A Window to the Mind

Lecture 05 (Analysis II)

Alessandro Vinciarelli

Outline

- A Window to the Mind?
- Example: Depression
- Example: Attachment
- Conclusions

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A Window to the Mind?

- So far the focus has been mostly on observation and perception;
- The work presented so far addressed the observation of behavioural patterns, the attribution of socially relevant traits and the analysis of social dynamics;
- The question left open is whether Social AI can tell something about the inner life of people, that is, whether the mental phenomena leave physical, machine detectable traces;
- The detection of mental health issues is an example.

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Why Psychiatry?

- Psychiatric issues do not leave (in general) physiological traces;
- The definition of the pathologies changes periodically with the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and of the International Classification of Diseases (ICD-11);
- The diagnosis process is mostly based on the observation of the way potential patients behave;
- The way psychiatrists work lends itself to the application of Social AI.

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Why Psychiatry?

"[…] emotion AI vendors have moved into completely new areas and industries, […] better customer experience and unlock real cost savings […] Software can help doctors with the diagnosis of diseases such as depression and dementia by using voice analysis."

S.Moore, "13 Surprising Uses for Emotion AI Technology", The Gartner Group, 2022
https://www.gartner.com/smarterwithgartner/13-surprising-uses-for-emotion-ai-technology

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Depression Facts (I)

"Globally, the total number of people with depression was estimated to exceed 300 million in 2015 […] 7.5% of all years lived with disability in 2015 […] major contributor to suicide deaths, which number close to 800,000 per year."

World Health Organization, "Depression and Other Common Mental Health Disorders", 2017

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Depression Facts (II)

"Between 2008 and 2018, prescriptions for antidepressant medications in the UK increased from 36 million to 70.6 million […] A study of 29 countries […] all of them had seen an increase in antidepressant prescriptions between 2000 and 2015, doubling on average."

Foulkes, "What Mental Illness Really Is (And What It Isn't)", Vintage, 2021

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Depression

"[…] an increase in negative emotions and feelings and a reduction in positive emotions and feelings […]"

Irons, "Depression", Palgrave, 2014

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The Data

Condition	Age	Female	Male	Low Education	High Education
Control	47.6 ± 12.6	42	12	19	33
Depressed	47.6 ± 12.0	37	18	23	31
Total	47.6 ± 12.2	79	30	42	64

- No differences between Control and Depressed (diagnosed by professional psychiatrists) in Gender, Age and Education;
- Publicly available at https://github.com/androidscorpus/data.

Irons, “Depression”, Palgrave, 2014

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#1

#2

- All 109 participants were asked to read the same text (“The North Wind and the Sun” by Aesop);
- The goal is to eliminate variance resulting from differences in spoken content;
- The depression patient is record #2.

Tao, Esposito and Vinciarelli, “The Androids Corpus: A New Publicly Available Benchmark for Speech Based Depression Detection”, Proceedings of Interspeech, 2023

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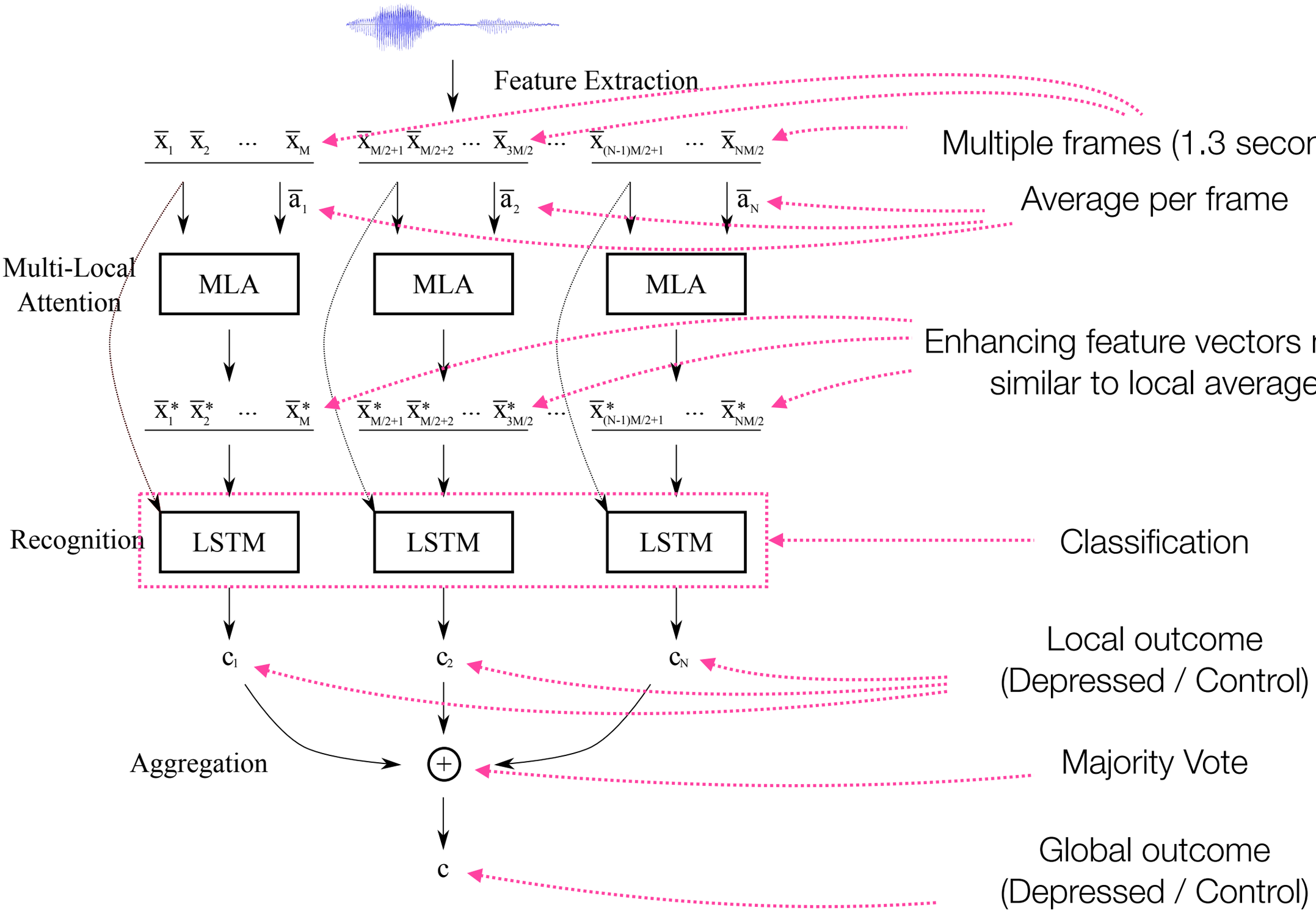

Tao, Ge, Ma, Esposito and Vinciarelli, “Multi-Local Attention for Speech-Based Depression Detection”, Proceedings of the IEEE International Conference on Audio, Speech and Signal Processing, 2023

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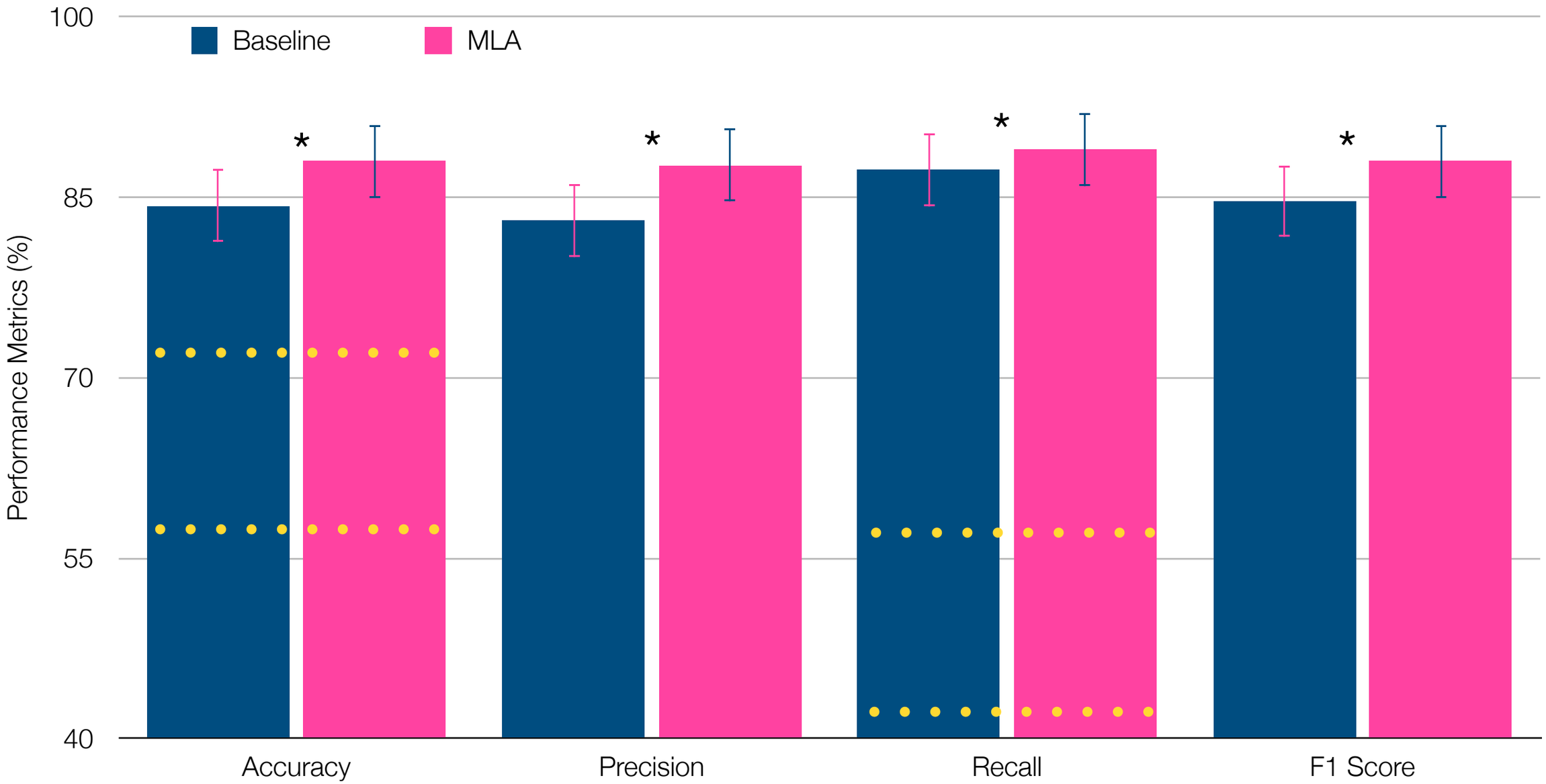
Results



Tao, Ge, Ma, Esposito and Vinciarelli, “Multi-Local Attention for Speech-Based Depression Detection”, Proceedings of the IEEE International Conference on Audio, Speech and Signal Processing, 2023

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Depression Speaks

- Depression leaves physical, machine detectable traces in the way people speak;
- The approach matches the decision of professional psychiatrists well beyond chance;
- The performance is better than General Practitioners (GP), the first line of intervention against depression;
- The way psychiatrists work lends itself to the application of Social AI;
- A question that remains open is whether it can be used.

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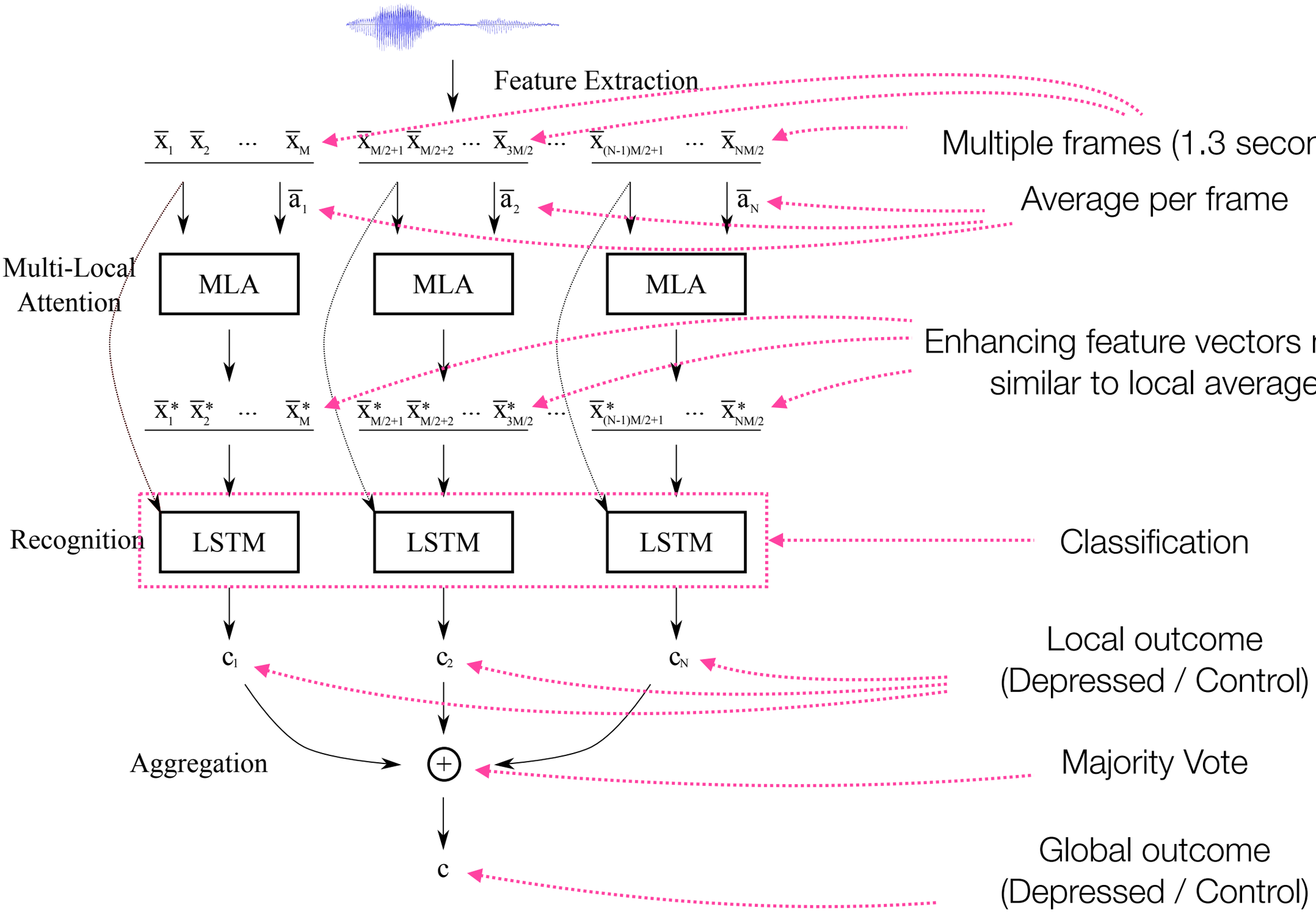

Tao, Ge, Ma, Esposito and Vinciarelli, “Multi-Local Attention for Speech-Based Depression Detection”, Proceedings of the IEEE International Conference on Audio, Speech and Signal Processing, 2023

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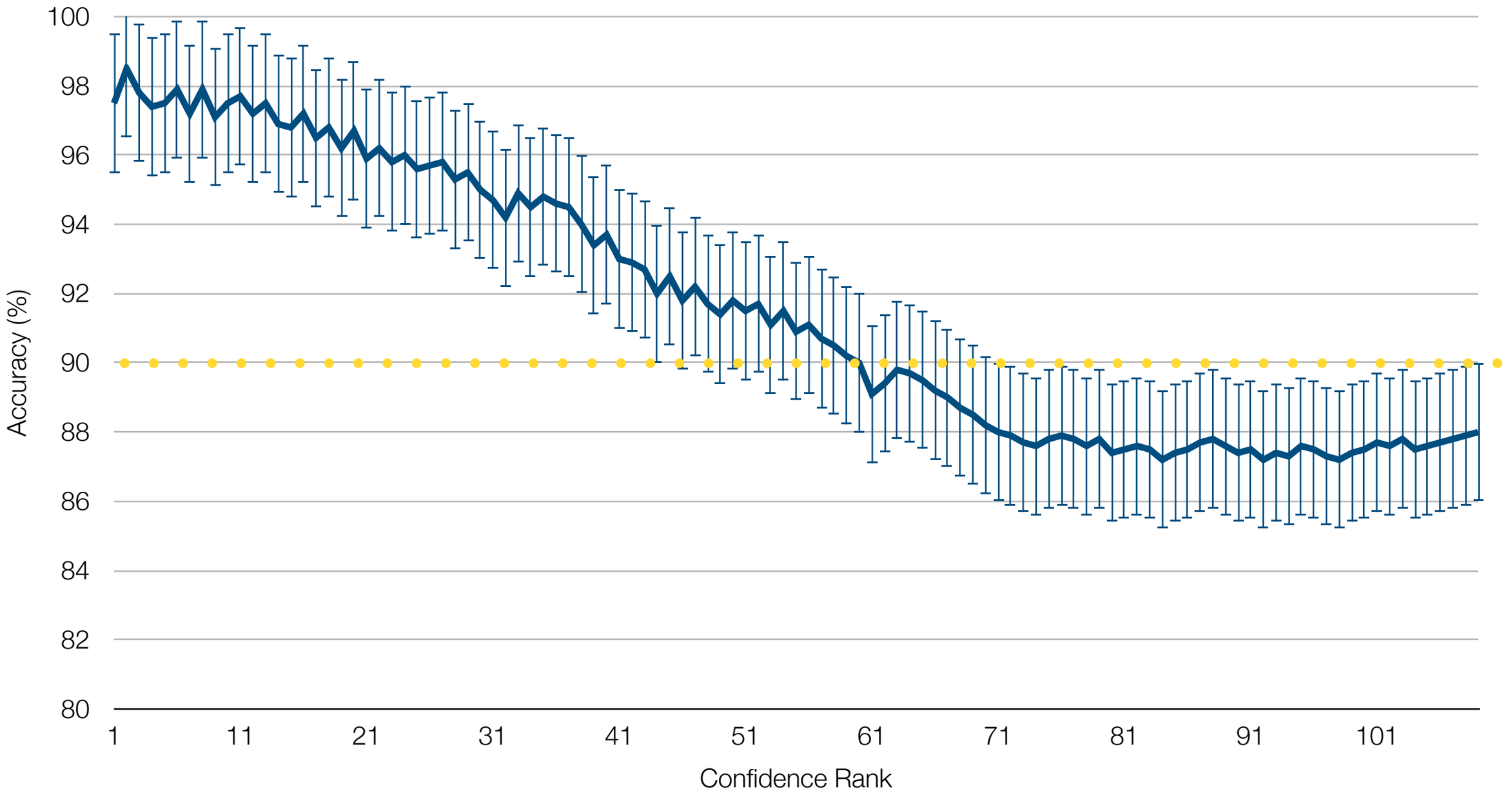
Accuracy vs Confidence Rank



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Confidence and Psychiatry Practice

- More than half of the cases are sufficiently evident to be recognised with accuracy above 90%;
- High confidence cases correspond to speakers who are clearly depressed or clearly non-depressed;
- The machine can automatically discriminate between high confidence cases and the others;
- The machine can help to reduce the amount of work by roughly 50%, thus increasing efficiency.

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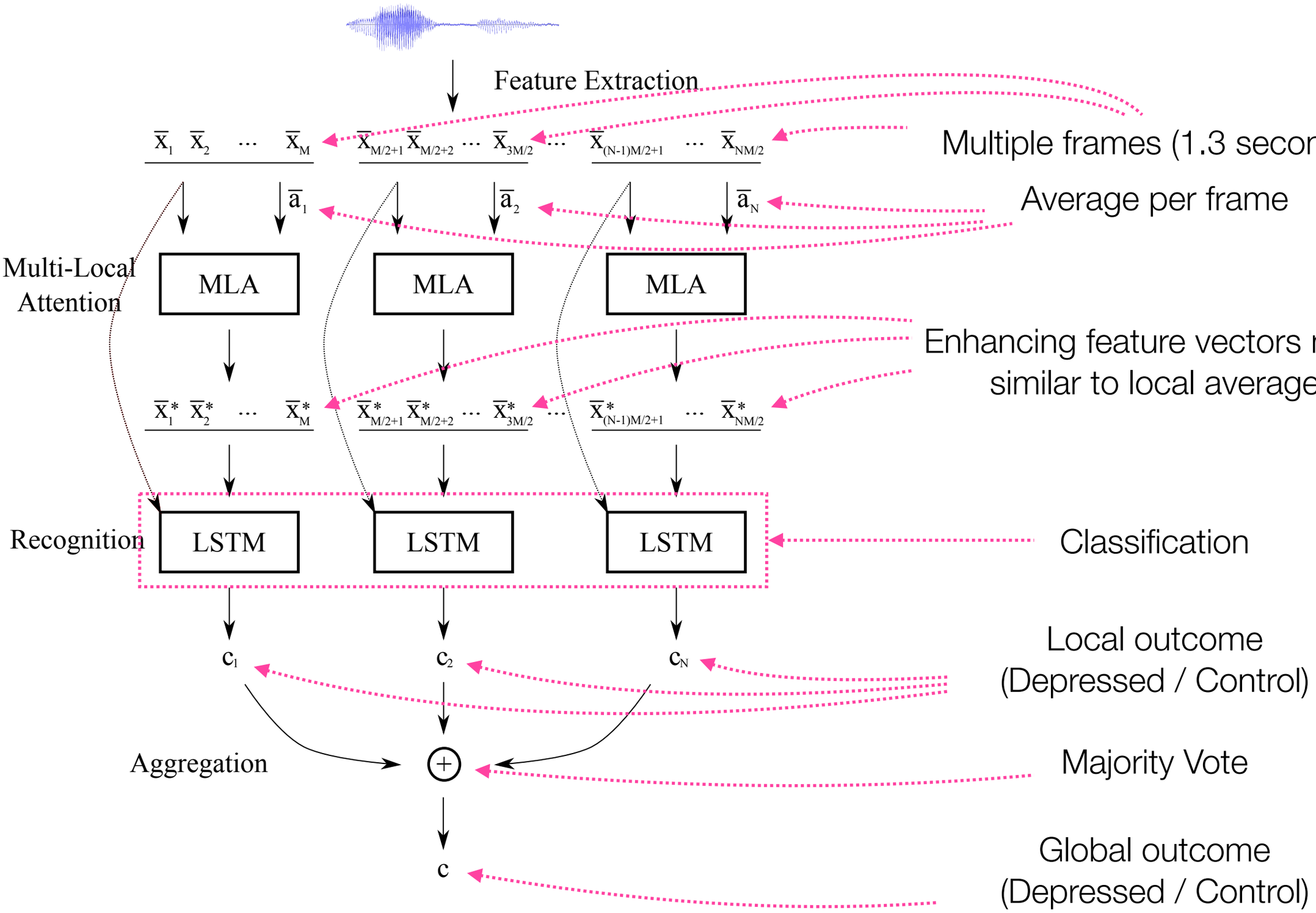

Tao, Ge, Ma, Esposito and Vinciarelli, “Multi-Local Attention for Speech-Based Depression Detection”, Proceedings of the IEEE International Conference on Audio, Speech and Signal Processing, 2023

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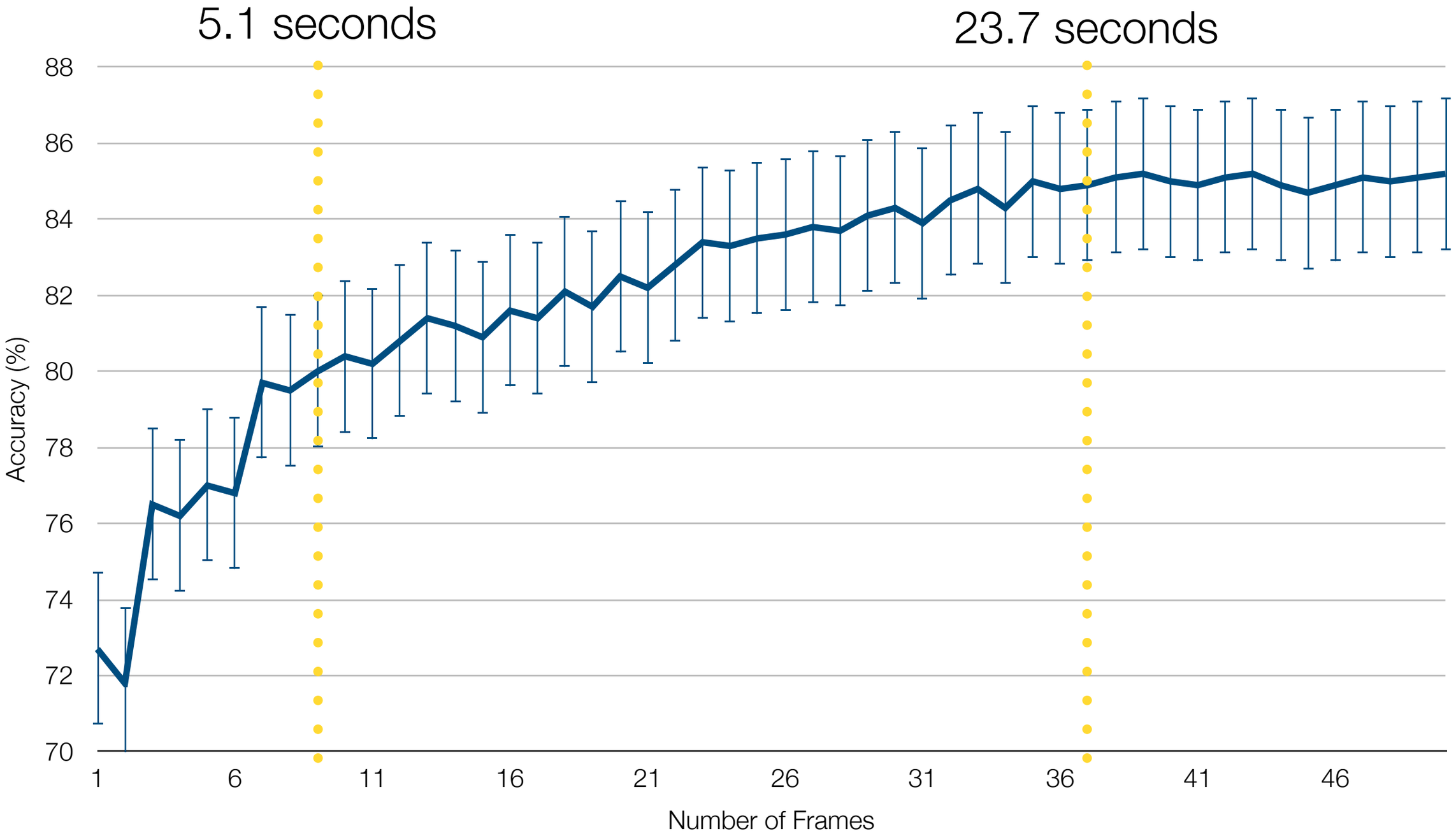
Accuracy vs Number of Frames



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Confidence and Psychiatry Practice

- The accuracy reaches 80% after roughly 5 seconds of reading;
- The accuracy reaches the same performance as the one achieved using all the data after 23.7 seconds;
- This reduces by roughly 8 times the amount of time needed to perform at the level of the best GPs;
- This has the double positive effect to increase efficiency and, most importantly, to limit the effort for depression patients.

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Why Attachment?

"[…] because successful parenting is a principal key to the mental health of the next generation, we need to know […] its nature and the manifold social and psychological conditions that influence its development for better or worse."

Bowlby, "A Secure Base", Palgrave, 1988.

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Secure Attachment

"Children whose needs have been met […] described as secure attachment […] do better at school and are likely to be good at making friends […] form close relationships later in life […] grow up knowing that when they need something someone will help them."

J.Furnivall, M.McKenna, S.McFarlane, E.Grant., "Attachment Matters for All - An Attachment Mapping Exercise for Children's Services in Scotland", Centre for Excellence for Looked After Children in Scotland

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Insecure Attachment

"Children whose early experiences of attachment have been less optimal can have insecure or disorganised attachments […] will potentially be more vulnerable with respect to coping with future relationships and life events."

J.Furnivall, M.McKenna, S.McFarlane, E.Grant., "Attachment Matters for All - An Attachment Mapping Exercise for Children's Services in Scotland", Centre for Excellence for Looked After Children in Scotland

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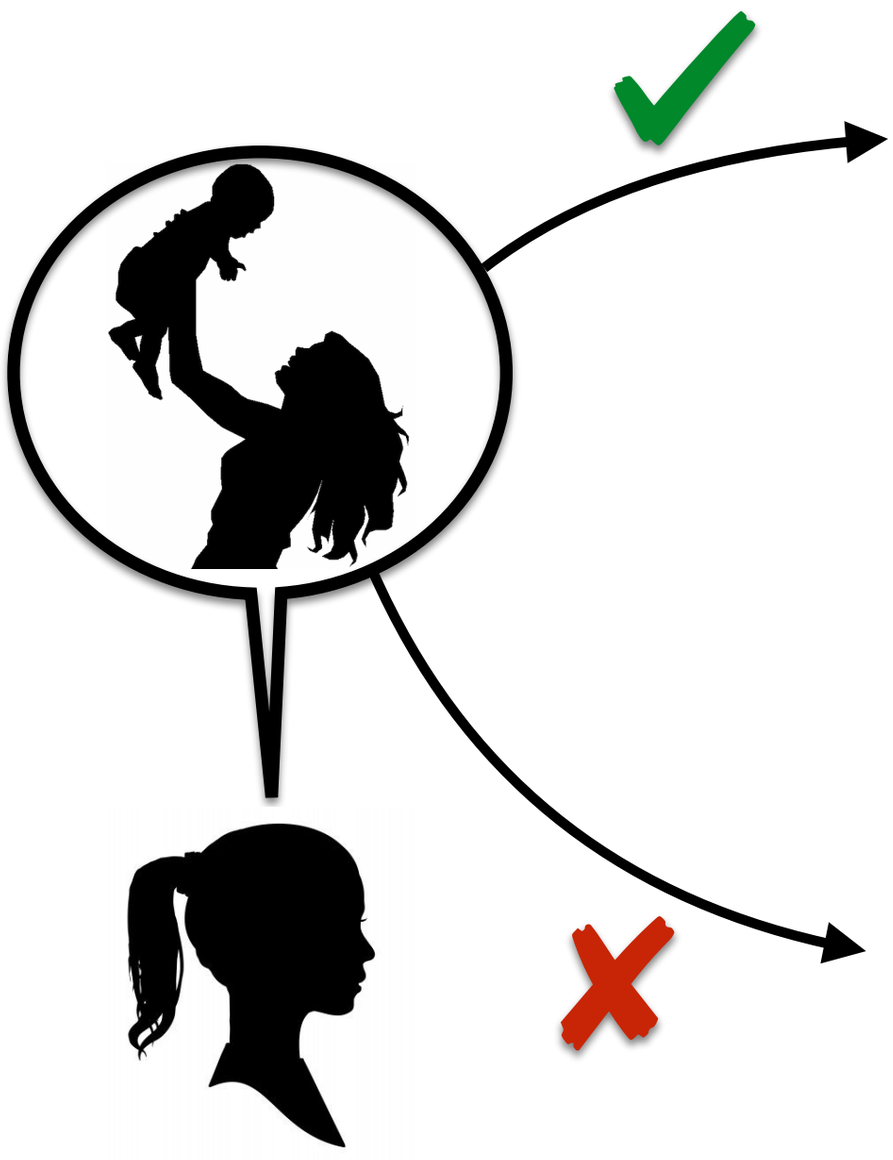

Secure Attachment (~60%)
The perception of the relationship with the parents is positive

Insecure Attachment (~40%)
The perception of the relationship with the parents is negative

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Insecure Attachment Consequences

- Children who have abnormal family attachments are at much higher risk of aggressive behaviours;
- By early adulthood, individuals with aggressive behaviour cost society 10 times more than their peers and have a mortality rate almost 10 times higher;
- Increased risk of suicide and violent behaviour, but also due to physical problems such as coronary heart pathologies.

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Story Stem Techniques

"[…] a vehicle for accessing the representational world of young children through the developmentally appropriate domain of play, and these techniques have been used successfully in investigations of representation and attachment […]"

Toth et al., "The relative efficacy of two interventions in altering maltreated preschool children's representational models: Implications for attachment theory", Development and Psychopathology 14(4):877–908, 2002.

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The MCAST

- The Manchester Child Attachment Story Task (MCAST) is a test commonly used to analyse the attachment condition of children;
- The children listen to a few story stems (e.g., a child wakes up after a nightmare) and complete them using dolls;
- The way the children represent the story accounts for their attachment condition;
- The main problem is that the MCAST is expensive and time-consuming.

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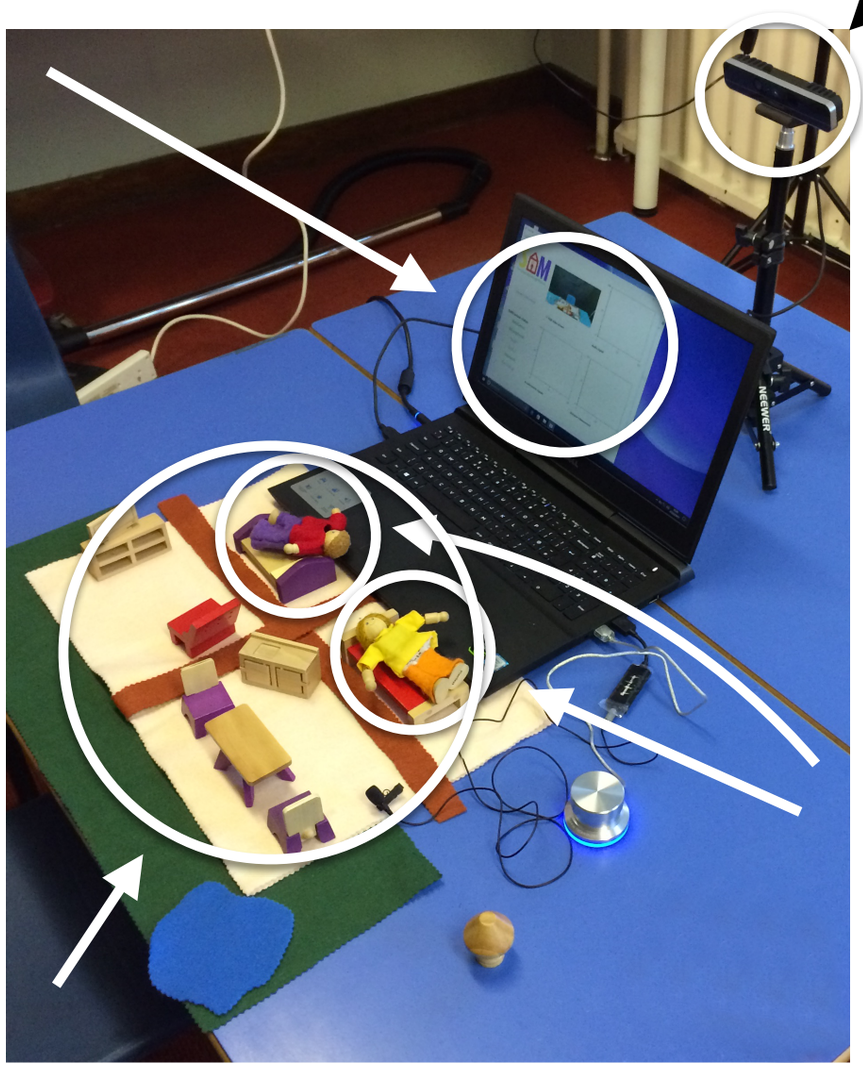
The screen shows the videos where the actors provide the story stems

Camera that records the child



Dolls (caregiver and child)

Play mat showing an apartment

The Participants

Level	P1 (5-6)	P2 (6-7)	P3 (7-8)	P4 (8-9)
Female	10 (8.3%)	25 (20.8%)	17 (14.2%)	12 (10.0%)
Male	14 (11.7%)	18 (15.0%)	18 (15.0%)	6 (5.0%)
Total	24 (20.8%)	43 (35.8%)	35 (29.2%)	18 (15.0%)

- The children were recorded while undergoing the Manchester Child Attachment Story Test, a common attachment assessment approach;

Roffo, Vo, Sorrentino, Rooksby, Tayarani, Di Folco, Minnis, Brewster and Vinciarelli, “Automating the Administration and Analysis of Psychiatric Tests: The Case of Attachment in School Age Children”, Proceedings of CHI, 2019

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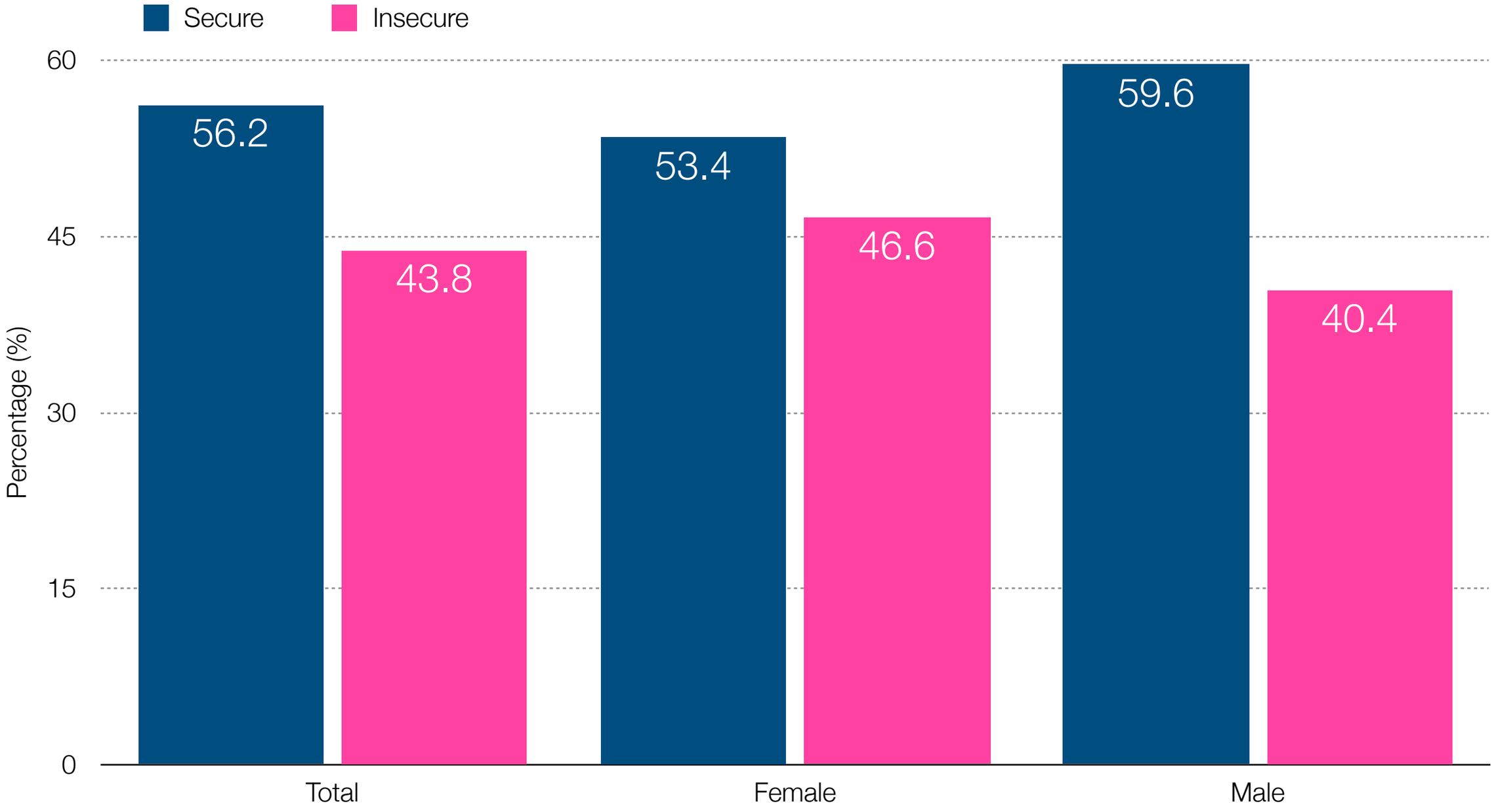
Does Administration Work?



Roffo, Vo, Sorrentino, Rooksby, Tayarani, Di Folco, Minnis, Brewster and Vinciarelli, “Automating the Administration and Analysis of Psychiatric Tests: The Case of Attachment in School Age Children”, Proceedings of CHI, 2019

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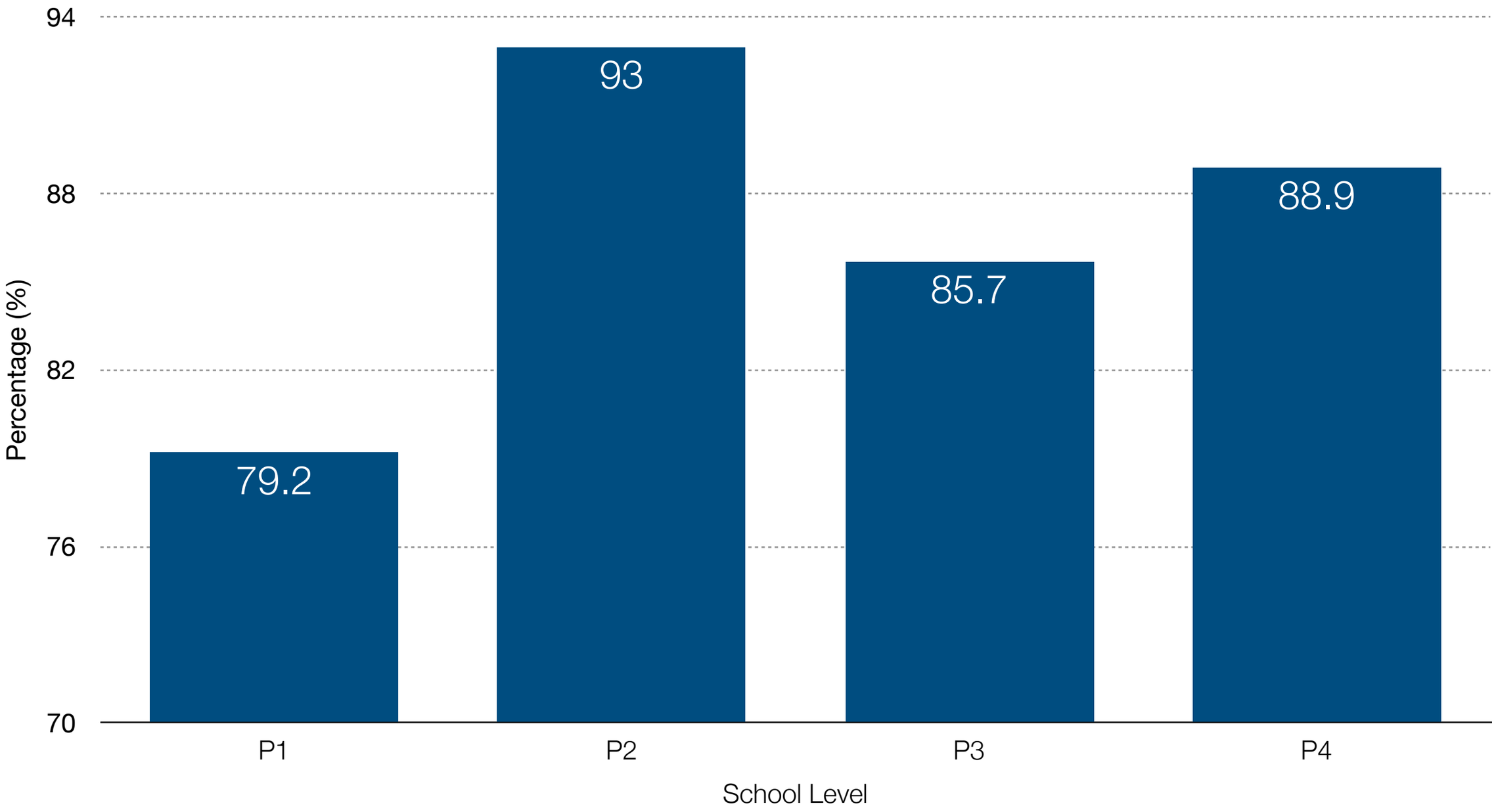
Administration Effectiveness (II)



Roffo, Vo, Sorrentino, Rooksby, Tayarani, Di Folco, Minnis, Brewster and Vinciarelli, “Automating the Administration and Analysis of Psychiatric Tests: The Case of Attachment in School Age Children”, Proceedings of CHI, 2019

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Administration Effectiveness (III)

- The administration of the MCAST has been successful for 104 children out of 120 (86.7%);
- According to a statistical test, the administration effectiveness is the same across all Primary School levels, even if they cover a wide spectrum of developmental stages;
- Still, younger children (P1) are sometimes in difficulty, while the oldest children (P4) tend to feel too much grown up for playing the game.

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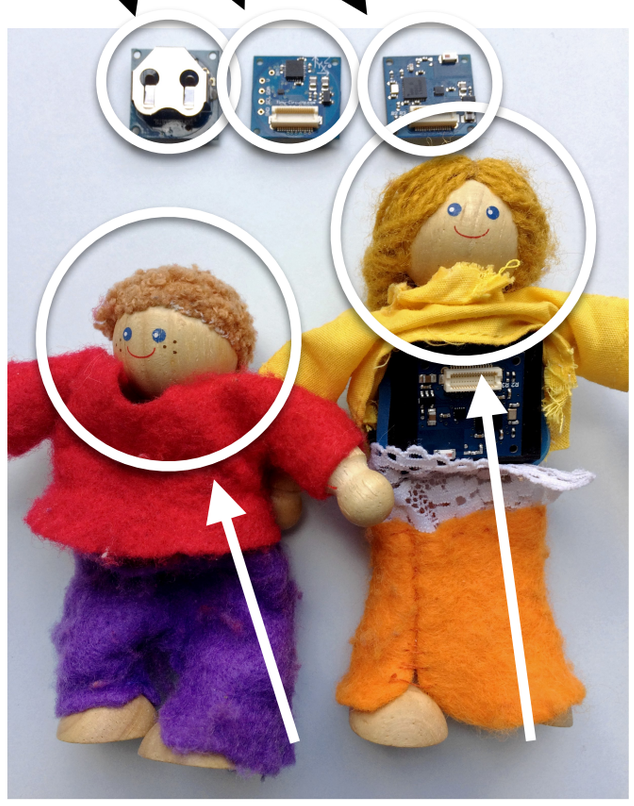
The dolls are instrumented



The child plays with the dolls to represent the story

Baby doll and Mommy doll (caregiver)

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Behaviour Extraction	Head Pose Analysis (Open Face)	Movement Analysis (Accelerometers)
Behaviour Representation	Feature Extraction	Extraction of 10 features
Combination	Multimodal Analysis	Early Fusion
Classification	Gaussian Mixture Models	Recognition of the Interaction Step

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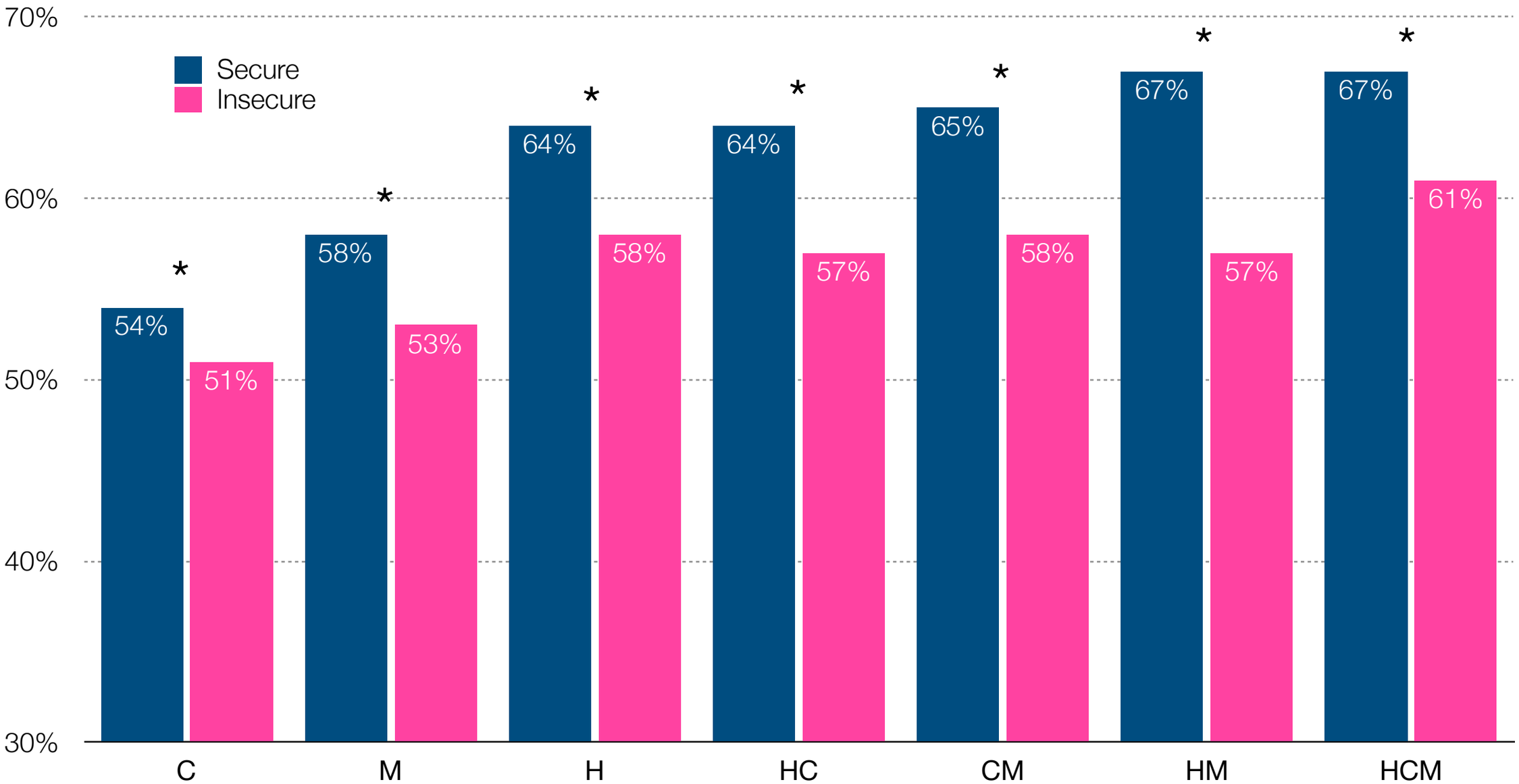
Attachment and Usability (I)



Vo et al., “Did The Children Behave? Automatic Analysis for Measuring Expected Child Behaviour with Interactive Software”, Proceedings of the ACM International Conference on Multimodal Interaction, 2020

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Attachment and Usability (II)

- Irrespective of the modality (or the combination of the combination of modalities), the performance is higher for secure children;
- Mommy doll performs better than child doll, in line with attachment theory (what matters is the perception of the relationship with parents);
- Secure children show higher concordance, that is, higher tendency to act according to the software design (compatible with attachment theory);
- The observation suggest an inclusive design problem.

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Insecure Attachment

Level	P1 (5-6)	P2 (6-7)	P3 (7-8)	P4 (8-9)
Female	9 (8.6%)	22 (21.1%)	15 (14.4%)	11 (10.6%)
Male	14 (9.6%)	18 (17.3%)	14 (13.5%)	5 (4.8%)
Secure	9 (8.6%)	22 (21.1%)	18 (17.3%)	10 (9.6%)
Insecure	10 (9.6%)	18 (17.3%)	11 (10.6%)	6 (5.8%)
Total	19 (18.3%)	40 (38.5%)	29 (21.1%)	16 (15.4%)

- The children were recorded while undergoing the Manchester Child Attachment Story Test, a common attachment assessment approach;

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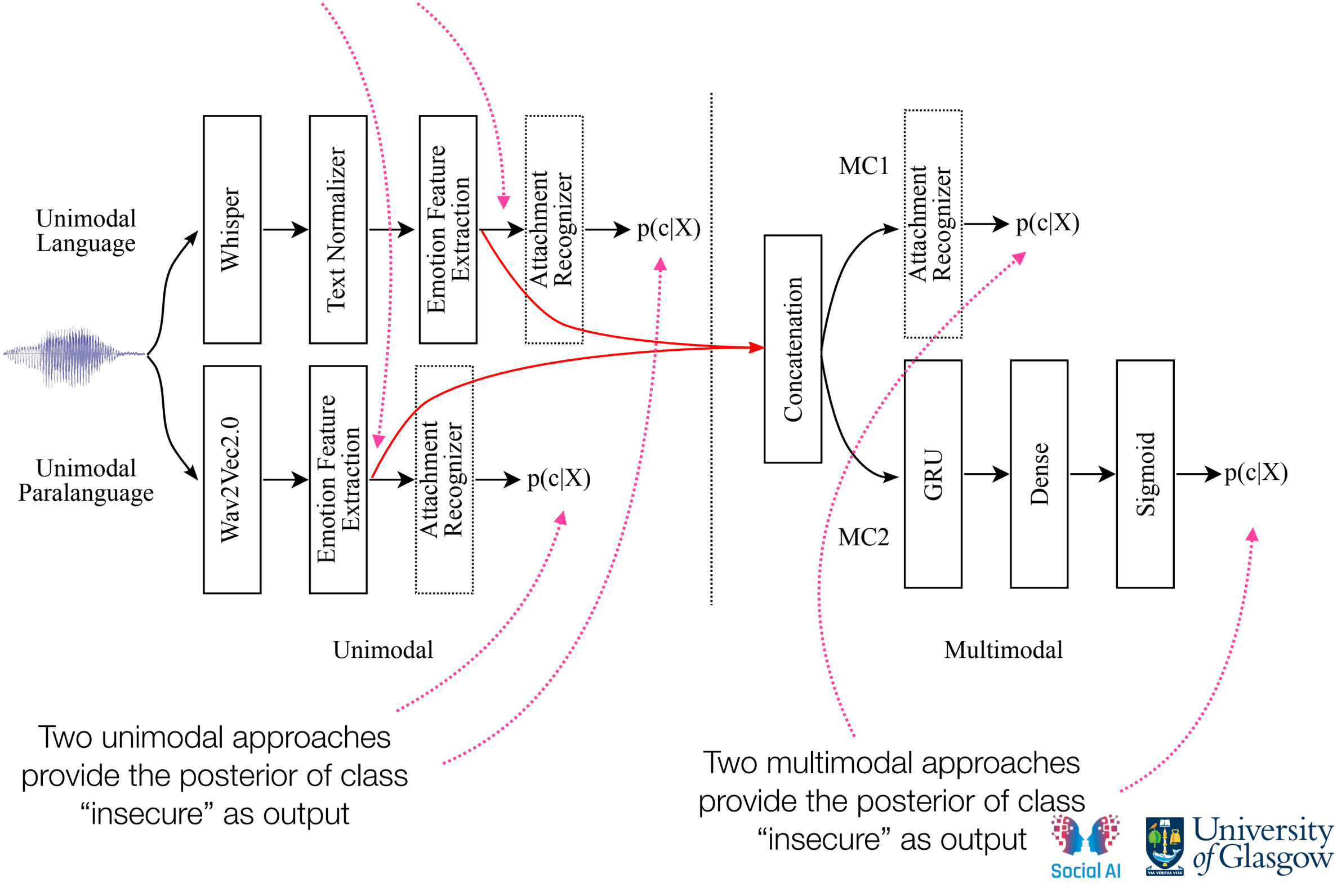
Language and paralanguage are represented in terms of their emotional content



Two unimodal approaches provide the posterior of class “insecure” as output

Two multimodal approaches provide the posterior of class “insecure” as output

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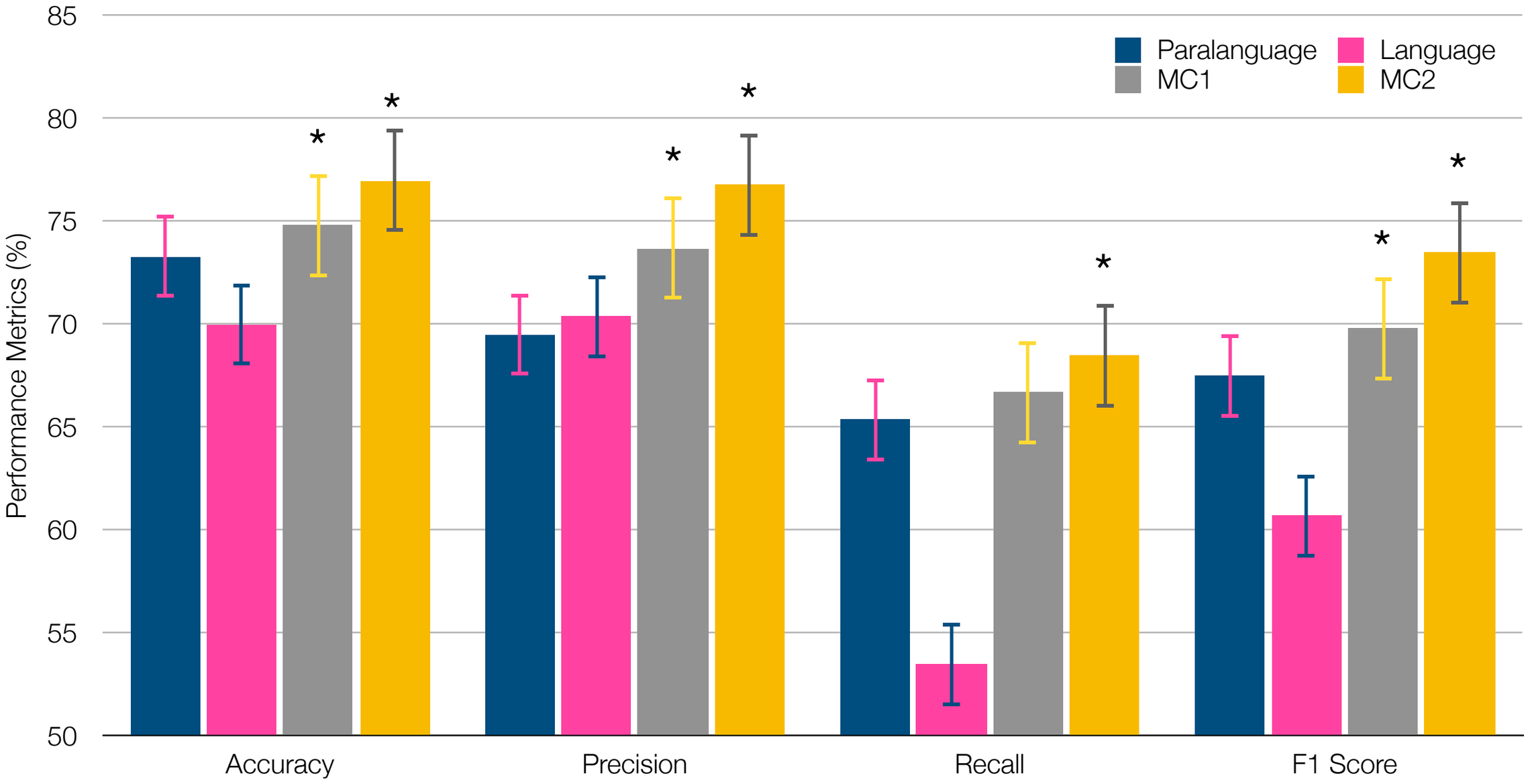
Results



Buker and Vinciarelli, “Emotion Recognition for Multimodal Assessment of Attachment in School-Age Children”, Proceedings of the ACM International Conference on Multimodal Interaction, pp. 312-320, 2024

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Confidence and Psychiatry Practice

- Automating the MCAST delivery can allow large scale screenings that are not possible otherwise;
- The percentage of insecure attachment cases can be used to identify social issues in an area;
- Paralanguage appears to be more reliable in covering attachment related information;
- However, multimodal approaches improve over best unimodal approaches in most cases.

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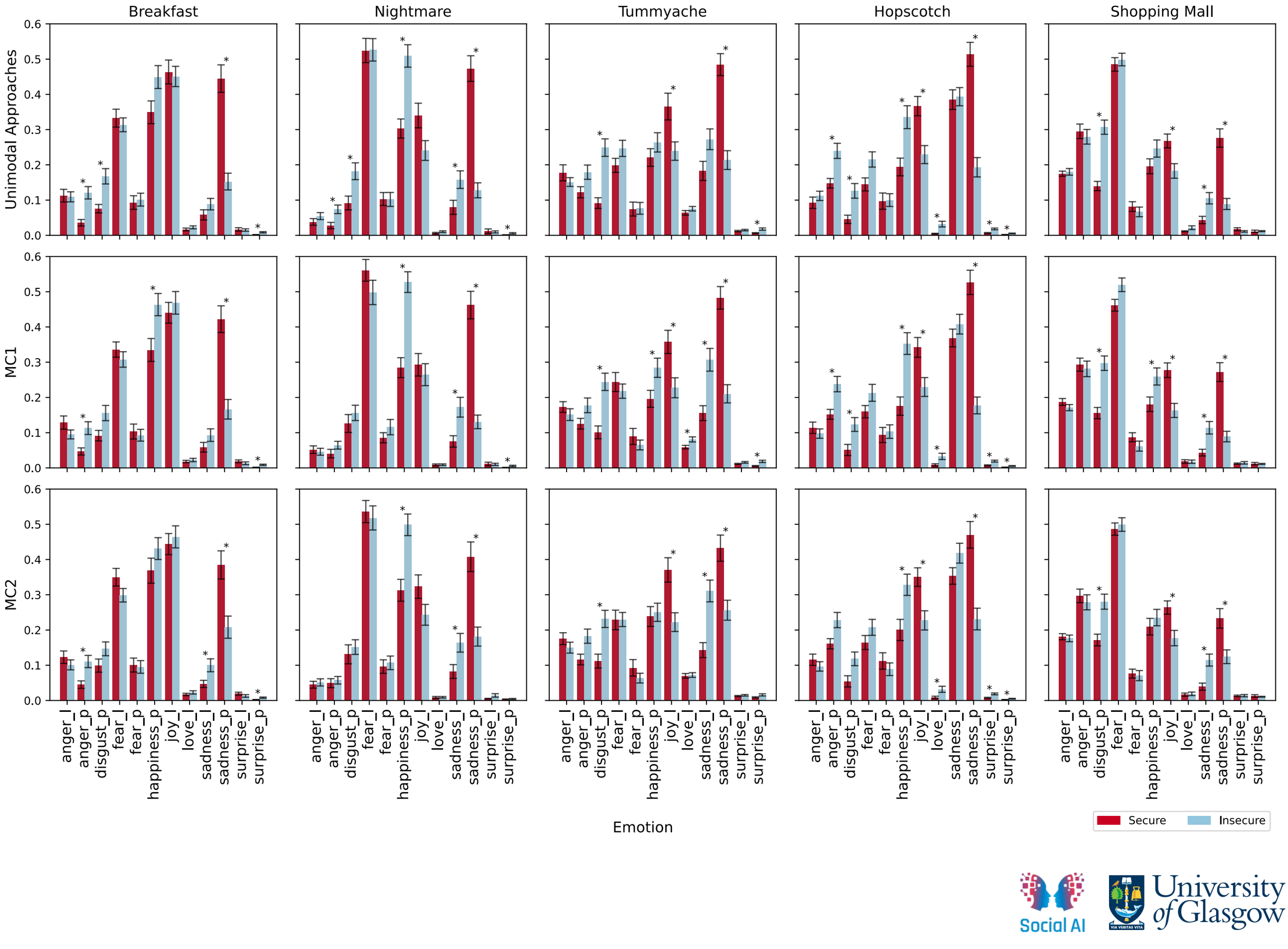

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Psychiatric Insight

- In total, there are 74 statistically significant differences (out of 180 comparisons);
- Paralanguage accounts for 46 of the 74 statistically significant differences;
- Negative valence emotions account for 50 of the 74 statistically significant differences;
- Besides improving efficiency, AI can provide insight.

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Conclusions

- Mental health issues leave physical, machine detectable traces accessible to Social AI technologies;
- The availability of data is crucial, like in any AI problem, but it is ethically challenging;
- Making the AI technologies usable, for both patients and clinicians, is necessary;
- The goal is to empower and support clinicians, not to replace them;
- The development of an interdisciplinary literacy will be a major step.

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Thank You!

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