

# Facial color is an efficient mechanism to visually transmit emotion

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# Context

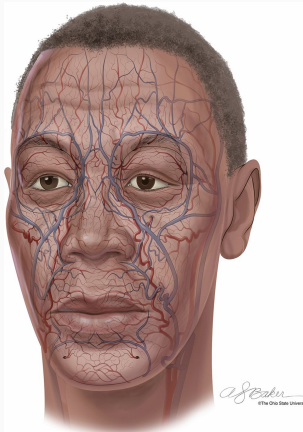
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It was **believed** that:

- people transmit emotions through action units

It is **known** that:

- emotions are the execution of a number of computations by the nervous system
- our faces posses complex networks of blood vessels



**Figure 1:** Blood vessel network (veins in blue, arteries in red)

It was **believed** that:

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It is **known** that:

- emotions are the execution of a number of computations by the nervous system
- our faces posses complex networks of blood vessels

⇒ **Do blood flow variations emit certain emotion patterns?**

## Main hypothesis

- For each emotions there is a color pattern.

## Secondary hypotheses

- The human eye is able to perceive and interpret them.
- Color patterns are independent of muscle expressions.

Composed of 4 experiments:

- The first two support the main hypothesis.
- The third one demonstrates the first secondary hypothesis.
- The fourth experiment confirms the second secondary hypothesis.



# Experiments

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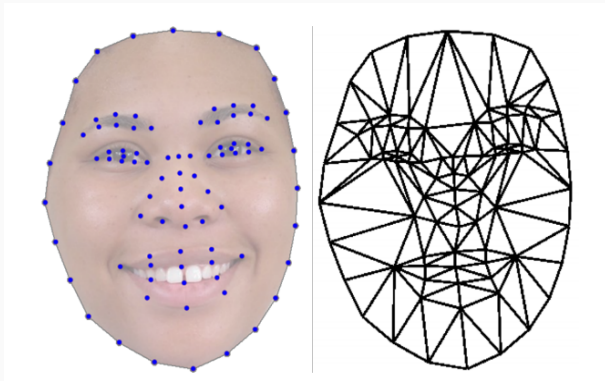
## Database:

- 18 different emotion types
- 184 individuals

## Each sample is:

- firstly, divided into 126 local regions defined by anatomical landmarks
- secondly, triangulated

# Experiment 1



**Figure 2:** Anatomical landmarks (on the left); Delaunay triangulation (on the right)

## Linear machine-learning classifier

- Learning method: linear discriminant analysis
- Input sample: 126 features
- Training and testing sets
- 10-fold cross-validation

# Experiment 1

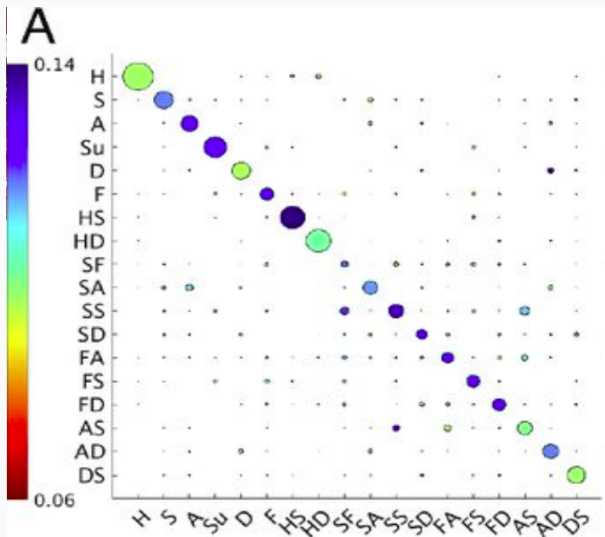


Figure 3: Confusion table of the results of a k-way classification (LDA) 10

# Experiment 1

## Accuracy score:

- Average score (over all emotion categories):  
> 50% (chance = 5.5%)

## Sub-experiment:

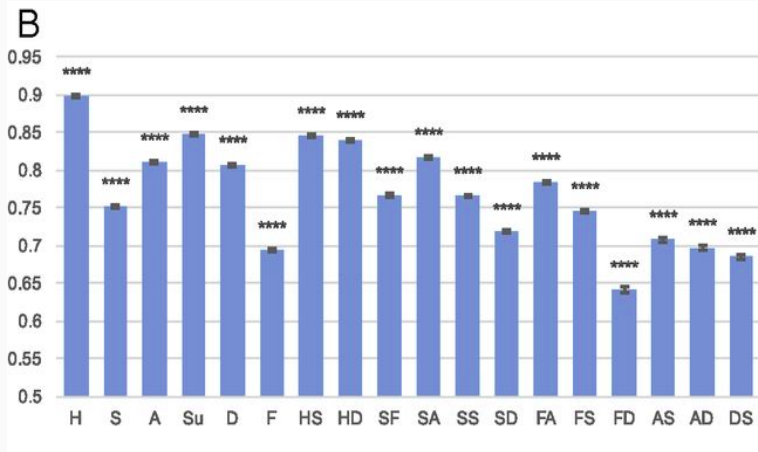
- Only 2 classes: positive vs. negative emotions
- Accuracy score: 92.93% (chance = 50%)

Identifies the most discriminant color features.

Linear machine learning classifier:

- One classifier for each emotion category (one vs. all)
- Learning method: linear discriminant analysis
- Input sample: 126 features
- Training and testing sets
- 10-fold cross-validation

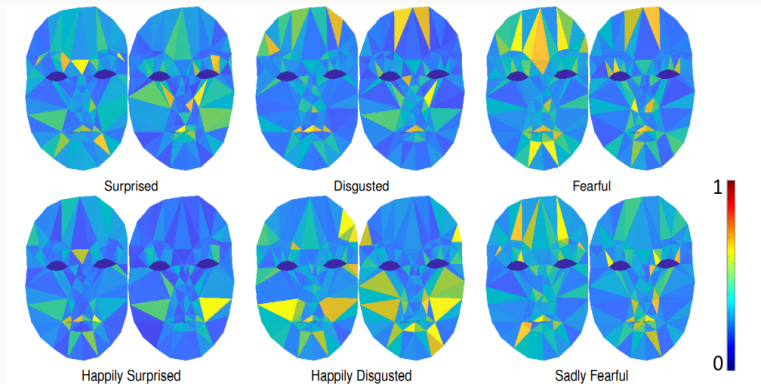
## Experiment 2



**Figure 4:** Classification accuracies and standard errors; chance = 50%



## Experiment 2

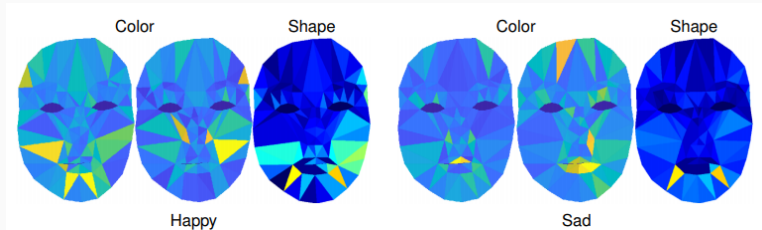


**Figure 5:** Contributions of the two color channels in opponent color space (yellow-blue, red-green)

## Experiment 2

- Best results obtained when both color channels were combined
- Experiment repeated for finding the most discriminant shape changes

## Experiment 2



**Figure 6:** Color changes vs shape changes; proof of color patterns and muscular changes independence

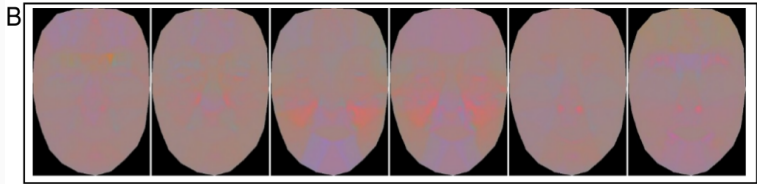
## Experiment 2

- Experiment repeated on a different database (spontaneous images)
- Uses only 5 emotions (including neutral)
- Average classification accuracy: 95.53%

## Experiment 3

- Used only 6 emotion categories (e.g.: happy, angry, disgusted)
- Color patterns added on neutral face surface
- 2 sub-experiments: two- and six- alternative choice

## Experiment 3



**Figure 7:** From left to right: angry, disgusted, happy, happily disgusted, sad, fearfully surprised

## Experiment 3: two-alternatives

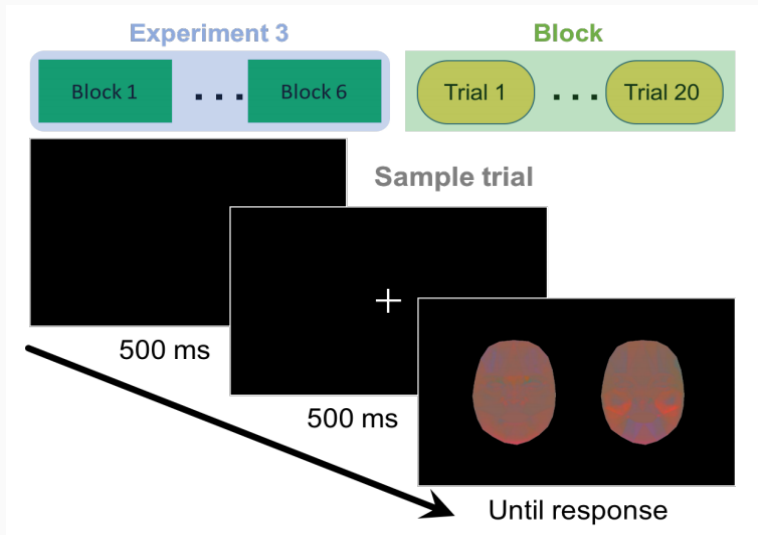


Figure 8: Forced-choice two-alternatives method

## Experiment 3: six-alternatives



Figure 9: Forced-choice six-alternatives method



## Results:

- Were statistically significant ( $>$  chance = 50%)
- For the 6-alternatives choice: 32.92% average accuracy (chance = 16.67%)

## Positive vs. Negative

- Experiment repeated using both the two- and six-alternatives method
- Average accuracy score: 82.65% and 72.9% ( $>$  chance = 50%)

### Two additional datasets

1. Added corresponding color patterns to all samples
2. Added non-target color patterns to all samples

# Experiment 4

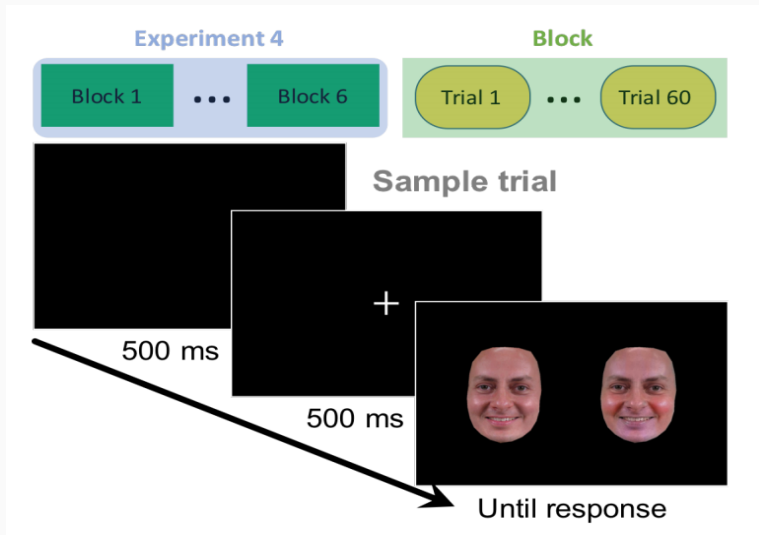


Figure 10: Forced-choice two-alternatives method

### Results:

- Were statistically significant ( $> \text{chance} = 50\%$ )

### Positive vs. Negative

- Experiment repeated using the 2-alternatives method
- Average accuracy score: 85.01% ( $> \text{chance} = 50\%$ )

⇒ Color features are (at least partially) independent of facial muscle changes

## Future Developments

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An addition to the already known emotion perceiver mechanism.

Other results in favor:

- Stimuli interpreters inside the retina (activated by motion or by colors) - two distinct mechanisms
- Humans are the only specie that has no facial hair (recent mechanism of emotion transmission)

# Questions raised

- Are other color patterns not yet associated with an emotion?
- If there are other frequently encountered patterns, what emotions do they express?
- Are there multi-valued valences for emotions?

**Computer Vision:** should consider using color patterns

**Human-Robot interaction**

**Psychopathology:** should revise the problem of missclassifying emotions



Artists: Color can solely influence emotions.

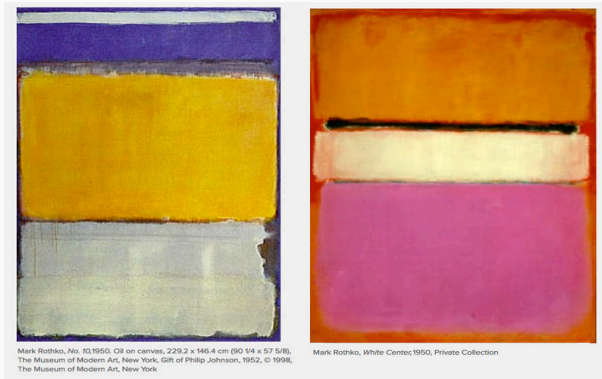


Figure 11: Mark Rothko's paintings

Questions?

## Database sample



**Figure 12:** Sample images of the facial expressions of emotion and the neutral face used in this paper.