# The Hypoalgesic Effect of 3-D Video Glasses on Cold Pressor Pain: Reproducibility and Importance of Information

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The first aim of the study was to evaluate whether it was possible to manipulate the distraction effect induced by 3-D video glasses on the perceived pain and unpleasantness of the subjects by giving them different information about the expected effect. Second, the study aimed to determine the reproducibility of the effect. Forty-five students enrolled, 39 students participated in the study (24 women and 15 men, median age 23 years, range 19–28 years) because 6 did not show up for the first trial, and 37 completed the study because 2 subjects did not show up for the second trial. The subjects were randomized into 3 groups, balanced with respect to age and sex, that received different information about the effect of 3-D video on pain and unpleasantness: the first group received positive information, the second group received neutral information, and the third group received negative information. Once assigned to a group, there were no crossovers between the groups. A cold pressor stimulus was used to induce experimental pain, and the volunteers rated the intensity of pain and unpleasantness on 100-mm visual analogue scales. A new generation of video glasses were used in the study. Each volunteer was exposed to the cold pressor test in 2 randomized trials (video and control) after the information was given, and the 2 trials were repeated in a second session after 4 weeks. There was no significant difference in the effect of video glasses on perceived pain ($P = .74$) nor on the perceived unpleasantness ($P = .84$) among the 3 information groups. The data were therefore pooled. The results of the pooled data showed a significant effect of 3-D video on perceived pain ($P = .03$) but not on unpleasantness ($P = .18$). After 4 weeks, the study was repeated, and there were no significant changes in the effect of video glasses. The median visual analogue scale scores were reduced in both the video and the control trials compared with the first session.

**Key Words:** Human experimental pain; Cold pressor; Pain assessment; Distraction.

Video glasses, a new kind of audio-visual equipment that has been developed for virtual reality purposes, have the capability of showing 3-D movies. The sound is transmitted through incorporated headphones held together in a headset. This gives a unique chance to simultaneously use video and music as distraction during dental treatment, a possibility that has not previously existed.

Distraction by the use of such video glasses has been shown to positively alter the perceived pain and unpleasantness in both experimental[1] and clinical situations.[2,3] In a recent experiment,[1] we showed that the use of 3-D movies resulted in a significant reduction in the perception of pain and unpleasantness in a group of male students undergoing a cold pressor test. As no studies on the reproducibility of the demonstrated effect

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**Table 1.** The Medians and Ranges (in Parentheses) for the Visual Analogue Score (VAS) Scores for the 3 Information Groups for the First Session

| First Session VAS Ratings | Pain Rating | | Pain Effect* | Unpleasantness Rating | | Unpleasantness Effect* |
|---|---|---|---|---|---|---|
| | Video Trial | Control Trial | Video–Control | Video Trial | Control Trial | Video–Control |
| Positive information ($N$ = 13) | 41 (6–86) | 53 (11–89) | −6 (−37–19) | 53 (11–87) | 62 (4–92) | −5 (−32–29) |
| Negative information ($N$ = 12) | 31 (12–66) | 53 (4–78) | 1 (−3–23) | 37 (8–77) | 39 (5–65) | −8 (−41–72) |
| Neutral information ($N$ = 14) | 51 (3–85) | 59 (17–84) | −4 (−38–30) | 43 (6–95) | 58 (2–86) | −5 (−30–29) |
| Total group ($N$ = 39) | 48 (3–86) | 55 (4–89) | −2 (−38–30) | 44 (6–95) | 49 (2–92) | −5 (−41–72) |

* Effect was defined as the differences in VAS scores between the video and the control situations.

are known to the authors, it is of interest to evaluate whether this hypoalgesic effect is robust over time or is merely caused by the fascination of a new technique. Moreover, it is important to understand if the effect of video glasses on the perceived pain is influenced by the belief in the effect because strong placebo effects might be involved in this type of pain modulation. Because a double-blinded design is impossible in this type of study, a shortcut to the understanding is to manipulate the volunteers to a preconceived opinion in the effect—positive or negative.

As an experimental pain model, the cold pressor test provides a standardized and relatively strong pain stimulus and has been widely used.[4–10] Visual analogue scales (VAS) have become one of the standards to measure the perceived intensity of pain and unpleasantness.[4–6,8,10,11]

Thus, the aim of this study was to evaluate whether the effect on the perceived intensity of pain and unpleasantness induced by 3-D video transmitted through video glasses could be manipulated by different information to the subjects, and if the possible effect of distraction was robust after 4 weeks.

There were 3 specific null hypotheses to be tested. The first hypothesis ($H_A$) was that there would be no effects on the intensity of pain and unpleasantness when watching 3-D video. The second hypothesis ($H_B$) was that there would be no effects caused by different information given to subjects concerning the intensity of pain and unpleasantness when watching 3-D video compared with no video during a cold pressor test. The third hypothesis ($H_C$) was that there would be no change in the effect of watching 3-D video on the intensity of pain and unpleasantness after 4 weeks.

## MATERIAL AND METHODS

### Volunteers

Forty-five undergraduate students enrolled in the study as volunteers and participated in the information session. Only thirty-nine students participated in the first trial (24 women and 15 men, median age 23 years, range 19–28 years) because 6 volunteers did not show up at the trial. Thirty-seven students completed the study because 2 did not show up for the second trial. The distribution of the dropouts is seen in Tables 1 and 2. All of the volunteers were healthy and used no type of medication. The groups were balanced with respect to sex and age. The cold pressor test was explained to the participants, and they were informed that they could stop the experiment at any time. Written informed consent was obtained in accordance with the Helsinki declaration. Two of the volunteers were left out of the reproducibility study since they did not show up for the second session after 4 weeks.

### Equipment

The cold pressor equipment consisted of a cold water tank with a water temperature of 1.5 ± 0.5°C. In the

**Table 2.** The Medians and Ranges (in Parentheses) for the Visual Analogue Scale (VAS) Scores for the 3 Information Groups for the Second Session After 4 Weeks

| Second Session VAS Ratings* | Pain Rating | | Pain Effect† | Unpleasantness Rating | | Unpleasantness Effect† |
|---|---|---|---|---|---|---|
| | Video Trial | Control Trial | Video–Control | Video Trial | Control Trial | Video–Control |
| Positive information ($N$ = 12) | 25 (6–82) | 35 (8–82) | −9 (−22–7) | 30 (6–78) | 40 (5–69) | −10 (−24–11) |
| Negative information ($N$ = 12) | 19 (2–46) | 31 (5–76) | −9 (−47–13) | 17 (4–33) | 25 (5–68) | −11 (−43–13) |
| Neutral information ($N$ = 13) | 38 (3–53) | 32 (11–83) | −4 (−38–28) | 32 (0–76) | 34 (9–85) | −7 (−51–28) |
| Total group ($N$ = 37) | 25 (2–82) | 32 (5–83) | −8 (−47–28) | 28 (0–78) | 32 (5–85) | −7 (−51–28) |

* The second session was held 4 weeks after the first session.

† Effect was defined as the differences in VAS scores between the video and the control situations.

center of the tank, a perforated cylinder was placed that separated the ice from the water inside the cylinder. This allowed the water to circulate freely but avoided direct skin contact with the ice. The video equipment consisted of a video recorder (NV-HD 660 Panasonic) connected to a pair of video glasses (I-Glasses, Virtual i-O, Seattle, Wash). A 3-D movie sequence showing roller skaters in action was shown to the volunteers in all video trials. The setup has been shown in detail in a previous study.[1]

### Experimental design

The study was designed as a controlled, randomized experiment. The volunteers were randomized into 3 groups that received different information on the effect of 3-D video on pain and unpleasantness, given by the same individual in all cases. One group received positive information: "Dental treatment under sedation with video glasses is today widely used in the US with a positive effect; preliminary studies on humans have under certain circumstances shown an effect equal to morphine; the effect is thought to be a gate effect." The second group received neutral information: "Video glasses are today used widely in the US on dental patients; preliminary studies have shown a change in the feeling of unpleasantness among approximately half of these patients." The third group received negative information: "Preliminary studies have repeatedly shown that video glasses have an effect on the sensation of pain and unpleasantness; unfortunately, this effect is negative—the patient gets the feeling of being blindfolded and unable to involve himself or herself in the treatment."

Each of the volunteers was exposed to the cold pressor test in 2 trials (video and control) after the information was given and then again after 4 weeks. The volunteers were thoroughly instructed; they then signed a statement not to discuss their participation in the study with anyone until the end of the experiments. During the cold pressor test, the volunteer was placed in a comfortable chair beside the cold water tank, the video glasses were mounted, and a test was conducted to ensure an optimal reception of the video sequence. The volunteer immersed his or her left hand completely in the water. The left hand was used for immersion every time as a previous study has shown that there is no difference in pain ratings using either the dominant or nondominant hand during a cold pressor test.[8] The hand was not strapped, allowing the volunteer to withdraw the hand if the sensation became unbearable. After 3 minutes (or sooner if the sensation was unbearable), the volunteer withdrew his or her hand and was allowed to dry it with a towel and warm it with a hair dryer. When the volunteer indicated that his or her hand had its normal temperature (minimum 15 minutes), the second trial was performed. The order of the video and control in the trial was randomized. The same 3-D movie sequence showing roller skaters in action was shown to all volunteers during the entire 3-minute cold pressor test in all video trials.

Immediately after each cold pressor test was completed, the volunteers scored their perceived pain intensity and unpleasantness on 100-mm VAS. The VAS was labeled with the statements "not at all painful" and "extremely painful" and, "not at all unpleasant" and "extremely unpleasant " in either end. After the second trial, the volunteers were asked which of the 2 options, 3-D video or no video, they would prefer if they had to participate in another cold pressor test. The volunteers were not able to manipulate the picture quality or to control the volume of the music after the adaptation period.

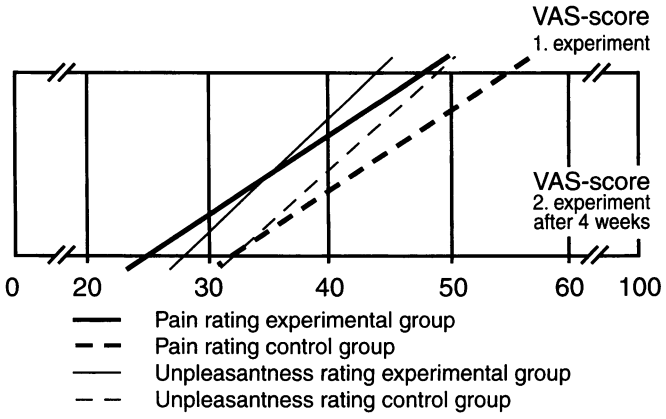
After a period of 4 weeks, the previously described trial (video and control session) was repeated with the same equipment, the same researcher, and the same volunteers (except the 2 who did not show up).

### Statistics

Effect was defined as the differences in VAS scores between the video and the control situations (video–control). In the first session, effect was compared between the 3 information groups by the Kruskal-Wallis test (testing $H_B$). Wilcoxon-Signed-Rank test for paired data was used to compare VAS scores between the video and control situation in the pooled data (testing $H_A$). The differences in effect after 4 weeks (second session) were compared ($H_B$) between the 3 information groups by the Kruskal-Wallis test. Wilcoxon-Signed-Rank test for paired data was used to compare the differences in effect between the first and second session in the pooled data ($H_C$). Spearman's rho test was used to detect the correlation between effect on pain and unpleasantness. When $P < .05$, the difference was accepted as statistically significant.

## RESULTS

None of the volunteers withdrew their immersed hand before the fixed time period of 3 minutes had been completed. The medians and ranges for the VAS scores for the 3 information groups for the first set of experiments can be seen in Table 1. There were no statistically significant differences in effects among the 3 information groups in the video trials—neither for pain ($P = .74$) nor for unpleasantness ($P = .84$). Since no difference could be shown among the 3 information groups, the results were pooled into 1 group. The pooled data dem-




VAS scores for pain and unpleasantness perception in the first and second experiment after 4 weeks.

onstrated a significant effect of 3-D video on pain compared to the control situation ($P = .03$) but no significant effect on unpleasantness ($P = .18$). The effect on pain was positively correlated to the effect on unpleasantness in the first setting (correlation coefficient $r = .585$; $P < .01$).

In Table 2, the medians and ranges for the VAS scores can be seen for the 3 information groups for the second session after 4 weeks. There were no significant differences between the groups regarding the differences in effect between first and second trial ($P = .54$ for pain and $P = .52$ for unpleasantness). The data were pooled, and likewise there was no change in effect over time ($P = .90$ for pain and $P = .43$ for unpleasantness). After 4 weeks, there was a generally lower VAS rating within all groups, both in the video and control situation (Fig. 1).

Seventy-five percent of the participants wanted to use video glasses if they were to repeat the cold pressor test.

## DISCUSSION

The hypoalgesic effect of 3-D video in a cold pressor test, which we have demonstrated previously,[1] was rediscovered in the present trial with a larger group of volunteers that included both sexes. Thus, $H_A$ had to be rejected. The sample size consisted of 12–13 individuals in each group because the above mentioned previous trial had shown a significant effect of video glasses with this sample size.

It was not possible to manipulate the different groups to believe that the effect of the video glasses was either positive or negative. This could be interpreted as a result of poor manipulation, which might have been tested by asking the volunteers about their expectations after the manipulative lecture. Moreover, a significant effect may have been obtained by a huge increase in the sample size in each group. However, if many more individuals are needed to demonstrate a statistically significant effect, it is doubtful that it would be clinically relevant. The most likely interpretation of the result is therefore that the effect of the video glasses on the perception of pain and unpleasantness is quite robust towards pre-information. The null hypothesis, that there was no difference between the information groups, could thus not be rejected. This is in opposition to the findings in another study[12] where it was shown that music, combined with a strong suggestion to the volunteer that it had a positive effect, produced a decrease in pain tolerance during a cold pressor test in comparison to music alone. This divergence could be due to differences in the setup of the studies.

It would be straightforward to assume that the effect of video glasses on the perceived pain and unpleasantness could be related to the fact that this is a new technique and that the interest in or fascination of this product would alone cause some degree of distraction. Therefore, after 4 weeks, exactly the same trial was performed again, and at this time there was a generally lower VAS score in both the video and control situation. This outcome may be speculated to be the result of the volunteers' familiarity with the nature of the trial and the magnitude of the pain stimulus. Looking at the effect of video glasses, there were no changes over time—the difference between VAS scores for video and control was unaltered after 4 weeks.

The fact that all volunteers in this study did complete the 3-minute cold pressor test is puzzling because other studies have shown a much higher sensitivity to the cold water (ie, one study[12] had to disqualify half of the volunteers because they were either too sensitive to the cold water or able to go on indefinitely). As the volunteers served as their own controls in the present design, this matter should be of little importance.

Video glasses have a dimension that enables a dentist to work almost freely in the oral cavity, and because of the minimal weight (240 g [8 oz]), they are comfortable for the patient to wear. The pain induced by a cold pressor stimulus with its slow onset cannot be compared directly to the pain that arises during dental treatment because the latter is often connected with a sharp pain and a rapid onset. In the cold pressor technique, it is mainly the Aδ-fibres that are activated, but in the dental pulp, Aδ and C-nociceptors are more likely stimulated. However, the cold pressor test provides a convenient and useful pain stimulus in experimental settings. It also must be remembered that a 1-dimensional stimulus modality and assessment technique was used in this study and that the cognitive background of an experienced clinical pain is not available in this experimental study.

The results can therefore not be directly transferred to a clinical situation. The magnitude of the pain reduction (13%–20%) was in accordance with another study on the effect of morphine compared to placebo using the cold pressor test[6]; therefore, it seems to be relevant to explore the effect of video glasses in connection with clinical pain situations.

Other parameters than the type of pain could influence the hypoalgesic effect of video glasses, such as the type of film and glasses, the mood of the patient, and the duration of the pain stimulus. Further studies are needed to investigate these aspects.

## CONCLUSION

In this cold pressor study, it was not possible to manipulate the hypoalgesic effect of 3-D video glasses by giving different information to the subjects, suggesting that the effect is robust towards the information given. The hypoalgesic effect of 3-D video glasses on pain and unpleasantness persisted after 4 weeks because the difference between VAS scores for video and control was unaltered.

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