Vocology in Practice
Cork, April 2019

Emotions and Senses: neurological triggers

Dr Jenevora Williams
Illustrations by Harry Venning

Emotions: why do we need them?

- Emotional responses are crucial for our survival
- Fear or reward - the three questions asked by the limbic system?



- Emotions enable us to respond appropriately to a stimulus
- The body has physical responses linked to feelings of pleasure or anxiety

Emotions - where in the brain?

- Brain structures develop through evolution like a series of extensions, the original rooms remain as they were
- Emotional expression = prefrontal cortex, hippocampus and amygdala
- Emotional response = ANS (involuntary)
- Same muscles can be triggered via different pathways in the brain: Voluntary or emotional
- laughter - real/fake
  tongue - swallowing/speaking

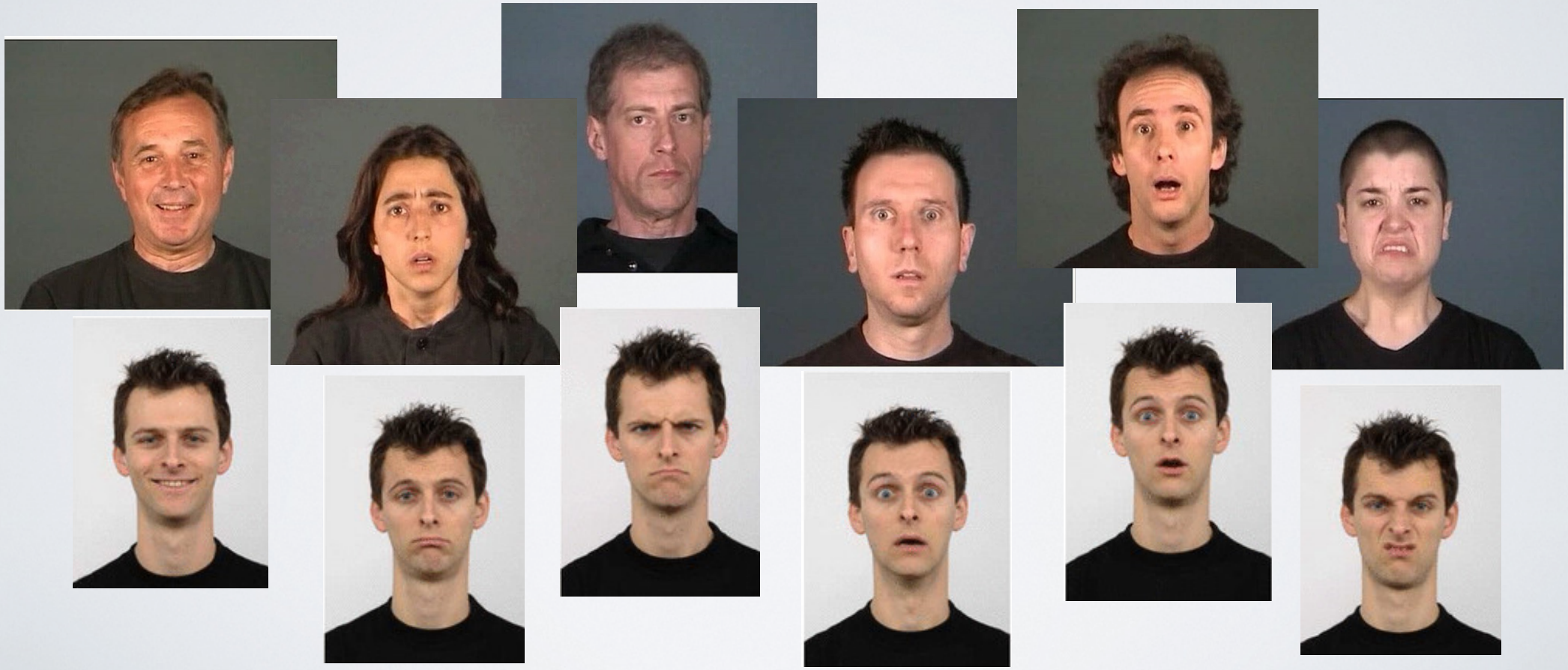
Pamela Davis

Autonomic nervous System

- Automatic
- No control
- Regulates body functions
- e.g. heart rate, digestion, cell repair
- Also emotional responses
- e.g. embarrassment, fear, attraction

How do we read emotions?

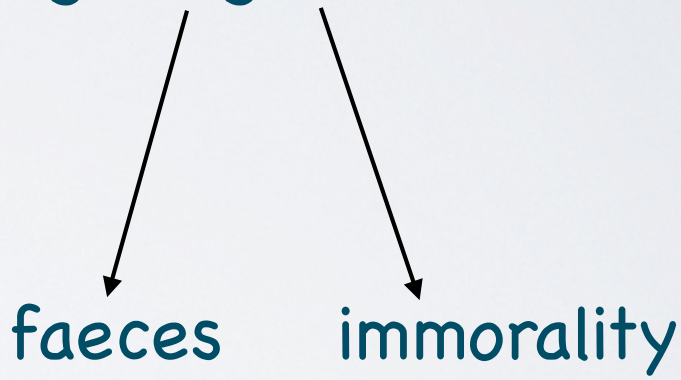
- Common biological inheritance - 6 basic emotions:
- joy distress anger fear surprise disgust



Emotions: basic and cognitive

- Higher cognitive emotions - still universal
- can be influenced by conscious thoughts
  - love
  - guilt
  - shame
  - embarrassment
  - pride
  - envy
  - jealousy

- Some basic emotions can become co-opted as higher cognitive ones
- eg: disgust



Emotions and Voice

- Voice can be triggered from basic brain area Anencephalic babies can cry at birth
- Midbrain periaqueductal grey - an interface for behaviour and pain control, autonomic reactions to stress and injury
- Stimulation of PAG - vocalisation
- Lesion of PAG - mutism
- PAG co-ordinates emotional responses, particularly linking respiratory and laryngeal motor patterns in response to ANS reflexes

Behbehani, M. (1995). Functional characteristics of the midbrain periaqueductal gray *Progress in Neurobiology, 46* (6),

Primal non-linguistic vocalisation

- What is singing?
  - Crying
  - Yelling
  - Wailing
  - Whooping
  - Sighing
  - Giggling
- all of these need emotional connection if they are to sound convincing
- More on emotions and the vagal response coming later...

The pleasure emotion and dopamine

- Chemical found in the brain, helps nerve cells to send messages to other cells
- Important for memory and learning
- Quantity is increased, partly linked to pleasure and partly to desire
- But also when something bad is avoided
- Increased expectation leads to a greater wash of pleasure (we can all think of examples...)

Synaptic links

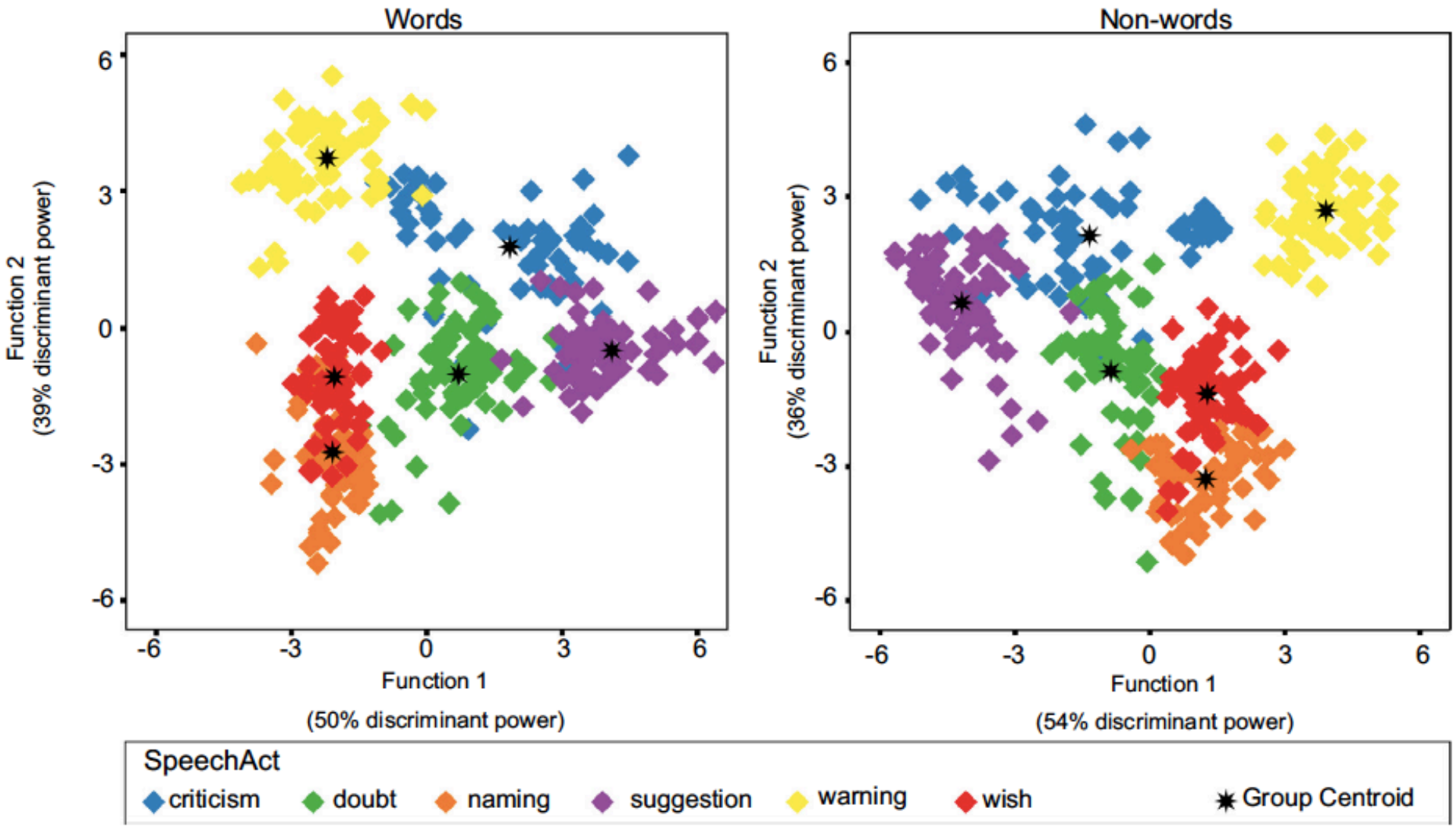
- If dopamine remains at the synapse for longer it draws attention to the link and enables it to be strengthened
- Memories are aided by emotion and general well-being

The brain - singing or speech

- Singing accesses more of the brain than speaking (eg prefrontal cortex)
- Singing as therapeutic use for stammerers, and for Autistic Spectrum Disorder
- Mirror Neuron System - enables the listener to understand the meaning and intention of a communicative signal
- Neurologically 'experiencing' the mind of another
- Accounts for the act of listening to song as an emotional journey

Molnar-Szakacs, I. and K. Overy (2006). "Music and mirror neurons: from motion to 'e'motion." Social Cognitive and affective neuroscience **1**(3): 235-241.

Emotions: Content or context?



Function 1 (x axes) = mainly pitch Function 2 (y axes) = mainly intensity

Emotions: interaction, affection and learning

- Two groups of young children being taught a second language:
  A learning from a live-person presentation
  B the same presentation delivered via a video screen
- Both groups paid attention
- Only group A learnt any of the language

Conboy, B., Brooks, R., Meltzoff, A., & Kuhl, P. (2015). Social Interaction in Infants' Learning of Second-Language Phonetics: An Exploration of Brain-Behavior Relations. *Journal of Developmental Neuropsychology, 40*(4), 216-229.

Emotions: interaction, affection and learning

- Listeners learn more when they are 'in tune' with the thoughts and feelings of the speaker
- If the teacher feels affection and warmth for the student, the learning process is more effective
- If students feel empathy towards their teacher, they will pay more attention

Dikker, S., Silbert, L., Hasson, U., & Zevin, J. (2014). On the Same Wavelength: Predictable Language Enhances Speaker–Listener Brain-to-Brain Synchrony in Posterior Superior Temporal Gyrus. *Journal of Neuroscience, 34*(18), 6267-6272.

Emotions summary…

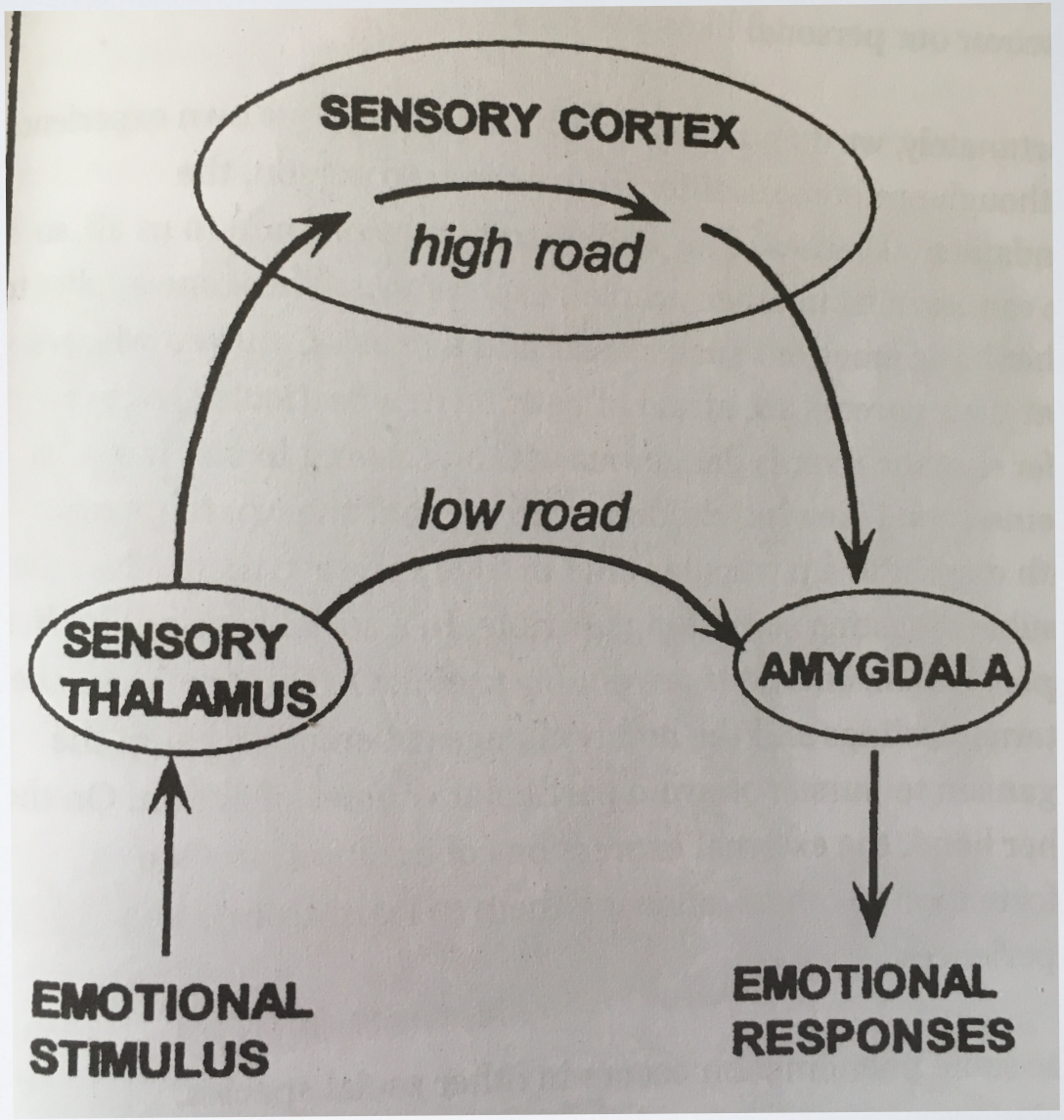
- Emotions and the ability to read them and respond appropriately are essential for our social interactions
- It is easier to read an emotion 'in the flesh' rather than onscreen or in a picture
- Reading emotions utilises mirror neurons, we mirror and experience the mind of another
- Focussed attunement with another can help to shift our own mood and responses

Autonomic Nervous System and the Vagus Nerve

- Body responses to perceived threat or reward are linked to the functions of the vagus nerve (amongst others)
- The same trigger can either excite/challenge or terrify, depending on context
- A cognitive event can trigger a visceral response from the body leading to an 'irrational' reaction

Two pathways to fear

- First pathway = quick response + false alarms
- Second pathway = consciously selective
- Phobia = loss of second pathway



LeDoux, J. (1998). The Emotional Brain. London, Weidenfeld and Nicolson.

Polyvagal Theory - Stephen Porges and the Triune brain 1

- Different branches of vagus nerve are linked to different levels of stress response
- Oldest part of the vagal nerve: (dorsal vagal complex) unmyelinated, use doesn't strengthen it = **immobilisation** (freeze response of reptiles) and primary control of digestive tract
- Limbic system: sympathetic nervous system = **mobilisation** (fight or flight)

Polyvagal Theory and the Triune brain 2

- More evolved (ventral vagal complex, myelinated) = social communication + puts the brakes on heart rate
- Part of the vagus nerve that controls the larynx and pharynx = vocalisation and facial expression (linked to our deepest emotional responses)
- All three origins of the vagus nerve have an effect of heart rate and RSA: some slowing and some speeding

Polyvagal Theory and Communicating

- Vagus nerve is central to phonation, respiration and hearing
- Neuro-regulation has strong influence on expressive voice
- The voice can express our internal visceral state
- Sympathetic-parasympathetic co-regulation supports the fundamental act of communication

Cazden, J. (2017). "Stalking the calm buzz: how the polyvagal theory links stage presence, mammal evolution and the root of the vocal nerve." Voice and Speech Review **11**.

Polyvagal Theory and Performing

- Sympathetic and parasympathetic systems are not a mutually exclusive see-saw
- They can exist together or one may dominate
- Mammals need to be simultaneously alert and calm
- Social communication requires dynamic equilibrium - externally aroused and internally reassured
- Calm yet dynamic quality of personal energy = fundamental to stage presence

Cazden, J. (2017). "Stalking the calm buzz: how the polyvagal theory links stage presence, mammal evolution and the root of the vocal nerve." Voice and Speech Review **11**.

Emotions: polyvagal theory

- Look beyond fight/flight for explanations
- Basic Emotional responses will affect our overall state of body-mind
- Social relationships are key to our survival
- Being seen and heard by the important people in our lives can make us feel calm and safe
- Being ignored or dismissed can precipitate rage reactions or mental collapse
- Focused attunement with another person can shift us out of disorganized and fearful states

- Porges summarizes: the polyvagal theory explains "the importance of physiological state as an intervening variable influencing behavior and our ability to interact with others ... that feeling safe is dependent on unique cues in the environment and in our relationships that ... promote health and feelings of love and trust."
- Think about other situations when arousal is really high (adrenalin), and yet safety and bonding is also really high (oxytocin), enhanced sensitivity to one's own internal sensations as well as the verbal and non-verbal signals of the partner...

Neural control of voice

- Both hierarchical and parallel
- Learned patterns are in the motor cortex
- Innate vocalisations are through the ACC (anterior Cingulate Cortex) and PAG
- Learned patterns can pass through either route (fake laughter and real laughter)
  - NB a baby crying in genuine pain has more vibrato

Jürgens, U. (2009). "The neural control of vocalisation in mammals: a review." Journal of Voice **23**(1): 1-10.

Emotions and Social interaction

- Social relationships are central to our healing processes and our ongoing wellbeing
- Social relationships are inextricably bound to our voices

The senses - links

- Boobah and Kiki
  - Taste: banana/lemon, dark/milk chocolate
  - Visual: cloud/star
  - Sound: bassoon/oboe
  - Touch: fur/sandpaper
  - Smell: tar/cut grass
  - Texture: still/sparkling water

Subconscious Somatosensory feedback

- Glossopharyngeal and vagus nerves
- Variations in air pressure will feedback to laryngeal muscles to regulate frequency
- Variations in frequency and the resulting changes in formant frequency will trigger changes in articulatory set-up in order to regulate vowel integrity
- Abdominal muscles respond to pressure receptors under the vocal folds to regulate air pressure

Auditory feedback

- Lombard effect (we speak louder against background noise)
  - Great tits sing at a higher frequency in noise polluted urban surroundings than quieter ones to help overcome the auditory masking that would otherwise impair other birds hearing their song.
    Slabbekoorn H, Peet M (July 2003). "Ecology: Birds sing at a higher pitch in urban noise". Nature. **424** (6946): 267.
- We adjust our pitch to match given frequency
- We adjust vocal timbre
- Auditory feedback becomes less crucial with more training
- Somatosensory feedback is trained to respond and guide instead (internal sensations are more reliable)

Auditory vs Kinaesthetic

- Professional singers and non-singers
- Singers rely on kinaesthetic feedback
- Non-singers rely on auditory feedback
- Masking auditory feedback - pitch-matching in non-singers declined, in singers it made no difference
- Anaesthesia of vocal folds - singers also less affected
- Brain activity showed a difference between the two groups
- Singers rely on learned neural patterns as well as kinaesthetic feedback

Kleber, B., et al. (2013). "Experience-dependent modulation of feedback integration during singing: role of the right anterior insula." Journal of Neuroscience **33**(14): 6070-6080.

Kleber, B., et al. (2016). "Experience-dependent modulation of right anterior insula and sensorimotor regions as a function of noise-masked auditory feedback in singers and nonsingers." NeuroImage **147**: 97-110.

The senses - the usual five

- Hearing
- Vision
- Touch
- Taste
- Smell
- Preferential learning styles - there is no neurological evidence for this
- Mental imagery exercises develop auditory somatic and visual brains as well as musical, phonological and emotional language abilities regardless of learning styles.
- The richness of imagery makes it possible for the learner to note details and relationships that are personal to their own learning

The senses - mix-ups

- Senses are mixed linguistically in our brains
  - taste/touch: lemons = sharp
  - hearing/vision: pitch = going up or down
    voice = bright or dark
  - vision/hearing: shirt = loud
  - speed - which is faster lemon or banana?
  - smell - mint = high, leather = low

If you drink wine or eat chocolate while listening to high percussion, it tastes sharper; if you listen to low percussion, it tastes rounder

The senses - Proprioception

- Proprioception = where your body is in space
- dependent on combining other senses
  - hold arms out at sides, close eyes, touch end of your nose with tip of finger
  - in aeroplane - seeing the other passengers, tilt/no tilt
  - hold thumb out front,
    wiggle thumb = blur, wiggle head = still (eyes vs ears)
  - stand on one leg with eyes open or eyes shut
- Proprioceptive feedback can be learned and corrected
- eg. spinning dancers (spotting), skaters (head-shake)

The senses - Interoception

- Exteroception = our awareness of the outside world
- Interoception = our awareness of our internal functions
- heartbeat, blood pulsing, gut movements
- We may be aware of these responses before we have cognitively processed the information
- This is 'gut instinct'

The senses - Interoception

- Interoception can be tested - how well you can track your heartbeat and changes to the heart rate
- Good interoceptors make better gut decisions (stock market traders)
- Better marksmen/snipers (fire between heartbeats)
- More empathy (subconsciously registering changes to another person's body eg. pupil size)

The senses - Interoception

- Can be a way of sensing things we can't actually sense another way
- eg. Infrasonic vibrations (too low to hear)
- may be an explanation for 'spooky' feelings
- Can be trained and learned

Use of imagery for brain stimulation (senses) and memory

- Working with meaning and making links between senses (metaphor)
- All words are metaphors...
- Use of external gesture to represent internal concept (pitch, loudness)

Use of imagery for brain stimulation (senses) and memory

- Early experience of play through song will lay down neural pathways for motor and auditory imagination
- Brain sorts input into patterns, these higher order structures are part of cognitive processing
- Enabling mental rehearsal and visualisation
- Hearing tunes or voice qualities in our head

Dual Coding Theory

- Two ways to expand on learned material:
  - verbal associations
  - visual imagery
- These have separate pathways in the brain
- If you reinforce both, then access to the information is quicker and more reliable

Paivio, A. (1969). "Mental Imagery in associative learning and memory." Psychological Review **76**(3): 241-263.

Imagery and real life

- Much more useful if linked to real-life experiences (get to know your student)
- Physical embodiment of intervals and rhythmic patterns (eg Kodaly and Dalcrose)
- Accurate body-mapping helps physical imagery (eg. tongue position)
- Mental rehearsal for confidence and flow state

In order to learn, the student needs:

- Positive affirmation
- Sensory stimulation
- Variety in the message
- Repetition and habit-learning (Mastery)
- Empowerment (Autonomy)
- Emotional connection (Purpose)

Daniel Pink

EVOLVING VOICE

Choral Directors' guide to Singing: 16-17 April

Acoustics of the Voice (with David Howard): 29-30 June

Teaching Young Voices: Manchester 7-9 Aug

Colchester 17-19 Aug

Singing in the Brain: a weekend in Oct (tbc)

www.jenevorawilliams.com

www.EvolvingVoice.com

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Why does singing make us feel good?

Dr Jenevora Williams
Illustrations by Harry Venning

What is singing?

- Vocalised sound
- Can be solo or group
- Pitch variation/control
- Temporal variation: breathing and articulatory gestures
- Quality or timbral variation: larynx or vocal tract
- Universal to all cultures
- Spans entire lifetime

Why do we sing? Philosophical angle

- "we do not have knowledge of a thing until we have grasped its why, that is to say, its cause." Aristotle
- Four causes:
  - Matter (material cause - what it's made of)
    Vocalised sound
  - Form (arrangement, shape or appearance)
    Pitch, temporal, timbral
  - Agent (where it's come from)
    An individual or group
  - Purpose (where it's going to)
    Another individual or group

Why would singing have evolved? There's a reason for everything

Tinbergen's four questions (1963)

* **Mechanism** (what) - physiology, context. What is happening in the nervous system
* **Function** (why) - look at why function has evolved in terms of genetic fitness
* **Ontogeny** (how) - development over lifetime, how do individuals develop the capability, nature/nurture
* **Phylogeny** (when) - how has it come about in evolutionary terms

Some facts about humans

- Brain size in early humans made a sudden leap 500,000 years ago
- Other physical changes at or soon before this time
  - Lower hyoid
  - Expansion of vertebral column in thoracic region (breath control)
  - Increase in size of hypoglossal nerve (tongue control)
- Singing is closer to emotive sounds than to speech (different part of the brain)
- Evidence for language (gene for grammar and presence of symbolic artefacts) = 200,000 yrs ago
- Singing (in modern humans) increases wellbeing and social cohesion

Singing is good for you

- Singing leads to changes in:
  - Feeling connected
  - Positive affect
  - Mental health

Tuning in to others: Exploring relational and collective bonding in singing and non-singing groups over time
Eiluned Pearce, Jacques Launay, Pádraig MacCarron, Robin I. M. Dunbar
Psychology of Music Vol 45, Issue 4, 2017

Singing and wellbeing

Participation in musical activities enhances social bonding between humans

Tarr, B., et al. (in press). "Music and social bonding: 'self-other' merging and neurohormonal mechanisms." Front Psychol.

Choral singing in the workplace results in overall positive responses for participants

Vaag, J., et al. (2014). "'Sound of Well-being' revisited - Choir singing and well-being among Norwegian municipal employees." Journal of Applied Arts and Health 5(1): 51-63.

Singing and wellbeing

Increased confidence, peer support, enhanced mood, increased motivation and changes to communication - all results for stroke patients from singing in a community choir

Tamplin, J., et al. (2013). "'Stroke a Chord': The effect of singing in a community choir on mood and social engagement for people living with aphasia following a stroke." NeuroRehabilitation 32: 929-942.

Improvements to respiratory condition and to psychological wellbeing

Skingley, A., et al. (2013). "“Singing for Breathing”: Participants' perceptions of a group singing programme for people with COPD." Arts and Health DOI: 10.1080/17533015.2013.840853.

Singing and wellbeing

People with quadriplegia: significant improvements in speech intensity and maximum phonation time, improvements in related muscle strength

Tamplin, J., et al. (2013). "Effect of singing on respiratory function, voice, and mood after quadriplegia: a randomised controlled trial." Archives of Physical Medicine and Rehabilitation 94: 426-434.

1124 choral singers surveyed: significant consensus on positive effects of choral singing on wellbeing and health

- Clift, S. and G. Hancox (2010). "The significance of choral singing for sustaining psychological wellbeing: findings from a survey of choristers in England, Australia and Germany." Music Performance Research 3(1): 79-96.

Singing and wellbeing

600 choral singers: significant improvements to wellbeing, quality of life and physical health. More so for women.

Clift, S., et al. (2010). "Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey." Journal of Applied Arts and Health 1(1): 19-34

Adults with chronic mental illness or disability: Personal impact, social impact and functional outcomes

Dingle, G. A., et al. (2013). "'To be heard': The social and mental health benefits of choir singing for disadvantaged adults." Society for Education Music and Psychology Research 41.

Singing and wellbeing

Parkinson's patients - an hour a week for 20 weeks: No measurable decline in speaking voice symptoms during this time, significant improvement in singing

Elefant, C., et al. (2012). "The Effect of Group Music Therapy on Mood, Speech, and Singing in Individuals with Parkinson's Disease — A Feasibility Study." Journal of Music Therapy 49(3): 278-302.

After three months in a choir, participants showed benefits to quality of life and reduction in depression plus increased lung function

Gale, N., et al. (2012). "A pilot investigation of quality of life and lung function following choral singing in cancer survivors and their carers." Cancer Medical Science.

A look at hormones

- How to measure endorphins?
- Actual hormone levels have to sampled from spinal fluid - not easy
- However - higher endorphin levels enable the person to endure pain for longer
- Individuals participating in active music-making have significantly higher pain thresholds
- Contributes to levels of wellbeing

Dunbar, R., et al., Performance of music elevates pain threshold and positive affect: Implications for the evolutionary function of music. Evolutionary Psychology, 2012. **10**(4): p. 688-702.

Other hormone changes

- Singing in groups also **raises levels of oxytocin**
- Facilitates bonding, social cohesion
- Plus **reduces levels of cortisol** (stress hormone)
- (both can be measured from saliva samples)

Respiratory Sinus Arrhythmia

- HR is speeding and slowing constantly
- HR and RR are irregular oscillators; when RR is slowed and guided, the rate of variability is coupled
- Expiration causes a vagal response which slows the heart
- Unison singing of regular song structures makes the hearts of the singers accelerate and decelerate simultaneously

Music Structure determines heart rate variability of singers; Vickers et al, Frontiers in Psychology July 2013

Respiratory Sinus Arrhythmia What's the point?

- Singing (slowed exhalation) will slow the HR and relates to the parasympathetic nervous system (calming effect)
- Group activity with a steady pulse or beat is advantageous for synchronised activity
  - marching
  - aggressive chanting
  - duets and pair-bonding

Geissmann, T. and M. Orgeldinger (2000). "The relationship between duet songs and pair bonds in siamangs, Hylobates syndactylus." Animal Behaviour **60**(6): 805-809.

Why these responses?

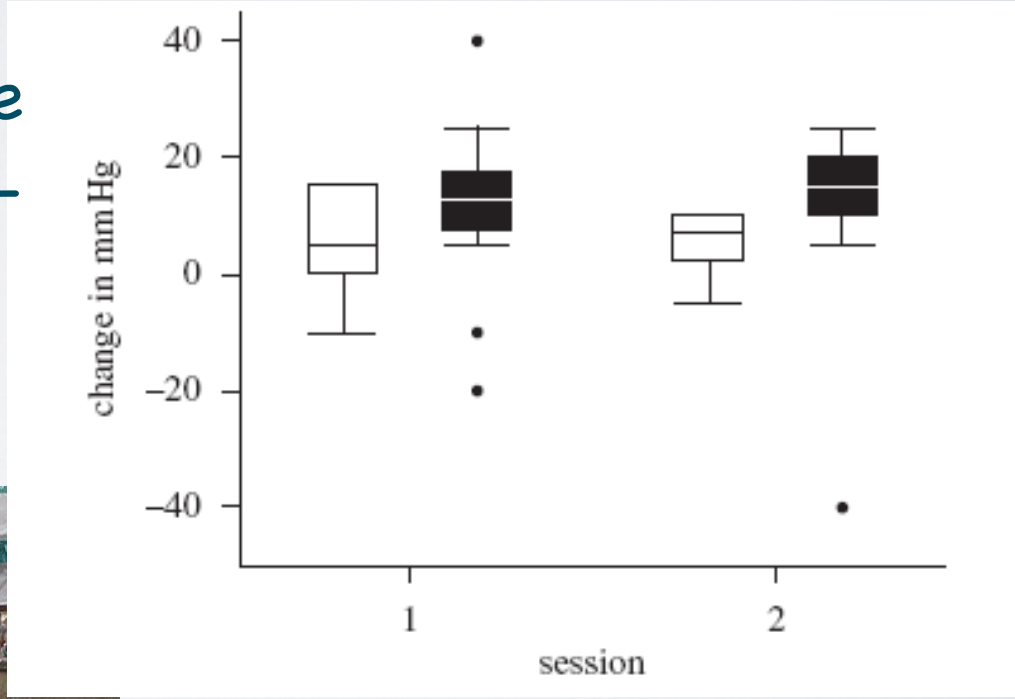
- Survival as a species is our reason for existence
- programmed to be seeking the most effective means of survival and reproduction
- if something is beneficial for our survival (eating high energy food, sexual attraction, looking after our offspring) that action will result in a positive hormone surge
- we will find it pleasurable and seek to repeat it/continue it
- **The feel-good factor is there to make us do it more**

It's not just singing in groups

- Activities with similar effects on the endocrine system
  - Drumming (Bittman 2001)
  - Team sports (Cohen et al 2010)
  - Dancing (Tarr 2014)

Better Together

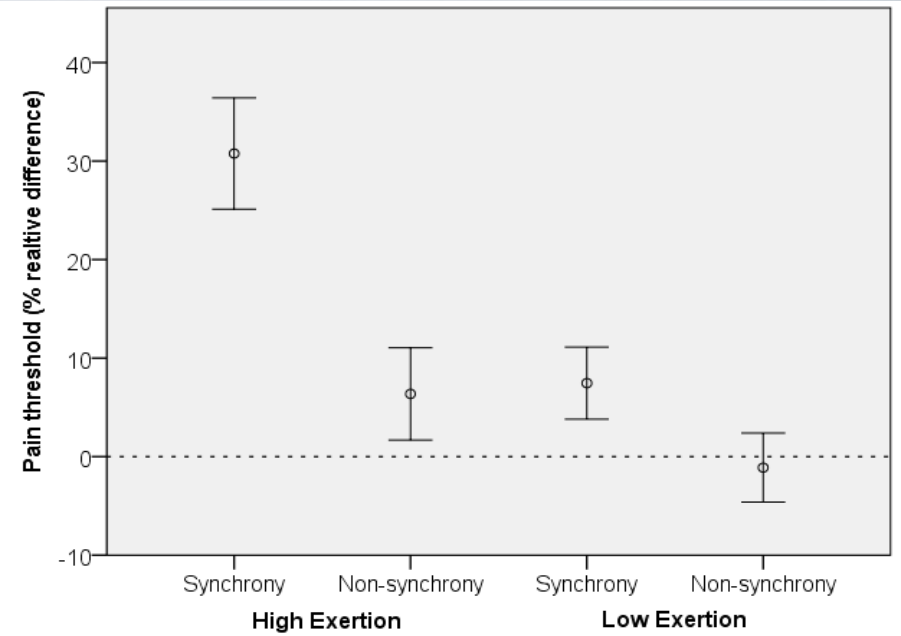
- Change in pain threshold before and after 45 mins rowing work-out on ergometers in the gym: Alone vs in a virtual boat

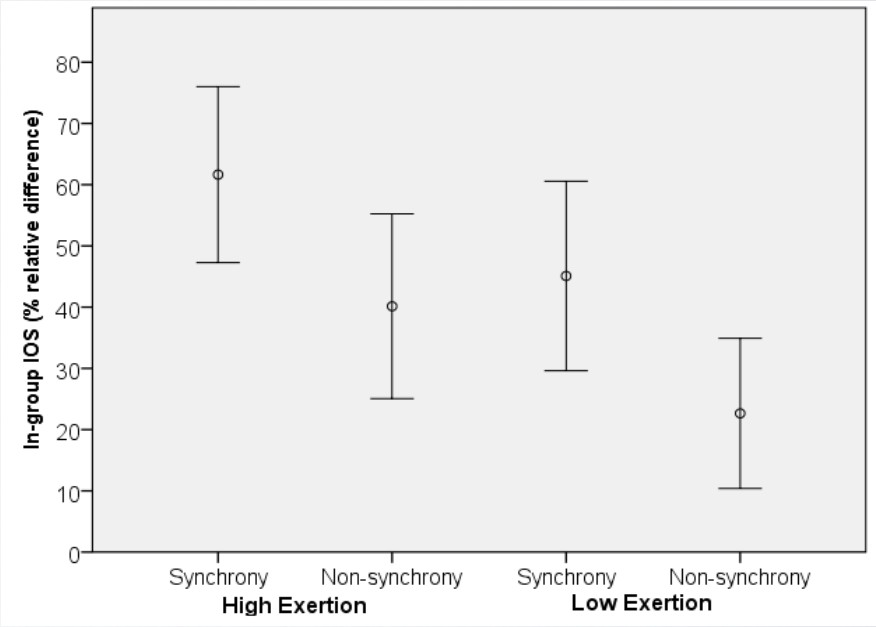


Rowers' high: behavioural synchrony is correlated with elevated pain thresholds
Cohen et al, Biology Letters, Vol 6 Issue 1 2010

‘Dance is the hidden language of the soul’ - Martha Graham

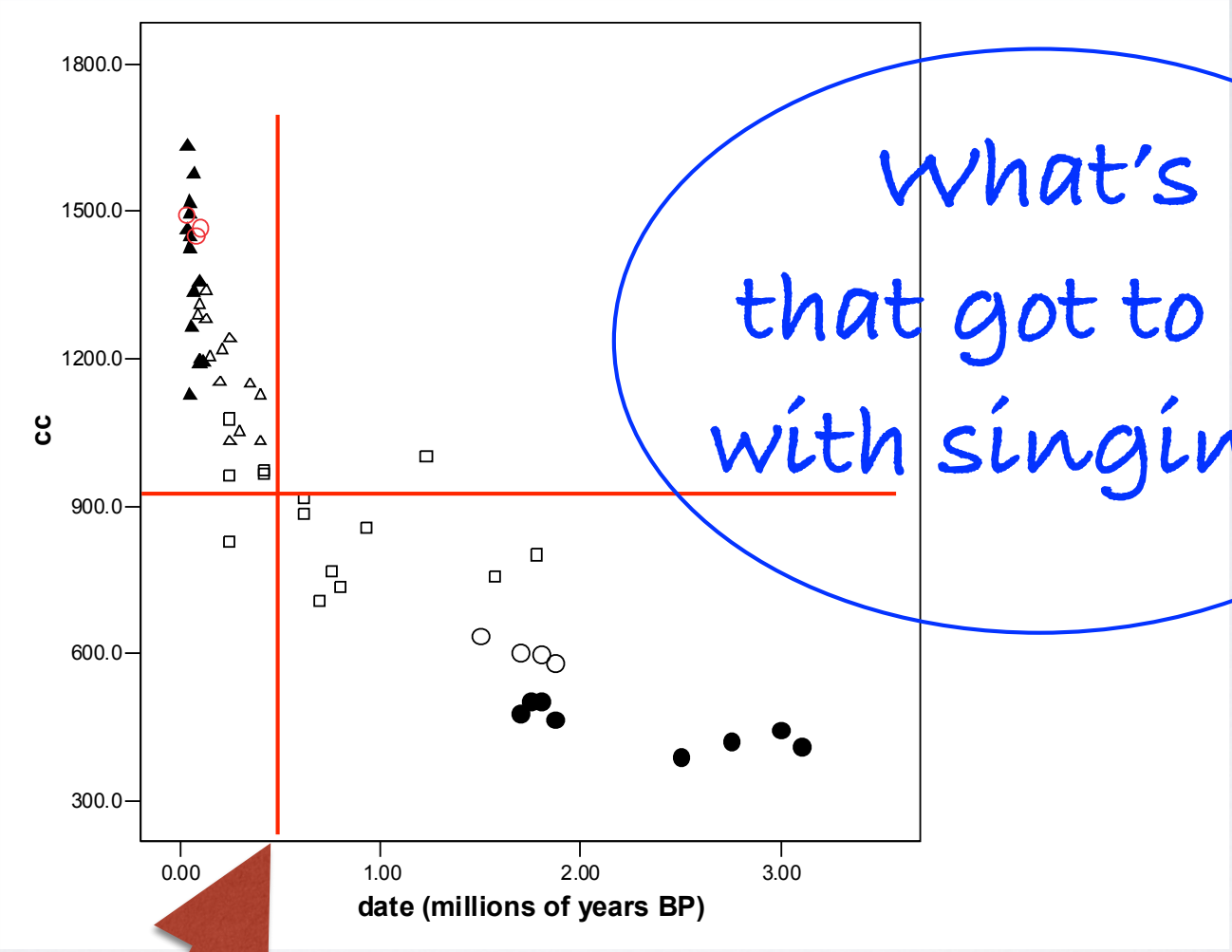
- A study carried out in Brazil with very simple dance moves
- Dancing in synchrony triggers a much bigger endorphin ‘kick’
- and makes you feel more part of the group





Synchrony and exertion during dance independently raise pain threshold and encourage social bonding
Tarr et al. Biology Letters, Vol 11, Issue 10 2015

Brain size in early humans made a sudden leap 500,000 years ago

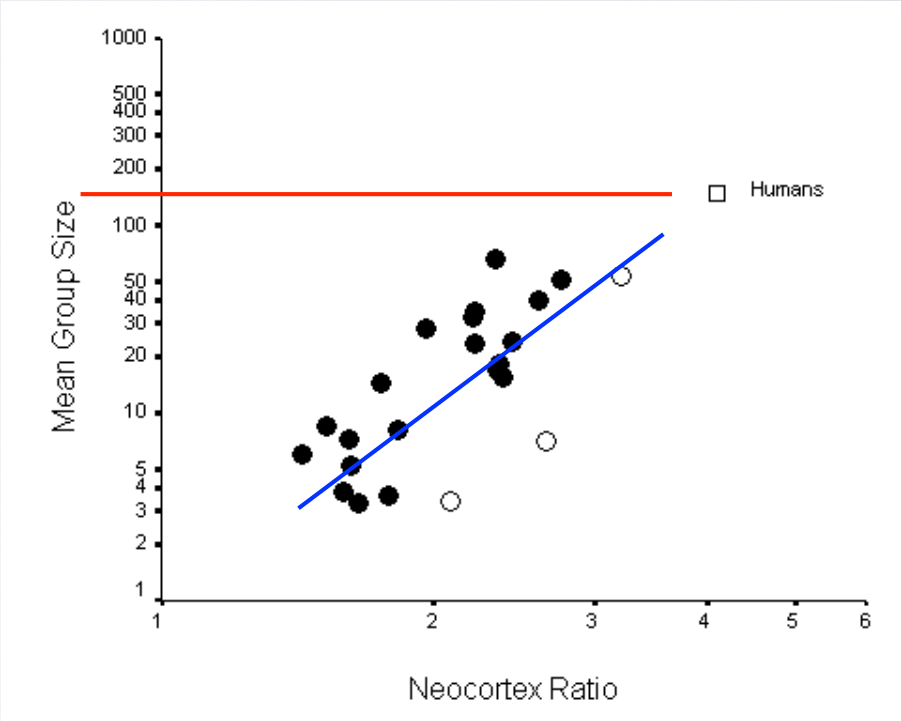


What's that got to do with singing?

Robin Dunbar

Social Brain Hypothesis

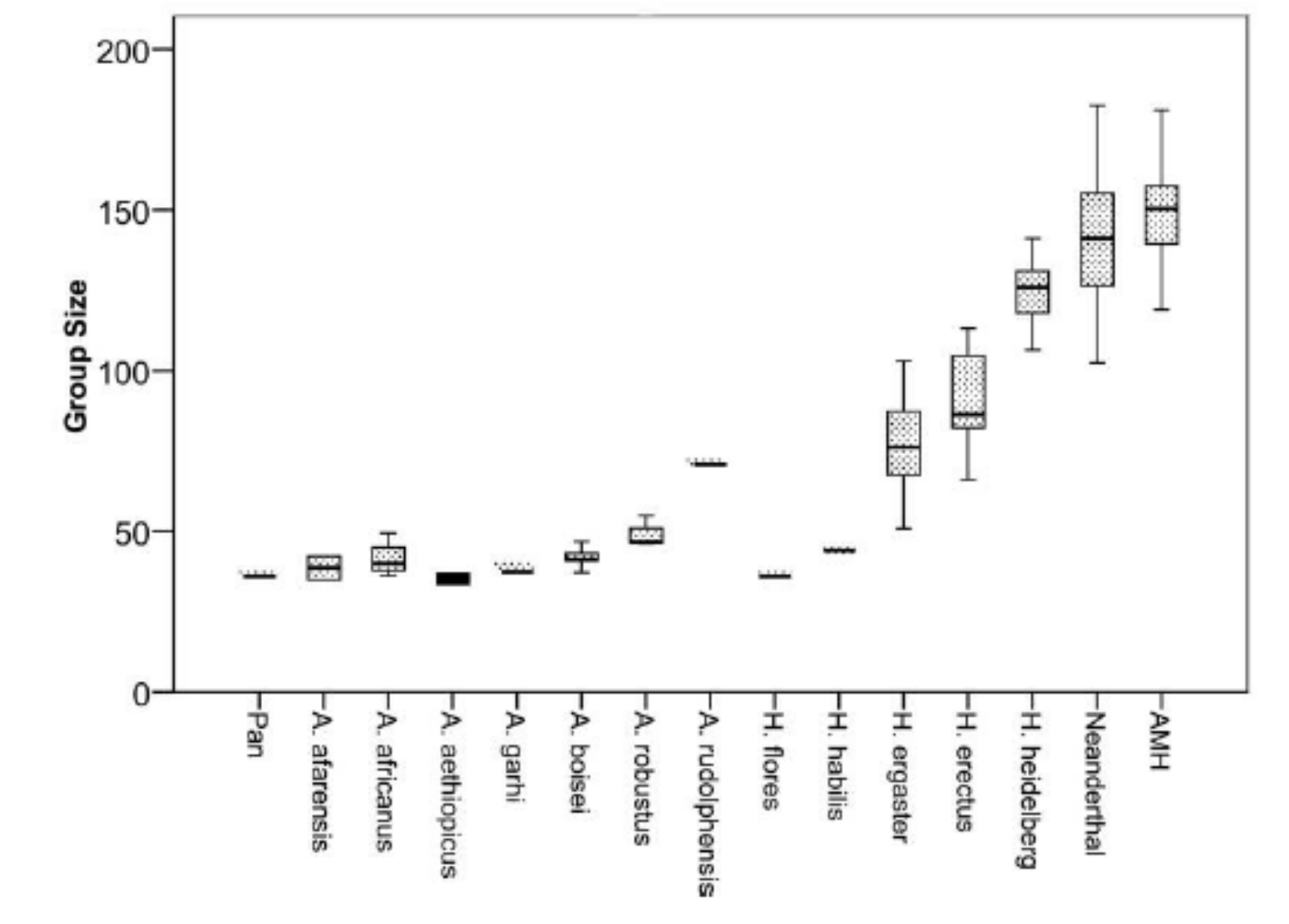
- Brain size is directly related to social group size
- Dunbar's Number = calculation of correlation between neocortical size and group size
- Group size for humans = 120-150
  Village size, parish records
  Army company
  Xmas card lists
- Remains consistent even with social media explosion



The Limits of Friendship, Maria Konnikova New Yorker 2014

Robin Dunbar

Social Brain Hypothesis

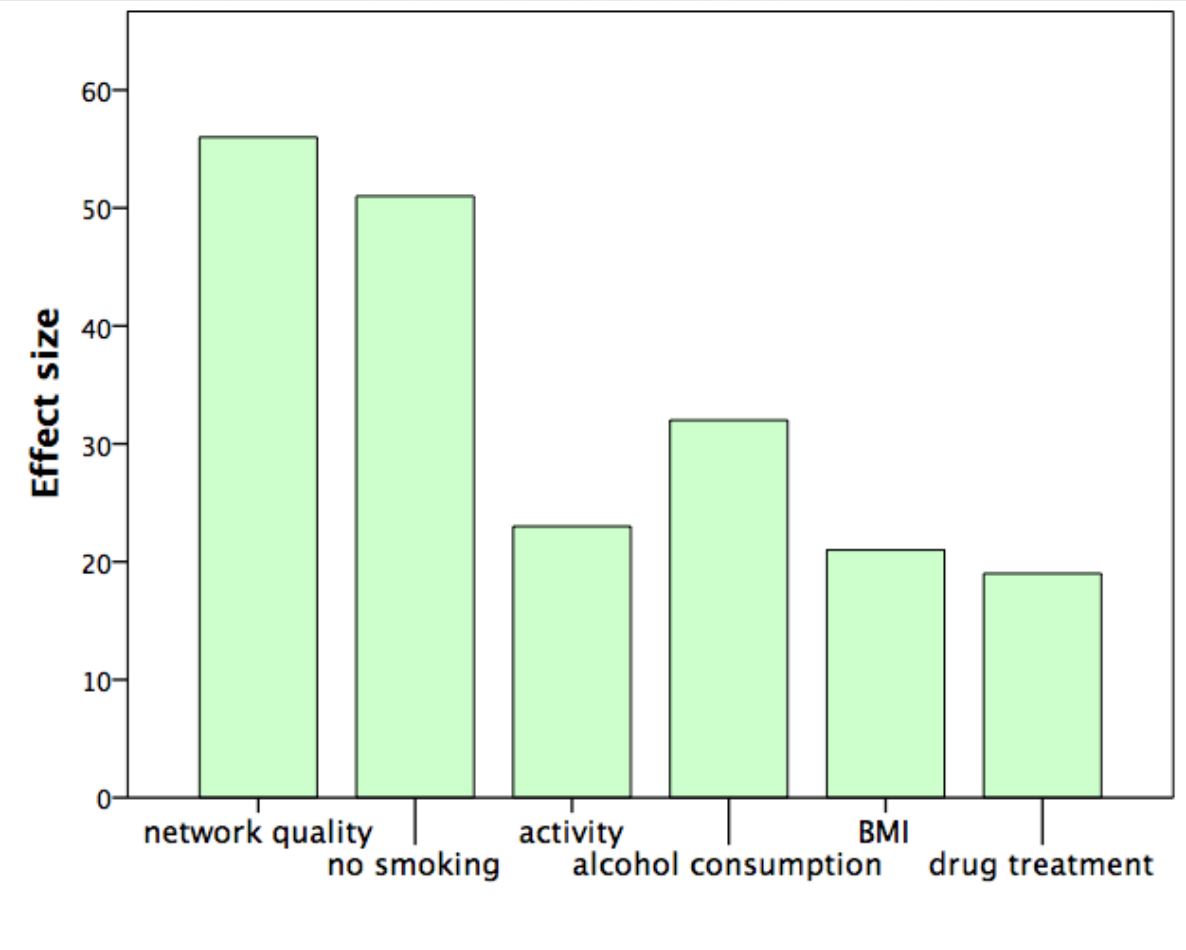


- Group size calculated from brain size

Robin Dunbar

Why does group size matter?

Meta-analysis of 148 studies of heart attack patients

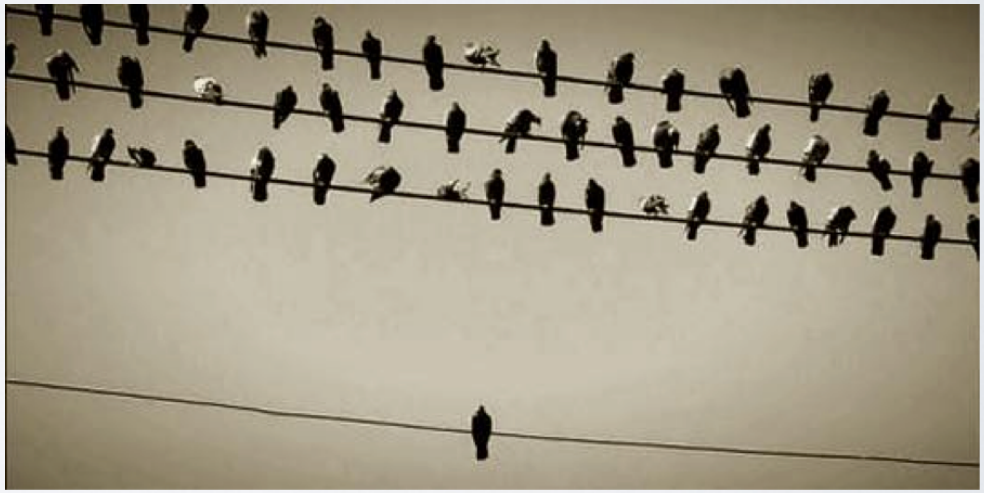


Best predictor of survival for 12 months after a heart attack

Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the **Framingham** Heart Study Fowler et al. BMJ 2008

Group bonding is essential for social contracts

- Primate social systems are implicit social contracts
- Primates solve the problems of successful survival and reproduction communally
  e.g. Finding food
  Care of the young
- But social contracts are notoriously prone to free-riders
- How do we establish and maintain these contracts?



Robin Dunbar

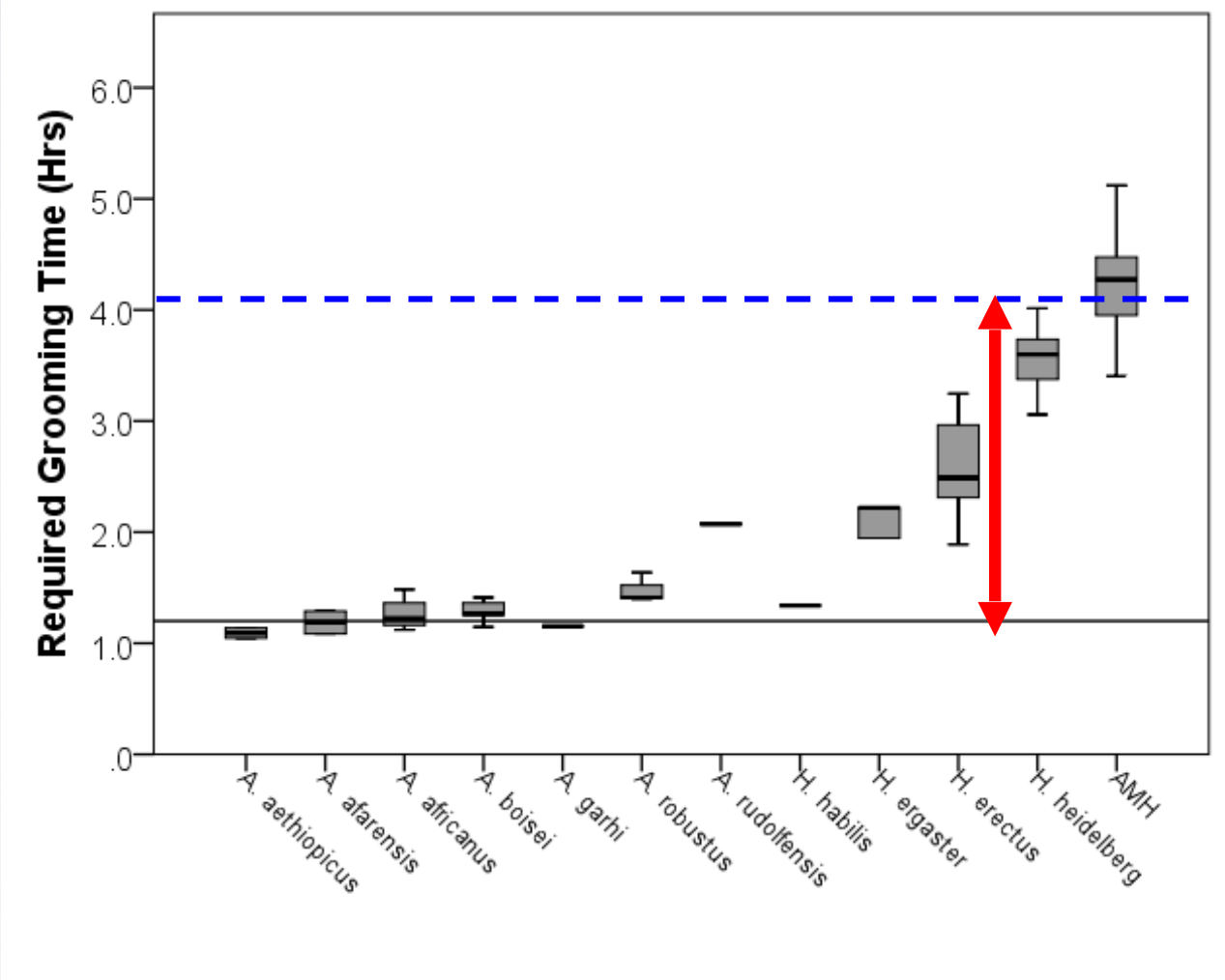
Group bonding is essential for social contracts

- Other primates bond with physical grooming
- Stimulates release of endorphins
- creating an opiate 'high'
- This fosters a sense of mutual trust
- Why can't grooming account for larger group sizes?

Robin Dunbar

Grooming time-limits

- In order to facilitate the grooming requirements for the modern human group size - we would need another three hours a day
- And group size would have grown incrementally, without the surprising leap
- There must be something else going on...



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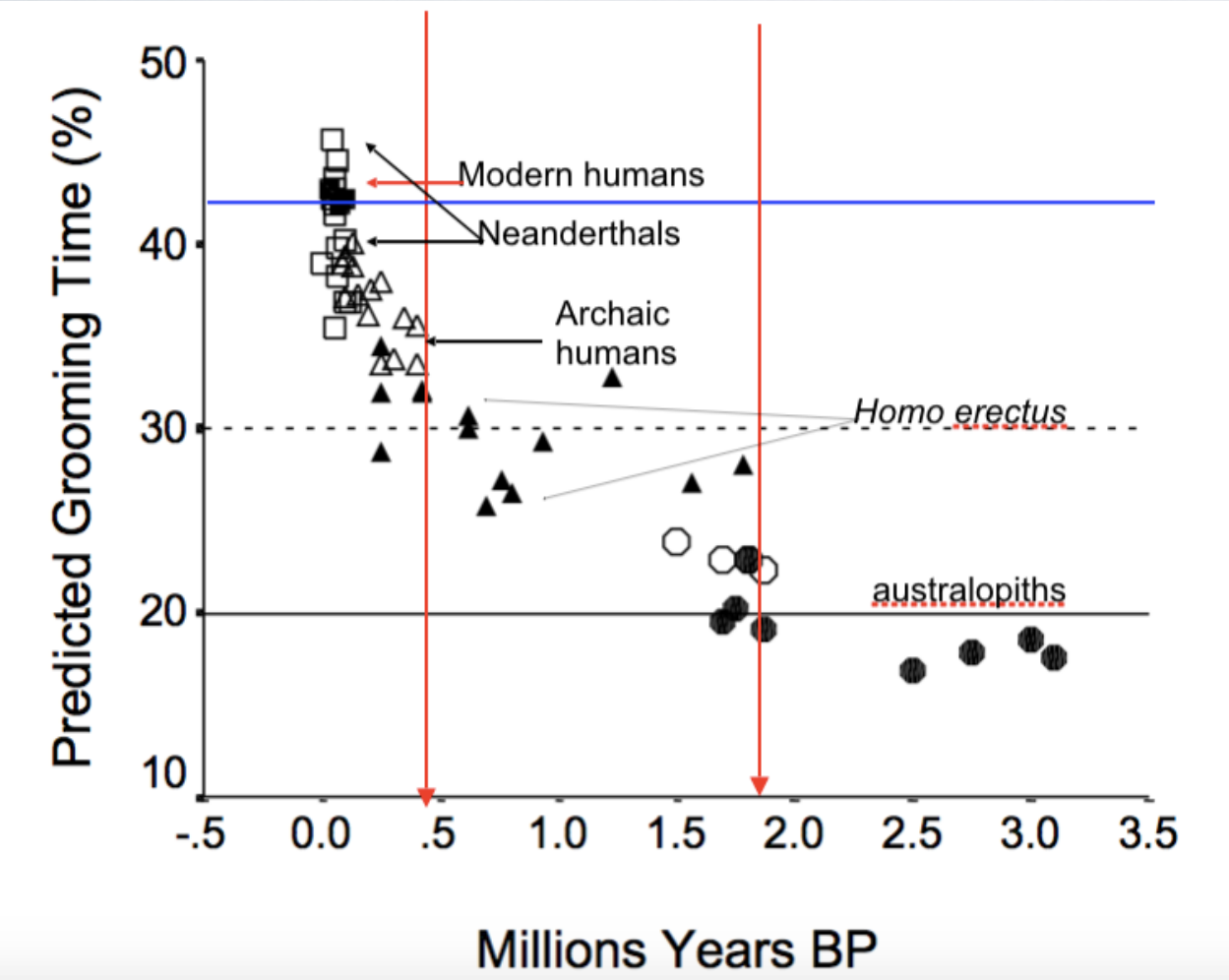
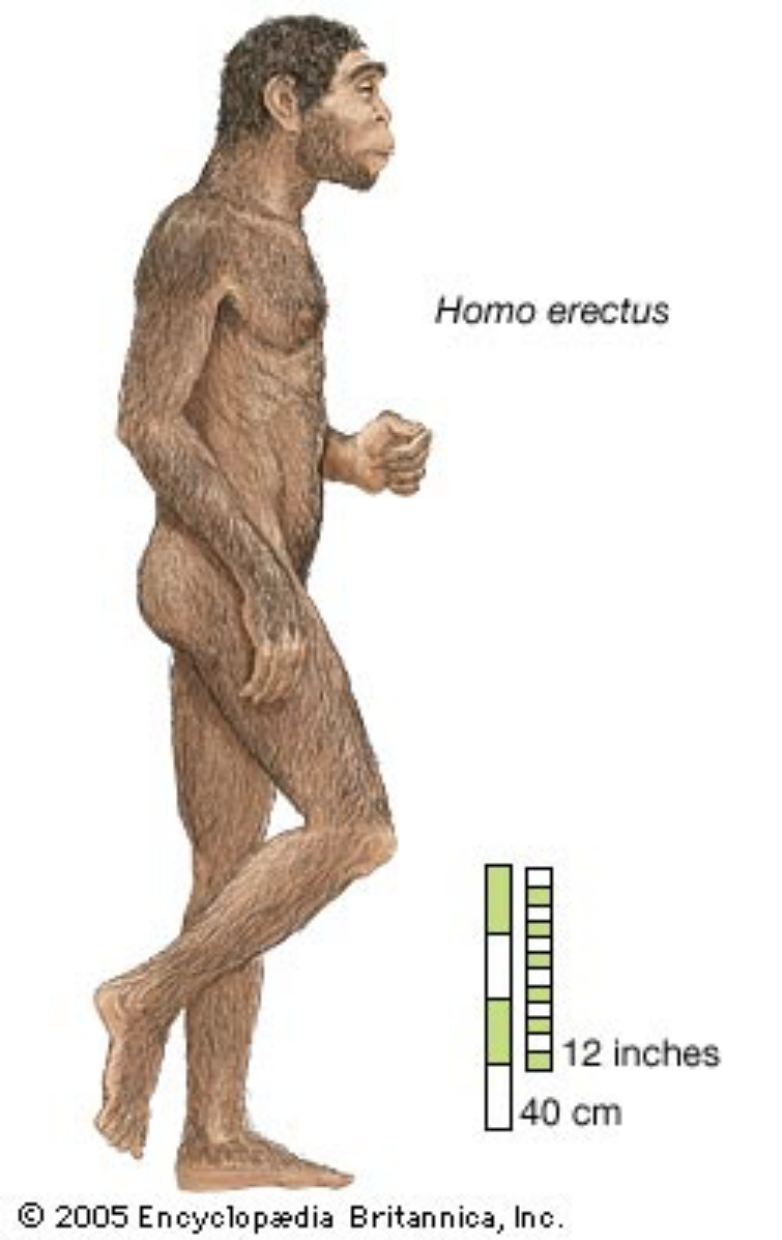
Two noticeable changes in brain size over time



- Two options (brain size): 2mya or 1/2mya
- We need more clues…

Robin Dunbar

Homo erectus



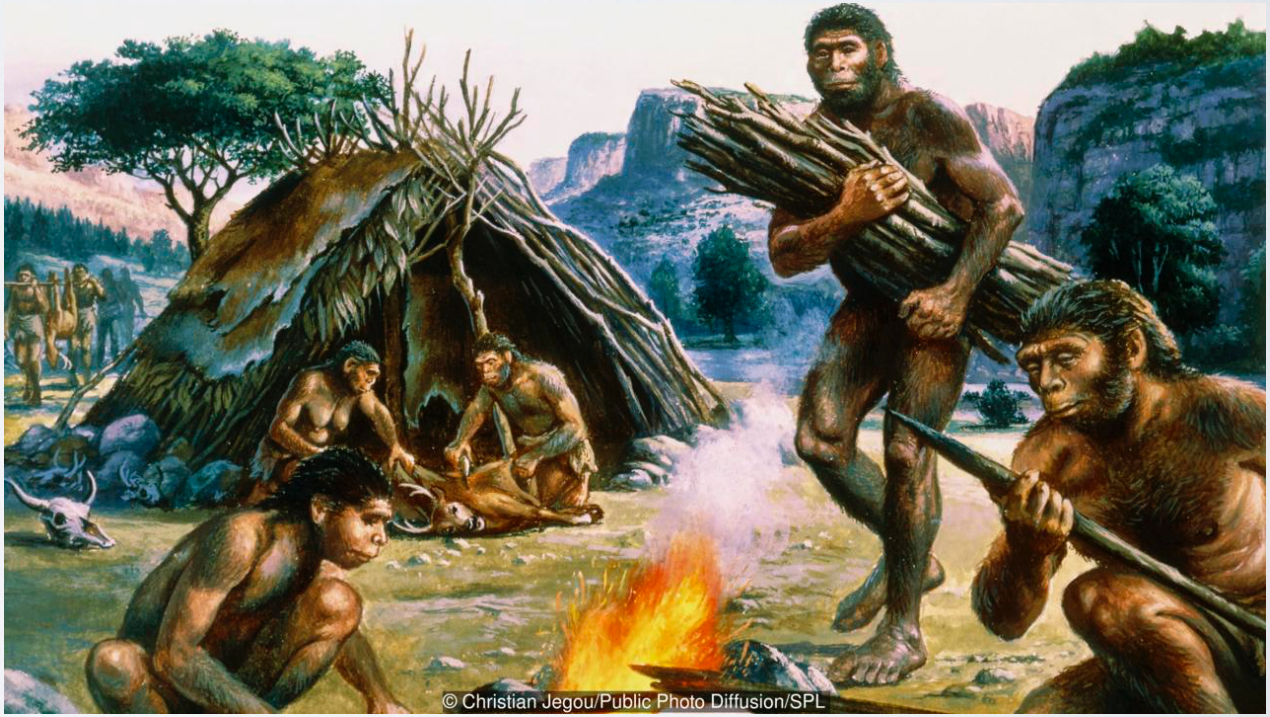
- 1.5 MYA - fully bipedal
- long-distance running (fully developed gluteus maximus)
- enhanced breathing control (independent of walking/running gait)
- head and neck alignment of spinal cord into the brain allows for a lower larynx
- Upper body now available for gesture/dance?

Steven Mithen
Daniel Lieberman

- bipedalism - narrow pelvis
- premature babies
- for 1st yr baby development is at foetal rate
- associated childcare needs
- Motherese? Infants more attentive to singing than speech

Singing and childcare

Steven Mithen
Michael Trimble



Trevarthen, C. (2002). Origins of musical identity: Evidence from infancy for musical social awareness. Musical Identities. R. Macdonald, D. J. Hargreaves and D. Miell. Oxford, OUP: 21-38.

Homo erectus

- hand axes show a sophisticated level of cultural transmission of skill
- Early skeletons have broken bones and injuries from big game hunting
- Close physicality of hunting requires co-operation, planning and trust (these are pre-language societies)
- Singing and dancing together?

Steven Mithen

More clues - other uses of voice…

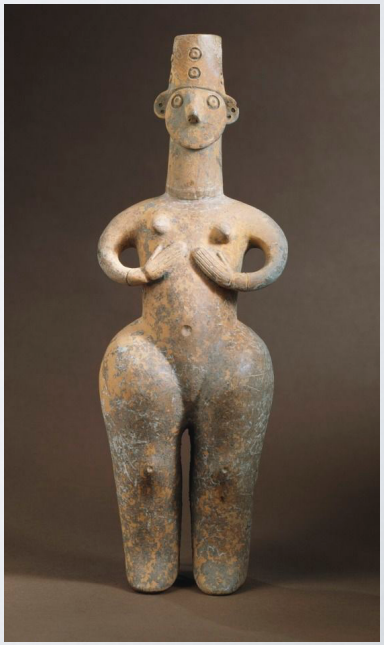
- **Laughter**
- Social emotion, we use it to maintain social bonds
- Synchronous exhalation - precursor to other vocalising
- laughter sounds are simpler than singing or speaking

- come from deeper part of the brain
- Shared with other primates and even other mammals
- so - it's older than 500,000 years ago

Sophie Scott

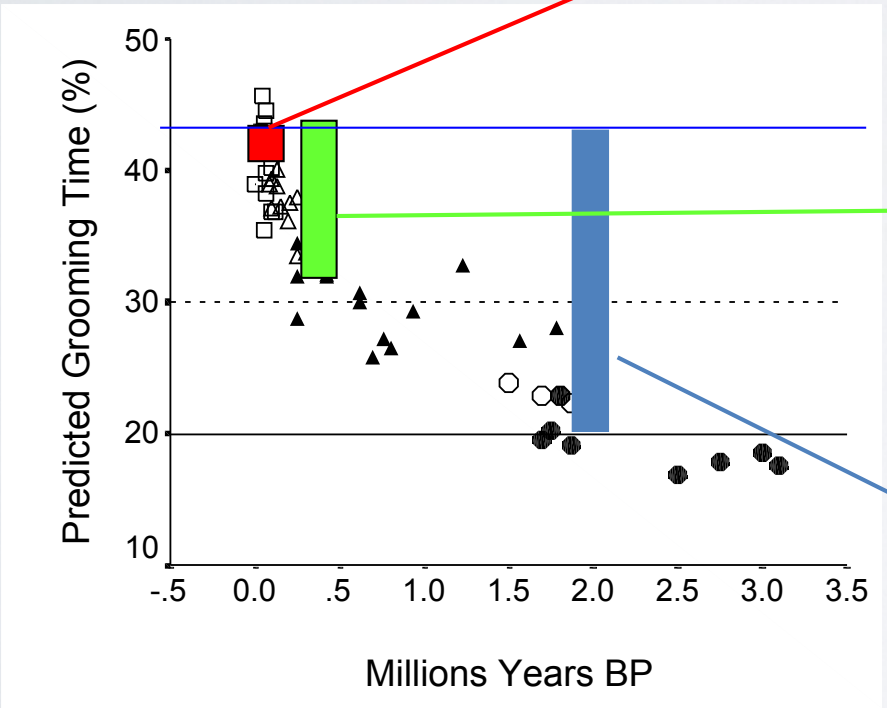
More clues for bonding and brain size…

- **Language**
- huge adaptive advantages
- detailed instructions
- story-telling
- religion and rituals
- representational artefacts
- 200,000 years ago



Bridging the gap in group size

Language



Singing

Laughter

NB Cooking also emerged at the same time as singing

What did Darwin have to say?

- Singing or music-making evolved as a way to enhance sexual attraction?
- Patterns of output of creative musicians, e.g.:
  Jazz musicians
  Pop musicians
  19c Classical composers
- Output grows during adolescence, peaks in the 20s and tails off during child-rearing years
- Musical creative output is greatest at the time of looking for a mate

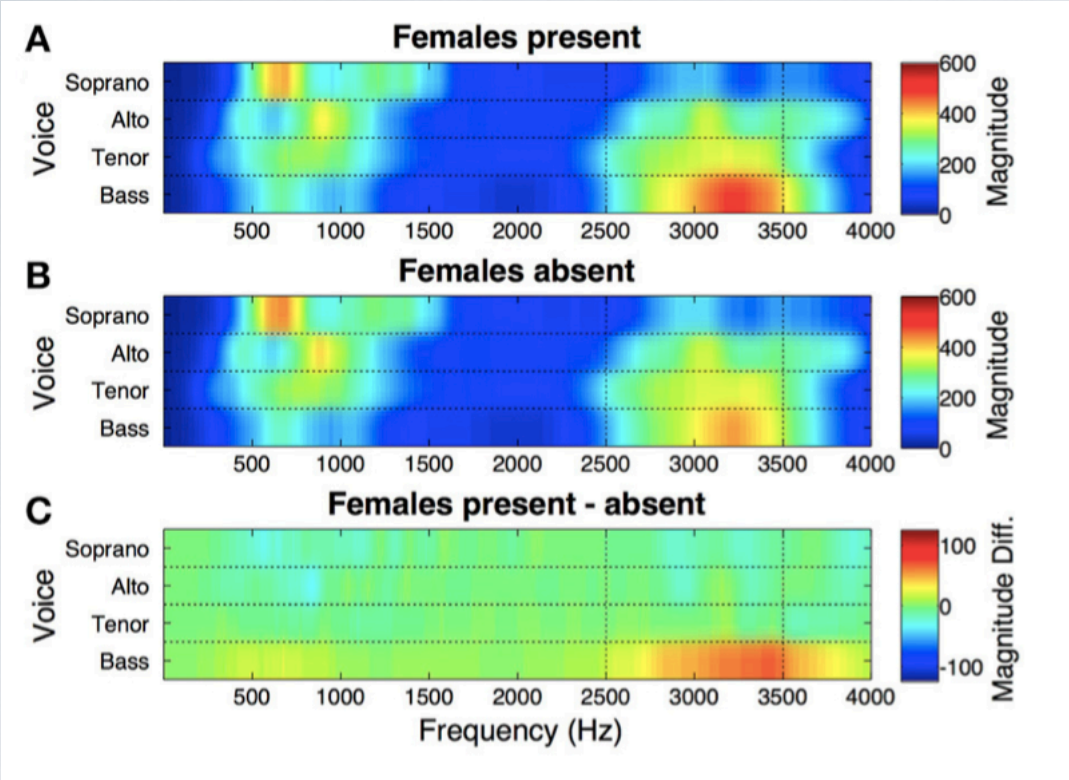
What did Darwin have to say?

- Singing or music-making evolved as a way to enhance sexual attraction?
- Musical creative output is greatest at the time of looking for a mate
- Not the case with, for example, interest in cooking, which tends to remain constant over the adult lifespan
- However, singing is consistent through all ages, from early childhood to elderly
- Therefore not **primarily** related to sexual attraction (although good singers are attractive - look at pop fans' behaviour)

Singing: cooperation or competition?

- Leipzig Thomanerchor
- Presence of female listeners

Keller, P. E., et al. (2017). "Simultaneous Cooperation and Competition in the Evolution of Musical Behavior: Sex-Related Modulations of the Singer's Formant in Human Chorusing." Frontiers in Psychology.



Singing: cooperation or competition?

- Boys with deepest voices enhance ringing frequencies (tenors and basses are more sexually aware than trebles)
- Maintaining choral cohesion
- Showing off individual prowess

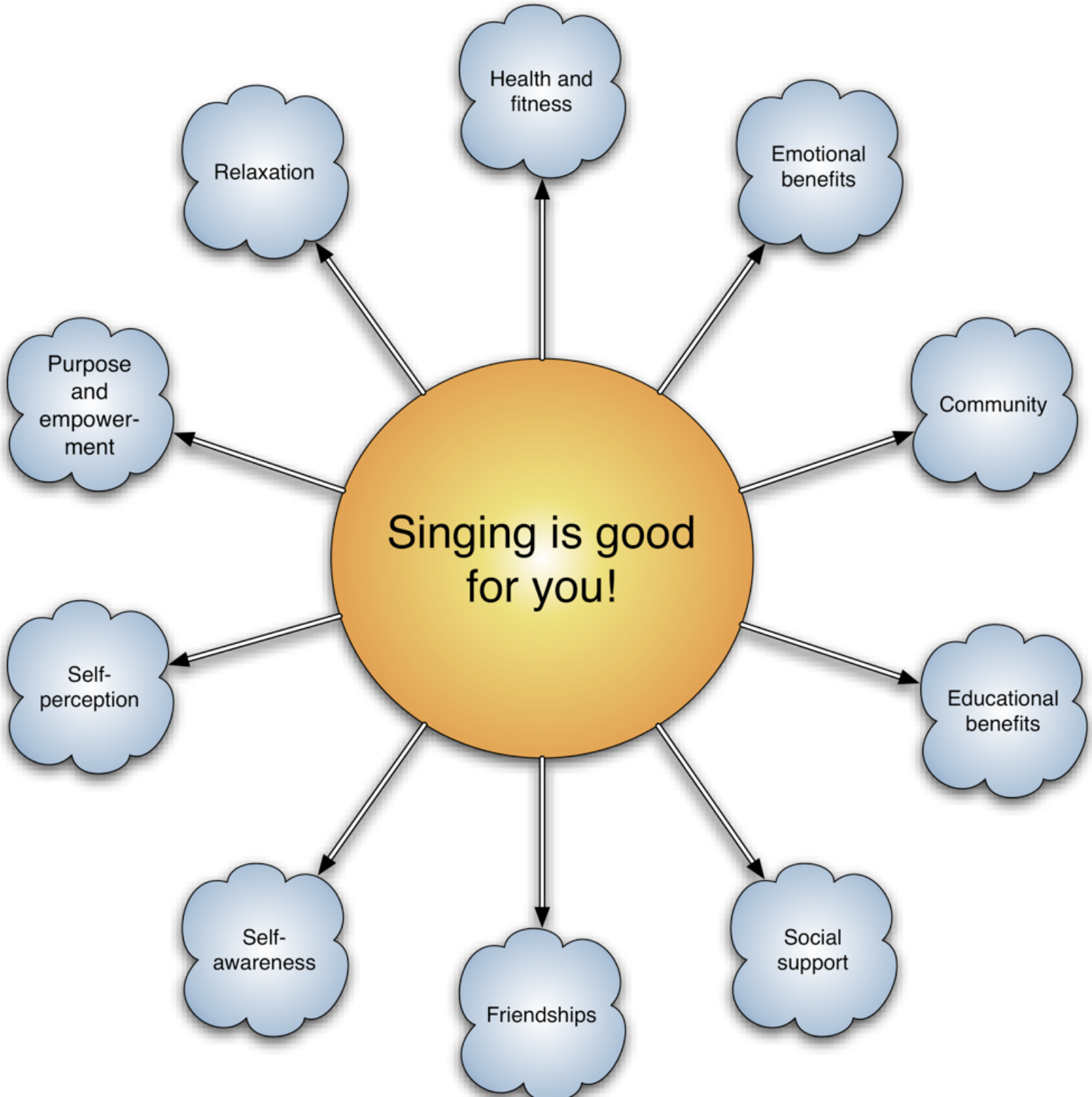
Keller, P. E., et al. (2017). "Simultaneous Cooperation and Competition in the Evolution of Musical Behavior: Sex-Related Modulations of the Singer's Formant in Human Chorusing." Frontiers in Psychology.

Singing in groups
The evidence suggests:

- Evolved 500,000 years ago
- Enabled early human group size to become significantly larger
- Facilitated communication and bonding
- Pre-dates language (200,000 ya)

Survival of the fittest

- ★ Mutational changes happen all the time within a species
- ★ Things only stick around if they are useful
- ★ There's a reason for everything in evolution
- ★ All of these changes we've explored happen to enable us to sing
- ★ They also make us feel great when we do sing
- ★ So - there must have been some advantage to the human species if we sing together
- ★ It enables us to bond in larger groups (120 instead of 40)


Singing is good for you!
Health and fitness
Emotional benefits
Community
Educational benefits
Social support
Friendships
Self-awareness
Self-perception
Purpose and empower-ment
Relaxation

EVOLVING VOICE

Choral Directors' guide to Singing: 16-17 April

Acoustics of the Voice (with David Howard): 29-30 June

Teaching Young Voices: Manchester 7-9 Aug

Colchester 17-19 Aug

Singing in the Brain: a weekend in Oct (tbc)

www.jenevorawilliams.com

www.EvolvingVoice.com