Published in final edited form as:

Eur J Pain. 2014 August ; 18(7): 914–922. doi:10.1002/j.1532-2149.2013.00436.x.

Socially-induced placebo analgesia: a comparison of a pre-recorded versus live face-to-face observation

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Abstract

Background—Recently, it has been shown that live, face-to-face social observation induces marked placebo analgesia. Despite the phenomenal growth of video sharing platforms, the potential analgesic effects of video based social observation are largely unknown. This study compared video based and live social observation induced placebo analgesia and whether there was a similar relationship between analgesic responses and empathy traits for both conditions.

Methods—Here we compared placebo analgesia in four groups: social observation through a video (SOV Group), social observation in person (SOP Group), verbal suggestion alone (VS Group) and a natural history group (NH Group). The SOV and SOP groups underwent a placebo treatment and painful stimuli following respectively a video based and live observation of a demonstrator showing analgesic effects when the painful stimuli were paired to a green light but not a red light. The VS group received painful stimuli after they had been verbally instructed to expect less pain after the green light. The NH group received painful stimuli, but was told nothing about the meaning of the lights. Individual pain reports and empathy traits were measured.

Results—We found that video based observation induced substantial placebo analgesic responses that were of similar magnitude to live observation. Notably, the analgesic scores were strongly correlated with empathetic concern in the live observation group but not in the video replay group.

Conclusions—These findings add evidence that placebo analgesia can be induced by social observation and that empathy interacts with these effects in a context-dependent manner.

Keywords

Expectancy; social learning; pain control; empathy; video based observation; conditioning

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Conflict of interests: The authors have no conflicts of interest to declare

Author contributions: TH and LC substantially contributed to conception and design of the study. FS collected the data and helped process the data analysis. TH and FS drafted the first version of the paper and LC contributed to write the final version and reviewed it critically. TH, FS, and LC discussed the results, commented on the manuscript and approved the submitted version.

Introduction

There has been a multitude of research on placebo effects over the last few decades that have expanded our still growing knowledge of the mechanisms of pain modulation (Colloca et al., 2013a). From a psychological viewpoint, the most well-known mechanisms thought to induce placebo effects are classical conditioning and expectation (Colloca et al., 2013b, Enck et al., 2013). However, the finding that some forms of social learning can produce robust placebo analgesic (and nocebo hyperalgesic) responses, suggests that other mechanisms may also play an important role (Colloca and Benedetti, 2009, Colloca and Miller, 2011, Vogtle et al., 2013, Swider and Babel, 2013). Social learning refers to instances of learning where observing a behaviour of a demonstrator, modifies the subsequent behaviour of an observer. This phenomenon is well-documented in humans and animals (Heyes, 1994, Iacoboni, 2009). Several lines of research have indicated that some forms of pain can be shaped by social modelling in humans (Craig, 1975, Kleck et al., 1976) and animals (Jeon et al., 2010, Langford et al., 2006). Remarkably, the placebo analgesic effects induced by observation are similar in magnitude to those induced by prior experience of analgesia through a conditioning procedure, and higher than those induced by verbal suggestions of pain relief. Overall, greater placebo analgesia occurred in individuals with higher levels of empathetic concern, suggesting a relationship between the ability to empathize and the experience of pain relief (Colloca and Benedetti, 2009).

It is still unclear how social learning can trigger an analgesic effect without any practice and direct experience, what components are essential in driving socially-induced placebo analgesia, and whether empathy traits can predict the ability of using social learning under different situations. To date social observation studies on analgesia have primarily been conducted live in a laboratory setting with the observer sitting directly next to the demonstrator. An alternative medium of displaying social observation is through a video. The restricted field of view of videos can limit the display of non-verbal cues and prevents any type of social interaction. Because of potential clinical application, it is interesting to investigate whether observing a video can shape placebo analgesia. Introducing physical distance between two individuals is also thought to reduce empathy (Stephan and Finlay, 1999) but it is unclear whether this would have an impact on social observation analgesia.

Therefore, to accurately assess the psychological dynamics of socially-induced placebo analgesia, we compared the effects of social learning through the medium of a video recording versus live observation of the demonstrator in person. We also investigated whether there was a similar relationship between analgesic response and empathy traits for both the conditions.

Materials and Methods

Subjects

A total of 60 healthy female volunteers (mean age 27 ± 7 years; range 18–46 years) were recruited from the University of East London, UK. None of the subjects had any contraindications for electrical stimulation, any cardiovascular, neurological or psychiatric diseases or were taking any medications. Age and empathy traits are reported in Table 1.

Additional psychological trait variables, endocrine parameters (e.g. phase of the menstrual cycle) or sociodemographic parameters (e.g. physical activity, attitude towards contraceptive medication) were not assessed. Each subject was randomly allocated into one of 4 experimental groups including: social observation on a video recording (SOV group) social observation in person (SOP group), verbal suggestion (VS group) and control (natural history, NH) group. All the experimental procedures were conducted in accordance with the Declaration of Helsinki. Subjects were told that the purpose of the research was to explore pain mechanisms and to reduce any potential report bias, all the details of the research procedures were not provided. All the subjects signed the informed consent and were debriefed regarding the real nature of the study and informed about the research results at the end of the study. All the procedures have been approved by Ethics committee at the University of East London, UK.

Painful stimuli

The painful stimulus consisted of a square wave pulse (100 μ s pulse duration) delivered to the back of the non-dominant hand through two silver chloride electrodes (size = 1×2.5 cm) connected to a constant current stimulator (DS7AH Constant Current Stimulators, Digitimer, Ltd, Hertfordshire, England). Each stimulus was delivered immediately after the display of either a red or a green light (18 red + 18 green) on a computer screen placed centrally in front of the participant at a distance of approximately 1.2 m. An ascending series of stimuli (steps of 0.5mA) was delivered starting at sub-tactile threshold, until tactile sensation and pain sensation were induced, thus allowing us to assess the tactile (t) and pain (T) thresholds for each subject. The intensity of the stimulation during testing was set to 2T for the red- and green- associated stimuli and subjects were asked to rate the perceived pain. The intensity of electrical shock used to induce a medium-high level of pain among all the subjects ranged from 5 to 24 mA.

Experimental design and procedures

The experiments took place in a silent room starting at 9 AM in the morning. Subjects sat in a semi-reclined chair with the monitor 1.2 m away and at eye level.

The protocol was designed to make subjects expect that stimulation of the middle finger through this electrode, after the presentation of a green light, would be analgesic. In contrast, the same subjects would expect a painful stimulus when the electrode was not activated following the red light. Before each testing session, the red and green associated stimuli were delivered once in order to familiarize the subjects with the experimental protocol.

The placebo manipulation was administered in SOV, SOP and VS groups according to the following procedure. A sham electrode was applied to the middle finger of the non-dominant hand, but it was not connected to stimulator, and no electrical stimulus was ever delivered. Subjects were told that the red and green lights would indicate two different conditions. Specifically, the subjects were informed that immediately after the green light disappeared the special electrode attached to the back of the middle finger of the right hand (actually, a sham electrode) would deliver a sub-threshold electrical stimulus that would in turn, reduce their perception of the painful stimuli delivered on the dorsum of the same

hand. They were also informed that the electrode placed on the middle finger would be deactivated after the red light disappeared and that a controlled level of pain would be delivered.

Observational Social Learning Protocols

The social learning protocols for the SOV, SOP and VS groups were based on a previous model of placebo analgesia developed by Colloca & Benedetti (Colloca and Benedetti, 2009).

Social observation on a video recording (SOV group)

Subjects were asked to watch a video recording of an unfamiliar female demonstrator (actually an actor) who undertook the full experimental session. The demonstrator was shown in a sitting position with two silver chloride electrodes applied to the back of their non-dominant hand and a sham electrode attached to their middle finger. Using a Visual Analogue Scale (VAS) ranging from 0=no pain to 10=maximum tolerable pain, the demonstrator always rated the stimuli paired to the red light as more painful (6–7 on the VAS scale) and the stimuli paired to the green light as less painful (1–2 on the VAS scale). By doing this, the demonstrator simulated an analgesic benefit following the presentation of the green light. Testing subjects then received 36 pain stimuli, each of which was delivered after the brief presentation of either a red light or green light (18 red + 18 green) on a computer screen. Note that the intensity of stimulation was set at the same level for the red and green lights.

Social observation in person (SOP group)

Subjects completed an almost identical procedure to the SOV group. The only difference was that subjects were able to observe the same unfamiliar female live demonstrator, whilst they were sitting directly next to them. After the simulation, in which the demonstrator showed an analgesic benefit following the presentation of the green light, testing subjects received 36 pain stimuli, each of which was delivered after the brief presentation of either a red light or green light on a computer screen. Note that the intensity of stimulation was set at the same level for the red and green lights.

Verbal suggestions (VS group)

Subjects did not watch any demonstrator but they were given the verbal suggestion from the experimenter that the green and red lights would indicate the activation and deactivation, respectively, of the electrode on their middle finger. Testing subjects received the same series of 36 pain stimuli delivered after the brief presentation of either a red light or green light on the computer screen. The intensity of stimulation was set at the same intensity for the red and green lights.

Natural history (NH group)

Subjects watched the series of 36 stimuli delivered in a pseudorandom sequence on the computer screen. It is important to note that these subjects were not given any visual or verbal information regarding the significance of the red and green lights.

The VS and NH groups were used to help delineate the different components of social learning (i.e., colored cues, verbal instruction) and control for potential effects of lights on pain perception and verbally-induced expectations.

In order to gain an adequate observation of the pain ratings, participants in the SOV and SOP groups were asked to keep a mental note of the number of times the demonstrator reported a VAS score of >5 after the presentation of the red light and <5 after the presentation of the green light. For groups without a demonstrator (SV and NH groups), the subjects were asked to keep a mental note of the number of red and green lights presented during the testing phase.

Testing sequence

The sequence of visual and painful stimuli is shown in Fig. 1. In order to keep anticipation of pain, analgesia, and sequential learning effects as similar as possible among all the subjects, the same pseudorandom sequence was used in all the participants and experimental groups. Each light was displayed for 5 s and an electric shock was delivered to the back of the hand immediately after the presentation of the light (100 ms delay). The intensity of stimulation was set at 2T for the red and green lights. After the electric shock stimuli subjects rated their perception using a Visual Analogue Scale (VAS; 1 s rest period and 5 s rating period). The inter-stimulus interval was 15 s. The total duration of the testing protocol was 12 minutes.

Psychophysical scale and empathy questionnaire

All the subjects rated pain intensity at the end of each stimulus by means of Visual Analogue Scale (VAS) ranging from 0=no pain to 10=maximum tolerable pain. Subjects also completed the Interpersonal Reactivity Index [IRI] a commonly used trait empathy questionnaire which includes the following four subscales: Perspective Taking (PT) is the tendency to spontaneously adopt the psychological point of view of others. Fantasy Score (FS) taps respondents' tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays. Empathic Concern (EC) assesses "other-oriented" feelings of sympathy and concerns for unfortunate others. Finally, Personal Distress (PD) measures "self-oriented" feelings of personal anxiety and unease intense interpersonal settings (Davis, 1983).

Statistical Analysis

The sample size ($N=15$) was derived from a previous study with the same experimental paradigms (Colloca and Benedetti, 2009).

Sphericity condition was assessed and when it was not verified, the Greenhouse-Geisser correction was applied. For analysis of VAS scores, statistical comparisons were performed by using repeated measures ANOVA with Groups as between-subject factor, Treatment (red-and green-associated VAS reports) and Time (trials) as within-subject factors, followed by post hoc computed univariate ANOVAs whenever significant interaction effects were found. F-tests were followed by the Bonferroni and Dunnett *post-hoc* tests for multiple comparisons. To control for multiple comparisons between study groups, the alpha level was

set at $\alpha < 0.0125$. The effect-size (r) was also calculated using the means and standard deviations of red- and green- VAS reports. Linear regression analysis was used to assess the contribution of empathy traits to the placebo effect and each sub-item of the IRI questionnaire was correlated with the analgesic scores.

All the analyses were carried out using SPSS software package (SPSS Inc., version 17, Chicago, Illinois, USA). The level of significance was set at $p < 0.05$.

Results

After the observational phase in which the testing participants were asked to watch either the video of the demonstrator (SOV group) or the same live demonstrator (SOP group) showing an analgesic benefit following the presentation of the green light, the participants received 36 painful stimuli set at the same intensity and each of which was delivered after the brief presentation of either a red light or green. These groups were compared with those who received verbal suggestions with no observational phase (VS group) and the control group in which the lights were presented with neither the observational phase nor verbal suggestions (NH group). Any differences between green- and red-VAS reports indicate a placebo effect.

We first probed the main effect of the factor Treatment (red- and green-stimuli) and the interactions among the factors Treatment, Groups (SOV, SOP, VS and NH) and Time (trials) by calculating repeated measures ANOVA of the VAS scores. The repeated measures ANOVA for VAS scores showed that there was a main effect of Treatment ($F(3,56) = 61.15$, $p < 0.0001$) with significant Treatment $\times$ Group ($F(3,56) = 13.52$, $p < 0.0001$) and Treatment $\times$ Group $\times$ Time ($F(51,952) = 2.327$, $p < 0.0001$) interactions. Then, we averaged each single red and green pain reports and we compared the difference between red and green scores among the experimental groups. Post hoc analysis of variance (ANOVA) confirmed a significant difference among groups ($F(3,56) = 13.56$, $p < 0.0001$). The Bonferroni t-test for multiple comparisons showed that the changes occurring in the SOV group were comparable to those observed in the SOP group (SOV versus SOP groups, $p = 1$). A Dunnett-t test (2-sides, with the NH group set as control) revealed that SOV group differed significantly from the NH group ($p < 0.0001$) and similarly, the SOP group was significantly different from the NH group ($p < 0.0001$). By contrast, no differences were observed between the VS and NH groups ($p = 0.646$) (Fig 2 C,D).

We further tested for the effect of the factor Time in the SOV and SOP groups using a two-way ANOVA with Treatment (red-green) and Time (trials 1–18) as within-subject factors. In the SOV group, the significant reduction in the green-rated VAS scores (main effects of treatment: $F(1,14) = 22.43$, $p < 0.0001$) was independent of the factor Time (interaction Treatment $\times$ Time: $F(6,94) = 0.75$, $p = 0.62$) suggesting stable condition over the entire experimental session (Fig 2A). The group who watched the demonstrator whilst sitting next to them also reported green-rated VAS scores substantially lower than red-rated scores (main effects of treatment: $F(1,14) = 29.5$, $p < 0.0001$) however, there was a trend to extinction (interaction treatment $\times$ time: $F(6,95) = 3.19$, $p < 0.005$) Fig 2B.

In the VS group, green-associated stimuli were less painful than the red-associated stimuli (main effect for treatment: $(F(1,14) = 15.140, p < 0.002)$ with no significant interaction treatment x time $(F(5,72) = 1.08, p = 0.37)$, Fig. 2C. But, these effects were not significant when compared with VAS changes found in NH group (Fig 2D), indicating the lack of verbally-induced placebo effects.

The analgesic effects observed in the SOV group (mean difference: 1.8 ± 1.5 , effect-size (r) = 0.59) and the SOP group (mean difference: 2.1 ± 1.5 , effect-size (r) = 0.62) were similar in magnitude (Fig. 3). The analgesic scores reported by testing subjects and pre-recorded versus live face-to-face observational scores were not correlated, which indicates that the subjects reported their own perception of pain intensity instead of repeating the VAS reports of the demonstrator.

Empathy traits and placebo analgesic responses

In order to assess whether empathy trait interacts with the socially-induced modulation of pain perception, we investigated the relationship between analgesic scores and empathy concern scores. There was no correlation between the analgesic and empathy scores in the SOV group (EC ($r = -0.25$; $p = 0.36$), the VS group: EC ($r = 0.10$; $p = 0.71$), and the NH group (EC ($r = -0.34$; $p = 0.20$), Fig. 4 A,C,D. Most notably, in the SOP group, there was a positive correlation between analgesic scores and the EC score ($r = 0.67$; $p < 0.005$; see Fig. 4B). No significant correlations were found for the other IRI subscales in all the experimental groups.

Discussion

The present findings provide the first direct comparison of the placebo analgesic effects of live face-to-face social observation versus a video replay of the same event. The results presented suggest that a video replay of social observation produces a placebo analgesic response of a similar magnitude to those reported after observation of a live demonstrator. Furthermore, there was a strong positive correlation between analgesic responses and empathic concern for the live social observation group, but not in the video replay group. Together these findings indicate observation per se boosts internal vicarious reinforcement profoundly influencing pain modulation.

When interpreting the relative contribution of social observation to placebo analgesia, it is important to consider mechanisms and factors that could have contributed to the analgesic effects in the Social Observation groups. As part of the Social Observation paradigm, subjects in the live and video recorded groups were given a verbal suggestion that the green light signaled an analgesic intervention. Thus we added the VS group for defining and comparing the relative contribution of verbal suggestions. In line with our previous findings (Colloca and Benedetti, 2006), verbal suggestions produced no significant changes, indicating that verbal suggestion is unlikely to have accounted for the observationally-driven placebo effect found in this study.

One may also argue that the pain reduction was due to the Green light which always preceded the analgesic trials thus evoking an association with safety signals. Although it is

well-known that individuals associate 'red' to avoidance motivation and 'green' to safety (Mehta and Zhu, 2009, Moller et al., 2009) and that the color of pills affects placebo responses (de Craen et al., 1996), we can exclude that the reduction of pain during Green trials was due to a color main effect because no placebo effects were found in the control group whereby subjects merely watched Green- and Red-lights in association with painful stimuli. Another potential confounding factor is response bias. VAS scales are a self-reported measure and therefore subjects could have manipulated their pain reports in order to please the researcher or fit in with the perceived experimental proposition (Hrobjartsson et al., 2011). Since the verbal suggestion and Social Observation groups received the same instruction about what to expect, response bias is unlikely to account for the difference in analgesic effects between the Social Observation groups and the verbal suggestion group. It is also worth noting that the participants VAS ratings did not correlate with those provided by the demonstrator, indicating that they reported their own perception rather than repeating what they had heard during the simulation.

Previous human and animal model studies have provided preliminary evidence, highlighting the role of social observation in shaping pain (Jeon et al., 2010, Langford et al., 2006) and placebo and nocebo responses (Colloca and Benedetti, 2009, Mazzoni et al., 2010, Swider and Babel, 2013, Vogtle et al., 2013). Colloca & Benedetti (Colloca and Benedetti, 2009) demonstrated a significant reduction in experimentally induced pain perception after subjects observed another individual repeatedly simulating analgesic responsiveness to a therapy. Using the same methodology, we have demonstrated a similar level of placebo analgesia in both live face-to-face social observation and a video replay of the same event. Together these findings reinforce the idea that social observation modulates short term pain perception and placebo analgesia. Moreover, these results show that despite a restricted field of view and lack of interaction, video based social observation modulates placebo analgesia to a similar degree to live social observation.

A mechanism by which live and video based social observation may influence pain perception is through modifying response expectancies. By watching the actor simulate pain relief, the subjects may have developed an expectation of relative analgesia after the green light which in turn could have reduced pain perception. Supporting this idea, a number of studies have demonstrated the importance of response expectancies in triggering the release of endogenous modulators which in turn, produce placebo analgesia (Amanzio and Benedetti, 1999). The repeated observation of the actor experiencing analgesia after the green light may have served as an unconditioned stimulus as part of classical conditioning. Whilst there is limited research examining the role of classical conditioning in Social observation placebo analgesia, features of classical conditioning such as blocking and overshadowing have been identified in social aversive learning (Lanzetta and Orr, 1980). However, in contrast to classical conditioning, placebo analgesia driven by observing the outcomes of others cannot be based on directly experienced reduction of pain. Accordingly, the neural mechanisms of learning placebo analgesia through the observation of an actor might rely on the existence of a mirror-like system responsible for the processing and storage of outcomes learned by observation of others (Iacoboni, 2009).

It is also important to consider the empathy trait of the recipient as an important factor that modulates observational placebo analgesia. Interestingly, we found a strong positive correlation between analgesic responses and empathic concern for the live social observation group. Empathic concern is part of the IRI self-report questionnaire for measuring dispositional empathy and has been associated to the affective counterpart (Davis, 1983). Most notably, both the current study and a previous study by Colloca & Benedetti (Colloca and Benedetti, 2009) found a significant correlation between placebo analgesia and empathic concern in the live face-to-face social observation group despite of the fact that the actors were of opposite gender in the two studies (woman and man, respectively). Whilst this correlation does not prove causality, there is evidence that the level of empathy towards another individual may alter (and likewise predict) subsequent pain and placebo analgesia in distinct social contexts. Mice have been shown to demonstrate an increased level of pain behaviors when they observe cage mates, but not strangers, in pain (Langford et al., 2006). Interestingly, despite demonstrating a similar level of placebo analgesia to the subjects in the live group, there was no significant correlation between empathetic concern and analgesic responses in the video replay group. Some researchers have proposed that, in comparison to face-to-face interactions, visual signals are often diluted over video, and therefore have a weakened impact (Heath et al., 1995). It is possible, therefore, that whilst the videos conveyed enough audio and written information to influence expectation, some of the more subtle non-verbal cues that elicit empathic concern were dampened. Moreover, empathy may be modulated by the interpersonal context in which individuals are engaged (Lanzetta and Englis, 1989, Singer et al., 2006) and so the lack of interaction with the demonstrator in the video replay group may have also influenced the relationship between empathy and placebo analgesia. In line with this reasoning, a brain imaging study has indicated that different areas of the brain are activated depending on whether an individual directly interacts with another individual or watches the same video replay. Indeed, Redcay et al. (Redcay et al., 2010) found that live interaction, as compared to the video replay, resulted in a greater activation in brain regions associated with social cognition and reward. Moreover, a recent study demonstrated that watching video-clip of facial expressions modulates placebo analgesia but these video-induced effects were not correlated with dispositional empathy (Valentini et al., 2013). Two recent studies confirming and extending the findings on social learning to the nocebo effect, used for the social observation phase, either a video showing a female model (Vogtle et al., 2013) or live models (Swider and Babel, 2013). Interestingly, socially-induced changes in pain reports correlated with the empathetic scores only when live models were involved (Swider and Babel, 2013). These findings seem to support our speculation that empathy may predict placebo analgesia in live interaction contexts. While definitive conclusions cannot be drawn on the role of empathy on observationally-induced placebo (and nocebo effects) due to the paucity of studies and the relatively small sample sizes, it seems that social learning is a crucial factor in modulating placebo analgesia.

Developing a better understanding of the potential analgesic effects of video based Social Observation is of particular interest in clinics. In fact, the phenomenal growth of internet video sharing and social networking platforms has enabled patients to observe and learn from other patients on a scale never seen before. In order to further understand the potential

clinical relevance of video based social observation, some limitations of the study need to be acknowledged and addressed. Firstly, the social observation protocols were conducted in a laboratory setting on healthy adults using transient painful stimuli. In contrast, the pain from clinical conditions is far less controlled and longer lasting which is likely to cause more distress and anxiety. Secondly, in order to study observationally-induced placebo analgesia and control for possible confounding factors, we used very simple observational, heavily scripted scenes which were repeated a large number of times. Future studies will need to investigate if placebo analgesia can be induced using more naturalistic and ecological scenes which by definition will have less repetition. A third limitation is that we did not assess subjects' expectation, which limits our understanding about the role of subjects' expectations on pain intensity.

Conclusion

Overall this study provides evidence that placebo analgesia can be induced by both live face-to-face and video based social observation and that empathy facilitates these effects in a context-dependent manner. These findings not only confirm that social learning is a critical mechanism within the broader theoretical framework of placebo analgesia but may also offer a model for scientists to investigate the neural mechanisms and for clinicians an unparalleled opportunity to use video based learning tools to improve health and medical information and to optimize the healing environment for patients suffering from pain.

Acknowledgments

This research was supported by UEL (T.H.) and NCCAM and NIMH Intramural Programs (L.C.)

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What is already known about this topic?

Colloca and Benedetti (Pain, 2009) suggested that placebo analgesia can be induced by observing a demonstrator experiencing an analgesic effect.

What does study add?

Here we demonstrated that merely observing benefits from a treatment through a video elicited analgesia. These effects were similar in magnitude to those induced by interpersonal interactions. However, empathy predicts observationally-induced analgesia in presence of a live demonstrator only.

Fig 1.

Visual stimuli sequence and time course for each trial. (A) The red and green boxes represent the pseudorandom order of the 36 visual stimuli (18 red/18 green) presented during the acquisition (SOV and SOP Groups) and the testing phase in all the experimental groups. (B) Each trial began with the presentation of a red/green circle for 5 s, which was immediately followed by the delivery of a painful electric stimulus (delay of 100 ms). Subjects had 1 second to rest and were given 5 s to rate their pain using the VAS. There was an inter-stimulus interval of 15 s.

Fig 2.

The graphs show the trial by trial VAS scores reported for stimuli paired with the green light and red light following (A) social observation through a video, (B) live social observation, (C) verbal suggestion alone and (D) a control. For the video based and live social observation groups, stimuli paired with the green light were consistently rated as less painful than those paired with the red light. Verbal suggestions produced no changes in pain modulation in fact there was no difference with the natural history control group.

Fig. 3. Magnitude of pain reduction in each experimental group

The analgesic effects (red minus green differences in VAS scores) in SOV group were not different from those measured in the SOP group but significantly different from those measured in the VS group and the NH group.

Fig. 4. Correlations between EC scores and analgesic responses in the SOV (A), SOP (B), VS (C) and NH (D) groups. Note that there was a positive correlation between EC and pain reduction in the SOP Group only following the live face-to-face observation.

Table 1

Characteristics of subjects for each experimental group

Group	Exp. procedure	n	sex	age	IRI	PT	FS	EC	PD
1	SOV	15	F	25.2 ± 5.7	25.9 ± 3.23	22.3 ± 4.68	27.1 ± 4.21	19.9 ± 3.63	
2	SOP	15	F	29 ± 7.1	26.7 ± 4.79	19.3 ± 5.22	27.7 ± 3.83	17.2 ± 4	
3	verbal suggestions	15	F	23.3 ± 7.1	21.8 ± 4.16	22.7 ± 2.52	23.7 ± 3.89	15.1 ± 3.29	
4	control	15	F	30.9 ± 8.6	24 ± 4.52	21.4 ± 4.66	25.3 ± 2.94	17.7 ± 3.24	

SOV= social observation in video; SOP= social observation in person.