

Töres Theorell  
Professor emeritus  
Karolinska Institutet and  
Stress Research Institute, Stockholm  
University  
Website: [www.stressforskning.su.se](http://www.stressforskning.su.se)  
e-mail: [Tores.Theorell@ki.se](mailto:Tores.Theorell@ki.se)

The first slides show results from a study (Grape et al, Integrative Physiological and Behavioral Science 2003) of sixteen singers (eight professional and eight amateurs) followed before, during and after a singing lesson. Visual analogue scales (VAS) measuring relaxation-tenseness, tiredness-vitality and depressiveness-joy before and after the lesson. Blood samples were taken before and after the lesson to assess the concentration of two substances associated with "stress" (TNF alpha and cortisol) and one substance associated with "counter-stress" (oxytocin). Finally heart rate (beats per minute) was followed minute after minute and also a more complex group of assessments derived from the electrocardiogram, heart rate variability. In general a high heart rate variability shows that the subject has good capacity to integrate breathing with cardiovascular activity

Mean VAS before-after singing lesson (high score more joyful)

Sad-joyful

Amateurs 7.0 - 9.1

Professional 7.0 - 7.0

Two-way interaction,  $p=0.045$

Grape, Sandgren, Hansson, Ericson, Theorell. Integr. Physiol. Behav. Sci. 2003

Mean VAS before-after singing lesson (high score good)

•Lazy-energetic

•Amateurs 5.2 - 7.2

•Professional 5.9 - 7.4

•Main effect ( $p=0.03$ ), both groups improved but no interaction

### Mean VAS before-after singing lesson (high score good)

- Tense-relaxed
- Amateurs            6.1-8.2
- Professional        4.9-8.3
- Main effect ( $p=0.004$ ) but no interaction

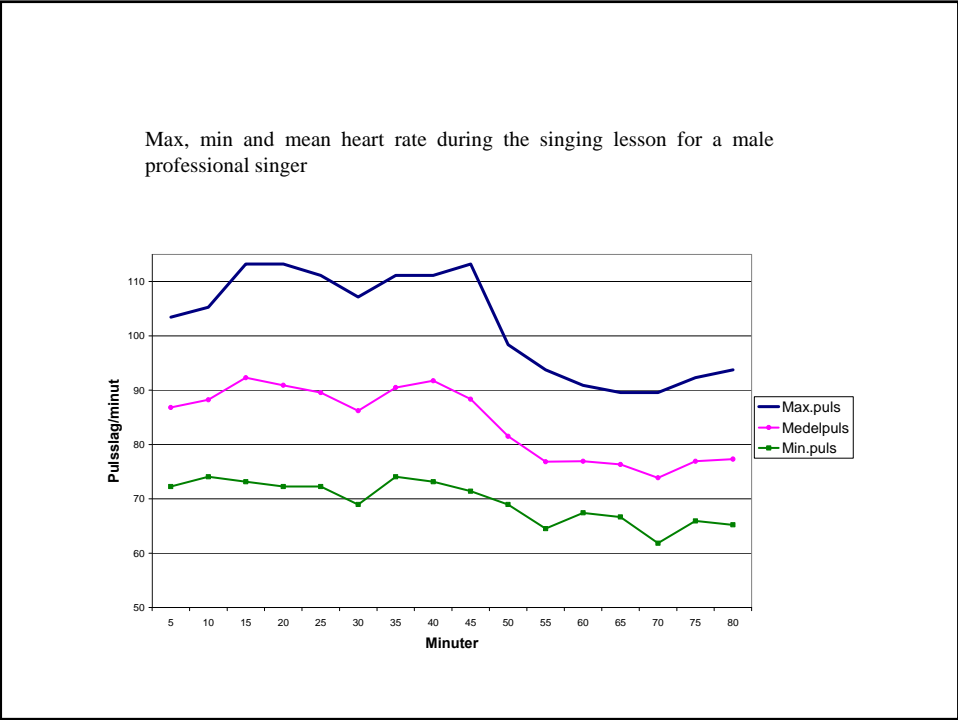
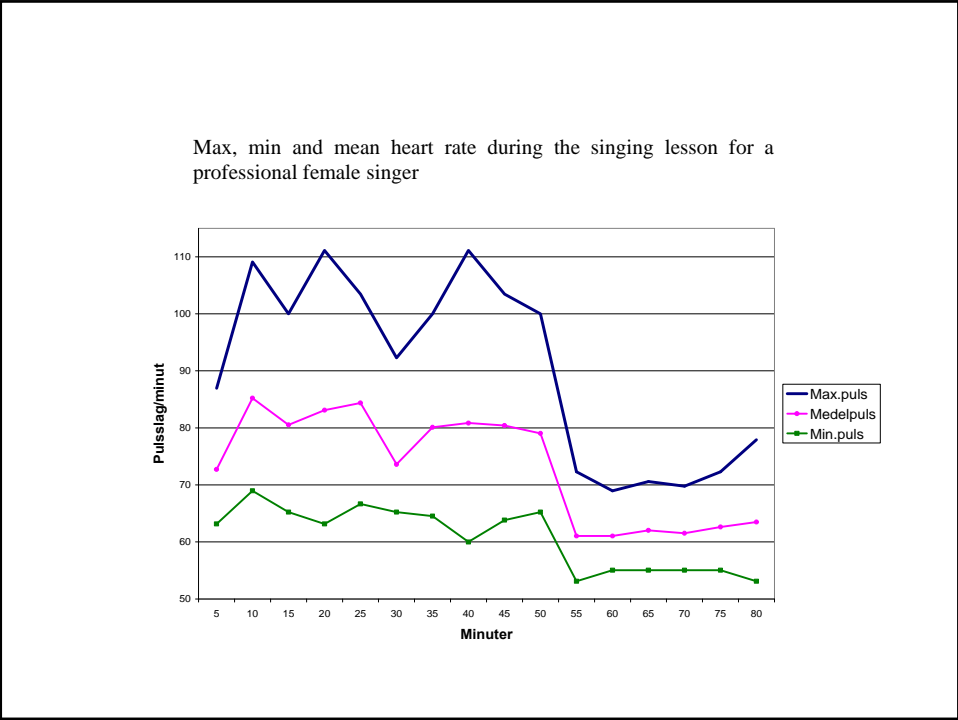
### Biological concomitants of the singing lesson

- In both groups rising plasma oxytocin ( $p= 0.009$ )
- Immunological parameter (TNF-alpha in serum) rising in professionals and decreasing in amateurs (interaction  $p=0.045$ )
- Similar tendency for serum cortisol (interaction  $p=0.063$ )

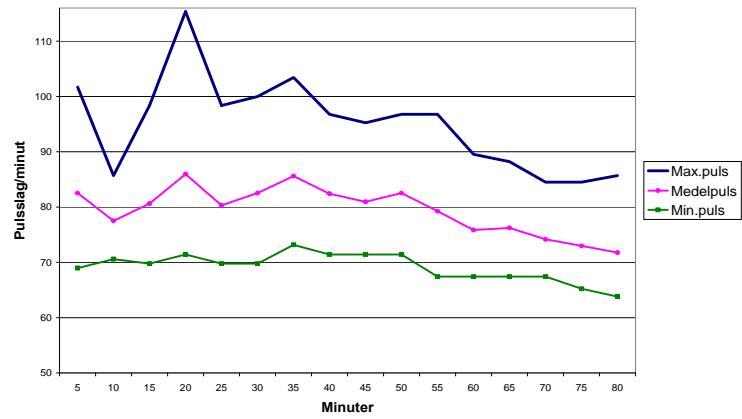
### Biological effects of singing lesson continued

- Professionals increased heart rate variability in general with increasing dominance during the lesson for sympathetic arousal in the professional group, in the amateur group unchanged balance between sympathetic and parasympathetic arousal (interaction  $p=0.02-0.04$  for variability and  $p=0.09$  for dominance of sympathetic)

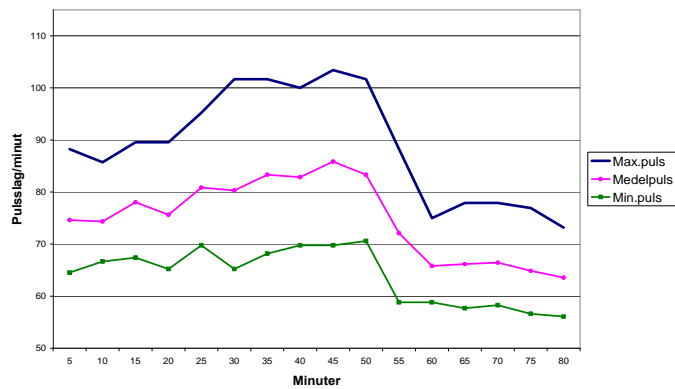
The following slides are examples of individual recordings. They show that there is little difference between amateurs and professionals with regard to heart rate per minute



Max, min and mean heart rate during the singing lesson for a female amateur singer

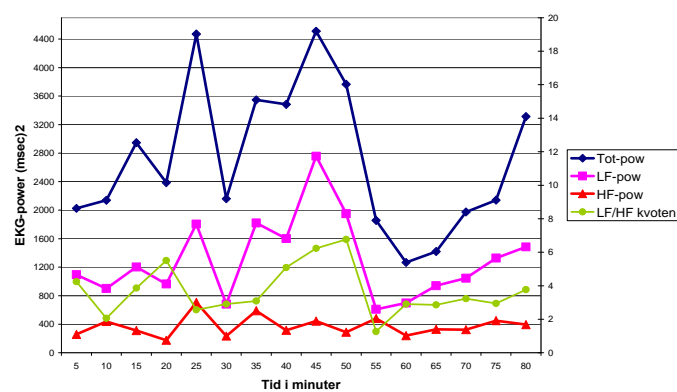


Max, min and mean heart rate during the singing lesson for a male amateur singer

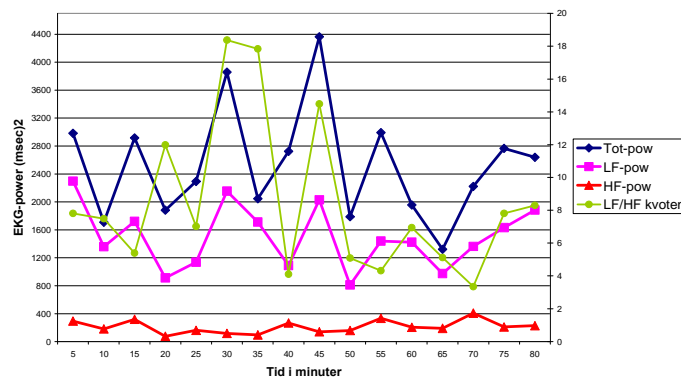


But with regard to heart rate variability there are marked differences between the two groups - much more variability in the professionals indicating better integration of breathing with cardiovascular function

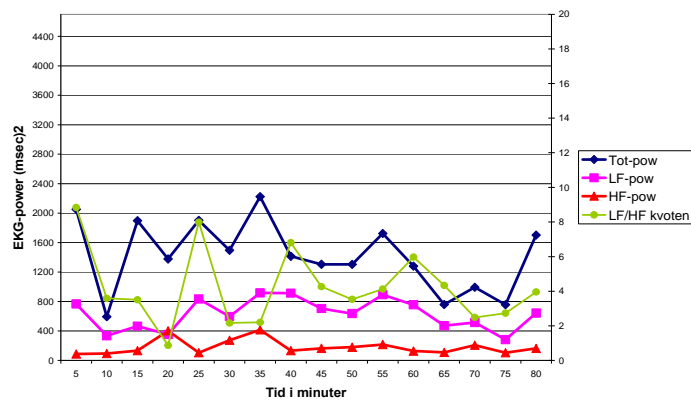
Tot-pow, LF-pow and HF-pow (0–4700 msec<sup>2</sup>) as well as LF/HF (0–20) during the singing lesson for a female professional singer



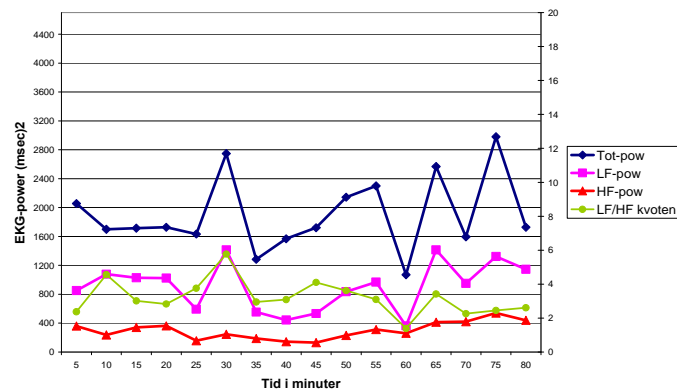
Tot-pow, LF-pow and HF-pow (0–4700 msec<sup>2</sup>) as well as LF/HF (0–20) for a male professional singer.



Tot-pow, LF-pow and HF-pow (0–4700 msec<sup>2</sup>) as well as LF/HF (0–20) for a female amateur singer.

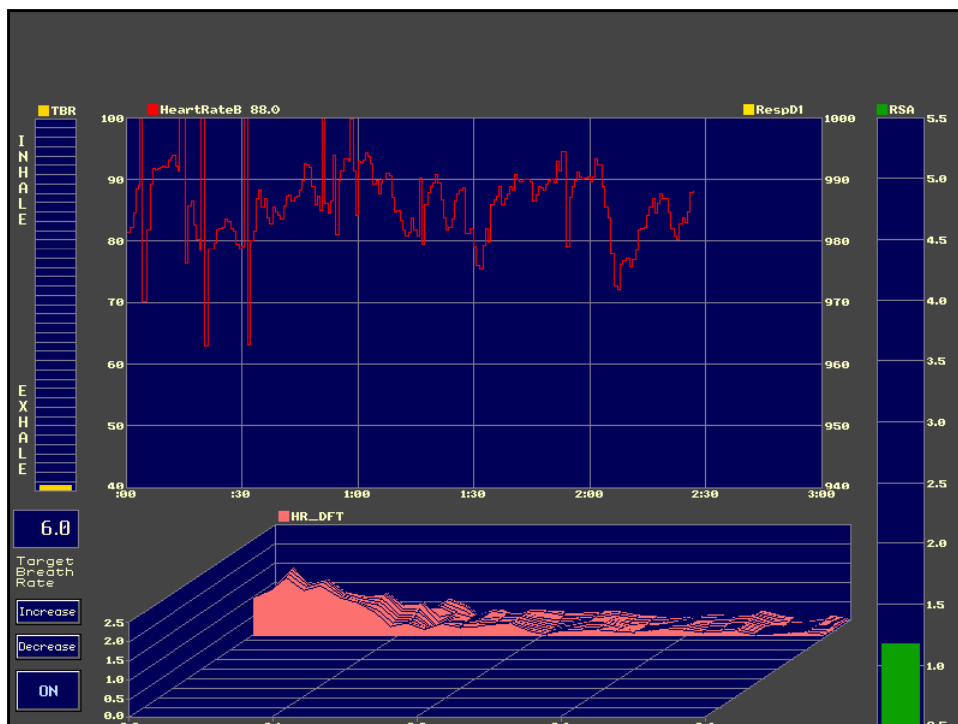
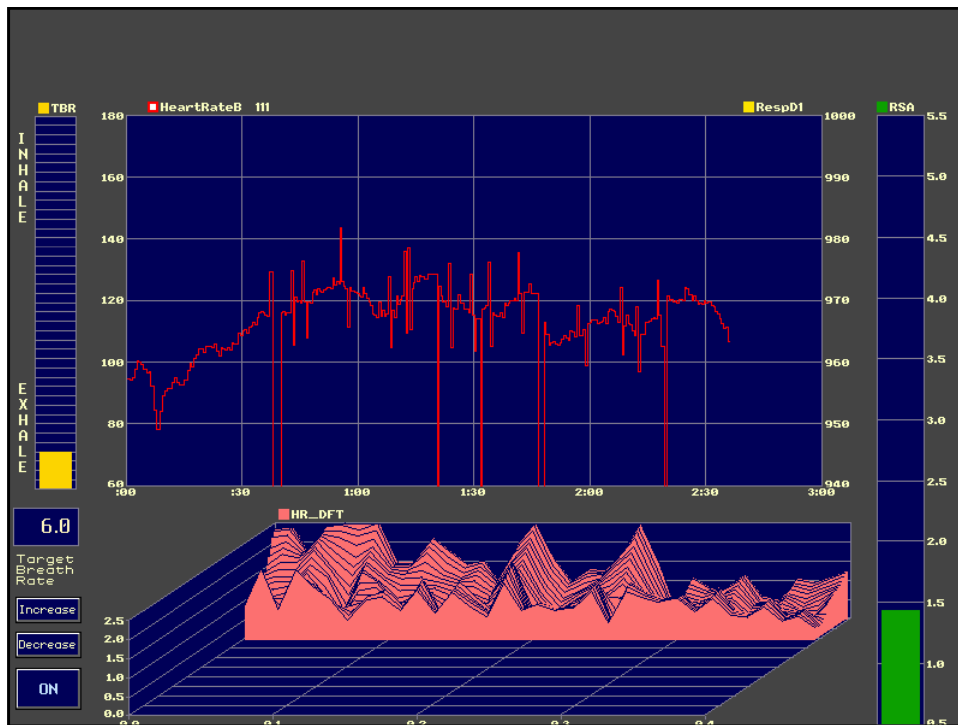


Tot-pow, LF-pow and HF-pow (0–4700 msec<sup>2</sup>) as well as LF/HF (0–20) for a male amateur singer.



The following two slides show "live" recordings from the lecturer while he sings two songs to an audience, one more strenuous and one more relaxed to an audience. Some artifacts have to be sorted out (long vertical lines) but apart from that the recordings show relatively high heart rates during the difficult piece, max 130 beats per minute during four relatively high (tenor) notes (G and A flat) during the strenuous but lower peaks (max 90) during the easy piece.

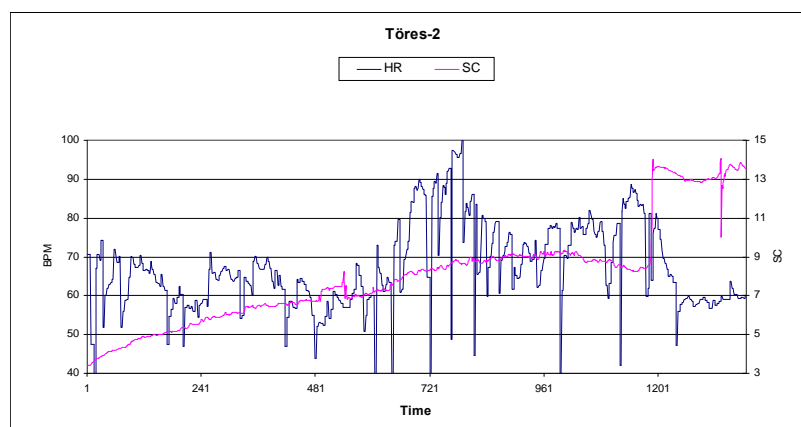
Courtesy of Bo von Scheele who made the recordings with his co-workers



These are the same songs recorded when the author sang without an audience, the relaxed song to the left and the strenuous song to the right.

Heart rates are lower (max 90 during the strenous and max 70 during the relaxed song) but we also see that heart rate variability increases when there is not audience

2005-09-13 1. Rangström + 2. Fridolin

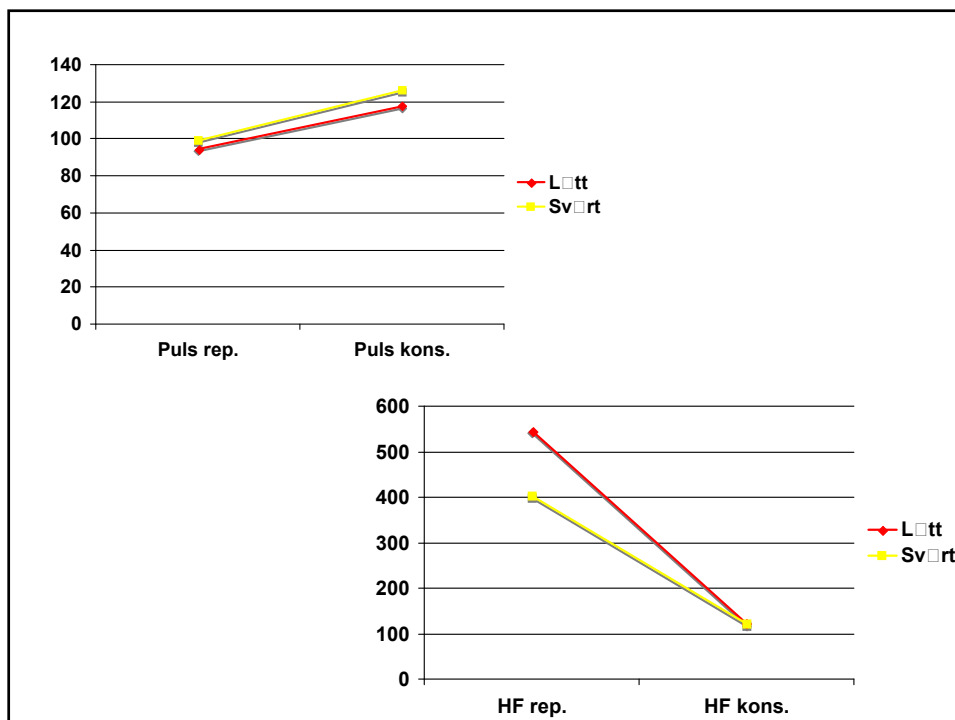


The next slide displays average heart rate and an average measure of a more sophisticated measure of parasympathetic (approximately corresponding to "counter-stress") activity (HF power, geometric mean) during four conditions in ten pairs of recordings (same easy and same strenuous piece with and without audience) in five singers and four flute players. The results show slightly higher heart rate and markedly lowered parasympathetic activity with audience. For strenuous/easy the difference is pronounced for parasympathetic activity without audience but there is no difference with audience

Lätt=easy Svår=strenuous

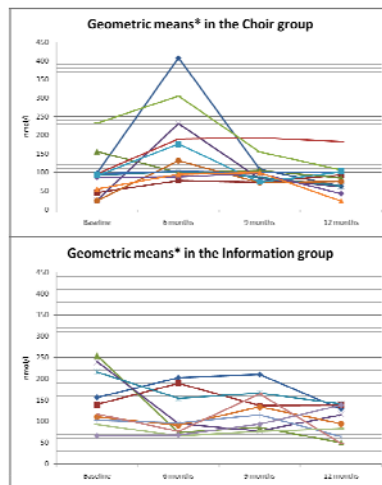
Kons=concert with audience, Rep=rehearsal in same place without audience

Harmat and Theorell, Music and Medicine, in press  
2009



25 classical pianists played a self-selected piece five times. The occasion with the highest flow rating (challenge-skill balance, concentration and "autotelic" - rating of positive affect which can make a task intrinsically rewarding) was associated with face muscle (mimics) activity, physiological arousal (sympathetic activity) and at the same time deep breathing which is associated with parasympathetic activity

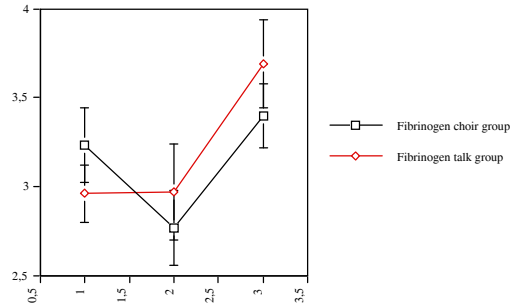
De Manzano Ö, Theorell T, Harmat L and Ullén F  
In press; Emotion 2009



Geometric means of individual saliva testosterone concentration in choir group (beginners) and information group of IBS patients, randomly selected for once a week meetings during a year. For each individual and assessment day there are geometric means of six assessments from morning to bedtime. Baseline, six months, nine months and twelve months from start

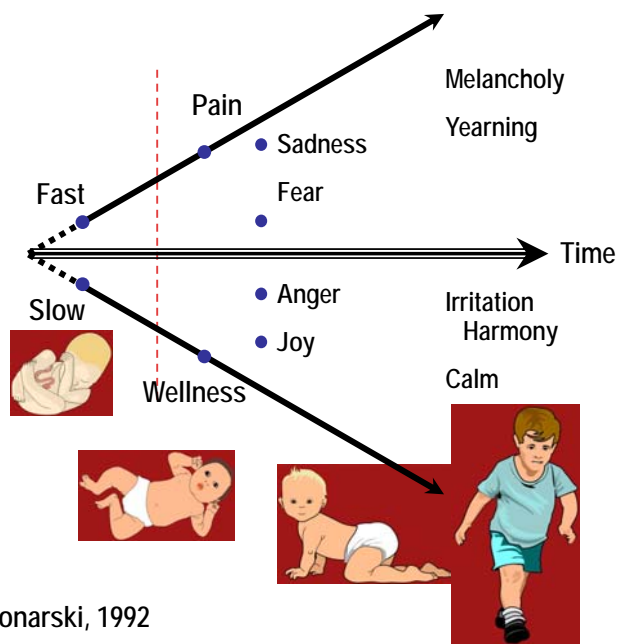
Grape, Wikström, Ekman, Hasson and Theorell Psychotherapy and Psychosomatics, in press 2009

Plasma fibrinogen in the two groups, Grape et al manuscript 2007



1= before start, 2= after half a year, 3= after a year

Grape, Theorell, Wikström and Ekman: Medical Hypotheses 2009



Konarski, 1992

Lindblad F, Hogmark Å och Theorell  
T: Music intervention for 5th and 6th  
graders – effects on development and  
cortisol secretion. Stress and Health  
23: 9-14, 2007

Three groups, one with extra music education (60 min every week of "socialising" music), one with extra computer education and one with "normal" curriculum. Saliva cortisol in the afternoon of regular school days decreased significantly during the study year in the music group but showed no significant change in the two other groups