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"A neurosciences-based multidimensional approach to assess the emotional response generated by olfactory and topical experiences"

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1. Introduction

In the ever-evolving field of cosmetic science, emotional benefits have emerged as a critical dimension of product efficacy. As consumers increasingly seek products that contribute not only to their physical appearance but also to their emotional well-being, the industry is challenged to substantiate such claims with robust methodologies. Traditional self-report tools, while valuable, are often limited by their subjective nature and lack of physiological grounding. Recent advances in neurosciences and psychophysiology provide new opportunities to assess emotional responses through objective, multimodal protocols [1,2]. By integrating psychological assessments with neurocognitive, behavioral, and physiological measures, it becomes possible to capture a comprehensive picture of how cosmetic products influence emotional states. This paper introduces a novel, neurosciences-based approach to emotional evaluation, applied to two cosmetic products delivered through distinct sensory modalities: olfactory-topical application [3,4]. Our aim is to validate this multimodal protocol and to characterize the emotional impact of each product using convergent data from eye-tracking [6,7], heart rate (HR) control [8], facial expression analysis, implicit emotional tasks (IET) [5] and well-being questionnaire (WBQ). This holistic approach seeks to bridge the gap between subjective consumer perceptions and scientifically substantiated emotional claims.

2. Materials and Methods

This study took place in a controlled sensory laboratory for two consecutive days. On the first day, the emotional experience of a panel of 22 female subjects aged from 23 to 56 years old was assessed through an olfactory test of a shower oil named HD (HDO condition). On the second day, the emotional experience of a panel of 24 female subjects aged from 23 to 58 years old was evaluated on a body oil named HS through an olfactory test (HSO condition) and a topical test (HST condition). Emotional responses were evaluated using a multimodal protocol incorporating four distinct methodologies: Hear rate (HR) monitoring, Eye-Tracking, Implicit Emotional Task (IET) and Well-Being questionnaire (WBQ).

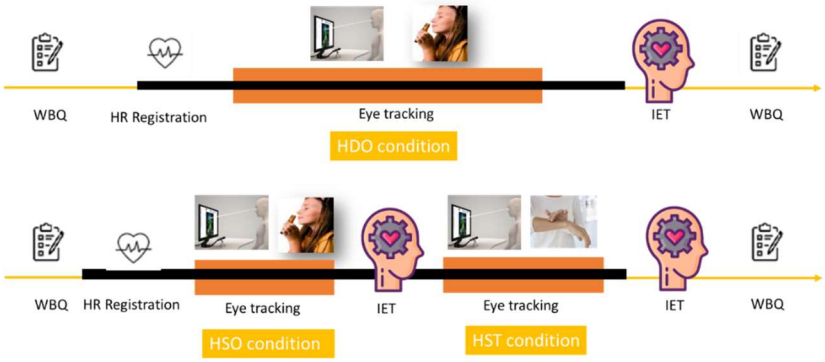

Figure 1: Experimental design

2.1 Heart Rate registration

Heart rate (HR) monitoring was used as a complementary non-invasive measurement during the eye-tracking test to combine physiological and behavioral data to provide a richer understanding of emotional reactions. The oximeter FARMAQO® measured cardiac activity across the finger's skin by recording electrical impulses associated with heart contractions, thanks to an infra-red plethysmography system. The participant sat down, and the oximeter was placed on the left thumb (or on the right thumb if left-handed). Registration of heart rate was launched at the start of eye tracking and lasted for all the test long. Data collected was the mean heart rate and its amplitude expressed in number of beats per minute.

2.2 Eye tracking

Eye tracking system registered eye position and movement through the optical tracking of corneal reflections. Eye tracking was used to quantify objectively visual attention by monitoring where, when, and what people looked at (Figure 2). This technique provided non-intrusive data in real time. A board of twelve fixed color-calibrated emotional images (positive, negative and

neutral) was created for each sensorial condition. The intention was to study the subconscious choice of images based on most viewed images during a test session.

Figure 2: Images used for Eye tracking test for HDO (A), HSO (B), HST (C) conditions

Each image referred to an emotional state and represented an area of interest (AOI) which was analyzed by the eye tracking system (Table 1).

Table 1: Emotional state for each image for each test condition

Emotional state	HDO	HSO	HST
Serenity	AOI 0	AOI 10	AOI 2
Softness	AOI 1		AOI 10
Disgust	AOI 2	AOI 8	
Neutral	AOI 3-6-10	AOI 1-9-11	AOI 7- 8
Sadness	AOI 4	AOI 0	
Gourmandize	AOI 5	AOI 3	
Delicacy	AOI 7	AOI 4	
Luxury	AOI 8	AOI 6	AOI 1
Joy	AOI 9	AOI 5	AOI 4
Loneliness	AOI 11		AOI 3
Anxiety		AOI 2	
Vitality		AOI 7	
Anger			AOI 0
Silkiness			AOI 5
Well-being			AOI 6
Stickiness			AOI 9
Cocooning			AOI 11

The participant was seated face to eye tracking system Gazepoint system® (Hardware: GP3 eye tracker, 60Hz machine-vision camera system, Software: GP3 Professional). Before the test, the system was specifically calibrated for each participant, adjusting eye position to ensure registration of eye movement in the best conditions. Then, the participant was invited to smell a product directly placed under the nose or apply the product on the forearm and to look at the board of images displayed on the screen. Eye movement tracking was recorded for 45 seconds. The participant was then asked to spontaneously choose 2 images which better represented his conscious emotional state. For each image, the parameter “Viewed” indicated

the number of participants who looked at the image, at least once. The parameter “1st viewed” was the mean time in seconds spent looking at the image for the first time. The parameter “Time Viewed” was the mean total time in seconds spent looking the image. This parameter was also expressed as a percentage (%) of the total session time. The parameter “Revisitors” indicated the number of participants who revisited the image. The parameter “Revisits” indicated the mean number of times the image was revisited.

2.3 Implicit Emotional Task (IET)

The Implicit Emotional Task (IET) assessed emotional response to olfaction and touch stimuli by measuring subconscious and spontaneous emotional reactions. Participants were simultaneously in contact (olfaction and/or touch) with the product and face to a support presenting four images. All the images were chosen according to the emotional dimensions selected for the test: joy, relaxation and good mood versus a neutral control image. Participants chose one in accordance with how the stimulus made them feel spontaneously, as quickly as possible. The most selected image was defined based on the percentage of participants who have selected it.

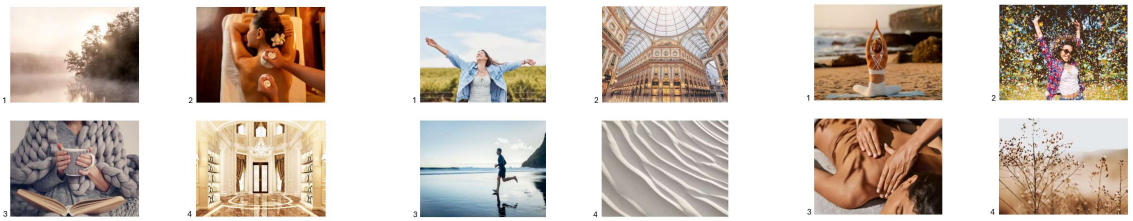

Figure 3: Images used for IET test for HDO (A), HSO (B) and HST (C) conditions

2.4 Well-being questionnaire (WBQ)

Psychological Well-Being Questionnaire (WBQ) [9] provided a standardized way to capture subjective emotional reactions. It consisted of 1 global question “How do you feel?” and 13 response items as emotional states equally divided between positive (relaxed, happy, confident, feeling good in my skin, open to others, protected, serene) and negative (stressed, tired, nervous, upset, irritable, worried). The participants had to assess the intensity of each emotional state using a 10 points scale: 0 corresponding to “not at all’ and 10 to “totally”. After welcoming the test, the participants filled in WBQ before and after eye tracking and IET sessions.

2.5 Data analysis

For eye tracking analysis, the most viewed images (subconscious choice) were ranked using Newman-Keuls (SNK) ANOVA comparative statistical test with a threshold of 5%. Images chosen after eye tracking session were ranked using Chi2 statistical test with a threshold of 5%. For Implicit Emotional Task (IET) test, the most chosen images are ranked using “Z” statistical test or “binomial” statistical test with a threshold of 5% by comparing the percentage of participants who chose each image with the probability of choosing this image at random (25%). For well-being questionnaire (WBQ), the mean variation of the positive and negative emotions was statistically studied using ANOVA statistical test with a threshold of 5% by comparing mean score for each item before and after experimental test.

3. Results

3.1. HR registration

The average heart rate was 77.76 bpm (min: 73.81 bpm, max: 82.61 bpm) for the panel of 22 women who tested HD product and 76.20 bpm (min: 64.67 bpm, max: 87.17 bpm) for the panel of 24 women who tested HS product. This result indicates that emotional conditions had the same arousal and did not cause any stress or anxiety.

3.2 Eye tracking

3.2.1 HDO condition

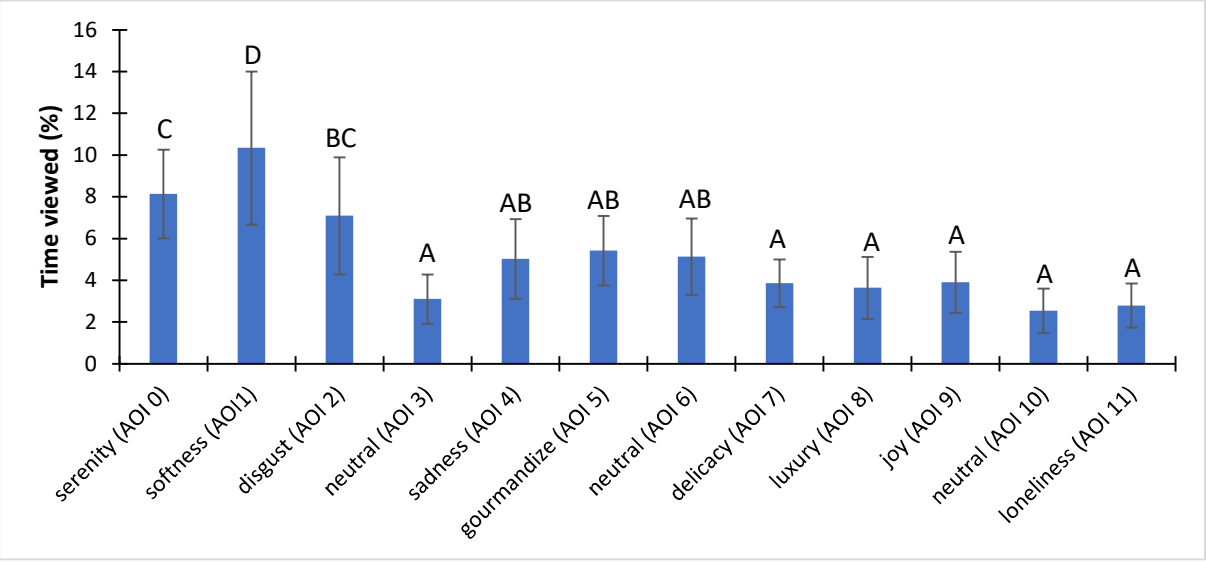

Figure 4: Time viewed in% for each image for HDO condition where letters defined statistical different groups of images according to Newman-Keuls (SNK) ANOVA statistical test with a threshold of 5%.

Softness was significantly the most viewed image (statistical group D in Figure 4) by the panel after breathing HDO product with a mean “Time viewed” corresponding to 10.3% of total time session. Serenity was significantly the second most viewed image (statistical group C in Figure 4) with a mean “Time viewed” corresponding to 8.5% of total time session. So, the scent of HD product subconsciously induced softness and serenity feelings.

Softness was significantly the first image chosen by 13 participants out of 22 (59.1% of the panel, Chi2 test, p(value) = 0.0001). Serenity and Delicacy were significantly both second images chosen by 7 participants out of 22 for both. (31.8% of the panel, Chi2 test, p(value) = 0.01197). So, the scent of HD product consciously provides softness, serenity and delicacy to the participants.

3.2.2 HSO condition

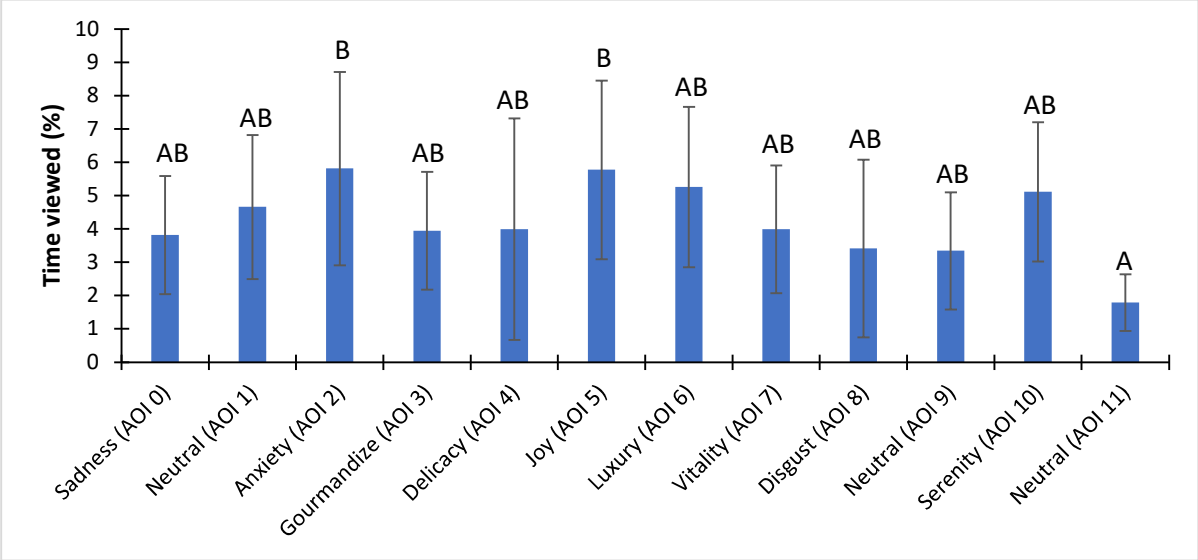

Figure 5: Time viewed in % for each image for HSO condition where letters defined different statistical groups of images according to Newman-Keuls (SNK) ANOVA statistical test with a threshold of 5%.

Anxiety and Joy were significantly both most viewed images (statistical group B in Figure 5) by the panel after breathing HS product with mean “Time viewed” values of respectively 6.65% and 6.60% of total time session. The mean “Revisits” number for Anxiety was 6.19 versus 7.24 for Joy. The hypothesis that odor could psychologically upset the panel in an unconscious way is allowed. The mean “1st viewed” time for Anxiety was 2.75 versus 3.24 for Joy. Participants seemed to give priority to Joy emotion, looking at it more quickly and returning to it more often.

Neutral picture (AOI 9) was the first image chosen by the participants (25% of the panel) without any statistical significance. Vitality was the second image chosen by 7 participants out of 24 (29.2% of the panel) without any statistical significance.

3.2.3 HST condition

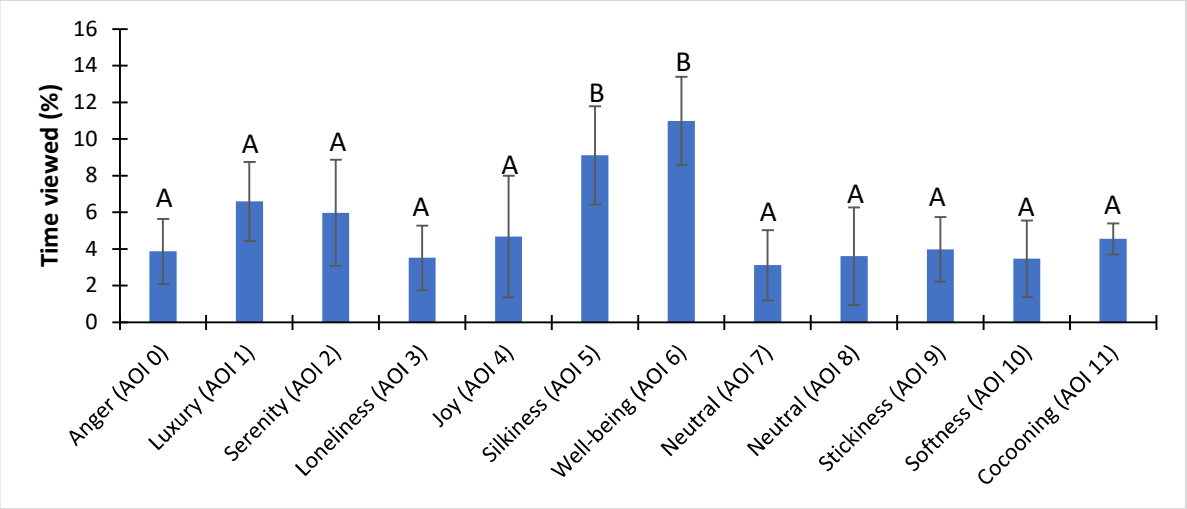

Figure 6: Time viewed in% for each image for HSO condition where letters defined statistical different groups of images according to Newman-Keuls (SNK) ANOVA statistical test with a threshold of 5%.

Silkiness and Well-being were significantly the most viewed images (statistical group B in Figure 6) by the panel after applying HS product with a mean “Time viewed” of respectively 9.50% and 11.99% of total time session. The application of HS product subconsciously induced silkiness and well-being feelings.

Silkiness and Well-being were significantly both first images chosen respectively by 12 participants out of 24 (50% of the panel) and 8 participants out of 24 (33,3%) with a Chi2 statistical test p(value) of 0.041. Silkiness was significantly the second image chosen by 9 participants out of 24 (36% of the panel, Chi2 test, p(value) = 0.004). So, the application of HS product consciously provided silkiness and well-being to the participants.

3.3 Implicit Emotional Task (IET)

3.3.1 HDO condition

The percentage of volunteers who spontaneously chose each image of Figure 3 (A) was as follows: 1 (neutral): 13.60%, 2 (well-being): 63.60%, 3 (cocooning): 18.20%, 4 (luxury): 4.50%. Well-being was significantly the most spontaneously chosen by 14 participants out of 22 with a “Z” statistical test p(value)<0.0001. The scent of HD product provided well-being to the participants.

3.3.2 HSO condition

The percentage of volunteers who spontaneously chose each image of Figure 3 (B) was as follows: 1 (joy): 50%, 2 (luxury): 8.30%, 3 (vitality): 4.20%, 4 (neutral): 37.50%.

Joy was significantly the most spontaneously chosen by 12 participants out of 24 with “binomial” statistical test p(value)=0.0072. The scent of HS product provided joy to the participants.

3.3.3 HST condition

The percentage of volunteers who spontaneously chose each image defined in figure 3 (C) was as follows: 1 (relaxation): 20.80%, 2 (joy): 0%, 3 (well-being): 66.70%, 4 (neutral): 12.50%. Well-being was significantly the most spontaneously chosen by 16 participants out of 24 with “Z” statistical test p(value)<0.0001. The application of HS product provided well-being to the participants.

3.4. Well-being questionnaire (WBQ)

3.4.1 HD product

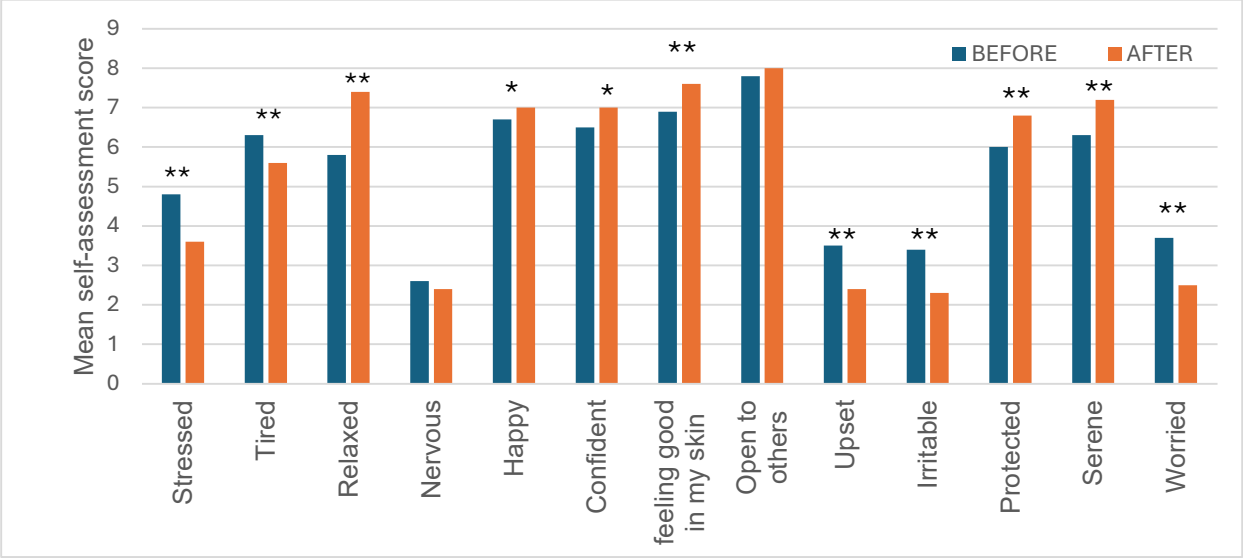

Figure 7: Mean self-assessment score for each emotional state before and after HDO condition, according to a 10 points scale (0= »not at all”, 10 = “totally”).**symbolizes statistically significant variations (ANOVA statistical test, p(value)<0.05).* symbolizes closed to statistical significance variations according to ANOVA statistical test,0.05<p(value)<0.1)

Stressed, tired, upset, irritable and worried felt emotional states significantly decreased after breathing HD product of respectively 24.76%, 11.51%, 31.17%, 31.08% and 32.10%Relaxed, feeling good in my skin, protected and serene emotional states significantly increased after breathing HD product of respectively 27.34%, 9.87%, 13.64% and 15.22% (Figure 7). Happy and confident emotional states tended to be statistically significantly improved also according to ANOVA statistical p(value) of 0.08. These results confirmed the positive impact of HD product’s olfaction on participants' emotional well-being.

4.2 HS product

Stressed, tired, upset, irritable and worried felt emotional states significantly decreased after breathing and applying HS product of respectively 27.73%, 14.20%, 38.95%, 40% and 35.24% (Figure 8). Relaxed, happy, confident, feeling good in my skin, open to others and serene emotional states significantly increased after breathing and applying HS product of respectively 44.35%, 14.38%, 12.16%, 13.73%, 4.49% and 14% (Figure 8). These results confirmed the positive impact of HS product's olfaction and application on participants' emotional well-being.

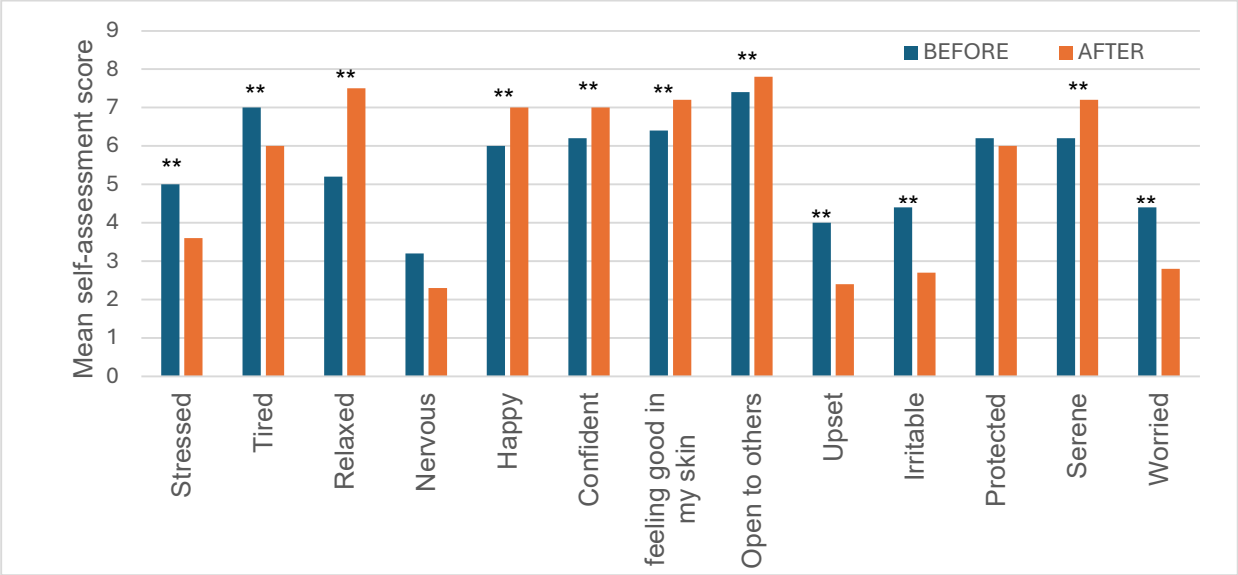

Figure 8: Mean self-assessment score for each emotional state before and after HSO and HST conditions, according to a 10 points scale (0= »not at all", 10 = "totally"). **symbolizes statistically significant variations (ANOVA statistical test, p(value)<0.05).

4. Discussion

Some of the emotion-measurement methods that provide conscious deliberate answers were criticized as being inefficient at detecting the real implicit emotions and the possibility of being affected by the Social Desirability Effect [10]. The complementary nature of the techniques used in this study makes it possible to go further by measuring more implicit emotions such as anxiety for HSO condition for example. This approach not only aligned product innovation with consumers' emotional expectations but also reinforced brand credibility through evidence-based communication. Future research may expand on this foundation by exploring individual differences in emotional responsiveness, cross-cultural variations, and the long-term impact of repeated product use on emotional health. The integration of neurosciences into cosmetic evaluation opens promising pathways for designing products that not only enhance appearance but also contribute meaningfully to emotional and psychological well-being.

5. Conclusion

This study emphasizes the complementary nature of sensory modalities: while olfaction alone can effectively induce calm and serenity, the addition of tactile stimulation significantly enriches the emotional experience, fostering a sense of indulgence, luxury, and deeper well-being. Analyzing images using Eye-tracking technology allowed researchers to explore implicit and explicit choices, providing deeper insights into human decision-making. Researchers can identify whether implicit attention aligns with explicit choices by correlating both data sets. Combination of eye tracking, IET and WBQ techniques could help to learn more about the emotional potential of a cosmetic product, through the senses used to experience it and using specific board of images representing different emotional universes.

6. References

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