Modeling Therapist Empathy and Vocal Entrainment in Drug Addiction Counseling

Bo Xiao1, Panayiotis G. Georgiou1, Zac E. Imel2, David C. Atkins3, Shrikanth S. Narayanan1

1SAIL, Dept. Electrical Engineering, University of Southern California 2Dept. Educational Psychology, University of Utah 3Dept. Psychiatry & Behavioral Sciences, University of Washington, U.S.A.

boxiao@usc.edu, georgiou@sipi.usc.edu, zac.imel@utah.edu, datkins@u.washington.edu, shri@sipi.usc.edu

Behavioral Signal Processing

- Acoustic Cues
- Visual Cues
- Entrainment

Lexical Cues

- Autism Diagnosis
- Emotion

Physiological Cues

- Drama Interaction
- Affect

Dynamical Model

- Statistical Testing
- Signal Processing
- Machine Learning


Computing Entrainment and Empathy

- Empathy — feeling for and taking the perspective of others
- Psychological process evident across human and animal
- Rating associated with positive outcome of interactions
- Key performance evaluation index in MI-type psycho-therapy

- Entrainment — behaviors of the interactants become similar
- Reflected in multimodal cues, a way to infer empathy level

Turn Taking Cues: ratio of patient segments / speaking time

- Variations of acoustic cues: speaking turn order, PCA space extraction and projection order, number of selected PCA components (J), weighting factor (θ), temporal functionals

Different pitch

PCA

PCA

Proj

Proj

Cues --- session wise functional: mean, var.

Fusion: Find PCA space of all features, select the single component that maximizes correlation with empathy score


Dataset

- Counselor training study of Motivational Interviewing (MI)
- MI: emphasize intrinsic motivation of changing addiction
- Three coders evaluated 144 therapists’ empathy score
- Select 72 high & 42 low scored sessions, 20 min each

Acoustic and Turn Taking Features

- Diarization
- Turn Taking Cues

- Pitch MFCC Pitch MFCC

- Temporal Weighting

VAD & Feature Extraction

- Difference of pitch

PCA

PCA

Proj

Proj

Similarity Cues

- Prox. Var. KL-div

Simulation Measure

- Pitch Cues

- Similarity Measure

- Correlation of Msim(PT,PT) and Msim(PT,TP)

Performance of integrated feature

Acc. — logistic reg. of binarized empathy

Correlation of features and empathy score

<table>
<thead>
<tr>
<th>Correlation of features and empathy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>gsim</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Msim(PT, PT)</td>
</tr>
<tr>
<td>-0.24</td>
</tr>
<tr>
<td>-0.25</td>
</tr>
<tr>
<td>-0.27</td>
</tr>
<tr>
<td>-0.29</td>
</tr>
<tr>
<td>Vsim(PT, PT)</td>
</tr>
<tr>
<td>-0.22</td>
</tr>
<tr>
<td>-0.23</td>
</tr>
<tr>
<td>-0.21</td>
</tr>
<tr>
<td>-0.19</td>
</tr>
<tr>
<td>Vpit(PT)</td>
</tr>
<tr>
<td>-0.31</td>
</tr>
<tr>
<td>-0.32</td>
</tr>
<tr>
<td>-0.31</td>
</tr>
<tr>
<td>-0.30</td>
</tr>
<tr>
<td>Ratio of patient speaking time</td>
</tr>
<tr>
<td>0.27</td>
</tr>
<tr>
<td>Ratio of patient speaking segments</td>
</tr>
<tr>
<td>0.28</td>
</tr>
</tbody>
</table>

p<0.05, otherwise p>0.01

Discussion

- Projecting T to P and J = 2 more effective than others
- The two features are closer in value with larger J
- Different turn orders lead to correlated feature values
- "T following P" correlates with empathy, but not the other

Conclusion

- Extend similarity measure for vocal entrainment behavior
- Provide computational model to infer therapist empathy
- In future, more effective features on vocal similarity
- Understand the asymmetry of turn order and PCA projection

This work is supported by NSF, NIH and DoD.

Correlation of Msim(PT,TP) & Msim(PT,PT)

<table>
<thead>
<tr>
<th>Corr. Msim(PT,TP) &amp; Msim(PT,PT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85</td>
</tr>
<tr>
<td>0.66</td>
</tr>
</tbody>
</table>

Correlation of Mpit(PT) & Mpit(PT)

<table>
<thead>
<tr>
<th>Corr. Mpit(PT) &amp; Mpit(PT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.71</td>
</tr>
<tr>
<td>0.53</td>
</tr>
</tbody>
</table>