with the intensity of stimulation so these groups are treated as referent. In groups 2 and 3 expectations were not congruent with the intensity of stimulation. The difference between groups 1 and 2 indicates the effect of expectations in lower-intensity stimuli and the difference between groups 3 and 4 indicates the effect of expectations in higher-intensity painful stimuli. The number of male participants is displayed in parentheses.

2.2. Stimulation

Electrical stimulation (DS5 Isolated Bipolar Constant Current Stimulator, Digitimer Ltd.) was applied to the upper side of the left index and ring fingers, near the fingernail. The size of the electrode was 1 cm^2. Duration of each stimulus was 1.5 s.

2.3. Measurement of participants' pain sensitivity

Measurement was conducted in isolated room of laboratory for psychological research. Participants were alone in the room but experimenter could see them at all times through glass that connected room for measurement with room in which aparates for electrical stimulation were.

The initial measurement was conducted prior to the main experiment for two reasons. The first was to introduce participants to the sensational quality of electrical stimulation. For that reason each participant received three different stimuli (1.96, 3.16 and 3.53 mA). The second purpose was to determine a participant's individual sensitivity to electrical stimulation, which was done in two separate steps. First, participants received a series of 15 different stimuli (intensity range from 2.76 to 3.56 mA) in quasirandom sequence (differences between adjacent stimuli were 0.2 mA). Their task was to assess the pain intensity of each stimulus on a scale from 0 (weak, non-painful stimulus) to 10 (exceptionally strong, non-bearable stimulus). Second, 10 min later, participants were engaged in an electrical pain tolerance measurement. Electrical stimulation started at 1.96 mA and was sequentially increased by 0.2 mA until participants stated they could no longer tolerate pain. Pain tolerance was defined as the maximum stimulus intensity a participant was willing to endure. Based on these two measures (average assessment of 15 stimuli and individual pain tolerance) blocks of similarly sensitive participants were formed to ensure equivalence regarding sensitivity to electrical stimulation.

2.4. Design and experimental manipulation

One month later, we conducted the main experiment. There were four independent groups in concordance with the study design (Table 1). The groups differed in (a) expectation manipulation and (b) intensity of stimuli series. Expectation manipulation was primarily conducted through verbal instruction. The first