Applied Ergonomics 1972, 3.4, 202-205

Music — an aid to productivity

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A series of experiments has investigated the relationship between the playing of background music during the performance of repetitive work and efficiency in performing such a task. The results give strong support to the contention that economic benefits can accrue from the use of music in industry. The studies show that music is effective in raising efficiency in this type of work even when in competition with the unfavourable conditions produced by machine noise.

Music and the actile period

A recent review (Fox, 1971) made it clear that amidst all the 'evidence', commercial and scientific, there were sufficient facts to justify a claim that background music could influence shopfloor productivity in a positive way.

The review pointed to a number of reports where the influence of the music was socio-psychological in that it reduced absenteeism and labour turnover. There were, however, a number of other studies which implied that the music influenced more directly the neuro-psychological mechanisms of the operator. It seemed that a number of investigators had empirically arrived at results which would be predicted from the current concepts of 'arousal theory' and the supposed role of the reticular activating formation in maintaining human attention in repetitive work.

This being so, it seemed reasonable that the refinement in the use of background music in industry, which the review suggested could make it more definitively effective, might be brought about by tying it more certainly to 'arousal', attention and job performance.

Any paced repetitive task, such as manual assembly work, has the characteristics which will lead to a drop-off in arousal or attention, and hence efficiency, after a relatively short period. Murrell (1962) in fact showed that such a decrement does occur in a manner which fits the arousal theory. In a further study, Murrell (1966) showed that the cycle of efficiency and decrement could be avoided if some form of stimulus were introduced towards the end of the period of maximum efficiency (or 'actile' period). More recently, Murrell (1970) has reported on the effects of alcohol, caffeine and amphetamine in raising arousal levels if introduced at the appropriate point in the work cycle.

The industrial importance of these ideas in scheduling rest pauses compatible with 'actile' periods has clearly been shown by the increased productivity it can induce (Bhatia and Murrell, 1969).

It was therefore plausible to suggest that the effects of background music could be related to the recently developed concepts of 'arousal', 'auto-arousal' and the reticular activating system of the brain, and that its use could be akin to Murrell's tea and coffee breaks.

A number of experiments have therefore been carried out to test the following idea: if music of a lively nature is played for a short period at prescribed intervals which coincide with the end of the actile period for that job (ie, the end of the maximum period for sustained attention, then the drop-off in arousal, and hence efficiency, which is a natural concomitant of the job, would be staved off. The repetitive task chosen was that carried out in industry as part of the quality control function: visual inspection of components by a method generally referred to as 'over-looking'. This was chosen for two reasons.

First, despite the fact that many sophisticated techniques are available, quality control is still to a large extent carried out in this way for social or economic reasons: that is, by a method which is dependent on the unaided senses of the human being and which is very dependent on arousal level. Yet despite its popularity it is not a job which is done well: 50% detection of faults can be considered good.

Secondly, the actile period is very short for this type of job (around 15–20 min), which made for experimental convenience.

Experiment 1

The first experiment took place in the laboratory where six subjects examined small metal parts on a conveyor belt. One in a hundred of the parts was defective in that it was physically damaged so that it could not pass over a metal cylinder of appropriate diameter. The inspectors examined the parts for a period of 30 minutes, throwing out any defects they spotted. All the subjects did the job under four different conditions:

1. no music (silence)
2. music played during the 15th – 20th minute of the test session using a programme of randomly selected music (random music)
3. as for (2) using a commercially prepared lively programme ('red' music)
4. as for (2) using a programme slected by the subjects from 'red' tapes.

The results of the experiment averaged for all the subjects are indicated in Fig 1. The plots in the figure clearly indicate an improvement in the performance of this task when music is played for a short period to act as a stimulant. The difference between the music and non-music conditions is statistically significant at $p < 0{\cdot}05$ and the difference in second half detection decrements is significant at $0{\cdot}02 < p < 0{\cdot}05$. The 'second half detection decrements' means the percentage drop-off in detection efficiency during the second 15 minutes of the job compared with the detection efficiency during the first 15 minutes.

Experiment 2

This was carried out in a factory. Eight inspectors, whose normal job it is, carried out a quality control inspection of rubber seals of a variety of shapes and sizes. Test sessions lasted 30 minutes at any one time and the job was done either with no music or with a 'red' programme played during the 15th – 20th minute of the session. It was known that the defect rate was 1 in 100 and that detection efficiency was normally 47%.

A summary of the results is given in Table 1. Again the use of music shows a pronounced effect in improving the detection score. The difference in detection efficiencies is statistically significant at $p < 0{\cdot}025$ and the difference between the second half decrements for the two conditions is significant at $p < 0{\cdot}05$.

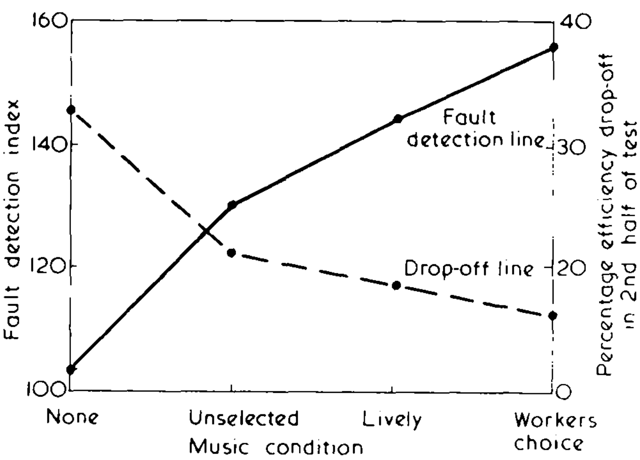

Fig 1 Mean number of detections for all subjects in Experiment 1, taking no music (silence) as the base 100 for the four music conditions (full line); and percentage decrement in detections during the second 15 minutes of the job compared with the first 15 minutes for the four music conditions (broken line).

Table 1 Mean detection efficiencies and decrements in performance over 30 minutes in an industrial inspection task.

	No Music (Silence)	'Red' Programme
Mean detection efficiency	51%	69%
Decrement in second 15 minutes of task compared with first 15 minutes	27%	18%

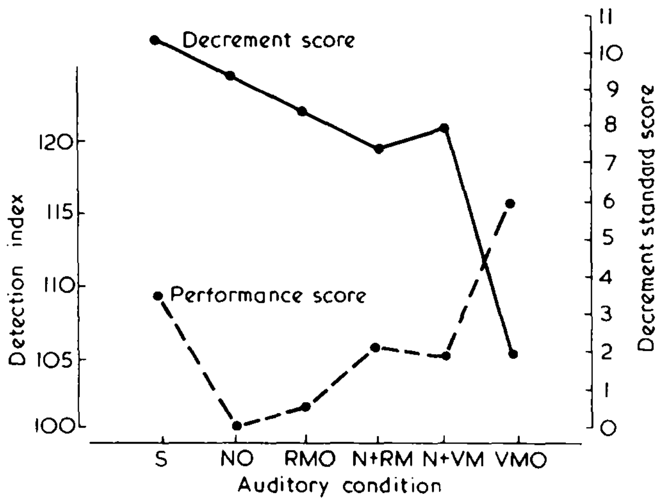

Fig 2 Subjects detection performance (broken line) in Experiment 3 and their drop-off in performance in the second half of a test session (full line) for the various auditory conditions.

Experiment 3

This was a laboratory experiment in which eight subjects carried out a task which simulated industrial inspection against various auditory backgrounds. The task was the identification of a slightly lighter dot in an array of black dots projected on a screen for 10 sec. There was a one-in-four chance that one of the series of projections presented continuously during the experimental period would have the wanted lighter dot. There were 160 successive frames to be examined within which the position of the frames containing the wanted dot was randomized. A test session lasted about 50 minutes. The task was done with the following auditory backgrounds:

(1) no music or noise, silence (S)
(2) continuous noise at 83dB (NO)
(3) continuous 'red' music at 81dB (RMO)
(4) a short period of vocal music at 81dB after the subject was 30 min into the task (VMO)
(5) continuous noise with a period of 'red' music after the subject was 30 min into the task (N+RM)
(6) continuous noise with a period of vocal music after the subject was 30 min into the task (N+VM).

The results are shown in Fig 2 averaged for all the subjects. Detection performance under the periodic music conditions was significantly better than under continuous noise alone ($p<0{\cdot}001$)

Experiment 4

This study took place in a factory manufacturing, among other things, metal fasteners. The job used as the vehicle for testing the effectiveness of the background music was the visual inspection of batches of metal fasteners for the purpose of separating out any defective articles which had resulted from the production process. Three main types of defect were searched for: two which modified the line of the metal part in some degree and a third which grossly mis-shaped the part. This third type was naturally the easiest to detect. To examine the batch, the inspectors spread-out handfuls of fasteners on a table and visually scanned the resulting display: picking out the defects if there were any present and putting them to one side. No optical aids were used in the inspection.

Five females normally employed in this task by the manufacturing company were used as the inspectors during the study. All gave acceptable audiometer records indicating their hearing was within acceptable limits. The inspection was carried out under three auditory conditions:

(1) Normal working conditions which had an ambient noise background of 83dBA: this has been designated the 'noise' condition

(2) Normal working conditions with background vocal music relayed at intervals: the ambient noise and music produced a total background of auditory stimulus of 86dBA: this is designated the 'noise and music' condition.

(3) In a room where the background noise level was 60dBA: this is designated the 'silence' condition.

Each inspector examined a single test batch on three consecutive days under the noise condition. These batches were actually fed into the normal throughput to the inspection benches and the inspectors were unaware of their appearance. On the same three days, immediately before or after dealing with the test batch in the noise condition, the inspectors searched through another batch for defects in what has been described as the silence condition. The bench layout and the illumination to do this task were the same as for the noise condition.

One week later, the same group again inspected a single batch of fasteners on three consecutive days when the batches were again fed into the normal throughput to the inspection benches. In the interim two days, a systematic programme of 10 minutes periods of background music at 40 minute intervals had been implemented and continued throughout the period of the tests. There were no other changes in the work arrangements or the official rest pause schedule of 15 minutes morning and 15 minutes afternoon breaks. The inspection therefore took place in what has been designated the noise and music condition. The overall results of the experiment are shown in Fig 3.

The most significant factor in the experiment was the difference in the ease with which different types of fault could be detected ($p<{\cdot}01$). The difference in the auditory conditions only reached a significance at the $p<0{\cdot}1$ level.

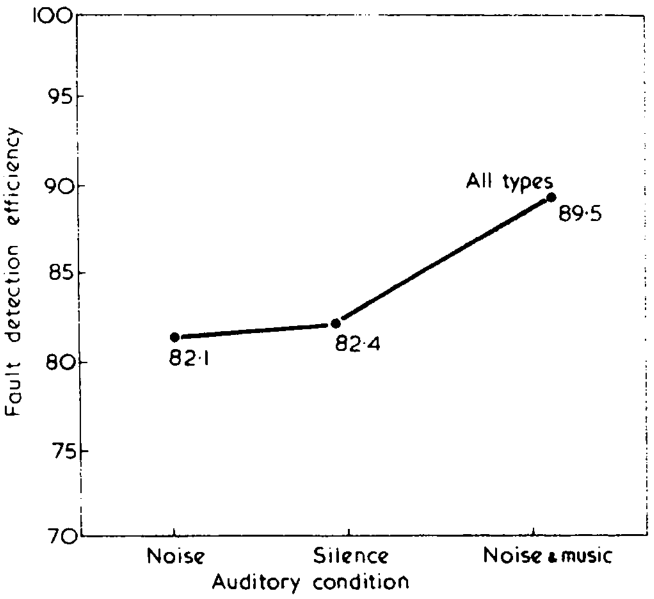

Fig 3 Mean fault detection efficiences for the auditory conditions in Experiment 4.

The Industrial Implications of the Experiments

Clearly, from all four experiments, music can influence in a positive way the efficiency of operative carrying out short cycle repetitive tasks. Even in the fourth experiment an increase of 7·4%, although modest in itself, is significant in that the subjects were already achieving creditable detection scores in their normal working environment by virtue of their experience in the job. Moreover, on one type of fault no further improvement was possible, for the use of the music brought the fault detection up to 100%.

The basis for the overall improved performance is highly significant for the premise these experiments were testing. The first and third experiments show that the improvement results from preventing the fall-off in efficiency which one would predict (and which occurs in the non-music conditions) in the second half of the experimental session: ie, in the period following the end of the actile period. This gives support to the appropriateness of the theoretical basis for the use of the music in this context and gives a framework for its successful use in industry. One aspect of its use comes through clearly from the tests using continuous 'red' music in Experiment 3: playing continuous music is no better than providing continuous noise as far as efficiency is concerned and both practices are more than likely to be counter-productive.

Accepting this theoretical basis for the use of music in industry, programming both in content and in time are important for effective use. This is in fact borne out by the results of Experiments 1 and 3.

The music must be lively. In Experiment 1, the 'red' programme with its lively, 'beaty', music was more effective than a random selection with a large proportion of slow, melodious but steady-rhythmed tunes. It would not, however, seem to matter, if we take the results of Experiment 3, whether it is vocal or non-vocal. This is probably only true, however, if the lyrics are well-known or of little interest: the opposite being true, then the vocals could perhaps be less effective than the non-vocals.

Scheduling the periods of music must, of course, be related to the length of the actile period for the job. In the present experiments, the nature of the tasks meant a programme of music about every 30 minutes. The evidence is that for tasks which intrinsically demand more activity – such as manual assembly – then 60 to 70 minutes would be the required interval between bursts of music.

The length of a period of music is yet another factor. A period of five minutes is probably sufficient to revitalise the human neuro-psychological elements, but for listener satisfaction, a period of ten minutes is probably ideal: or even 15 minutes if the actile period is a long one.

The four experiments have dealt with an industrial activity which is most sensitive to changes in alertness and arousal. From Murrell's (1969) work it would seem reasonable to extrapolate from them to less sensitive areas: notably production activity. A current investigation is aimed at confirming that the use of music can be an aid directly to productivity. However, taking the most conservative view of the experiments reported here, it is clear that music can influence the efficiency of operators carrying out visual quality control tasks and, where improvements are sought, the use of music is worthy of economic consideration.

Acknowledgement

The authors wish to thank Professor N.A. Dudley for providing facilities for the laboratory experiments; and Reditune Ltd for support to undertake the research.

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