Perception of melodic accuracy in occasional singers: role of pitch fluctuations?

Pauline Larrouy-Maestri & Peter Q Pfordresher
What we know

- Complexity of the signal
  (e.g. Larrouy-Maestri et al., 2014; Sundberg, 2013)

- Parameters contributing to the beauty of the voice
  (Ekholm et al., 1998; Garnier et al., 2007; Rothman et al., 1990)

- Effect of these parameters on pitch perception
  (e.g. Hutchins et al., 2012; Russo & Thompson, 2005; van Besouw et al., 2008; Vurma et al., 2010; Warrier & Zatorre, 2002)

- Example of Western operatic voices
  (Larrouy-Maestri et al., in press)
Occasional singers

- Not « operatic » but pitch fluctuations
- Evaluation of melodic accuracy

(Larrouy-Maestri et al., 2013)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Non experts</th>
<th>Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>$F(3,165) = 104.44; p &lt; .01$</td>
<td>$F(3,165) = 231.51; p &lt; .01$</td>
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<tr>
<td>% variance</td>
<td>66%</td>
<td>81%</td>
</tr>
<tr>
<td>Criteria</td>
<td>Interval deviation</td>
<td>Interval deviation Tonality modulations</td>
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</table>
Occasional singers

What we don’t know

- Which pitch fluctuations?
- Depends on the quality of the singer?
- Effect on the perception of pitch accuracy?
Occasional singers

What we are doing to know

☐ Which pitch fluctuations?
   Model describing pitch fluctuations

☐ Depends on the quality of the singer?
   Comparison accurate/inaccurate singers

☐ Effect on the perception of pitch accuracy?
   Evaluation of manipulated melodic sequences
Description of pitch fluctuations
Modification of the temporal adaptation model of Large, Fink & Kelso (2002)

Designed to get relevant summary statistics for pitch fluctuations

Pitch at time $t$
Comes from “start” fluctuations and “end” fluctuations influencing an asymptote

$$\text{Pitch}_t = Y_{s_t} + Y_{e_t} + \text{asym}$$
Descriptive model of pitch fluctuation

\[ \text{Pitch}_t = Y_{s_t} + Y_{e_t} + \text{asym} \]

\[ Y_{s_t} = [A_s \exp(-b_s t) \cos(2\pi f_s t + \theta_s)] \]

- **Beginning perturbation**
- **Approach to asymptote**
- **Oscillation around target** (overshoot)
- **Approach is down** (= 0)
  Or up ( = π)

Similar to starting fluctuations, except
- Time values mirror reversed
- New and adjusted parameters

Larrouy-Maestri & Pfordresher
April 26th, 2014
Difference between accurate/inaccurate singers?
Comparison of singers
Comparison of singers

Database
- Pfordresher & Mantell (2014)
- 12 “inaccurate” and 17 “accurate” singers
- Imitation of accurate singers
- Melodies of 4 notes
- 1902 tones to analyse

VAF not different depending on the quality of the singer (p = .637)
- $\text{Mean } \text{VAF}_{\text{accurate}} = .62$
- $\text{Mean } \text{VAF}_{\text{inaccurate}} = .61$
Influence of beginning/end on pitch perception?
Influence of pitch fluctuations
Influence of pitch fluctuations

- **Creation of melodies** (According to Pfordresher & Mantell, 2014)

- **Conditions**

<table>
<thead>
<tr>
<th>Level</th>
<th>Start perturb.</th>
<th>None</th>
<th>Up</th>
<th>Down</th>
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<tbody>
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<td>Task 1&amp;2</td>
<td>Task 1&amp;2</td>
<td>Task 1&amp;2</td>
</tr>
<tr>
<td></td>
<td>Up</td>
<td>Task 1&amp;2</td>
<td>Task 2</td>
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<td>Down</td>
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<td>Task 1</td>
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<tr>
<td></td>
<td>Up</td>
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- **Evaluation task by non musicians**
Melodies - Task 1

PITCH

TIME

+71 Shift +50

+71

-68

0

+115

-86

+71 Shift -50
Participants
- 12 (5 women)
- Age from 19 to 22 ($M = 19.58, ET = 1.31$)
- No absolute pitch, low formal musical training

Pairwise comparison
- All the sequences compared
- No reference

Ranking from “most out of tune” to “most in tune”
No interaction

Middle*Start and Middle*End
Melodies - Task 2

[Diagram showing pitch and time with various sound representations]
Results - Task 2

Trials varying start and end perturbation

Independent effects of start and end

No apparent effect of direction (- vs +)
Focus on perturbation types as “features”
Task 1
- Listeners respond to the perturbations of pitch
- Center value yields strongest effect (low score if the middle is up)
- Main effect of start/end perturbation (low score if up)

Task 2
- Independent effects of start and end
- No apparent effect of direction
- One perturbation less perceived than two
- Ending perturbations matter more
Future projects

- **Exp 2**
  - Variation of the musical context
  - Same procedure as for the first experiment (tasks 1 & 2)
  - Material created according to Pfordresher & Mantell (2014)

- **Exp 3**
  
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- **Exp 4**
  - Magnitude of the fluctuations on perception
(Current) Conclusions

- **Acoustical description of vocal tones**
  - Modeling voices of occasional singers
  - Fluctuations of pitch at beginning and ends predict singing quality
    (Note that most analyses of pitch accuracy throw out)

- **Perceivers’ judgment of pitch accuracy influenced by these fluctuations**
  - Center value still yields strong effect but does not explain everything
  - Effect of ending perturbation
    - Beginning perturbation sounds probably more “natural”
    - Interpretation of ending fluctuations as a failure of motor planning in the singer
Perception of melodic accuracy in occasional singers

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2014

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Perception of melodic accuracy in occasional singers

Thank you!


