ACCOUNTING FOR MUSICIANS' SUPERIOR AUDITORY SERIAL-ORDER IDENTIFICATION: AUDITION OR NOTATION?

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1.0 Introduction

Short-term memory for sequences of tones is typically better for listeners who have had musical training than for listeners who lack such training (e.g., Cohen, Trehub & Thorpe, 1989). It would seem that superior auditory skill would account for the the musicians' advantage. However, several experiments in which listeners match visual patterns to short auditory sequences (e.g., Parncutt & Cohen, in preparation) suggest that facility with a notation system may be an important factor. Since there is no definitive answer as to whether the musicians' superiority for auditory serial-order identification is due to audition or to familiarity with notation, the present study examines various possibilities by presenting subjects with both visual and auditory cues to aid recognition of sequential patterns. Evidence for the relative ease with which musicians and non-musicians use such cues enables us to explore the effects of musical training and determine the extent to which such effects are confined to or extend beyond the auditory realm. If auditory memory rather than knowledge of musical notation accounts for the musicians' advantage, then musicians' performance on an auditory task should exceed that on a visual task which entails the same sequential notational matching. In this case, only auditory, not visual, task performance should be higher for the musician as compared to the non-musician. If, however, superior notational ability accounts for the musicians' advantage, then musicians' performance on both tasks should be equal and, at the same time, better than that of the non-musician.

2.0 Method

It was the task of the subject to match the order of eight items of an audio, visual, or audiovisual stimulus sequence to one member of a closed set of nine orders shown in Figure 1.

The tone sets from which 8-item sequences were comprised were the major (successive intervals 2212221), minor (2122122), and chromatic (1111111) scales, as well as a scale of successive intervals of four semitones (4444444) - augmented triadic, as used by Cohen & Frankland (1990). The lowest tone in each scale was 256 Hz (C_4). Tones were 200 msec in duration with an intertone interval of 200 msec. Sequences of visually presented numbers corresponded with the successive intervals of the four scales used. One numerical step equalled one semitone; hence, the chromatic scale was represented by 1 2 3 4 5 6 7 8 while the major scale was represented by 1 3 5 6 8 10 12 13 and the augmented by 1 5 9 13 17 21 25 29.

The set of nine different sequences used by Cohen and Frankland (1990), and Parncutt & Cohen, (in prep.) represented a range of complexity with respect to organization and processing difficulty (see Figure 1).

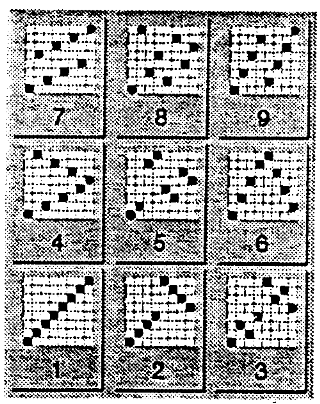

Figure 1. Graphic representation of nine sequential patterns

There were 36 sequences generated from all possible combinations of the 4 sets (of tones or numbers) and 9 orders. In audiovisual and visual conditions, at the base of the screen, there was displayed simultaneously the series of numbers corresponding to the scale notes. In audiovisual and audio conditions, the sequences were presented through headphones. The experiment consisted of 3 blocks (Audiovisual task, Audio task, or Visual task) of 36 randomly ordered trials each.

Twenty-four students participated. One half of them, designated musicians, had received an average of 12.6 instrument-years of formal music training. The other half, designated non-musicians, had received an average of 0.5 instrument-years of formal training. Groups were matched for age and sex.

3.0 Results

Overall, musicians significantly outperformed non-musicians but this was attributable primarily to the audio task, as seen in Figure 2 , $F(2,44) = 6.35$; $p<.005$, mixed model ANOVA.

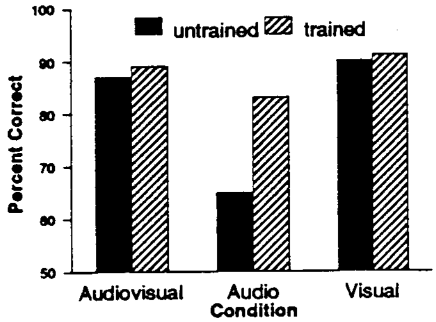

Figure 2. Mean percent correct on the three tasks by untrained (non-musicians) and trained (musician) subjects.

Response time was also significantly influenced by the interaction of condition and training, $F(2,44)=7.61$;$p<.005$ (See Figure 3). For musicians, the presence of the auditory stimulus (audio and audiovisual task) decreased response time by almost 6 seconds as compared to the visual task.

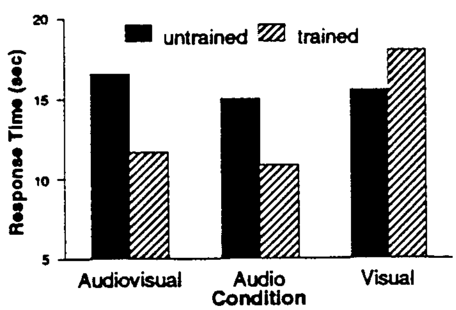

Figure 3. Mean response time on the three tasks for untrained and trained subjects.

Other effects of scale and order, unrelated to training, were in general comparable to those observed in previous studies and though of interest, are not discussed further here.

4.0 Discussion

Musicians produced better scores on the audio task and were faster than non-musicians on both tasks with an auditory component. As musicians were not superior to non-musicians on the visual task it seems unlikely that their advantage in auditory serial-order identification is due to skill in converting sequential information to visual patterns. Performance in the audiovisual condition was equal for both groups but the pattern in time was not (musicians were faster). Hence, it appears that the auditory code of musicians is both fast and accurate.

A practical application of the above findings is that an auditory code can be more efficient than an equivalent visual sequential code in a sequential pattern-tracking task. However, only musically trained listeners seem able to exploit this auditory code. This is the case, even though the auditory sequences used in the experiment were generally not musically structured. The present results suggest that the musicians' advantage in auditory sequential tasks is by virtue of auditory memory rather than familiarity with musical notation; such memory is not specific to musically structured sequences *per se*, though it may be specific to nonverbal auditory information.

5.0 Acknowledgements

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6.0 References

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