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

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Perception of pitch accuracy

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

What we know

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

(Larrouy-Maestri et al., 2013)

	Non experts	Experts
Model	$F(3,165) = 104.44$; $p < .01$	$F(3,165) = 231.51$; $p < .01$
% variance	66%	81%
Criteria	Interval deviation	Interval deviation Tonality modulations

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

Descriptive model of pitch fluctuation

- 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 "**s**tart" fluctuations
and "**e**nd" fluctuations
influencing an ***asym***ptote

$$Pitch_t = Y_{s_t} + Y_{e_t} + asym$$

Descriptive model of pitch fluctuation

$$Pitch_t = Y_{s_t} + Y_{e_t} + asym$$

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

Beginning perturbation

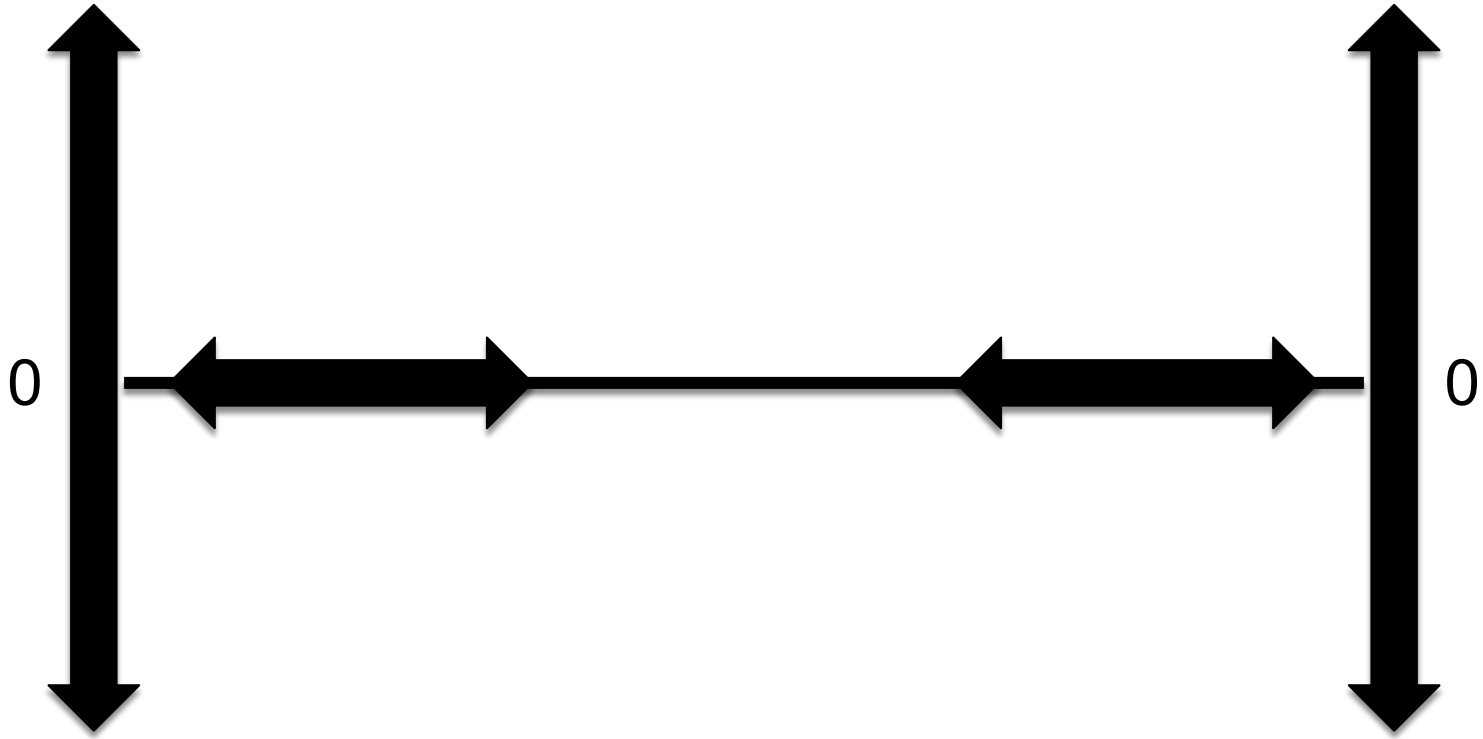
Approach to asymptote

Oscillation around target (overshoot)

Approach is down (= 0) Or up (= pi)

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

Descriptive model of pitch fluctuation



➔ **Difference between accurate/inaccurate singers ?**

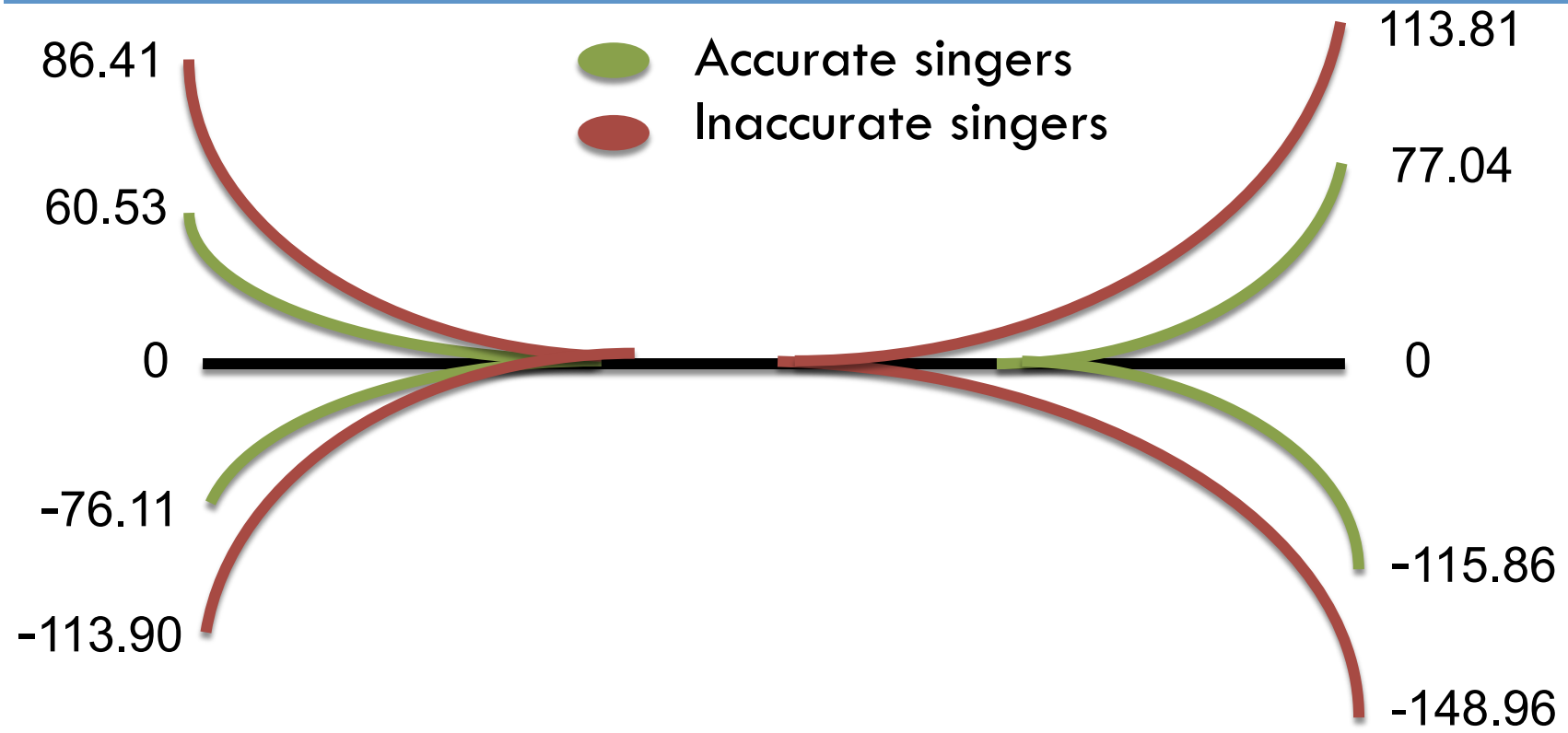
Comparison of singers

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 ($p = .637$)
  - Mean $VAF_{accurate} = .62$
  - Mean $VAF_{inaccurate} = .61$

Comparison of singers



➔ **Influence of beginning/end on pitch perception ?**

Influence of pitch fluctuations

Influence of pitch fluctuations

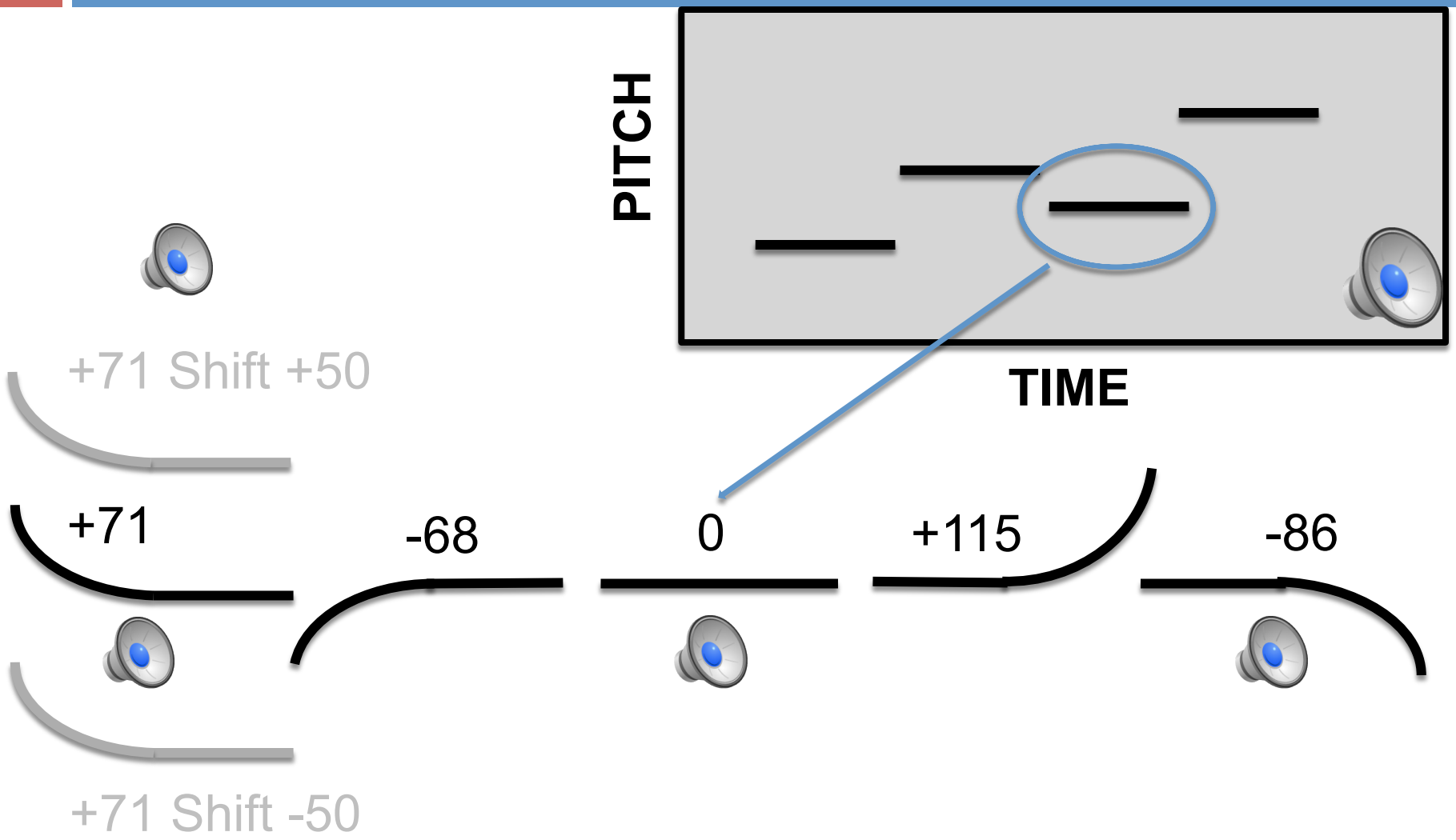
- Creation of melodies (According to Pfordresher & Mantell, 2014)

- Conditions

Level	Start perturb.	End perturb. None	End perturb. Up	End perturb. Down
Normal	*None*	Task 1&2	Task 1&2	Task 1&2
	Up	Task 1&2	Task 2	Task 2
	Down	Task 1&2	Task 2	Task 2
+50 cents	*None*	Task 1	Task 1	Task 1
	Up	Task 1	N/A	N/A
	Down	Task 1	N/A	N/A
-50 cents	*None*	Task 1	Task 1	Task 1
	Up	Task 1	N/A	N/A
	Down	Task 1	N/A	N/A

- Evaluation task by non musicians

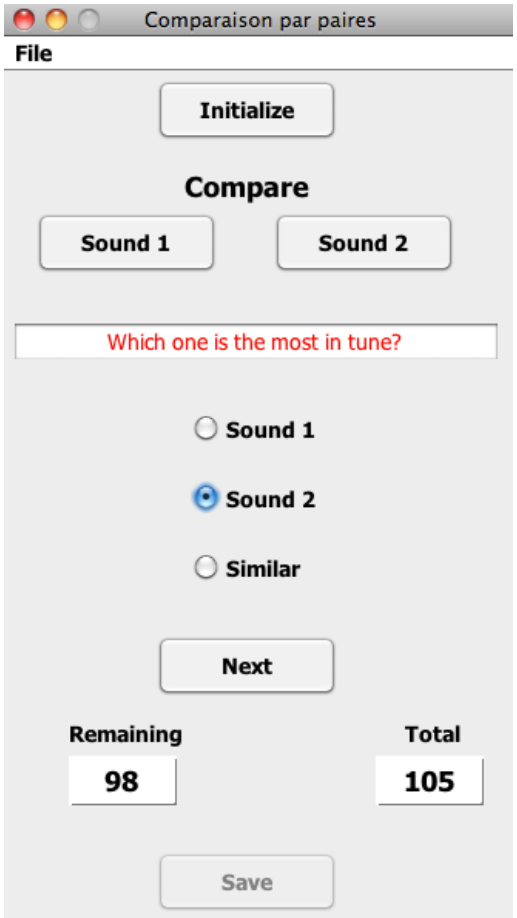
Melodies - Task 1



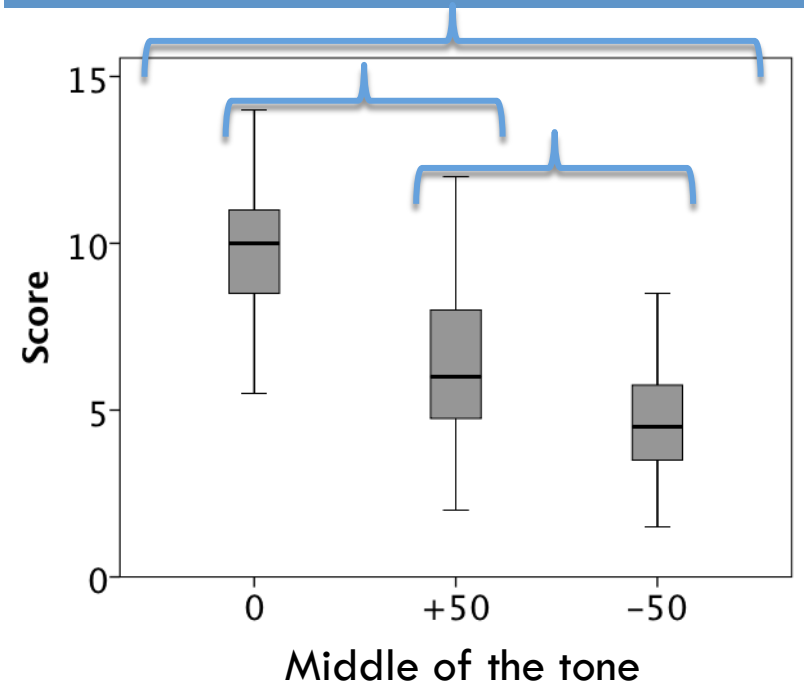
Method - Task 1

- 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

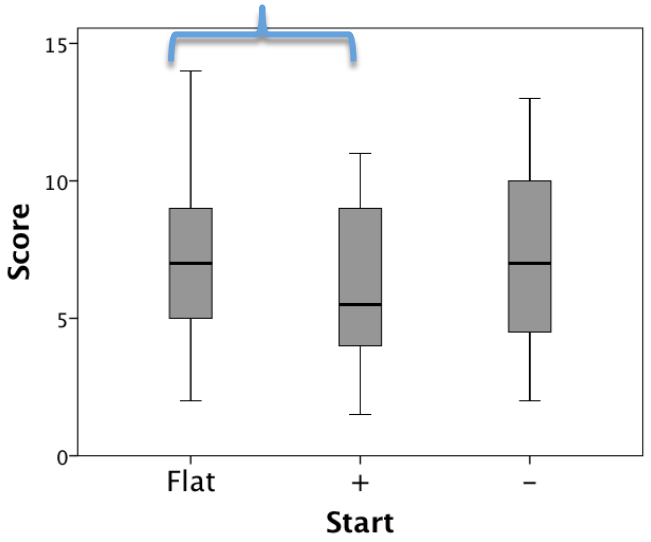
- Ranking from “most out of tune” to “most in tune”

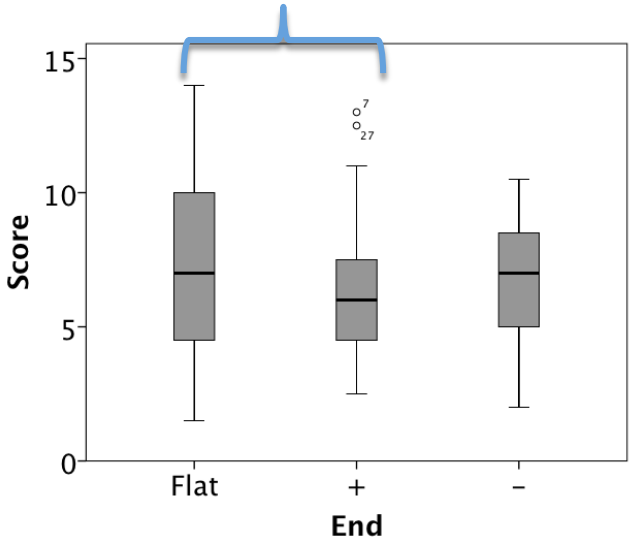


Results - Task 1

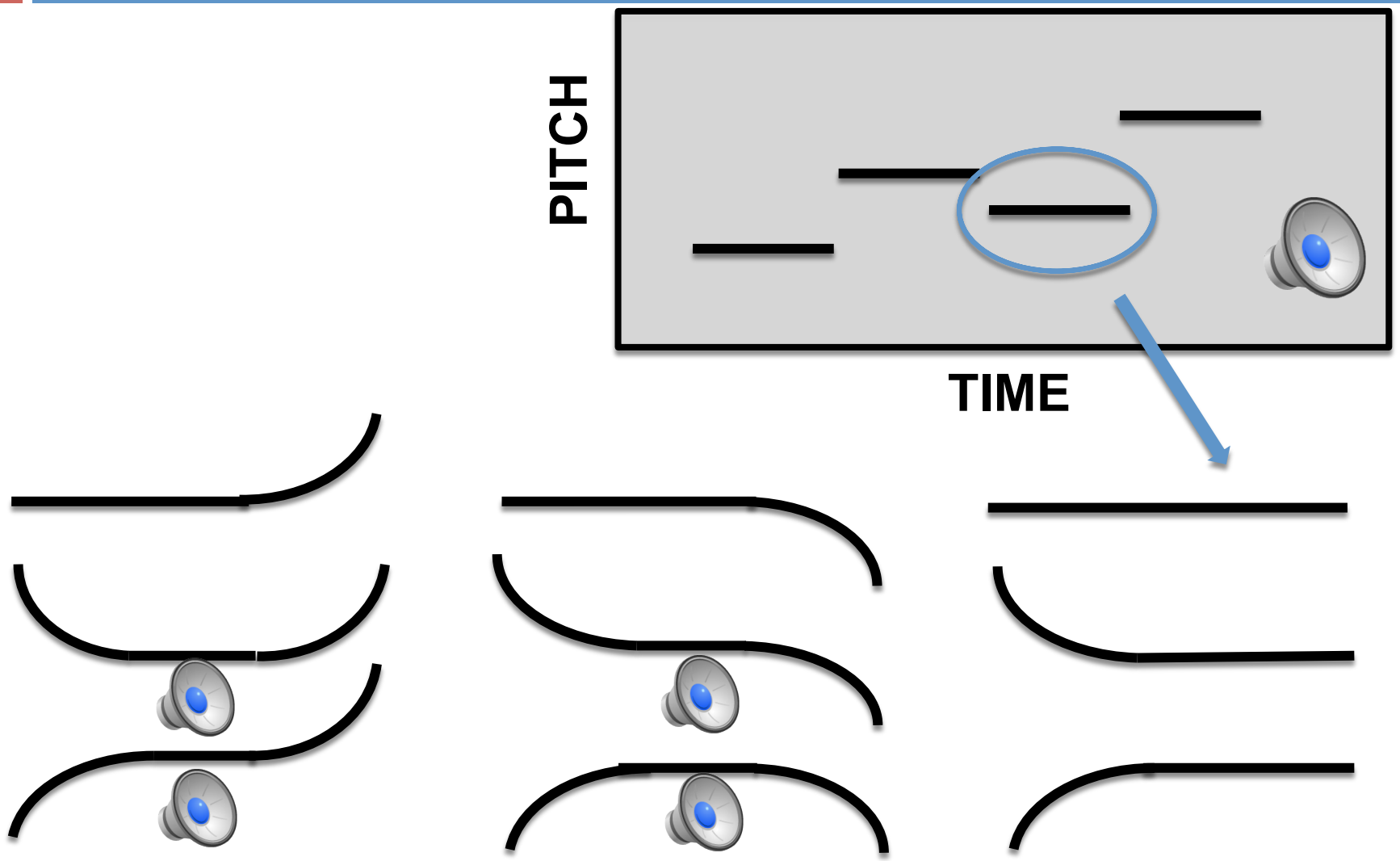


No interaction
*Middle*Start and Middle*End*

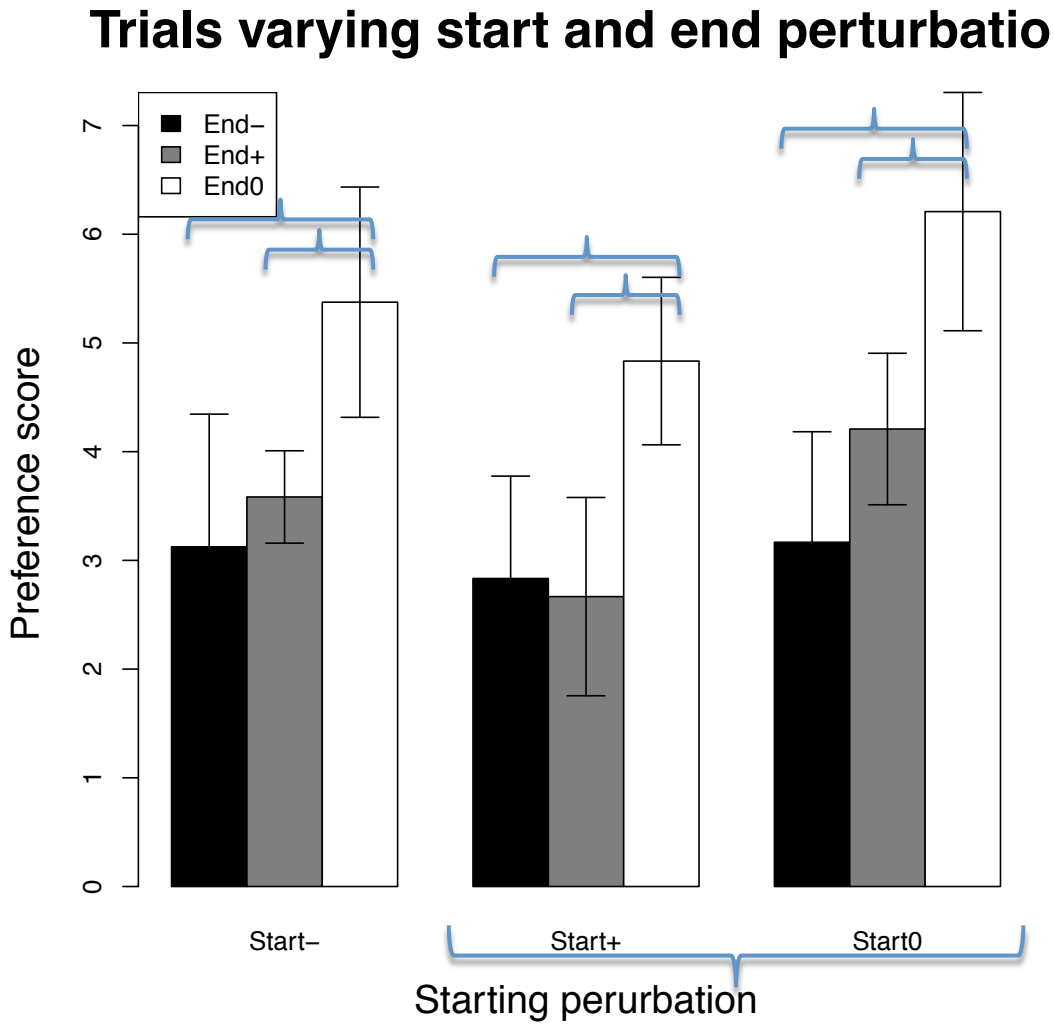




Melodies - Task 2



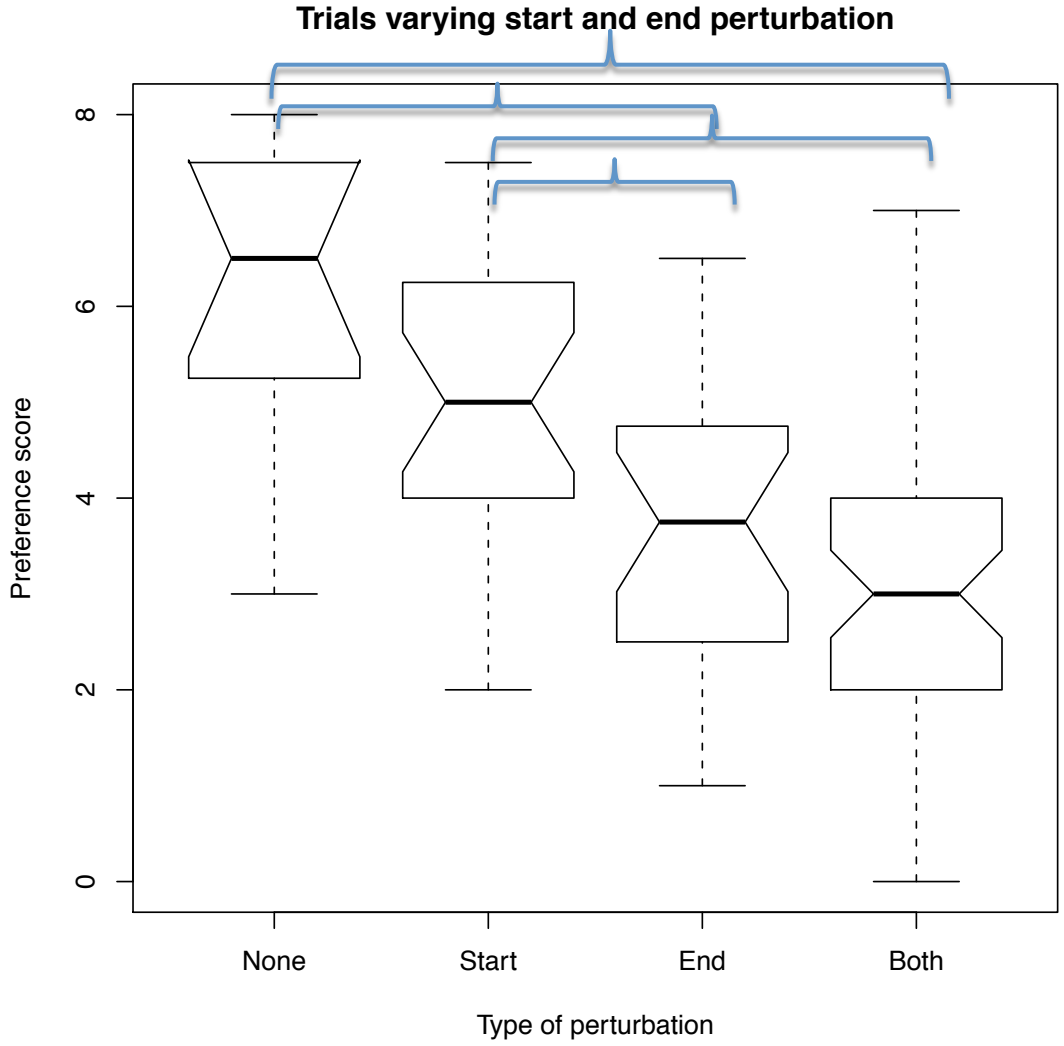
Results - Task 2



Independent effects of start and end

No apparent effect of direction (- vs +)

Results - Task 2



Focus on perturbation types as “features”

Summary - Tasks 1&2

- 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

Level	Start perturb.	End perturb. None	End perturb. Up	End perturb. Down
Normal	*None*	Exp 1	Exp 1	Exp 1
	Up	Exp 1	Exp 1	Exp 1
	Down	Exp 1	Exp 1	Exp 1
+50 cents	*None*	Exp 1&3	Exp 1&3	Exp 1&3
	Up	Exp 3	Exp 3	Exp 3
	Down	Exp 3	Exp 3	Exp 3
-50 cents	*None*	Exp 1&3	Exp 1&3	Exp 1&3
	Up	Exp 3	Exp 3	Exp 3
	Down	Exp 3	Exp 3	Exp 3

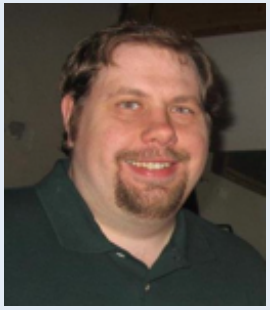
- Exp 4
  - Magnitude of the fluctuations on perception

(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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Thank you!

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References

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