The Effects of Timbral Variation on Melodic Perception

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Introduction

Pitch and timbre form two of the foundational elements of music. Variations in pitch typically produce the percept of a melody, and variations in timbre are heard as different instruments (Warrier and Zatorre, 2002)

Do pitch and timbre interact?

When listening to music, one can recognize a familiar melody, regardless of the instrument on which the melody is played. This recognition implies that pitch and timbre are independent of one another.

In contrast, previous work by Warrier and Zatorre (2002) found that pitch and timbre interact, when making tone judgments for notes presented in isolated context, tone-series context, and a melodic context. Given these findings, it seems that the question of whether pitch and timbre are heard independently or interactively in melodic processing remains open. The current project explored this question in two studies:

Experiment 1: Pitch-timbre interactions in same-different judgments of constant versus variable timbre melodic pairs.

- This study examined the impact on melodic recognition of having melodic tones vary randomly in their timbre from note to note, compared to melodic tones that did not vary.

Experiment 2: Pitch-timbre interactions in same-different judgments of variable matching versus mismatching timbre melodic pairs.

- This study examined the impact on melodic recognition of creating a predictable structure for the changing timbre of melodic tones, and having this predictable structure either stay the same or change.

General Methods

Participants: Experiment 1 employed 40 participants, and Experiment 2 employed 48 participants. Half of the participants in each study were musical trained (≥ 5 yrs of formal training) and half were untrained (< 5 years of formal training).

Experimental Task & Design: Same-different recognition task in which listeners judged whether pairs of 9 note melodies (a standard followed by a comparison) were the same or different.

Pairs of melodies were manipulated in two ways: Comparison Type and Melody Timbre.

- **Comparison Type:** Three comparison melodies were created (Figure 1):
  - *Transpositions*: Same melodic contour and pitch intervals for standard and comparison
  - *Same Contour*: Same melodic contour, different pitch intervals for standard and comparison
  - *Different Contour*: Different melodic contour, different pitch intervals for standard and comparison

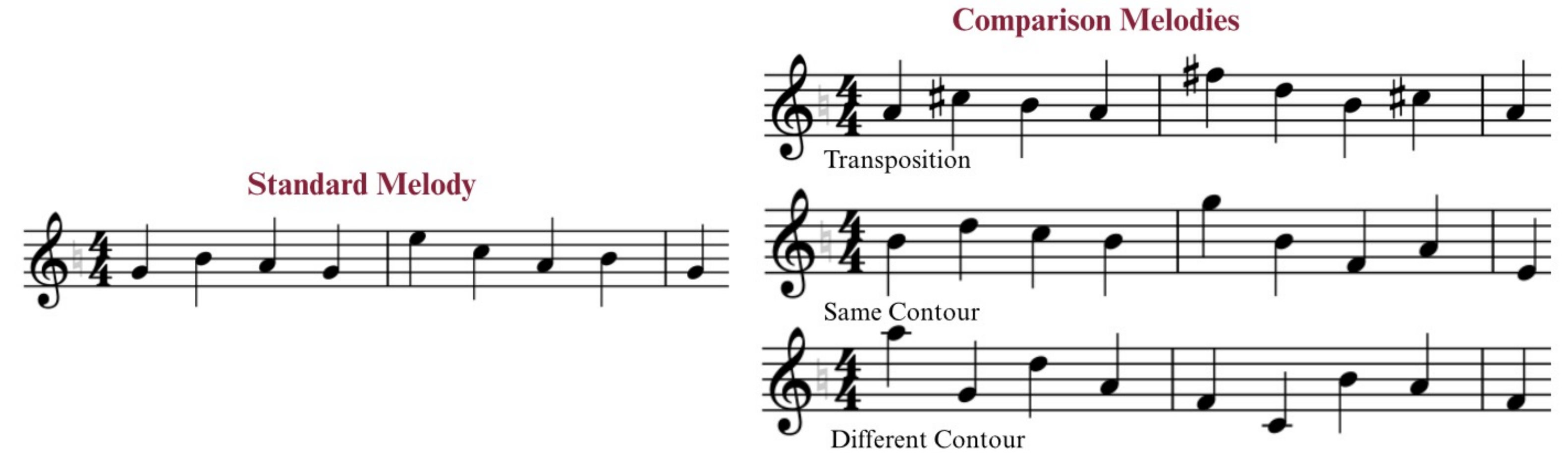

Figure 1: Comparison type manipulations employed in Experiment 1 and 2

- **Melody Timbre:** Standard and comparison melodies varied in the timbre of the melodic notes. Three timbres were employed: a saxophone, a trumpet, and a guitar.

Experiment 1: *Constant vs Variable Timbres*

- Standard/comparisons contained constant timbres (e.g., all saxophone) or varying timbres (e.g., random saxophone, trumpet and guitar timbres (Figure 2).

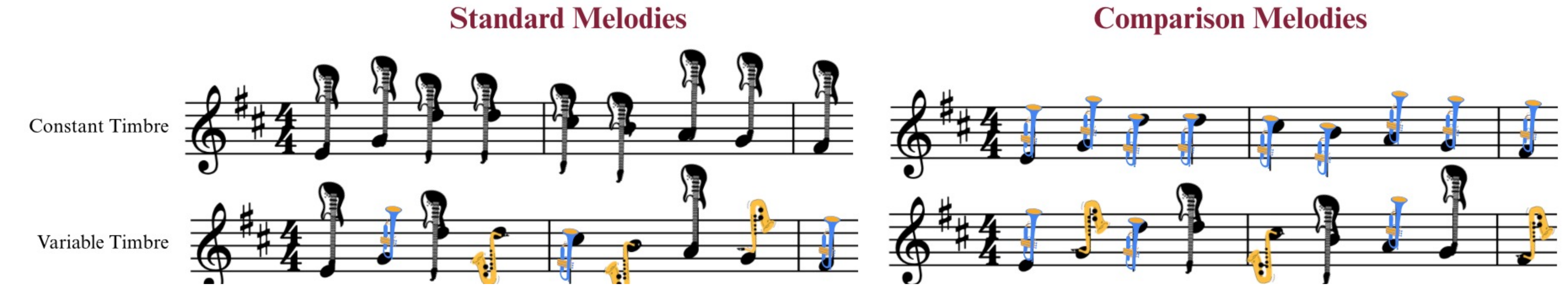

Figure 2: Standard and comparison melodies for the constant and variable timbre conditions of Experiment 1

Experiment 2: *Matching vs Mismatching Variable Timbres*

- Standard/comparisons contained grouped sets of three timbres (e.g., sax sax sax trumpet trumpet trumpet guitar guitar guitar), with the order of these groups either matching or mismatching between standard and comparisons (Figure 3)

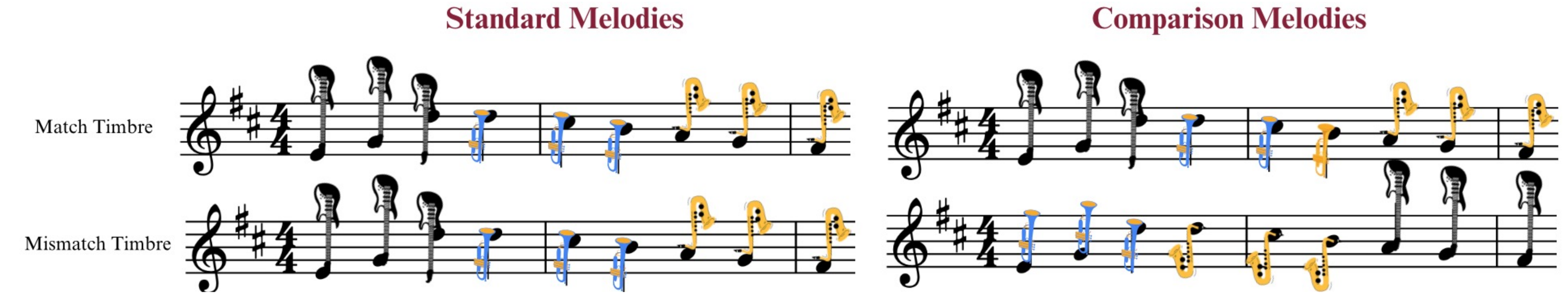

Figure 3: Standard and comparison melodies for the matching and mismatching conditions of Experiment 2

Results

D-primes were calculated, using the %correct for same/different comparisons as the hit rate, and 1 - %correct for transpositions as the FA rate. D-primes were analyzed in three-way ANOVAs, with within-Ss factors of Melody Type (same contour vs. different contour) and Timbre Type (Experiment 1: constant timbre vs. same timbre; Experiment 2: matching timbre vs. mismatching timbre), and the between-Ss factor of Musical Training (trained vs. untrained).

Experiment 1: *Constant vs Variable Timbres*

- Main Effects: *Timbre Type:* $F(1, 36) = 55.28$, $p < .001$; *Melody Type:* $F(1, 36) = 66.82$, $p < .001$.
- Interactions: *Timbre Type*Melody Type* $F(1, 36) = 9.08$, $p = 0.005$ (Figure 4a)

Experiment 2: *Matching vs. Mismatching*

- Main Effects: *Timbre Type:* $F(1, 44) = 19.943$, $p < .000$; *Melody Type:* $F(1, 44) = 90.497$, $p < .001$.
- Interactions: *Timbre Type*Melody Type* $F(1, 44) = 6.190$, $p = 0.17$ (Figure 4b)

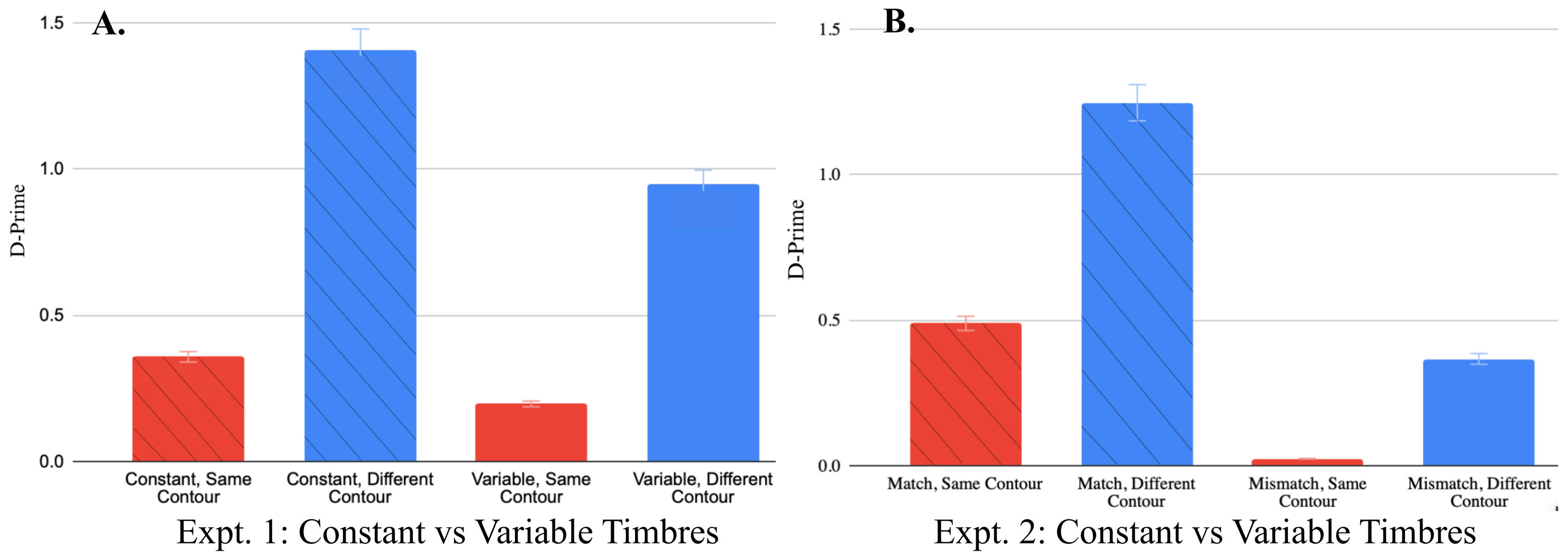

Figure 4: D prime scores for the same and different contours, as a function of timbre condition

Conclusions

Melody recognition is influenced by timbral constancy, with listeners experiencing greater difficulty discriminating different contour comparisons from a previously presented melody when the timbre of the melody notes varies across notes. This finding is unexpected, based on previously reported abilities to distinguish different contour comparisons from standards (Dowling, 1994).

Not all timbral variations exert the same effect on melody recognition. Grouping timbres into coherent sets enhances listeners' differentiation of standard and comparison melodies, particularly when both melodies have the same (changing) timbral structure. Thus, introducing predictability into timbral variation facilitates performance. Generally, these findings reveal notable pitch-timbre interactions in melodic processing, emphasizing how timbral variation can shape and influence overall melodic perception.

References

Dowling, W. J. (1994). Melodic contour in hearing and remembering melodies. In R. Aiello & J. A. Sloboda (Eds.), *Musical perceptions* (pp. 173–190). Oxford University Press.

Warrier, C.M., Zatorre, R.J. (2002)Influence of tonal context and timbral variation on perception of pitch. *Perception & Psychophysics 64*, 198–207. https://doi.org/10.3758/BF03195786