PERCEPTION OF TIMBRAL FUSION

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1. INTRODUCTION

The concept of timbre has been a difficult topic to study in the field of musical acoustics due to its multidimensional nature. This study was aimed at gaining more knowledge on this musical attribute. In particular, this study was aimed at understanding the phenomenon of timbral fusion, wherein one perceives a set of simultaneous frequency components as one complex tone. In order to explore the perception of timbral fusion, pairs of instrumental timbres were perceptually fused or simultaneously sounded together. Listeners were required to make a judgment on whether they heard one or two instruments after listening to each tonal stimulus. Performance differences between musicians and non-musicians were examined. It was hypothesized that musicians would perform better than non-musicians because of their extensive experience with musical tones.

2. METHODS

2.1 Participants

Thirty-three participants (17-29 yrs) participated in the study for course credit. Musicians (n = 10) had at least 8 years of formal musical training.

2.2 Stimuli and Procedure

Stimuli were pairs of simultaneously sounding natural instruments, and simultaneously sounding simple tones. All tones were 300 ms in duration. The steady state portions of three instrumental timbres were used in this study, including clarinet, trombone and harp. Ten selected pitches were considered in this study: Eb4, Ab4, A5, Bb5, B5, C5, C#5, D5, and Eb5. The pairs of stimuli were constructed such that the two timbres began one octave apart (Eb4) then gradually sounded closer together until the two timbres merged as one (Eb5). The combinations of the three timbres yielded three experimental groups: 1) clarinet Eb5 / trombone (10 pitches); 2) harp Eb5/ clarinet (10 pitches), 3) trombone Eb5 / clarinet (10 pitches). The control group consisted of pure tones corresponding to the combination of the 10 pitches in the experimental conditions. The combination of the 10 pitches from the four groups produced 40 different stimuli. Each stimulus was repeated 10 times in random order for a total of 400 trials. These trials were broken into five blocks with 80 trials each.

In the one-hour session, participants were required listen to the 400 signals. Their task was to make a judgment on whether they heard one or two instruments after listening to each tonal stimulus.

3. RESULTS

The following results report only a preliminary comparison between musicians and non-musicians. Overall means and standard deviations of the two groups were calculated and compared.

In the control condition, musicians outperformed non-musicians in all signals except for the Eb4 and Eb5 combination. For this signal, non-musicians' mean score was 15.5% (SD = .189) versus musicians' score of 13% (SD = .152).

In the Experimental Condition 1 (Clarinet at Eb5 and Trombone), musicians on average performed better than non-musicians. For two signals, however, non-musicians outperformed musicians. The first signal was Clarinet and Trombone (Eb4) where non-musicians achieved a mean of 84% (SD = .230) and musicians with a mean of 77% (SD = .295). Clarinet and Trombone (Eb5) was the second signal where non-musicians (m = 55.5%; SD = .287) outperformed musicians (m = 46%; SD = .353). Compared to the other signals in this condition, both groups found it harder to perceive the Eb5 combination as two timbres.

In Experimental Condition 2 (Harp at Eb5 and Clarinet), both musicians and non-musicians performed fairly well overall. However, musicians performed consistently better than non-musicians in every signal.

In Experimental Condition 3 (Trombone at Eb5 and Clarinet), musicians again outperformed non-musicians. The differences between the two groups for all signals were quite consistent.

4. DISCUSSION

The hypothesis that musicians would perform better than non-musicians was supported. Apparent differences were found in this study. Overall, musicians had higher percentage scores than non-musicians in identifying that there were two timbres in each stimulus. Thus, it was easier for musicians than non-musicians to hear two simultaneous sounding timbres. This may suggest that musical training or experience enhances the perception of timbre. This difference between musicians and non-musicians is in accordance to other studies (e.g., Kendall, 1986).

Pairs of instrumental timbres (Experimental Conditions) were more accurately perceived by both groups than pairs of pure tones (Control Condition). The differences in performance between the experimental conditions and the control condition in this present study can be explained by the characteristics of the waveform. All tones produced by musical instruments are not pure tones but mixtures of pure-tone frequencies or partials (White & White, 1980). The perception of fusion depends on the synchrony of the frequency partials in complex sounds, therefore, the fusion of two instrumental timbres is often harder to perceive because there is a lower probability of synchronicity between all the partials.

Overall, the octave combinations were more difficult for listeners to perceive as two timbres. When tones are separated by an octave they are considered to be musically and perceptually equivalent. Physically, the octave is the only interval in which the harmonics will coincide exactly; therefore, two notes that are separated by octaves cannot create dissonance. In this study, octave combinations were often lower compared to the other pitch combinations. It is interesting to note that the only combinations where non-musicians appeared to perform better than musicians were the Eb4 and Eb5 combinations (i.e., pure tones combinations of Eb4 and Eb5, Clarinet at Eb5 with Trombone Eb4). This result was unexpected; perhaps musicians have more experience with harmonic sounds (i.e., triads and chords), therefore they can fuse the harmonic partials more readily than non-musicians.

5. CONCLUSION

The study of timbre as a musical attribute has received much more attention in the recent decades. However, we still do not fully understand its multidimensional nature. Timbral fusion or timbral blending appears to be an important area of study since most music is created by the simultaneously sounding of instruments; however, timbral fusion is still a relatively unexplored area in timbre research. In listening to orchestral music, the perception of fusion also depends on the type conducting. Conductors may manipulate timbre by combining and emphasizing instruments in a certain way. This illustrates that timbral manipulation commonly takes place in the real world, and therefore, in order to understand music in an ecological sense, we must strive to understand timbre.

6. SELECTED REFERENCES

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