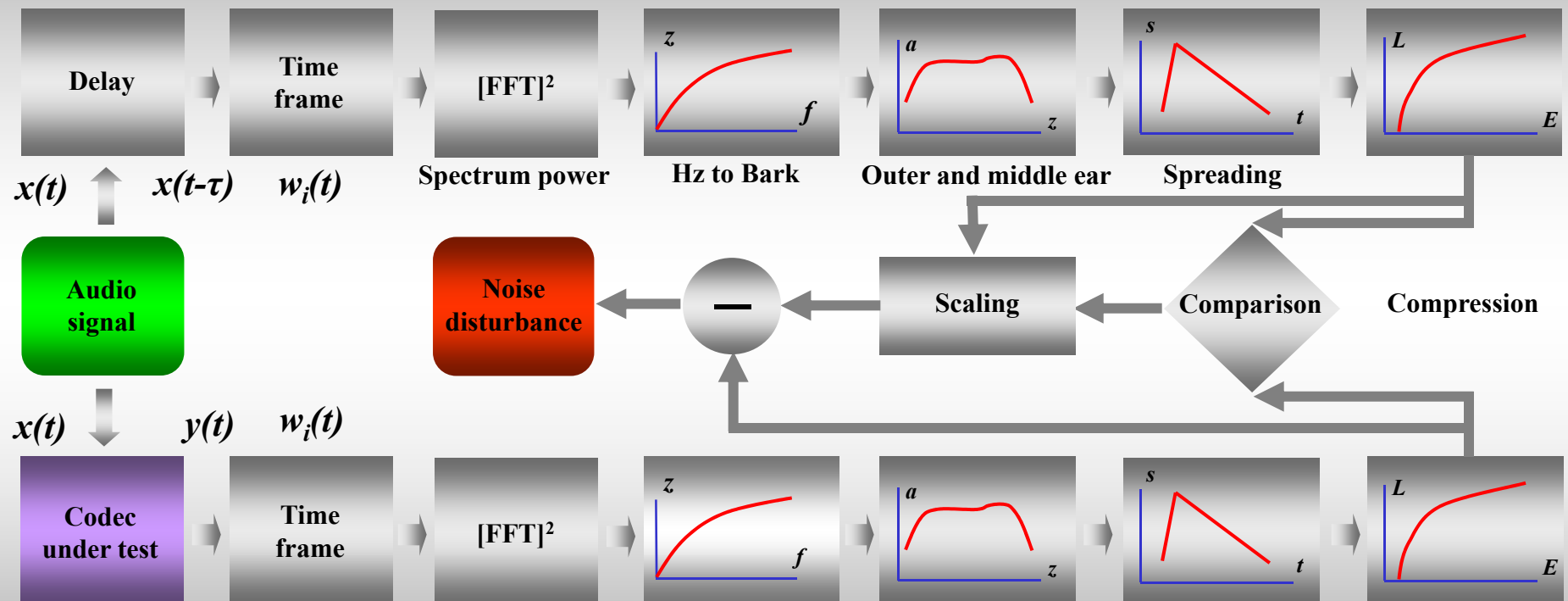


# Perceptual methods

## Perceptual models based on internal representations

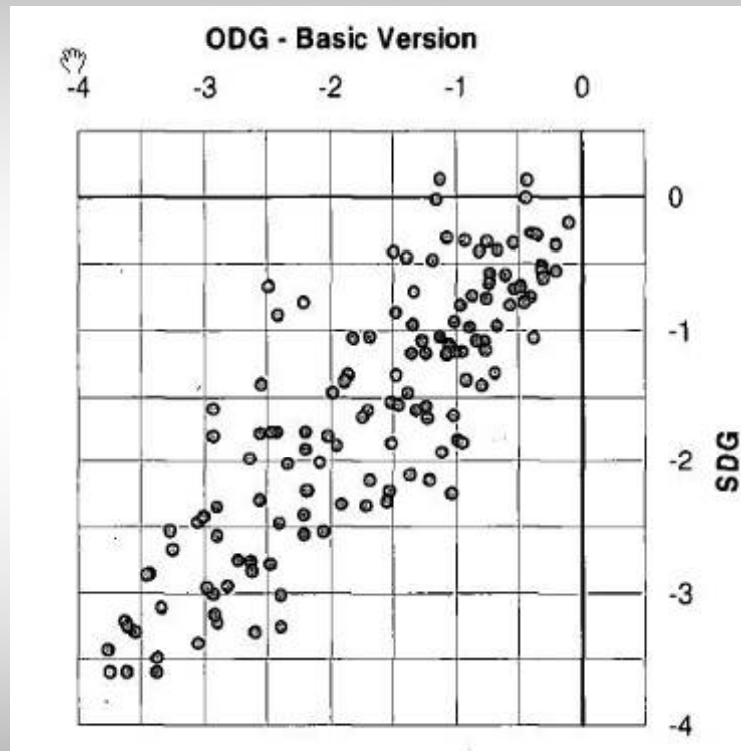


R. Beaton et. al. "Objective Measurement of Audio Quality", *Collected Papers on Audio Bit-Rate Reduction*, AES, 1996

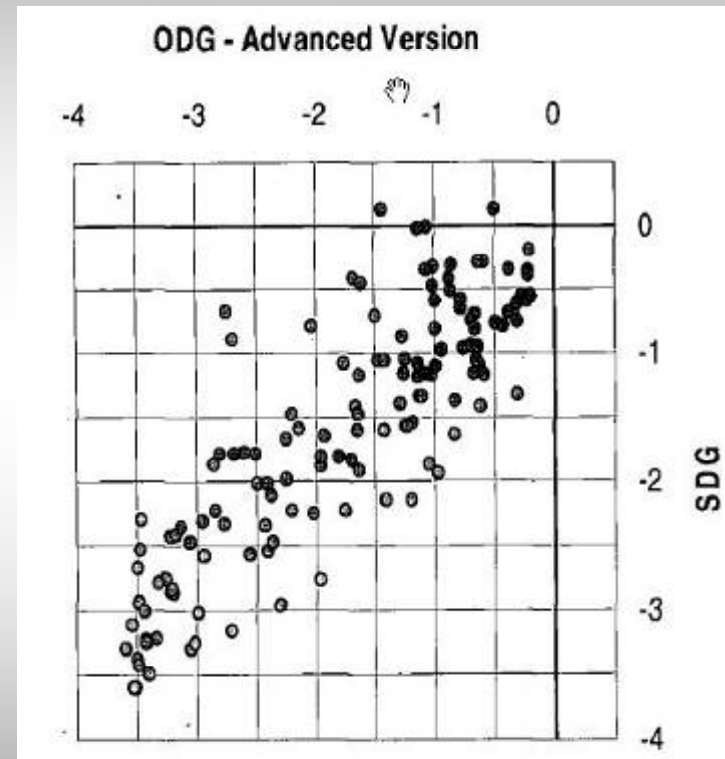
Simulation of physiological, psychoacoustical, and cognitive processes of hearing system

# Perceptual methods

## PEAQ



Result of using basic version of PEAQ

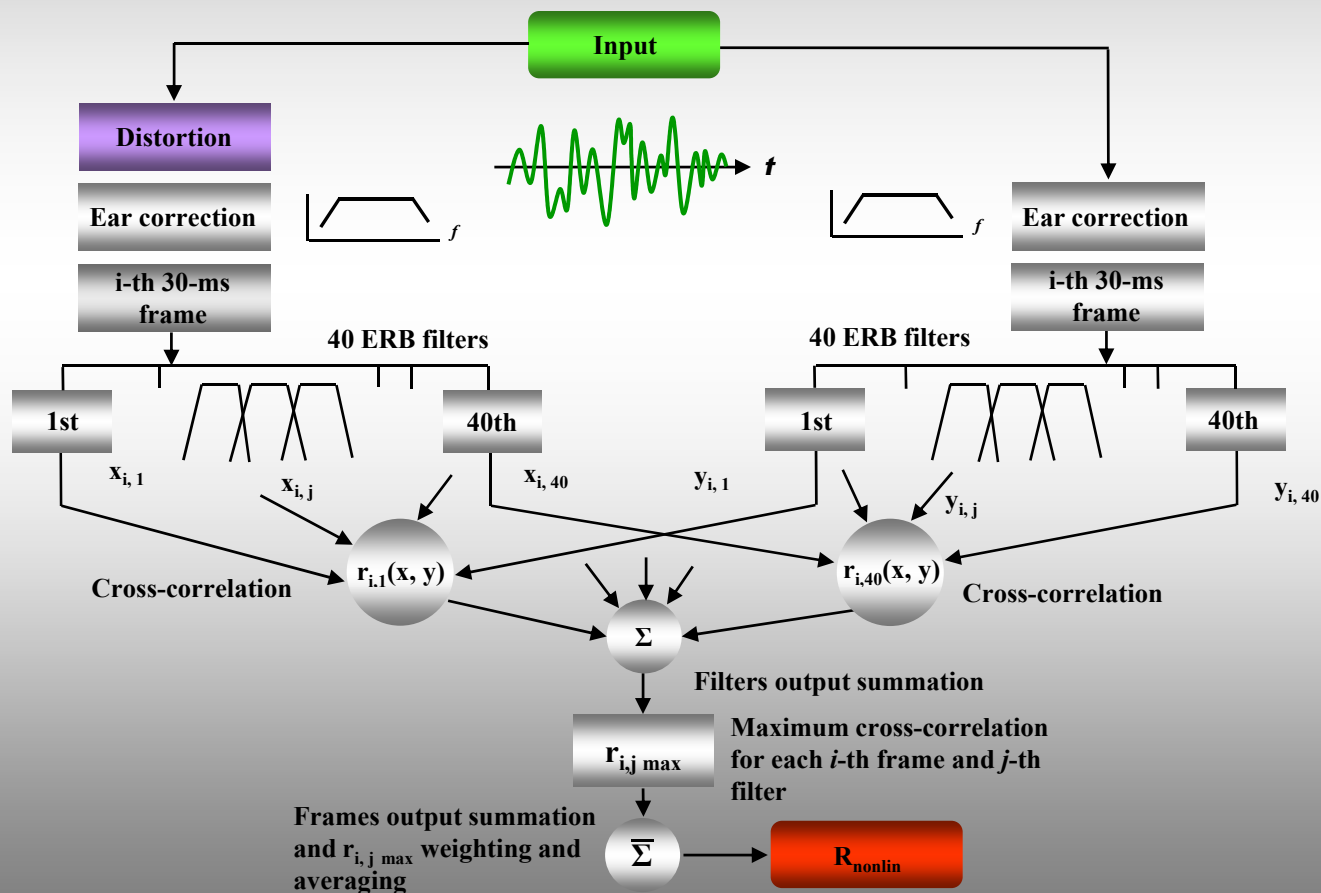


Result of using advanced version of PEAQ

T. Thiede et. al. "PEAQ – The ITU Standard for Objective Measurement of Perceived Audio Quality, JAES, vol. 48, No.1/2, 2000, January/February

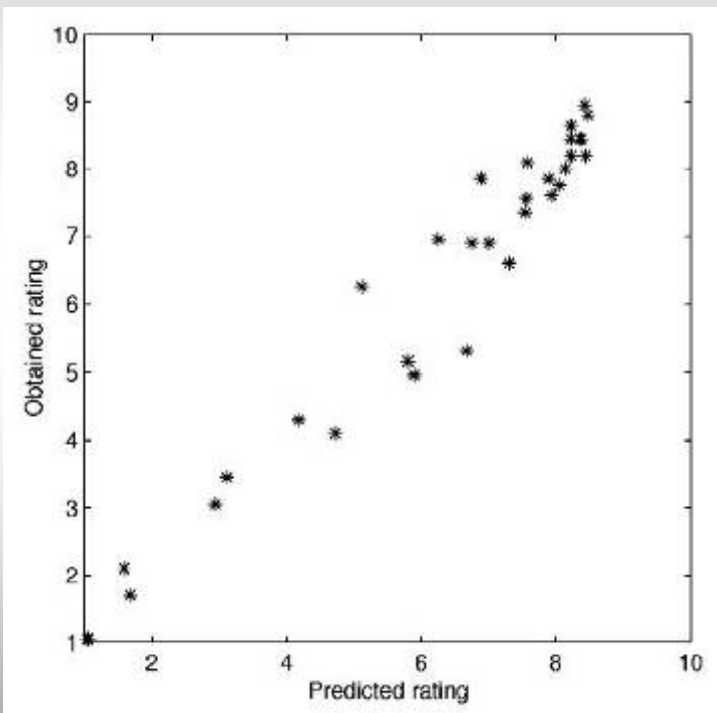
# Perceptual methods

C. Tan, B. Moore, N. Zakharov, 2004 Perceptual measurement model based on musical and speech signals.

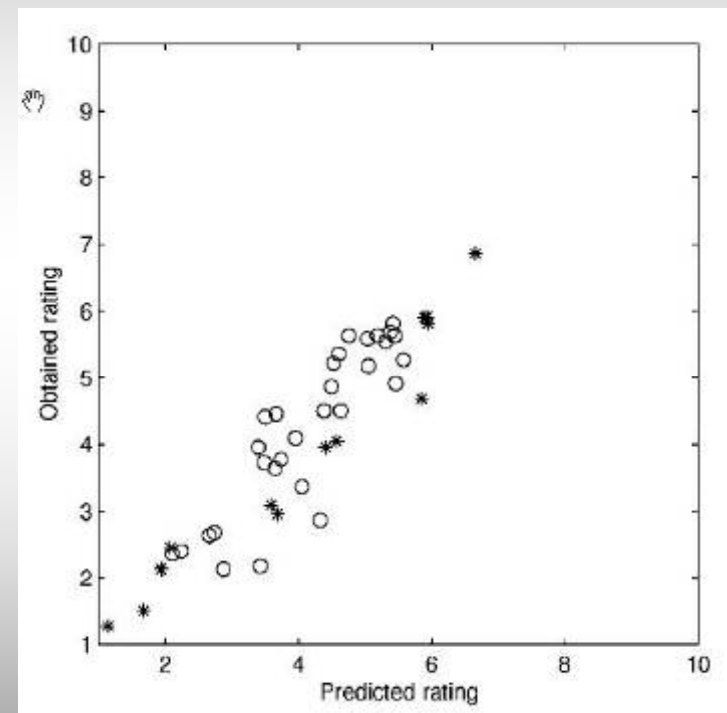


# Perceptual methods

C. Tan, B. Moore, N. Zakharov, 2004 Perceptual measurement model based on musical and speech signals.



Subjective ratings versus predicted ratings. Static nonlinearity



Subjective ratings versus predicted ratings. Real transducers

# Perceptual methods

## Benefits of using perceptual measurement for loudspeakers

- Replacement of labor- and time-consuming subjective listening tests with computerized perceptual evaluation of sound quality
- Higher accuracy of estimation of transducers' sound quality compared to traditional objective measurements
- Different approach to the design of transducers and loudspeaker systems. Linearization of psychoacoustically relevant nonlinear effects rather than minimization of all possible nonlinearities
- Using perceptual criteria rather than THD and other objective metrics in nonlinear correction of transducers

# Future possible developments

- Further development of the methods initiated by Tan, Moore, and Zakharov by possibly adding more components to the model (loudness, nonlinear compression, etc.).
- Work on the problem of separation of linear and nonlinear distortion
- Investigate feasibility of using existing methods, such as Opera and PEAQ directly without modifications
- Using sound quality criteria not lumped into a single number, but kept separately for each individual critical band, therefore providing “perceptual frequency response” of distortion – valuable information for engineers
- Investigate viability of using semi-perceptual methods

# Conclusions

- Conventional measurement methods often fail to correlate with perceived sound quality in transducers
- The reason for the dismal correlation includes:
  - The complexity of nonlinear dynamic systems
  - The complexity of the human auditory system
- Some approaches in existing perceptual methods may be applicable to loudspeakers
- Early experiments applying these perceptual models to measurement of transducers show promise
- Semi-perceptual method seem to be a promising addition to the true-perceptual methods
- Continuing using only conventional method, the loudspeaker industry lags several years behind the state of art in perceptual technology

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*55 years ago:*

*If any manufacturer or group of manufacturers can carry out the necessary research required to correlate listening tests with various methods of measuring nonlinear distortion, it will be a great and valuable service for the industry.*

*Herman Hosmer Scott, "Intermodulation Distortion",  
JAES, 1953.*

# END