Feasibility of facial expression analysis as an objective palatability assessment of paediatric medicine

Rabia Aziza[1], Elisa Alessandrini[2], Clare Matthews[1], Sejal Ranmal[2], Ziyu Zhou[2], Elin Haf Davies[1], Catherine Tuleu[2]

[1] Aparito Ltd

[2] University College London School of Pharmacy, UK

Background

Understanding children's taste sensitivity and preferences helps formulators to make more acceptable paediatric medicines.
For drugs administered orally, palatability is a main attribute that determines patient acceptability and treatment compliance.
Current palatability assessment tools lack validity and have several limitations in their suitability for use with children.
There is a need for a specific tool that can accurately and impartially assess the palatability of oral medicines for children.

Can facial analysis technology be used as an objective palatability assessment tool in children?

Aim of this study

Explore changes in facial landmarks, in response to a child's reaction to gustatory taste strips (bitter, sweet and sour), and explore the potential of these changes to provide an objective assessment of the perceived taste sensation, which correlates to self-reported responses on a 5-point smiley face scale.

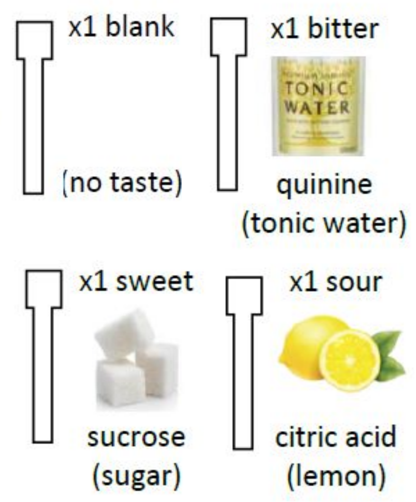
Methodology

- Approved by the UCL university research ethics committee Study ID: 4612/029.
- Primary school children aged 4-11 years old.
- Conducted in a home setting under supervision of an adult caregiver.
- Participants received a study pack with instructions and 4 different taste strips packaged in individual coloured packs for blinding.

Taste strips are a rapid, safe and age-appropriate method to safely gauge children's taste perceptions. Participants evaluated 4 strips impregnated with solutions representing basic taste qualities:

- 1 blank control: no tastant
- 1 bitter strip: 0.006 g/mL quinine hydrochloride
- 1 sweet strip: 0.4 g/mL sucrose
- 1 sour strip: 0.3 g/mL citric acid

Responses were recorded using smartphone video technology and self-reported questionnaires. These were submitted via a study specific app on Aparito's Atom5™ platform [1].



Tasting Procedure

Participants were instructed to place one strip on the middle of their tongue, close their mouth and test each sample for 10 seconds before removing, while video recording their facial reactions.

Each sample was rated on a 5-point hedonic scale and open comments recorded.

1 2 3 4 5

The blank strip was tested first.
The other three test strips were evaluated in one of three different randomisation orders (generated within the app).
Water was used between samples to remove residual taste.

Results

- Data received from 64 participants.
- In total 265 self-reported scores and 222 videos were recorded (9 videos were excluded as the content did not show the child correctly testing a strip).
- Children were aged between 5 to 11 years.
- Similar proportion of boys (44%) and girls (56%).

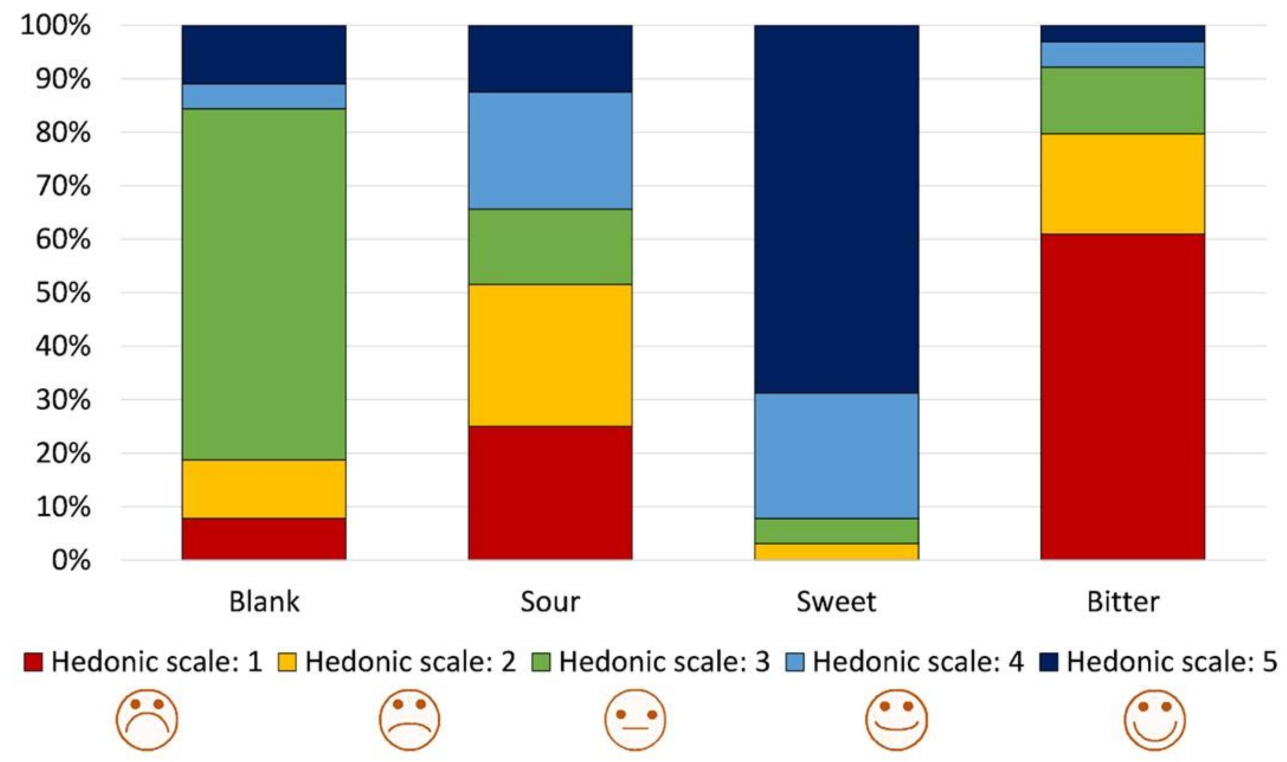


Figure 1. Graph shows participants' hedonic scale rating for each taste strip.

Hedonic scale

- Age, sex, and sequence order of the strips did NOT have any significant influence on children's ratings.
- There was a statistically significant difference in ratings across the different tastes (Kruskal-Wallis H test $\chi^2(2)$= 124.62, and p= 0.001), as illustrated in Figure 1.

Predominant scores:
Blank (no taste) = 3
Bitter = 1
Sweet = 5
Sour = Various

This suggests that our methodology elicits the expected response: children like sweetness, dislike bitterness, and have different opinions for sourness.

Facial reaction analysis

To analyse the changes in the children's facial expressions in reaction to tasting the strips, we use MediaPipe (MP) [2], a machine learning framework for pose estimation. We apply the Face Mesh component of MP, which provides estimates of 468 3D facial landmarks per frame.

To account for variations in the initial facial expressions (right before tasting), for each video we identify a baseline frame as a reference to which we will compare the reaction.

The reactions to the tastes also vary - not only in the nature and magnitude of the facial expressions, but also in their duration and time of occurrence. For instance, some children show the full extent of their reaction as soon as they taste the strip, others do so after they remove the strip from their mouth. Therefore, we identify one frame per video to represent the child's best reaction.

We process each video as follows:

- We manually identify the baseline frame (e.g. fig. 2.a) and a best reaction frame (e.g. fig. 2.b).
- We process the frames with MP to extract the 3D face mesh landmarks (fig. 2.c and 2.d).
- We use the extracted landmarks to compute some facial measurements, such as the frown, eyebrow elevation, eye openness, mouth openness, etc. (fig. 2.e and 2.f). In our process, we define a facial measure as the distance between two specific landmarks.

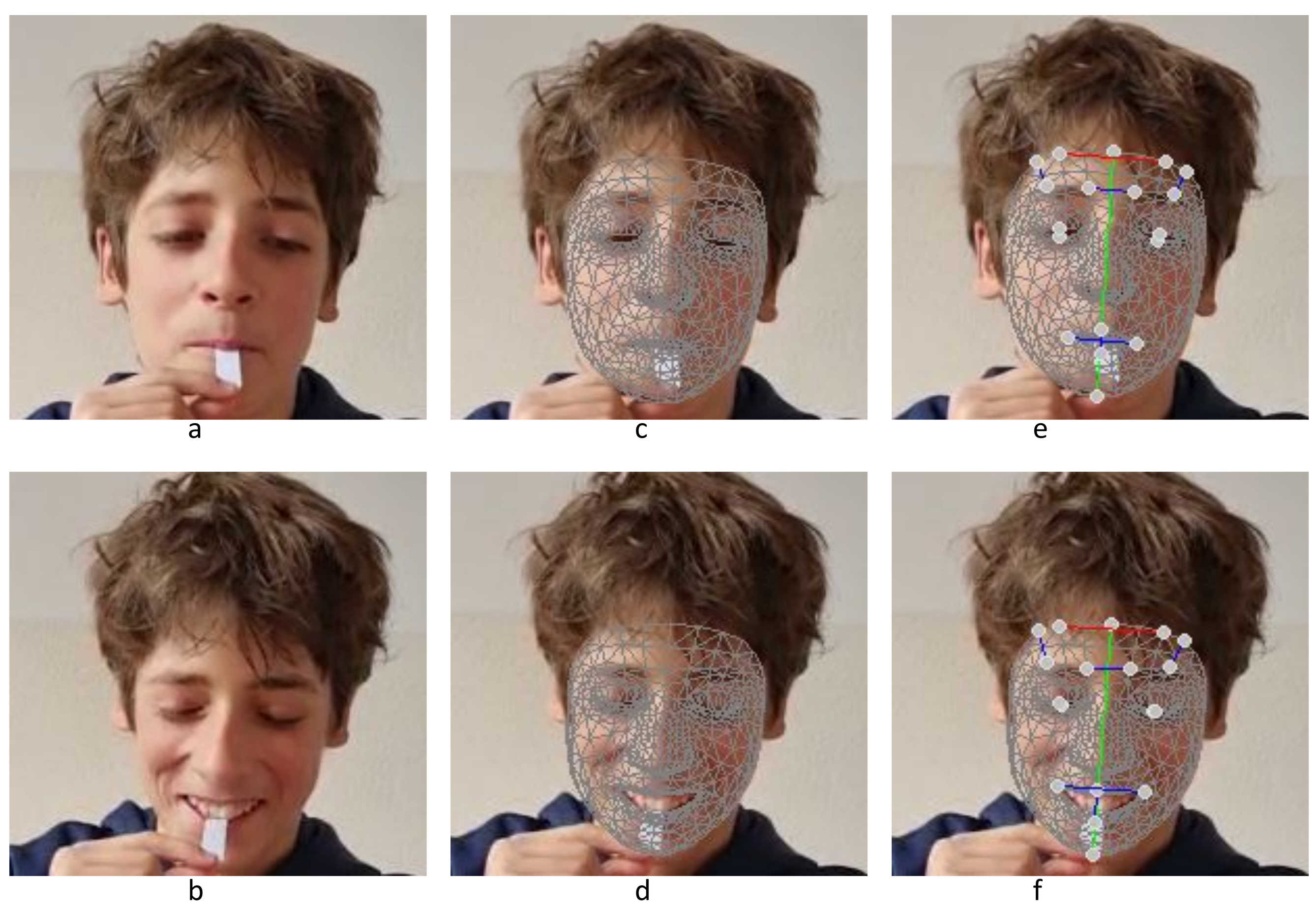


Figure 2. Facial reaction analysis process for each video in both the baseline frame (a, c, e) and the best reaction frame (b, d, f).

Challenges

There are a number of challenges in transforming the facial landmarks to quantitative measures for training a classifier:

- Orientation of the face to the camera varies across videos and even within the same video (fig. 3). Scaling and transformation of measures are required to ensure that values are comparable.
- Adherence to instructions provided is variable. For example, in some videos the mouth remains open during the test, making it difficult to interpret landmarks around the mouth.

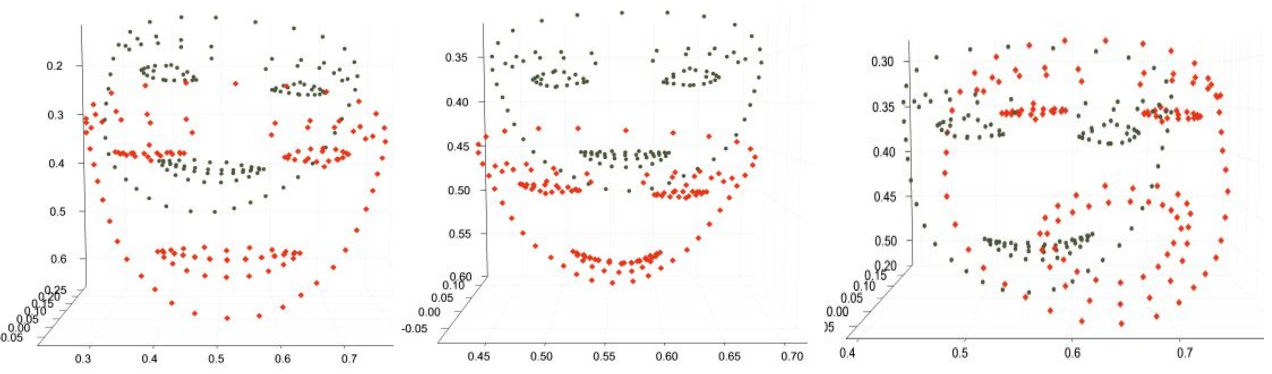


Figure 3. Plots of the baseline frame (gray) and best reaction landmarks of three subjects tasting (from left to right) the bitter, sour and sweet strips.

Next steps

With the facial landmark measures generated, we will train models to classify the different tastes, and the hedonic rating.

This study demonstrated the feasibility of collecting such data in a decentralised, at-home way. It has also highlighted areas for focus to enhance the quality of the data from future studies by improving standardisation e.g., through clearer instructions or incorporating a feedback mechanism.

References

[1] www.aparito.com/platform/

[2] google.github.io/mediapipe/

Contact

clare.matthews@aparito.com