Laughter in Child-Robot Communication

Workshop on Laughter etc., Berlin, 2009

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Overview

- database, phenomena and annotations
- phonetics of laughter
- laughter and syntax
- (communicative) function of laughter
- automatic classification
- a taxonomy fragment
- summary
IT's fun but — there was some work to do: the database

- German children interacting with a pet robot (AIBO), emotion-related states elicited in a WoZ scenario, AIBO controlled over WLAN
- task: directing through "parcours", AIBO behaves disobediently; ~ 40 min per child
- 51 children (10-13 years old, 21 m, 30 f), 2 schools
- 8.9 hours of speech, 48,401 words
Map of the Parcours task

POSITION: START
AIBO addresses child: gesture `Hi'
CHILD: tells AIBO what to do
+ co-operative: gets up
+ co-operative: goes forward
....

POSITION C, 4th crossing
- co-operative: stops
- co-operative: lays down
+ co-operative: stands up
- co-operative: lays down
+ co-operative: stands up
- co-operative: lays down
+ co-operative: stands up
+ co-operative: turns left
AIBO addresses child: turns head towards child
+ co-operative: goes forward

the child wants AIBO to follow his/her commands, in fact, AIBO follows its own script, i.e., the child reacts to AIBO's actions

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numbers 1-6: crossings;
A-D: AIBO behaves disobediently
Dance and Sit: tasks to fulfil;
goals: cups 1-3 and GOAL
Annotations

- transliteration incl. non-verbals
- emotional user states, word-based
- prosodic peculiarities, word-based
- manual corrections: segmentation, pitch
- syntactic chunking
- …
Prosodic Peculiarities, Word-based

- **very long pauses** (child waits for AIBO to fulfil a command: [PAUSE\_LONG]
- unusual pauses between phrases: [PAUSE\_WORD]
- pauses within a word, between syllables: [PAUSE\_SYLL]
- lengthening of syllables: [LENGTH\_SYLL]
- **insertion of syllables**, for instance /stop/ [:StO:|hOp]: [INS\_SYLL]
- marked emphasis: [EMPHASIS]
- **shouting**: [SHOUTING]
- **shift of accent position**, for instance /Aibo/ [aI\'bo:] : [ACC\_SHIFT]
- very clear articulation: [CLEAR\_ART]
- laughter: [LAUGHTER] *
- **vocative** (only for the word Aibo): [VOCATIVE]

*re-annotated
Emotional User States, Word-based, 5 Labellers (Majority Voting)

- joyful (101)
- surprised (0)
- motherese (1260)
- neutral (default: 39169)
- rest (non-neutral, not belonging to other categories: 3)
- bored (11)
- helpless, hesitant (3)
- emphatic (2528)
- touchy (=irritated: 225)
- angry (84)
- reprimanding (310)
# Annotation of Non-Verbals

<table>
<thead>
<tr>
<th>Non-Verbals</th>
<th>Code</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>hesitation (vocal, nasal)</td>
<td>&lt;&quot;A&quot;&gt;</td>
<td>20</td>
<td>1.1 %</td>
</tr>
<tr>
<td>hesitation (vocal)</td>
<td>&lt;&quot;a&quot;&gt;</td>
<td>35</td>
<td>2.0%</td>
</tr>
<tr>
<td>hesitation (nasal)</td>
<td>&lt;m&gt;</td>
<td>23</td>
<td>1.3%</td>
</tr>
<tr>
<td>noise</td>
<td>&lt;#&gt;</td>
<td>809</td>
<td>46.2 %</td>
</tr>
<tr>
<td>breathing</td>
<td>&lt;A&gt;</td>
<td>570</td>
<td>32.5 %</td>
</tr>
<tr>
<td>human noise</td>
<td>&lt;G&gt;</td>
<td>151</td>
<td>8.6 %</td>
</tr>
<tr>
<td>cough</td>
<td>&lt;H&gt;</td>
<td>32</td>
<td>1.8%</td>
</tr>
<tr>
<td><strong>laughter</strong></td>
<td>&lt;L&gt;</td>
<td><strong>110</strong></td>
<td><strong>6.3 %</strong></td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td></td>
<td><strong>1749</strong></td>
<td><strong>100.0 %</strong></td>
</tr>
</tbody>
</table>

* re-annotated
Laughter and Speech Laughter *

- 102 turns with 110 laughters \(<L>\): \textbf{L}
- 94 speech laughters \([\text{LAUGHTER}]\) in 59 turns (0.2 % of all words): \textbf{SL}
- in 22 turns, both L and SL

* note: preliminary figures, to be checked
Examples

- Mont_10_041 da hin p3 los s1 lauf s3 aufstehen
  <L>

- Ohm_19_074 <L> der *is witzig

- Ohm_18_256 <G> lauf auf dem Teppich v1 Aibo v2
  *n bisschen nach links drehen <L> v1 Aibo v2 keine
  Fax'n machen hier <L>

- $s_n$: clause, $p_n$: free phrase, $d_n$: dislocation, $v_n$: vocative, ...
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The Phonetics of Laughters

- Speech Laughter SL
  - tremolo with \(2 \cdot n\) pulses/cycles
  - more or less breathy

- laughter L: \([h@]\)
  - laryngealizations between pulses, or
  - voiceless expiriation, or
  - ingressive, in a few cases
An Example

n   a:   |   h   I   |   ?   n
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Examples for Syntactic Position

- **Ohm_14_217** <L> <A> <L> war ja klar s2 dass er sich *gleich wieder hinsetzt* 🎧

- **Mont_06_075** *steh* auf v1 Aibo 🎧

- **Mont_13_003** und was passiert s2 wenn er in die giftige *Sch"ussel geht* d2 zur giftigen Sch"ussel geht 🎧

- \( s_n \): clause, \( p_n \): free phrase, \( d_n \): dislocation, \( v_n \): vocative, ...

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Syntactic Positions of Laughter in Percent

| %  | |- | - | -| | # words in sequ. | # word-seq. * |
|----|----|----|---|----|-----------------|----------------|
| L  | 28 | 5  | 68 |    |                 |                |
| SL | 13 | 2  | 24 | 61 |                 |                |
| SL | 21 | 3  | 38 | 38 |                 |                |

* 2.6 words per SL-sequence on average, all SL-sequences adjacent to -|

laughter positions:

- few in chunk onset,
- almost none in chunk nucleus
- most in chunk offset or co-extensive with whole chunk

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g'radeaus Aibolein ja M fein M gut M machst M du M *da M | *tz l"aufst du mal bitte nach links | stopp E Aibo stopp | nach links E umdrehen | nein M <*ne> nein M <*ne> nein M <*ne> so M weit M *simma M noch M nicht M aufstehen M Schlafm"utze M komm M hoch M | ja M so M ist M es M <*>is> guter M Hund M lauf mal jetzt nach links | nach links Aibo | Aibolein M aufstehen M *son M sonst M werd' M ich M b"ose M hoch E | nach A links A | Aibo A nach A links A | Aibolein A ganz A b"oser A Hund A jetzt A stehst A du A auf A | hoch A | dreh dich ein bisschen | ja M so ist es <*>is> gut stopp Aibo stopp | *tz lauf g'radeaus |
Prosodic Peculiarities vs. Emotional User States, Word-based: Frequencies in Percent of Total

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Motherese vs. \{L, SL\}

- Mann-Whitney test: no sign. diff. between m and f as for \#\{motherese, L, SL\}
- Spearman's r for correlation of \# motherese with:
  - \# laughter: .24
  - \# speech laughter: .09

* Spearman's r for S with SL: .70 (sig. < .000)
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Automatic Classification

- large feature vector with 5,967 features
  - 39 low level feature contours: energy, pitch, HNR, MFCC, Spectral
  - many functionals (means, regression, ....)
- single vector for every word or word-like unit
- 94 words without SL selected from the corpus
- Support-Vector-Machines
  - linear kernel
  - SMO
## Classification Performance

<table>
<thead>
<tr>
<th></th>
<th>with FS</th>
<th>w/o FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/O</td>
<td>62.6</td>
<td>66.0</td>
</tr>
<tr>
<td>LOSO</td>
<td>64.1</td>
<td>72.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% class. as</th>
<th>S</th>
<th>SL</th>
<th>L</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>51</td>
<td>40</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>SL</td>
<td>16</td>
<td>74</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>L</td>
<td>4</td>
<td>21</td>
<td>75</td>
<td>56</td>
</tr>
</tbody>
</table>
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A Tentative Taxonomy Fragment of Speech Laughter in Communications

- **uncontrolled** (bursts of laughter)
  
  $\pm [equal, solidary, intimate]$

- "controlled" - sort of
  
  - symmetrical  $[+ equal], [+ solidary]$
  - asymmetrical
    
    - submissive  $[+ inferior], [\pm solidary], [- intimate]$
    - caring (= motherese)  $[+ superior], [+ solidary], [+ intimate]$
    - amused  $[+ superior], [0 solidary], [- intimate]$

- **note:** here, no "full-grown" interaction because Aibo is "only" a "tin-box": Ohm_18_322 Blechbüchse aufstehen
Summary

- phonetics and syntactic position of laughter and speech laughter as expected/looked for
- confusion matrix for automatic classification as expected/hoped for
- most interesting is the relationship of interactional attitude and the (non-) occurrence of laughter
Thank you for your attention