Analyse av koblinger mellom lyd og bevegelse

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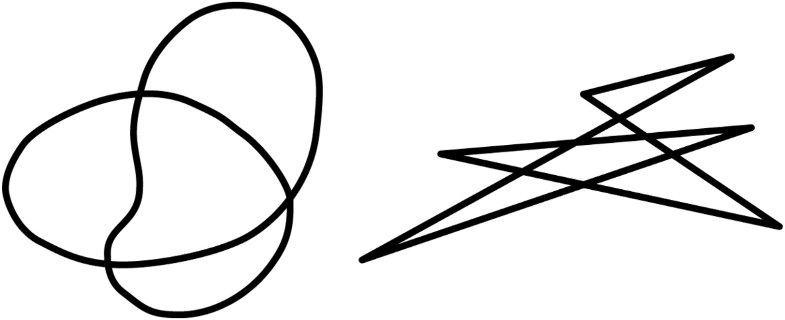
Cross-modality

Takete and Maluma



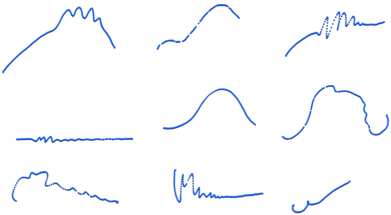
Sonic objects and action objects

If musical sound is made up from sonic objects, maybe we could learn more about how people perceive musical sound by observing their responses to short sonic objects?

⇒ “Sound-tracing”

Sound-tracing on a digital tablet

Godøy, Haga, Jensenius (2006): "Exploring music-related gestures by sound-tracing. A preliminary study", in 2nd ConGAS International Symposium on Gesture Interfaces for Multimedia Systems, Leeds, UK.



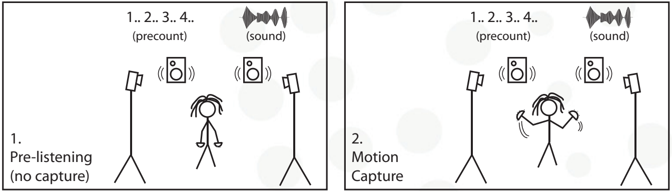
Experiment design

Some things to to think about when designing a sound-tracing experiment...

- Sounds
  - how many?
  - what types?
  - controlled (e.g. sine tones) or natural?
- Motion
  - How to record?
- Participants
- Questionnaire?

+ more....
All depends on what you want to study...
E.g. If the goal is to study differences between experienced musicians and non-musicians, your subjects should be chosen accordingly.

3D sound-tracing



3D sound-tracing

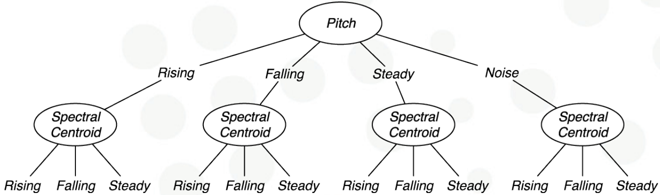
Experiment 1 (2009):

- 15 participants (4 female)
- 10 sounds
- 3 recordings per sound
- 450 recordings in total
- Rod used for recording

Experiment 2 (2010):

- 38 participants (9 female)
- 18 sounds
- 1 recordings per sound
- 684 recordings in total
- Two handles used for recording

Sounds



Sound	Pitch	Sp.Centroid	Dyn.Env.	Sound	Pitch	Sp.Centroid	Dyn.Env.
1	Rising	Falling	Non-impulsive[1]	10	Noise	Falling	Non-impulsive[1]
2	Falling	Rising	Non-impulsive[1]	11	Noise	Rising	Non-impulsive[2]
3	Falling	Falling	Non-impulsive[1]	12	Noise	Steady	Non-impulsive[2]
4	Rising	Rising	Non-impulsive[1]	13	Steady	Rising slightly	Non-impulsive[2]
5	Rising	Steady	Non-impulsive[2]	14	Steady	Falling slightly	Non-impulsive[2]
6	Falling	Steady	Non-impulsive[2]	15	Rising	Falling	Impulsive
7	Steady	Falling	Non-impulsive[1]	16	Steady	Steady	Impulsive
8	Steady	Rising	Non-impulsive[1]	17	Noise	Steady	Impulsive
9	Steady	Steady	Non-impulsive[2]	18	Noise	Falling	Impulsive

Example 1: Impulsive sound

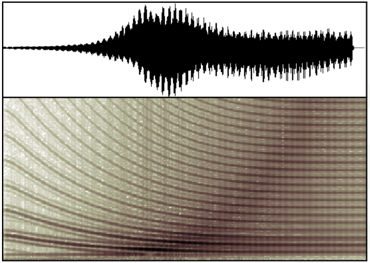
Example 2: Steady sound

Example 3: Opposing ideas

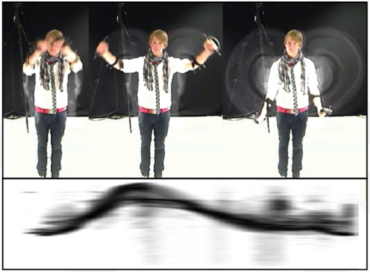
Example 4: Engine metaphor

Visualisations:

Sounds represented by waveform and spectrogram

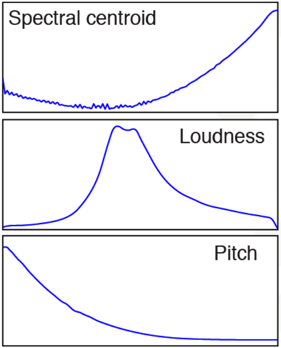


Movement represented by motion images and motiongram

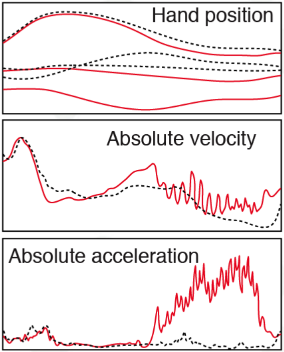


Feature Extraction: Time-varying features (examples)

Sound features



Movement features



Feature Extraction: Global features (examples)

Sound features

- Categorical:
  - “Ballistic”, “Sustained”, or “Iterative”
  - “Rising” pitch
- Calculations:
  - Duration
  - Overall dynamic energy
  - Onset rise time

Movement features

- Categorical:
  - “Ballistic”, “Sustained”, or “Iterative”
  - “Two-handed”
- Calculations:
  - Mean vertical velocity
  - Mean absolute acceleration
  - Mean change in distance between hands

Analysis

Methods:

- Statistical tests
- Pattern recognition
- Correlation of time-series
- Canonical correlation analysis

Statistical tests

Example experiment:
Ask people to rate the expressivity of some musical performance beteen 1 and 10. Compare the results of “musical experts” to “non-experts”

non-experts	experts
5	6
7	8
8	5
5	5
5	5
2	6
6	5
6	7

mean non-experts: 5.5
mean experts: 5.9

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- T-test

Statistical tests

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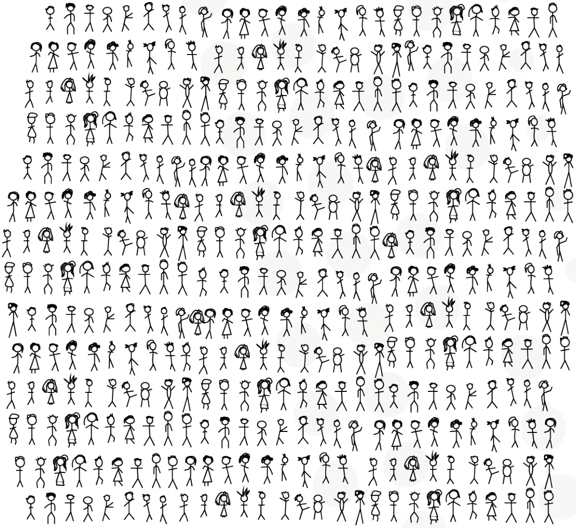
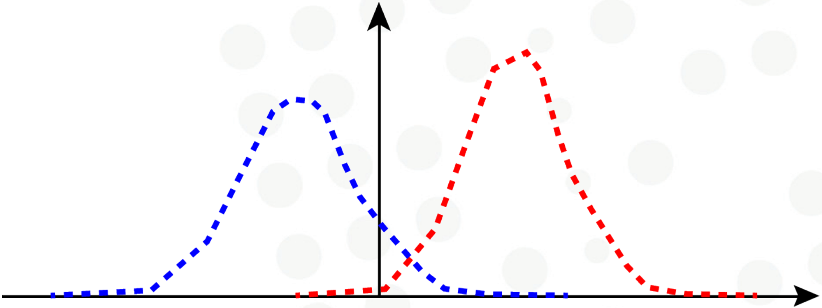
- T-test
- Anova

Statistical tests



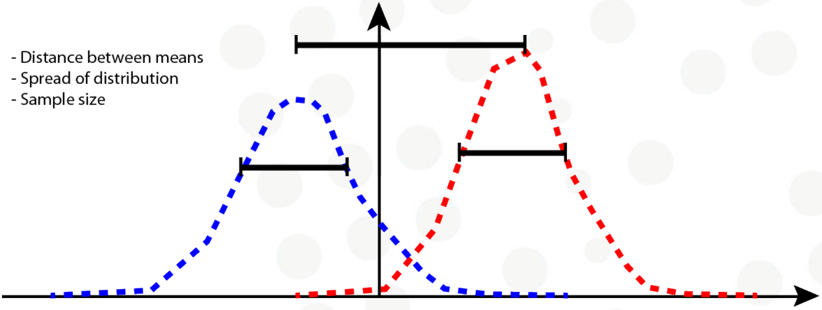
Statistical tests

Statistical tests

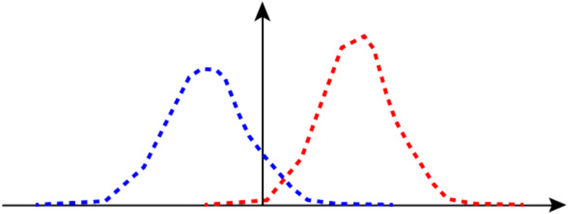


Statistical tests

- Distance between means
- Spread of distribution
- Sample size



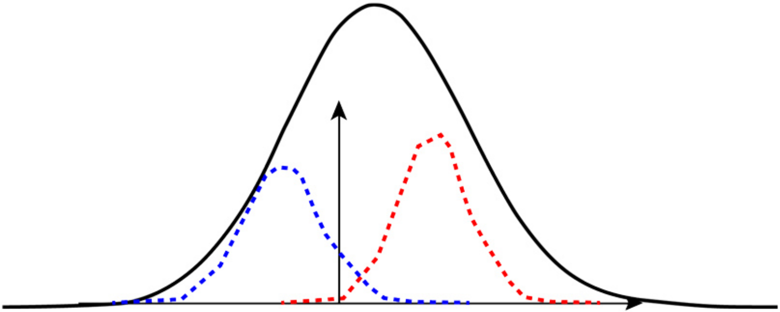
The meaning of the p-value



p: the probability that the two selections stem from the same population

Typical thresholds for p to claim statistical significance: 0.05, 0.01, 0.001

The meaning of the p-value



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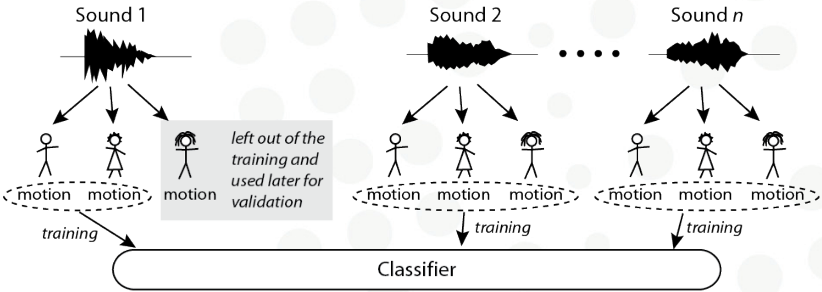
Typical thresholds for *p* to claim statistical significance: 0.05, 0.01, 0.001

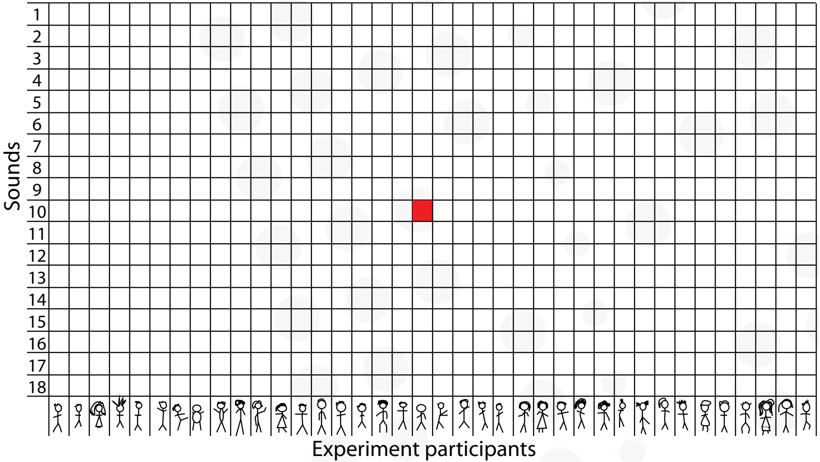
My results

Motion feature	Comparison	*df*	*t*	*p*
OnsetAcceleration	Impulsive vs non-impulsive sounds	526	13.65	< 0.01
VerticalVelocityMean	Rising vs falling sounds	284	18.89	< 0.01
AbsAccelerationMean	Pitched vs noise-based sounds	179	5.53	< 0.01

Pattern recognition classifier



Pattern recognition classifier



Classification results: based on all features

	True 1	True 2	True 3	True 4	True 5	True 6	True 7	True 8	True 9	True 10	Class Precision
Pred. 1	34	6	1	1	1	0	0	0	0	4	72.3 %
Pred. 2	9	36	0	0	0	1	0	2	0	0	75.0 %
Pred. 3	0	0	36	2	0	2	0	0	0	0	90.0 %
Pred. 4	0	0	2	32	1	0	1	3	0	0	82.1 %
Pred. 5	0	0	1	2	31	6	1	2	1	0	70.5 %
Pred. 6	1	0	3	0	6	32	0	1	2	0	71.1 %
Pred. 7	0	0	0	0	1	0	40	3	0	0	90.9 %
Pred. 8	1	0	0	6	3	1	0	34	0	0	75.6 %
Pred. 9	0	1	0	0	2	2	0	0	36	6	76.6 %
Pred. 10	0	0	0	0	0	0	0	0	6	34	85.0 %
Class Recall	75.6 %	83.7 %	83.7 %	74.4 %	68.9 %	72.7 %	95.2 %	75.6 %	80.0 %	77.3 %	

Overall classification accuracy: 78.6 %

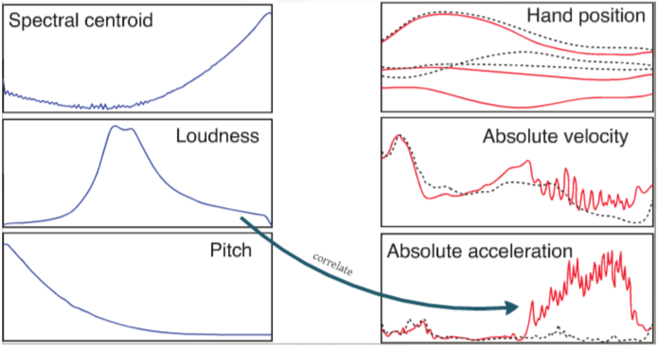
Classification results: based on only vertical features

	True 1	True 2	True 3	True 4	True 5	True 6	True 7	True 8	True 9	True 10	Class Precision
Pred. 1	7	11	0	0	0	0	1	0	0	4	30.4 %
Pred. 2	7	5	0	1	0	0	0	0	0	0	38.5 %
Pred. 3	0	0	34	0	2	10	0	1	1	0	70.8 %
Pred. 4	0	2	1	22	6	1	1	3	0	0	61.1 %
Pred. 5	0	1	0	3	5	4	0	9	0	0	22.7 %
Pred. 6	0	0	3	2	3	2	2	0	0	0	16.7 %
Pred. 7	9	5	2	6	2	6	16	3	6	6	26.2 %
Pred. 8	0	0	0	4	11	0	0	21	0	1	56.8 %
Pred. 9	14	15	3	1	12	14	7	6	31	18	25.6 %
Pred. 10	8	4	0	4	4	7	15	2	7	15	22.7 %
Class Recall	15.6 %	11.6 %	79.1 %	51.2 %	11.1 %	4.6 %	38.1 %	46.7 %	68.9 %	34.1 %	

Overall classification accuracy: 36 %

For only the sounds with changing pitch: 61 %

Correlation of time-series



How related are the two variables?

Canonical Correlation

Look at correlation between two <u>sets</u> of variables