A STUDY OF THE EFFECT OF AUDIO-ANALGESIA

by

G. OLOF CARLSON

The importance of distraction as a means of bringing about partial or total analgesia has long been known. Two extreme variants are the methods of "twitching" well known in veterinary medicine and suggestion of various degrees of depth up to the point of complete hypnosis.

The phenomenon of audio-analgesia was described in 1959 by *Gardner & Licklider*. With the help of ear-phones the patient was exposed to tape-band recorded music, to which was added a special distracting sound, so-called white noise. This sound is a buzzing tone which is so composed as to cover the widest possible spectrum of audible frequencies. From a control-box in his hand the patient was himself able to regulate the sound volume and cut off white noise either wholly or in part. In a very large number of cases it was then possible to carry out dental operations without conventional anesthetics.

Cherry & Pallin (1948) have shown that the choice of background music plays an essential rôle. Thus, exciting music may have a diametrically opposite effect and even provoke muscular tensions and psychic lability. The patient's psychological status, too, is a very significant factor, an aspect which has been studied with illuminating results by *Licklider* (1961).

The neurophysiological mechanism of audio-analgesia has not yet been fully investigated, but a number of studies in adjacent

fields have thrown some light upon it. It has been shown by, *inter alios, Hagbarth & Kerr* (1953) that an electric stimulus in the reticular formation can block the ingoing signals in the sensitive dermal channel. This blocking may take place at different levels in the C.N.S.: in the spinal marrow, in medulla oblongata, in thalamus and in the cerebral cortex itself. It is possible that the reticular formation may enter into the mechanism serving audio-analgesia. In an experiment on cats with transmission from the cochlear nucleus *Hernandez-Peón, Scherrer, & Jouvet* (1955) show that the central response to an auditory stimulus may be blocked by other sensory impulses, i.e. the reverse of what is the case in audio-analgesia.

To obtain total analgesia in the oral cavity is probably not always possible with the aids at present available. It does, however, seem possible in the majority of cases effectively to raise the pain threshold. The author has therefore considered it worth while to try to measure the audio-analgesic effect upon the pain threshold and to make a statistically established comparison with random-selected material.

METHOD

The apparatus used for bringing about audio-analgesia described below is called Audio-Sonic and is of American origin; the name of the firm is Cavitron. It is probably the same as that described by *Licklider* (1959). The patient material is random-selected and the experiments are standardized as far as possible. A graduated pulp-tester of standard type (Ritter Unit D 60) was used. In principle this is based upon the effect of a high-frequency current (approx. 400 cycles) the voltage of which may be varied by means of a graduated rheostat. Graduation from 0 to 10. As the teeth to be experimented upon the lower canines were chosen. An essential requirement was that the teeth were clinically intact. If none of the lower canines were suitable, one of lower incisors or upper canines was used. This probably had no effect upon the experimental results, since only the variations in each individual tooth are of interest. The examination was performed under a rubber dam.

The study comprises three experimental groups: In the first group the pulp-tester was applied to the tooth and the voltage sucessively increased from 0. When a reaction was obtained from the patient, the value was read off from the graduated scale of the pulp-tester. The value was then recorded once more, the patient being this time provided with the Audio-Sonic apparatus with only music switched on. Finally, white noise was applied at maximum volume and the new threshold value recorded. The subjects of the experiments were not instructed beforehand concerning the effect that might be expected in connection with the different distracting components. In order to counteract still further the possibility of the individual influencing the results by exerting his will, the sequence of the distracting components was varied. The variations were administered according to the following scheme, where WAS = without Audio-Sonic, AS = with Audio-Sonic (music only) and AS + S = with Audio-Sonic + white noise:

Group I: WAS → AS → AS + S,

Group II: AS → AS + S → WAS,

Group III: AS + S → AS → WAS.

RESULTS

All three groups show the same tendency. In the first group it emerges with strong significance that music raises the pain threshold. A possible explanation of the stronger significance in this group may be that the distracting components were given in a more favourable sequence. The two other groups give almost significant values. It also emerges that the exposure to white noise raises the pain threshold, though this elevation of the threshold is numerically inferior to that produced by music alone. In Group III the effect of white noise is not even significantly positive. The material was also studied according to sex and age. It was not possible, however, to observe any connection between these variables and the actual effect-variables.

Table I.

Pain-threshold variations in Group I (50 patients)

Name	Sex	Age	Tooth	WAS	AS	AS+S
KL	M	26	3—	4.0	8.0	8.0
AGL	K	43	3—	3.8	3.5	4.2
ES	K	18	3—	1.0	2.0	3.0
GA	K	19	3—	4.2	5.2	5.5
OB	M	41	3—	1.6	1.1	1.1
BS	K	23	3—	2.0	2.2	2.3
KA	K	46	3—	3.9	3.2	4.0
BT	M	31	—3	7.2	7.2	7.2
GA	K	19	3—	3.6	4.2	4.8
KF	K	23	3—	4.0	4.8	4.8
FJ	M	45	3—	1.8	1.8	1.8
JS	K	21	3—	7.4	8.6	8.7
GE	M	51	3—	1.8	3.2	5.2
AH	K	69	—3	3.1	3.9	4.1
VJ	K	20	3—	5.6	6.9	6.9
RL	K	68	1—	0.9	1.0	1.0
MF	K	18	3—	5.6	5.9	6.6
TB	M	22	3—	5.4	6.2	6.2
JO	M	54	3—	1.4	1.4	1.6
KOM	M	22	3—	3.2	3.8	4.0
HJ	M	53	3—	5.0	6.2	6.2
MLB	K	41	3—	1.8	2.2	2.2
KW	K	53	3—	2.0	2.0	2.0
AS	M	27	3—	1.4	5.8	6.0
MN	K	30	3—	2.1	2.2	2.6
GR	M	31	3—	3.3	3.5	3.6
OL	M	34	3—	5.6	6.9	7.2
MA	K	41	3—	5.6	5.6	5.6
AH	M	43	3—	8.0	7.1	7.9
BN	M	45	2—	4.8	4.9	4.9
EÖ	K	36	3—	1.9	2.0	2.0
AE	K	25	—3	1.4	0.6	0.8
MT	K	21	—3	3.0	3.8	4.0
BB	M	23	3—	7.3	7.6	7.9
SI	M	21	—3	4.8	8.3	8.5
MH	M	17	3—	5.8	6.1	6.5
LG	M	26	—3	4.8	5.1	5.8
ON	M	43	3—	3.4	4.6	3.6
NOM	M	23	—3	6.0	6.4	7.2
SM	K	17	3—	4.0	4.0	4.2
MBE	K	36	3—	2.1	3.0	3.2
BP	K	23	3—	4.5	4.7	4.2
GI	K	18	3—	3.2	3.2	1.8
BL	K	50	3—	1.8	2.4	3.8
BH	K	22	3—	4.0	4.5	4.2
SP	M	21	3—	2.5	2.8	2.8
SAK	M	18	3—	3.4	3.4	4.6
GK	M	52	1—	8.9	>10	>10
SS	M	41	3—	3.7	5.7	4.2
RE	K	39	3—	1.0	1.0	1.0

WAS = Without Audio-Sonic
AS = With Audio-Sonic (only music)
AS+S = With Audio-Sonic + white sound

K = female
M = male

Sequence observed in the experiment: WAS → AS → AS+S

Table II.

Pain-threshold variations in Group II (20 patients)

Name	Sex	Age	Tooth	WAS	AS	AS+S
EW	K	17	—3	4.9	5.2	6.1
OL	M	34	3—	5.0	4.4	5.8
BB	K	25	3—	5.2	6.0	6.6
MP	K	34	3—	3.0	4.0	4.3
IW	M	21	3—	4.3	4.8	4.3
ME	M	37	3—	2.5	2.9	2.9
PSO	M	25	—1	2.3	2.5	2.9
JH	M	29	3—	4.6	5.0	5.0
MBH	K	36	3—	1.8	2.4	2.0
SP	M	35	3—	5.2	5.2	6.2
KM	K	37	3—	4.0	4.4	4.4
SS	M	26	3—	2.8	3.0	2.8
KE	M	55	—3	2.0	3.6	3.6
GM	K	47	2—	1.6	1.8	1.6
IS	K	21	3+	8.2	8.8	9.0
IL	K	17	3—	5.0	5.2	4.5
AB	M	34	3—	2.0	2.2	1.8
GM	K	47	—3	2.2	2.2	2.0
DB	K	66	—3	2.2	2.4	2.6
WB	M	66	3—	8.1	7.2	5.9

Legend: see Table I.

Sequence observed in the experiment: AS → AS+S → WAS

Table III.

Pain-threshold variations in Group III (21 patients)

Name	Sex	Age	Tooth	WAS	AS	AS+S
RH	M	42	3—	2.9	3.2	3.9
GE	K	26	3—	4.2	6.4	5.8
HH	M	48	—3	0.8	1.2	1.2
ML	K	24	—3	3.2	2.2	3.0
MA	K	28	3—	3.9	4.0	4.6
EB	K	31	3—	3.4	3.4	3.9
TD	K	66	3—	5.2	5.9	5.9
LJ	K	37	3—	2.8	2.8	3.6
LIJ	M	23	2—	5.9	7.9	7.1
GL	K	17	3—	7.6	7.6	8.8
BA	M	29	3—	1.9	2.1	4.0
AH	K	23	3—	4.6	5.6	5.8
WJ	M	23	3+	7.2	7.2	7.2
IH	K	18	3—	1.0	1.2	1.4
LK	K	21	3—	0.8	0.4	0.4
TO	M	27	3—	2.2	2.4	2.4
UD	K	25	3—	2.6	3.2	3.0
EÅ	M	20	3—	5.0	5.7	5.8
BM	M	26	3—	4.5	3.4	3.2
LG	K	27	3—	2.5	1.2	1.2
MÖ	K	17	3—	3.0	2.2	3.0

Legend: see Table I.

Sequence observed in the experiment: AS+S → AS → WAS

Statistical treatment

Three determinations were made for each patient. x = without music and white noise, y = with music but without white noise, and z = with music and white noise. No determination was made with white noise alone, as this was considered to be without clinical significance. The quantity z--y thus measures the white-noise effect *with* music. $y + z - 2x$ expresses the pure-music effect on the threshold values. It is assumed that the distracting components are additive. The material has been treated in accordance with the principle for orthogonal comparisons.

Table IV.

Survey of the statistical results

Group	Number of patients	Mean values			Music effect			White noise		
		x	y	z	$y+z-2x$	S^2_{y+z-2x}	t	z-y	S^2_{z-y}	t
I	50	3.772	4.392	4.590	1.438	4.5578	3.93[3]	0.198	0.3420	2.37[1]
II	20	3.845	4.160	4.215	0.685	1.5719	2.41[1]	0.055	0.3826	0.398
III	21	3.581	3.771	4.057	0.666	2.5873	1.90[1]	0.286	0.3763	2.13[1]

Hypothetical mean value = 0

[1] = "almost significant" (95 % level) unilateral test

[2] = "significant" (99 % level) unilateral test

[3] = "strongly significant" (99.9 % level) unilateral test.

Test variable: $t = \frac{\text{mean value} - 0}{\frac{s}{\sqrt{n}}}$

Degrees of freedom (n—1) = 49 (I)
19 (II)
20 (III)

S^2 = the estimated variance

t = Student's t = the mean value difference divided by its estimated dispersion.

DISCUSSION

It is quite evident that the central response to a moderate auditory stimulus can very easily be blocked (*Hernandez-Peón, Scherrer, & Jouvet,* 1955). Thus, in order to obtain an effect from white noise this must be so constructed that a very strong impulse is obtained, so strong, in fact, that the response will perhaps not only be an auditory stimulus, but will actually release secondarily a pain impulse. A measurement with a noise-meter inbuilt in an ear-phone gives, when white noise is applied at maximum volume, the interesting figure of 100 decibels. In this connection it should be noted that the limit beyond which it is considered that the hearing may be damaged is estimated at 90 decibels. It should also be borne in mind that the decibel scale is logarithmic. The risk of actual damage to the hearing is, however, probably relatively slight, in view of the fact that white noise is to be used at maximum volume for brief periods only. Nevertheless, attention should be given to this problem. If in this way it is possible to block ingoing pain impulses from dental operations, then what one obtains is something of a 'twitching" effect, the value of which with human material is probably open to debate. The results of the investigation show rather unequivocally that in connection with the use of the Audio-Sonic apparatus the main distracting effect is obtained by the pure musical element.

SUMMARY

In the literature there are several accounts of different methods of blocking pain impulses with distracting devices. In the present investigation the writer studied the possibility of obtaining dental analgesia or at least an elevation of the pain threshold with the help of music, and in a number of cases with music + a strong buzzing tone. The material comprises 91 cases. On the strength of the statistically treated material it may be said that the effect of music is good. In almost every case a rise of the pain threshold is attained. It is doubtful whether total dental analgesia can be produced. As regards the effect of music + white noise, this, too, is good. The increase of the effect on the addition of white noise is, however, only slight. The mode of operation of white noise as a distracting agent is also debatable.

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RÉSUMÉ

ÉTUDE SUR L'EFFET DE L'AUDIO-ANALGÉSIE

Il existe dans la littérature plusieurs comptes rendus sur différentes méthodes pour bloquer les impulsions douloureuses par des dispositifs de distraction. Dans le présente étude, l'auteur a examiné la possibilité d'obtenir l'analgésie dentaire, ou tout au moins une élévation du seuil de la perception douloureuse à l'aide de musique, et, dans un certain nombre de cas, à l'aide de musique + un fort bourdonnement. Le matériel comprend 91 cas. En se basant sur l'étude statistique du matériel, on peut dire que l'effet de la musique est bon. Dans presque tous les cas, une élévation du seuil de la perception douloureuse a été atteinte. Il est probablement douteux qu'une analgésie dentaire totale puisse être produite. En ce qui concerne l'effet de musique+bruit blanc (analogie avec lumière blanche: mélange de tous les sons du spectre), cet effet est bon aussi. Cependant, l'augmentation de l'effet par addition de bruit blanc est peu considérable. Le mode d'action du bruit blanc en tant qu'agent de distraction est aussi discutable.

ZUSAMMENFASSUNG

EINE UNTERSUCHUNG ÜBER DEN EFFEKT DER AUDIOANALGESIE

In der Litteratur sind mehrere Methoden zur Blockierung der Schmerzimpulse durch ablenkende Mitteln beschrieben worden. In dieser Arbeit hat der Verfasser die Möglichkeit untersucht eine dentale Analgesie oder wenigstens eine Erhöhung der Schmerzschwelle mittels Musik, und in einer Zahl von Fällen Musik+eines stark brummenden Tones, zu erreichen. Das Ma-

terial umfasst 91 Fälle. Mit dem statistisch behandelten Material als Grundlage darf man sagen, dass der Effekt von Musik gut ist.

In fast jedem Falle ist eine Erhöhung der Schmelzschwelle erreicht worden. Es ist zweifelhaft, ob eine totale Dentalanalgesie erreich werden kann. Der Effekt von Musik + "white noise" ist auch gut. Die Erhöhung von der Wirkung unter Zusatz von "white noise" ist jedoch nur schwach. Die Wirkungsweise von "white noise" als Ablenkungsmittel ist auch nicht aufgeklärt.

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Address: *38, Centralgatan,*
Hofors, Sweden