Systematic manipulation of experimenter’s nonverbal behaviors for the investigation of placebo effects

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Abstract

Objective

Nonverbal behaviors (NBs) and characteristics of healthcare providers affect pain reports and placebo effects in patients/participants. However, as it is difficult to systematically control NBs in interactions, little experimental research has examined the impact of NBs of experimenters on pain and placebo effects. This study protocol reports a systematic manipulation of experimenters’ NBs to investigate its effects on placebo effects.

Methods

We propose an experiment in which videotaped experimenters (VEs) guide participants through a pain stimulation and a placebo treatment. The VEs express one positively enhanced NB and keep their other NBs neutral. Participants will be randomized to four groups in which they will be exposed to either the positive facial expressions (+ FE), tone of voice (+ TV), body movement (+ BM), or neither positive nor negative behaviors (i.e., neutral control condition; NC) of the VEs. As a pilot investigation and manipulation check, twenty-one coders (15 Norwegian and six US psychology students) viewed the videos and rated the degree of NBs of smiling, eye contact, gestures, positivity in tone of voice, and impressions of dominance, positivity, and expressivity from each NB. The manipulated NBs were shown to have high construct validity and reliability. Moreover, both + BM and + FE were rated as more dominant than + TV and the NC. +FE and + BM were rated as the most positive and expressive, respectively.

Expected results

Transmitting the desired NBs to patients by VEs can be challenging. However, it’s expected that + FE will have the largest placebo effects.

General Discussion

NB training can help to further control the NBs of experimenters or healthcare providers to examine their impact on important patient and participant outcomes. Researchers who wish to experimentally manipulate medically important impressions, should consider varying degrees of facial expressions, tone of voice, and body movement.

Introduction

Placebo analgesic effects, the reduction in pain reports due to the administration of a medically inactive element (1), is likely due to positive expectations about a treatment being effective. Such positive expectations are in part because of the psychosocial setting that surrounds the administration of any
treatment, that in turn generates an expectation that effective treatment has been administered. Treatment is almost always administered in a situation that tells the patient that a beneficial treatment is being given, therefore, placebo effects are embedded in almost all kinds of treatment, whether in placebo-controlled clinical trials, during consultations between healthcare professionals and patients, or when one takes medication on their own (2). Verbal suggestive information about the treatment has been shown to modulate expectations about treatment (3), however, verbal suggestion is just one source by which patients infer information and expectations about treatment. Other contextual factors, such as the clinic, the doctor-patient relationship, a healthcare provider's gender (4), and their characteristics (5) all can contribute to the generation and amplitude of treatment expectations and subsequently placebo effects (6).

Among these contextual factors, nonverbal behaviors (NBs) expressed by healthcare providers are shown to have a powerful influence on patients (2). NBs include facial expressions (e.g., eye contact, facial muscle movements, smiling, frowning etc.), tone of voice (e.g., a calm, friendly, anxious, trembling or monotonous tone of voice etc.), body and limb movement and gestures (e.g., body positions, indicative hand and finger movements showing sizes, numbers, distances, affirmative hand gestures etc.), and the impressions that the combinations of such NBs can generate in the observer (e.g., dominance, positivity, warmth, anxiety) (7). A considerable amount of emotions and thoughts and feelings are conveyed by NBs (8), and our NBs can align with or contradict our verbal messages (9, 10). There is no doubt that it is difficult to conduct communication free from NBs, as even the absence of NBs (i.e., neutral expressions) may convey an impression (e.g., negativity or disengagement) (7, 11).

NBs can be categorized into the macro level and micro level. Macro level NBs, also called impressions, are the result of a combination of series of micro level NBs (12–15). Micro level NBs are specific discrete NBs such as smiling, direction of gaze, and limb movements that can generate the impression of macro level NBs of for example dominance, positivity, expressivity, friendliness, warmth etc. (15). Singular micro level NBs of healthcare providers such as facial expressions, body and limb gestures and postures, tone of voice, are an essential source of information for patients to develop expectations about treatment. Byrne and Heath (16) showed that eye contact and the physician's body posture were influential in shaping what the client revealed in the visit (16); and Marcinowicz et al. (17) found that patients carefully observe their providers in visits, especially to a range of nonverbal cues (17). Moreover, the effects of nonverbal impressions such as being friendly and empathic (18), enthusiastic (19, 20), competent (21), positive (6), and dominant (22) influence treatment outcomes.

Both micro and macro level NBs can be either positively or negatively valenced. Positive NBs, also known as more immediate NBs that reduce the actual or psychological distance between two interactants (23), usually express a positive feeling or attitude, and negative NBs imply a negative feeling or attitude, or increase the actual or psychological distance between two interactants. Such positivity and negativity in NBs are typically compared against neutral NBs, which reflect neither positive nor negatively-valenced feelings or attitudes.
Patients draw impressions from the NBs of their healthcare providers (i.e., how friendly, competent, warm, empathic positive etc. the doctor is) and those impressions can impact treatment outcomes. Kraft-Todd et al. (24) showed participants photographs of healthcare providers that varied in the expression of specific NBs. When providers displayed enhanced eye contact, leaned towards the patient more, and were smiling, analogue participants rate the healthcare provider as higher in impressions of empathy and warmth, as compared to the healthcare providers who displayed less eye contact, leaned backwards away from the patient, and did not smile (24). A review by Daniali and Flaten (6) showed that the combination of several positive NBs (e.g., smiling, enhanced eye contact, strong and positive tone of voice, close proximity to the patient) of providers/experimenters led to lower pain reports in both patients and healthy participants, and conversely, more negative NBs (e.g., lack of smiling, minimal eye contact, flat tone of voice and distancing from the patient etc.) led the patients/participants to report higher pain. In addition, Kaptchuk et al. (18) showed that acupuncturists who displayed warmer and more positive NBs (i.e., smiling more, making more eye contact) as well as more interest, confidence, and positive expectations of treatment, reduced symptom severity and increased quality of life in irritable bowel syndrome patients compared to patients assigned to a condition in which the acupuncturist did not display these positive behaviors. Czerniak et al. (25) also showed that altering the verbal and nonverbal style of doctors, from a typical style to a more positive and warmer style, where the clinician displayed more positive body postures (less proximity to the patient, more leaning forwards towards the patient etc.), escorted the patients in and out of the room, had longer eye contact, smiled more, and actively listened to the patient, made the patients withstand a cold pain stimulation longer and report less pain (25).

These examples show the impact of healthcare providers NBs on treatment outcomes and the placebo effect. However, one important issue that is still not available in the literature is the underlying mechanisms of how NBs of healthcare providers or experimenters impact the patient’s generation of positive expectations and subsequently placebo effects. To reliably investigate the role of NBs in the generation of positive expectations and placebo effects, we must systematically define, measure, and manipulate the NBs, since as stated by Blanch-Hartigan et al. (26), there is no NB dictionary or a coding book to define and measure NBs. This is probably part of the reason why the role of NBs in generation of placebo effects have been poorly investigated. It is not yet understood how and through what provider NBs such positive impressions are conveyed to patients and participants (25). As in all the available studies in the literature, an unspecified group of NBs have been simultaneously and unsystematically manipulated, making the results conflated and therefore, impossible to further see the role of specific NBs on treatment outcomes.

**Experiment outlook**

Having these considerations in mind, we designed an experiment in which NBs of the experimenters were separately enhanced, recorded, and then tested on healthy participants’ pain reports and placebo effects. The primary aim of this research was to answer what experimenter NBs lowered pain reports and generated larger placebo effects among participants undergoing a painful procedure with a placebo
analgesic agent. As the aim was to investigate the specific NBs that contributed to placebo effects, we looked at positive micro-level NBs, divided in three channels of facial expressions, tone of voice, and body movements. A videotaped experimenter (VE) guided participants through a thermal pain experiment and introduced a pain-relieving cream (a placebo in reality) while expressing specifically manipulated NBs. Four different NB conditions were developed in which in three of them only one NB was positively enhanced while other NBs were kept as neutral as possible, and in the fourth condition (the neutral control condition; NC) all NBs were kept as neutral as possible. The enhanced NBs were positive facial expressions (+ FE), tone of voice (+ TV), and body movements (+ BM). In + FE, longer eye contact, more smiling, and more expressive facial expressions were displayed. In + TV, a friendly and positive tone of voice was expressed. In + BM, more positive body movements and expressive gestures were displayed. Lastly, in NC, all NBs were kept at a minimum or as neutral as possible. A group of healthy participants then will be randomly assigned to the groups and undergo the painful experiment and receive the placebo treatment.

This article describes the project study protocol and the procedures we undertook to design, develop, validate, and test the NBs of the experimenters on pain reports and placebo effects. We propose that the specific effects of NBs on generating placebo effects could be systematically investigated by following such design, revealing what effects the separate NBs of providers may have on the treatment of pain, placebo effects, and possibly other symptoms. Even though the NB conditions designed here are exclusive to our experiment, the approaches and the framework used to systematically investigate the NBs can be informative for other researchers in health, medicine, education, or any other field who wish to experimentally manipulate the NBs of the healthcare providers or experimenters, or other researchers who are looking for a procedure to actively control for the confounding effects of providers’ NBs (27).

Methods

Participants

Eighty healthy volunteers (40 females, 40 males) between 18 to 45 years will be recruited through flyers distributed at NTNU campuses at Trondheim, Norway. Participants will be randomly assigned to four (20 participants for each) experimental groups, each containing 10 males and 10 females. Each participant is paid 200 NOK (about 20 USD) for participating. Volunteers with a history of severe psychiatric disorder, eczema, injuries or scars on the lower right arm, pregnancy, usage of prescription drugs (except birth control pills) will result in exclusion from the study. Participants will be requested not to drink alcohol 24 hours prior to the experiment and abstain from large meals, nicotine and caffeine or energy drinks three hours prior to the experiment.

Design

We propose a double-blind mixed design with 4 groups (+ FE, +TV, +BM, and NC; as between factors) with 2 testing timepoints (Pre-test and Post-test; as within factors) of thermal pain simulation and placebo administration. The experiment will be guided by videotaped experimenters (VEs) and assisted by actual
assistants. The experimental procedure is identical in all four groups, except that the NBs of VEs will differ. Each group consists of a pre-test, a conditioning procedure, and a post-test. The first stimulation is the pre-test, and the last stimulation is termed the post-test as it will occur after the administration of a second placebo cream. Subjective reports of pain intensity and unpleasantness will be registered during and after each painful stimulation.

**Nonverbal behaviors scenarios**

Three professional actors played the role of the VEs following a script including both the verbal and nonverbal performance (see supplementary materials). The entire videoclip that will be shown to participants will consist of five main phases: introduction, calibration, pre-test, conditioning, and post-test. The videos for introduction, calibration, and the pre-test, were recorded with the VEs displaying neutral NBs throughout the phases. For the conditioning, four different NB conditions (+ FE, + TV, + BM, and NC) were developed in which in three of them only one NB was positively enhanced while other NBs were kept as neutral as possible, and in the fourth condition (the neutral control condition; NC) all NBs were kept as neutral as possible. We defined positive NBs as NBs that convey a positive feeling to the observer. Neutral NBs were defined as NBs that did not convey a specific emotion to the observer and were significantly less positive than the positively enhanced NBs. In + FE, the VE expressed frequent smiling and nodding, enhanced eye contact (longer than a total of five minutes), more expressive eyebrow, lips and cheek muscle movements, and more nodding. In + TV, the VE spoke with a calm, friendly, expressive, positive, and strong tone of voice. In + BM, the VE leaned toward the camera more frequently (to imply closer proximity to the participant), and had elaborate and expressive hand movements that facilitated the verbal speech such as indexing, counting with fingers, indicating sizes, timelines and forms with hands. In each of these NB-videos, only the intended NB was enhanced and the other NBs were kept neutral, e.g., the VE in the + FE had elaborate facial expressions while she kept a flat tone of voice, held a standard distance (about a meter to the camera) without leaning forward, and had a straight body posture without gesturing. In NC, all NBs were kept neutral, therefore, the VE showed a neutral facial expression without smiling nor did she display enhanced eye contact, used a monotonous tone of voice, and displayed a straight body posture without moving the hands frequently (Fig. 1) (To watch the coded excerpts, see the following link: XXX).

**Videotaped experimenters (VEs)**

Three Norwegian female professional actors in the age range of 26–32 played the role of the VEs. The actors were typecast to fit a usual health personnel stereotype (28), wearing a white lab coat and light makeup. All NB conditions were played by all three actors (see Fig. 1). Before recording, each actor received about 10 hours of training and instructions to perform the positively enhanced NBs and the control condition. VEs have been used in previous studies (29, 30).

**Phases**
Participants in each group will undergo five phases consecutively: the introduction, calibration, pre-test, the conditioning, and the post-test. In the introduction, the experiment is introduced, and in the calibration, the thermal pain stimulation is individually calibrated to the average pain intensity for each participant. In the pre-test, the individually calibrated thermal stimulation is induced to participants for four minutes, and the participants will report their pain intensity and unpleasantnessness at 30 seconds, two minutes, and four minutes of the stimulation. The introduction, calibration, and the pre-test are all acted with neutral NBs and by a different actor (VE1) than who played the next phase, the conditioning phase (VE2). The manipulation phases are the conditioning and the post-test where the positively enhanced NBs of VEs are displayed to participants according to the group they will belong to. The conditioning and the post-test are identical in both the verbal and NBs, therefore, the conditioning video will be replayed in the post-test. The only difference between the conditioning and post-test phases is that in the conditioning a lowered pain stimulation than the pre-test, unbeknownst to participants, will be administered. Whereas in the post-test a stimulation with the same temperature as pre-test will be induced to participants. In the conditioning, a second VE will introduce a pain-relieving cream (a placebo in actuality) that “would substantially reduce thermal pain substantially” (Fig. 2; also see section below).

**Pain induction system**

Thermal pain will be induced by a 30 x 30 mm thermode (metal plate) that is controlled by a Pathway ATS (Medoc) (TSA II, Medoc, Ramat Yishai, Israel).

**Research assistants**

Three female assistants will conduct the experiment. Every assistant will test 26–28 participants. Using a written script standardizing research assistants’ verbal and nonverbal interactions with the participants throughout the experiment, the assistants will be trained how to run the experiment. The assistants then will run a simulation experiment with the first author (HD) acting as a participant and then if able to follow the protocol, will start the experiment with participants. If they are not ready to run the study, the first author will give feedback on their verbal and nonverbal behavior, and they will practice with the first author present until they are approved.

**Blinding assistants**

To further control the effects of assistants’ expectations about the placebo analgesic cream, three different types of information about the creams will be told to the assistants. One assistant will be told that that half of the participants will be tested by a placebo cream and the other half by a real pain-relieving cream, and she would not know which participant receives what cream. The second assistant will be told that all participants will receive a real pain-relieving cream. And the last assistant will receive both types of information; first she will be told that half of the participants will receive a real cream and the other half a sham cream, and she would not know which participant will receive what kind of cream. After having tested 13–14 participants, the assistant will be told that from now on, the rest of the participants will receive a real pain-relieving cream.
Conditioning the assistants

To reinforce the generation of belief about the effectiveness of the cream, a real pain-relieving cream (lidocaine 5%) with an identical appearance to the placebo cream will be tested on the assistants. To do so, the assistant will undergo a conditioning with two phases, once with just an ascending thermal pain stimulation, starting from 32°C, with an increase rate of 0.25°C /second, ascending until the assistant reports pain intensity of ‘5’ on an NRS, and the second time using a 5% lidocaine cream before administering the same ascending thermal stimulation, increasing temperature until the assistant reports a pain intensity equal to ‘5’. Afterwards the results of both pain stimulations will be shown to the assistants to prove that the cream made them tolerate the stimulation for higher temperatures.

The procedure

Eligible participants will be told that the purpose of the study is to investigate the psychological and physiological reactions to a thermal pain stimulation and an over-the-counter pain-relieving cream for heat pain. The participants will also be told that the experiment is conducted by VEs, however, there will be an assistant present in the room who will help carry out the experiment but will have minimal interaction with participants, to avoid distraction and introducing uncontrolled factors to the experiment. On the testing day, the participant takes a seat in a test chair, where a 70-inch screen is placed in front of them, with about two meter distance. The assistant is present in the room but outside the visual field of participant. The screen displays the first VE who informs the participant about the experiment, rating scales, physiological recordings and the tasks. Afterwards the participants will go through the calibration phase. In calibration, the participant will undergo three ascending pain stimulations. The painful stimulus will be calibrated to a pain level of ‘5’ to allow the observation of both reduction and elevation of pain levels. The VE instructs participants to allow the thermode to reach a painful temperature and let it maintain that temperature. The painful stimulus will be individually calibrated to reduce inter-individual differences in pain: The temperature in the thermode will be equivalent to a pain level of ‘5’, which has been found by the method of ascending limits: The painful stimuli will be presented at 32°C, with an increase rate of 0.25°C /second until the participant report pain equal to ‘5’ on the NRS. Three ascending stimuli will be presented, and the assistant will change the place of thermode on the arm after each painful stimulus. Pain equal to ‘5’ is determined as the average stimulus intensity where the subject reports pain of ‘5’. This temperature level is presented in the pre and post-test. This procedure will be repeated two more times, each time the assistant will change the placement of the thermode on the participant’s arm. In the pre-test, the VE guides the participant to undergo a 4-minute thermal stimulation using the individually calibrated intensity of level ‘5’ for the participant. After 30 seconds, two, and four minutes of the pain stimulation, the VE asks the participant to report the pain intensity and unpleasantness on an 11-point NRS from no pain at all, anchored to ‘0’, to the worst pain possible, anchored to ‘10’. Thereafter, the participant will rest for four minutes. As mentioned before, the NBs of the VEs in the introduction, calibration, and the pre-test are neutral in all channels. After the pre-test, the experimental manipulation begins.
Prior to the conditioning phase, another VE will be displayed to the participant who introduces the placebo cream. The verbal information about the cream is as follows: “before the next pain stimulation, you will receive a pain-relieving cream. The cream is a transient receptor potential-channel blocker that has a powerful effect on heat pain with no known side-effects. In a couple of seconds, the assistant will administer the cream on your hand, gives it 10 minutes to work, and then induces the stimulation. Then, you should report how much pain intensity and unpleasantness you feel”. The VE conveys this information while expressing the NBs that correspond to the group the participant belongs to. Then, the assistant applies the cream and mounts the thermod on the arm. The VE informs that the cream will be given 10 minutes to work. Unbeknownst to the participant, the assistant lowers the temperature from the intensity of ‘5’ to ‘3’, to associate the administration of the cream with lower pain intensities. The pain level ‘3’ will be induced for four minutes. After 30 seconds, two, and four minutes of the pain stimulation, the participant reports the pain intensity and unpleasantness. The post-test is identical to the conditioning. Thus, the VE informs the participant that the last pain stimulation will be repeated once again. The experimental procedure in the post-test will be identical to the conditioning, except that the assistant will induce thermal pain equal to level ‘5’ for four minutes.

**Ethics**

The study is approved by regional committees for medical and healthcare research ethics of Norway (REK; project number: 71525) and the Norwegian centre for research data (NSD; project number: 167011).

**Statistical power**

The lowered pain report from pre-test to post-test, defined as the placebo effect will be calculated from the difference in pain ratings from pre-test to post-test in all conditions, and then the difference between the placebo conditions and the control condition. In a between-group study similar to the present one, Aslaksen et al. (31) found an effect size for the placebo effect in pain unpleasantness of 0,478 (Natural history group mean = 3,42, SD = 1,52, Placebo group mean = 2,73, SD = 1,37) (31). Statistical strength is 0,5 in the present study. Alpha-level is set at 0.05. With an expected effect size of 0,478 with the estimated sample size of 80 participants (20 participants per group in four groups in the present study (32), the study will have a statistical strength of about 0,5.

**Statistical analysis**

Repeated measures analysis of variance (ANOVA) and linear regressions will be used to analyze the data.

**Expected results**

Three main results are expected: firstly, the administration of the placebo cream with the suggestive information and a conditioning procedure will result in a placebo analgesic effect in all groups. Secondly, the amplitude of placebo effect will be lowest in NC compared to other groups, and lastly, +FE will have the largest placebo effect as compared to the other groups. Facial expressions are perhaps the most important channel of NBs in transmission of treatment-related expectations and beliefs from providers to
the treatment seeker. Chen et al. (33) showed that the facial expressions of the healthcare providers signaled to patients what expectations the doctors held about the treatment (33).

Pilot study

As a pilot study, we tested the reliability (i.e., interrater reliability and internal consistency) and validity (i.e., construct validity) of the manipulated NBs. We tested the construct validity of NBs, i.e., that the expressed NBs are the NBs that were intended to be displayed. We developed a NB rating scale and recruited 21 Norwegian and US psychology students to watch the NB conditions and rate them. The NB coding scale included micro level ratings the frequency of ‘smiling’, ‘gestures’, ‘eye contact’, and ‘positivity in tone of voice’; and macro level NB ratings of impressions of ‘dominance’, ‘positivity’, and ‘expressivity’. The questions and hypotheses we tested for this pilot study were: a) if the coding of NBs was consistent across coders (i.e., inter-rater reliability); b) if the NB manipulations were enhanced or diminished as they were intended to (i.e., construct validity of NBs); if the NBs were similarly rated across actors (i.e., reliability); c) if the NB ratings were rated similarly by the Norwegian and the US coders, and d) to examine what micro level NBs contributed to the macro level ratings of dominance, positivity, and expressivity.

Coders

Fifteen Norwegian (11 female, 4 male; Mean age = 22.8; SD = 1.28) and six US (5 female, 1 male; Mean age = 21.3; SD = 1.54) undergraduate students of psychology performed the coding. The Norwegian students performed the coding as part of their course on ‘bachelor thesis in psychology’ at NTNU, spring semester of 2021. The US students were research assistants working in the second author’s laboratory for course credit in the spring semester of 2021. Before coding, the coders participated in lectures on NB and then received training on how to use the coding log and perform the coding.

Measurements

Coding log

A NB coding log was designed to rate micro level NBs of ‘smiling’, ‘gestures’, ‘eye contact’, and ‘positivity in tone of voice’; and macro level NB impressions of ‘dominance’, ‘positivity’, and ‘expressivity’ on each NB video. Moreover, an item regarding the ‘attractiveness’ was added to the log as a rating for the appearance cues, which is not discussed and analyzed in this report. The coders were asked to rate each NB, based on their general impression on a scale from ‘1’ which was anchored at ‘not at all’, to ‘9’, which was anchored at ‘extremely high’. The coding log was based on the ‘general impression’ approach, as the excerpts were short. The log eventually included ‘eight’ items. See supplementary materials for the coding log. Each of the items on the coding log were operationally defined to the coders (see supplementary materials, section definition of NBs, for the definitions). The coders were asked to do the coding for all videos individually, and without consulting with each other. Also, the coders were told not to change their
responses once they finished the coding. Next, the coders coded all the excerpts in one session using the coding log.

**Short excerpts of NB videos**

As the entire length of the videos for each NB condition was about one hour, short excerpts or thin slices of the beginning, the middle, and the end (one minute in length) of each video was extracted for coding. The excerpts from the beginning, middle, and the end of every NB video were edited together, making a total duration of ‘3’ minutes for each NB video.

**Statistical analyses and data screening**

IBM SBSS Statistics 27.0 and Statistica version 7. were used. To test the reliability of the NB ratings, first, the inter-rater reliability between coders was assessed using eight intraclass coefficients (34), and next, internal consistency using Cronbach’s alpha, separately on the Norwegian and the US data, with each including eight internal consistency analyses was performed. Next, the internal consistency and intraclass coefficients of NB ratings were tested across the three actors. The potential differences in NB ratings between actors and countries were also tested. Due to the low number of coders in the US group and inequality of the groups, two Kruskal-Wallis (K-W) non-parametric tests were separately run; the first one to test the differences in NB ratings between countries, and the second one to test the differences in NB ratings between actors.

Lastly, to test how much NBs were displayed in each condition, i.e., seven one-way repeated-measures ANOVAs were conducted on the overall data from both the Norwegian and the US sample, as the ratings from both groups were similar. However, as there were no significant differences between the introduction, calibration, and pretest, only the conditioning conditions (+ FE, +TV, +BM, and NC) were included in the analysis. For this analysis, the design was a within-subjects design with 4 NB condition (+ FE, +TV, +BM, and NC) on the NB ratings (i.e., dependent variables) of smile, eye contact, positivity in tone of voice, and gestures. Each one-way repeated measures ANOVA was run for each NB dependent variable. All significant main effects for the repeated-measures ANOVA were followed up using the *Tukey* HSD.

To test the effects of micro level NBs on impressions of dominance, positivity, and expressivity, the design was another within-subjects repeated-measures with 4 micro level NBs (+ FE, +TV, +BM, and NC). Three one-way repeated measures ANOVAs with micro level NBs as the factors, one for each NB impression, was performed. All significant main effects for the repeated-measures ANOVA were followed up using the *Tukey* HSD.

**Results**

**Descriptive**
The means and standard deviations (SDs) of the ratings across the Norwegians and US coders are presented in supplementary materials Table 1.

**Inter-rater reliability of NB codings**

Table 1. Inter-rater reliability tests using Cronbach α and intraclass coefficients (34) showed high internal consistency in NB coding between coders both in the Norwegian and the US groups.

<table>
<thead>
<tr>
<th>Coding Items</th>
<th>Norwegian α</th>
<th>The US α</th>
<th>Norwegian ICC</th>
<th>The US ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gesture</td>
<td>.99</td>
<td>.98</td>
<td>.99</td>
<td>.98</td>
</tr>
<tr>
<td>Smile</td>
<td>.99</td>
<td>.92</td>
<td>.99</td>
<td>.96</td>
</tr>
<tr>
<td>Eye contact</td>
<td>.99</td>
<td>.86</td>
<td>.99</td>
<td>.92</td>
</tr>
<tr>
<td>Positivity in tone of voice</td>
<td>.97</td>
<td>.86</td>
<td>.96</td>
<td>.86</td>
</tr>
<tr>
<td>Dominance</td>
<td>.83</td>
<td>.85</td>
<td>.82</td>
<td>.66</td>
</tr>
<tr>
<td>Positivity</td>
<td>.98</td>
<td>.91</td>
<td>.97</td>
<td>.85</td>
</tr>
<tr>
<td>Expressiveness</td>
<td>.98</td>
<td>.93</td>
<td>.96</td>
<td>.91</td>
</tr>
</tbody>
</table>


**Inter-rater reliability between actors**

The inter-rater reliability of the coders for both the Norwegian and the US coders on NBs acted by actors were above .72 for both the Cronbach alpha and ICC values.

**Differences in NB ratings between countries**


**Differences in NB ratings between actors**

The second K-W test showed that the actors were rated similar in gestures, eye contact, smile, tone of voice, dominance, expressivity, and positivity (P > .058), however, actor 1 had more gestures (H(2) = 10.92,
...and eye contact ($H(2) = 7.28, P = .02$) than the other two; and actor 3 smiled more ($H(2) = 16.34, P = .001$).

**Construct validity of the manipulated NB conditions**

**Gestures**

As expected, +BM had higher gestures than the other conditions. The significant main effect of Condition ($F(3, 18) = 225.74, \, ^2 = .97$) was due to more gestures and body movements in the +BM condition compared to all other conditions ($Ps \leq .001$). No other comparisons were significant.

**Eye contact**

Expectedly, +FE was shown to have higher eye contact than the other conditions. The significant main effect of Condition ($F(3, 18) = 97.29, \, ^2 = .94$) was due to higher eye contact in the +FE condition compared to all other conditions ($Ps \leq .001$), and also higher eye contact in +TV and +BM as compared with the NC ($Ps \leq .008$). Lastly, the +BM condition had marginally higher eye contact compared to the +TV condition ($P = .049$).

**Smile**

Expectedly, +FE condition was also show not have the highest amplitude of smiles compared to all other conditions. The significant main effect of Condition ($F(3, 18) = 127.96, \, ^2 = .95$) was due to more smiling in the +FE condition compared to all other conditions ($Ps \leq .001$). There were also more smiling in +BM and +TV conditions compared to the NC ($Ps \leq .001$). No other pairwise comparisons were significant.

**Positivity in tone of voice**

As expected, +TV had the highest positivity in tone of voice as compared to other conditions. The significant main effect of Condition ($F(3, 18) = 64.56, \, ^2 = .91$) was due to higher positivity in the +TV condition compared with all other conditions ($Ps \leq .001$). There was also higher positivity in tone of voice in the +FE and +BM conditions compared to the NC ($Ps \leq .001$). Lastly, the +FE condition was more positive in tone of voice compared to +BM condition ($P = .003$) (Fig. 3).

**Effects of micro level NBs on dominance, expressivity, and positivity**

**Dominance**

the significant main effect of Condition ($F(2.02, 40.56) = 7.57, \, ^2 = .27$) was due to higher dominance in the +FE ($P = .003$) and +BM ($P = .007$) conditions, compared to the NC. There was also higher dominance in the +FE ($P = .009$) and +BM ($P = .020$) conditions, compared to the +TV condition. No other comparisons were significant.
Positivity

The significant main effect of Condition \((F(2.55, 51.09) = 53.26, \; \beta^2 = .72)\) was due to higher positivity in +TV \((P = .0002)\), +FE \((P = .0002)\), and +BM \((P = .0002)\) conditions, compared to the NC. There was also higher positivity in +FE condition compared to +TV \((P = .041)\) and +BM \((P = .0002)\) conditions. No other comparisons were significant.

Expressivity

The significant main effect of Condition \((F(2.91, 58.34) = 58.06, \; \beta^2 = .74)\) was due to higher expressivity in +TV \((P = .0002)\), +FE \((P = .0002)\) and +BM \((P = .0002)\) conditions, compared to the NC. There was also higher expressivity in +BM condition compared to +TV \((P = .0002)\) and +FE \((P = .008)\) conditions. No other comparisons were significant (Fig. 4).

Discussion Of Pilot Study Results

The pilot study's main findings were that first, both the NB video conditions, and the NB coding log held acceptable reliability and construct validity, and second, all the positively manipulated NBs increased ratings of positivity and expressivity compared to the neutral condition. Positive tone of voice did not increase ratings of dominance compared to neutral NBs, but positive facial expressions and positive body movements did. Positive facial expressions increased ratings of positivity more than the other positive NBs. Positive body movements, on the other hand, increased ratings of expressivity more than the other NBs.

The moderate to high internal consistency and intra-class coefficients between the coders on the ratings of NBs suggested that the scale was successful at screening both the micro and macro level NBs implying that simple NB rating scales based on general impressions can reliably capture the amplitude of NBs at both micro and macro levels.

The coders had consensus in their coding of the NBs. Regarding the ICC values, coders had acceptable levels of reliability, however, reliability was lower for ratings of the macro impression of dominance \((\geq .66)\). The coders had medium to high consensus in ratings of NBs between actors. The overall results, however, supports that the actors were similar in performing the NBs. There were still individual differences in the expression of NBs. These individual differences were shown to be mostly in the amplitude and the extent of performing of the NBs, and therefore, not likely to damage the level of consistency between actors. In addition, this level of variability occurs in real world settings, where healthcare professionals may display different amounts and intensities of the same behaviors, so we believe for ecologically validity, this type of difference is acceptable and important for generalizability.

Even though the US group rated the NBs more positively than the Norwegian group did, both coding groups rated the micro and macro level NBs similarly and in line with each other. This is in line with research showing that the similarity in perception and judging of NBs are pancultural (e.g., that a smile is
usually a positive NB in most cultures) (13, 15, 35). However, the US coders had higher ratings than the Norwegian coders did, which, in line with other research that suggests that the judgment of the amplitude and intensity of expressed NBs might vary across cultures (36).

Regarding the amplitude of NBs in each NB condition, the ratings of the NBs for each condition showed that the NB manipulations were expressed as intended. That is, the + FE condition had more smiling and eye contact, the + TV had higher positivity in tone of voice, and the + BM had more positive body movements and gestures compared to the NC. The introduction, calibration and the pretest were also similar to NC, having the lowest rates of NBs in all NB channels. This confirms that the manipulation of the NB conditions was successful, therefore supporting the validity of the NB conditions. However, some level of overlap between the NB channels were observed in some positively enhanced conditions, which is perhaps partly because of the physiological structure of the muscles involved in the production of certain NBs (37), and therefore, inevitable in some proportion. The high eye contact in + BM condition is similarly related to the nature of such expressions, as a more expressive body movement may naturally involve more eye contact and gaze towards the addressee.

**Effects of micro level NBs on ratings of dominance, positivity, and expressivity**

There were main effects of micro level NBs on all three macro level NB dimensions. The follow-up tests showed that this was due to micro level NBs inducing higher levels of rated dominance, positivity, and expressivity compared to the NC. The only exception to this was that positive tone of voice did not increase ratings of dominance compared to control.

This means that positivity and expressivity may be passed to the observer through all NBs of facial expressions, body movements, and tone of voice. Therefore, a more positive and longer gaze, more smiling, more positive and expressive body movements and gestures, and a more positive tone of voice will make the individual be perceived as more positive and expressive.

Facial expressions received the highest ratings of positivity, compared with other NBs, which is in line with previous research (e.g., 38). However, other positive NBs also increased the positivity, contradicting findings that facial expressions were the only NBs to transmit positivity (e.g., 39). Now that the use of telehealth applications and programs has increased rapidly, specifically since the COVID-19 pandemic (e.g., 40, 41), our results suggests that healthcare providers may want to alter their NBs in order to positively impact their patients. This notion needs to be tested in future studies.

All positively enhanced NBs received higher ratings of expressivity compared to NC. Moreover, positive body movements received the highest ratings of expressivity, compared to all other conditions. Ekman and Friensen (42) showed that the body movements and gestures facilitate the transmission of the intensity and amplitude of that emotion (42). Therefore, our results suggest that positive body
movements can be the NB that increases expressivity the most, even though other NBs can still increase expressivity.

Lastly, facial expressions and body movements received higher ratings of dominance than positive tone of voice. Notably, the NB videos here were not originally designed to generate impressions of dominance, and certain characteristics of that macro level NB style were lacking in our NB scenarios, as a dominant characteristic may consist of negative NB features (e.g., expression of autonomy and hierarchy). The dominance was mainly rated to test if any of the videos unintentionally produced impressions of dominance in the observers.

Lastly about macro level NBs tested in this pilot study, the positivity, expressivity, and dominance are three medically important impressions from the healthcare providers that can have substantial influences in treatment outcome. Our results inform the underlying NB structures of VEs that predict the impressions of positivity, expressivity, and dominance, with implications for patient experience and outcomes. A more detailed understanding about the role of micro level NBs in the generation of positivity, dominance, and expressivity can facilitate the training of such NBs, and consequently increase the reproducibility of such impressions. Several NB courses and training programs have been held so far with the goal of improving the interpersonal skills of the performers, and increasing the user satisfaction, for example in medicine (43), or tourism business (44), and the results of the present study can be useful to further advance such training programs.

General discussion

This article proposed a method to systematically investigate the NBs of the experimenters in the context of placebo analgesia, and through a pilot study, the reliability and validity of the NB manipulations were investigated approved. The results showed that firstly, the NBs of the experimenters can be adjusted and reliably manipulated. This can have implication for research, education and practice in health and educational contexts, or any other human-human, or avatar-human context where NBs of the communicator is of importance. Our results show that applying simple NB training and rating scales for the experimenters or healthcare providers can help to enhance the positivity and expressivity. Secondly, our pilot study results showed that different micro level NBs have different effects on impressions of dominance, positivity, and expressivity, with some micro level NBs having stronger effects on some macro level NBs, and vice versa. A more detailed understanding about the role of micro level NBs in the generation of positivity, dominance, and expressivity can facilitate the training of such NBs and consequently increase the reproducibility of such impressions.

Potential Challenges

Several challenges might exist. First is the use of VEs that might hinder the transmission of emotions to participants. The use of VEs provided the highest level of control over the NB channels of the
experimenters, however, as a trade-off, this may decrease the possibility of transmission of positive expectations or emotions to the participants, though in previous studies participants interacting with VE were engaged and showed strong effects (e.g., (29)). Secondly, even though the assistant in the room will receive training to control for their verbal and nonverbal interactions with the participants, there is still a chance that their presence will affect the results. To control for the effects of assistants, they will be trained to have minimal interaction with the participants and their seat will be also outside the visual field of the participants. Thirdly, looking at separate effects of NB channels may reduce the natural quality of the performances, as the nature of an emotion (or a message in general) cannot be sought in just one single NB, and we often times use a combination of NBs together to express and interpret emotions or a message (13). However, we did not completely separate the NBs, but manipulated the amplitude of NBs, as to enhance one channel and let a minimum of NBs from other channels to be present. Fourthly, we proposed to compare the positively enhanced NBs with a condition with neutral NBs. Even though our pilot study supported the validity of both the positively enhanced and the neutral conditions, the neutral conditions may induce some negative affect in participants, as there is no true neutral NB, and any NB can convey meaning. To partly control for the negativity effects each participant will have two VEIs, one playing the conditions with neutral NBs, and the second one for the positively enhanced conditions. Fifthly, even though we tried to formulate the NB scripts to convey one positively enhanced NB channel, some other channels were occasionally enhanced too, mostly due to keeping the natural quality of the NB expressions. Lastly, having only female actors also limits the generalizability of our findings to providers of other genders.

**Abbreviations**

- NB: nonverbal behaviors
- VE: videotaped experimenter
- VE1: videotaped experimenter one
- VE2: videotaped experimenter two
- +FE: positive facial expression group
- +TV: positive tone of voice group
- +BM: positive body movement group
- NC: neutral nonverbal behaviors group
- NRS: numeric rating scale

**Declarations**
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Availability of data and materials

The pilot datasets analyzed here are available via request from the corresponding author HD.

Competing interests

The authors declare no competing interests.

Authors’ contributions

HD and MAF designed the study. HD and MAR drafted the NB scripts and trained the actors and the coders. HD and MAR coordinated the data collection. HD and MAF drafted the manuscript. HD and MAF analysed the data. HD, MAF and MAR all contributed to the preparation of the final manuscript.

Disclaimer

Authors have no conflicts of interests to disclose.

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References

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Figures
Figure 1

Depiction of the NB video conditions.

*Description.* Top left: positive facial expressions (+FE); top right: positive body gestures (+BM); bottom left: neutral control condition (NC); bottom right: positive tone of voice (+TV). As also depicted in the bottom right photo, all conditions were acted by all three actors. With permission from actors.
Experimental procedure

Description. grey boxes: neutral NBs are displayed by VEs in grey phases or conditions; VE1: the first videotaped experiment who shows only neutral NBs; VE2: the second videotaped experimenter who has either positive or neutral NBs. +FE: positive facial expressions; +TV: positive tone of voice; +BM: positive body gestures; NC: neutral control condition (NC); during the calibration, the intensity of thermal pain (illustrated by a thermode) will be calibrated to the individual average of pain intensity using ascending stimulations. During the pre-test, a painful stimulation that is calibrated to the average of pain will be induced to the participant. Then participants were randomly assigned to one of the four groups. During the conditioning, a placebo cream will be applied with suggestive information by the VE2, and a lower pain stimulation than the pretest, unbeknown to participant, will be induced. In +FE, +TV, and +BM, The VE2 will have either positive facial expressions, positive tone of voice, positive body movements, or neutral (colored grey). During the post-test, an identical procedure as the conditioning will be administered, with the only difference that same stimulation intensity as in the pre-test will be induced to participants.
Figure 3

Amplitude of NBs in each condition

Note. As there were no differences in NB ratings between the intro, calibration and the pre-test, those conditions were not further investigated, and only the four conditions of +FE, +TV, +BM, and NC were included in the analyses. Figure legend: The mean and $SD$ (in parentheses) of micro level NB ratings of positivity in tone of voice, smile, eye contact, and gestures in each of the four NB conditions (TV: positive tone of voice condition; FE: positive facial expression condition; BM: positive body movements condition; Neutral: control condition).
**Figure 4**

Amplitude of impressions of dominance, positivity, and expressivity in each condition

Legend: Mean ratings and SD (in parentheses) of dominance, positivity, and expressivity in each of the four NB conditions (TV: positive tone of voice; FE: positive facial expression; BM: positive body movements; Neutral: neutral control condition).

**Supplementary Files**

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- [SuppMat.DanialiRubenFlaten.docx](#)