

# When one suffers less, all suffer less: Individual pain ratings are more effective than group ratings in producing placebo hypoalgesia

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## Funding information

The study was funded by the National Science Centre in Poland within grant no. 2016/23/B/HS6/03890. The open access license of the publication was funded by the Priority Research Area Society of the Future under the programme “Excellence Initiative – Research University” at the Jagiellonian University in Krakow

## Abstract

**Background:** Placebo hypoalgesia can be induced by observing a person (model) whose pain relief is the result of the use of an inert substance or procedure. This study examined whether verbal modelling, that is, showing pain ratings provided by other people, is sufficient to induce placebo hypoalgesia.

**Methods:** Participants from the experimental groups were acquainted with pain ratings (presented on VASs) derived from a single person (groups 1 and 3) or a group of people (groups 2 and 4) that were allegedly subjected to the same painful procedure. The ratings of pain stimuli that were allegedly applied with placebo were lower than the ratings of stimuli applied without placebo. In two of the experimental groups (group 3 and 4), participants also watched a video recording showing individuals who allegedly provided pain ratings; however, they did not observe them undergoing pain stimulation. The control group did not undergo any manipulation. Then, the participants received a series of the same thermal pain stimuli that were applied either with or without placebo and rated their intensity.

**Results:** Placebo hypoalgesia was induced only in participants presented with pain ratings provided by a single person, regardless of whether this person was previously seen. However, the pain ratings presented to the participants generally decreased individual pain sensations, regardless of whether they came from a group of people or a single person.

**Conclusions:** Verbal modelling can produce placebo hypoalgesia and reduce pain sensations. It may be effectively used in clinical practice to modify patients' responses to pain treatment.

**Significance:** This study shows that knowledge about pain ratings provided by another person is sufficient to induce placebo hypoalgesia; thus, neither direct nor indirect observation of a person experiencing pain is necessary to induce this effect. Pain ratings derived from a group of people can decrease pain sensations but they do not produce placebo hypoalgesia.

## 1 | INTRODUCTION

There is ample evidence that other people's pain experiences affect individual's pain perception (Goubert et al., 2011). Individual pain responses are influenced by pain reports, paralinguistic vocalizations, facial expressions or body postures of other people experiencing pain (Craig et al., 2010). Other people's pain-related behaviours can also shape placebo hypoalgesia. Observing an individual whose pain decreases after the use of an inert treatment may elicit a similar effect on an observer undergoing the same treatment (Bajcar & Babel, 2018; Faasse & Petrie, 2016).

According to the social learning model of placebo effects (Bajcar & Babel, 2018), which is based on Bandura's social learning theory (Bandura, 1976, 1985), pain-related information can be conveyed to the observer through behavioural modelling (direct demonstration of specific behaviour), symbolic modelling (indirect pictorial representation of behaviour) or verbal modelling (verbal description of behaviour). The conveyed information may contribute to the formation of expectancies of hypoalgesia or hyperalgesia and thereby induce placebo effects. Previous studies have shown that behavioural modelling (Colloca & Benedetti, 2009; Świder & Babel, 2013, 2016) and symbolic modelling (Schenk & Colloca, 2020; Vögtle et al., 2013, 2016, 2019) contribute significantly to placebo and nocebo effects. Although previous research has provided evidence that verbal modelling, that is, showing pain ratings of other people subjected to the same painful stimulation (Koban & Wager, 2016; Yoshida et al., 2013) modulates the pain perception of participants who saw these ratings, the role of verbal modelling in the induction of placebo effects has not yet been established. The main aim of the current study was to test the social learning model of placebo effects by investigating the role of verbal modelling in shaping the placebo effect.

According to theories of social influence that have been developed in the field of social psychology, people tend to adjust their behaviour to that presented by the majority, especially when the majority provides coherent information (Asch, 1955; Cialdini & Goldstein, 2004). Moreover, previous studies have shown that observing a person reporting changes in pain sensation can modify the observer's pain experiences (Bajcar & Babel, 2018; Goubert et al., 2011). Based on these studies, we hypothesized that pain ratings provided by a single person or a group of individuals would induce placebo hypoalgesia. We also hypothesized that pain ratings from a group of people would produce more robust placebo hypoalgesia than pain ratings from a single person. To increase the source of information credibility, participants in two groups were primed with a movie showing people who allegedly provided pain ratings. We hypothesized that pain ratings provided by a single person or a group of individuals that the participants were able to see would elicit more robust

placebo hypoalgesia than pain ratings provided by anonymous people.

Based on previous findings on placebo effects induced by behavioural and symbolic modelling, we expected positive correlations between empathy (Colloca & Benedetti, 2009; Hunter et al., 2014; Świder & Babel, 2013), pain-related expectancies (Schenk & Colloca, 2020) and placebo hypoalgesia induced by verbal modelling. Also, the conformity of the participants and their tendency to yield to social influence were controlled for to examine whether they are involved in placebo hypoalgesia induced by verbal modelling.

## 2 | MATERIALS AND METHODS

### 2.1 | Study design

During the experiment, participants received a series of thermal pain stimuli and rated their intensity. They were randomly allocated to one control and four experimental groups. Participants in the experimental groups were shown pain ratings that had allegedly come from other participants (models) in the same study. Participants in experimental groups 1 and 3 were shown pain ratings purportedly from a single participant, while participants in groups 2 and 4 were shown distinct pain ratings supposedly from a group of eight participants. The ratings of pain stimuli that were allegedly applied with placebo were lower than the ratings of the stimuli applied without placebo. Additionally, participants in groups 3 and 4 watched a video showing one or eight alleged participants, respectively, from whom the pain ratings were obtained; however, they did not observe them undergoing pain stimulation. The purpose of the videos was to increase the credibility of the alleged participants as a source of information about pain intensity. No videos or ratings were presented to participants in the control group. The overall design of the study is presented in Figure 1.

### 2.2 | Sample size

The sample size was determined based on the effect sizes from a previous study (Bajcar, Wiercioch-Kuzianik, Farley, et al., 2020) using G\*Power 3.1 software (Faul et al., 2007). In order to detect a significant difference in pain intensity between the experimental groups and the control group, it was estimated that a sample of a minimum of 21 participants would be required per group ( $\alpha = 0.05$ , 80%, within-group comparison). This number was extended to 30 participants in each experimental group and the control group in order to be sufficient for all planned statistical analyses. The collection of the data ended when the goal of 30 participants in each group was obtained.

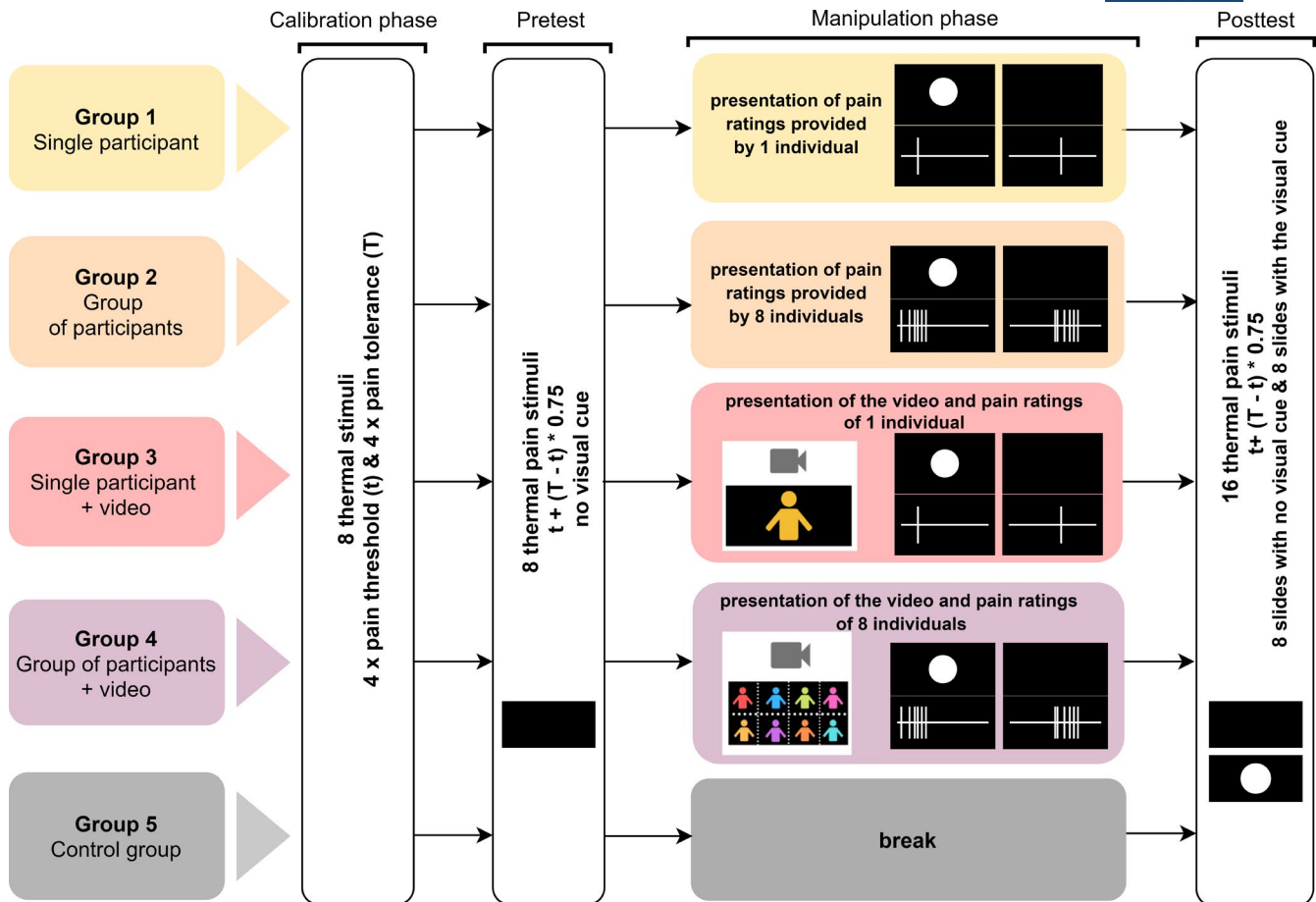


FIGURE 1 Study design presenting the experimental procedure in all five groups

## 2.3 | Participants

A total of 220 volunteers took part in the study, including 121 females (55%). They were recruited through postings on social media and classified advertisement websites; they were compensated financially for their participation in the study. All participants were 18 to 35 years of age, were mentally and physically healthy, had no prior experience with pain research, and were not using drugs, alcohol or stimulants around the time of the study. The *Hospital Anxiety and Depression Scale* (HADS; Zigmond & Snaith, 1983) was applied during the screening phase in order to exclude individuals with symptoms of anxiety or depression. The height and weight of the participants were recorded in order to control for differences between participants in different groups because of evidence suggesting that body mass index may be associated with thermal pain thresholds (Price et al., 2013; Tashani et al., 2017). The participants were informed that they would take part in a study on the perception of thermal pain and that they would receive painful thermal stimulation. Participants could withdraw their consent to participate at any time without providing a reason. The study protocol was accepted by the Research Ethics Committee at the Institute of Psychology, Jagiellonian

University, Kraków, Poland; it was preregistered on the Open Science Framework, webpage: <https://osf.io/ph8m2>

## 2.4 | Stimuli

### 2.4.1 | Pain stimuli

Thermal heat pain was delivered to the volar surface of the nondominant forearm using the Pathway Pain & Sensory Evaluation System (model ATS, Medoc). The intensity of thermal stimuli was calculated individually for each participant based on the calibration procedure described below. The target temperature was maintained for 4 s with a ramp-up and ramp-down rate of 10°C/s.

### 2.4.2 | Placebo stimulus

The placebo stimulus was a white circle presented in full-screen mode on a computer screen (size 17", resolution 1280 × 1024) placed in front of each participant at a distance of approximately 50 cm.

### 2.4.3 | Verbal modelling

During the manipulation phase, participants in the experimental groups were shown pain intensity ratings derived from other alleged participants; in fact, these ratings were calculated by a computer. The ratings were presented as vertical bars on a visual analogue scale (VAS; see Section 2.5 for details): each bar represented the rating of one 'other participant'. Notably, the ratings were displayed repeatedly, half of them were accompanied by the placebo stimulus, and the other half were presented without the placebo. The ratings that accompanied the placebo stimulus (white circle) were always lower (by 15 to 25 VAS points; the exact position was chosen randomly by a computer) than the actual participant's average rating from the pretest phase. For this reason, participants whose mean pain rating in the pretest phase was below 25 on VAS were excluded from the analysis. The ratings presented in the non-placebo condition were similar ( $\pm 5$  VAS points) to the real average rating of the actual participant. Because the study aimed to investigate the effect of verbal modelling on placebo hypoalgesia, the participants were acquainted only with other people's pain ratings but did not observe them experiencing pain.

### 2.4.4 | Video recordings

Eight models were filmed in total: four men and four women in the same age range as the participants. In group 3, the video presented one model that was either a man or a woman. The video recording was chosen randomly by a computer from eight available recordings. In group 4, all eight models were presented at the same time on one screen divided into eight parts. Each part of the screen showed a video recording of one model. The models were shown in succession: (1) entering the laboratory, (2) having a thermode attached to their forearms, (3) looking straight at the viewer and (4) leaving the laboratory. The models were not shown experiencing pain stimuli. The video was meant to convince the participants that the ratings came from other actual participants in the study.

## 2.5 | Measures

### 2.5.1 | Pain intensity and pain expectancy assessments

Both pain intensity and pain expectancy were assessed on the VASs: ranging from 'no pain' at the left-hand end to 'the most intense pain tolerable' at the right-hand end. During the experiment, the VAS was presented on the computer screen until participants made their response.

### 2.5.2 | Psychological traits

Three questionnaires were administered in order to probe the relationship between the magnitude of the placebo effect and the level of empathy, compliance and susceptibility to social influence. The *Interpersonal Reactivity Index* (IRI; Davis, 1980) is a scale for measuring trait empathy. The Polish version of the questionnaire (Kaźmierczak et al., 2007) contains 21 items divided into three subscales: *Empathic Concern*, *Perspective Taking* and *Personal Distress*. The Polish version does not contain the *Fantasy Scale* from the original IRI. The items were rated on a 5-point Likert scale. The final score was calculated jointly for *Empathic Concern*, *Perspective Taking* and *Personal Distress* scales. The *Gudjonsson Compliance Scale* (GCS; Gudjonsson, 1989) is a self-report questionnaire for measuring compliance (the tendency to conform to requests made by others) as a psychological trait. It consists of 20 statements that can be answered "True" or "False". The global score was calculated as the number of affirmative responses. The *Measure of Susceptibility to Social Influence* (MSSI; Bobier, 2002) was designed to assess the three possible responses to social influence: pressure-independence (*Principled Autonomy*), conformity/compliance (*Social Adaptability*) and anticonformity (*Social Friction*). It consists of 34 items rated on a 5-point Likert scale. The global score equalled the sum of all subscales. In order to control for differences between participants in the fear of pain, the *Fear of Pain Questionnaire-III* (FPQ-III; McNeil & Rainwater, 1998) was applied. FPQ-III is a 30-item measure of fear of pain and is divided into three subscales: *Fear of Severe Pain*, *Fear of Minor Pain* and *Fear of Medical Pain*. Items are rated on a 5-point Likert scale.

## 2.6 | Procedure

Each experimental group underwent four phases of the study: calibration, pretest, manipulation and posttest. The control group did not undergo the manipulation phase.

### 2.6.1 | Calibration

During the calibration, pain threshold and pain tolerance were established by increasing the temperature of the thermode from the 32°C baseline at a rate of 10°C/s (Price et al., 1999) until the participant reported a painful sensation (i.e. pain threshold) or the most intense pain they could tolerate (i.e. pain tolerance). In order to obtain reliable assessments, this procedure was repeated four times for pain threshold and four times for pain tolerance; it alternated between the two and started with pain threshold. To avoid tissue damage, the maximum temperature was set to 50°C. Pain threshold ( $t$ ) and

pain tolerance ( $T$ ) were, respectively, defined as the mean of the last three measurements of the pain threshold and pain tolerance. The temperature of the stimuli used in the pretest and the posttest was set at  $t + (T - t) * 0.75$ , which allowed the intensity of the stimuli to be fixed between  $t$  and  $T$  for each participant individually.

### 2.6.2 | Pretest

During the pretest, participants in all groups received eight thermal stimuli and assessed pain intensity each time on VAS immediately after the stimulus ended. No placebo stimuli were applied in this phase. By default, the computer screen was black (control condition). Before each stimulus, a white fixation cross appeared on the screen for  $\sim 1$  s in order to alert the participant that a painful stimulus was about to appear. The design of a single trial is presented in Figure 2.

### 2.6.3 | Manipulation

During the manipulation, participants in the experimental groups were shown pain intensity ratings that were supposedly provided by other participants of the study. They were told that some of the pain stimuli that other participants experienced were or were not preceded by a white circle and that they would be able to see how both types of stimuli were rated. In other words, the ratings were accompanied by either the placebo stimulus (i.e. white circle) or not. No further explanation was provided to the participants concerning the

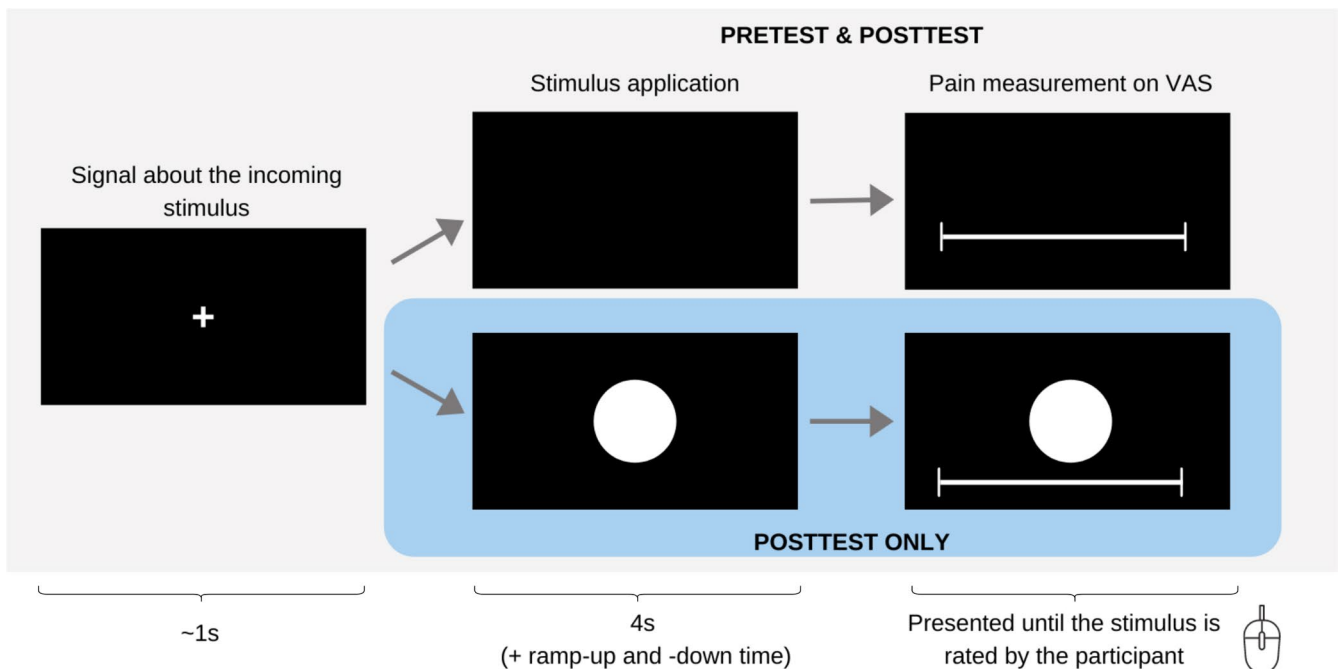
video and the white circle. Participants in groups 3 and 4 were also informed that they would be able to see video recordings of the participant or participants, respectively, who provided the ratings. Video recordings were used in the experimental groups once at the beginning of the manipulation, before the presentation of VASs showing the pain ratings of the alleged participant/participants.

### 2.6.4 | Posttest

During the posttest, participants in all groups received 16 thermal pain stimuli of the same temperature as during the pretest and assessed pain intensity each time on VAS. Half of the thermal pain stimuli were preceded by the placebo; the other half were not preceded by any visual stimuli (non-placebo condition). Otherwise, the trials were identical to the pretest. Pain expectancy was measured towards the end of the posttest. The participants rated how much pain they would expect in the placebo and non-placebo conditions. After the posttest, the participants in the experimental groups answered a series of manipulation check questions and questions about the pain ratings that had been presented to them (the questions are reported verbatim under Table 4). The questions were followed by the psychological questionnaires described above.

## 2.7 | Statistical analyses

Participants were excluded from the analyses for the following reasons: they terminated the experiment prematurely;



**FIGURE 2** Trial design in the pretest and the posttest



they realized what the real aim of the study was; they did not follow the instructions; they generated outlier results (did not feel pain during the procedure). However, the excluded participants were compared with the final sample in terms of basic characteristics by means of *t*-tests to check whether this group differed somehow from participants included in the analyses.

First, descriptive statistics (means and standard deviations) were calculated for age, height, body mass, FPQ-III score, tactile and pain thresholds; this was followed by analyses of baseline differences between the groups, calculated by means of one-way analysis of variance (one-way ANOVA) with “group” as a between-subject factor.

In the main analyses, two separate repeated-measures ANOVAs on pain intensity assessments followed by planned comparison tests were performed in order to test all of the hypotheses. Two separate ANOVAs were conducted since there was no control group with video manipulation (its use was unjustified), which resulted in an incomplete design. The first ANOVA tested the induction of the placebo effect, where “group” (experimental, control) was a between-subject factor and “condition” (pretest non-placebo, posttest non-placebo, posttest placebo) was a within-subject factor. We defined the following necessary conditions for the determination of the placebo effect: (1) there is a significant difference between posttest non-placebo and posttest placebo pain assessments separately in combined experimental groups and the control group; (2) there is a significant difference between pretest non-placebo and posttest placebo pain assessments separately in combined experimental groups and the control group; (3) there is no significant difference between pretest non-placebo and posttest non-placebo pain assessments separately in combined experimental groups and the control group. In the second ANOVA, which was conducted on the data from the experimental groups to determine which factors contributed to the placebo effect, a  $2 \times 2 \times 3$  design was used with “video” (no video, video) and “source of information” (single participant, group of participants) as between-subject factors, and “condition” (pretest non-placebo, posttest non-placebo, posttest placebo) as a within-subject factor.

Additionally, Pearson product-moment correlation coefficients (*r*) were calculated to explore the relationship between the placebo effect (calculated as the difference between pretest non-placebo and posttest placebo and posttest non-placebo and posttest placebo) and either questionnaires' scores (GCS, MSSSI and IRI) or answers to manipulation check questions and expectancy pain assessments.

The alpha level was set at 0.05 for rejection of the null hypothesis in all the statistical analyses. Bonferroni correction was used in the correlational analyses to control for multiple comparisons. All the analyses were conducted using STATISTICA data analysis software, version 13 (StatSoft Inc.).

### 3 | RESULTS

The aim of the study was figured out by 42 of 220 participants (19.1%; 7–14 per group). A total of 23 participants' mean pain assessments in the pretest in the experimental groups were below 25 on VAS, which made it impossible to provide the placebo manipulation and resulted in the premature termination of the experiment. The course of the study was disrupted in three participants (e.g. they did not follow instructions, power outage) and two others generated outlier results (they did not feel any pain in most trials). A total of 70 participants were excluded from further analyses, including those who figured out the aim of the study. *T*-tests on participants' characteristics at baseline in age, height, body mass, tactile threshold, pain threshold or FPQ-III confirmed that the excluded participants did not differ from the analysed sample in terms of basic characteristics. The final sample for the analyses consisted of data obtained from 150 participants. The one-way ANOVA revealed that there were no significant differences in participants' characteristics at baseline among all groups (means and standard deviations are presented in Table 1).

#### 3.1 | Main analysis

The first analysis tested the induction of the placebo effect. The repeated measures ANOVA on pain intensity assessments revealed a statistically significant “group”  $\times$  “condition” interaction ( $F_{(2, 296)} = 5.49, p = 0.005, \eta_p^2 = 0.04$ ). No significant main effects for “group” ( $F_{(1, 148)} = 0.05, p = 0.832, \eta_p^2 < 0.01$ ) and “condition” ( $F_{(2, 296)} = 2.26, p = 0.107, \eta_p^2 = 0.02$ ) were found. In the experimental groups, within-group planned comparison tests on pain assessments associated with pretest non-placebo, posttest non-placebo and posttest placebo showed statistically significant differences between posttest non-placebo and posttest placebo ( $F_{(1, 148)} = 7.99, p = 0.005, \eta_p^2 = 0.05$ ), between pretest non-placebo and posttest placebo ( $F_{(1, 148)} = 9.342, p = 0.003, \eta_p^2 = 0.06$ ) pain assessments, while no difference was found between pretest non-placebo and posttest non-placebo ( $F_{(1, 148)} = 1.90, p = 0.170, \eta_p^2 = 0.01$ ) pain assessments. Thus, all of the conditions necessary for the determination of the placebo effect were met. The same within-group planned comparison tests performed in the control group revealed statistically significant differences between posttest non-placebo and posttest placebo ( $F_{(1, 148)} = 4.11, p = 0.044, \eta_p^2 = 0.03$ ) as well as between pretest non-placebo and posttest non-placebo ( $F_{(1, 148)} = 5.07, p = 0.026, \eta_p^2 = 0.03$ ) pain assessments, while the difference between pretest non-placebo and posttest placebo pain assessments was not

**TABLE 1** Characteristics of participants in each group and in total (means and standard deviations)

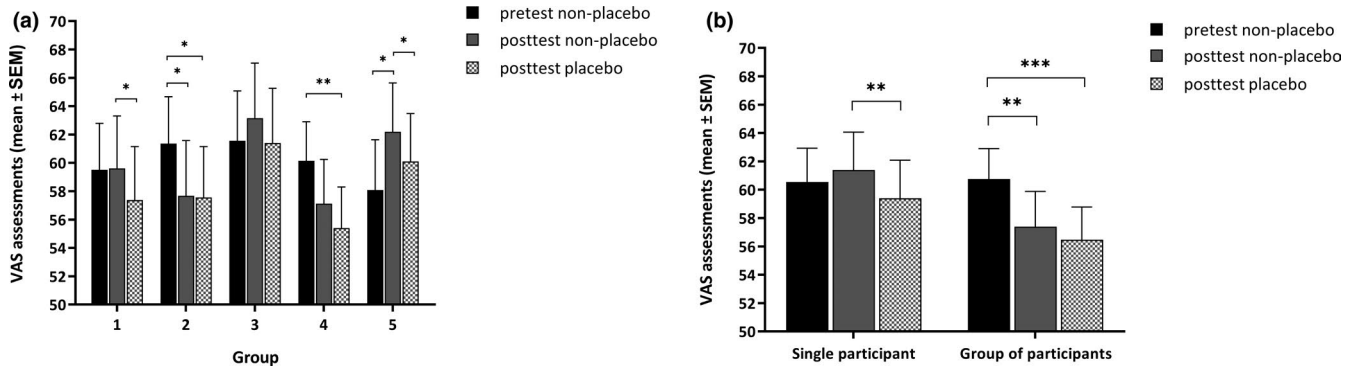
Gr.	N	Age (yo)	Height (cm)	Weight (kg)	t (°C)	T (°C)	FPQ			HADS		
							General	FSP	FMP	FM/DP	A	D
1	30	22.17 ± 2.80	173.87 ± 9.23	70.32 ± 13.30	44.12 ± 1.97	48.58 ± 1.25	67.27 ± 14.90	28.00 ± 6.06	16.63 ± 5.18	22.63 ± 7.62	3.13 ± 1.96	1.40 ± 1.52
2	30	22.67 ± 4.51	171.43 ± 9.51	64.57 ± 13.38	43.74 ± 2.75	48.42 ± 2.12	72.37 ± 24.02	27.83 ± 10.21	18.87 ± 7.21	24.67 ± 9.12	3.20 ± 1.94	1.73 ± 1.68
3	30	23.70 ± 3.64	171.87 ± 8.76	63.16 ± 11.03	43.38 ± 2.21	48.34 ± 2.25	67.63 ± 19.99	29.03 ± 9.59	16.83 ± 5.39	21.77 ± 7.62	3.00 ± 1.60	1.67 ± 1.54
4	30	23.30 ± 3.44	173.87 ± 11.27	68.92 ± 15.56	43.66 ± 2.47	48.81 ± 1.46	70.97 ± 18.26	28.80 ± 9.20	18.33 ± 5.41	23.83 ± 7.15	3.57 ± 1.85	1.73 ± 1.86
5	30	22.17 ± 3.11	173.40 ± 9.49	65.88 ± 10.84	43.87 ± 2.35	48.56 ± 1.64	70.53 ± 17.53	29.33 ± 7.52	17.60 ± 5.20	23.60 ± 7.59	3.47 ± 2.18	1.77 ± 1.91
All	150	22.60 ± 3.53	172.89 ± 9.62	66.57 ± 13.04	43.75 ± 2.34	48.54 ± 1.77	69.75 ± 19.03	28.80 ± 8.54	17.65 ± 5.72	23.30 ± 7.81	3.27 ± 1.90	1.66 ± 1.69

Abbreviations: A, anxiety; D, depression; FM/DP, Fear of Medical/Dental Pain; FMP, Fear of Minor Pain; FPQ, Fear of Pain Questionnaire; FSP, Fear of Severe Pain; HADS, Hospital Anxiety and Depression Scale; PT, pain threshold; TT, tactile threshold.

**TABLE 2** Descriptive statistics for pain intensity, pain expectancy, IRI, GCS and MSSSI scores in each group and in total (means and standard deviations)

Gr.	Pain intensity (VAS)		Pain expectancy (VAS)				IRI				MSSI			
	Pretest non-placebo	Posttest non-placebo	Pretest placebo	Posttest placebo	Non-placebo	Placebo	PT	PD	EC	PA	GCS	SA	SF	
1	59.51 ± 17.99	59.61 ± 20.27	57.38 ± 20.62	57.56 ± 19.67	55.97 ± 24.65	56.30 ± 21.32	34.73 ± 5.30	20.90 ± 6.19	36.8 ± 6.90	6.80 ± 2.19	55.80 ± 6.56	33.37 ± 6.59	24.63 ± 4.18	
2	61.36 ± 18.13	57.68 ± 21.36	61.41 ± 21.12	61.56 ± 21.12	62.93 ± 19.82	61.13 ± 20.90	35.30 ± 4.00	20.23 ± 5.60	39.37 ± 7.72	7.33 ± 3.17	58.00 ± 6.51	31.73 ± 7.61	25.30 ± 5.71	
3	61.56 ± 19.26	63.16 ± 21.26	61.41 ± 21.12	61.56 ± 21.12	62.57 ± 25.54	61.80 ± 24.07	34.43 ± 5.04	23.07 ± 4.88	38.63 ± 6.74	7.50 ± 3.48	53.33 ± 6.58	33.30 ± 7.92	24.37 ± 4.42	
4	60.15 ± 15.10	57.12 ± 17.11	55.40 ± 15.87	59.93 ± 18.07	59.93 ± 18.07	55.07 ± 16.63	33.37 ± 5.74	21.40 ± 5.09	37.93 ± 6.38	7.40 ± 3.12	54.70 ± 7.80	33.27 ± 7.90	26.67 ± 5.39	
5	58.09 ± 19.43	62.19 ± 18.90	60.10 ± 18.53	61.77 ± 18.26	61.77 ± 18.26	58.90 ± 22.48	35.60 ± 3.81	21.60 ± 5.36	40.23 ± 6.12	7.43 ± 3.05	55.27 ± 8.05	34.20 ± 7.25	25.73 ± 4.27	
All	60.14 ± 17.85	59.95 ± 20.07	58.37 ± 19.42	58.37 ± 19.42	60.63 ± 21.35	58.64 ± 21.10	34.69 ± 4.83	21.44 ± 5.45	38.60 ± 6.81	7.29 ± 3.00	55.42 ± 7.20	33.17 ± 7.41	25.34 ± 4.84	

Abbreviations: EC, Empathic Concern; GCS, Gudjonsson Compliance Scale; IRI, Interpersonal Reactivity Index; MSSSI, Measure of Susceptibility to Social Influence; PA, Principled Autonomy; PD, Personal Distress; PT, Perspective Taking; SA, Social Adaptability; SF, Social Friction; VAS, Visual Analogue Scale.



**FIGURE 3** (a) Pretest non-placebo, posttest non-placebo and posttest placebo pain assessments (means and SEM) in every group; (b) Pretest non-placebo, posttest non-placebo and posttest placebo pain assessments (means and SEM) in the single participant condition (groups 1 and 3) and in the group of participants condition (groups 2 and 4). \* $p \leq 0.05$ , \*\* $p \leq 0.01$ , \*\*\* $p \leq 0.001$

statistically significant ( $F_{(1, 148)} = 1.30, p = 0.256, \eta_p^2 < 0.01$ ). Since only one of the conditions necessary for determination of the placebo effect was met, it was not found in the control group. These results indicate that information about pain intensity ratings obtained from other people elicited the placebo effect. Means and standard deviations for pretest non-placebo, posttest non-placebo and posttest placebo pain and expectancy assessments are presented in Table 2.

To further examine the obtained placebo effect, a repeated measures  $2 \times 2 \times 3$  ANOVA was performed. The results showed a statistically significant main effect of “condition” ( $F_{(2, 232)} = 5.68, p = 0.004, \eta_p^2 = 0.05$ ) and the “source of information”  $\times$  “condition” interaction ( $F_{(2, 232)} = 3.71, p = 0.026, \eta_p^2 = 0.03$ ). The main effects were not statistically significant for the following: “video” ( $F_{(1, 116)} = 0.08, p = 0.778, \eta_p^2 < 0.01$ ); “information” ( $F_{(1, 116)} = 0.44, p = 0.508, \eta_p^2 < 0.01$ ); “video”  $\times$  “source of information” interaction ( $F_{(1, 116)} = 0.45, p = 0.503, \eta_p^2 < 0.01$ ); “video”  $\times$  “condition” interaction ( $F_{(2, 232)} = 0.22, p = 0.800, \eta_p^2 < 0.01$ ) and “video”  $\times$  “source of information”  $\times$  “condition” interaction ( $F_{(2, 232)} = 0.44, p = 0.642, \eta_p^2 < 0.01$ ). Considering that the “video” factor did not affect the magnitude of the obtained placebo effect, the within-group planned comparisons were conducted only for the “source of information”  $\times$  “condition” interaction. The analyses show that the differences observed in both the single participant condition and the group of participants condition accounted for the obtained placebo effect. In the single participant condition (groups 1 and 3), the planned comparison tests revealed a statistically significant difference between posttest non-placebo and posttest placebo ( $F_{(1, 116)} = 6.82, p = 0.010, \eta_p^2 = 0.06$ ) pain assessments. No differences were found between pretest non-placebo and posttest placebo ( $F_{(1, 116)} = 0.82, p = 0.366, \eta_p^2 < 0.01$ ) and between pretest non-placebo and posttest non-placebo ( $F_{(1, 116)} = 0.42, p = 0.518,$

$\eta_p^2 < 0.01$ ) pain assessments. In the group of participants condition (groups 2 and 4), the planned comparison tests revealed statistically significant differences between pretest non-placebo and posttest placebo ( $F_{(1, 116)} = 11.65, p < 0.001, \eta_p^2 = 0.1$ ) and between pretest non-placebo and posttest non-placebo ( $F_{(1, 116)} = 6.53, p = 0.012, \eta_p^2 = 0.05$ ) pain assessments, but not between posttest non-placebo and posttest placebo ( $F_{(1, 116)} = 1.45, p = 0.231, \eta_p^2 = 0.01$ ) pain assessments (see Figure 3). These results show that the placebo effect was induced when information about pain intensity ratings came from an individual rather than a group of people. However, it seems that when the information came from a group of people, pain sensation decreased regardless of the condition: placebo or non-placebo.

The analysis including both the participants who did and did not figure out the aim of the study revealed a very similar pattern of results to those described above (both in the first and second analysis). Additionally, one result emerged to be significant after including data from those who figured out the aim of the study. In the analysis 2, in the single participant condition (groups 1 and 3), the planned comparison test revealed a statistically significant difference between pretest non-placebo and posttest placebo ( $F_{(1, 158)} = 4.70, p = 0.032$ ). This result provides an additional argument for the placebo effect in the single participant condition.

### 3.2 | Correlations

Correlational analyses revealed that there was no relationship between the placebo effect (measured as the difference between both pretest non-placebo and posttest placebo or between posttest non-placebo and posttest placebo pain assessments) and the questionnaires' scores (GCS, MSSSI and IRI). These results indicate that participants' levels of empathy, compliance and susceptibility to social influence were not



**TABLE 3** Results of correlational analysis of the placebo effect and questionnaire scores (Pearson's  $r$ )

	IRI			GCS	MSSI		
	PT	PD	EC		PA	SA	SF
Placebo effect (posttest non-placebo/posttest placebo)	-0.13	0.04	0.03	0.03	0.04	0.01	0.01
Placebo effect (pretest non-placebo/posttest placebo)	0.12	-0.17	0.14	0.05	0.12	0.08	0.04

Abbreviations: EC, Empathic Concern; GCS, Gudjonsson Compliance Scale; IRI, Interpersonal Reactivity Index; MSSI, Measure of Susceptibility to Social Influence; PA, Principled Autonomy; PD, Personal Distress; PT, Perspective Taking; SA, Social Adaptability; SF, Social Friction.

**TABLE 4** Results of correlational analysis between the placebo effect and answers to manipulation check questions and pain expectancy ratings (Pearson's  $r$ )

	Pain expectancy (VAS)	MCQ	MCQ	MCQ	MCQ
		1	2	3	4
Placebo effect (posttest non-placebo/posttest placebo)	0.28*	0.06	0.13	0.20	0.07
Placebo effect (pretest non-placebo/posttest placebo)	0.18	0.22	0.22	0.10	0.12

Notes: MCQ1 = How accurately did the person/persons<sup>a</sup> whose pain intensity ratings you saw assess pain intensity?

MCQ2 = How similar to you in terms of responding to pain stimulation is/are the person/persons<sup>a</sup> whose ratings you saw?

MCQ3 = How much did the other person's/persons'a pain ratings affect your pain sensation?

MCQ4 = How much did you try to adjust your pain intensity ratings to the other person's/persons'a ratings?

Abbreviations: MCQ, Manipulation Check Question; VAS, Visual Analogue Scale.

<sup>a</sup>Depending on the experimental group

\*Statistically significant after Bonferroni correction.

associated with the placebo effect (see Table 3 for obtained correlation coefficients). Similarly, no correlation was found between the placebo effect and the answers to manipulation check questions (see Section 2). However, there was a significant correlation between the difference between posttest non-placebo and posttest placebo pain assessments on one hand, and the difference between placebo and non-placebo expectancy assessments ( $r = 0.28$ ,  $p = 0.002$ ) on the other. This indicates that expectancy was related to the magnitude of the obtained placebo effect. Bonferroni correction was implemented in all correlational analyses (see Table 4 for the obtained correlation coefficients).

## 4 | DISCUSSION

This study demonstrated that placebo hypoalgesia could be induced by verbal modelling only when an individual was presented with pain ratings provided by a single person, regardless of whether this person had previously been seen or not. Placebo hypoalgesia induced by verbal modelling correlated with expectancy but not with observers' empathy, conformity or their tendency to yield to social influence. Interestingly, we also found that the presentation of pain ratings derived from other people generally reduced pain sensations, regardless of whether they came from a group of

people or a single person, or whether this person had previously been seen or not.

Previous studies have shown that both behavioural and symbolic modelling can induce placebo and nocebo effects in pain (Bajcar, Wiercioch-Kuzianik, Farley, et al., 2020; Colloca & Benedetti, 2009; Świder & Bąbel, 2013, 2016; Vögtle et al., 2013, 2019). The current study demonstrated the efficacy of verbal modelling in shaping placebo hypoalgesia. This result supports the social learning model of placebo effects (Bajcar & Bąbel, 2018). Moreover, the model assumes that placebo effects induced by modelling are mediated by expectancy. Two recent studies on symbolic modelling supported this assumption (Raghuraman et al., 2019; Schenk & Colloca, 2020). Our study shows that verbal modelling also generates pain expectancies that are related to the magnitude of the obtained placebo effect, which further supports the social learning model of placebo effects (Bajcar & Bąbel, 2018).

However, placebo hypoalgesia was induced only by pain ratings derived from a single person. This result contradicts our expectation, which was based on data which showed that information from a group is prevalent over information provided by an individual (for review, Bond, 2005). It seems, however, that the participants presented with pain ratings derived from a single person received more explicit information about the impending pain. This information could have

easily been linked to the stimulus (placebo) that preceded it. In contrast, participants who were presented with pain ratings from a group of people had to link pain-related information together; thus, they may have been less attentive to the stimuli that preceded this information.

Information on pain from a group seems to divert participants' attention from contextual stimuli; however, it allows predictions concerning pain. Our study found that the presentation of pain ratings derived from other people generally reduced pain sensations. This is in line with previous studies showing that pain ratings provided by a group of people could modulate responses to pain (Koban & Wager, 2016; Yoshida et al., 2013). However, our study extends these findings by showing that responses to pain can be changed not only by the presentation of pain ratings from a group of people but also by the presentation of pain ratings provided by a single person. Moreover, our findings suggest that pain information has not only an immediate but also a delayed effect on pain. In previous studies, the VAS showing others' pain ratings was displayed immediately prior to the pain stimulus, whose intensity was subsequently assessed by the participants (Koban & Wager, 2016; Yoshida et al., 2013). In our study, the VAS showing lower pain ratings was first repeatedly displayed together with the placebo stimulus to create a link between pain information and placebo (while higher pain ratings were displayed in the absence of the placebo); only then were the pain stimuli applied. Thus, in the current study, there was a certain time interval between the exposure to other people's pain ratings and the pain experience. Despite this, the verbal modelling effectively modulated the pain sensations.

In the control group, we observed the difference between posttest non-placebo and posttest placebo pain assessments, as well as the difference between pretest non-placebo and posttest non-placebo pain assessments, which might be the result of a novelty effect in the control group. In the experimental groups, participants were familiarized with the occurrence of placebo stimuli in the manipulation phase of the study and observed the association between the white circle (placebo trials) and pain intensity. Whereas for participants in the control group, in which there was a break corresponding to the manipulation phase in experimental groups, it was only in the posttest, when they were first introduced with placebo trials. Furthermore, the posttest pain assessments in the control group were generally higher than in the pretest, which is contrary to the pattern observed in the experimental groups indicating naturally occurring sensitization.

The social learning process is more effective when those who provide information to the observer are perceived as credible (Bandura, 1997). To increase the credibility of the source of pain-related information and thereby its efficacy, half of the participants in our study were primed with a movie showing the people who supposedly provided this information. Contrary with our expectations, however, pain-related

information was equally effective, regardless of whether provided by anonymous or previously seen people. This result is in line with another study showing that the model's attributes may not be the most important determinant of the placebo effect in pain (Bajcar, Wiercioch-Kuzianik, Farley, et al., 2020). In this study, participants observed a model who was introduced as another participant in the experiment or as a coworker of the experimenter. Thus, in the first case they were convinced that they were observing the pain reactions of a person who was in a position similar to theirs, while in the other case they were convinced that they were observing a trained person who was demonstrating how to use the pain rating scales. Despite such diverse information about the models, participants utilized the pain-related information provided by them which, in turn, produced the placebo effect. The results of the current study and the cited study may indicate that individuals utilize all possible information to predict aversive stimulation. This assumption is also confirmed by a study on observationally induced placebo hypoalgesia which showed that a placebo effect of similar magnitude was induced regardless of the type of the cue (i.e. colour, geometrical shape) used to induce this effect (Świder & Bąbel, 2016).

The magnitude of placebo hypoalgesia did not correlate with the observers' empathy. This result is in line with previous studies in which symbolic modelling was used to induce placebo and nocebo effects (Hunter et al., 2014; Schenk & Colloca, 2020; Vögtle et al., 2013, 2016, 2019). However, the empathy of the observer seems to be a factor that modulates placebo effects induced by behavioural modelling (Colloca & Benedetti, 2009; Hunter et al., 2014; Świder & Bąbel, 2013). Thus, it seems that the influence of empathy on placebo and nocebo effects depends on the type of observational learning, and empathy may not be inherently involved in placebo and nocebo effects induced by symbolic and verbal modelling (Hunter et al., 2014; Vögtle et al., 2013, 2016, 2019). Also, the magnitude of placebo hypoalgesia did not correlate with participants' compliance and susceptibility to social influence. It seems that pain-related information from alleged participants exerted an informative rather than normative influence on participants (Cialdini & Goldstein, 2004; Deutsch & Gerard, 1955).

In conclusion, this study showed that neither direct (behavioural modelling) nor indirect (symbolic modelling) observation of a model experiencing pain was necessary to induce placebo hypoalgesia: knowledge about pain ratings provided by another person (verbal modelling) was sufficient to induce this effect. Unlike previous studies examining placebo effects induced by observational learning, in this study a pretest was implemented in order to show the extent of pain sensation changes induced by pain ratings provided by others. Moreover, the sample size was large compared to the sample sizes of previous studies on placebo and nocebo effects induced by behavioural and symbolic modelling (Colloca &

Benedetti, 2009; Hunter et al., 2014; Świder & Bąbel, 2013, 2016; Vögtle et al., 2013, 2016, 2019), as well as studies in which verbal modelling was used to modulate pain responses (Koban & Wager, 2016; Yoshida et al., 2013). Although including into the analysis data from those participants who figured out the aim of the study provided an additional argument for the placebo effect in the single participant condition, we decided to exclude their data to reduce the potential impact of demand characteristics on the research results (Orne, 1996).

According to Miller and Kaptchuk (2008), the placebo effect is produced by the context surrounding treatment. Thus, placebo and nocebo effects are not the result of specific intervention but may be produced by each stimulus that previously accompanied the changes in pain sensation. In the current study, a visual stimulus was a placebo. This type of placebo was also used in previous experimental studies on placebo and nocebo effects (Bajcar, Wiercioch-Kuzianik, Adamczyk, et al., 2020; Egorova et al., 2017; Jensen et al., 2012, 2015; Świder & Bąbel, 2013, 2016); in two of these studies, geometrical shapes were used to induce placebo hypoalgesia (Świder & Bąbel, 2016) and nocebo hyperalgesia (Bajcar, Wiercioch-Kuzianik, Adamczyk, et al., 2020). Unlike medically connoted placebo in the form of sugar pills or fake ointment, this type of placebo is not a vehicle for any specific pre-experimental expectancies. The use of this type of placebo allowed us to study the role of experimental manipulation in shaping pain expectancies.

In the present study, neither expectancy nor pain ratings were measured retrospectively; however, no pain stimulation followed expectancy ratings as they were measured at the very end of the posttest. The experiment designed in this way allowed us to eliminate the biasing influence of pain expectancy measurement on pain experience.

The main limitation of the study is that only healthy volunteers participated, therefore its results should be generalized to the clinical population with caution. Moreover, the variables rely on self-reports, but this is also the case in other studies on placebo and nocebo effects induced by observational learning (Hunter et al., 2014; Świder & Bąbel, 2013, 2016; Vögtle et al., 2013, 2016, 2019). In future similarly designed studies, it would be advisable to control whether the manipulation introduced to increase the credibility of the presented pain ratings (i.e. presentation of the movie showing participants who allegedly provide them) was convincing.

These findings might have practical implications. They show that pain ratings provided by other people, even if not accompanied by observation of them, can profoundly influence pain behaviour. The judgments and opinions of others affect not only recipients' attitudes and preferences but also their pain sensations. It seems that the presentation of pain ratings could be an effective tool for changing responses to

naturally occurring pain and could be easily used in clinical settings.

## CONFLICT OF INTERESTS

None declared.

## AUTHOR CONTRIBUTIONS

EAB and PB conceptualized the study. EAB, KWK, JB, DF, HB and PB designed the study. EAB, KWK, JB, DF and HB conducted the study. KWK and JB analysed the study results. EAB, KWK, JB, DF, HB and PB interpreted the study results. EAB, KWK, JB, DF, HB and PB drafted the manuscript. All authors discussed the results and commented on the manuscript.

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**How to cite this article:** Bajcar, E. A., Wiercioch-Kuzianik, K., Brączyk, J., Farley, D., Bieniek, H., & Bąbel, P. (2022). When one suffers less, all suffer less: Individual pain ratings are more effective than group ratings in producing placebo hypoalgesia. *European Journal of Pain*, *26*, 207–218. <https://doi.org/10.1002/ejp.1855>