Sleep disturbance caused by impulse sounds

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ABSTRACT

Objective

Detailed information about sleeping disturbance caused by nocturnal impulse sounds such as those produced at military training fields by firearms, and those produced in docks by container transshipment, is lacking. Both the Dutch Ministry of Defense and the Dutch Ministry of Housing, Spatial Planning, and the Environment contracted TNO Human Factors to determine, amongst other things, relations between the sound level of impulse sounds and the probability of behaviorally-confirmed noise-induced awakening reactions.

METHOD

Due to the limited frequency of the training activities, it was not feasible to conduct a study in residential areas around military firing ranges or training fields. Due to the poor predictability of the occurrence of the sounds of interest, and the uncertainty about the availability of a sufficient number of participants, the feasibility was low for designing a conventional field survey also for the other more civil sounds. As an alternative, the sounds were presented by means of loudspeakers in the bedrooms of 50 volunteers. The shooting sounds had been produced by a small and a medium-large firearm, and the sound fragments consisted of individual bangs or volleys of ten isolated or partly overlapping impulses. The civil impulse sounds had been produced by slamming one of the doors of a van, and by transshipment of a container. Again, the sound fragments consisted of single or multiple events. Aircraft sound was included as a reference source. The sounds were presented during a six-hour period that started 75 min after the beginning of the sleeping period. The time period between the various stimuli varied between 12 and 18 min. Each subject participated in 18 nights to be completed within four weeks.

RESULTS

Forty-four subjects completed all or nearly all 18 nights. Half of this group was presented with the shooting sounds, and the other half was presented with the civil impulse sounds. For these subjects, the probability of awakening clearly increased with increasing A-weighted sound exposure level (ASEL) of the impulse and aircraft sounds. The dose-response relations for the single impulse sounds, thus both for those produced by the rifle and the machine gun, and those produced by the door slam and the container transshipment, were much the same as that for the aircraft sounds. At equal indoor ASELs, the probability of awakening induced by the sound fragments with multiple events, i.e., the volleys of the shooting noise and the repetitive door slam and container sounds, was significantly higher than that induced by the single impulse and aircraft sounds. In the course of the three or four weeks with

experimental sounds, the probability of awakening induced by the multiple impulse sounds and the aircraft sounds decreased by nearly a factor of two.

CONCLUSIONS

At equal indoor ASELs, the probability of awakening for single impulse sounds was equal to that for aircraft sounds. The probability of awakening induced by the multiple impulse sounds, however, was significantly higher than that induced by the single impulse sounds and the aircraft sounds. In spite of the significant relation between awakening and ASEL within the set of multiple events, we must therefore conclude that ASEL is not a universal measure for predicting awakening. For obtaining equal probabilities of awakening, the ASELs of the multiple shooting sounds (volleys) must be about 15 dB lower, and the ASELs of the multiple civil impulse sounds (door slam and container transshipment) must be about 12 dB lower than those of the single bangs and the aircraft sounds. The 12-15 dB level difference did not depend on the degree of habituation. Repetitive sounds led to more awakenings than single isolated sounds did. Future research should focus in more detail on the effect of the multiple sounds.