The skin sensitivity index: paving the way to objective evaluation and grading of skin sensitivity

ID 427

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1 - Introduction

Skin sensitivity is identified as the feeling of skin discomfort without any clinical evidence of skin lesions. It impacts life quality causing skin dryness, itching sensations, appearance of pimples and redness in response to environmental factors, hygiene, skincare or cosmetic products, stress, emotional burden. . . Its evaluation remains a difficult and unreliable process.

2 - Project endpoints

- To investigate existing methods and appraise if they are correlated with subjects' skin sensitivity
- To objectively analyze the skin in a multi-parametric way
- To develop simple, quick, reliable, repeatable sensitivity assessment tools
- To automatically compute continuous sensitivity grades based on instrumental data from hyperspectral image analysis and self-perceived sensitivity as ground truth

3 - Sting test correlation study

To investigate if sting test results are correlated with expert binary classification

- Panel: 90 Caucasian women
- Sensitivity classification according to an expert, based on subjects' interview
- Binary classification (sensitive versus not sensitive)
- Stinging test: self-grading of stinging, prickling, heating sensations

in nasogenian folds treated with lactic acid solution or physiologic serum

Stinger positive = score ≥ 4

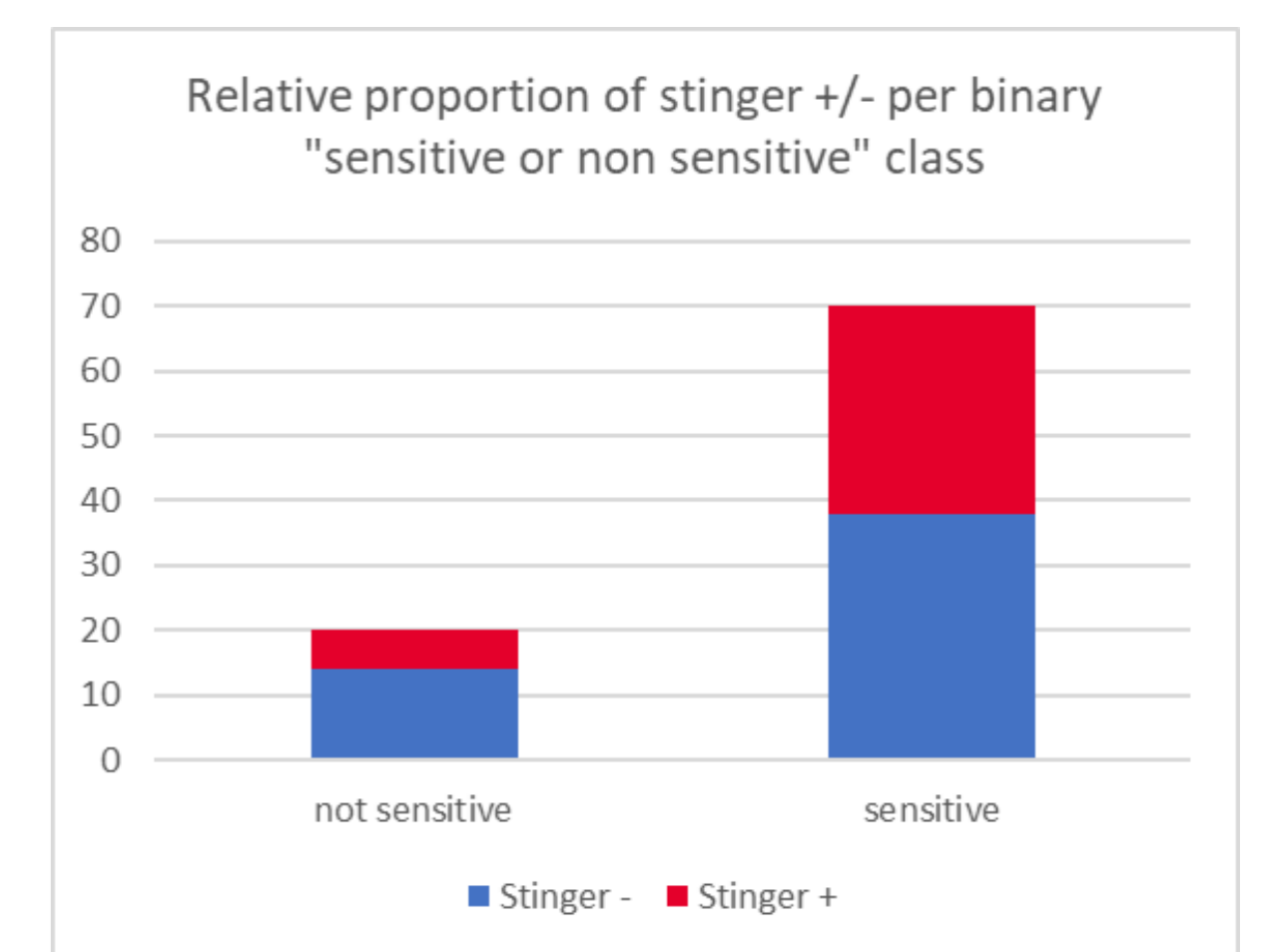➢ Low correlation - classification accuracy of 51%

Fig. 1: Sensitivity distribution across stinger status

4 – Clinical sensitivity index

To move from a binary classification to an approach based on sensitivity levels

- 4 questions self-perception questionnaire. "Do you feel abnormal and repeated reactions on the face to care products? to hygiene products? to the environment? to other factors?" (answers from "no reaction" to "marked reactions")
- Weighing of the answers according to severity of reported reactions to achieve score calculation

Results: scores range from 0 (not sensitive) to 15 (highly sensitive) with sensitive classification in case of a score ≥ 2

➢ Very high correlation - classification accuracy of 97%

5 – Self-perception repeatability

To investigate the self perception repeatability to ensure reliability of ground truth in the context of machine learning

- Panel: 183 Caucasian women
- Self-perception questionnaire
- Repetitions: 3 times over a 2 week-period

Results : High variability in the given answers with a median maximal deviation of 3

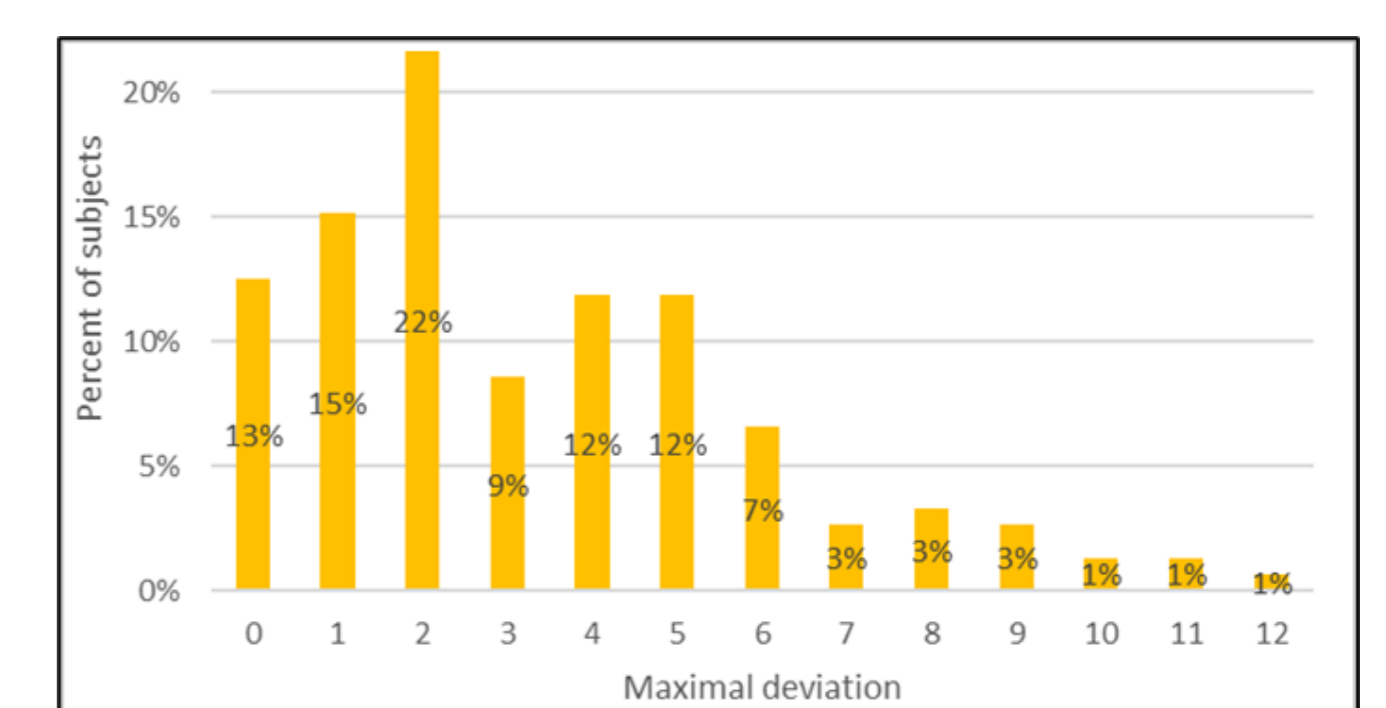➢ Requirement to select reliable subjects for machine learning

Fig. 2: Panel distribution across maximal deviations.

6 – Instrumental skin sensitivity index

To develop an instrumental-based index to objectively predict skin sensitivity, based on hyperspectral full face image analysis and machine learning

- Objective instrumental measures in a reliable panel
- Inclusion condition: maximal repeatability deviation ≤ 3
- Training panel: 98 Caucasian women - Testing panel: 21 Caucasian women
- Images: Full-face hyperspectral SpectraFace® acquisitions

Image analysis to ROIs: Nasogenian folds, nose sides, cheeks and full half-faces
- Parameters: colorimetry, oxygenated and deoxygenated hemoglobin rates

Machine learning model architecture: Multi-layer perceptron (MLP)
- Ground truth: Median of the clinical skin sensitivity index repetitions

Results: Regression correlation: High performances (R^2 = 0.9726)

Repeatability: Robust to positioning variations (R^2 = 0.9958)

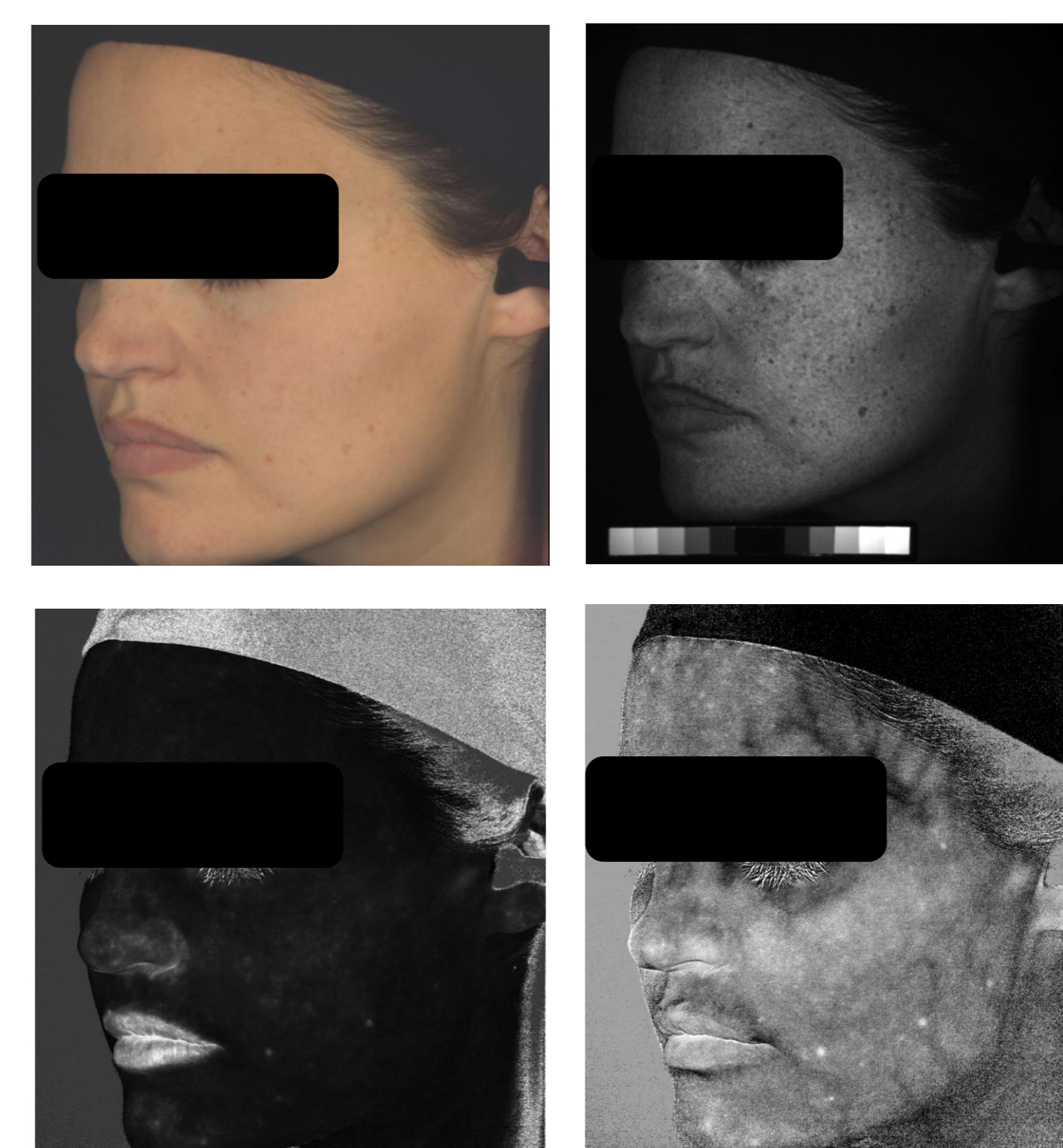➢ Very high correlations - Classification accuracy: 88%

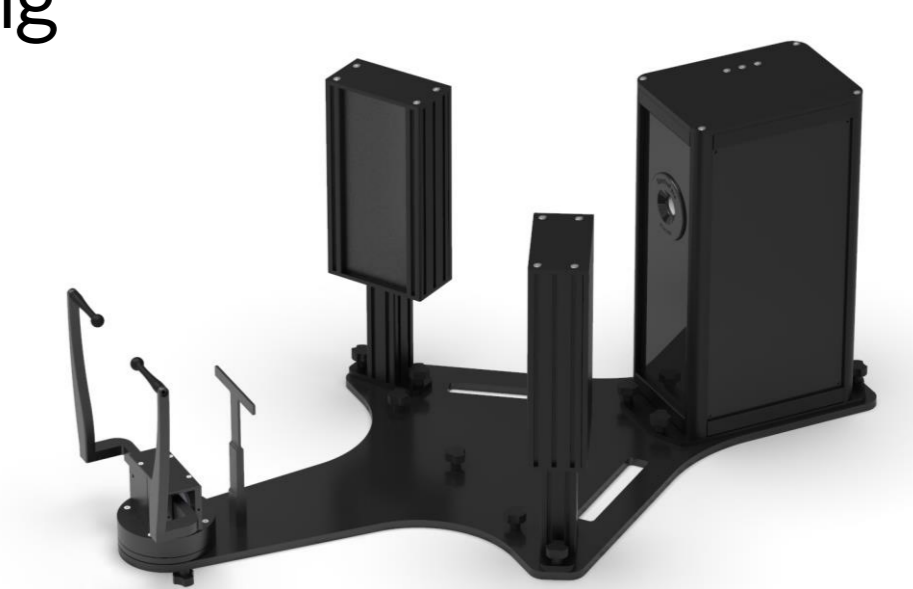Fig. 3: Images and concentration maps from hyperspectral optical system
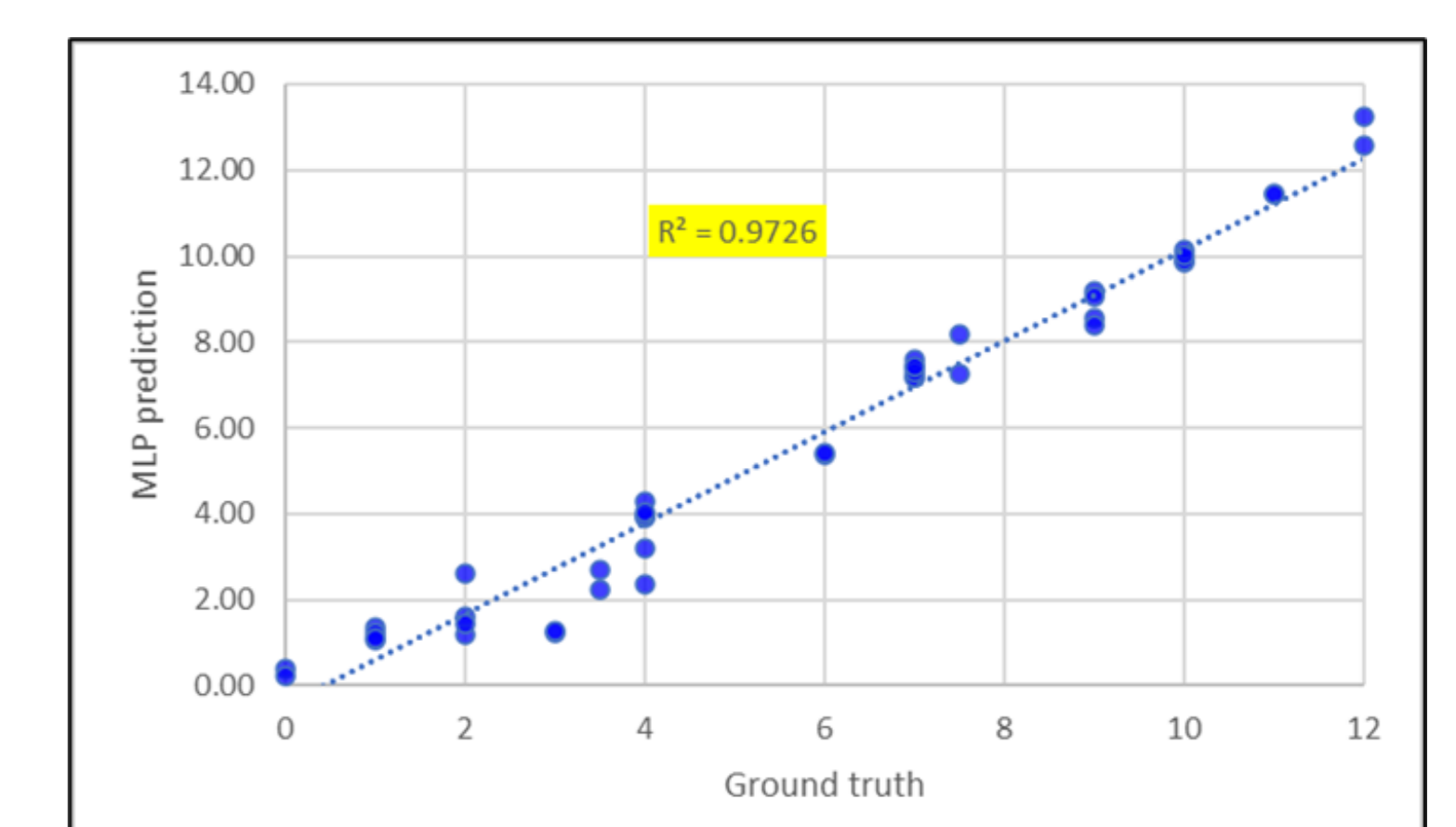

Fig. 4: SpectraFace®

Fig. 5: Correlation between the MLP predictions and the ground truth

7 - Conclusion

Classical methods such as the sting test may not be correlated or precise enough to address skin sensitivity evaluation. Instead, we introduced two **groundbreaking indices**. The **clinical index**, based on self-perception, should be used to get quick and easy evaluations with a more complete approach than a binary one. The **instrumental image based index** is more complex. It predicts the sensitivity from parameters computed from hyperspectral acquisitions. It has the advantage to be completely objective and robust to subjects' positioning variations. Both indices complement each other.

8 – Next steps

To further investigate the ability to the instrumental index to measure subtle evolutions of the skin sensitivity in the context of cosmetic products, soothing performance assessment, subjects with reliable self-perception of their skin sensitivity will be recruited and involved in new testings.