EFFECT OF WHITE SOUND ON PAIN THRESHOLD

BY

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SUMMARY

It has been claimed that intense acoustic stimulation, using "white sound", can reduce or eliminate pain. The effect of white sound on visceral pain produced by contraction of ischaemic muscle has therefore been investigated. Pain threshold estimations were made under the following conditions: (A) control; (B) music alone at comfortable listening level; (C) white sound of moderate intensity (90 db SPL); (D) white sound of maximum intensity (120 db SPL). The results do not indicate that sound stimulation alters the threshold for pain produced by the contraction of ischaemic muscle.

"White sound" consists of a mixture of sounds of all audible frequencies, and is so called by analogy with white light. It has been claimed that intense acoustic stimulation, using white sound, can reduce or eliminate pain. Gardner and Licklider (1959), using white sound and music supplied to patients through stereo earphones, reported that suppression of pain in dental operations by sound was fully effective for 63 per cent of 387 patients who previously required inhalation or local analgesia for comparable operations. For 25 per cent of patients sound-induced analgesia was sufficiently effective so that no other analgesia or anaesthetic agent was required. For 10 per cent it was less than adequate. Two hundred teeth were extracted without report of objectionable pain.

Carlin et al. (1962) studied the effect of sound stimulation on dental sensation threshold by application of electrical stimulation to teeth. White sound was administered at noise levels of 100 db SPL (sound pressure level) and 120 db SPL to fifty-six dental clinic patients. They found no evidence that noise reduced sensitivity when a tooth is stimulated electrically. There was only a hint that suggestion raised the threshold slightly. The results indicate that auditory analgesia is probably not an example of cross-sensory masking, and that its successful use in the clinical situation depends both on distraction and on suggestion.

Robson and Davenport (1962) studied the effects of white sound and music on superficial pain threshold recorded as volts applied to a heating wire. A wide range of white sound and music pressures was administered to thirteen subjects. No statistically significant alteration in superficial pain threshold due to the thermal stimulus was observed. The conclusion was that any effect white sound or music has on the pain of dental work must either be due to the relative insignificance of the pain or to hypnotic suggestion. It was found that a rise of statistical significance in this method of threshold stimulation occurred with the administration of 20 to 30 per cent of nitrous oxide in oxygen.

Clutton-Brock (1962) studied the effects of white sound on pain threshold measured by the technique of graded application of pressure. White sound was administered at various measured intensities to eleven subjects. In approximately half the subjects a fair degree of analgesia could be produced by moderate intensities of white sound (90 db SPL). The analgesia produced was compared with that caused by distraction and found to be of much the same order and similar, also, to that produced by a moderate dose of morphine. Very profound analgesia could be produced in certain subjects, but only by white sound of sufficient loudness to cause pain (120 db). The conclusion was that white sound will produce useful degrees of analgesia in certain people and that it does not seem that the "randomness" of the stimulus
(i.e. the fact that the sound is white) can be the whole explanation for the analgesia produced by white sound. It was found that the analgesia produced was antagonized by sub-anaesthetic doses of thiopentone.

PRESENT INVESTIGATION

In the studies dealing with the effect of sound stimulation on pain threshold, the assessments were based upon response to superficial or cutaneous stimuli. Cutaneous pain, however, is different in quality from deep or visceral pain. It is suggested that the pain of the uterine muscle during exaggerated uterine contraction is due to ischaemia (Moir, 1934). The effect of white sound on visceral pain produced by contraction of ischaemic muscle has therefore been investigated, using a modification of the method described by Hewer and Keele (1948).

METHOD

Electrical noise with uniform distribution of frequencies down to 5 cycles per second is obtained from a gas-filled triode valve (type EN93) surrounded by a magnet (Mullard type M3459). This noise is amplified by an amplifier with a flat frequency response in the range 15 c/s to 10 kilocycles/sec and applied to a pair of head-phones (S. G. Brown super "k") which have a flat response from 25 to 9000 c/s. The intensity of sound at the headphones is measured with a standard sound level meter (Dawe Instruments) and the apparatus is adjusted so that a sound level of 120 db could not be exceeded.

The headphones with appropriate sound are applied 30 seconds before obliteration of circulation of the arm. A sphygmomanometer cuff is applied to the elevated arm, and is inflated to 250 mm Hg. The subject then lowers his arm, forms a fist round the bulb of a manometer and squeezes it in time with a metronome set at a rate of 60 beats/min. The bulb is squeezed with sufficient force to measure 150 mm Hg on a manometer. The first unpleasant sensations in the arm are vague. Later the unpleasant sensation becomes more definite. Suddenly a severe arresting pain is felt which seems to grip the muscles of the arm so that further squeezing of the bulb causes extreme pain. The point of onset of the severe pain is taken as the end point, and is recorded as time in seconds from the obliteration of circulation.

Measurements of the time taken to reach the pain threshold were made under the following conditions:

(A) Control.
(B) Music alone at comfortable listening level.
(C) White sound of moderate intensity (90 db SPL).
(D) White sound of maximum intensity (120 db SPL).

The experiment was planned in the form of three Latin squares, as shown in the upper half of figure 1. These were chosen so that, in each square, in addition to the usual Latin square feature of each treatment appearing once on each day and once for each subject, each treatment appeared once following each other treatment, for the same subject but the next day. Within this restriction the squares were chosen at random.

The experiment was performed over three weeks, each Latin square taking four successive days within one week.

ANALYSIS

It should be noted that the days bear a relationship to each other that the subjects do not. Thus day 1 is the first day for the first four subjects, and day 5 is the first day for the next four subjects. Day 1 therefore bears a relationship to day 5 (and to day 9) that it does not bear to days 6, 7 and 8 (or to days 10, 11 and 12). Subject 1, however, bears no relationship to subject 5 that he does not also bear to subjects 6, 7 and 8. Days and subjects do not, therefore, appear symmetrically in the analysis.

The results are shown in the lower half of the figure, and the analysis of variance of the results in table I. There is only one effect which reached the conventional 5 per cent significance level, namely differences between subjects, but this is not at all a surprising conclusion.

Differences between treatments, so far from being significant, were not even as great as would be expected on the average purely by chance. Thus no analgesic effect has been demonstrated by this experiment.
Latin squares, and results measured in seconds.

**TABLE 1**

*Analysis of variance of results.*

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of squares (sec²)</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between weeks</td>
<td>29.2</td>
<td>2</td>
<td>14.6</td>
<td>P&gt;0.50</td>
</tr>
<tr>
<td>Between treatments</td>
<td>179.2</td>
<td>3</td>
<td>59.7</td>
<td>P&gt;0.50</td>
</tr>
<tr>
<td>Between days</td>
<td>342.4</td>
<td>3</td>
<td>114.1</td>
<td>P&gt;0.50</td>
</tr>
<tr>
<td>Weeks × treatments</td>
<td>730.8</td>
<td>6</td>
<td>121.8</td>
<td>0.50&gt;P&gt;0.25</td>
</tr>
<tr>
<td>Weeks × days</td>
<td>1459.1</td>
<td>6</td>
<td>243.2</td>
<td>0.10&gt;P&gt;0.05</td>
</tr>
<tr>
<td>Between subjects (within weeks)</td>
<td>2996.8</td>
<td>9</td>
<td>333.0</td>
<td>0.05&gt;P&gt;0.025</td>
</tr>
<tr>
<td>Residual</td>
<td>1762.8</td>
<td>18</td>
<td>97.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7500.3</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMENT**

These results do not indicate that sound stimulation alters the threshold for pain produced by the contraction of ischaemic muscle. As the effects of analgesics upon visceral pain are similar to those on superficial pain (Harrison and Bigelow, 1943), the findings are in accordance with the observations of Robson and Davenport (1962) and Carlin et al. (1962). On the other hand, Clutton-Brock (1962) found that with moderate intensities of white sound a fair degree of analgesia was produced in about half the subjects. It has been stated (Hesse, 1962) that a reduction in the band width of white sound, either in the upper or lower frequencies, keeping the total power constant, reduces any analgesic effect. Neither Robson and Davenport nor Carlin et al. stated the band width used, and it is possible that an effect may have been missed by having too limited a range of frequencies. However, our experiment has shown no effect while using a wide range of frequencies.

**ACKNOWLEDGMENTS**

We wish to acknowledge the advice and assistance of Dr. J. R. Mallard, Reader in Medical Physics, and Mr. J. E. Pallett, Lecturer in Biophysics.
REFERENCES

EFFET DU SON AIGUS SUR LE SEUIL DE LA DOULEUR

SOMMAIRE
On a prétendu qu'une stimulation acoustique intense peut réduire ou même éliminer la douleur. Voilà pour-