Quantitative Observational Practice in Family Studies (2 of 3)

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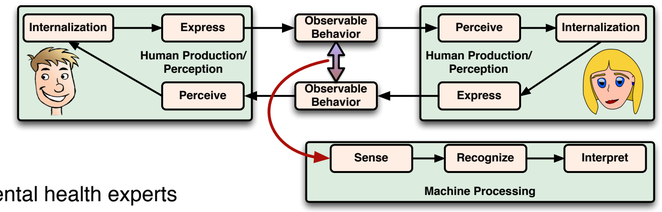
Abstract

Goal:

- Transform observational behavior analysis
- Through computational framework
- Modeling of emotionally-rich human interactions
- Signal processing and machine learning
- Existing family therapy data
- Alleviate the tedium of manual annotation
- Offer new analysis capabilities and empower the mental health experts

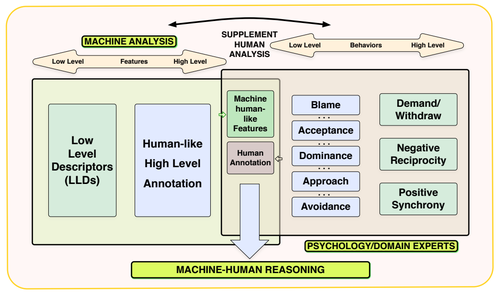


Significance: USA-10mil people receive psychotherapy every year and state of the art hasn't changed for decades

Approaches

+ This poster: [- Other two posters]

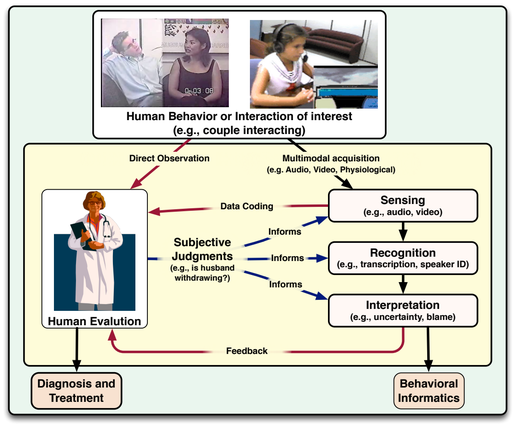
- \- Model interlocutors independently
- \+ Model dynamics of interlocutors:
  - ×Acoustic and visual modalities
- \- Incorporate Saliency



Data

Couple Therapy Corpus

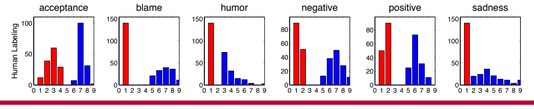
- 117 real distressed couples
- 10-minute dyadic interactions
- 596 sessions (96 hours)



Data used

Audio/Lexical and Visual subsets used

- Use top/bottom 20% for audio, lexical and 25% for video
- Choose subsets with acceptable audio/video qualities
- Used 6 codes with highest human agreement
- Some distributions skewed and not very separable



Entrainment

Behavioral Entrainment (a.k.a., interaction synchrony, accommodation, mirroring, etc.)

- Naturally-spontaneous coordination between interacting dyads' behaviors at multiple levels across multiple communicative channels
- Theoretical Implications
  - Achieving communication efficiency, rapport
  - Communicating interest and involvement in the interaction
  - Increasing mutual understanding
  - Affective mechanism, e.g., emotion contagion, empathy, etc.
  - Children's development and learning
  - Many more …

Highly-qualitative; a felt-sense of "in-sync"

Vocal Entrainment

Quantify vocal entrainment through signal processing

Challenges/Motivation

- Human annotation difficult
- Turn-taking structure of human conversation
- Variable length of speech
- Rich information encoded in vocal features
- Multiple informative vocal features for entrainment
- Entrainment process inherently is directional

Vocal: Features/LLD's

Q: Does pca channel capture behavior?

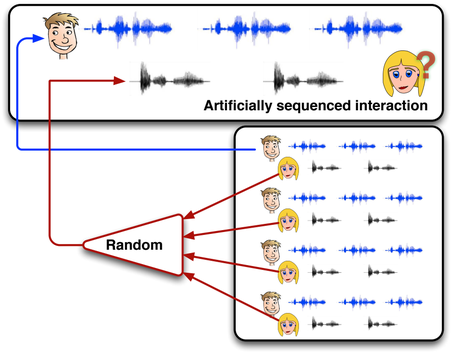
- (Explicit speaking): Pitch, Energy, Speech-rate.
- (Implicit speaking): MFCC &Statistical functionals

Representative vocal Parameters (35)	
Pitch (5)	$[\alpha_1, \alpha_2, \alpha_3, \mu_{f0}, \sigma_{f0}]$
Intensity (3)	$[\beta 1, \mu_{int}, \sigma_{int}]$
Speech Rate (1)	[sylb]
MFCC (26)	$[\mu_{MFCC}(i), \sigma_{MFCC}(i)]$, i=1,…,13

Vocal Entrainment: Validation

Hypothesis 1: Verification: verifying the proposed signal-derived measures capture psychologically-valid notions of entrainment

- Compare real couple interactions with
- Artificially sequenced interactions
- Vocal entrainment on real couples higher ✓



Hypothesis 2: Analysis: analyzing the relationship of the vocal entrainment phenomenon and spouses' affective states

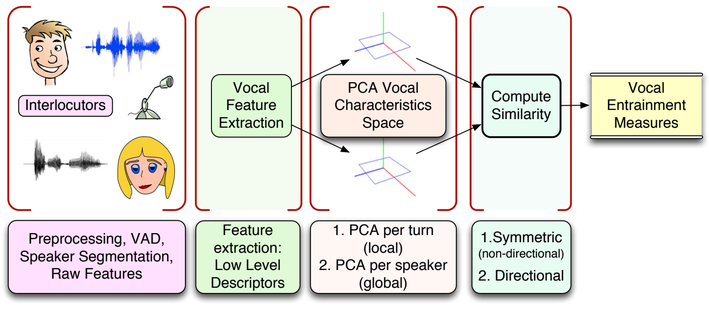
- Compare positive interactions with negative interactions
- Vocal entrainment on positive couples higher ✓

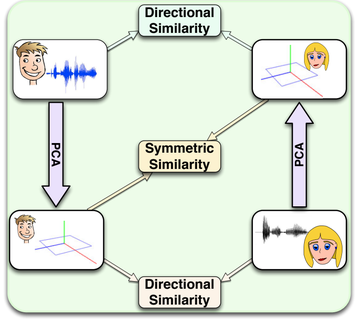
Hypothesis 3: Application: applying vocal entrainment measures as features in a affective state recognition task

- Entrainment correlated with affective behaviors
- Model temporal dynamics of entrainment
- Dataset: Same as Acoustic and Lexical
- Statistical Framework Factorial Hidden Markov Model
- 62.8% accuracy ✓

Vocal: Unsupervised Computational Framework

- Intuitively, "how do two people sound alike as they interact in a conversation?"
- Similarity between two vocal characteristics spaces
- Directional & Symmetric Similarity Measures
- Kullback-Leibler Divergence (KLD) on normalized variance vector or (weighted) angles between PCA directions

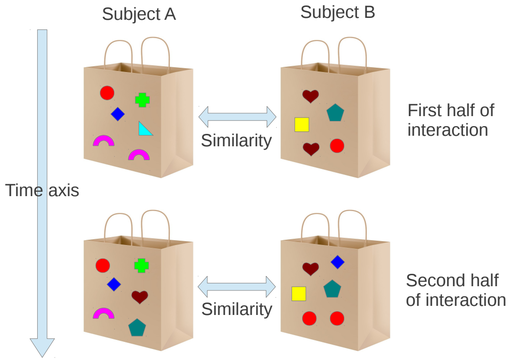




Visual: Head Motion Similarity Measure

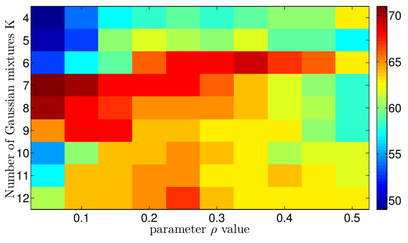
- Based on two bags of events and GMM posteriors
- Compute pair-wise KL divergence of events
- Average of small divergence
  - Similar events are salient
  - Variation of other events no effect

Dynamic change of similarity

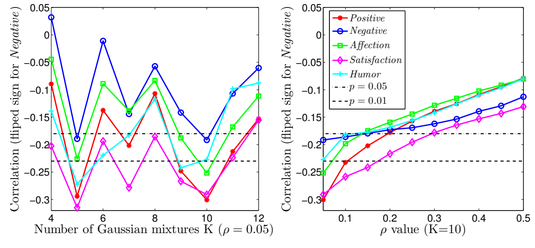


Hypotheses Tests

- Similarity increases along time
  - log-average ratio of similarity on 50-GMM
  - Binomial test against 50% chance
- Relative change of similarity correlated with affect
  - Using the same log-average ratio
  - Student's t-test of correlation



- ρ — percentile of small KLD pairs
- $p \leq 0.01$ for result of 61%



- Significant correlation with behavior codes
- Increasing similarity related to positive affect
- Do not generally happen in random coupling

Citations, Acknowledgments

Full list of publications at `http://sail.usc.edu`
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