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Effects of song familiarity, singing training and recent song exposure on the singing of melodies

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Motivation

- ‘Query by humming’ requires people to sing
- But, how well do people sing

- We do not know that well!

  Lack of knowledge on

  - singing skills of the general public
  - long-term memory issues
  - how that all relates to the singing by ‘professionals’ and
  - real-world song material (everyday singing)

- How can knowledge on singing be used in ‘query by humming’ applications?

What do we know?

Memory for melodies

- What properties are essential for a melody?
- Almost always essential are:
  - rhythm
  - intervals
  - contour
- But, you can change
  - key
  - tempo
  - timbre
  - loudness

  without changing the melody

What do we know?
Memory for melodies

- Rhythm is essential

  (Marilyn Boltz, Mari Riess Jones, Edward Large, Carolyn Drake)
  - Listeners attend rhythmically to music
  - Just tapping the rhythm can be sufficient to recognise well-known melodies
  - Melodies under a different rhythm are hard to recognise
  - Melodies with complex rhythms are hard to remember

What do we know?

Memory for melodies

- Contour and intervals are essential
  (W. Jay Dowling, Dane Harwood, Judy Edworthy, Wouter Croonen)
  - The contour is the first thing you learn about a new melody
  - Melodies with the same contour get easily confused
  - For cueing long-term memory, intervals are required

- Only with
  - increasing song familiarity
  - increasing cognitive abilities (child ➔adult)
  - musical training

  intervals become more important

What do we know?

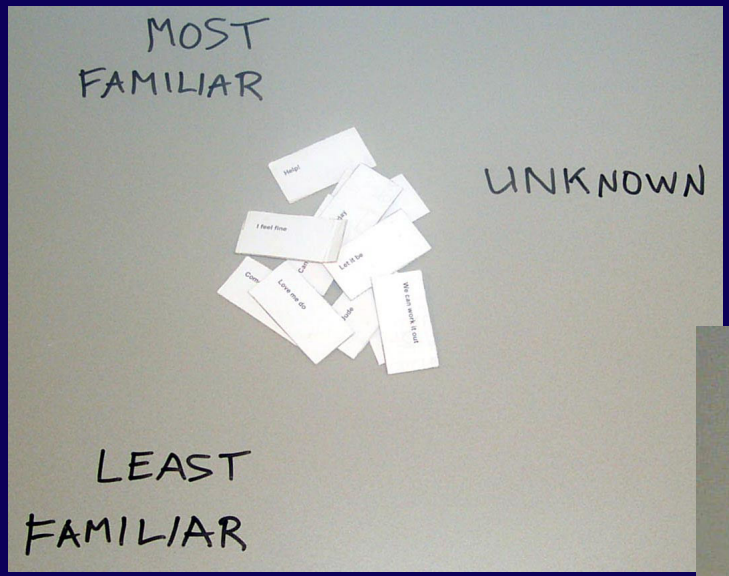
Singing melodies

- Singing refers to articulating a recalled melody

- Voice is the most difficult musical instrument
  (Lee Davidson, Daniel Levitin, Perry Cook, Johan Sundberg)
  - Delicate control of muscles with auditory feedback
  - Untrained singers tend to
    - use only a contour to control their singing
    - sing large intervals flat
    - accumulate interval errors (ending in a different key)
    - be unable to reflect on and improve their singing
  - However, some people can sing their favourite song at the correct pitch and at the correct tempo

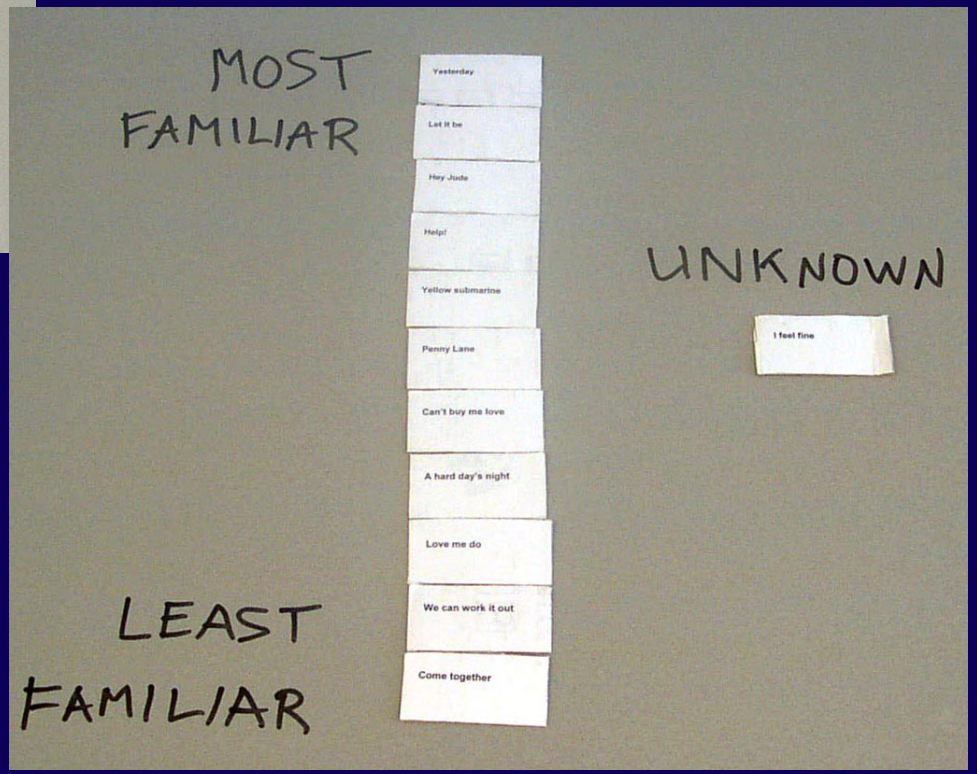
Experiment

- Study of
  - singing familiar and less familiar songs of ‘the Beatles’
  - being a trained singer or an untrained singer
  - singing from memory and after listening to the song on CD
    (trial 1 and 2: singing from memory; trial 3: singing after listening)
- Participants
  - Trained singers: 8 students ‘Classical voice’ and ‘Musical theatre’ from Tilburg school of music
  - Untrained singers: 10 colleagues without any singing education
- Material
  - 12 songs, ‘The Beatles’, ‘1’ , EMI, 2000



Sort the 12 cards with Beatles song titles

Sing 2 (most) familiar songs and 2 less (least) familiar songs twice from memory



Sing the songs once more after listening to the song on CD

Experiment
Measures

- Singing measured by
  - Tuning (‘starting at the correct pitch?’)
  - Contour (‘following the ups and downs?’)
  - Intervals (‘singing the correct tone distances?’)
  - Tempo (‘singing at the correct tempo?’)

Using reference melodies and tempo measurements of the original songs on CD

All reproductions were manually segmented

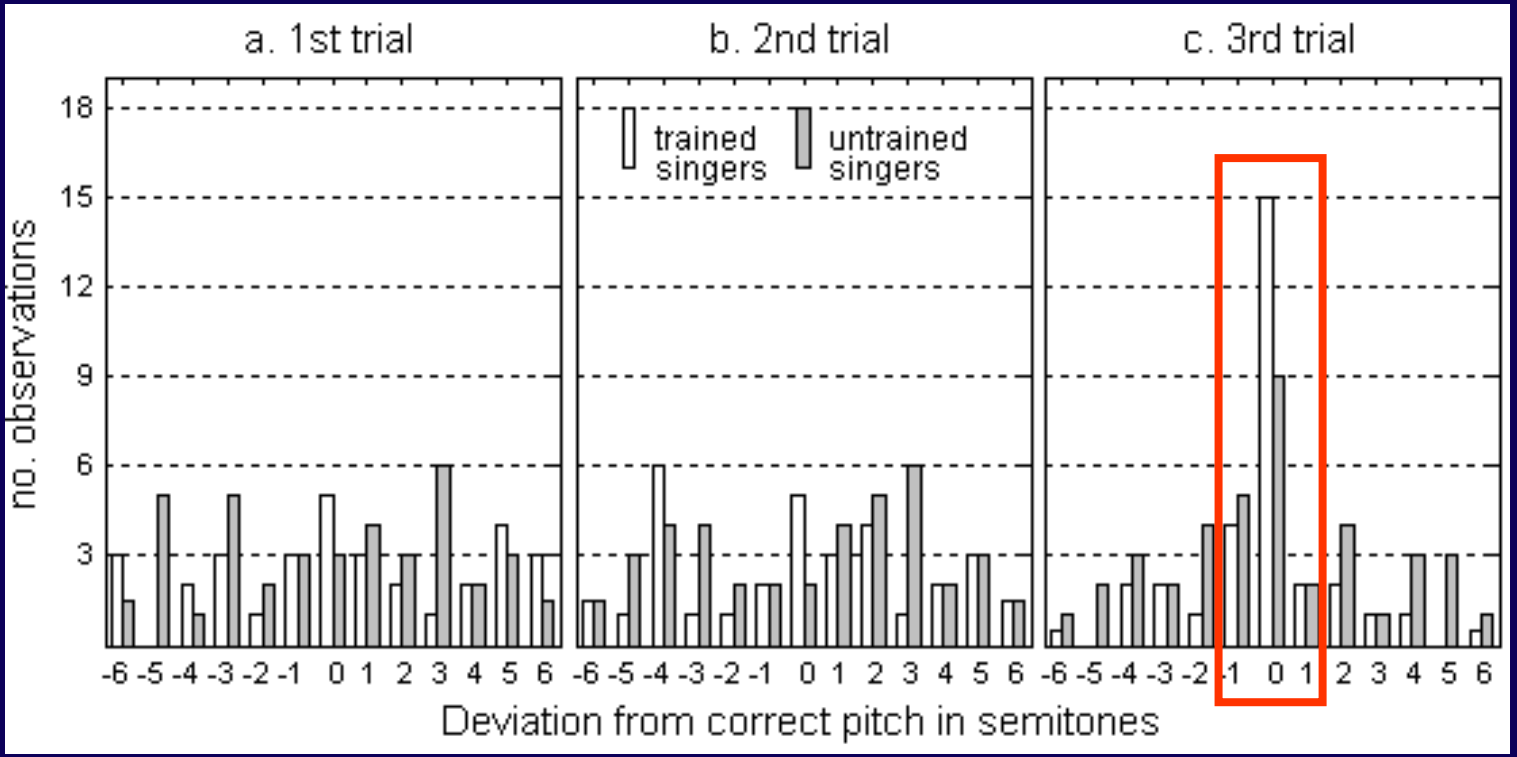
Experiment
Results: general

- 216 (18*4*3) reproductions of 12 Beatles songs
- Trained singers sang more notes (45) than untrained singers did (28)
- For familiar songs
  - 36 notes were sung (min: 12, max: 94)
- For less familiar songs
  - 19 notes were sung (min: 3, max: 65)

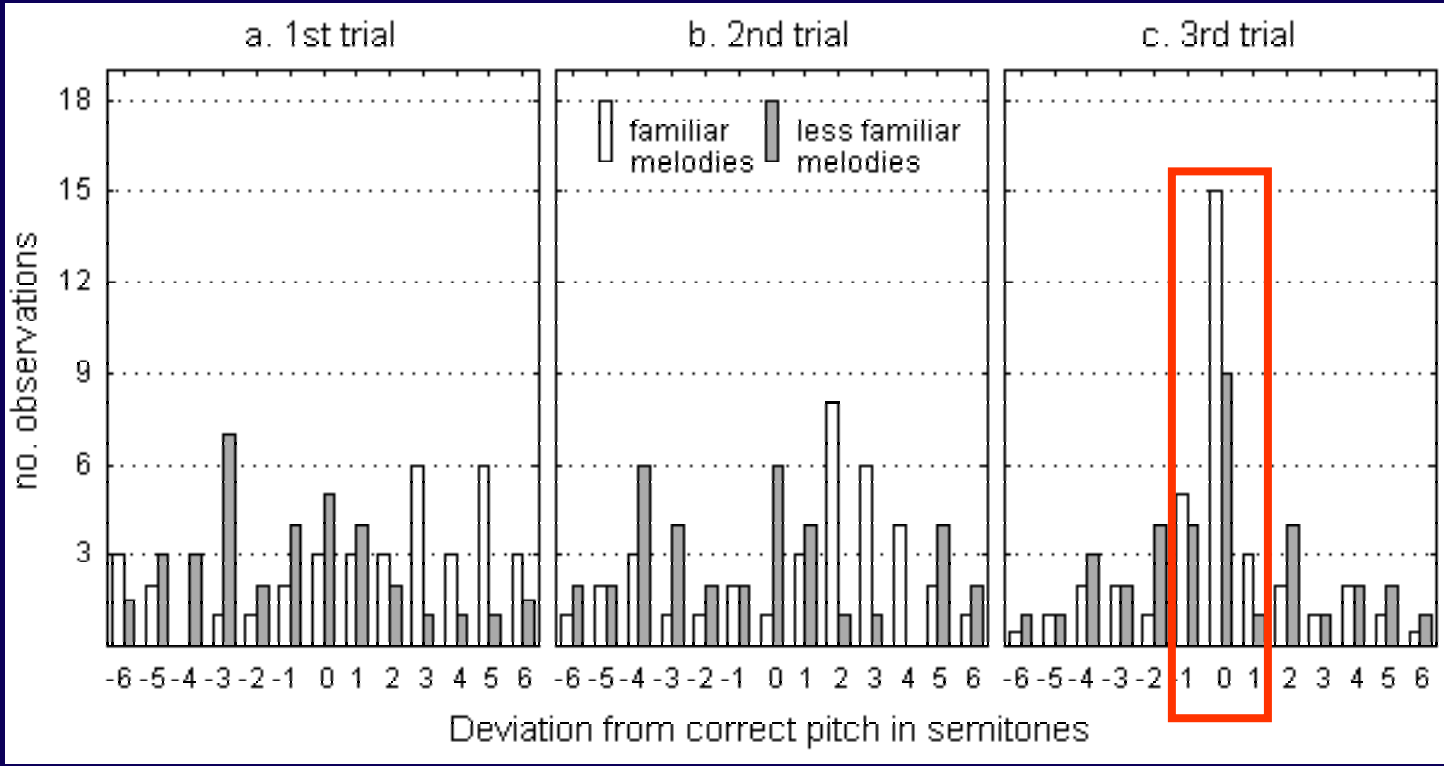
Experiment
Results: tuning

- Measure: deviation from the correct tone in semitones
- When singing from memory
  - participants chose randomly a pitch to start with
  - no absolute memory for the correct pitch
- After listening
  - trained singers (15/32) were better in adopting the correct pitch than untrained singers (9/32)
  - familiar songs (15/36) were better pitched than less familiar ones (9/36)

Experiment
Results: tuning



Experiment
Results: tuning



Experiment
Results: contour

- Measure: percentage correctly going ‘up’ or ‘down’
- In general
  - trained and untrained singers performed equally well (80%)
  - contours of familiar (82%) and less familiar songs (78%) were sung equally well
- After listening
  - contours of less familiar songs improved (75% ➔ 82 %)

Experiment
Results: interval

- Measure: percentage correctly sung intervals
- In general
  - trained singers (62%) sang more correct intervals than untrained singers (56%) did
  - familiar songs (63%) were better sung than less familiar ones (55%)
- After listening
  - the singing of less familiar songs improved (53% ➔61%)
  - the singing of familiar songs did not

Experiment
Results: tempo

- Measure: average beats per minute sung, correlated and compared with actual tempo on CD

- In general
  - trained and untrained singers performed equally well ($r > 0.9$)
  - tempo of familiar songs came close to actual tempo ($r > 0.9$)
  - tempo of less familiar songs came *not* that close to actual tempo ($0.8 < r < 0.9$)

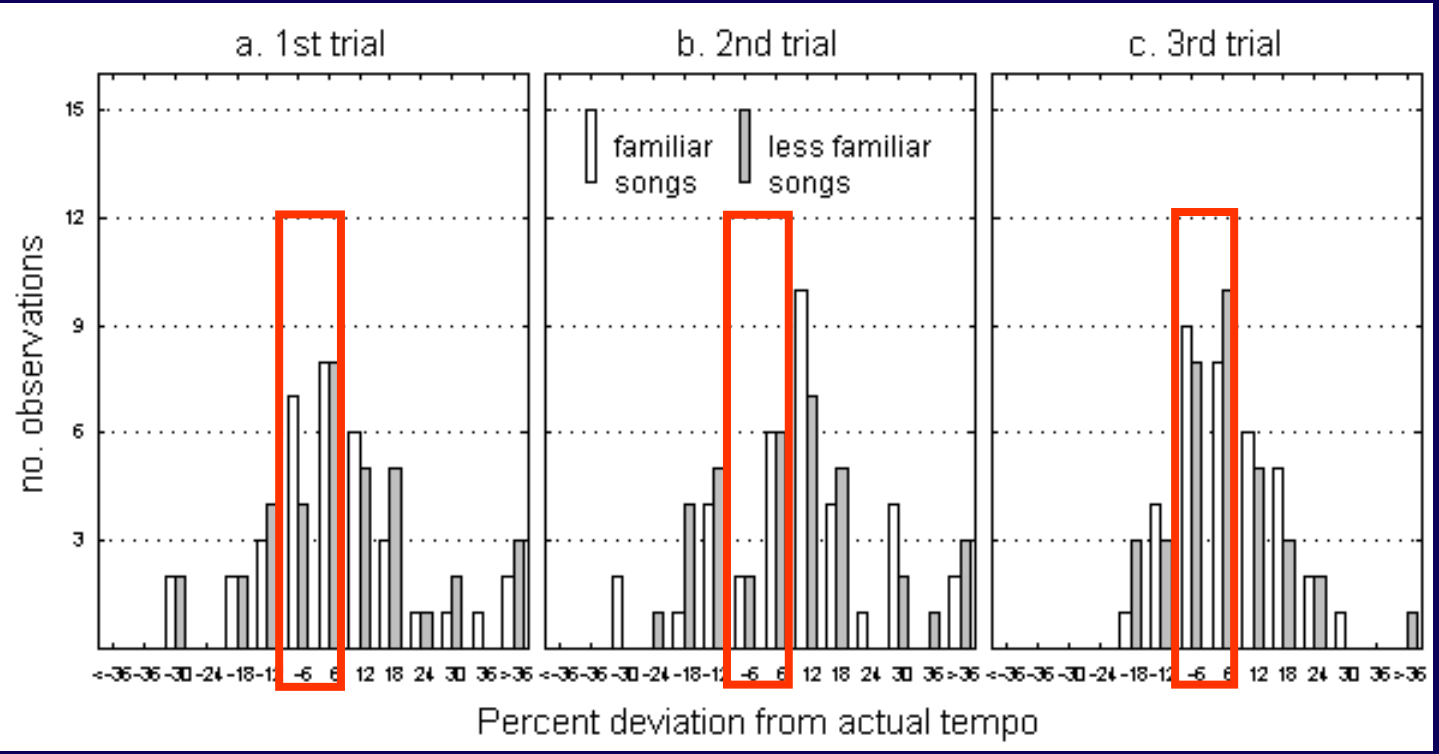
- After listening
  - matching the actual tempo improved

Experiment
Results: tempo

- People cannot perceptually discriminate tempi that differ less than 6% (JND = 6%)
  - A tempo of 100 bpm is perceived similar to all tempi in the range of 94-106 bpm

- Taking this finding into account
  - 30% of reproductions had the 'correct' tempo, when singing from memory
    - Evidence for latent absolute memory for tempo
  - 49% of reproductions had the 'correct' tempo, after listening

Experiment
Results: tempo



Experiment
Discussion

- Study did not assess
  - the beauty and the willingness of singing
  - song complexity
  - music idiomatic differences

- It did assess singing performance while varying
  - singing training (trained and untrained singers)
  - song familiarity (familiar and less familiar songs)
  - recent exposure (singing from memory and after CD listening)

Experiment
Discussion

- No absolute memory for pitch; trained singers adopted the correct pitch only after listening to the song
- Some latent absolute memory for tempo: 1 out of 3
- Trained and untrained singers did not differ on contour (80%), they did on interval (62-56%)
- Except for contour, familiar songs were better sung than less familiar ones, but less familiar ones improved after listening to them
- Both trained and untrained singers improved their singing after listening to the song

Conclusion

Implications for ‘query by humming’

- Query by humming
  - Melody retrieval by search algorithms
  - Finding optimal alignment between pitches and durations of sung melody with melodies in database while taking into account singing errors

Conclusion

Implications for ‘query by humming’

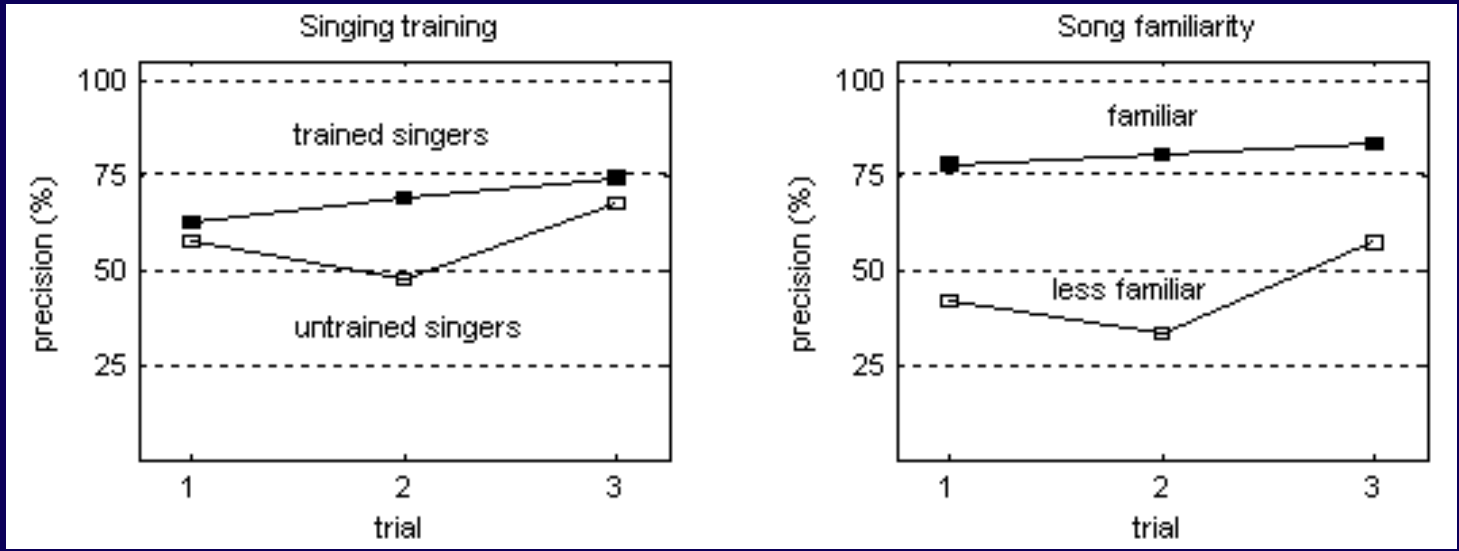
- Users choose a random pitch to start
- Users sing contour and tempo most reliably
- Users sing intervals less precisely

- Singing performance differ on song familiarity, singing training and recent exposure, retrieval performance likewise

- Important user data for accurate retrieval
  - How familiar are you with the song?
  - When was the last time you listened to the song?
  - What is your singing ability (training)?
- and change search accordingly

Conclusion

Implications for ‘query by humming’



Retrieval performance statistics of ‘CubyHum’ QBH system on singing data using 1000-melody database (melody ~ 300 notes)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