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EFFECTS OF MUSIC ON COGNITIVE PERFORMANCE: FROM THE WORKPLACE TO THE LABORATORY TO OPEN-PLAN OFFICES

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ABSTRACT

Music was often played in factories to try to relieve the boredom caused by monotonous jobs. Laboratory research has examined the effects of music on cognition, and usually, the results depend on the type of music and the task being carried out (e.g. the Mozart effect). In open-plan offices, noise is a common problem that can reduce employee performance. This noise may come from many different sources (e.g. telephones ringing, air conditioning, traffic noise, and the speech of others). Irrelevant speech is often the most annoying source of noise. Previous studies have indicated that continuous exposure to irrelevant speech impairs working memory. A recent study assessed the impact of music ("For Elise" by Beethoven) on the working memory performance of individuals in a simulated open-plan office exposed to irrelevant speech. Music improved the accuracy of simple and more complex working memory tasks compared to the irrelevant speech-only condition. In conclusion, music offers a straightforward and cost-effective strategy to mitigate the adverse effects of noise in open-plan offices

Keywords: *Music; Noise; Cognition; Open-plan offices*

1. MUSIC IN THE WORKPLACE

The use of music in the workplace can be traced back to the early 1900s [1,2]. Music was viewed as a motivational tool to improve productivity. One of the best examples was the BBC radio programme "Music While You Work," broadcasting to British factories from 1940 to 1967 [3]. The evidence for a positive effect of the music was inconclusive [4]. Indeed, the general view was that music did not improve performance per se but prevented the decline in repetitive work [5]. Music boosted morale, and the workers opposed its removal [6]. This effect on well-being is protective against adverse workplace effects [7].

A shift to offices has largely replaced blue-collar work, and there are many ways of playing music, making it an easily accessible resource [8]. The tasks performed are also different, generally being complex cognitive ones. Interest has also focused on the type of music, with background music and lyrics hurting concentration [9]. Similarly, disliked and relaxing music has also been shown to impair performance. Selection of music can, however, increase positive affect and improve performance [10].

Several types of music have been suggested to improve performance and/or lead to a more positive mood: Classical music – the "Mozart effect" – see the following section; Nature music – the sound of waves etc.; Cinematic music – can lead to mood enhancement; Video games and music – increases engagement; 50-80 beats per minute leads to an "alpha state" where the person can resume focus and think without listening to the music; and Favourite music – which may increase positive affect and performance.

Personality may also be important in the effects of music on affect and performance, with introverts being more susceptible to the adverse effects of background music [11]. Recent research has examined the impact of different types of music usage on job satisfaction and performance [12]. Emotional use positively affected job performance, both directly and through the mediating effect of job performance. Cognitive usage did not affect performance and job satisfaction. Background use negatively affected job satisfaction but did not affect performance.

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2. THE MOZART EFFECT

It has been found that performance on spatial ability tasks improves after listening to a Mozart sonata [13], which became a widely publicised phenomenon. If music improves cognition, it could enhance the performance of office workers. Many subsequent studies have failed to demonstrate similar findings with other types of music and have been critical of the interpretation of positive mood and arousal-improving performance. Smith, Waters and Jones [14] replicated the Mozart effect and showed that it was not due to mood changes. The Mozart effect has been reproduced using other enjoyable music [15], but sad music made the effect disappear [16]. However, none of this research considered the complexity of the study. Steele et al. [17] found that music of similar complexity (works of Yanni) replicated the Mozart effect. The problem is the definition of complex music. However, complex music, defined in various ways, has a more significant cognitive effect than simple music.

3. OFFICE NOISE AND COGNITION

The background noise in open-plan offices has become essential for job satisfaction, performance, and health. Office workers seldom risk developing hearing damage due to the low intensity of the noise. Systematic research on such noise problems in the workplace has been relatively rare. Excessive background noise in the office may result in stress, lack of concentration, and reduced performance and efficiency. One reason for the lack of research could be that office sound noise can lead to habituation after 20 minutes. The development of the open-plan offices accentuated the noise problem. Nemecek and Grandjean [18] surveyed 15 offices in Switzerland and found that co-workers' talk was the noise that caused most complaints. Other research has confirmed that noise from co-workers is the most mentioned noise source in offices, and complaints increased with the number of people sharing the office. Boyce [19] found that telephone signals and conversations were the most frequent noise disturbance sources. Banbury and Berry [20] found that 99% of employees reported that their concentration was impaired by telephones ringing and people talking, and there was no evidence of habituation with these specific sounds. It has been concluded that reducing the effects of background noise requires consideration of those exposed to noise, the nature of the cognitive task, and the nature of the noise. Such factors apply to most areas of noise and cognition.

4. THE IRRELEVANT SPEECH EFFECT

Colle and Welsh [21] identified the irrelevant speech effect, where the speech impairs recall of 7-9 digit or consonant lists. The irrelevant speech effect was initially explained by phonological confusion between the speech and the to-be-recalled items. Morris and Jones [22] found that the impact of irrelevant speech is reduced markedly after a habituation phase where the speech is the same as in the test phase. However, some factors other than phonological confusion may be responsible for the disruptive effects of irrelevant speech. The critical factor in the disruption of serial recall is whether the irrelevant auditory input contains changing state information, where each physical unit in the sound stream, such as a tone burst or syllable, must be different to the one that precedes it [23]. A changing state sequence of tones with a different pitch from the preceding produces serial recall disruption, whereas repeated tones produce little disruption. This is why continuous broadband noise is not disruptive, as it does not involve changing states [24]. Disruption results from a conflict in the structure of the two streams of information; one from the deliberately rehearsed material and the other from the automatic processing of irrelevant speech. The changing state hypothesis provided the basis for the Object-Oriented Episodic Record (O-OER) model of short-term memory [25]. The model has two components: objects and the temporal order of objects. Objects are viewed as abstract representations of events in the world which are not modality-specific. A sequence of changing auditory items has separate objects for each item, whereas repeated auditory items attract only one object, which affects performance less. This results in navigation being more affected by changing state rather than steady-state auditory material.

Banbury and Berry [26] suggested that habituation effects can be accounted for by adding a filter before forming links and objects. After prolonged exposure to the irrelevant stream, the filter is impermeable, allowing objects to form on the episodic surface without creating links between them. This version of the O-OER model can account for habituation after prolonged exposure to the irrelevant sound stream. Several studies have shown that the irrelevant sound effect does not habituate [27, 28]. The concept of habituation is related to the view that irrelevant speech causes an "orienting response" (OR) that captures attention [29]. There is strong

evidence that ORs do not produce the changing-state effect in serial recall. However, habituation of ORs may occur for other tasks, such as memory for prose and mental arithmetic, and these impairments may indeed be due, at least in part, to ORs. Smith, Waters and Jones [14] addressed the issue of habituation to office noise using a mental arithmetic task and tried to determine how long the filter takes to attenuate the irrelevant sound stimuli. The results showed that the office noise impaired performance but that the effects of the noise were removed by 10 minutes of exposure to the noise between tasks.

5. MUSIC AND OFFICE NOISE

A recent study [30] assessed the impact of music ("For Elise" by Beethoven) on the working memory performance (the n-back task) of individuals in a simulated open-plan office exposed to irrelevant speech. Thirty students participated in the study and were randomly assigned to either the irrelevant speech condition or the irrelevant speech plus music condition. In the n-back task, the participant had to press a button when consecutive numbers (either I back or two back) were the same. Accuracy and speed of response were recorded. Each type of n-back task lasted for 8 minutes. The music was played on a piano and consisted of repeats of a one-minute track with 120 beats per minute. It was played with an intensity of 5dB more than the background irrelevant speech. The intensity of the irrelevant speech was set at 56 dB, mimicking the noise peak during busy working times.

The results showed that the number of correct responses was more significant in the music condition than in the irrelevant speech-only condition. This was true for both the simple and more difficult n-back conditions. However, music had no significant effect on reaction time, although the numerical trend was for faster response times under the music condition. This study has several limitations, the first being the lack of quiet and music-only conditions. Secondly, the music was not tailored to individual preferences or acceptability. The study was also conducted in a laboratory rather than an open-plan office. Nevertheless, the present results suggest an easy strategy to reduce the adverse effects of irrelevant speech on working memory in open-plan offices. Future research must examine the efficacy of this approach in actual offices with realistic performance tasks.

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