

ACCURACY IN THE SINGING VOICE

Pauline Larrouy-Maestri

PhD Student, Logopédie de la Voix, Dpt Scs Cognitives, ULg

Supervisor: D. Morsomme

Managing team: R. Kolinsky, S. Majerus

May 2011

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- I. **Theoretical basis:**
 - Reference model
 - Context
 - Research problematic
- II. **Current studies:**
 - Study 1: “Subjective perception of accuracy”
 - Study 2: “Technique: Singers Vs Non-singers”
 - Study 3: Corpus “Joyeux Anniversaire”
 - Study 4: “Impact of performance anxiety”
- III. **Collaborations for those studies**
- IV. **References**

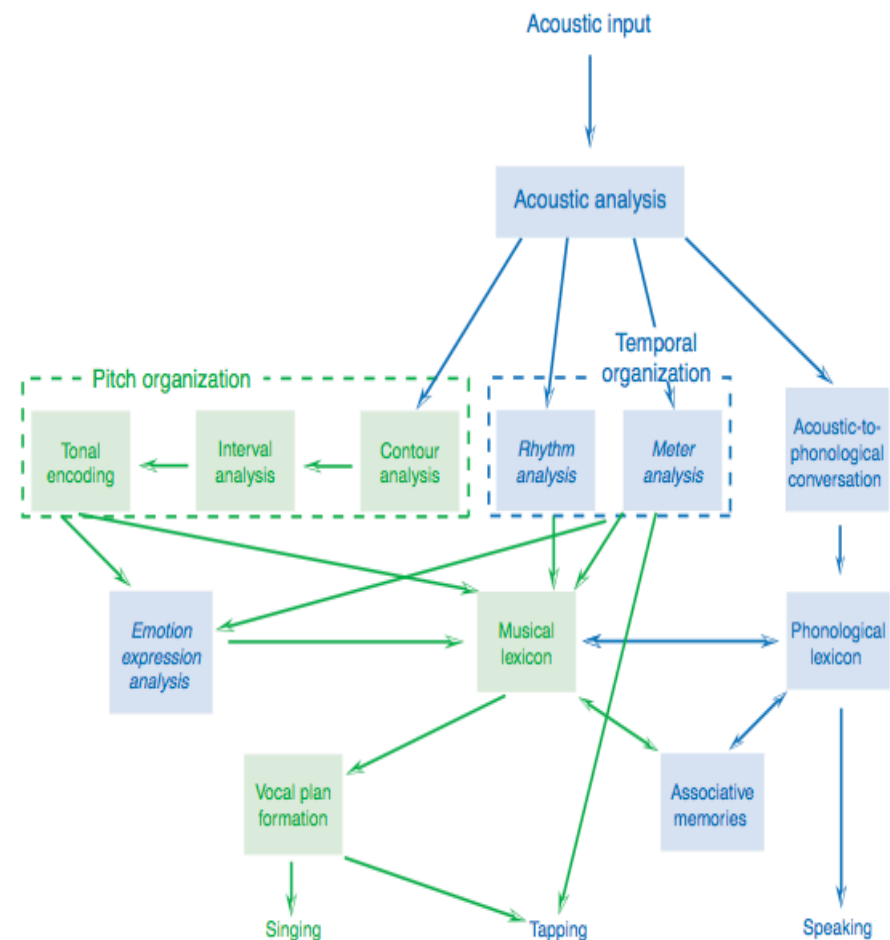
I. Theoretical basis: Reference model

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- Music (reception thereof) processing: Peretz and Coltheart model (2003)

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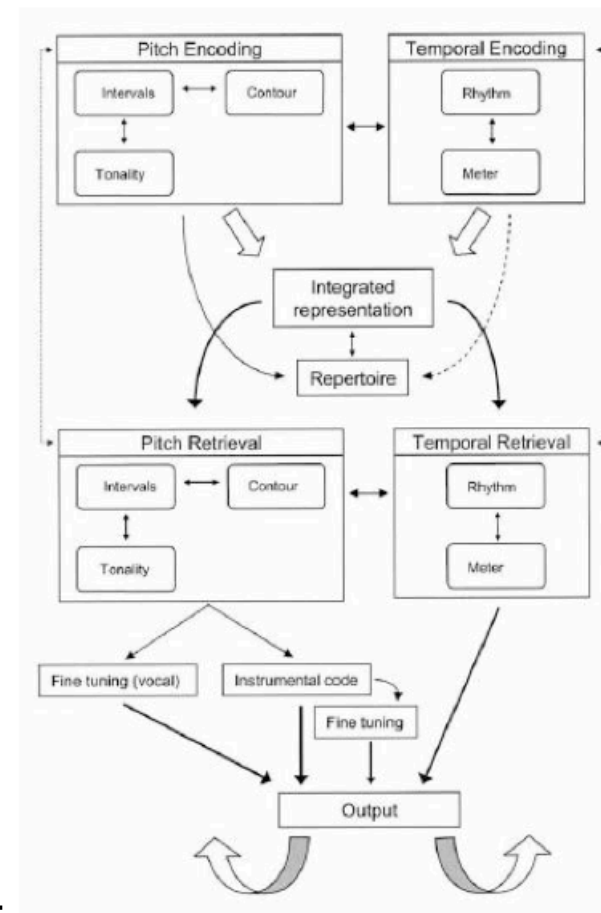
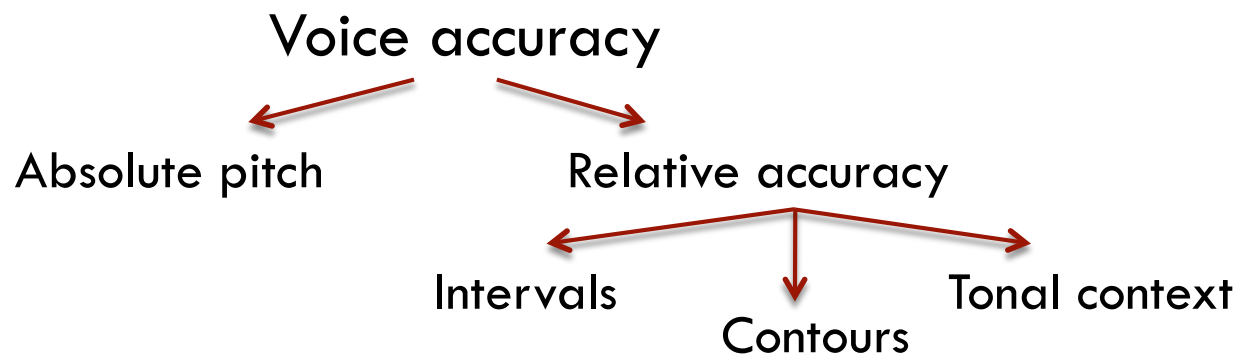
- ▣ Peretz (2001)
 - ▣ Hébert et al. (2003)
 - ▣ Dalla Bella and Peretz (2003)
- Dissociation rhythm and pitch
 - 3 frequential subsystems:
 - ▣ Contours
 - ▣ Intervals
 - ▣ Tonal centre



I. Theoretical basis: Reference model

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- Music production improved model Schön (2004)
- Evaluation Battery
 - ▣ Reception: MBEA (Peretz et al., 2003)
 - ▣ Production: Dalla Bella et al., 2009
- **Definition of singing accuracy:**



I. Theoretical basis: Context

Prevalence

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- **Everybody can sing in tune!** Dalla Bella, Giguère & Peretz, 2007
- Yet according to Pfordresher et al., 2007: this is far from what participants perceive (59% state they cannot imitate a simple melody)
- How prevalent?
 - ▣ 4% of population – regarding amusia (Kalmus & Fry, 1980)
 - ▣ For 30 years, each author has had his own answer... (Henry & McAuley, 2010)

I. Theoretical basis: Context

Investigated factors

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- Stimuli: synthetic or vocal sound, various registers and pitch directions (Russo & Thompson, 2005; Pfordresher et al., 2009, 2010; Hutchins, in progress)
- Audio feedback (Burnett, 1997; Watts, 2003; Pfordresher, 2007; Hutchins, 2010)
- Pitch memory (Belin, 2005; Watts, 2006)
- Vocal training (Watts, 2005; Bradshaw, 2005; Sonninen et al., 2005; Wilsonarboleda & Frederick, 2008)

I. Theoretical basis: Research problematic

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- Debatable points:
 - ▣ Methods in studying accuracy
 - ▣ Precision of analysis tools
 - ▣ Evaluative criteria for accuracy
 - ▣ Non-investigated factors: technique, emotional state...
- Our questions:
 - ▣ How to measure accuracy?
 - ▣ What shall be considered out of tune?
- Aim: definition of singing voice accuracy

II. Current studies investigating this problematic

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- Study 1: “Subjective perception of accuracy”
 - Refine perception in different contexts (isolated sounds, musical phrases)
 - Define the relevant criteria to analyze
- Study 2: “Vocal Technique”
 - Analysis tools for accuracy
 - Effect of vocal technique
- Study 3: Corpus “Joyeux Anniversaire”
 - Prevalence of an accuracy problem?
 - Profiles for “good” and “bad” singers
 - Comparison of different analysis methods
- Study 4: “Impact of performance anxiety”

II. Study 1: “subjective perception of accuracy”

Aims and method

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□ Aims:

- Refine perception in the context of musical phrases
- Comparison with an isolated sound
- Comparison between perception and production
- Define the relevant criteria to analyze in study 3


□ Method:

- Participants: 30 non-musicians (15 women, 15 men)
- Materials:
 - Sequence creation from JA corpus
 - Sound manipulation with Audiosculpt: creation of errors

II. Study 1: “subjective perception of accuracy”

Materiel: Sequence creation from JA corpus

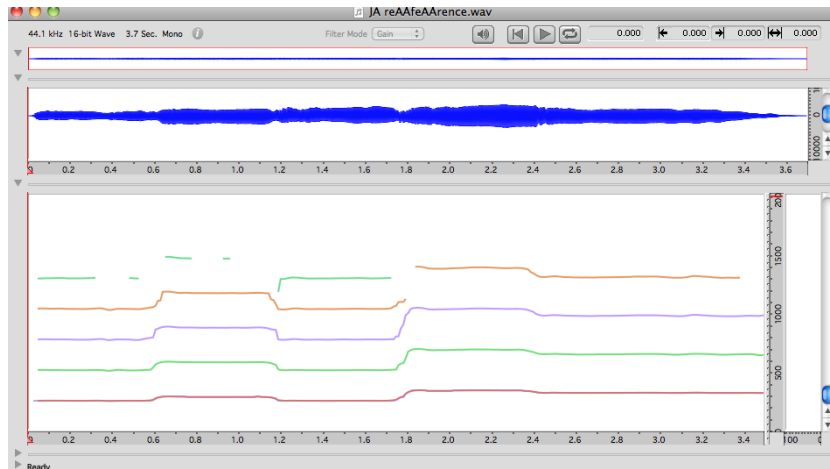
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- Parameters in our sequence
 - ▣ Tempo: **100**
 - ▣ Tonality (equal temperament): **F Major**
 - ▣ Timbre : woman voice filtered as alto (plus light audio processing)
 - Compromise between natural, controlled voice (Alcock, 2000)
- 
- Follow-up: integrating increasingly large pitch and key errors

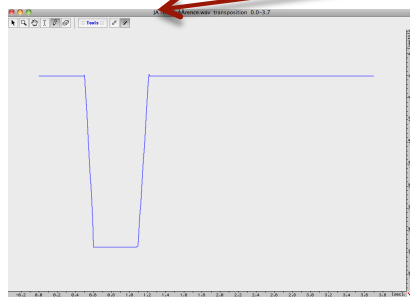
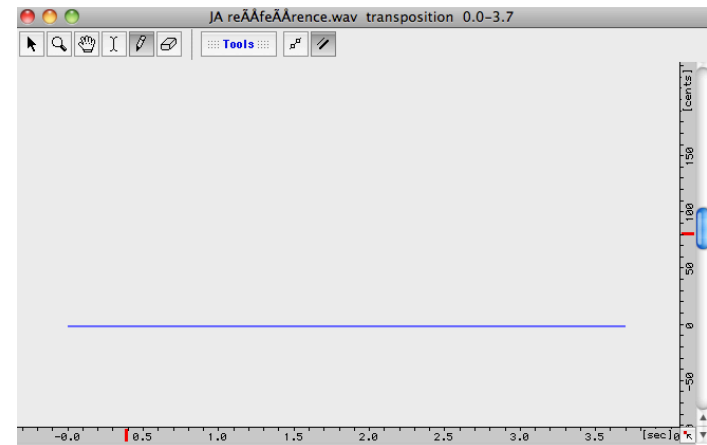
II. Study 1: “subjective perception of accuracy”

Materiel: Sound manipulation

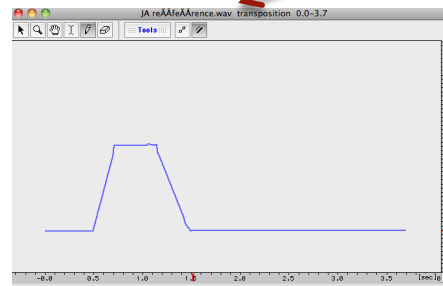
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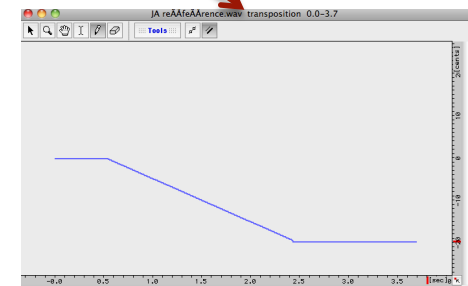
Sequence without manipulation



Ex : altered-down Maj 2nd



Ex : altered-up Maj 2nd





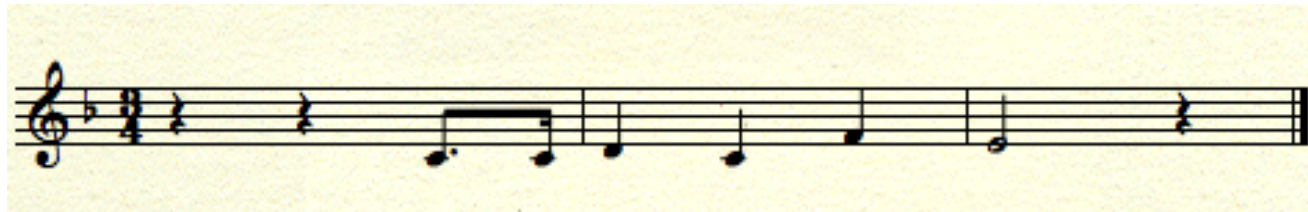
E.g.: downshifting key

II. Study 1: “subjective perception of accuracy”

Procedure

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- Production task (glissandi and JA)
- d' estimation to test discrimination abilities (E prime)
 - ▣ E.g. sine tones 
 - ▣ E.g. complex tones 
- Evaluation of perception for each accuracy error within melodic phrases



II. Study 1: “subjective perception of accuracy”

Procedure

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- Threshold estimation for each type of error (pairwise comparison paradigm with target)



- E.g. ascending 2nd Maj interval +20 cents 

- E.g. descending 2nd min interval -60 cents 

- E.g. ascending pitch slope +40 cents 

- Comparison of error types (pairwise comparison paradigm without target)

- E.g. « which is most out of tune between descending 2nd min interval -30 cents and ascending pitch slope +40 cents? »



II. Study 1: “subjective perception of accuracy”

Conclusions

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- Results:
 - ▣ In progress...
- Discussion and perspectives:
 - ▣ Validity of our task
 - ▣ Type of error perceived
 - ▣ Which size of error
 - ▣ Information about what is worth analyzing to assess accuracy in production
 - ▣ Follow-up with “experts”?

II. Study 2 : “Vocal technique”

Aims and method

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□ Aims:

- Analysis tools for accuracy
- Effects of lyrical technique

□ Method:

□ Participants: 77 women

- 63 non-singers, 15 to 75 years old (m: 29,83, SD: 14,99)
- 14 singers from RSAMD of Manchester (opera section), 19 to 54 years old (m: 24,21, SD: 8,79)

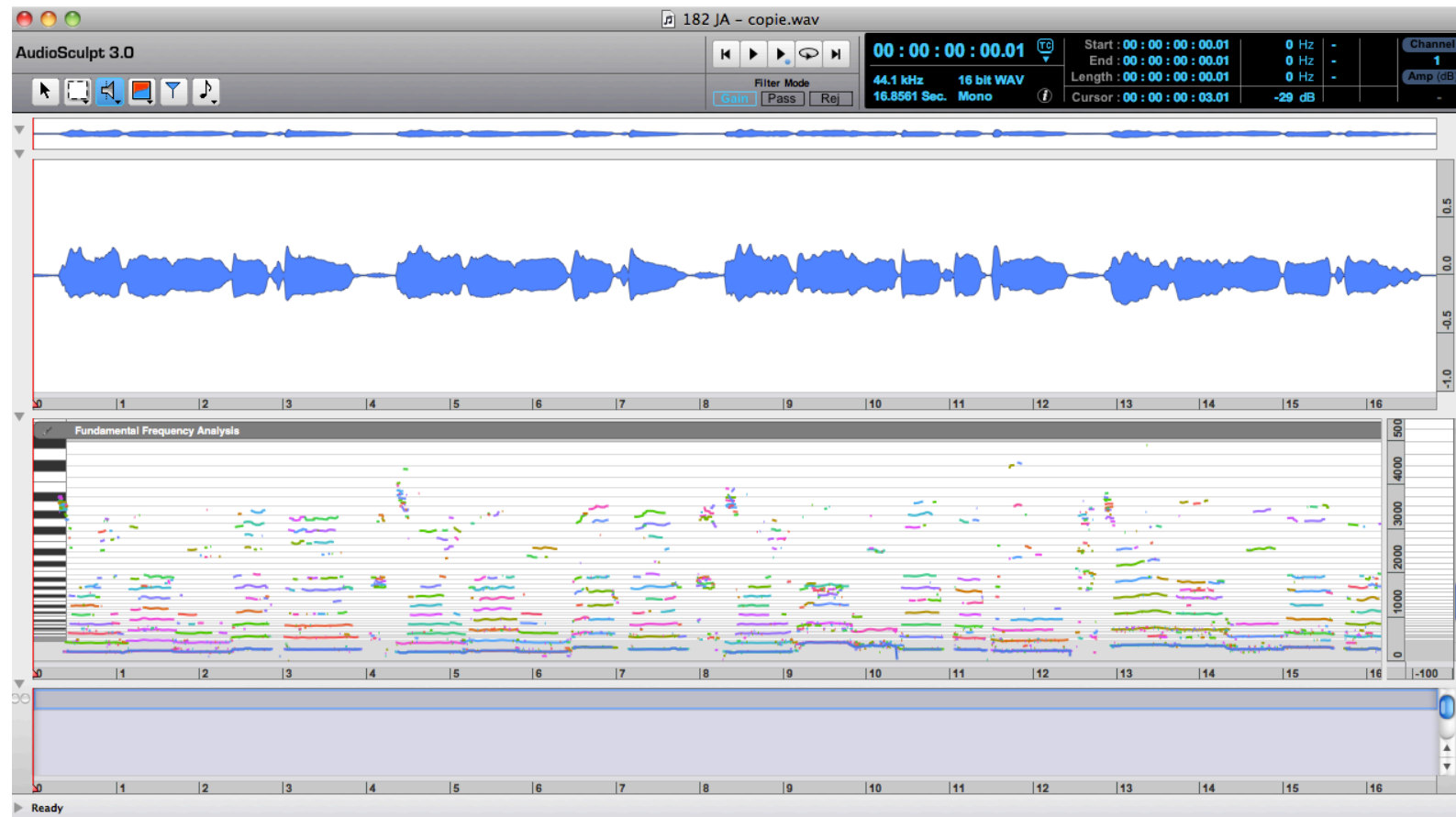
□ Instructions:

- Sing 2 glissandi then “Joyeux Anniversaire” (calmly)
- For singers, sing a self-chosen melody then JA in stage-like conditions
- Therefore one Technique-less (TL) condition and one With-technique (WT)

II. Study 2 : “Vocal technique”

Acoustical analysis: AudioSculpt

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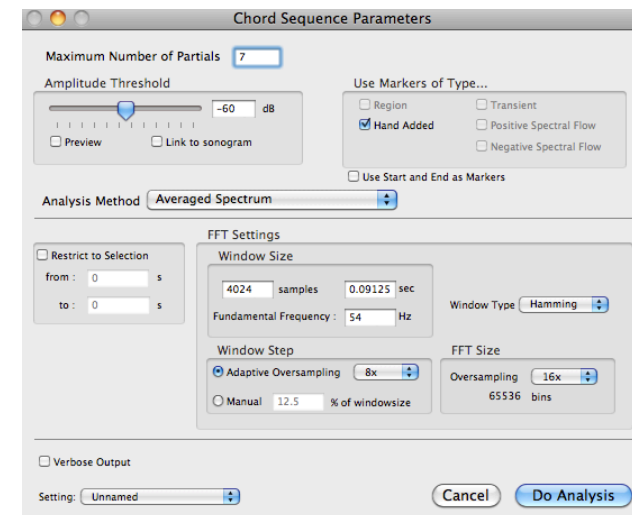
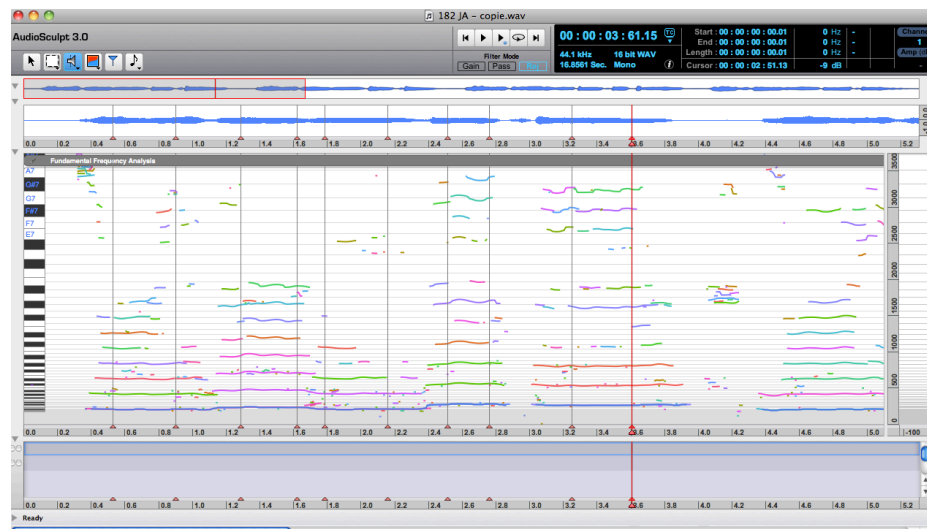
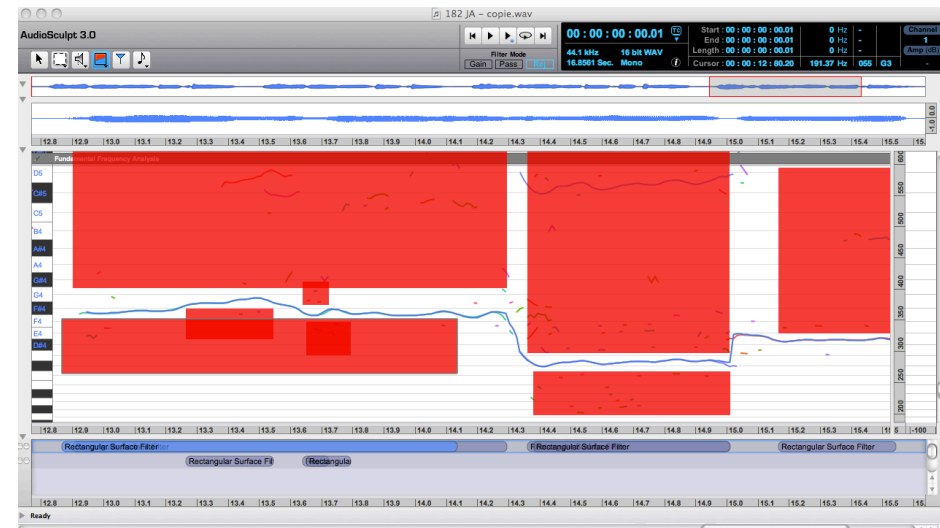


II. Study 2 : “Vocal technique”

Acoustical analysis: AudioSculpt

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Filtering, marking and analyzing...

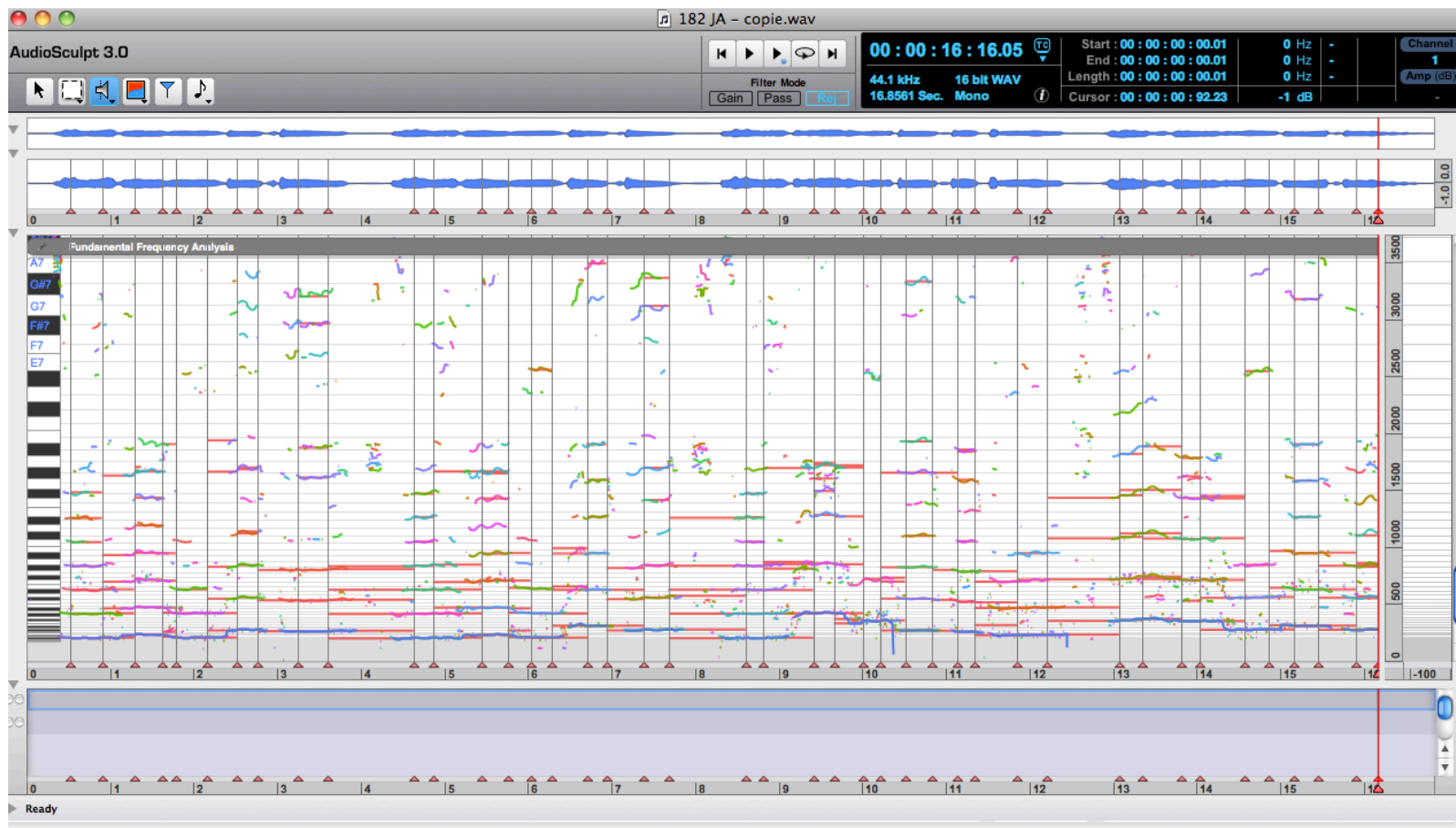


II. Study 2 : “Vocal technique”

Acoustical analysis: AudioSculpt

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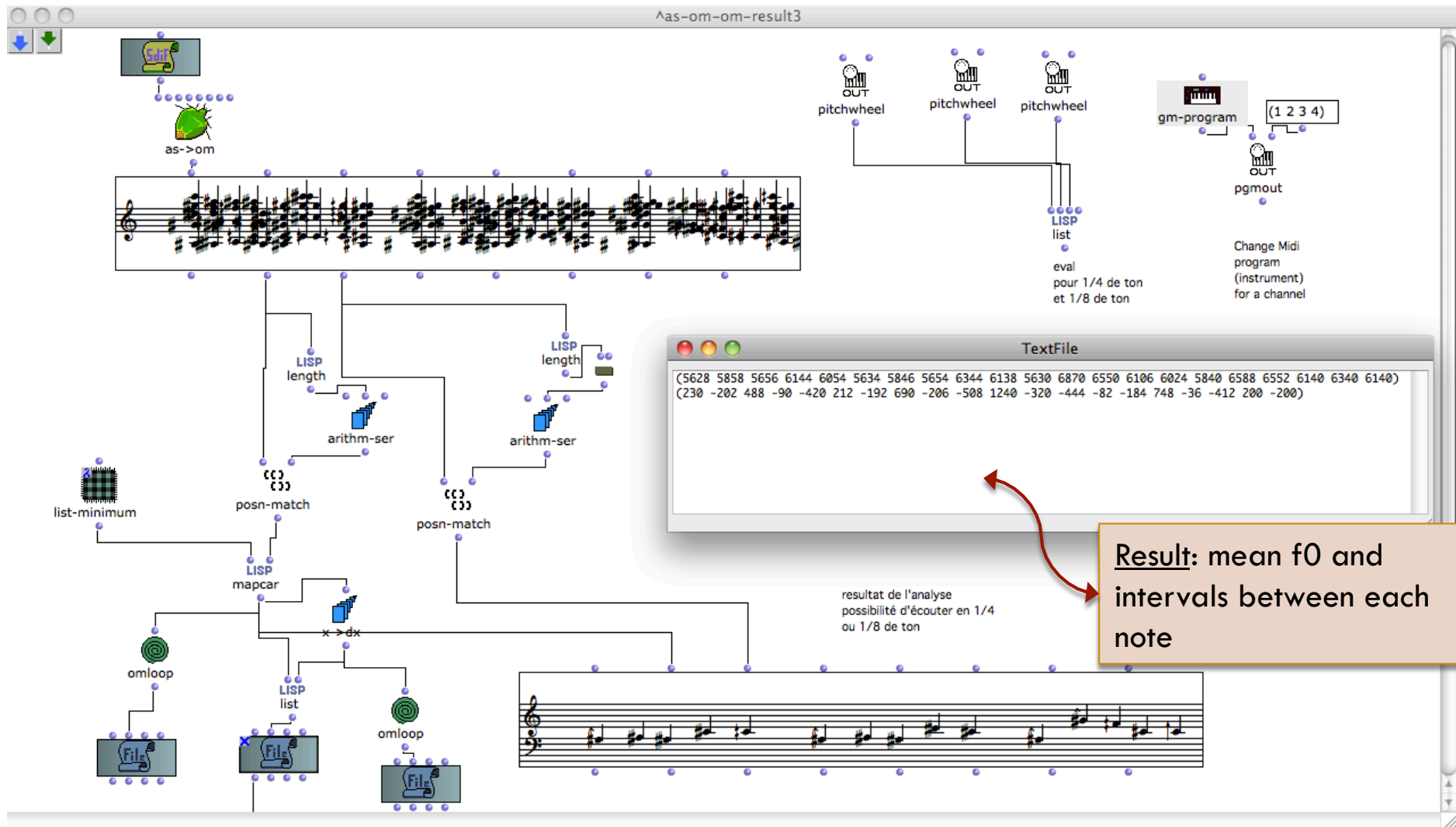
Final visualisation of the melody



II. Study 2 : "Vocal technique"

Acoustical analysis: AudioSculpt

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II. Study 2 : « Vocal technique »

Results

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- For each group:
 - ▣ Non-singers: correlation tempo – accuracy
($r=.321$, $p=.01$), **the slower the more accurate**
 - ▣ TL singers: correlation pitch – accuracy
($r=.640$, $p=.014$), **the higher the less accurate**
 - ▣ WI singers: correlation tempo – accuracy
($r=-.662$, $p=.01$), **the faster the less accurate**
- Differences between groups in
 - ▣ Tempo ($F(2,88)=16,61$, $p<.001$)
 - ▣ Pitch ($F(2,88)=165,63$, $p<.001$)

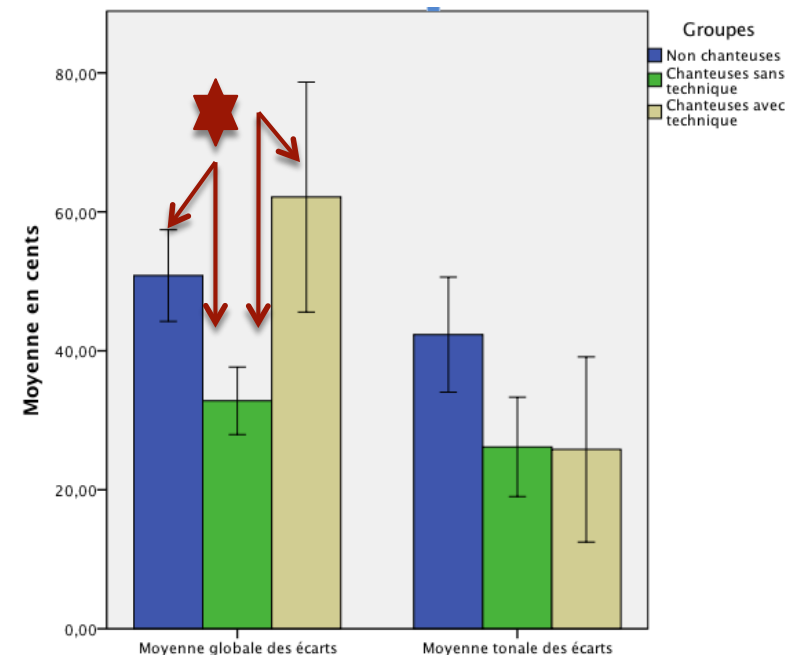
NB: Correlation tempo / pitch for the whole sample set ($r=-.267$, $p=.011$)

II. Study 2 : “Vocal technique”

Results

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- No difference between groups in mean **tonal** errors
- Difference between groups in mean **global** errors:
 - Non-singers < TL singers:
Effect of **expertise** on accuracy
 - WT singers < TL singers:
Effect of lyrical **vocal technique**
 - No difference between:
Non-singers – WT singers



II. Study 2 : “Vocal technique”

Discussion and perspectives

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- Correlations “Tempo / Accuracy” thus better control of tempo required

- Big surprise: singers with technique are utterly out of tune!
 - Difficult to effectively analyze this vocal technique
 - Use of resonators
 - Large harmonic content
 - Missing or masked fundamental in some cases
 - Vibrato: no regularity in F0
 - Software tools unadapted to voice analysis when lyrical technique is involved

II. Study 3 : “Corpus JA”

Aims and method

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□ Aims:

- Creation of database “Joyeux Anniversaire”
- Prevalence of an accuracy problem
- Profiles for “good” and “bad” singers
- Comparison of different analysis methods

□ Method:

- Participants: 166 non-singers, 14 to 76 years old (m: 29,93)
 - 57 men, 14 to 76 years old (m: 32,4)
 - 109 women, 15 to 75 years old (m: 28,6)
- Gathering of objective and subjective data

II. Study 3 : “Corpus JA”

Objective and subjective data

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- Objective data:
 - ▣ About glissandi and JA
 - ▣ Same analysis process as for Study 2
- Subjective data:
 - ▣ Biographical questionnaire: personal information, estimated musical training
 - ▣ Subjective questionnaire: self-evaluation, information on voice (singing and spoken, self-assessment thereof) movement, vocal abilities, notion of accuracy...
 - ▣ Evaluation of sample recordings by 18 judges (voice experts, singers, composers, repeaters)

II. Study 3: “Corpus JA”

Results

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- Data gathering OK
- Acoustical analyses OK
- Result formatting OK
 - ▣ Interval between each successive notes
 - ▣ Identification of contour errors and interval errors magnitude
 - ▣ Mean error in each performance
 - ▣ Estimation of tonal errors
- Experts evaluation OK
- Analyses in progress...

II. Study 4: “Impact of emotional state on the singing voice”

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- Theoretical context:
 - ▣ Emotional state yields physiological and psychological modifications (Langendörfer, Hodapp, Kreutz & Bongard, 2006)
 - ▣ Repercussions on voice (Harrigan, Wilson & Rosenthal, 2004), particularly on intensity and frequency variations
 - ▣ Thus **impact on accuracy**
- Aim: observing relationships between performance anxiety and singing production (and improving the production model)

II. Study 4: “Impact of emotional state on the singing voice”

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□ Method:

□ Participants:

- Students from Royal Conservatories of Belgium
- Non-singers yet able to read music and sing well enough

□ Material:

80 :

Voice

1 2 3 4 5 6 7
15 16 17

8 9 10 11 12 13 14
18

- one octave range
- same structure, tempo, key and intervals as JA

- Biographical, subjective, Spielberger and coping questionnaires
- Heart rate monitoring

II. Study 4: “Impact of emotional state on the singing voice”

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□ Procedure:

- Score learning in music theory courses
- 3-step recordings
 - 2 quiet situations
 - During the exam, in front of a jury
- Analysis of objective (heart rate, acoustic features) and subjective (perception of performance anxiety, coping strategies, self-evaluation, experts judgments) data

□ Hypotheses:

- Differences between the different phases
- If so, analysis of accuracy error type

□ Results: data gathering in progress

II. Four studies: Research problematic

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Accuracy in the singing voice

- ▣ Estimate a prevalence of accuracy trouble and observe different profiles (study 3)
 - Relevant criteria to analyze singing voice production (study 1)
 - Analysis tools for accuracy (study 2)
- ▣ Impact of emotional state on the accuracy in the singing voice (study 4)

III. Collaborations for those studies

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- ❑ Bachelors and Masters Students from **Université de Liège**
- ❑ Battery of singing accuracy evaluation: **S. Dalla Bella's lab**
- ❑ Collaboration with **CRFMW** (Centre de Recherche en Formation Musicale de Wallonie)
- ❑ **Royal Conservatories of Belgium**
- ❑ Collaboration with **Yohana Lévêque**, PhD Student with D. Schön and A. Giovanni (Study 3)
- ❑ **M. Schoentgen's lab** in ULB
- ❑ Seminars at **IRCAM**
- ❑ 3-month research residency at **BRAMS** 😊

Thank you !

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