

# Analysis of correlation and development of a predictive model of skin transparency using parameters extracted and computed from digital images of the face

Marin, Quentin<sup>1</sup>; Honda, Tatsuya<sup>2</sup>; Nakajima, Hiroaki<sup>2</sup>; Okano, Yuri<sup>3</sup>; Cherel, Marie<sup>1</sup>; Prestat-Marquis, Elodie<sup>1</sup>

1. Newton Technologies, 13 bis place Jules Ferry, 69006 Lyon, France
2. DRC Co., Ltd., The 9th Tabuchi Bldg., 3F 2-10-31 Higashi-Temma, Kita-ku Osaka, Japan
3. CIEL Co., Ltd., 302, 2-10-11 Midori, Sumida-ku, Tokyo, Japan

Poster  
NT\_331



## BACKGROUND

Skin transparency is a cosmetic asset corresponding to the ideal appearance of the skin for Asian women. Still not fully understood, there is no objective method to measure it. As the appearance of the skin results from complex light interactions, transparency mostly depends on diffuse reflected light and light absorption by chromophores. However, it also implies subjectivity and experience.

## OBJECTIVE

Previous studies attempted to link transparency to skin characteristics acquired using multiple specific devices. Besides, almost all studies focused on the cheek. To better understand and predict expert's grading, we build an easy-to-use predictive model relying on skin parameters measured only from digital images of the entire face taken with a single device.

## MATERIALS & METHODS

### Subjects

An initial group of 71 Japanese women (50-60 years old, 53.7±2.6) were recruited. This group was then extended to 262 women (21-60 years old, 41.0±10.6).

### Acquisition of facial pictures and regions of interest

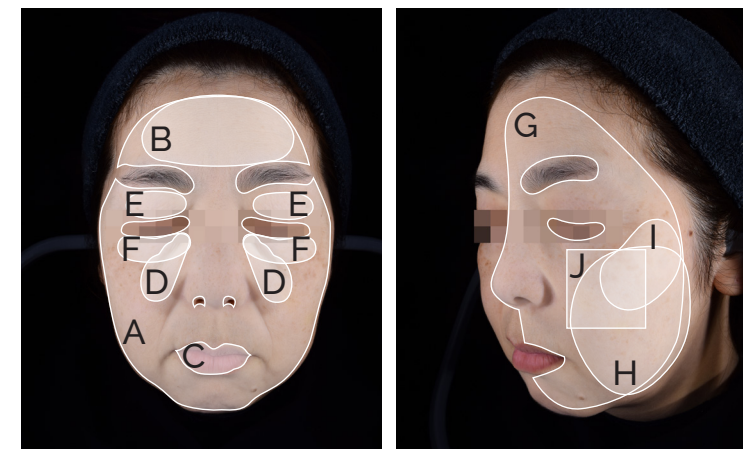
Standardised facial pictures were acquired (ColorFace®, Newton Technologies) under normal diffuse light and different polarisation angles (45, 60 and 90°). The regions analysed are: A. full front face, B. forehead, C. lips, D. tear troughs, E. superior eyelids, F. inferior eyelids, G. entire side-face, H. cheek, I. cheek-bone and J. a 4x4 cm square zone at the upper part of the cheek (ROI cheek).

### Grading of skin transparency by clinical experts

Four clinical experts graded skin transparency on diffuse light pictures. Scoring was performed in triplicate and the transparency score of a subject was the median of the median scores given by experts.

### Computation of skin parameters

Colour, roughness, texture, gloss, pores, small wrinkles, and pigmentation spots parameters were computed from the different regions of the pictures.



## RESULTS

### Many parameters correlate with skin transparency

In the initial group of 71 women, 313 of the 958 parameters (32.6%) show some correlation with skin transparency ( $r > 0.55$  or  $r < -0.55$ ) with:

- Skin colour parameters representing 81.2% of correlated parameters (254),
- The other correlated parameters are skin gloss, texture, and roughness,
- Almost a third of correlated parameters (93, 29.7%) are from the cheek (47), cheekbone (23) or ROI cheek (23).

### If the cheek presents the best correlations, other regions have higher frequencies of correlated parameters

Analysis of best correlation coefficients for colour, roughness, texture and gloss parameters reveal that frequency of correlated parameters is higher for the tear trough and the entire face.

Facial region	Freq. best correlation	Facial region	Freq. best correlation
Cheek	4.76 %	Full front face	42.86 %
Cheekbone	9.52 %	Entire facial side	14.29 %
ROI cheek	9.52 %	Tear trough	19.05 %

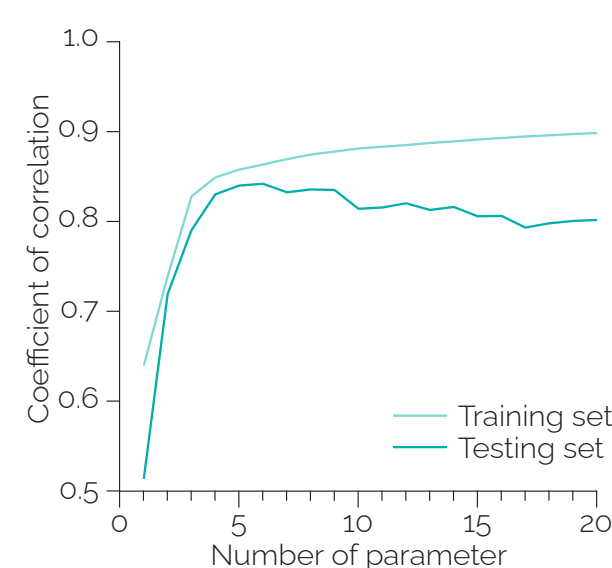
### Weakly correlated parameters remain important

Using the 21 cheek parameters acquired under cross-polarisation and focusing on models with the minimum number of non-collinear parameters, predictive models of skin transparency using multiple correlations indicate that:

- Models with few parameters can poorly predict scored transparency,
- The number of parameters increases with correlation (11 parameters for  $r > 0.88$ ),
- All models include a colour parameter,
- All models include parameters that, individually, are poorly correlated with transparency.

### Stepwise regression led to a 6-parameter model predicting 84.1% of skin transparency scored by experts

Stepwise regression on parameters from an enlarged group of 262 subjects led to a list of parameters ordered according to their relevance. After including a first parameter that most correlates with skin transparency, iteration after iteration, the non-correlated parameters best optimising correlation was added, limiting the maximum number of parameters to 20.



Relation between the coefficient of correlation of the predictive model of skin transparency and the number of parameters.



Correlation between the transparency score given by the expert and the score calculated with the six-parameter predictive model.

When the evaluation is performed on the testing set, six parameters are enough to reach a maximum correlation of 0.841. This six-parameter model combines:

- Colour homogeneity (cheek),
- Pigmentation spots (cheek),
- Colour (cheek),
- Colour (tear trough),
- Colour (entire face),
- Gloss (cheekbone).

## CONCLUSION

So far, the identification of factors correlated with skin transparency used several devices and techniques. Analysing parameters acquired by a single fully integrated camera system, we narrowed down factors of interest to a small set of parameters. We also revealed the influence of facial regions other than the cheek and that of weakly correlated parameters.

This new approach has a clear advantage and should enable an almost fully automated, simple, fast, reliable and objective quantification of transparency for future dermatology and cosmetology research.

Furthermore, the six parameters identified should provide important clues for the development of cosmetics improving skin transparency.