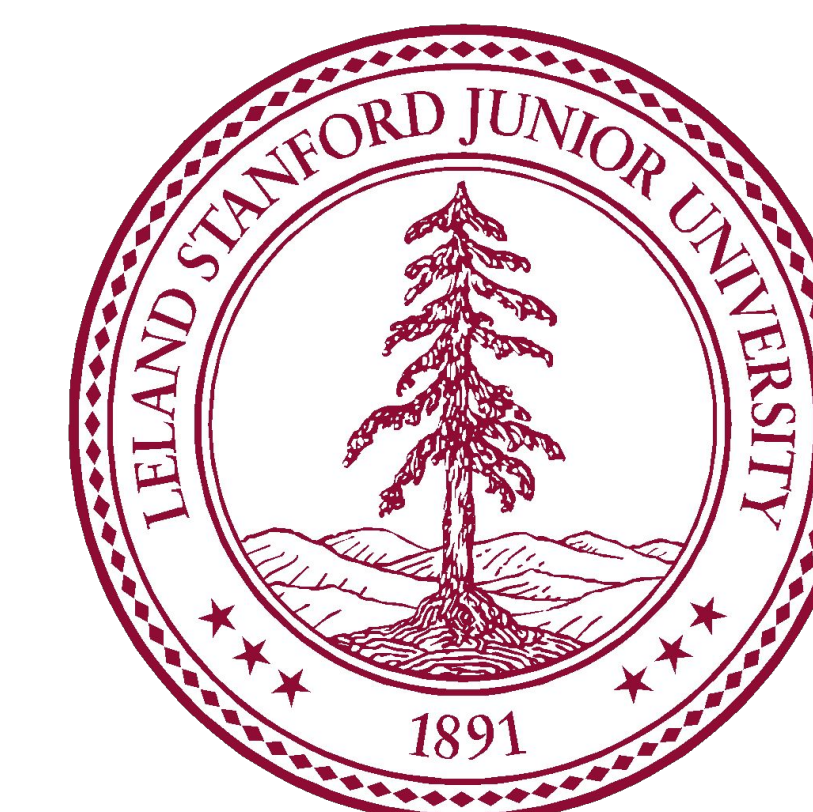# Development and validation of a facial emotion classifier for applications in the treatment of autism spectrum disorder

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Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder affecting one in 40 children in the United States and is associated with impaired social interactions, restricted interests, and repetitive behaviors. Previous studies have demonstrated the promise of applying mobile systems with real-time emotion recognition to Applied Behavioral Analysis (ABA) therapy, but existing platforms have shown limited performance on videos of children with ASD. *Guess What?* is a charades-style mobile game that we developed to deliver a form of Discrete Trial Training (DTT) and Pivotal Response Treatment (PRT) to children at home and mitigate the high costs and short supply of traditional interventions. *Guess What?* also serves as a data acquisition tool, aggregating emotive videos for autism research.
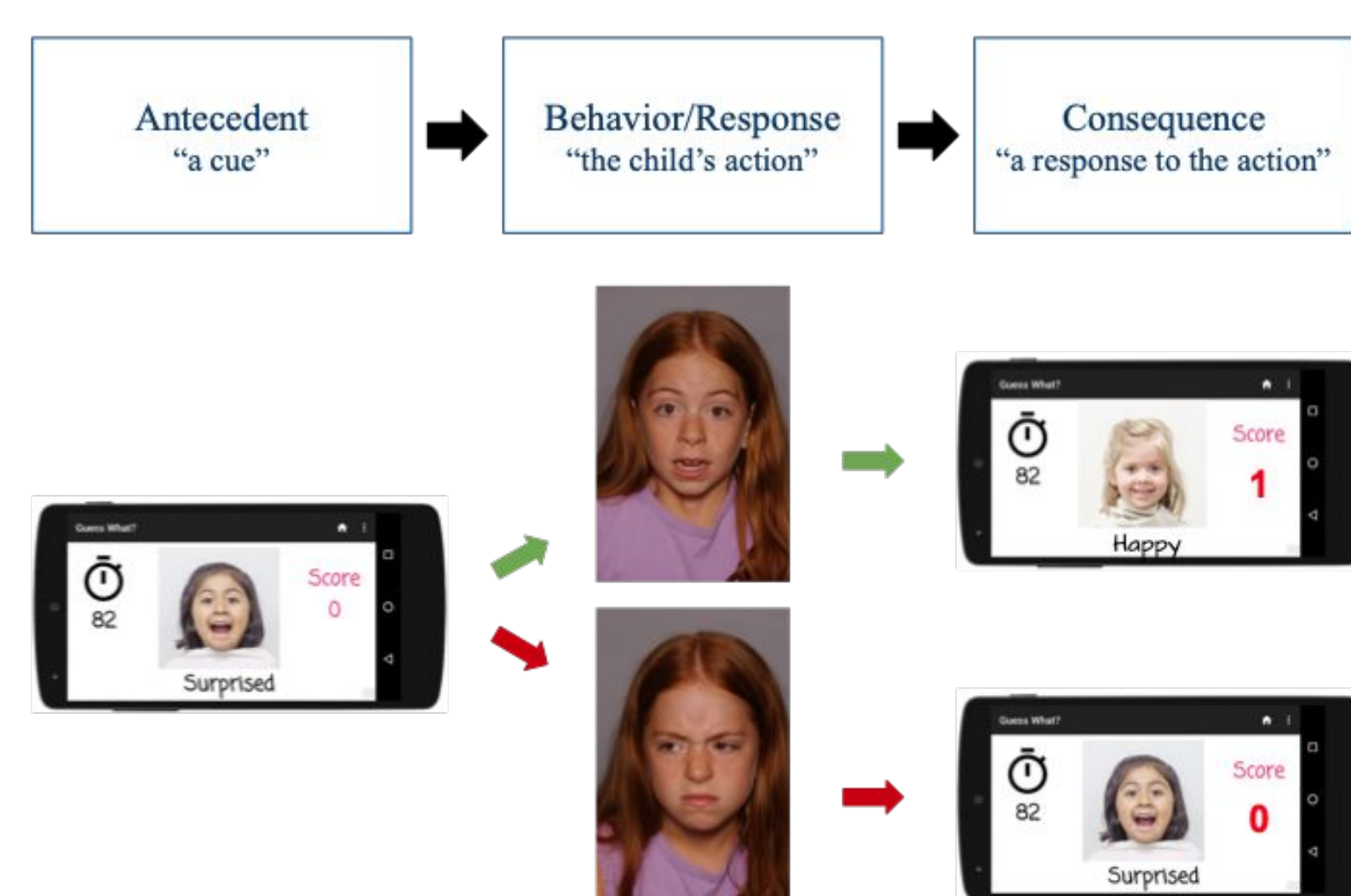

Figure 1. Discrete Trial Training
Guess What? incorporates DTT and Pivotal Response Treatment (PRT), two teaching strategies that fall under the umbrella of ABA.

Hypothesis

We propose the development of a new emotion classifier designed specifically for pediatric populations, trained with images crowdsourced from an educational mobile charades-style game: *Guess What?*.
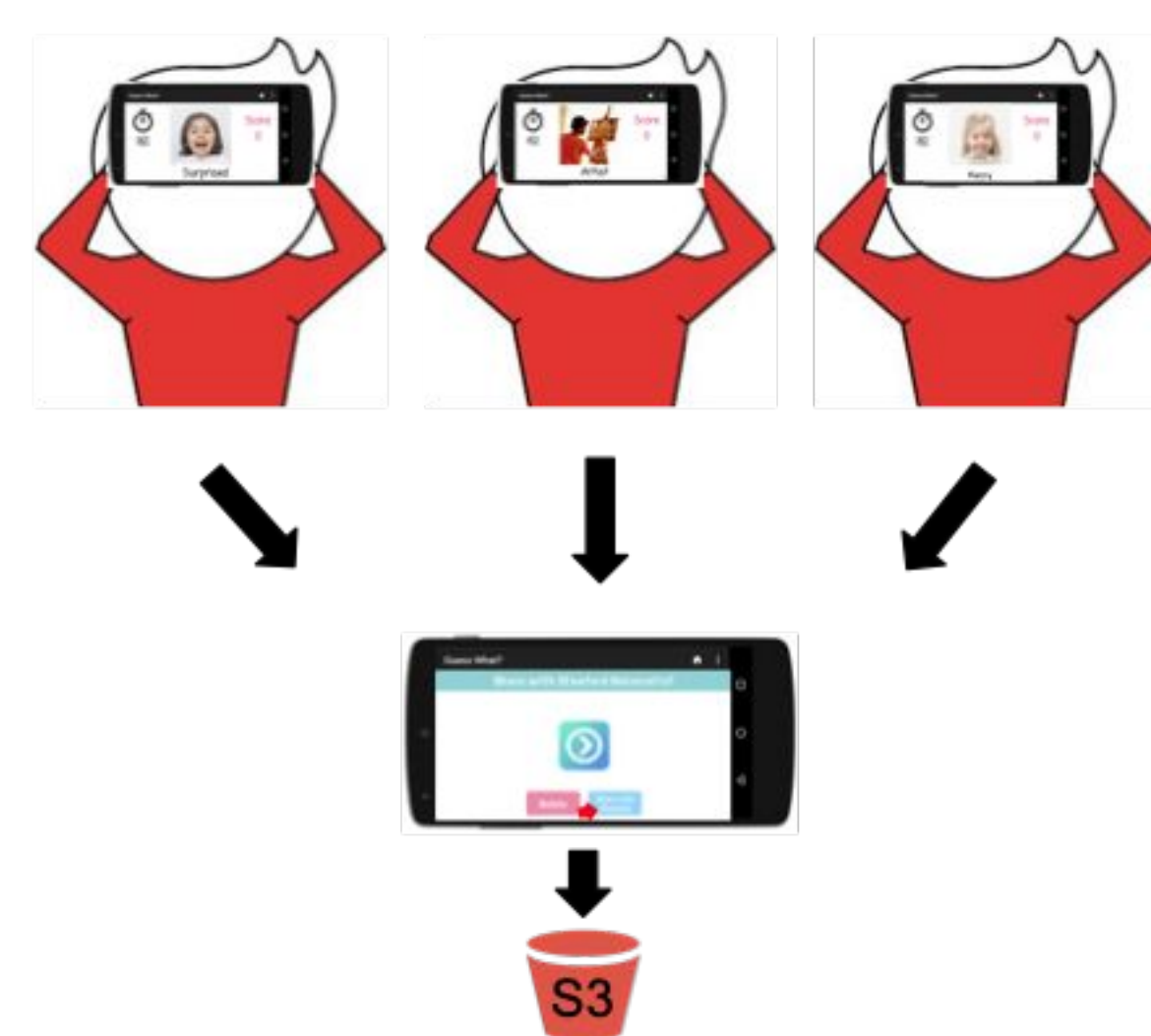
Methods & Materials

Figure 2. Data acquisition process
Crowdsourced videos taken during game sessions are stored in an Amazon S3 bucket (with participant's consent).
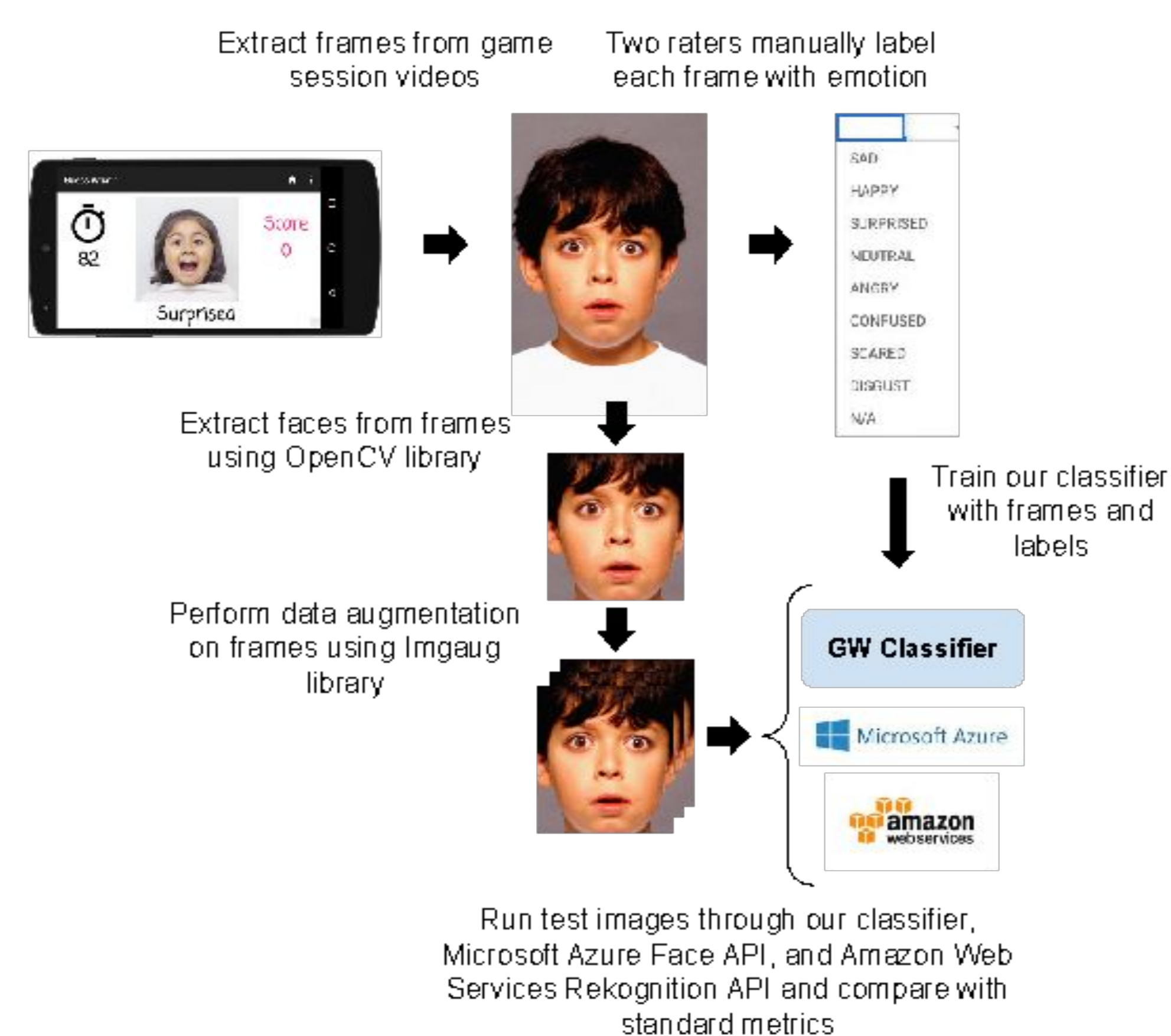

Figure 3. Emotion classifier training and evaluation process
Remote game sessions of *Guess What?* yielded 6,344 frames from fifteen subjects. Two raters manually labeled the frames with four of the Ekman universal emotions (happy, scared, angry, sad), a "neutral" class, and "n/a". The data were pre-processed, and a model was trained with a transfer-learning and neural-architecture-search approach using the Google Cloud AutoML Vision API. The resulting classifier was evaluated against existing approaches: Microsoft's Azure Face API and Amazon Web Service's Rekognition using the standard metric of F1 scores.

Results

PROPOSED

Figure 4. Confusion matrix of proposed classifier
Most discrepancy occurs between differentiating neutral from happy. However, this classifier generally shows very strong performance for all five emotions.

AZURE

Figure 5. Confusion matrix of Azure classifier
This classifier shows rather strong performance for happy and neutral, but performs poorly for the others, specifically mistaking sad for scared and neutral for sad.

REKOGNITION

Figure 6. Confusion matrix of Rekognition classifier
Results indicate strong performance for happy and neutral, but weak agreement for the other emotions.
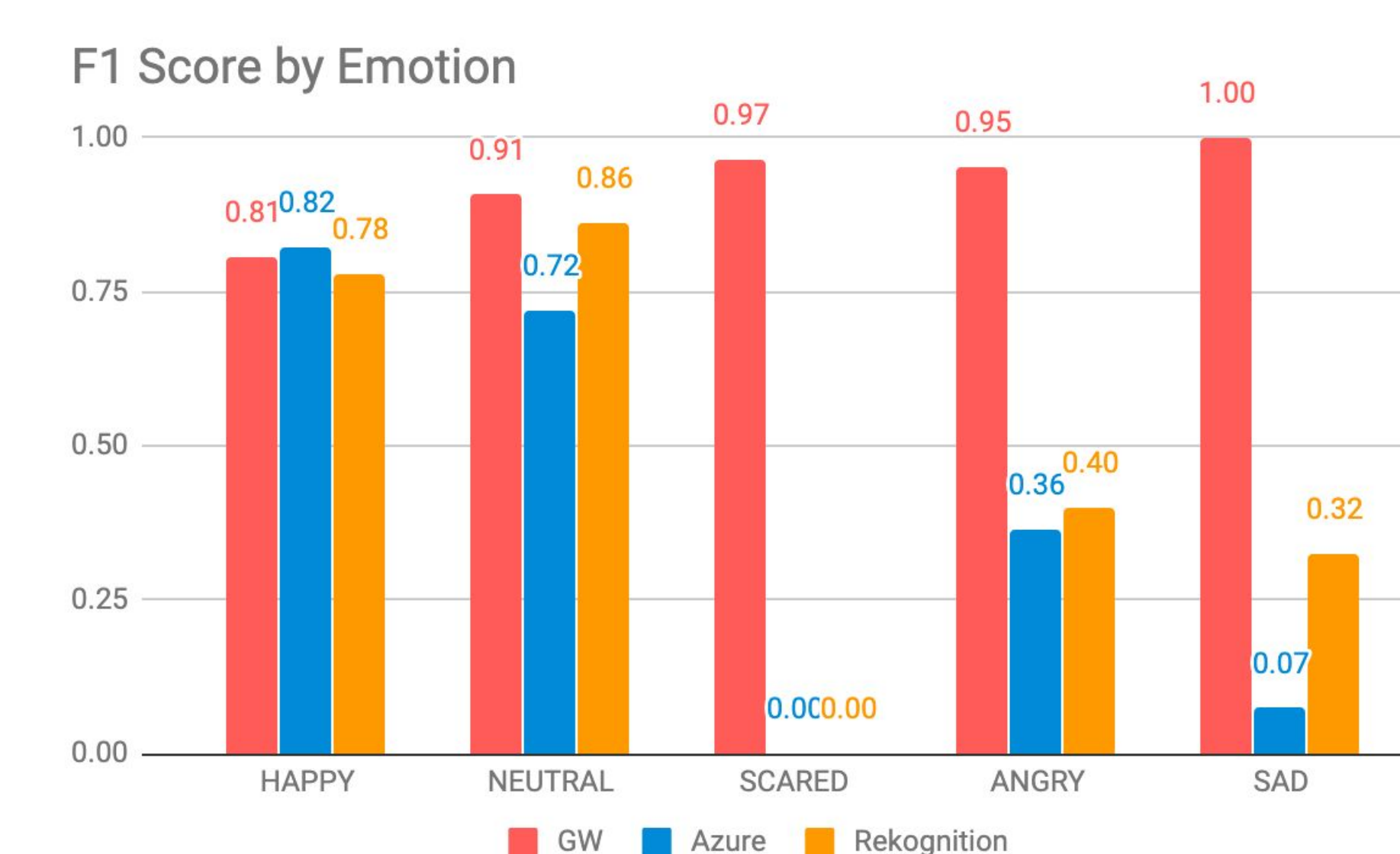
Results (cont.)

Figure 7. F1 scores by classifier and by emotion
In general, the proposed classifier showed the highest F1 scores across all emotions.

Conclusions

- The proposed classifier demonstrated superior performance across all evaluated emotions.
- Results suggest a new strategy to develop precision therapy for autism at home by integrating the model trained with a personalized dataset to the mobile game

Future Work

- The proposed emotion classifier will be integrated into *Guess What?* to serve as additional reinforcement for the caregiver.
- New features of *Guess What?* will be developed to include more aspects of ABA therapy including adapting difficulty to target individual's specific deficits and providing appropriate visual feedback.

References

[1]Kogan, Michael D., Catherine J. Vladutiu, Laura A. Schieve, Reem M. Ghandour, Stephen J. Blumberg, Benjamin Zablotsky, James M. Perrin et al. "The prevalence of parent-reported autism spectrum disorder among US children." Pediatrics 142, no. 6 (2018): e20174161.
[2]H. Kalantarian, "A Mobile Game for Automatic Emotion-Labeling of Images," IEEE Transactions on Games, pp.1-1. 10.1109/TG.2018.2877325.

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