Learning to Generate Context-Sensitive Backchannel Smiles for Embodied AI Agents with Applications in Mental Health Dialogues

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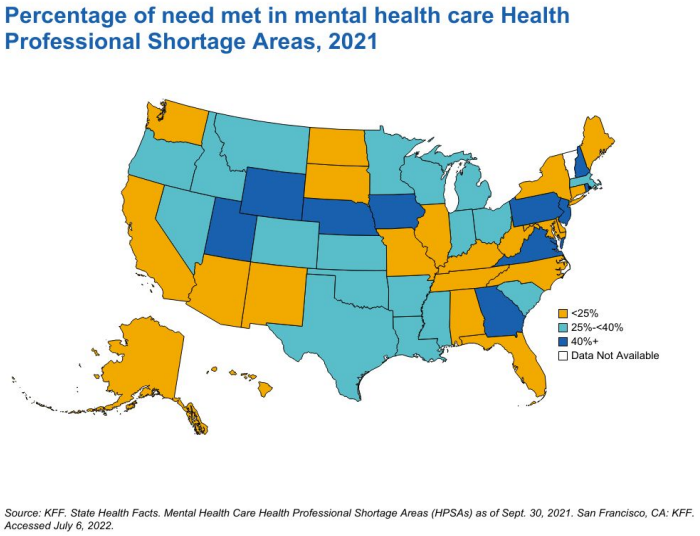
AI addressing Mental Health needs

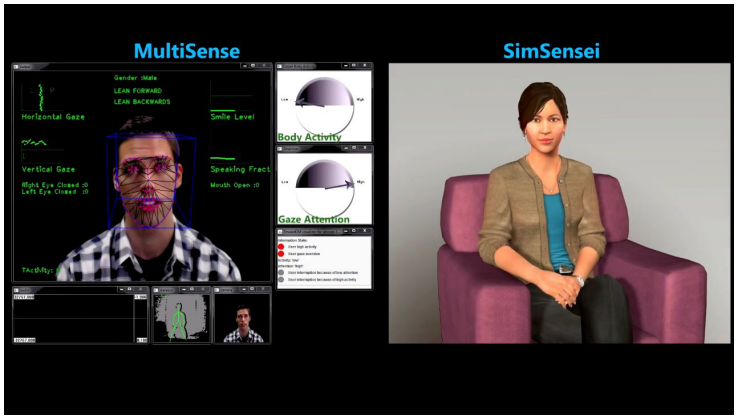
- Only **30% of Americans** in need have access to mental health care.
- AI has made great progress in symptom detection and monitoring treatment efficacy.



Modi et al. (2022)

Backchannels and Context

- Achieving common ground is important for the success of an interaction.
- Backchannel smiles help achieve the common ground.
- Not all backchannel smiles are created equally. Context defines the right fit.



DeVault et al. (2014)

What are Backchannels?

- Backchannels (BC) are listener behaviors.
- They express engagement, agreement and emotional response.
- **Rapport builders:** too short or too long might lead to conversational failures.
- Speaker prosody-based **rules** for BC generation. **Mimicking** speaker behavior or **discriminative** approach for production.

Research Questions

- Hypothesis: Do **speaker and listener behaviors influence** backchannel smiles?
- Can **generative models leverage salient behaviors** and improve the performance?

RealTalk Dataset

Lack of open-source datasets with patient-therapist interactions.

- YouTube-based video dataset of intimate dyadic interactions.

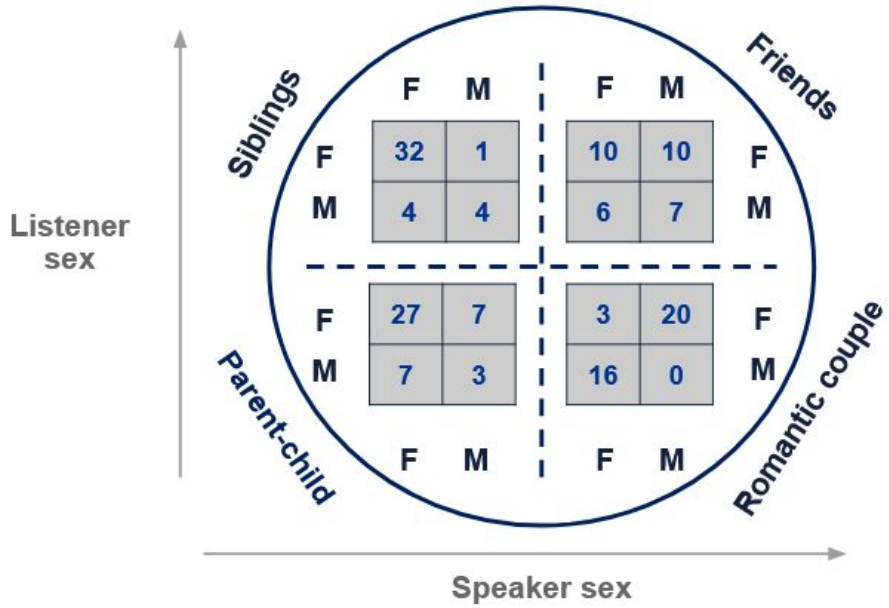
- Questions about:
  - Family relations
  - Dreams
  - Mental health etc.

Question: When do you feel closest to me?

Snippet from RealTalk (Geng et al. 2023) curated from the *SkinDeep* YouTube channel.

Annotating RealTalk: Identifying Backchannel Smiles

- **191 backchannel smiles from 48 interactions.**
- **83 % smiles had A-level or higher intensity.**



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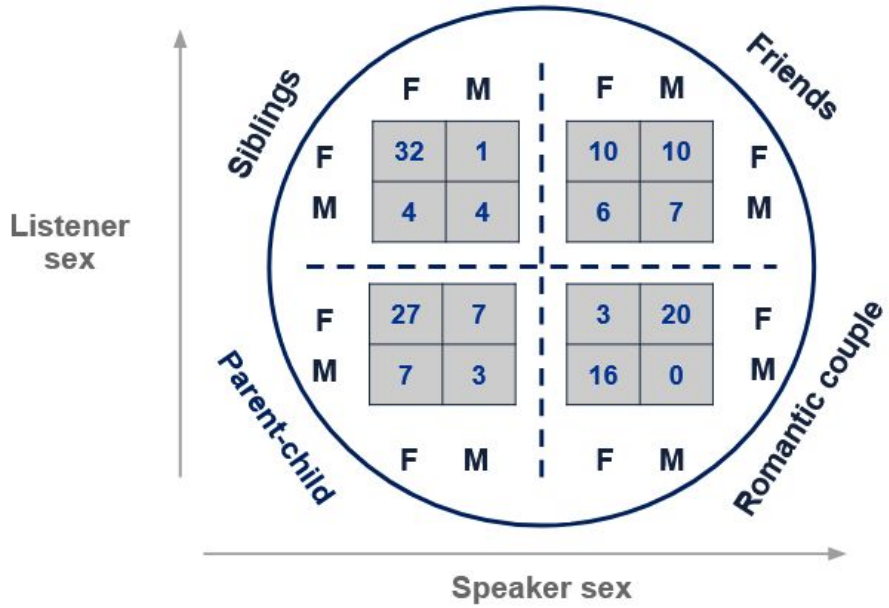


- How are smiles affected by dyadic characteristics like sex and relationship type?
- How do context-cues affect them?
- Can we leverage them in a generative approach?

Sex and Relationships Affect Backchannel Smiles

- We considered sex of the individuals and the nature of their interpersonal relationship for their effect on smile intensity and duration.
  - **Duration** of smiles differ by **listener sex** and **listener sex * relationship**
  - **Male listeners with their sibling (regardless of the sex) express longer BC smiles** ($p<0.05$).
  - **Intensity** marginally differs by speaker sex: Male speakers evoke less intense smiles than female speakers.

How Context Cues Affect Backchannel Smiles?

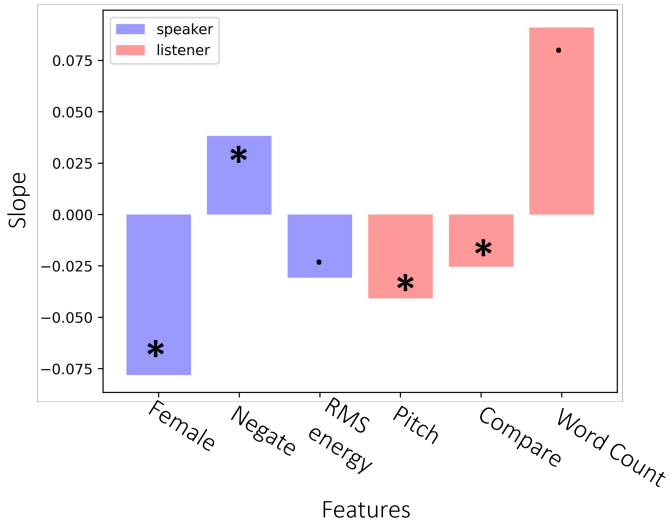
- Both speaker and listener preceding turns effect BC smiles.
- Prosodic and language cues from the turns were used to identify significant predictors.

Prosody	Language
Mean vocal pitch	Word-count
Range of pitch	Negations, Comparisons and Interrogatives
Loudness	Valence
	Focus on past, present and future

Effect of Context Cues on Backchannel Smiles

- When a speaker used **negations** the BC smiles were bigger. **Women speakers** evoked smaller BC smiles.

- When listeners used **high pitch voice** or **comparison words**, the BC smiles were smaller. If the listeners were **talkative**, the BC smiles were bigger.



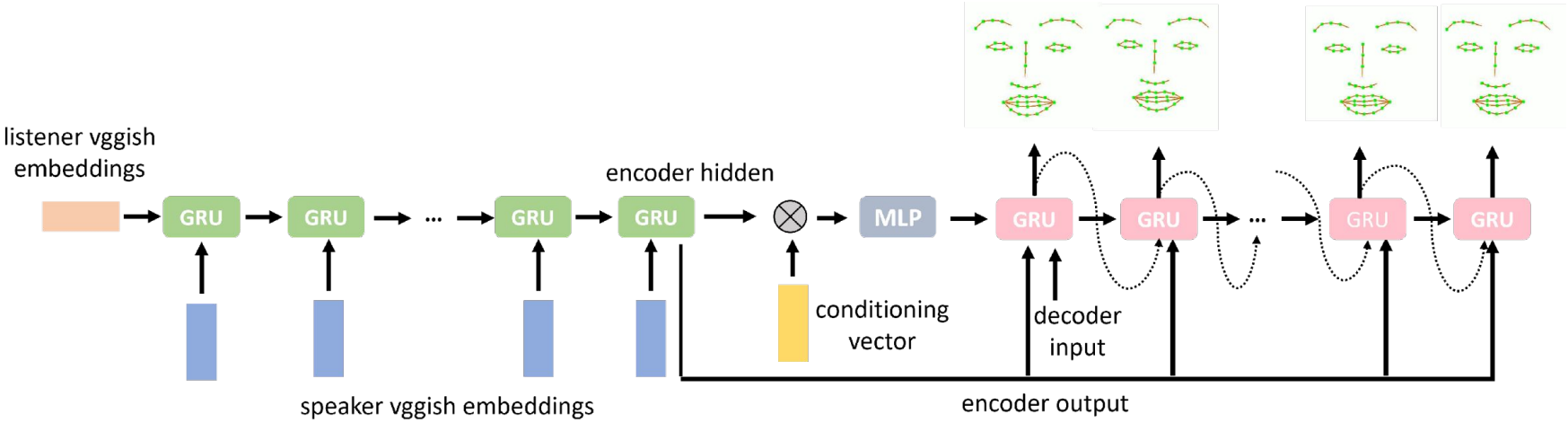
R^2=0.243.
"*" denotes $p<0.05$
"." denotes $p<0.1$.

Duration had no significant outcomes.

Context-Sensitive Backchannel Smile Generation

- Can generative models produce backchannel smiles that are context sensitive?
- Can we improve generative models from our understanding of context and backchannel smiles?

Proposed Architecture



Input:

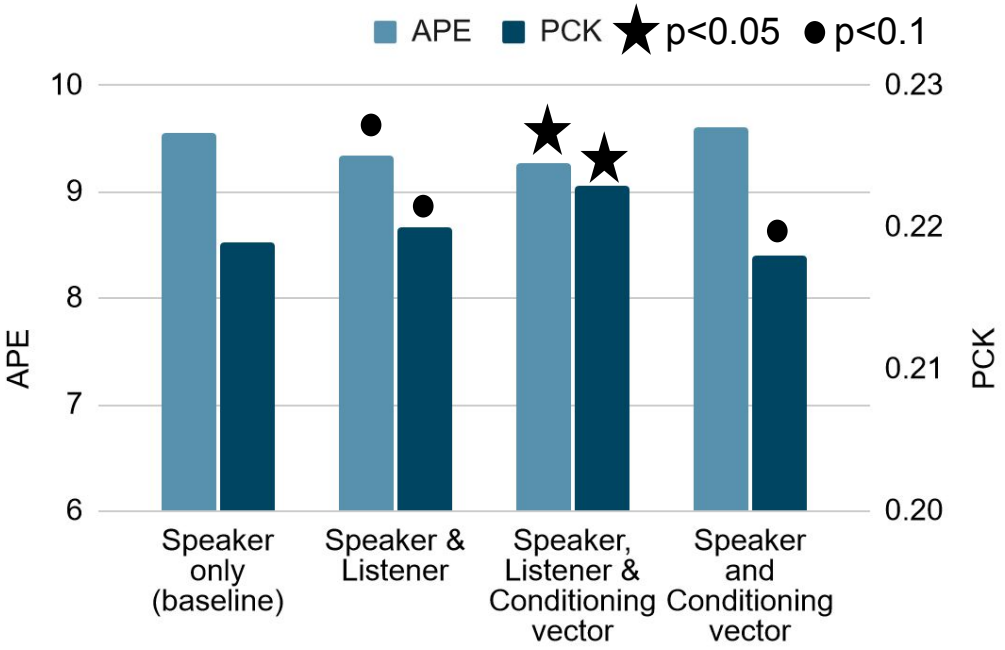
- **vggish embeddings:** turn-specific audio embeddings from vggish model for speaker and listener.
- **Conditioning vector:** speaker features (sex, negations), listener features (comparisons, mean pitch, word-count).

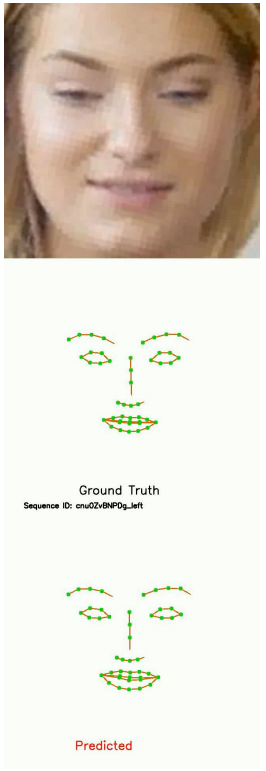
Output:

- Autoregressive prediction of 49 facial landmarks optimised with MSE loss.

Automatic Evaluation

- **Metrics:** Average Pose Error (APE) and Proximally Correct Keypoints (PCK).

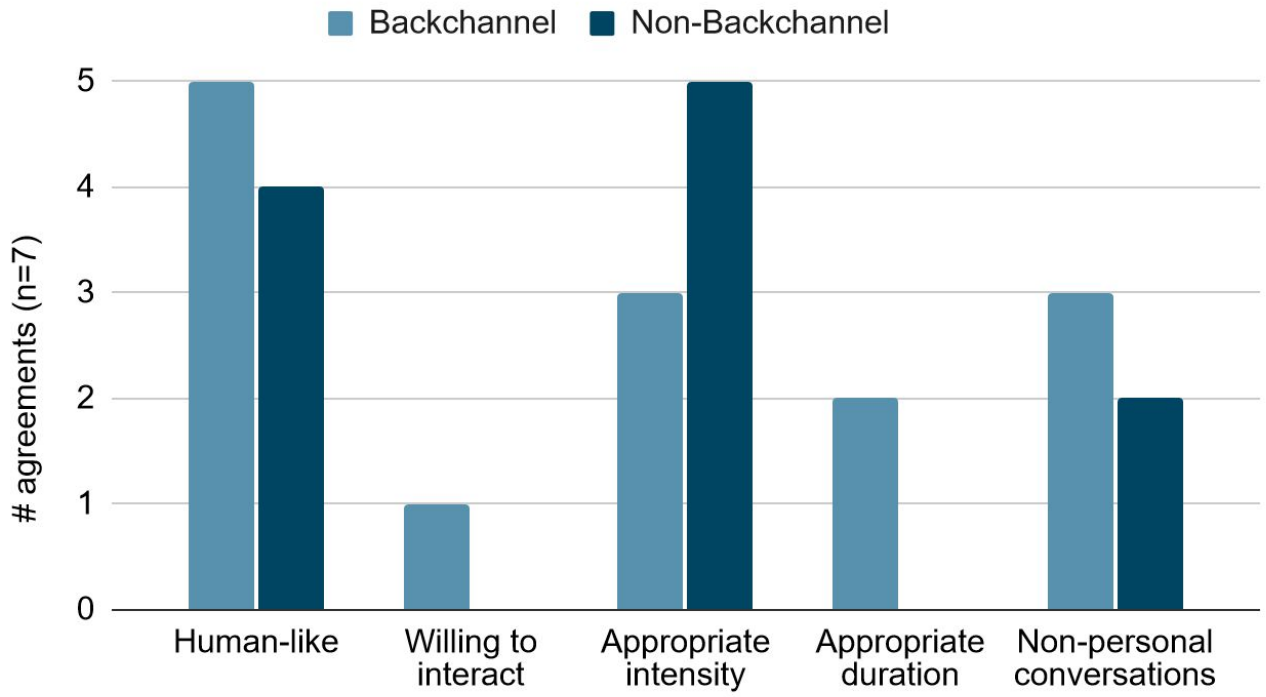




- Generations of **low-intensity smiles are better.**

Human Evaluation with an Embodied Agent

- Watch a Furhat agent interacting with a *human **with backchannels** and **without*** smiles.



Discussion

- Speaker-listener prosodic and linguistic behaviors, and demographics are significant predictors of backchannel (BC) smiles.
- BC smile generation had significant improvements when predictors from speaker and listener were used with their audio embeddings.
- BC smiles that co-occur with vocal activity are harder to predict.
- **Limitations:** improving annotation reliability, one smile-per-person assumption, tracking challenges, advanced generation models.

Contributions

- We annotated video dataset of diverse dyads for backchannel (BC) smiles.
- Our statistical analyses identified the affect of sex, relationship, and context-cues.
- We found that leveraging select context-cues generate better BC smiles.
- We bridged the gap between generation and realization by transferring facial landmarks to an embodied agent.
- We found that humans preferred agents with BC smile behaviors for non-personal conversations.

Thank you

Authors:

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Code and Dataset

SCAN ME