Emotional Speech Synthesis: a comparison of different methods

TNO | Knowledge for business

Melanie Kroes
Judith Kessens
Mark Neerincx

MultimediaN

Outline

- Introduction
- Emotional speech synthesis
- Methods
- Results
- Conclusions

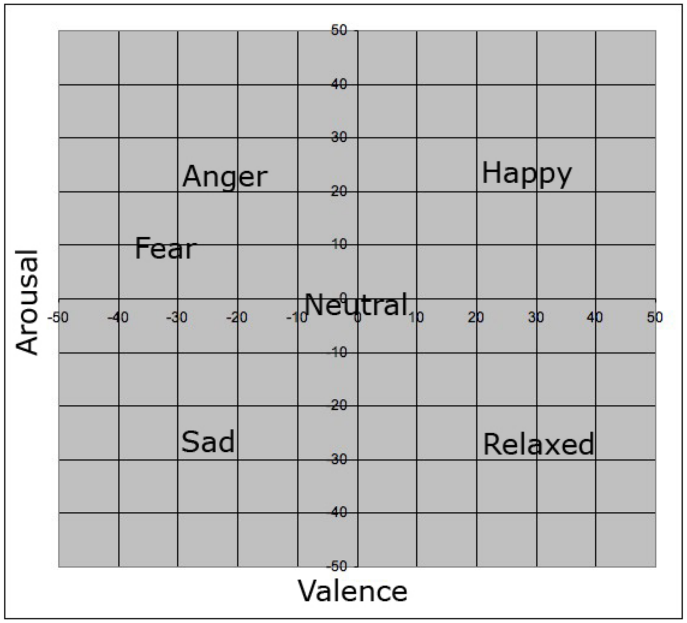
Introduction

- Internship TNO Human Factors
- Literature study
- Experiment
  - Research question: to what extent is it possible to identify intended emotions in synthetic speech, which are produced by altering synthesis parameters (duration and F0)?

Emotional speech synthesis (1)

Emotions

- How to describe emotions?
    - Categories
    - Dimensions
        - Arousal
        - Valence



- Which emotions?
    - Four basic emotions: anger, fear, happy and sad
    - Other emotions: relaxed and neutral

Emotional speech synthesis (2)

Synthesis techniques

- Diphone synthesis
  - Concatenation of diphones
  - Emotion modeling possible with open source systems
  - Most relevant for TNO research

Emotional speech synthesis (3)

Parameter settings

- EmoFilt (Felix Burkhardt)
    - Standard settings for 9 emotions (categories)
    - Converts durations and F0

- EmoSpeak (Marc Schröder)
    - Parameters (duration and F0) are changed according to the dimensions arousal, valence and power

- Copy synthesis
    - F0 and durations copied from naturalistic emotional speech

Methods (1)

Data selection

- Emotional speech database
  - Belfast Naturalistic Database (Queens University Belfast)
  - Dimensional and categorical annotations

- Semantics
  - Neutral vs. emotional

- Language
  - English

Methods (2)

Speech generation Examples

- With EmoFilt & EmoSpeak 🔊 🔊
  - Creating durations and F0 pattern with MARY
  - Manipulation of durations and F0

- With copy synthesis 🔊
  - Extraction of F0 with Praat
  - Extraction of durations with TNO speech recognizer

- Speech generation with MBROLA diphones

Methods (3)

Conditions

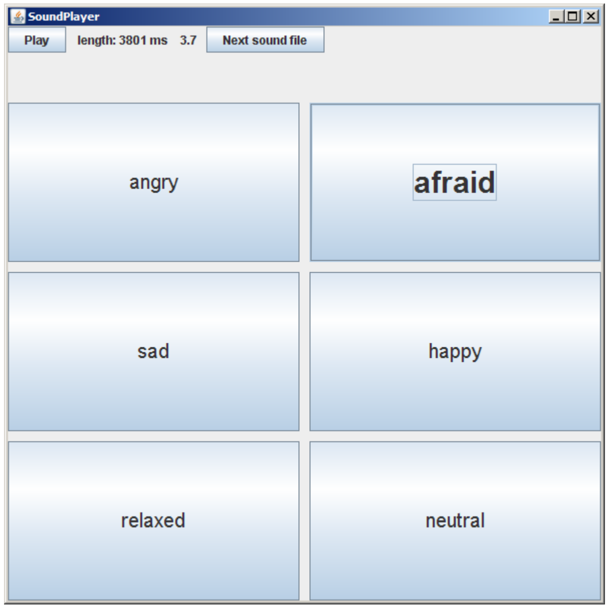
- 35 unique conditions:
  - 6 emotions
  - 2 types of semantics
  - 3 different settings, plus neutral synthesis
- 2 sentences per condition
- 10% (7 sentences) presented twice
- each participant annotated 77 trials categorically and dimensionally
- 20 participants

Methods (4)

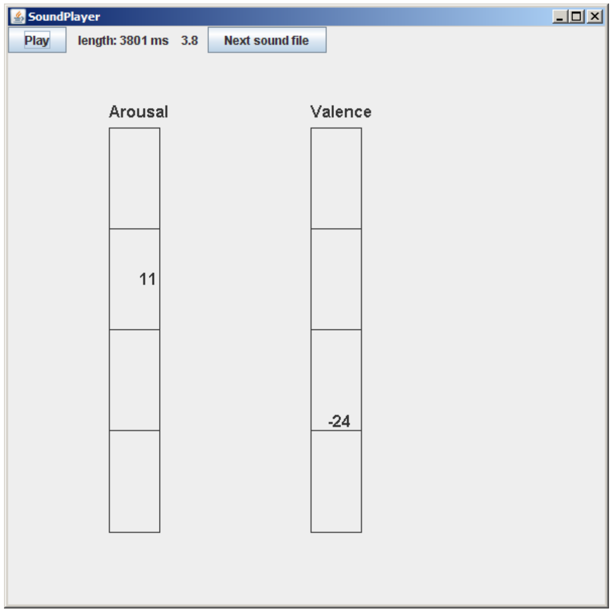
Setup

- For both dimensional and categorical annotations:
  - Training with natural and synthetic speech
  - Experiment:

Dimensional



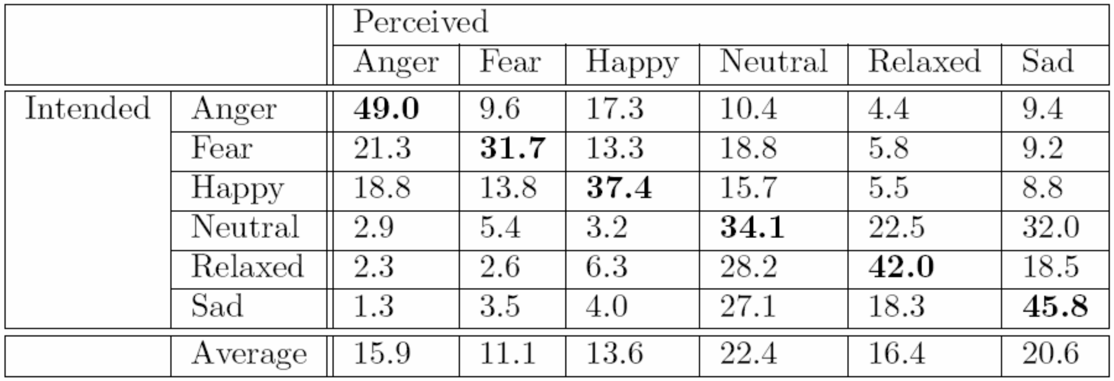
Categorical



Results (1) **Categorical annotations**

Emotions

- Percent of correct recognition significantly better than chance
- Confusion between:
  - Relaxed/sad and neutral (and vice versa)
  - Fear and anger (but **not** vice versa)



		Perceived					
		Anger	Fear	Happy	Neutral	Relaxed	Sad
Intended	Anger	**49.0**	9.6	17.3	10.4	4.4	9.4
	Fear	21.3	**31.7**	13.3	18.8	5.8	9.2
	Happy	18.8	13.8	**37.4**	15.7	5.5	8.8
	Neutral	2.9	5.4	3.2	**34.1**	22.5	32.0
	Relaxed	2.3	2.6	6.3	28.2	**42.0**	18.5
	Sad	1.3	3.5	4.0	27.1	18.3	**45.8**
	Average	15.9	11.1	13.6	22.4	16.4	20.6

Results (2) **Categorical annotations**

Settings

- Settings of EmoFilt and EmoSpeak only differ on the emotion fear, copy synthesis had the worst recognition

Comparison with neutral synthesis

- Modification of parameters was better than neutral synthesis

Semantics

- Semantically emotional sentences were better recognized than semantically neutral sentences

Results (3) **Dimensional annotations**

Comparison with natural speech

- Annotations made in the experiment are less extreme than in the naturalistic database

Settings

- Fear synthesized with EmoSpeak less extreme values than EmoFilt and copy synthesis
- Sad synthesized with copy synthesis less extreme values than EmoFilt and EmoSpeak

Results (4) **Dimensional annotations**

Comparison with neutral synthesis

- Modification of parameters results in more extreme arousal values than no modification
- Valence values lie (with and without settings) around zero

Semantics

- Semantics do not influence the dimensional annotations