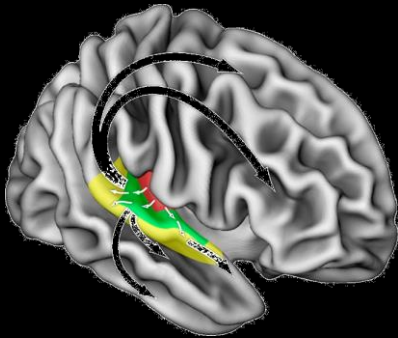


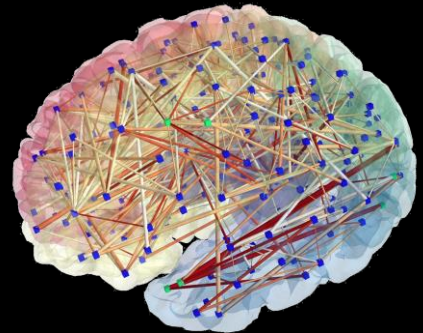


The Benefits of Singing in a Choir



Zatorre & Salimpoor (2013)

Professor Graham F Welch
UCL Institute of Education, London



Loui (2013)

What are the benefits of singing? Some examples

❖ Physical benefits

- ❖ Respiratory (aerobic)
- ❖ Cardiac
- ❖ Immune
- ❖ Neurological
 - Development
 - Integration

❖ Psychological benefits

- ❖ Intra-personal communication
- ❖ Catharsis
- ❖ Inter-personal communication



❖ Musical benefits

- ❖ Understanding of music, e.g., structure, phrasing
- ❖ The development of musical memory
- ❖ Increased expertise in vocal tone colouring, pitch, rhythm and loudness
- ❖ Creation of a musical repertoire

❖ Educational benefits

- ❖ Increasing knowledge, understanding and skills about the world around us
- ❖ Impact on other aspects of intellectual development, such as literacy

• Social benefits

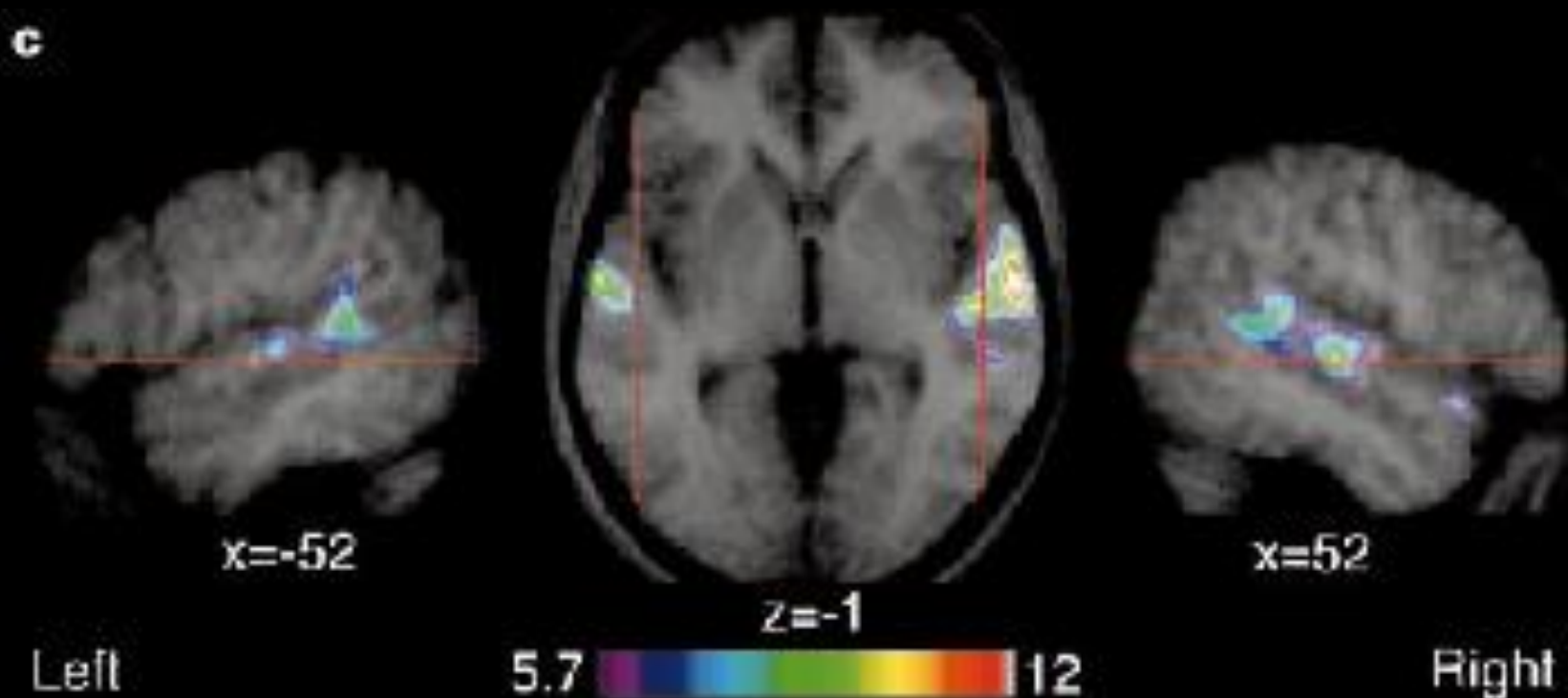
- ❖ Group membership
- ❖ Communication
- ❖ Sense of community
- ❖ Social integration

Neuropsychobiological aspects: Brain Architecture and Singing



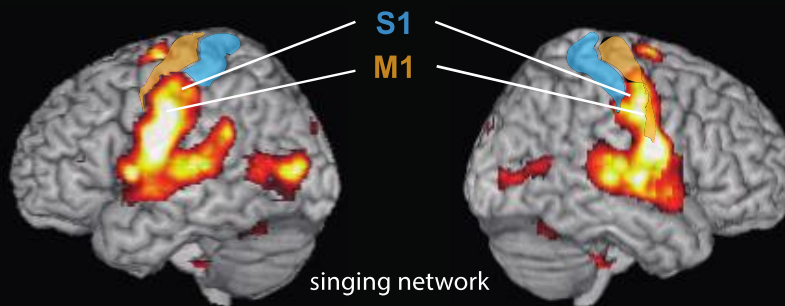
The brain has an integrated neurological modularity

For example – these parts of the brain are involved in the analyses of human voices

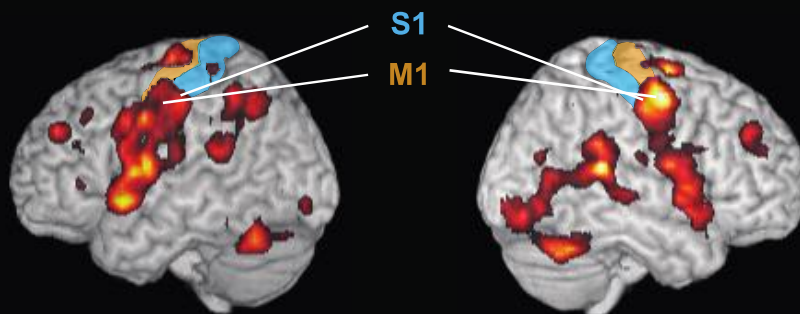


Belin *et al* (2000) Voice-selective areas in the human auditory cortex. *Nature*. 403: 309-312.

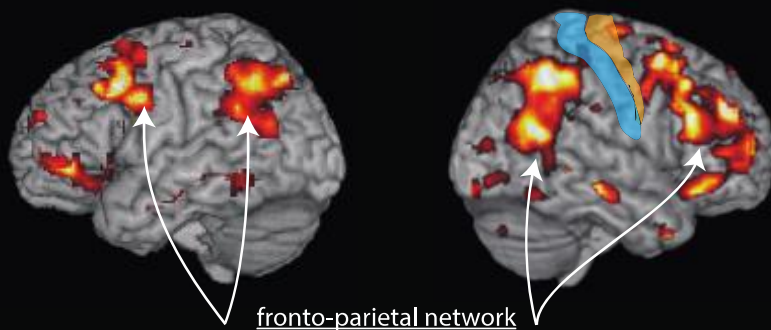
A: Overt singing only



B: Imagined singing only



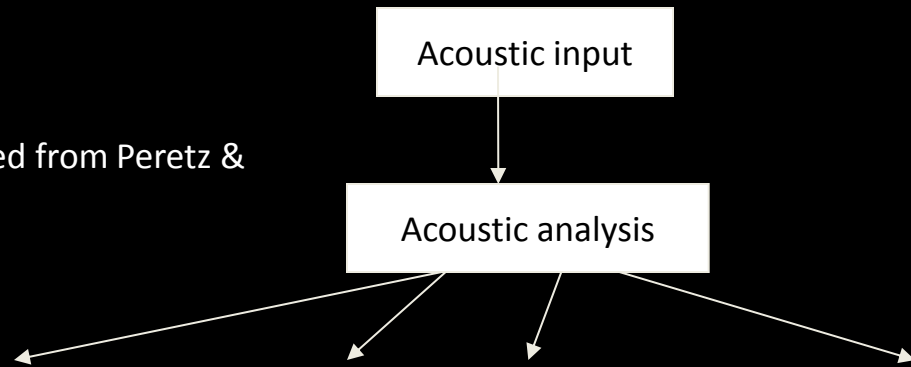
C: Imagined more than overt singing



(Kleber & Zarate, 2014
Singing students & professionals)

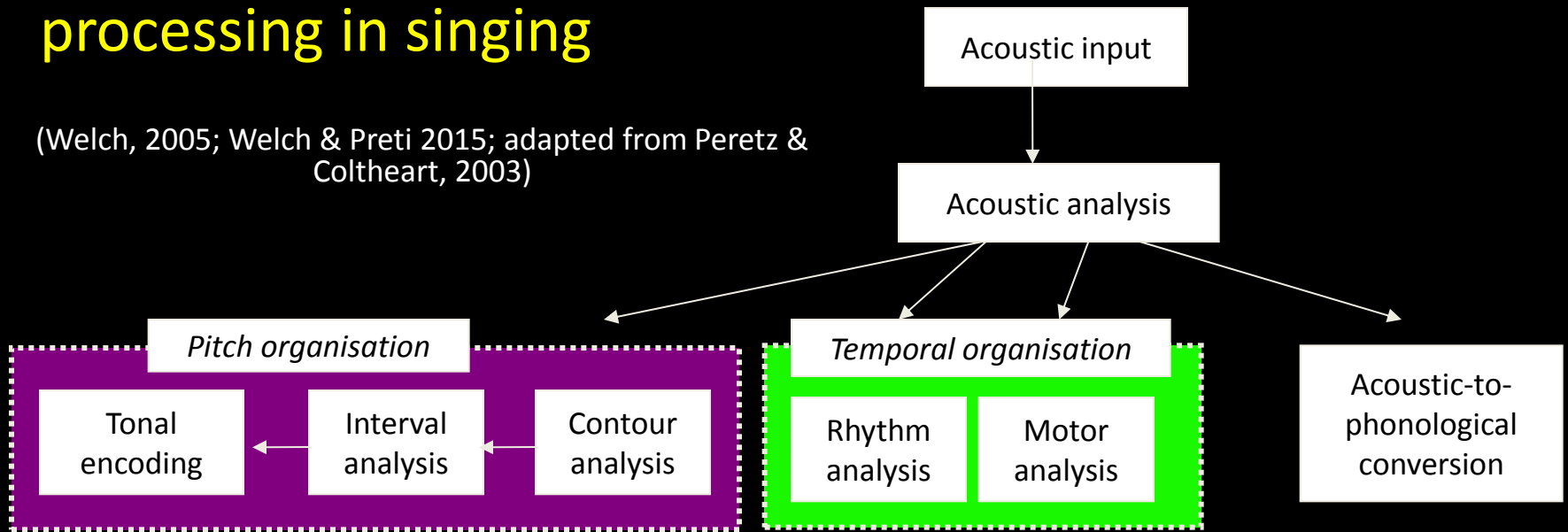
A modular model of music processing in singing

(Welch, 2005; Welch & Preti 2015; adapted from Peretz & Coltheart, 2003)



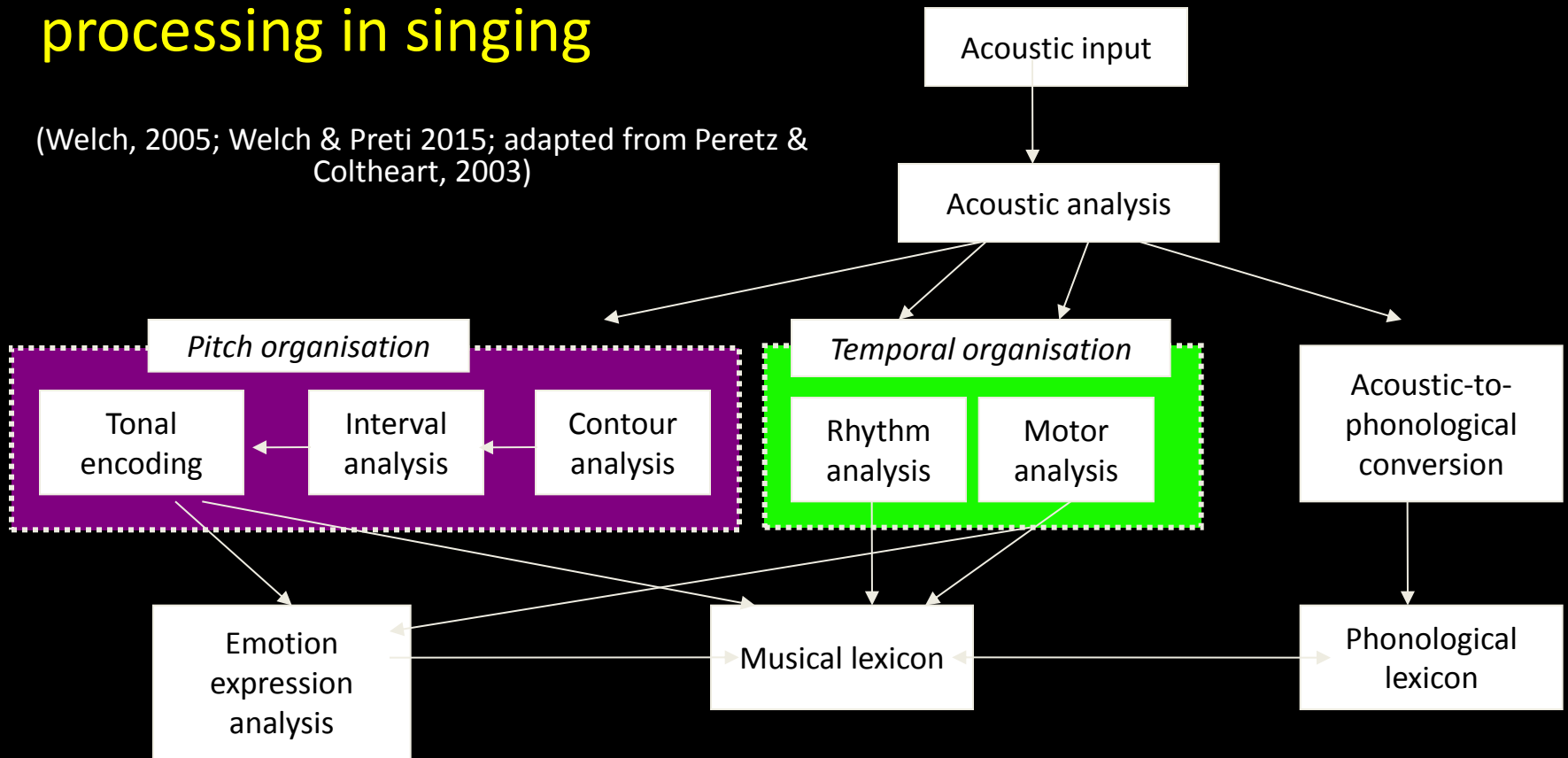
A modular model of music processing in singing

(Welch, 2005; Welch & Preti 2015; adapted from Peretz & Coltheart, 2003)



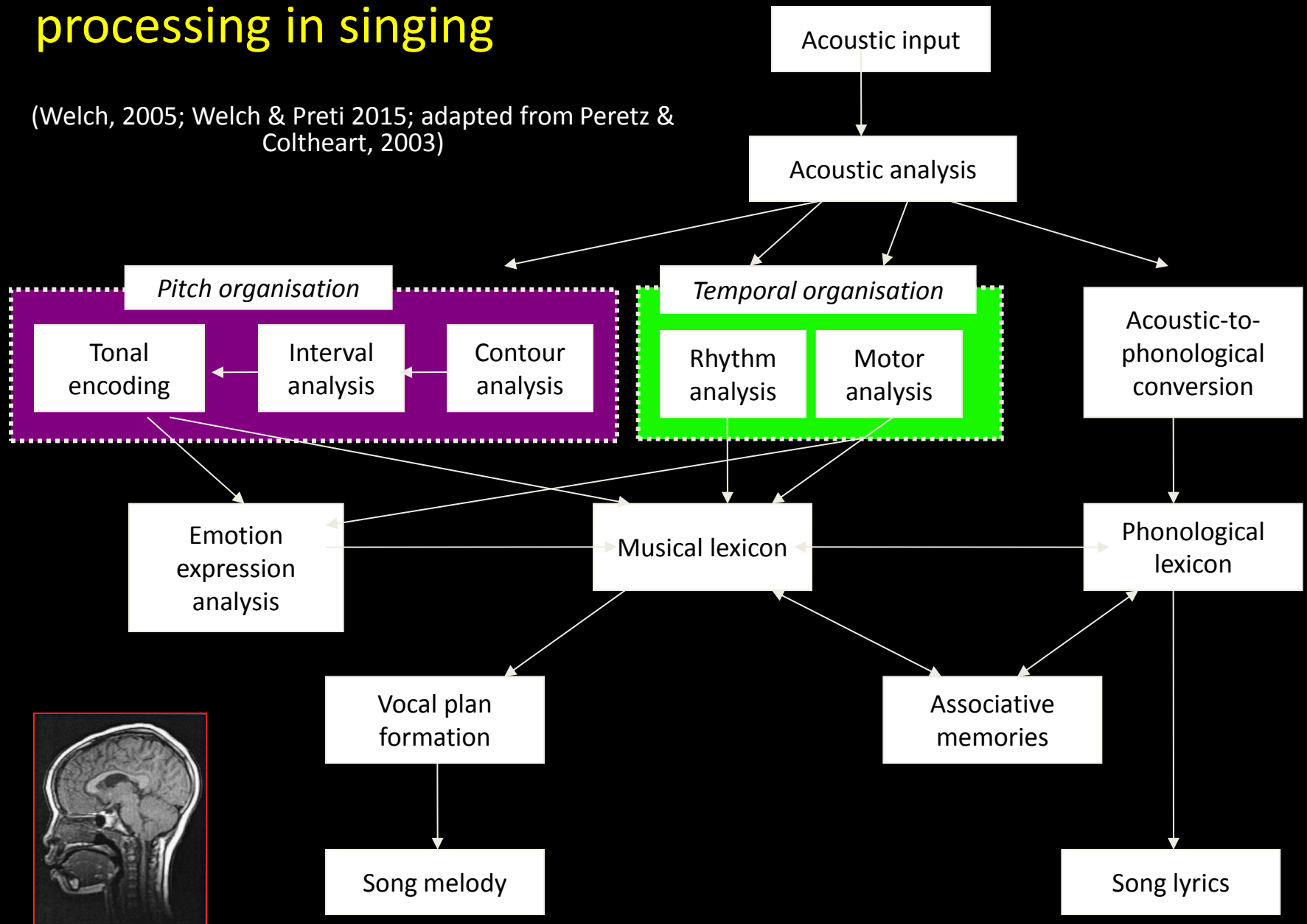
A modular model of music processing in singing

(Welch, 2005; Welch & Preti 2015; adapted from Peretz & Coltheart, 2003)

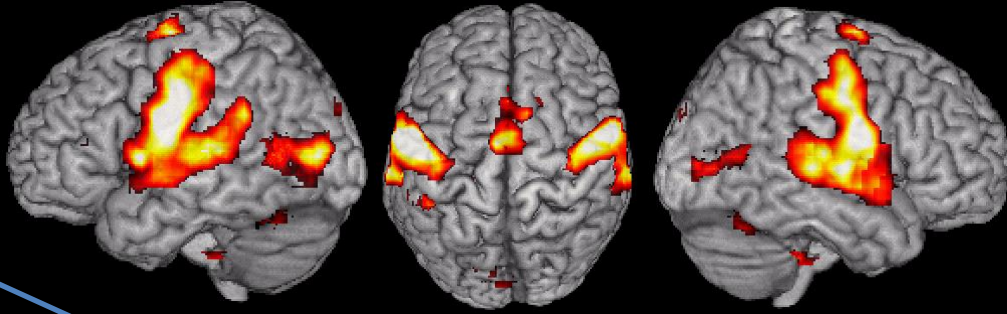


A modular model of music processing in singing

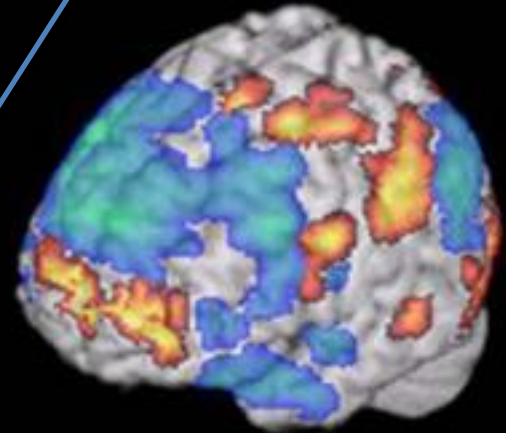
(Welch, 2005; Welch & Preti 2015; adapted from Peretz & Coltheart, 2003)



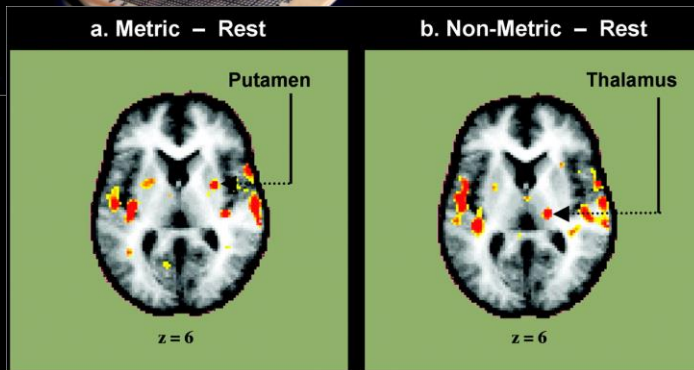
An integrated neurological modularity: music and dance



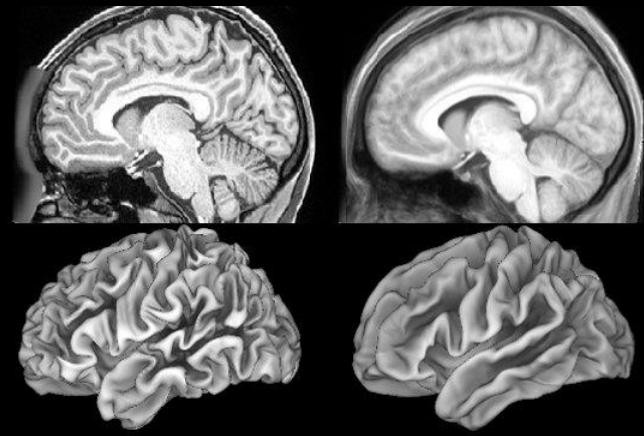
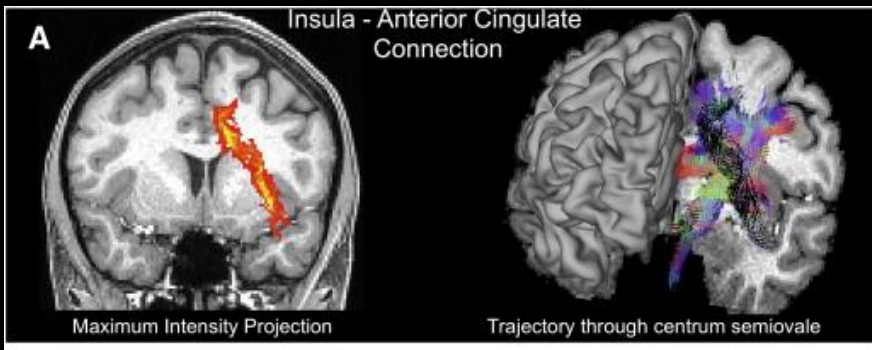
Singing (Kleber et al, 2007)



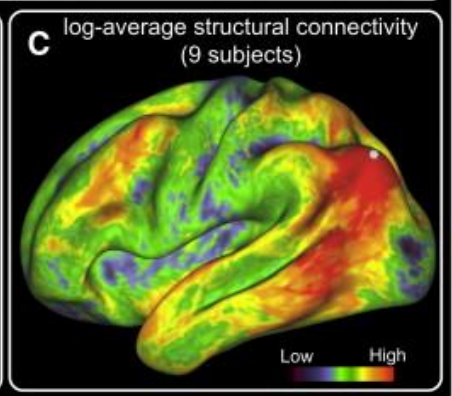
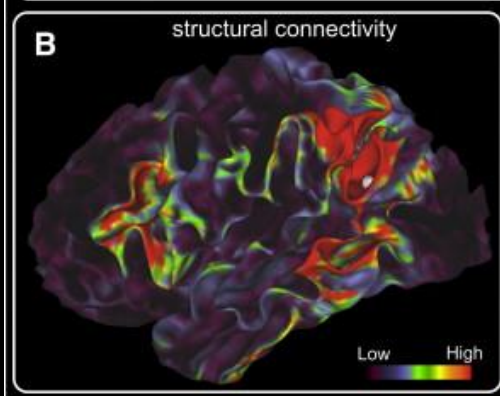
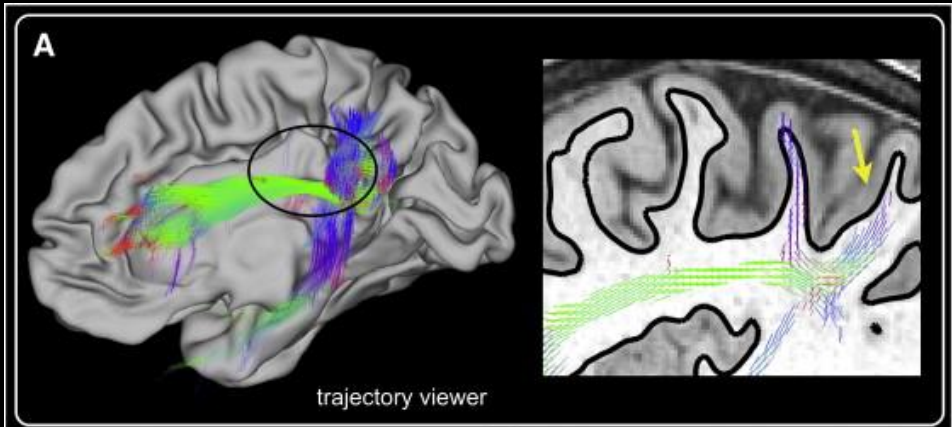
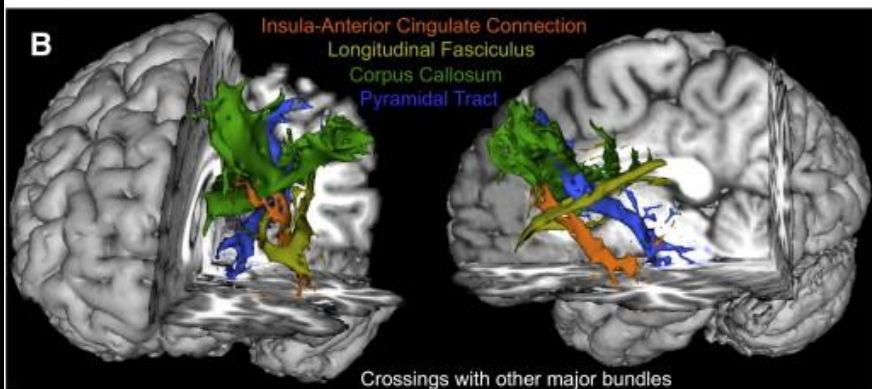
Improvisation during jazz (Limb & Braun, 2008)



Dance (tango) (Brown et al, 2006)



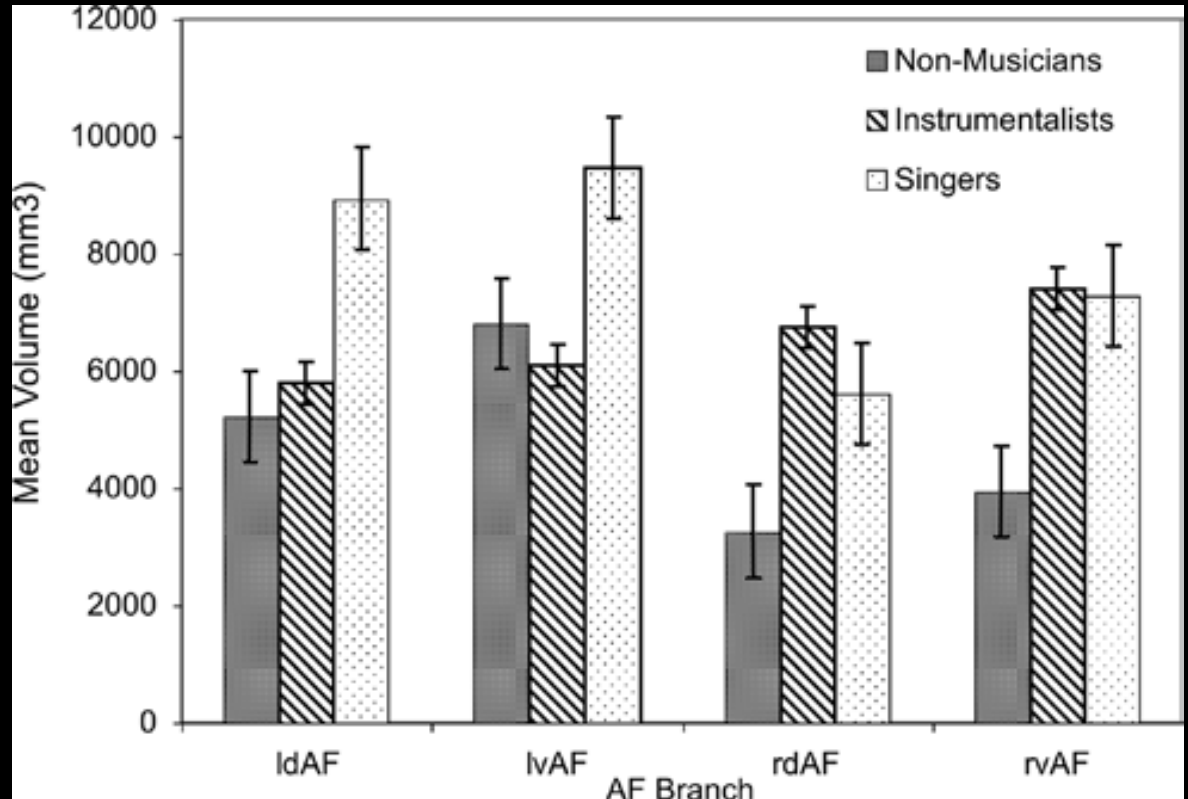
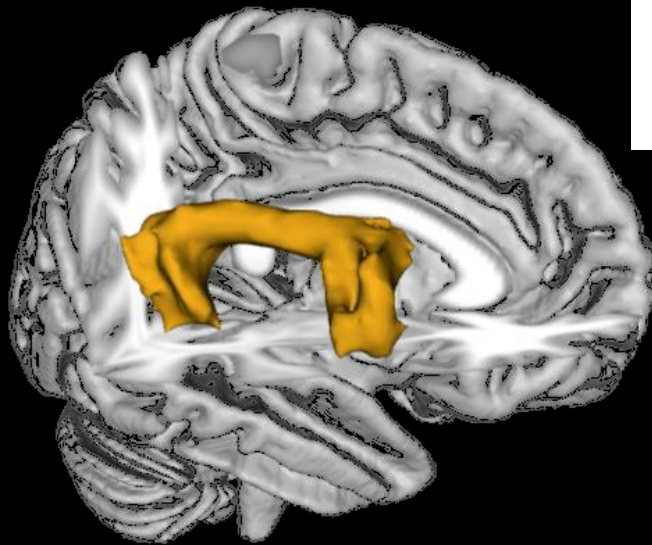
HCP



Recent advances in neuroimaging from the Human Connectome Project (2013)

Sotiropoulos *et al*, 2013 connectivity examples

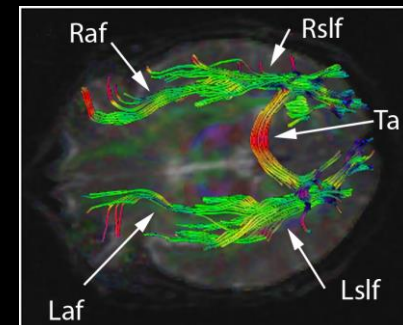
Modularity and use-dependent neuroplasticity: an example of the impact of music education



Arcuate Fasciculus (AF) volume in Singers (n = 11), Instrumentalists (n = 11), and Non-Musicians (n = 11) $p < .05$ (Bonf.)

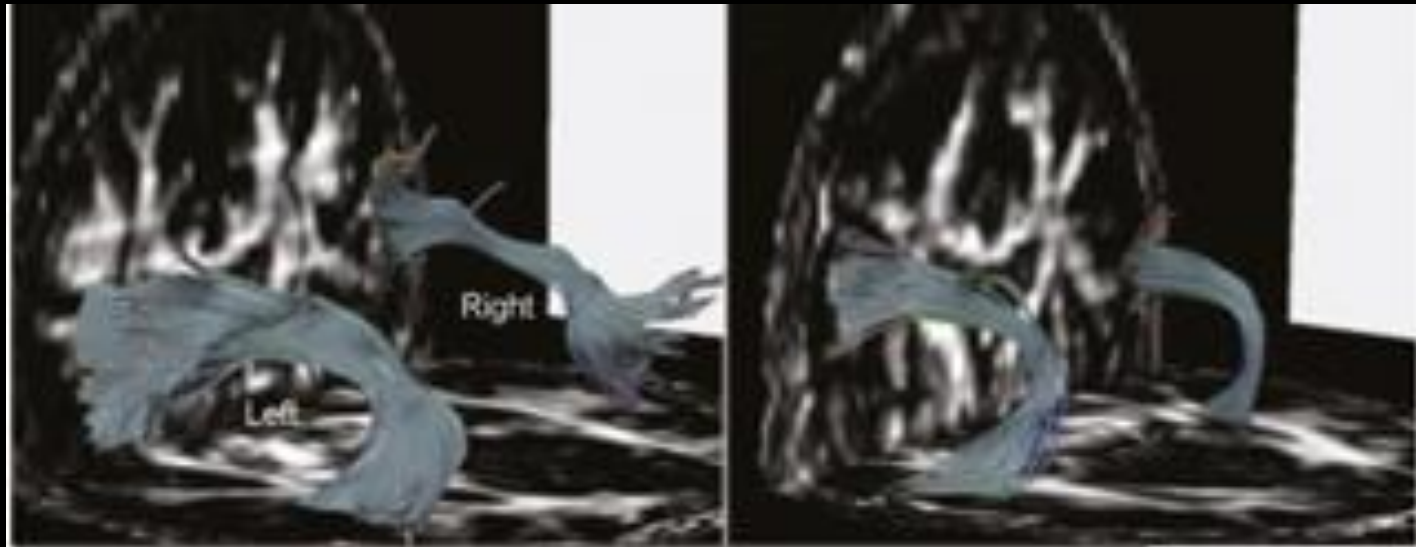
Halwani, Loui, Rüber, Schlaug (2011)
Frontiers in Psych.

AF region is implicated in normal short-term memory use for language and also RH vocal pitch processing (singing in tune vs 'tone deafness')



Filler (2009)

http://en.wikipedia.org/wiki/File:DTI_Brain_Tractographic_Image_A_panal.jpg



Images of the arcuate fasciculus, an auditory-motor tract, in each hemisphere of (left) a healthy musician and (right) a healthy non-musician, both in their 60s, demonstrating brain-enhancing benefits of lifelong music making

(Ford Thompson & Schlaug, 2015, p37 *Scientific American Mind*)



- The sequence above shows how, over time, melodic intonation therapy (MIT) built up connections between the hearing and speaking regions in a healthy right brain.
- The patient had suffered a massive stroke at age 11 that had destroyed her speech pathways in the left hemisphere.
- ‘Over time, with therapy, she learned to draw on undamaged brain regions that moderate the rhythmic and tonal aspects of language, bypassing the speech pathways on the left side of her brain that were destroyed. In other words, she found her way back to language through music.’

- 'When she began therapy in 2008, she could not string together more than two or three words, and her speech was often ungrammatical, leaving her frustrated whenever she tried to communicate.
- Her treatment plan was intensive—an hour and a half a day for up to five days a week, with 75 sessions in all.
- By the end of the 15-week treatment period, she could speak in sentences of five to eight words, sometimes more.
- Over the next several years she treated herself at home using the techniques she learned during the sessions.
- Today, eight years after her stroke, she spends some of her time as a motivational speaker, giving hope and support to fellow stroke survivors.'

Example of social processes and musical learning

Children

Age 6 at start

2 groups

(I) Studying a keyboard instrument (n=15)

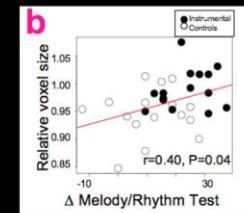
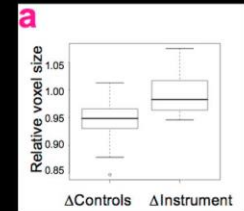
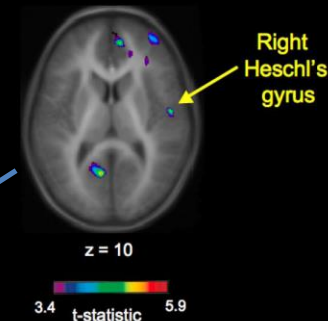
Weekly 30 minute lessons x 15 months

(C) Controls (n=16)

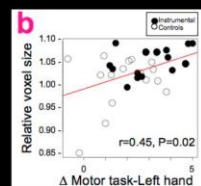
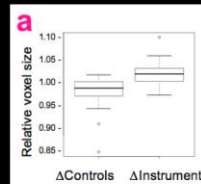
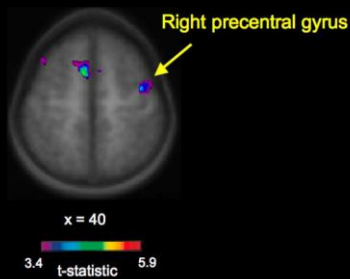
Weekly 40 minute music class

Evidence of longitudinal brain changes in three regional areas in keyboard group

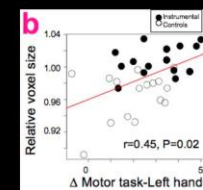
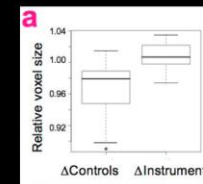
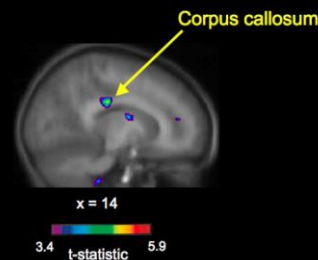
Primary auditory area (Instrument > Controls)



Primary motor area (Instrument > Controls)



Corpus callosum (Instrument > Controls)

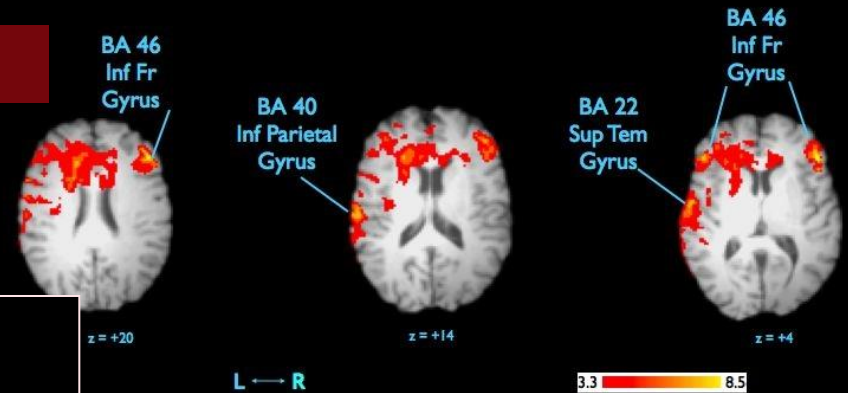


Impact of singing lessons on brain function after one year? Activity *changes* brain function

Prior to singing lessons

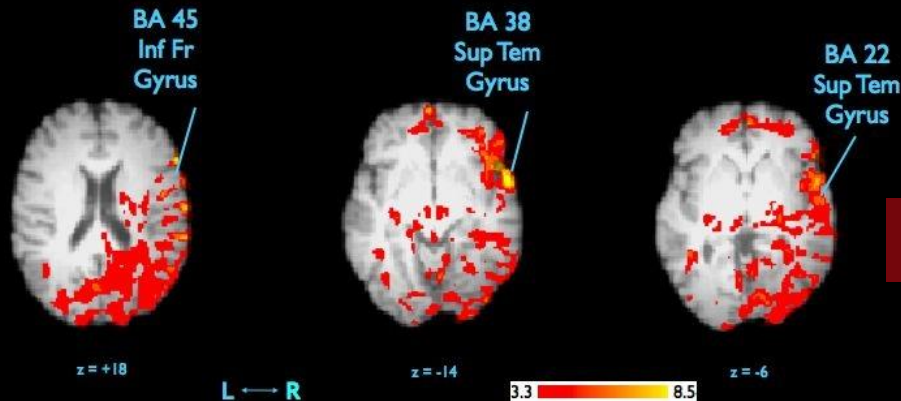
Functional Activity Decreases in non-Musical Adult
After 1 Year Singing Lessons/Practice
(Initial Singing Minus After Lessons/Practice)

Overall Combination of 12 Singing/Sightreading Tasks
(Involving Song, Pitch, Tone, Timbre, Dynamics, Rhythm)
fMRI (3 Tesla) ($p < 0.005$)



Functional Activity Increases in non-Musical Adult
After 1 Year Singing Lessons/Practice
(After Lessons Minus Initial Singing)

Overall Combination of 12 Singing/Sightreading Tasks
(Involving Song, Pitch, Tone, Timbre, Dynamics, Rhythm)
fMRI (3 Tesla) ($p < 0.005$)



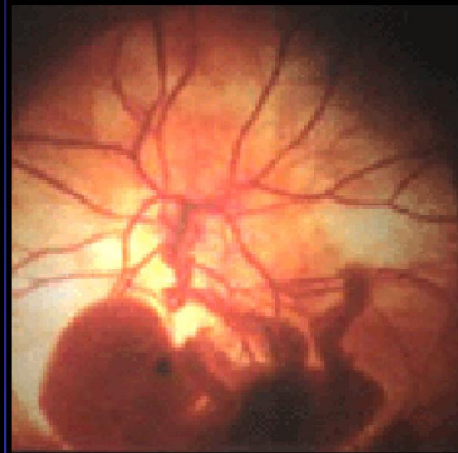
After one year of singing lessons

Singing development

Musical development begins pre-birth

Acoustic links

Prosodic and melodic features of mother's voice (speaking & singing) are perceived *in utero*



foetus

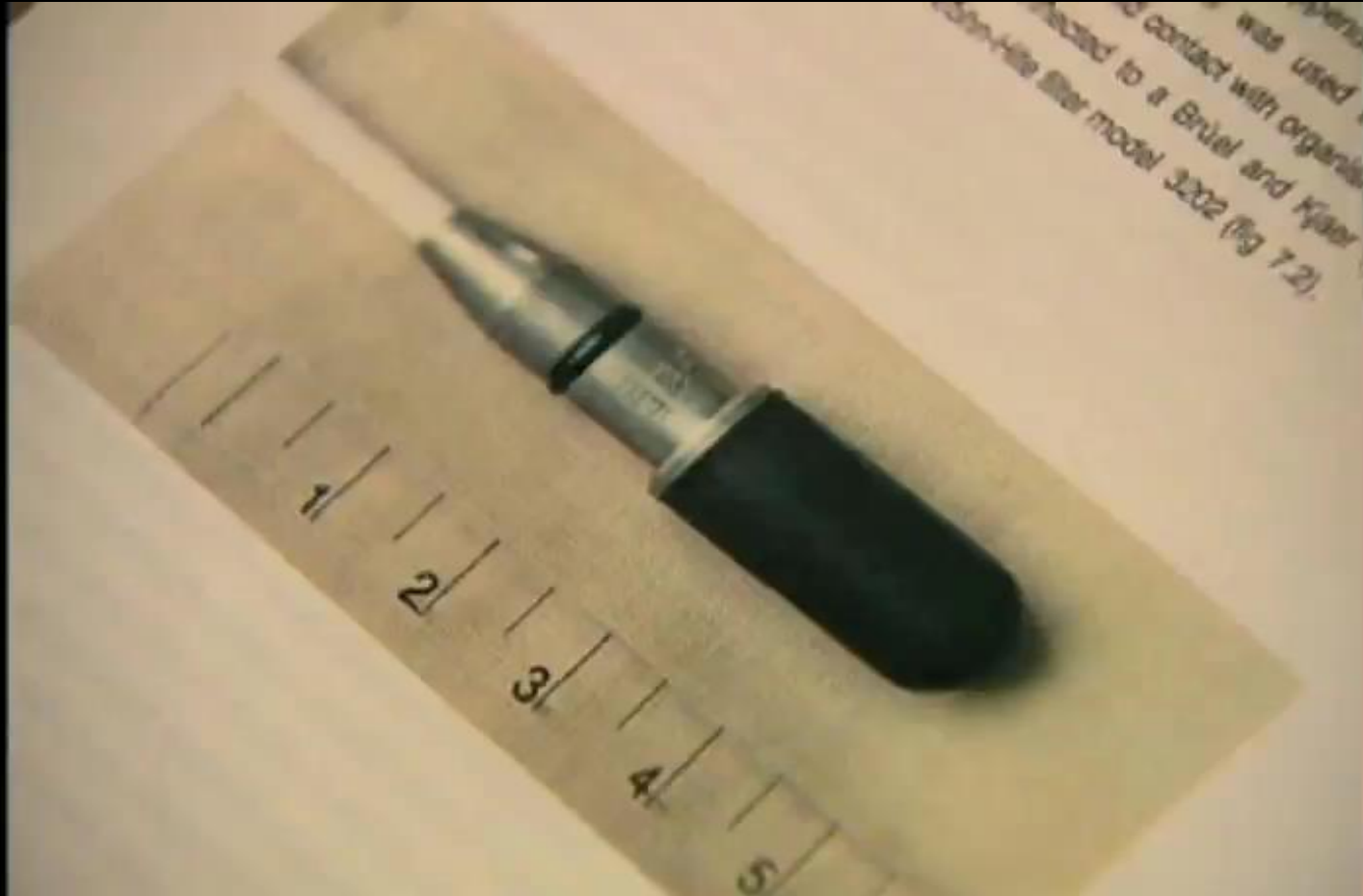
mother



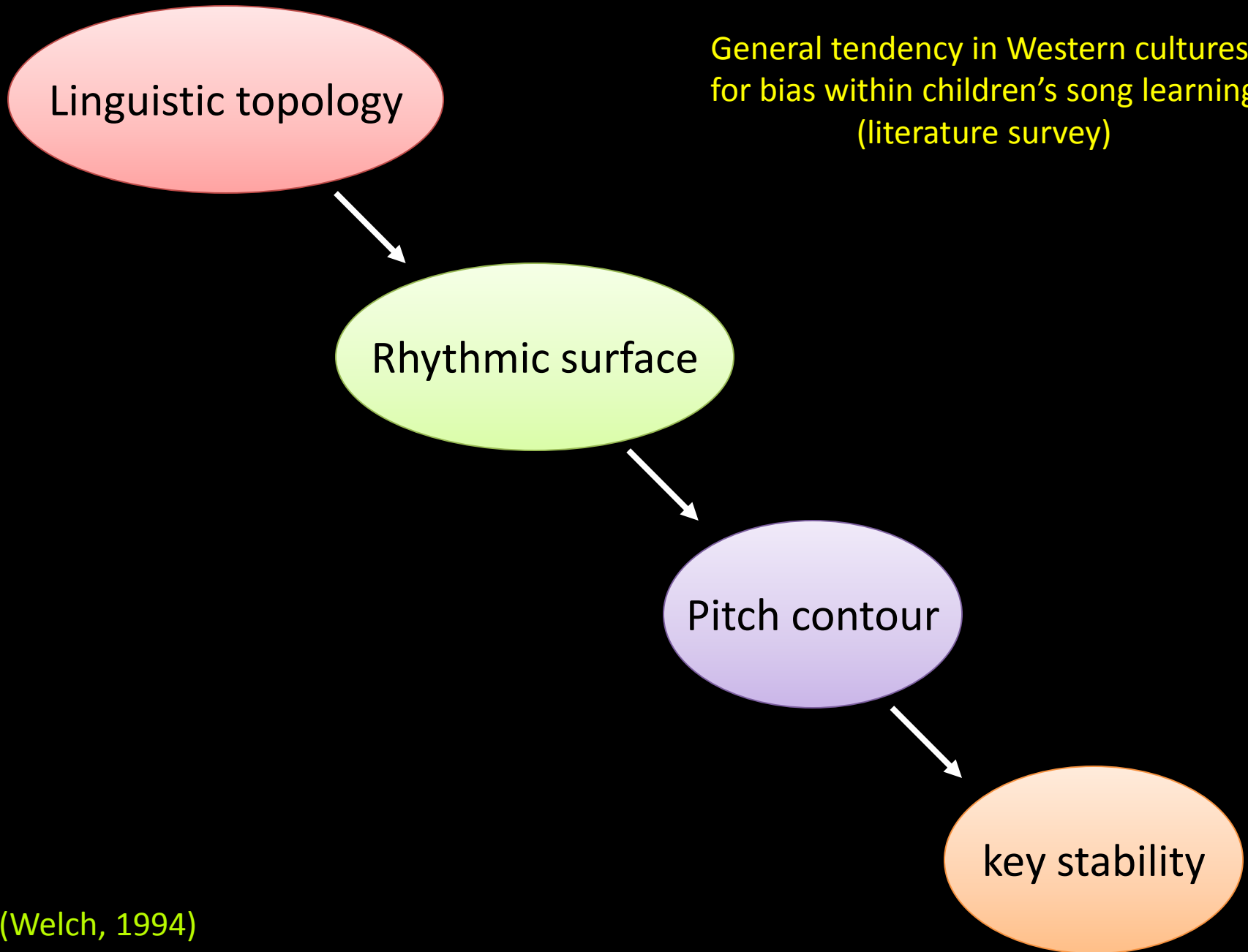
Mother's emotional state when vocalising (speaking & singing) is 'encoded' hormonally in the filtered interfacing of the mother's and foetus' bloodstreams

Hormonal links

Foetal experiences of maternal voice



General tendency in Western cultures
for bias within children's song learning
(literature survey)

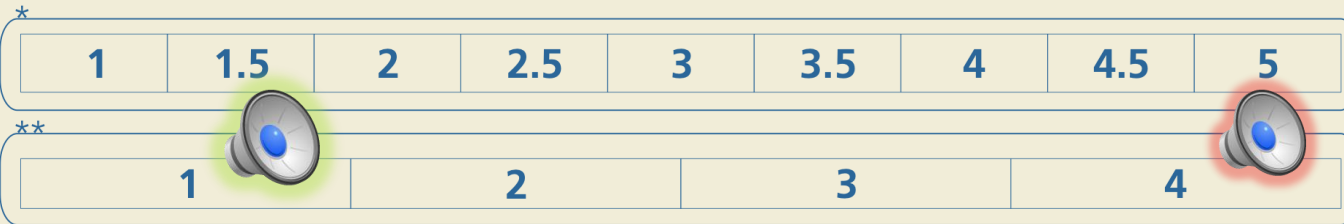


(Welch, 1994)

song 1

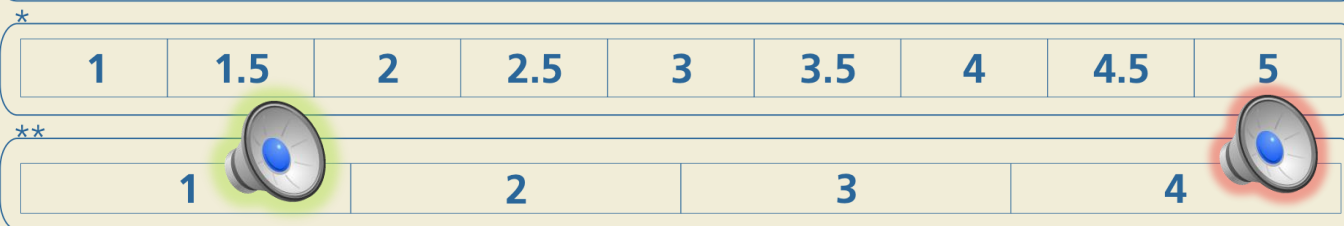
Type song name IF NOT **Twinkle, Twinkle:**

Examples of children's singing aged 9y+ (f)



song 2

Type song name IF NOT **Happy Birthday:**



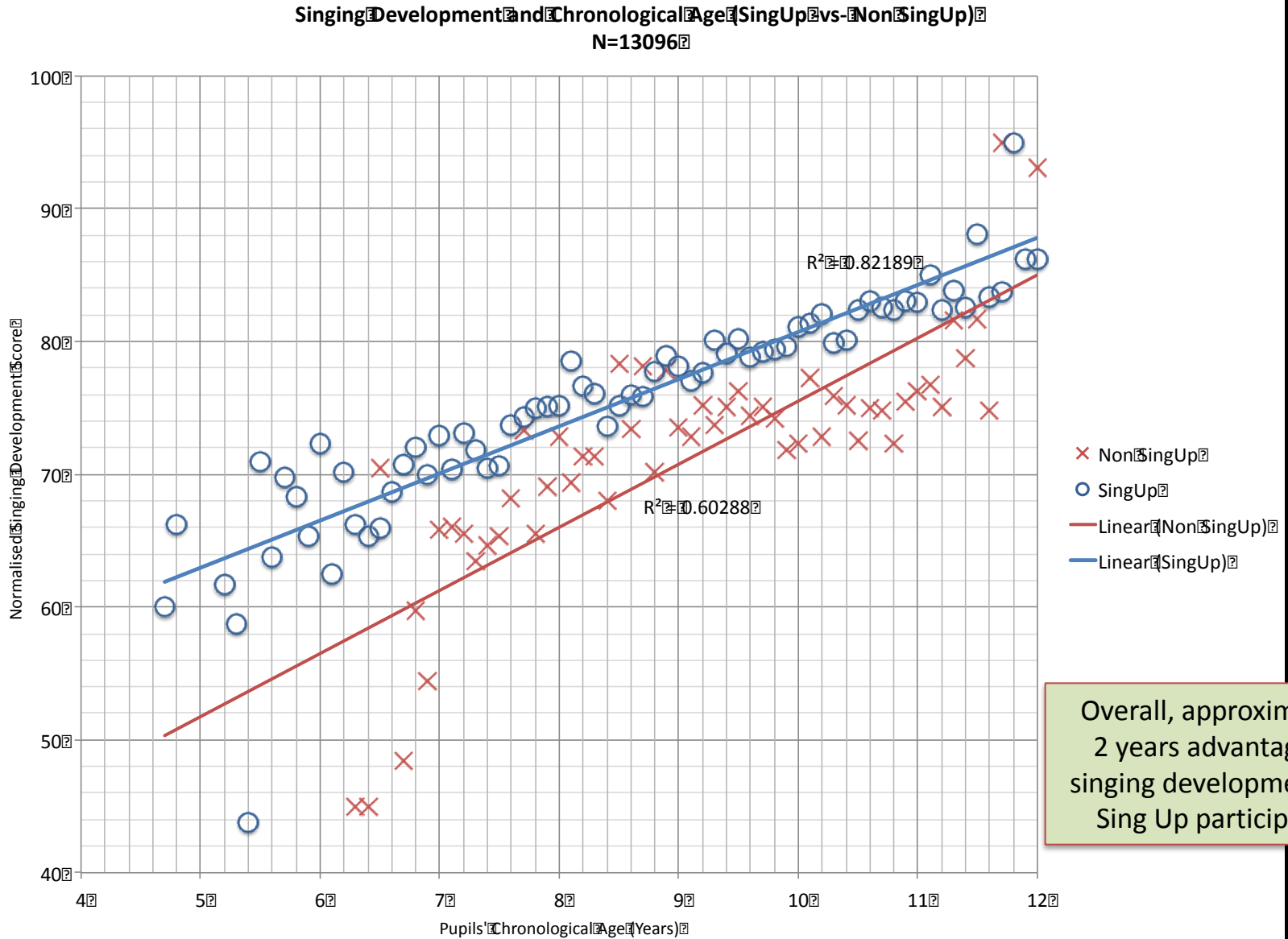
*Rutkowski (1997) Singing Voice Development Measure (SVDM)

**Welch (1998) A revised model of vocal pitch-matching development (VPMD)

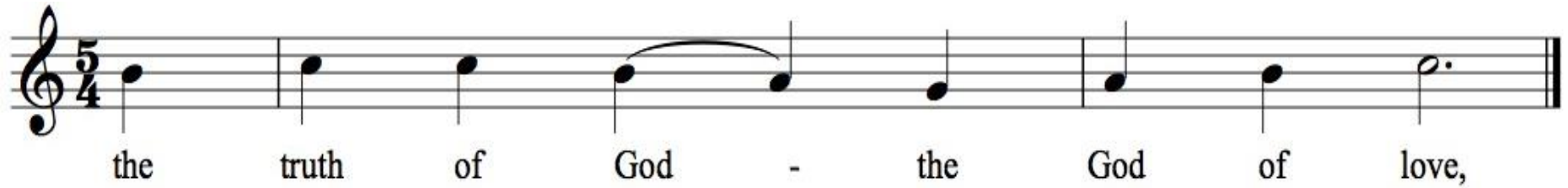
- 1 "Pre-singer" does not sing but chants the song text.
- 1.5 "Inconsistent Speaking Range Singer" sometimes chants, sometimes sustains tones and exhibits some sensitivity to pitch, but remains in the speaking voice range (usually a3 to c4)
- 2 "Speaking Range Singer" sustains tones and exhibits some sensitivity to pitch but remains in the speaking voice range (usually a3 to c4).
- 2.5 "Inconsistent Limited Range singer" waivers between speaking and singing voices and uses a limited range when in singing voice (usually up to f4).
- 3 "Limited Range Singer" exhibits consistent use of initial singing range (usually d4 to f4).
- 3.5 "Inconsistent Initial Range Singer" sometimes only exhibits use of limited singing range, but other times exhibits use of initial singing range (usually d4 to a4).
- 4 "Initial Range Singer" exhibits consistent use of initial singing range(usually d4 to a4).
- 4.5 "Inconsistent Singer" sometimes only exhibits use of initial singing range, but other times exhibits use of extended singing range (sings beyond the register lift: bb4 and above).
- 5 "Singer" exhibits use of extended singing range (sings beyond the register lift: bb4 and above).

- 1 The words of the song appear to be the initial centre of interest rather than the melody, singing is often described as 'chant-like', employing a restricted pitch range and melodic phrases. In infant vocal pitch exploration, descending patterns predominate.
- 2 There is a growing awareness that vocal pitch can be a conscious process and that changes in vocal pitch are controllable. Sung melodic outline begins to follow the general (macro) contours of the target melody or key constituent phrases. Tonality is essentially phrase based. Self-invented and 'schematic' songs 'borrow' elements from the child's musical culture. Vocal pitch range used in 'song' singing expands.
- 3 Melodic shape and intervals are mostly accurate, but some changes in tonality may occur, perhaps linked to inappropriate register usage. Overall, however, the number of different reference pitches is much reduced.
- 4 No significant melodic or pitch errors in relation to relatively simple songs from the singer's musical culture.

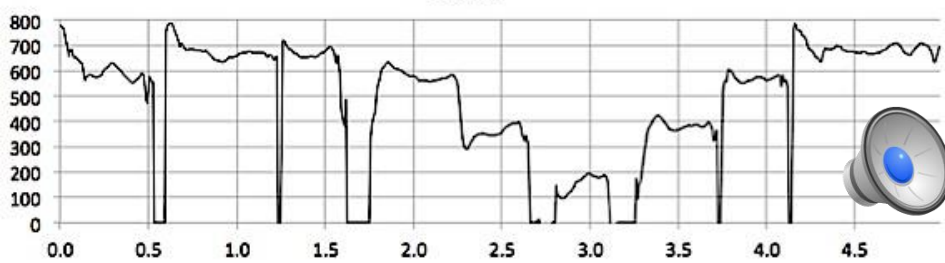
Children's Singing Development: Impact of *Sing Up*



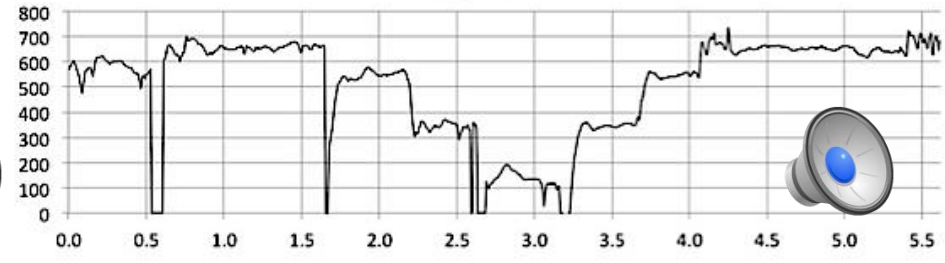
Overall, approximately 2 years advantage in singing development for Sing Up participants



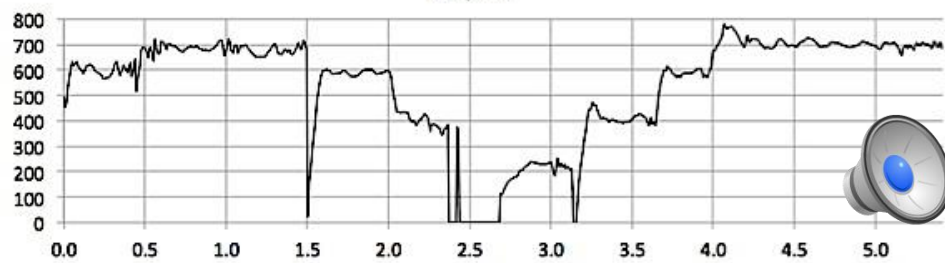
May-99



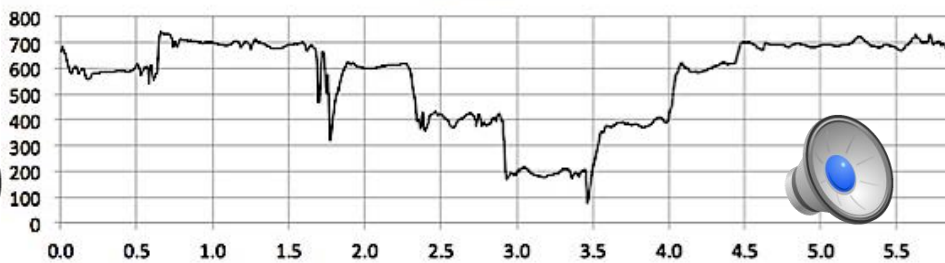
May-03



May-01

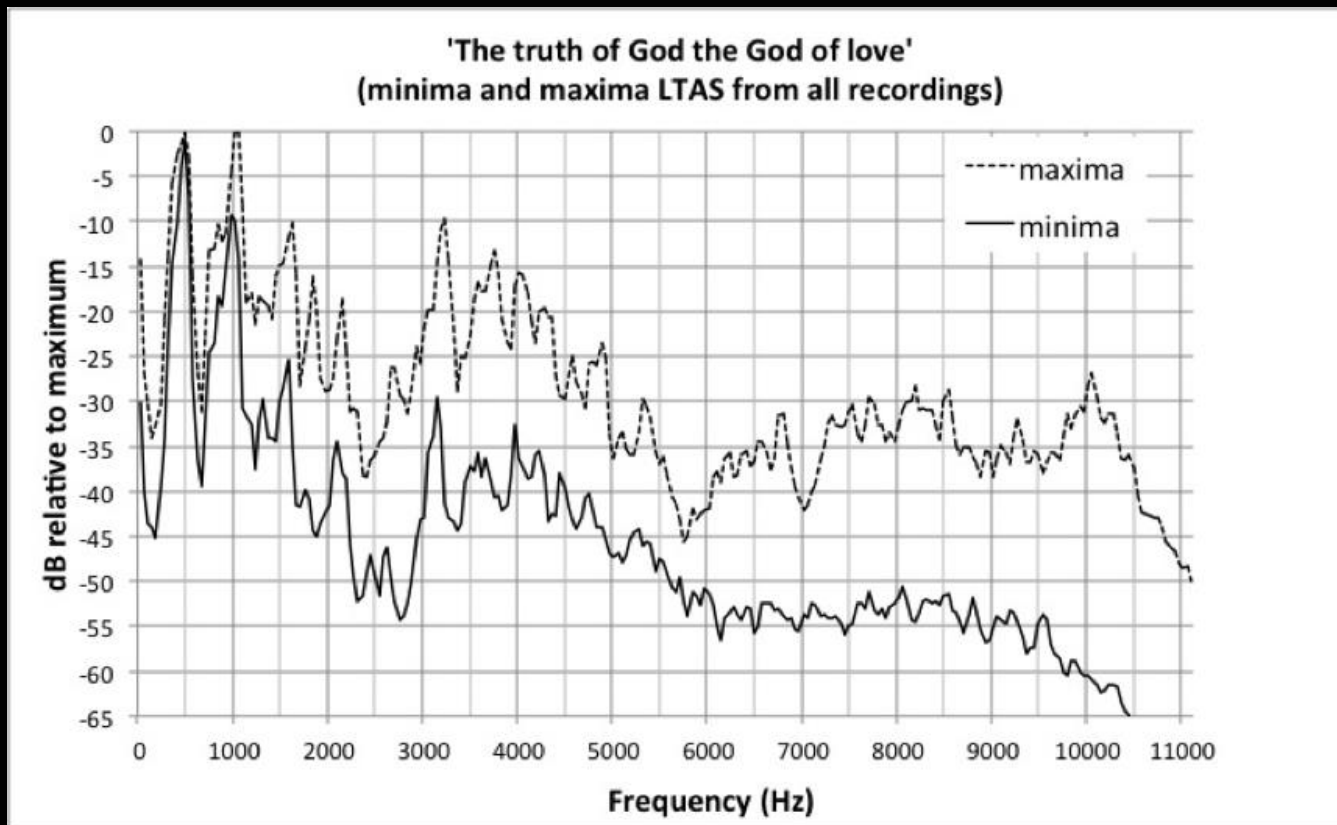


Jun-04



Longitudinal changes in the vocal pitching behaviour of a female chorister over a five-year period (song phrase above)

(Howard & Welch, in press)



Spectral changes (vocal timbre) in singing for the same female chorister over 4 years

the truth of God - the God of love,

(Howard & Welch, in press)

General singing ability in the adult population?



- The majority of adult individuals can carry a tune
(Dalla Bella, Giguère, & Peretz, 2007; Pfordresher & Brown, 2007; Pfordresher, et al., 2010)
- **10-20% of the general population is inaccurate when singing a melody from memory, or in pitch-matching tasks**
(Dalla Bella & Berkowska, 2009; Dalla Bella, Giguère, & Peretz, 2007; Pfordresher & Brown)
- Occasional singers tended to sing at a faster tempo and with more pitch and time errors relative to professional singers....but....when asked to sing more slowly, they are as accurate as professional singers

(Dalla Bella, Giguère, & Peretz, 2007; Larrouy-Maestri & Morsomme, 2014)

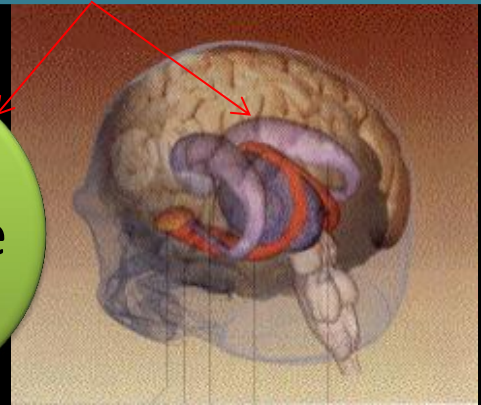
Singing and emotion

Neuropsychobiological design and music: the 'bodymind' (Pert, 1986; Thurman & Welch, 2000; Welch, 2005; Welch & Preti, 2015)



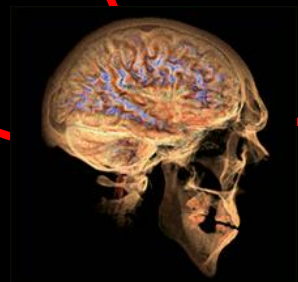
Image by Tsiaras (2005)

*Music is an
'emotional' experience*



endocrine

nervous



immune

Emotion and listening to music

- Intense pleasure when listening to music – experiencing an abstract sequence of sound unfolding over time – is associated with dopamine activity (in the mesolimbic reward system) [combined fMRI and PET study].
- The pleasure sequence of dopamine release over time embraces both anticipation and resolution.
- Also increase in heart rate ($p < 0.05$), respiration ($p < 0.001$) and electrodermal response ($p < 0.05$), with decreases in temperature ($p < 0.01$) and blood volume pulse amplitude ($p < 0.001$).

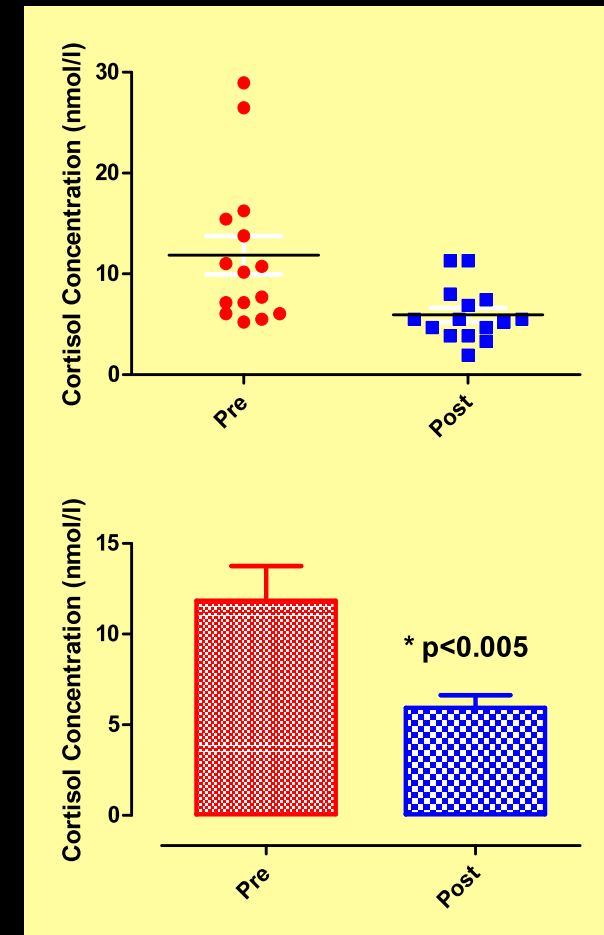
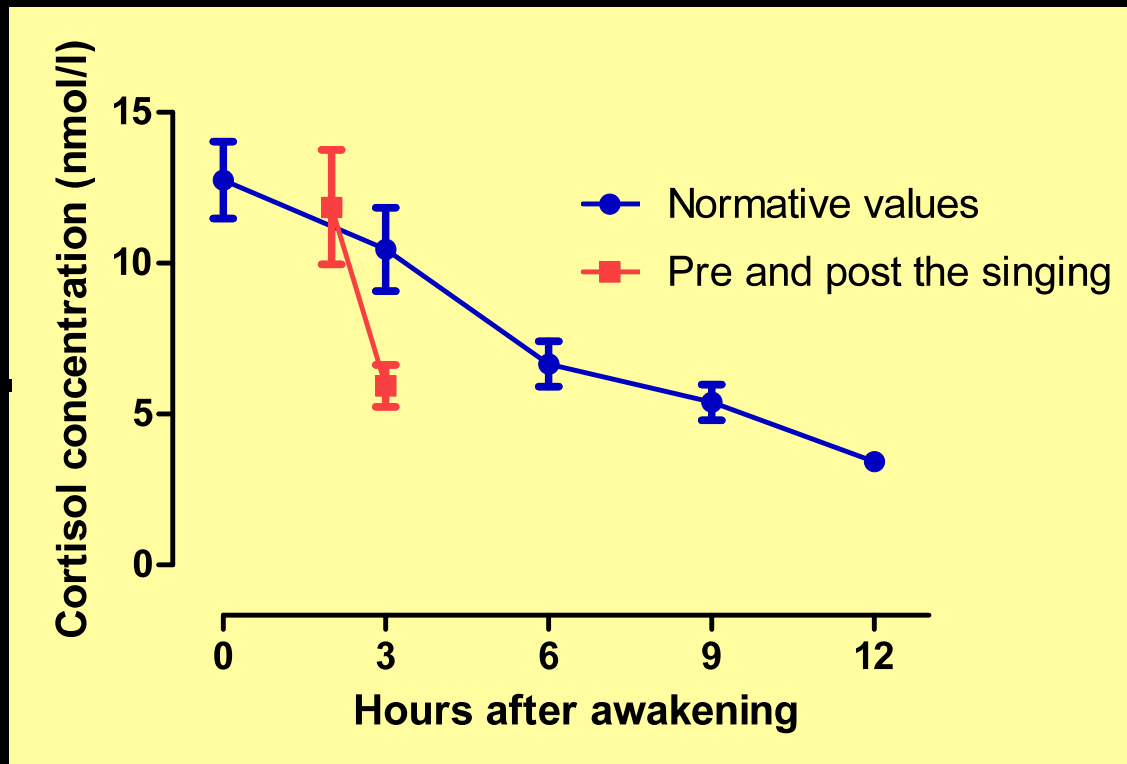


Nucleus accumbens – NAcc region – associated with reward

(Salimpoor *et al*, 2011)

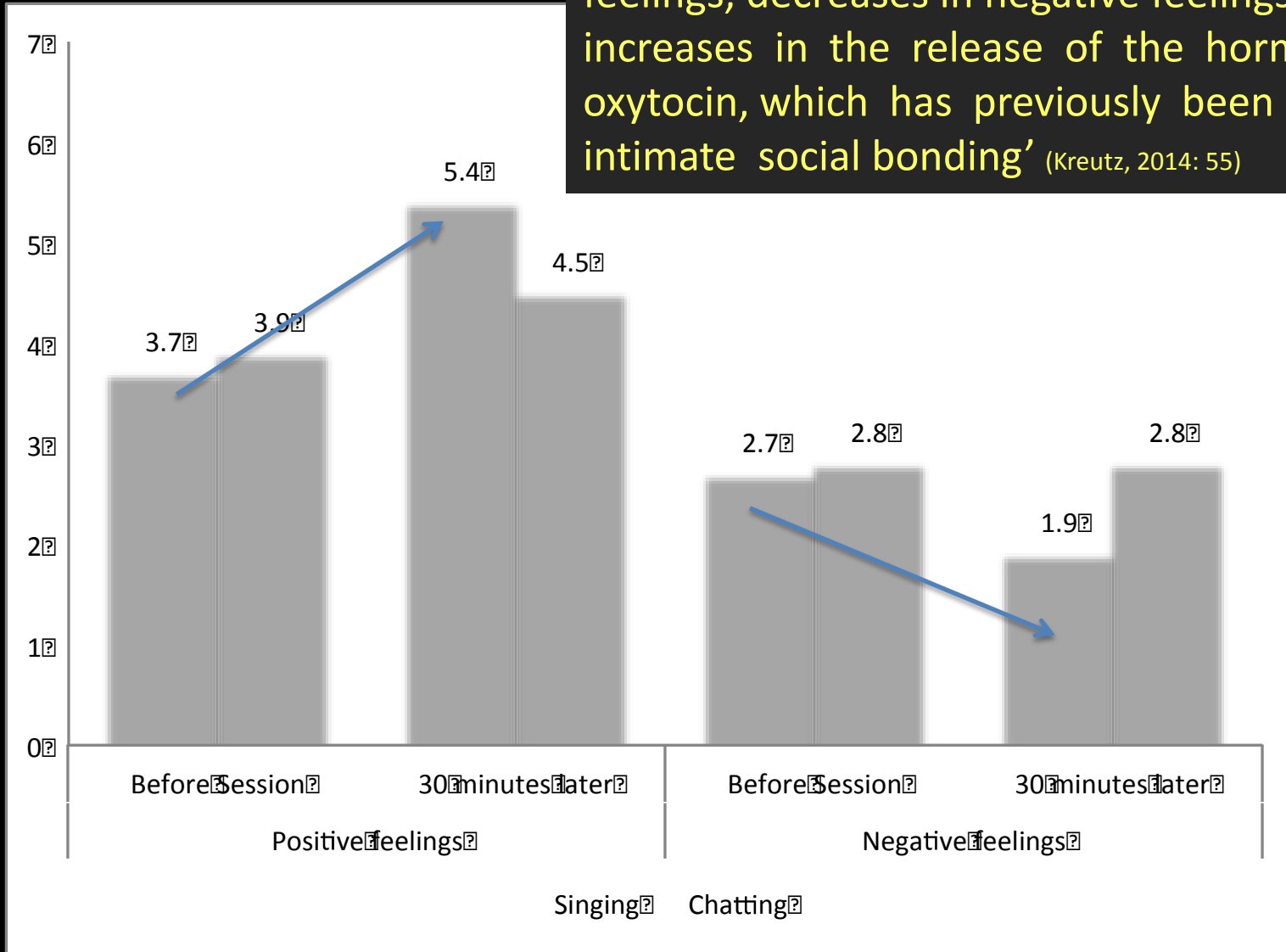
Singing & physiological benefits

Singing in a choir rehearsal = reduction in cortisol (the stress hormone)



Clow (2009)

'...group singing may lead to increases in positive feelings, decreases in negative feelings as well as to increases in the release of the hormone oxytocin, which has previously been implicated in intimate social bonding' (Kreutz, 2014: 55)



Self-reported impact of singing compared to chatting in two choral rehearsals (Kreutz, 2014)

Low-stress and high-stress singing have contrasting effects on glucocorticoid response (Fancourt, Aufegger, & Williamon, 2015)

- N=15 professional singers, highly experienced as a group
- Singing with and without audience in a concert venue, two consecutive evenings
- Low-stress performance context = reduction in cortisol and cortisone, i.e., singing in itself is stress-reducing

BUT

- High-stress performance context (with audience) = increase in cortisol and cortisone

ALSO

- Levels of stress hormone impacted on levels of singers' perceived anxiety

Other physical benefits?

- There is evidence of short-term and long-term health and well-being benefits of group singing – for young and old
- Physical benefits include improved vocal and lung functions, enhanced mobility and strengthening posture
- Psychological benefits include distraction, positive thoughts, feelings and emotions
- Social benefits include sharing positive experiences with other people, opportunities for social interactions and social acceptance

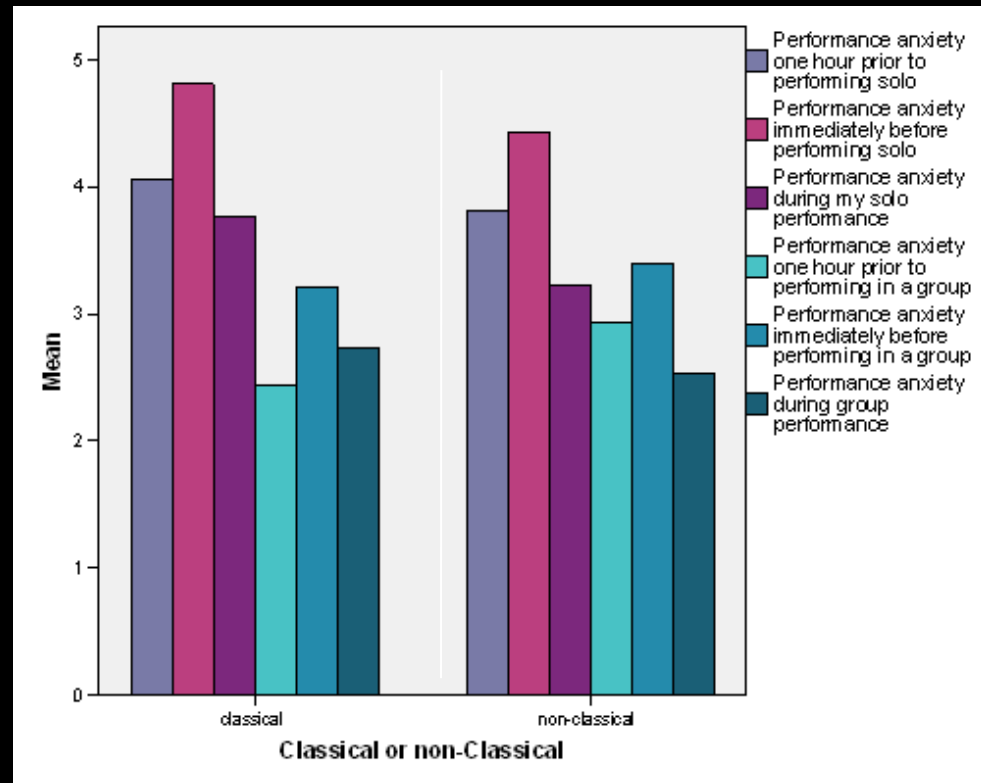


(Kreutz & Clift, 2015)

Singing and performance:
Solo versus Group

Performance anxiety in relation to context

- Solo performance produced higher levels of performance anxiety (both classical and other-than-classical musicians)
- Anxiety levels increased as the performance event approached, reaching a peak immediately before performing and decreasing during the actual solo or group performance



The presence of anxiety in solo and group performances

% of participants feeling distressed 1 hour, immediately before and during performances (summary of three conditions)

	Solo performance	Group performance
Distress level		
LOW	39.8%	75.1%
MODERATE	14%	10.1%
HIGH	46.2%	9.8%

- Solo performances tended to evoke high levels of distress
- Group performances induced low levels of stress

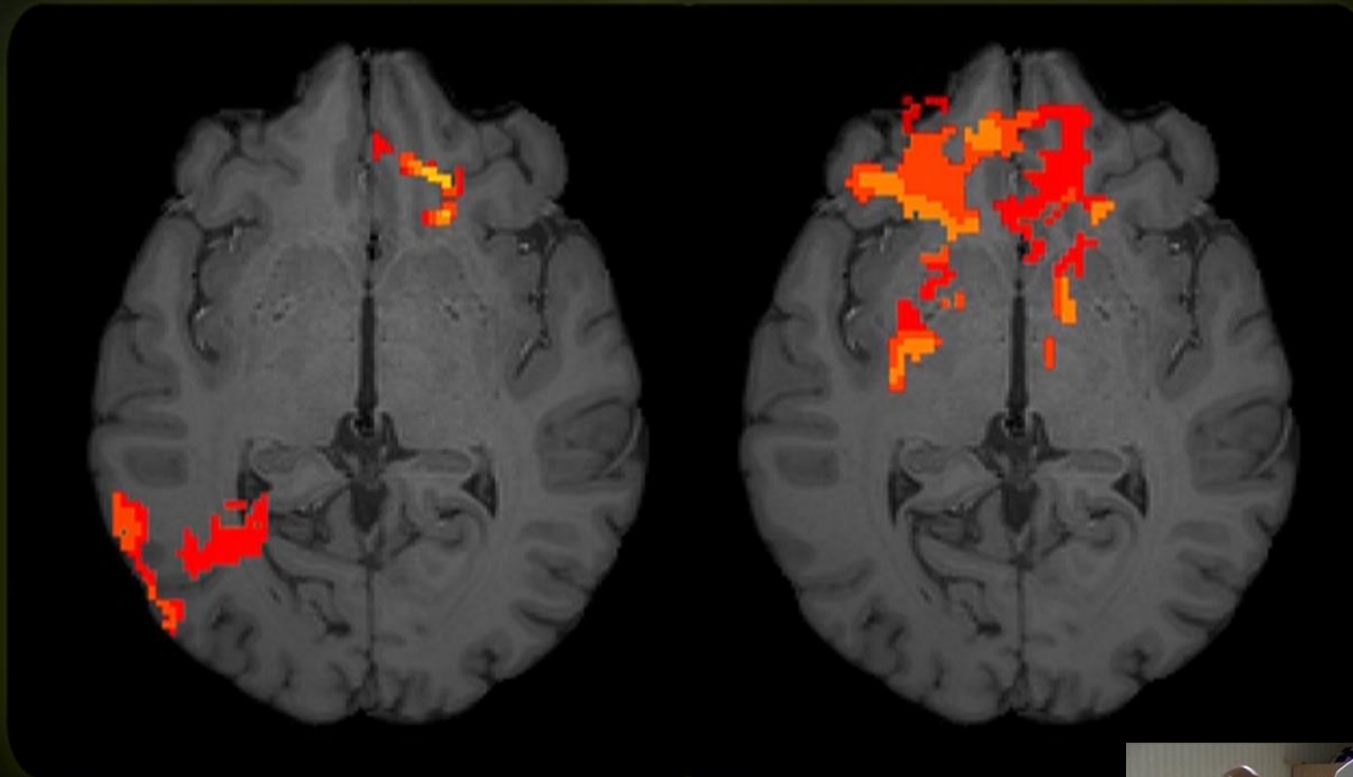
(Papageorgi, Creech & Welch, 2011)

Social benefits?

The musical brain is a social brain



Neurological differences in singing alone or with others

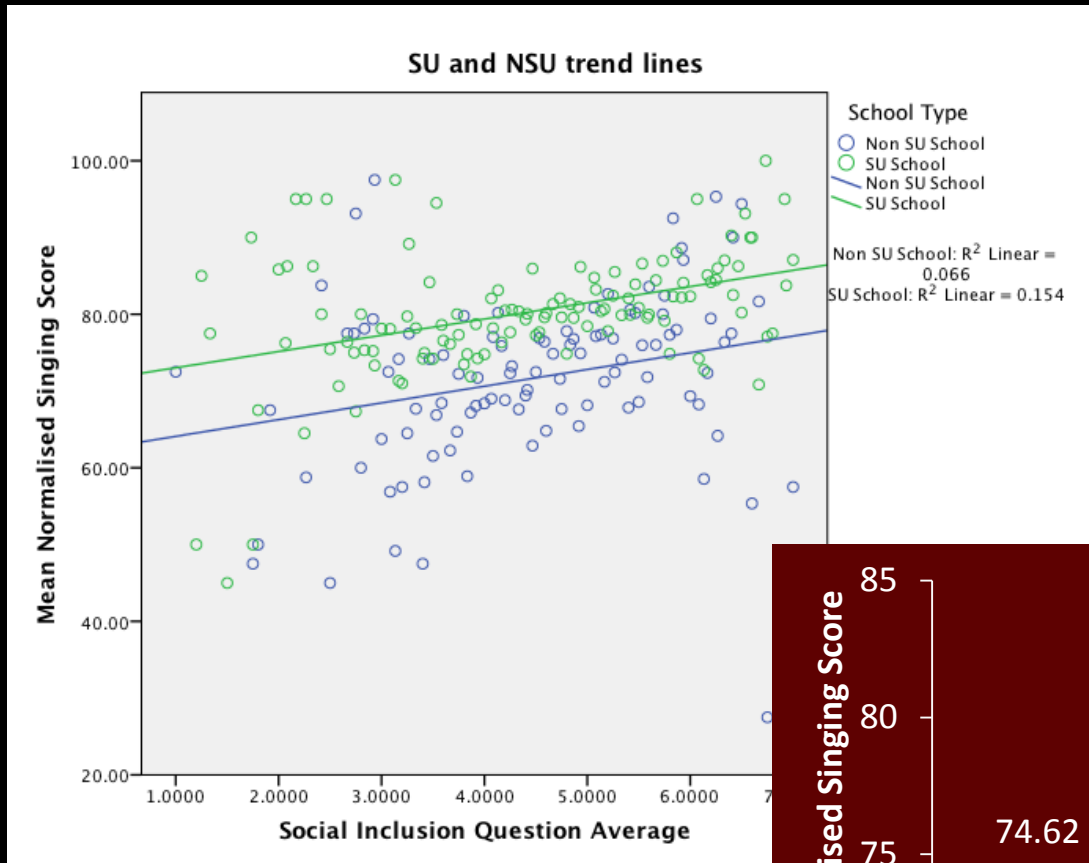


Professor Larry
Parsons with Jarvis
Cocker

www.pbs.org/musicinstinct



Singing development, self concept and social inclusion

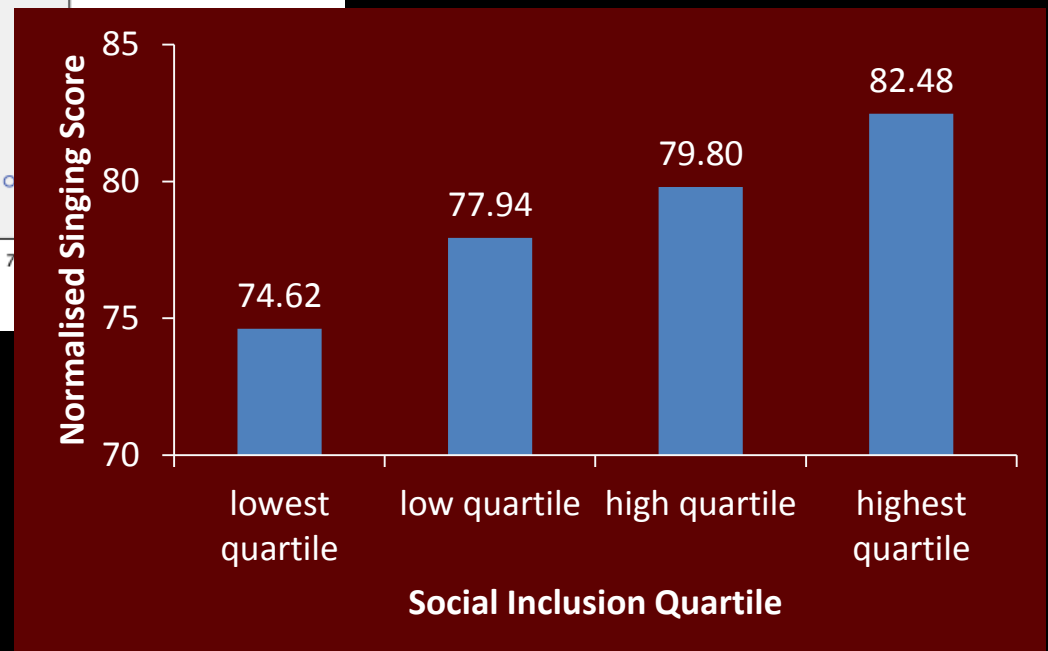


Correlation between sense of being social included and singing ability is similar for both groups ($n = 6,087$)

($p < .0001$)

But

Sing Up participants > Non-Sing Up participants

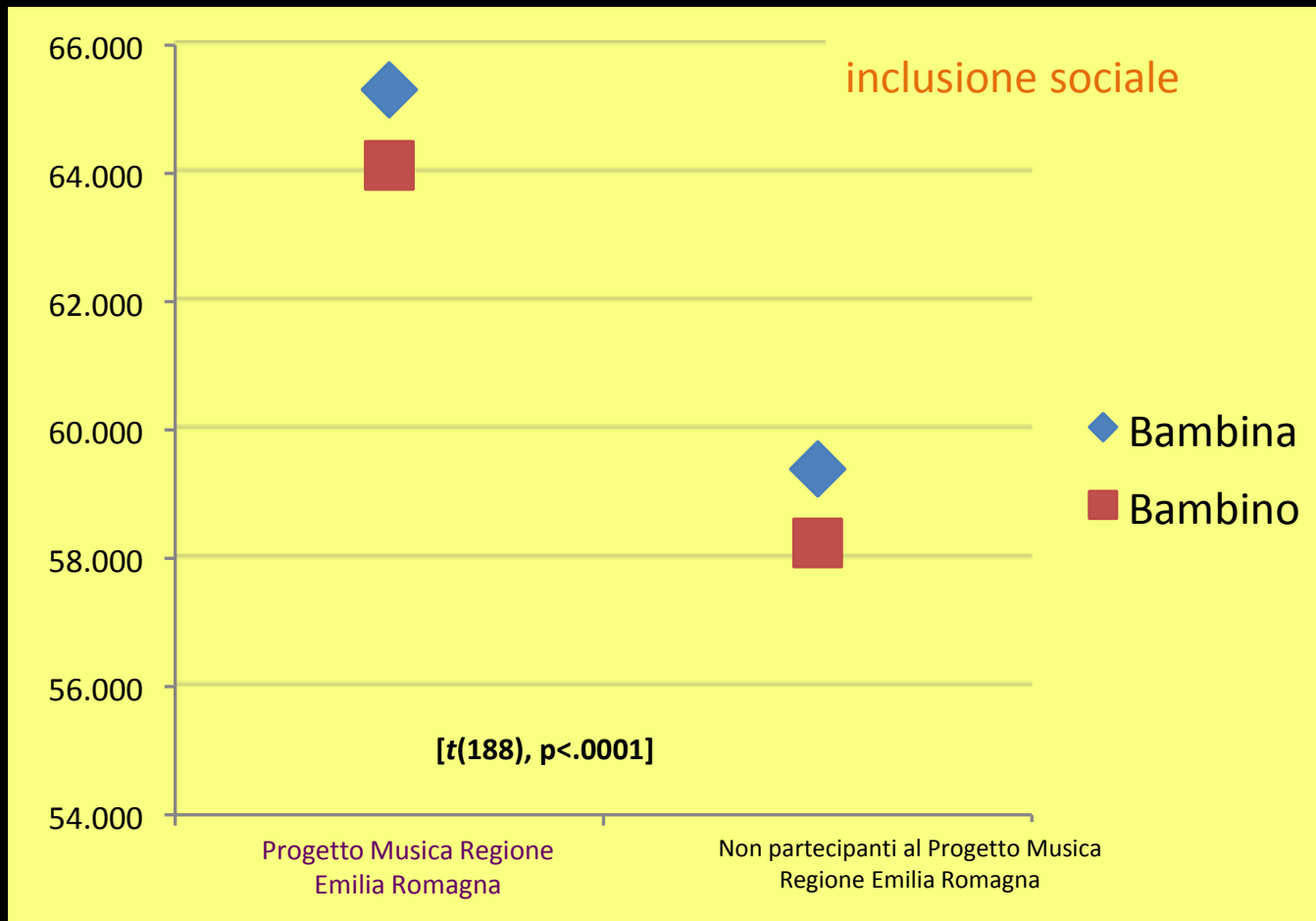


(Welch, Himonides, Saunders, Papageorgi & Rinta, 2014)

Similar data found in Italy: *Progetto Musica Regione Emilia-Romagna*

Musica ed inclusione sociale

dati del questionario - bambini n=190 (bambina = 112; bambino = 78)



n=98

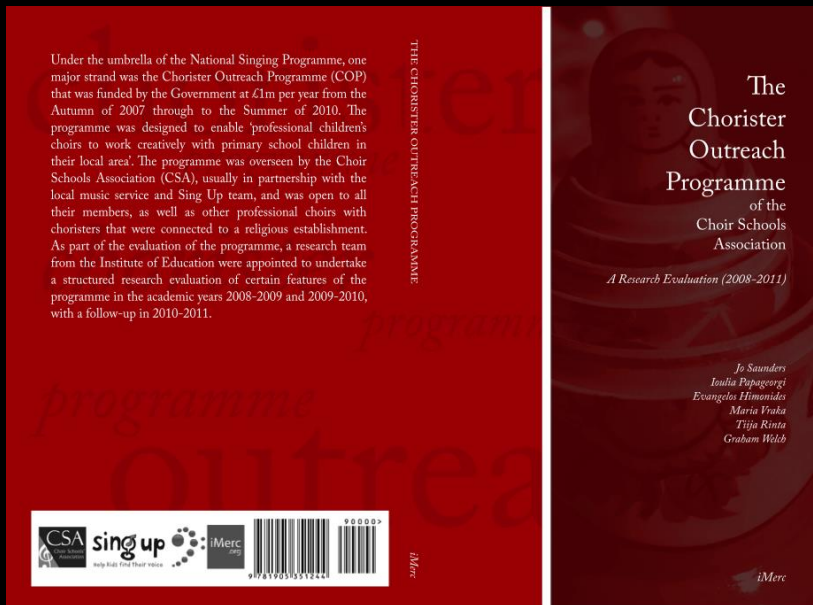
n=92

(Welch, Preti, Himonides & Toni, 2010)



Sing Up's *Chorister Outreach Programme*

- Primary school children who experienced the *Chorister Outreach Programme* (n=943) had:
- the highest positive mean attitudes to singing;
- the strongest reported engagement with singing; and
- the highest average social inclusion score

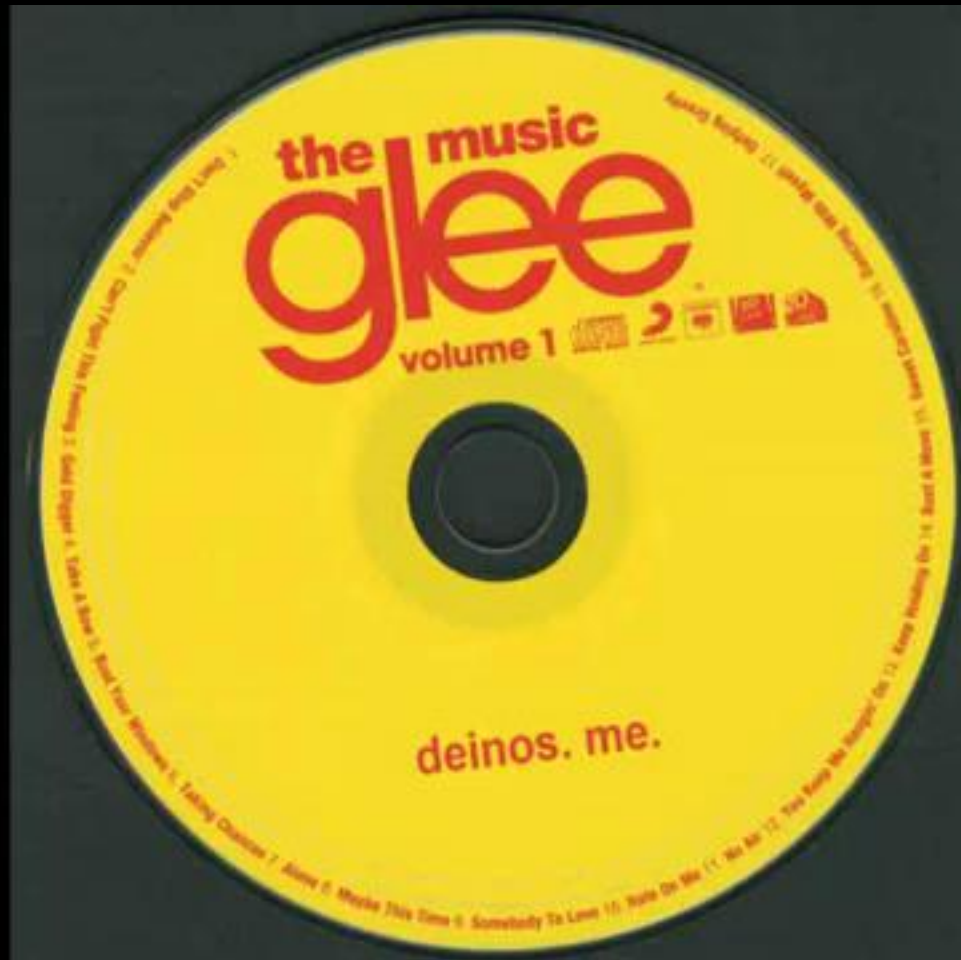


(Saunders et al, 2012)



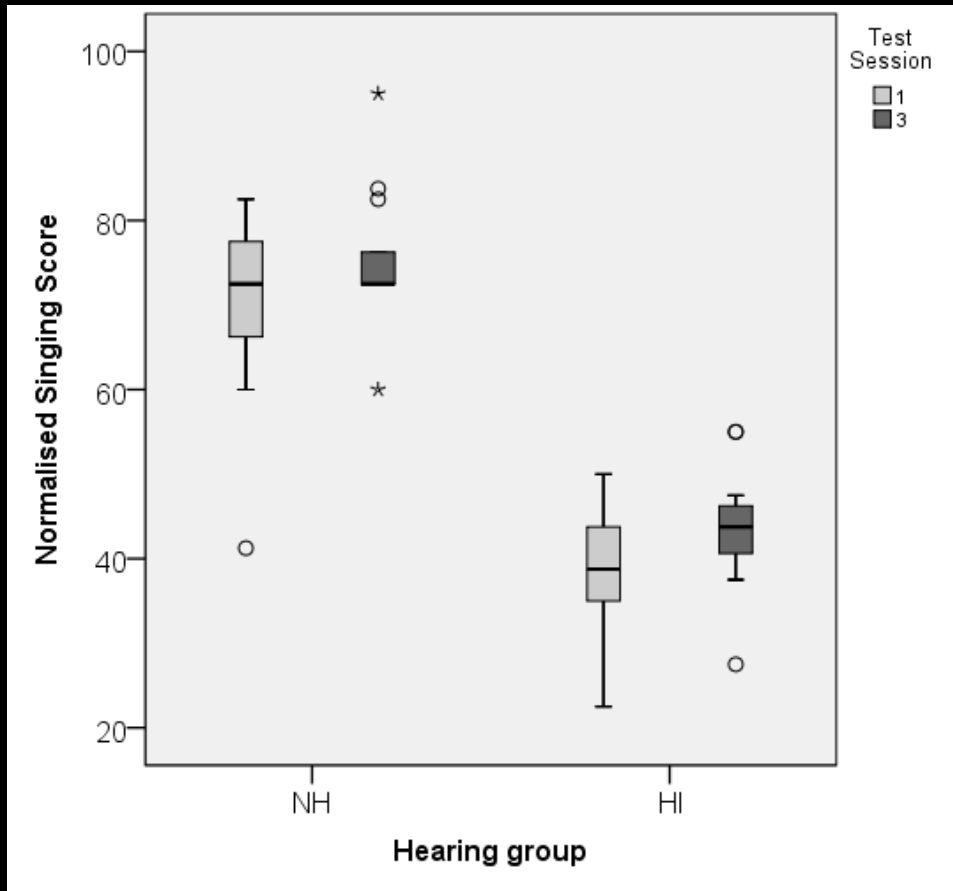
Singing (dis)ability?

Singing and hearing – and our bodymind response



The Deaf Show Choir
performing as 'Haverbrook School for the Deaf'
in 'Glee'

Group singing with hearing-impaired children



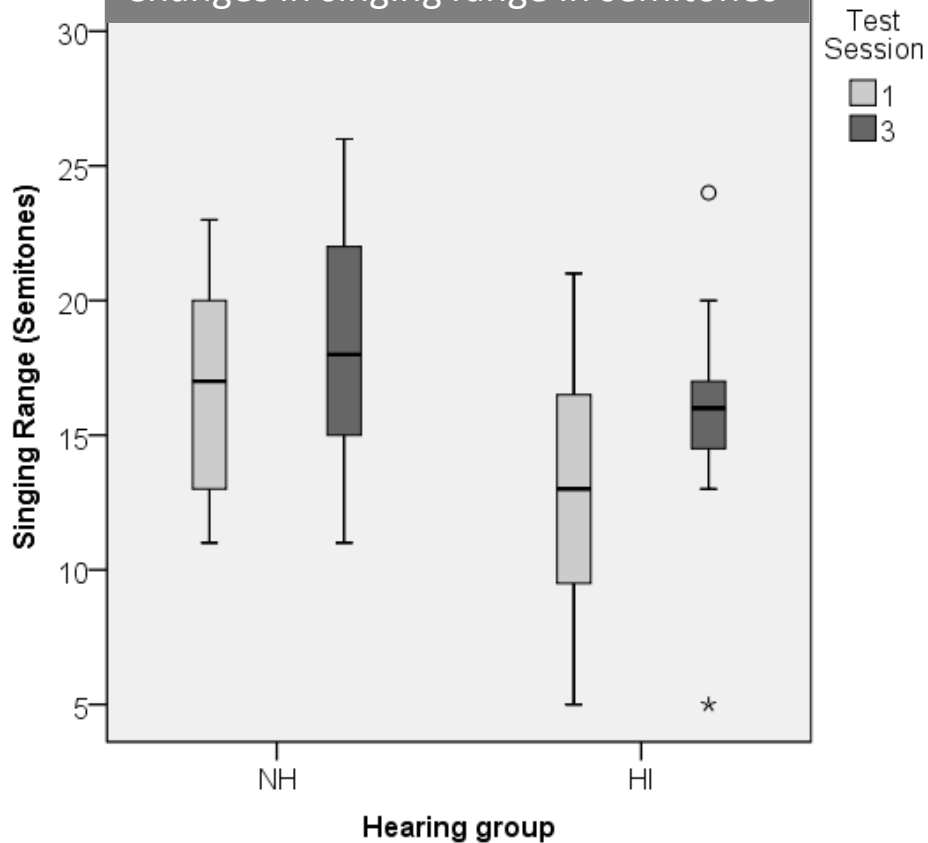
N=34 , aged 5-7 years, 20-week singing programme, including visual stimuli and feedback

Singing accuracy of pitch and vocal production score (blind scoring at the IoE by trained listeners)

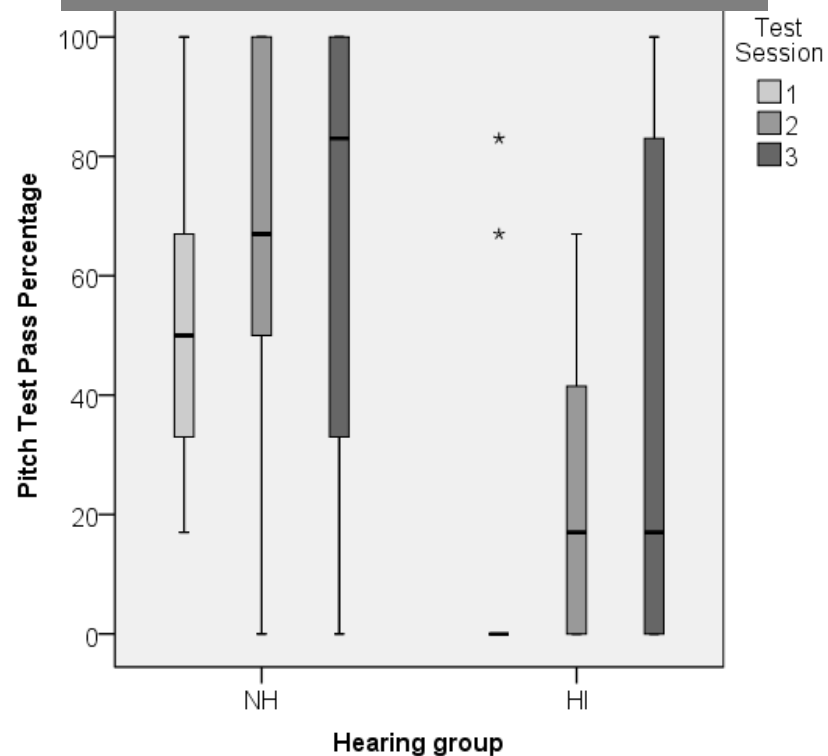
- *HI group far poorer than the NH group from the outset*
- **Improvements observed for HI group across sessions**

(Welch, Vickers et al, in press)

Changes in singing range in semitones



Changes in pitch discrimination scores

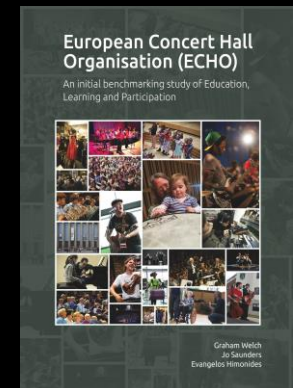
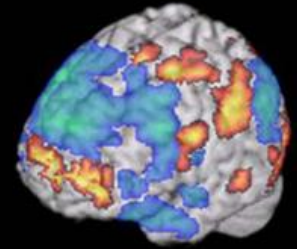


(Welch, Vickers et al, in press)

Conclusions

Social benefits of music (and other arts)?

- Artistic behaviour involves many different parts of the brain acting simultaneously
- Successful involvement in arts will embrace integrated neural functioning and potential near and far transfer, including sense of social inclusion
- Benefits are possible across the lifespan (e.g., 570,000+ children, young people and adults attended music activities in 20 European concert halls in 2011 – Welch et al, 2012)



Key concepts

- **Basic neuropsychobiological design and maturational development are mediated by socio-cultural imperatives** (Altenmuller, 2004; McPherson, 2006; Welch, 2006)
- **Particular musical behaviours become more or less developed** (Welch, 2000; cf Sternberg et al, 2000; Eraut, 2004)
- **Learning happens within a social process** (Engeström, 2001; Welch, 2007)
- **Singing development is possible across the lifespan**
- **Negative experience can hinder or halt singing development – and impact negatively on singer identity**

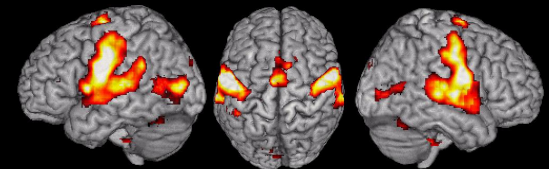


The Benefits of Singing in a Choir?



- Singing with other people brings a wide range of benefits, especially...

- Physical
- Psychological (including emotional)
- Social



Singing (Kleber et al, 2007)

- This is in line with the kinds of the benefits that accrue from other successful group music making
- BUT is likely to be more marked for singing because the human voice is an integral part of our identity, of who we are...



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