

PERCEIVING MISSING FUNDAMENTALS IN MELODIC CONTOURS

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INTRODUCTION

- Musical tones are “complex”, containing multiple frequency components (also known as **spectral content, SC**) above the fundamental frequency (f_0 ; see Figure 1). These components combine with the f_0 to produce a percept of pitch consistent with the f_0 .
- The **Missing Fundamental (MF)** occurs when listeners hear f_0 even when not physically present; this percept occurs due to the spectral content (Niebuhr et al., 2020)
- MF** percepts are influenced by musical training (Seither-Preisler et al., 2007), the **SC** of **MF** tones (Dai, 2000), the range of frequencies examined (Smooenbrug, 1970), etc.
- Previous work is limited in that it typically employs interval judgments of isolated two note contexts.

Research Question: Examine **MF** percepts when presented in larger musical contexts.

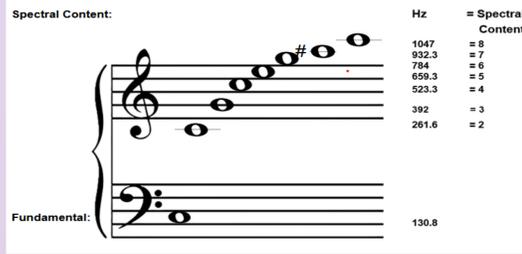


Figure 1. Complex tone based on C₃ (130.8 Hz)

METHODS

Participants:

- Trained ($N = 20$, $M_{age} = 21.2$ yrs, $M_{training} = 11.9$ yrs)
- Untrained ($N = 20$, $M_{age} = 19.3$ yrs, $M_{training} = 1.4$ yrs)

Stimuli:

- Eighteen eight-note melodies manipulating the melodic contours of the **MF** and **SC** components.
- Melodies employed complex tones, using either **MF** tones (f_0 missing) or typical tones (**TT**) (fundamental present)
- Tones contained 3 consecutive harmonics (**SC**) above f_0

Comparison Type: Standard produced 4 comparisons crossing contour equivalence of f_0 and **SC** (Figure 2: **MF** melodies; Figure 3: **TT** melodies)

- f_0^{Same}, SC_{Same} : f_0 contours same, **SC** contours same
- f_0^{Same}, SC_{Diff} : f_0 contours same, **SC** contours different
- f_0^{Diff}, SC_{Same} : f_0 contours different, **SC** contours same
- f_0^{Diff}, SC_{Diff} : f_0 contours different, **SC** contours different

Melody Type: Two types of melodies: **MF** melodies and **TT** melodies

Experimental Design:

- Listeners rated the similarity of melodic contours (1 = highly dissimilar ... 6 = highly similar) of pairs of standard and comparison melodies

HYPOTHESES

TT melodies:

- $f_0^{Same}, SC_{Same} = f_0^{Same}, SC_{Diff}$: Higher rating
- $f_0^{Diff}, SC_{Same} = f_0^{Diff}, SC_{Diff}$: Lower rating

MF melodies:

MF percepts affected by melodic context

- Same pattern for comparisons as **TT** melodies
- MF** percepts: Trained = Untrained

MF melodies:

MF percepts unaffected by melodic context

- f_0^{Same}, SC_{Same} : Highest rating
- f_0^{Diff}, SC_{Diff} : Lowest rating
- $f_0^{Same}, SC_{Diff} > f_0^{Diff}, SC_{Same}$: Tracking **MF** content
- $f_0^{Same}, SC_{Diff} < f_0^{Diff}, SC_{Same}$: Tracking **SC** content
- MF** percepts: Trained > Untrained

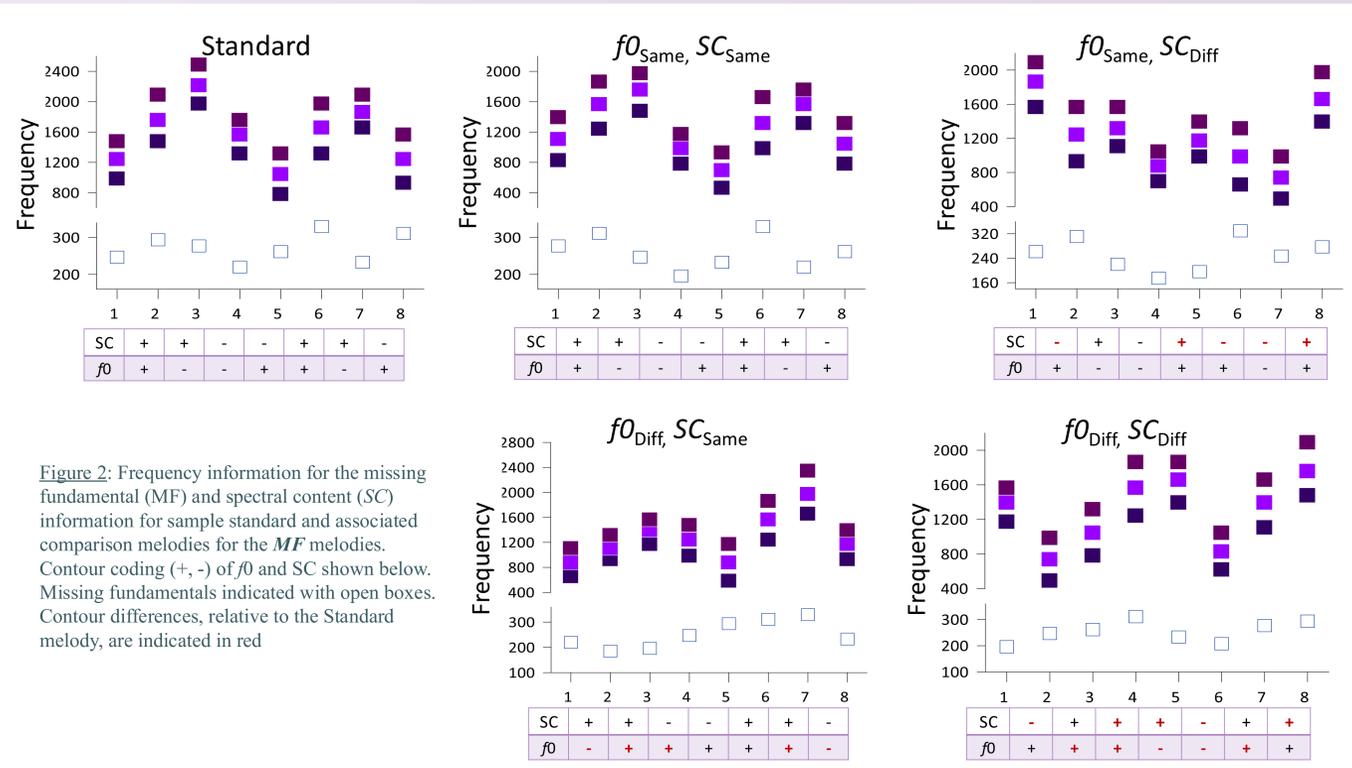


Figure 2: Frequency information for the missing fundamental (MF) and spectral content (SC) information for sample standard and associated comparison melodies for the **MF** melodies. Contour coding (+, -) of f_0 and **SC** shown below. Missing fundamentals indicated with open boxes. Contour differences, relative to the Standard melody, are indicated in red

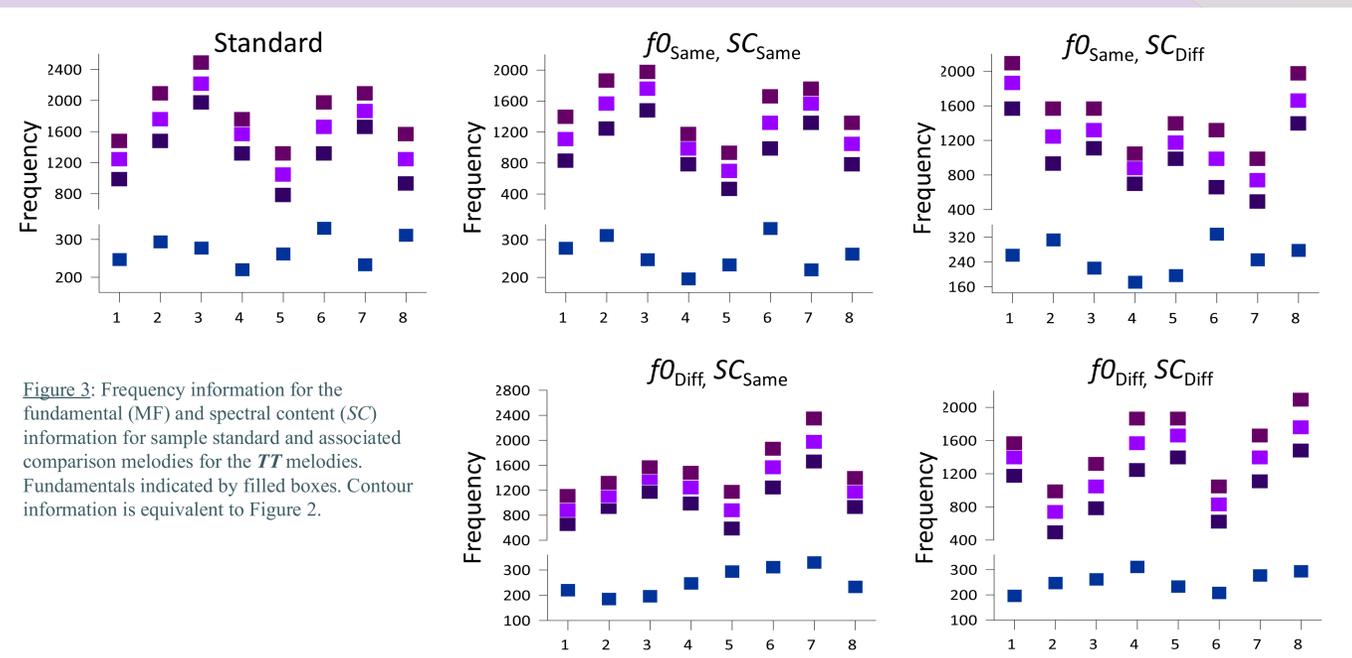


Figure 3: Frequency information for the fundamental (MF) and spectral content (SC) information for sample standard and associated comparison melodies for the **TT** melodies. Fundamentals indicated by filled boxes. Contour information is equivalent to Figure 2.

RESULTS

Ratings analyzed in 3-way ANOVA, with *Comparison Type*, *Melody Type* (**MF**, **TT**), and *Musical Training* (see Figure 4)

- Main effect of *Comparison Type*: $F_{(3,108)} = 71.4$, $p < .001$
- Follow-up t-tests examined different comparisons, separately for **MF** and **TT** melodies (averaging across training)
- MF** melodies: Ratings between all comparisons type differed significantly (all p 's < .005) **except** f_0^{Diff}, SC_{Same} and f_0^{Diff}, SC_{Diff}
- TT** melodies: Ratings between all comparisons type differed significantly (all p 's < .001) **except** f_0^{Diff}, SC_{Same} and f_0^{Diff}, SC_{Diff}

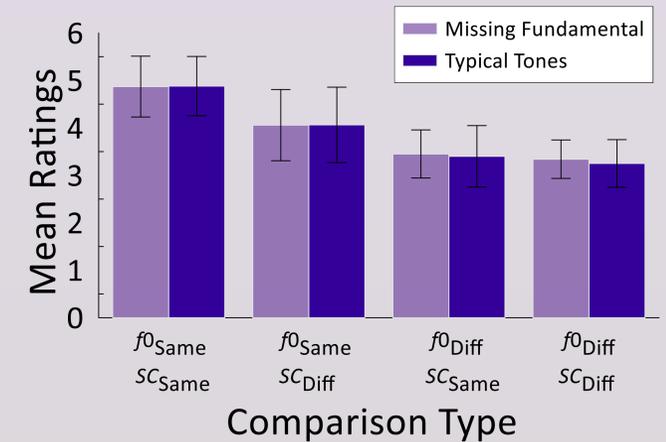


Figure 4. Marginal means for the different comparison types, as a function of **MF** melodies and **TT** melodies

DISCUSSION

- In melodic context, listeners consistently perceive missing fundamental information
- Missing fundamental percepts **not** influenced by musical training, or stimulus variables (e.g., spectral content, specific frequency ranges)
- Note-by-note timbral changes, as produced by changing spectral content influenced melody perception, with similarity ratings for same contour spectral content melodies (f_0^{Same}, SC_{Same}) exceeded different contour spectral content melodies (f_0^{Same}, SC_{Diff})
- On-going research is examining whether the current findings occur for two-note pitch judgments (i.e., Seither-Preisler et al., 2007) embedded in melodies

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