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"A multidimensional and transversal approach to fully assess lipsticks through perception, emotion, and textural characterization"

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1. Introduction

Lipstick is one of the fundamental pillars of the makeup market and France is no exception with French women spending 10% of their makeup budget on lipsticks [1].

Consumers expect for all cosmetic products a certain level of performance, strongly dependent on the ingredients of the formulation [2]. However, for lipsticks and make-up products in general, the aesthetic dimension is as important as the efficacy [3]. A wide variety of colors, shades, textures (balm, creamy, liquid, ink) and finishes (matte, glossy, satin) exist in order to suit consumers' diverse expectations and individuality.

Every formula allows a different aesthetic result and performance which will necessarily impact the evaluation of the product by the consumer. However, nowadays we understand more and more that applying lipstick is also, beyond the aesthetic function, a full sensorial and emotional experience, unique for each product [4]. Sensation is the body's immediate response to a stimulus. It is followed by a complex psychological operation by the brain to give meaning to the sensation, it's called the perception. Emotions can then arise as a reaction to the perceived experience, involving subjective, physiological and behavioral or expressive responses [5]. Thus, sensations, perception and emotions felt during the application of the lipstick and throughout the day necessarily play an important role on the opinion the consumer will have of the product.

Therefore, in addition to performance evaluation, working on sensation, perception and emotion in the field of makeup is essential during the development of lipsticks. Understanding these aspects and the links to formulation composition can help create products that better meet consumers' needs in their globality thereby increasing their satisfaction and loyalty.

This study proposes a multidimensional approach combining objective sensory evaluation, subjective perception and unconscious emotional assessments, to better understand the user experience associated with lipsticks and the impact of texture and formula composition. We aimed to link lipstick's characteristics (color, finish, texture) and formula composition with product perception and emotions to determine the best formulation characteristics among samples.

2. Materials and Methods

2.1 Samples, subjects and environment:

The lipsticks selected for all evaluations are products currently commercialized from different brands. We chose to work on red and pink lipsticks as those are among the most frequent colors for this kind of product [6]. Since products belong to different brands, the shades were not strictly identical for both colors however the selected product shades were chosen as close as possible to each other. Finally, all products were blinded prior to their use by the volunteers to avoid bias due to the brand.

For the sensory evaluation, we selected 15 lipsticks based on the claimed finish: 6 matte products, 5 glossy products) and 4 satin products. Every sample was identified with a three digits number as usually done in sensory analysis.
For the emotion and perception assessments, we selected 6 lipsticks based on the outputs of the sensory analysis to which we added 6 pink equivalents. We had a total of 12 samples: 6 matte, 4 glossy, 2 satin. For a better comprehension, we will label the samples in the text and graphs as follows “color + finish + number” (e.g : Red matte 1).

For each study, the recruitment and selection procedures guarantee that the subjects receive clear and accurate information about the aim of the study, the benefits and consequences of their participation in the study. Volunteers consent, prior to starting the evaluations, is free and informed.

All evaluations were conducted in controlled environments with standardized lighting conditions and under a monitored temperature and were supervised by a technician or panel leader. The volunteers completed the evaluations facing a mirror with standardized light as well.

2.2 Sensory evaluation:

First, we aimed to determine if red lipsticks with different finishes have distinctive sensorial characteristics. We therefore conducted a descriptive sensory analysis of 15 red lipsticks with different finishes: matte, glossy, satin. A monadic sequential procedure was used and only one formula was assessed per session (15 sessions).

Each lipstick has been objectively described by 12 expert judges (exclusively women), previously trained to score lipsticks using 24 sensorial attributes. The attributes were assessed during application (e g: slipperiness, immediate pay off/charge), immediately after application (e g: coverage, shine, greasiness…), the lasting of the lipstick before and after lunch without reapplying (uniformity, color intensity, migration). Each attribute has a specific description and application protocol performed by all experts.

The analysis was made through descriptive statistics, standard statistics (Anova…) principal component analysis (PCA) and agglomerative hierarchical clustering (AHC) and other graphic representations. All products were individually assessed and then compared all together during the results analysis.

2.3 Perception & emotions assessment:

To evaluate the in vivo perception of performance (e.g: homogeneous result, stick/lips shade match), cosmetic qualities (e.g: not sticky, easy to apply), satisfaction, and to characterize the emotional signature of twelve red and pink lipsticks, an open and non-comparative study was also conducted on healthy female. 32 volunteers evaluated in a randomized order 12 lipsticks matte, glossy or satin finish, corresponding to the 6 most pertinent red determined from the sensory analysis to which we added 6 pink equivalents. The addition of pink equivalent limits the color bias when comparing the products but also allows us to gain insight on the impact of the color on emotions. The presence of matte, glossy and satin lipsticks allow us to explore the possible existence of shared characteristics due to the finish.

2.3.1 Emotions:

In general, to assess and quantify the emotional impact of cosmetic products, a multidimentional approach is recommended in order to consider the subjective, expressive and visceral components. We therefore used a combination of methods including vocal analysis (prosody), semantic analysis, a psychometric emotional scale called the Geneva Emotion Wheel (GEW) and an emotional characterization tool scoring 7 main positive emotional dimensions (0 to 10 scale) using an algorithm. The 7 emotional dimensions being: Awakening, Relax, Sensuality, Pleasure, Tenderness, Fun and Self-esteem.

2.3.2 Perception:

Furthermore, to assess the overall opinion and behaviour toward each product tested, the same volunteers completed a subjective self-assessment questionnaire on perceived efficacy, cosmetic qualities, emotional impact, and appreciation after every application. For each item, the possible answers range from “completely agree” to “completely disagree” (4 possibilities).

2.4 Complementary evaluations and analysis:

Complementary instrumental measurements and statistical analyses were conducted.

First, texture, distance and penetration profiles analysis were conducted using a texturometer on the 6 red lipsticks, to obtain instrumental data on the texture and explore potential links between physical parameters and sensation or perception.

The INCI lists were also analyzed to study the potential relationships between functional ingredients' structures and emotional perceptions with the aim to be able to anticipate the emotions which could be induced by a specific formulation. The methodology consisted in observing the type of ingredients used in both natural and non-natural formulations and identifying a potential correlation between the type of chemistry and specific emotion induction. Then, the position of the different types of ingredients in the INCI list was analyzed to evaluate the percentage of use and precise the level of use needed to generate specific emotions.

Finally, the results of the different tests and research were crossed through various statistical analysis to gain more insight on the possible relationships between formulas with specific finishes, textures and colors, and the resulting sensations, perceptions and emotions.

3. Results

3.1 Sensory analysis:

The sensorial dimensions separated lipsticks studied into two main groups visible through the PAC with 76.2% of representativity (Figure 1):

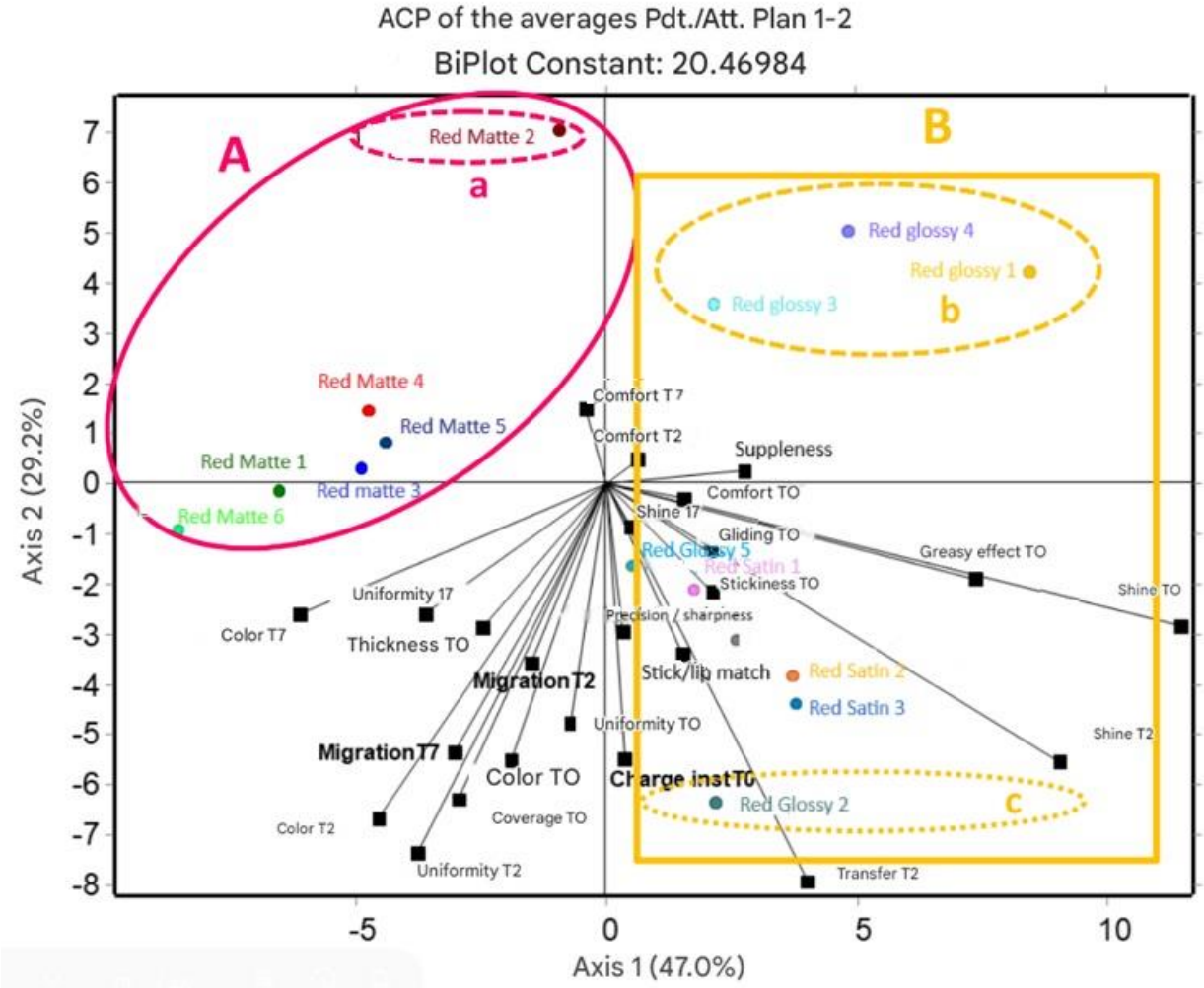


Figure 1. PAC based on the sensorial attributes (in black) of 15 red lipsticks (in color)

The first group (A) on the top left corner is composed exclusively of the claimed matte lipsticks (all 6 matte are in the same groupe) and a second larger group (B) on the right is constituted of the claimed glossy and satin lipsticks. Lipsticks appear to be grouped according to their universe (A and B) with a mix of glossy and satin in group B.

We can notice in group A a subgroup composed of only one specific lipstick that is not as close to the other matte products and for group B two subgroups (b and c) with glossy lipsticks on both sides of axis 2. Therefore, we can say that matte lipsticks seem to be more consensual (A/a) compared to the glossy and satin groupe (B/b/c).

Matte lipsticks seem to be more characterized by thickness upon application, color intensity, and uniformity of the product residue at the end of the day. Satin and glossy lipsticks form a group more characterized by shine, greasy and stickiness.

3.2 Emotion and perception results:

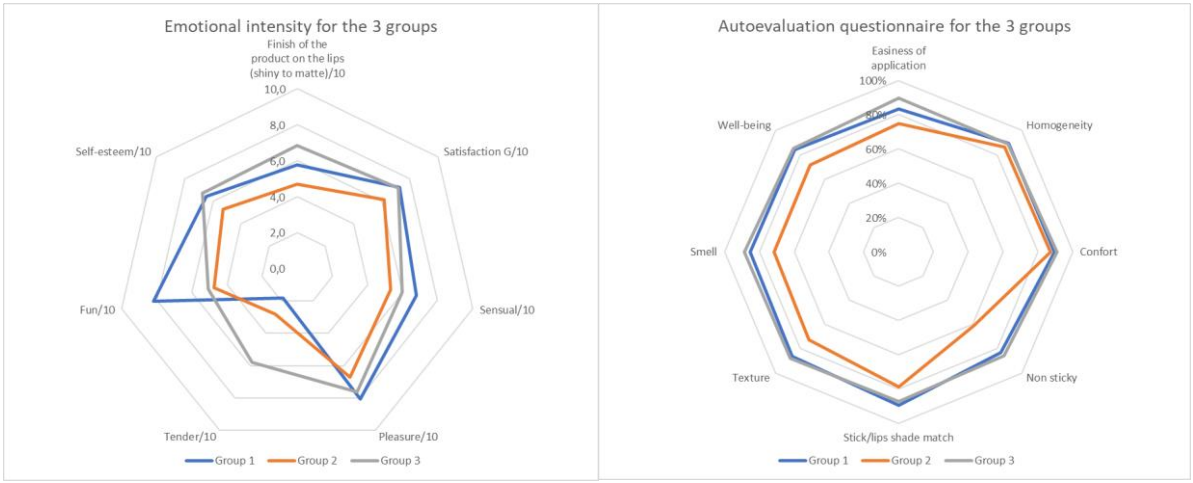
The emotional assessment allowed us to determine for each product the type of emotions activated (valence and level of arousal), the level of consensuality, the emotional domains significatively activated and the main emotional representations.

Furthermore, we obtained for each product the percentage of favorable responses for eight perception questions (easiness to apply, texture appreciation, feeling of well-being provided by the product…).

On the collected data for the 12 lipsticks, we launched an AHC, and we obtained three main groups:

- Group 1: Red Satin 1, Red Glossy 1, Red Matte 1
- Group 2: Red Glossy 2eq, Pink Glossy 1, Pink Glossy 2
- Group 3: Red Matte 2, Red Matte 3, Pink Matte 1, Pink Matte 2, Pink Matte 3 Pink Satin 1

We represented the means of the values of the 3 groups on the following spider graph based on perception items and emotional dimensions intensity (Figure 2.a and 2.b):



(a) **(b)**

Figure 2. Figure showing the 3 emotional intensity groups (a) and perception answers (b)

All products generate a positive valence of emotion and an emotional dimension “pleasure”.

Group 1 is exclusively composed of red lipsticks and is characterized by the emotional dimensions of Fun, Pleasure, and Sensual. It is also performing well on Self-esteem (emotions) and perceived global Satisfaction (perception). This class is composed of the most highly scored lipsticks for the emotional dimensions “Fun” and “Sensual’.

Group 2 is composed of glossy lipsticks (no matte) and the main emotional dimension is Pleasure although the intensity is lower than in the other groups. This group is composed of products scoring the lowest for all positive emotional dimensions. This group is also showing the lowest results in the self-assessment questionnaire for the following items: stick to lip shade match, texture and smell appreciation, easiness of application, perceived well-being and the absence of stickiness (perception).

Finally, Group 3 is mainly composed of pink lipsticks, mostly matte and is characterized by the emotional dimension of Tender (the most tender). It also shows good performance on Pleasure, Sensual and Self-esteem dimensions.

The responses are rather positive on the self-assessment questionnaire and are very close between group 1 and 3. The products are well appreciated, and they induce well-being, texture satisfaction, stick/lip shade match, absence of stickiness and ease of application. This is coherent with the fact that they generate the most positive emotions.

3.3 Multidimension crossed analysis:

We crossed the objective sensorial data with the subjective conscious and unconscious perception and emotional evaluations through a PCA graphic (Figure 3).

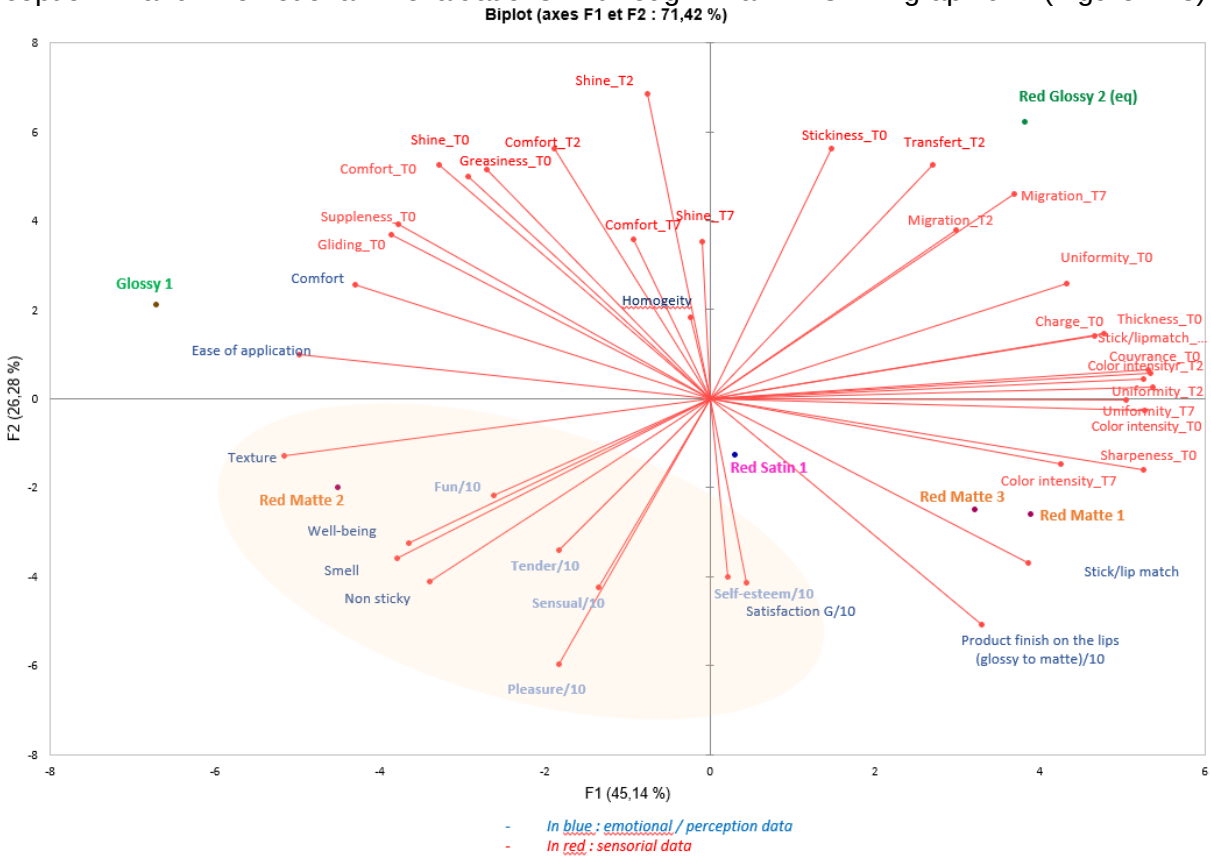


Figure 3. PCA based on emotion, perception and sensation data

We can notice that all emotional dimensions are close and are all located on the lower part of the PCA. Also, most sensorial attributes are located on the upper part and right part of the graphic. The perception items are mostly on the left and lower part of the graphic.

We can see that global Satisfaction (perception) is very close to the Self-esteem dimension (emotion). The perceived comfort and ease of application seem to evolve closely with the slipperiness and flexibility/suppleness of the lipstick upon application (objective sensorial data).

Also, the emotional dimension of pleasure seems to be completely opposite to the sensorial attributes of migration of the lipsticks (after 2 and 7 hours) and to lipstick transfer after 2 hours.

We launched another PCA analysis combining texturometer measurements with perception. The FMAX parameter associated to the lipsticks was on the opposite side of the perceived comfort and ease of application.

3.4 Composition analysis

Observing the data collected during the emotion and perception study, we spotted in group 1 that a natural glossy lipstick and a non-natural matte lipstick could generate the same emotional profile (Table 1).
The only difference noticed in the emotional profile concerned the Fun attribute which could be linked with the resulting make-up appearance on the lips.

Emotion	Matte non natural lipstick	Glossy natural lipstick
Pleasure	8,03	8,03
Fun	7.26	9,09
Sensuality	6,58	6,58
Self Esteem	6,26	6,26
Awakening	3.42	3.42
Relax	3.90	3.90
Tender	1.81	1.81

Table 1: Comparative emotional profile between a non-natural and a natural lipstick

The analysis of formulations also demonstrated that melting textures were linked to Fun and Sensuality.

4. Discussion

Sensory data analysis generated distinct groups and gave us a vision of the characteristic attributes of each group. It seems that matte lipsticks form a more concentrated group

confirming their claimed matte categorization, and are caracterized by thickness upon application, color intensity, and uniformity of the product residue at the end of the day. Glossy and satin are gathered in a must larger group in terms of sensation compared to matte lipsticks. They are caracterized by higher values of shine, greasiness and stickiness. However, in this larger group, we can see that the distinction between glossy and satin is less defined sensorialy wise. Firstly, this suggests that glossy and satin lipsticks can cover a larger sensorial universe and secondly claimed glossy and satin lipsticks are less sharp defined.

Regarding the emotion and perception results, we can notice that the Pleasure is present in all kind of products and they all generate a positive valence so these elements are not discriminative between our products. However, some specific emotions are more present for matte lipsticks whereas others are more present for glossy and satin lipsticks. The lipstick finish may influence the emotions.

Also, group 1 of the AHC is exclusively composed of red lipsticks and generate the highest scores for Sensual while the group 3 is constituted of mostly pinks and generate the most Tender emotions. These observations may display the impact of color on emotions.

The group 2 contains the three least appreciated products which are also the ones generating the lower levels of emotions. Furthermore, these three products were also perceived with the highest level of sticky finish and least appreciated smells compared to the other products. Theses attributes may reduce the appreciation of lipsticks.

Group 1 and 3 are composed of the most appreciated products and they activate positive emotional dimensions, induce perceived well-being and are well evaluated regarding texture satisfaction, lip/stick shade match, low stickiness and ease of application.

The PCA analysis combining texturometer measurements and perception. The results showed a potential anti-correlation between FMAX that represents the hardness of the texture and the perceived comfort and ease of application of a lipstick.

From the combined analysis of formulation composition and emotional profile, it is interesting to note that it is possible to generate with a natural formulation an emotional profile like the one of a non-natural formulation. This also confirms that natural lipsticks can adequately lead to consumers' benefits and induce the same level of satisfaction than a silicone-based formlation.

The only difference in the emotional profile was on the Fun attribute where the matte lipstick resulted in a lower rate than the shiny lipstick. This suggests that mattifying agents would lead to lower Fun perception.

Further investigation in the formulation composition linked to emotional profile suggests a relation between ingredients having a melting profile close to body temperature with Fun and Sensuality attributes. In addition, it seems that the use of very fluid ingredients led to a specific emotion. We could also identify a link between another specific emotion and the use of very large complex molecules.

5. Conclusion

The sensorial evaluation shows that based on the finish of the product (matte or satin/glossy), the sensorial features will differ.

Furthermore, the cross-evaluation of sensation, emotions and perceptions data showed that groups predominantly composed of a certain color generate specific emotions and that specific lipstick finishs stand out by generating different emotions. It also revealed potential links between specific items of perception with emotions and between sensory attributes and perception.

However in some specific cases, we could surprisingly also see that different finish of lipsticks could generate the same emotional profile. On top of this, these 2 formulations were of natural composition on one hand and non natural composition on the other hand. This second observation shows that it was possible to produce the same level of positive emotional profile with natural ingredients.

By exploring links between ingredients, textural characteristics, product perception, and emotional responses, this study highlights the importance of considering a multidimensional approach to develop products that best meet consumer expectations and provide an optimal experience. It also offers interesting perspectives for the cross evaluation of other product categories.

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