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Physiological benefits associated with facial skincare: Well-being from emotional perception to neuromodulation

Sara Bouhout[1] | **Arnaud Aubert**[2] | **Francis Vial**[2,3] | **Benjamin Choquenet**[1]

[1]Biologique Recherche, Suresnes, France

[2]Emospin, Tours, France

[3]Spincontrol, Tours, France

Correspondence
Sara Bouhout, Biologique Recherche, 28, rue de la Procession, Suresnes 92150, France.
Email: sara.bouhout@biologique-recherche.com

Funding information
Biologique Recherche, France

Abstract

Objective: This study aimed to demonstrate the specific nature of well-being induced by a facial skincare by deciphering its physiological and psychological impacts out of a therapeutic context.

Methods: Objective and subjective evaluations were performed on two groups of healthy participants. One group of 32 participants received 1-h facial skincare, while the second group of 31 participants were subjected to a resting condition during the same period. Electroencephalography, electrocardiography, electromyography, and respiratory rate measurements were assessed before and after both experimental conditions. Prosody and semantic analyses were also performed to evaluate the emotional perception in both groups.

Results: Physiological relaxation was observed after both experimental sessions; however, the effect was higher after the facial skincare. The cerebral, cardiac, respiratory, and muscular relaxation induced by facial skincare was 42%, 13%, 12%, and 17% higher, respectively, than that induced by the resting condition. In addition, non-verbal and verbal assessments showed that positive emotions were more markedly associated with the perception of facial skincare.

Conclusion: The comparison between parameters recorded after a rest period allowed us to distinguish the physiological and psychological signature of facial skincare. Moreover, our results suggest an involvement of positive emotions in the physiological relaxation enhancement. All these observations contribute to the very scarce data available on the specific profile of well-being associated with facial skincare.

KEYWORDS

facial skincare, neuromodulation, physiological activity, positive emotions, well-being

Résumé

Objectif: Cette étude visait à démontrer la nature spécifique du bien-être, induit par un soin du visage, en décryptant son impact physiologique et psychologique en dehors d'un contexte thérapeutique.

Méthodes: Des évaluations objectives et subjectives ont été réalisées sur deux groupes de participants sains. Le premier groupe, de 32 participants, a reçu un soin du visage d'une heure ; tandis que le second groupe, de 31 participants, a été soumis à une session de repos de même durée. Des mesures d'électroencéphalographie, d'électrocardiographie, d'électromyographie, ainsi que de fréquence respiratoire, ont été enregistrées avant et après ces deux conditions expérimentales. Des analyses prosodiques et sémantiques ont également été effectuées, pour évaluer la perception émotionnelle dans chacun des deux groupes.
Résultats: Une relaxation physiologique a été observée après les deux sessions expérimentales ; cependant, celle-ci fût plus importante après le soin du visage. En effet, comparativement à la session de repos, le soin du visage a induit une relaxation cérébrale, mais aussi cardiaque, respiratoire et musculaire, plus élevées de 42%, 13%, 12% et 17%, respectivement. De plus, les évaluations verbales et non verbales ont montré que les émotions positives étaient nettement plus associées à la perception du soin du visage, plutôt qu'à celle du repos.
Conclusion: Cette étude comparative nous a permis de distinguer la signature physiologique, mais aussi psychologique, du soin du visage. Egalement, nos résultats suggèrent une implication des émotions positives dans l'amélioration de la relaxation physiologique. Ces observations contribuent à enrichir les rares données disponibles sur le profil spécifique du bien-être associé au soin du visage.

INTRODUCTION

It is commonly perceived that cosmetics are tools used in the quest for well-being. Such products are considered to have a dual dimension, which is both physical and emotional. This concept has reached the clinical field, as recent psychosocial programs have emerged to demonstrate the positive influence of aesthetic care on supporting the treatment of disease [1, 2]. The Global Wellness Institute has quantified the economic weight of the personal care and beauty sector. With a consumer spending of 955 billion dollars in 2020, the cosmetic sector represented a quarter of the global wellness economy, despite a 13% decline in consumption during the COVID-19 crisis [3]. Furthermore, it is interesting to note that the skincare field was particularly resilient during the pandemic, as it still displayed a sale growth [4]. This could be explained by the universal human constant that the perception of health and well-being, according to the World Health Organization (WHO) definition [5], is mirrored by the skin appearance [6–8].

Well-being has become a societal issue associated with numerous individual and collective benefits in view of WHO, which now explains a proliferation of studies on it. However, as well-being is multi-faceted [9], it is often used as an inappropriate label, which is a major concern. For example, in the cosmetic case, well-being merchandising has been improperly developed through a diversity of products associated with extravagant claims [10]: well-being fruit infusions, anti-dandruff and well-being shampoos, shower gels that deeply nourish delicate skins while leaving a real feeling of well-being, etc.

Due to this misuse, it is worth asking what well-being could mean in the case of a specific cosmetic treatment. Indeed, various beauty care practices are not necessarily comparable to each other. The specific condition of facial skincare was chosen to conduct our work since it combines two interesting factors. First is the aesthetic effect, which necessarily produces positive emotions because it is perceived as improving one's physical appearance [11]. Furthermore, the effect on physiological relaxation is usually associated with classical body massages outside the context of a beauty treatment. Thus, the emotional and physiological factors are part of this context-sensitive well-being; and their study is even more so relevant since they are both biologically interdependent. Indeed, emotion arises from several brain regions' activity and is expressed in the peripheral organs by modulating their activity through the control of the autonomic nervous system (ANS) [12]. The ANS is divided into two nerve branches: the orthosympathetic and parasympathetic pathways. Schematically, the orthosympathetic division induces a stimulation state, which is essential to the well-known "fight or flight" response, while the parasympathetic one leads to a state of relaxation [13]. Therefore, depending on the emotional perception of a situation, the activity of the peripheral organs will be stimulated under the orthosympathetic control or, on the contrary, reduced under the parasympathetic influence. However, in the particular case of positive emotions, recent work has discussed the limitations of the state of the art related to this concept; thus, reducing their impact to no, or little, influence on ANS reactivity [14]. This hypothesis invites to an in-depth investigation of psychophysiological parameters when studying a well-being involving positive emotions.

Both psychological and physiological impacts of body massage are well documented [15]; however, fewer studies are available on the effect of facial skincare. Yamada et al. have demonstrated that facial skincare improves the feeling of comfort. They used psychometric evaluations, which only report subjective information [16]. Furthermore, these results were completed by objective data using only electroencephalography (EEG), showing that facial skincare enhances cerebral deactivation close to the relaxation recorded in a state of rest [17]. Twenty years later, Hatayama's team conducted an electrocardiographic analysis and contested the relaxation effect, calling it a refreshing effect corresponding to a physiological stimulation [18]. However, the authors only assessed the heart rate variability (HRV) to support this conclusion. Moreover, psychometric questionnaires related to anxiety and distress states were used in this latest work, occulting the evaluation of positive emotions inherent to well-being induced by facial skincare.

This study aimed to overcome the lack of data establishing the specific profile of well-being associated with facial skincare. We hypothesized that facial skincare induced a relaxation effect rather than a stimulation effect, without being comparable to that seen in a state of rest. On the contrary, we expected it to have its own physiological signature, driven by both specific neuromodulation and emotional perception. To achieve this goal, we assumed that using several tools was necessary to avoid contradictory conclusions, as presented by the previous studies [17, 18]. Therefore, during facial skincare or a rest period, parasympathetic activity was assessed across the activity of diverse peripheral organs; using electrocardiography [19, 20], electromyography (EMG) [21, 22], and respiratory rate (RR) [23] measurements. While the activation or relaxation state of the brain was interpreted from its alpha and beta waves recorded with EEG [24]. These objective data were completed by analysing prosody and *verbatim*, which are expressive and declarative parts of a classical subjective evaluation, respectively [25]. Finally, a system of feeling characterization, named EmoChar [26], was developed to decipher the perceived discrete positive emotions, as defined by the Geneva emotion wheel [27]. This latest approach combines verbal and non-verbal cues to provide psychometric data more appropriate for evaluating well-being associated with a positive experience, such as cosmetic care, outside the pathological context of stress, distress, or anxiety.

MATERIALS AND METHODS

Participants

Data were collected from 63 healthy women aged between 25 and 47 years (mean age: 33 years). The participants were divided into two groups. The first group (treated group) of 32 participants aged between 25 and 46 years (mean age: 33 years) received 1-h facial skincare. The second group (reference group) of 31 participants aged between 26 and 47 years (mean age: 35 years) did not receive facial skincare but were subjected to a resting condition for 1 h. This study was conducted with the approval of the Committee (Veritas-IRB; 22-Sep-2021). Written informed consent was obtained from each participant after they received clear and accurate information about the aim of the study.

Experimental sessions

During the experimental procedure, both groups were alternately installed in the bed in the same room, settling at a temperature of 21 ± 1.5°C. In the first group, the same restructuring and smoothing facial skincare was performed for 1 h using massage gestures associated with products free of synthetic fragrance: emulsion, serum and powder, tissue mask, cream, and cosmetic steel spoon. A trained aesthetician conducted this treatment. The participants in the second group were at rest for the same duration of 1 h. Physiological data (HRV, EMG, and RR) were recording along the 1 h-test session. EEG, prosody and verbatim were measured before and just after the test session.

Physiological parameters

Electroencephalography recording and power spectrum analysis

The EEG analysis involved treating frontal activity using an EEG portable wireless headset (Muse EEG system) with a pre-set 500 Hz sampling rate. The EEG headset measures the signals corresponding to Fpz, AF7, AF8, TP9, and TP10, with the electrode Fpz as the reference electrode. Raw EEG data were analysed using specialized modules under the Matlab environment. Before recordings, the main source of noise was controlled by removing all unnecessary sources of electromagnetic noise from the recording room. Moreover, motion artefacts were prevented as subjects were resting immobile during recordings. Subjects were installed in a comfortable chair in a calm dimly-illuminated temperature-controlled room (21°C), and were asked to relax for 3 min, listening to relaxing music. Before analysis, standard signal averaging and high-pass (<0.01 Hz)/low-pass (>100 Hz) filtering procedures were applied to suppress the remaining uncontrolled noise. This routine procedure was automatically applied by EEG analysis module at the very first steps of signal treatment. Supplementary, an artefact subspace reconstruction was applied to eliminate the remaining artefacts. In this study, the power ratio of interest was the Alpha to Beta ratio. The Power Spectral Density (PSD) of Alpha (8–13 Hz) was divided by the PSD of Beta (13–30 Hz) to get this ratio. PSDs were computed using the standard Welch method. This ratio was used because it offers a reliable index of emotional arousal, stress load, and mindfulness [24]. Alpha brainwaves (8–13 Hz) are dominant during quietly flowing thoughts and in some meditative states. Conversely, Beta brainwaves (13–30 Hz) correspond to faster brain activity and are present when we are stressed, attentive, and engaged in problem-solving, judgement, decision-making, or focused mental activities. Therefore, the greater the ratio, the greater the Alpha power relative to Beta power, which indicates a more relaxed state.

Heart rate variability evaluation

The HRV is the cardiac measure of the interaction between the orthosympathetic and parasympathetic branches of the ANS. Therefore, HRV provides a measure to express the activity of the ANS and consequently provides a valid emotional response [19, 20]. Measures and analyses were made in accordance with previously published guidelines and recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [28]. Measures were taken using a non-invasive infra-red captor (Thought Technology Ltd. model SA9308M) clipped to the ear of participants and connected to a specific apparatus for further analysis (ProComp5 Infiniti, Thought Technology, Ltd). The sampling rate was set to 256 samples/sec. Considering the time-length of the test session, this study used a Frequency Domain Analysis to assess the global effect of the massage session. HRV was determined in the frequency domain using spectral components of low frequencies (LF, 0.04–0.15 Hz), which is influenced by both branches of the ANS, and high frequencies (HF, 0.15–0.40 Hz), which reflect the parasympathetic activity. The LF/HF ratio was used to infer the sympathetic modulation and autonomic balance [19, 20].

Respiratory rate variability

RR was measured using a thoracic belt (Though Technology Ltd, model SA9311M) connected to a specific apparatus for further analysis (ProComp5 Infiniti, Thought Technology, Ltd) using a standard procedure. The captor was installed around the chest of the participant, and it is sensitive to stretch and convert the expansion and contraction of the rib cage to a rise and fall of the RR signal. The raw waveform signal was computed using BioGraph Infiniti software.

Muscular tension measurement

Upper-back stiffness was assessed using EMG analysis of trapezoid muscle. The EMG activity was recorded unilaterally from the right upper trapezius (at a point two-thirds of the distance from the spinous process of the seventh cervical vertebrae towards the lateral edge of the acromion) in accordance with the Standards for reporting EMG data. The raw EMG signal was initially subjected to standard band-pass filtering (i.e. 5–20 Hz and 200 Hz–1 kHz), and then the EMG signal was smoothed using one-second Hamming windows. Data were recorded and treated through a ProComp Infiniti hardware and BioGraph software solution.

Psychometric parameters

In the case of the following two evaluations, two questions were asked from the participants: 'how are you feeling now?' (Q1) and 'What did you like during this relaxation phase?' (Q2). The answers of the participants were recorded and served as support for the prosody and semantic analyses.

Prosody evaluation

Prosody evaluation involves a speech parameters analysis concomitant to stimulation (here, before/after, massage, or resting period) [29]. The speech signal's spectral analysis informs about the participant's emotional state [30]. This analysis is performed using a specific software package

[31] after treatment of the sound signal (such as digitization, applications of filters, Fourier transform, etc.) to get a signal on which the speech parameters are extracted. This physical analysis of acoustic signals has already been successfully discriminating different emotional states, and it represents a reliable tool to evaluate the emotional level of participants at a given moment. Extracted vocal parameters consisted of: (i) frequency-related parameters (mean fundamental frequency (F0), minimum F0, maximum F0, standard deviation F0, and jitter), (ii) energy/amplitude-related parameters (shimmer, amplitude [dB], peak amplitude, mean harmonic to noise ratio (HNR), maximum HNR, and standard deviation HNR), and (iii) temporal features (duration and peak time). Prosodic parameters were processed using the EmoVoc™ proprietary algorithm and translated into emotional dimensions: valence and arousal [26]. Following the procedures of Goudbeek and Scherer [32], Sauter et al. [33], and Juslin and Laukka [34], the measurements were made over the entire utterances across all speakers and all items of the same type of stimulus. The extracted variables were then processed according to a proprietary algorithm (i.e. EmoVoc™) to obtain two prosody-based emotional indices: vocal arousal index and vocal pleasantness index.

Semantic analysis

The *verbatim* analysis corresponds to a quantitative approach (statistic) involving the word content of the participants' answers to the questions asked by the technician during the study. This approach is a traditional method of the social and human sciences in which we provide evidence of the frequency of the different verbal occurrences to determine the statistic's importance. These analyses may be eventually made for associations between items, especially as part of the study concerned with the structure of the language. All verbal responses (i.e. *verbatim*) were recorded and transcribed into text files for analysis. Textual statistics were applied according to current standards [35, 36] using the R statistical environment. In summary, the analyses involved the following steps: (i) disambiguation (understanding the context in the sentence, i.e. 'this is calm' versus 'this is not calm'); (ii) lemmatization (categorization into the root of the words to increase statistical power, i.e. sleep, sleeping, sleepy = 'sleep'), (iii) statistical processing (see 'statistics').

Emotion characterization–EmoChar

EmoChar® is a system of emotional characterization, scoring seven main emotional dimensions from 0 to 10:

- Stimulation: focus, attention, and awakening.
- Relaxation: serenity, relaxation, and appeasing.
- Sensual: arousing, sexy, and erotic.
- Pleasure: liking, « gourmand », and satisfaction.
- Tenderness: gentleness and softness.
- Joy: excitement, fun, and enthusiasm.
- Self-esteem: confidence and assurance.

EmoChar was developed in response to the double need: (i) to have at one's disposal a reliable characterization system that is not only based on verbal responses but mainly focuses on non-verbal outputs [37]; (ii) to have at one's disposal a system that can differentiate various forms of positive emotions relevant to consumers experiences [26, 37]. Each score is obtained using an algorithm, mixing verbal and non-verbal responses of volunteers to a specific product or stimulus in a given context. The proprietary algorithm was developed from extensive field data and in accordance with scientific literature and validated biobehavioural patterns associated with various emotional states.

Statistics

Each physiological data was expressed as means ± standard deviation (SD). EEG data were calculated at each time point and compared using variance analysis (ANOVA, followed by a paired comparison using the Newman–Keuls test, with a 5% threshold). For the other physiological parameters, the verification of the normality of distributions was performed using the Shapiro–Wilk test ($\alpha = 1\%$) and the homogeneity of variance using the Bartlett test. Statistical analysis for each of the measured parameters was performed either with Student's *t*-test (if the normality of the distributions was confirmed) or with the Wilcoxon test (if the normality of the distributions was rejected). The level of significance was set at 5%.

Concerning the prosodic analysis, parameters were calculated at each time point and compared using variance analysis (ANOVA, followed by a paired comparison using the Newman–Keuls test, with a 5% threshold).

Textual statistics were obtained using the R statistical environment. After disambiguation and lemmatization, the semantic space was analysed using a Factorial Analysis of Correspondence, followed by the determination of specific terms of each verbal corpus (i.e. those statistically representative of a specific corpus) on a *t*-test basis. Each EmoChar score was analysed using a *z*-test one-sample procedure, with the significance threshold fixed at 5%.

RESULTS

Objective dimension and physiological parameters

Data are expressed as a percentage of baseline values to decrease the relative weight of inter-individual variability.

Electroencephalography measurements

The Alpha/Beta ratio increased for both groups after their respective session compared to the initial state before the start (Figure 1). However, a statistically significant difference was observed between the treated and reference groups ($t = 2.745$; $p = 0.008$). Indeed, the treated group, which received the facial skincare, showed an increase of approximately 391% in the ratio. In contrast, the reference group, which remained at rest, showed an increase of approximately only 275%. This result reflects a 42% superiority in cerebral relaxation provided by facial skincare compared to a moment of rest within the same duration.

Electrocardiography analysis

The LF/HF ratio decreased for both groups after their respective session compared to the initial state before the start (Figure 2). A statistically significant difference was observed between the two groups ($t = 2.749$; $p = 0.008$). The group that received the facial skincare showed a decrease of approximately 30% in HRV. In contrast, the group that rested showed a decrease of approximately only 20%. This result reflects a 13% superiority in cardiac relaxation provided by facial skincare compared to a resting period within the same duration.

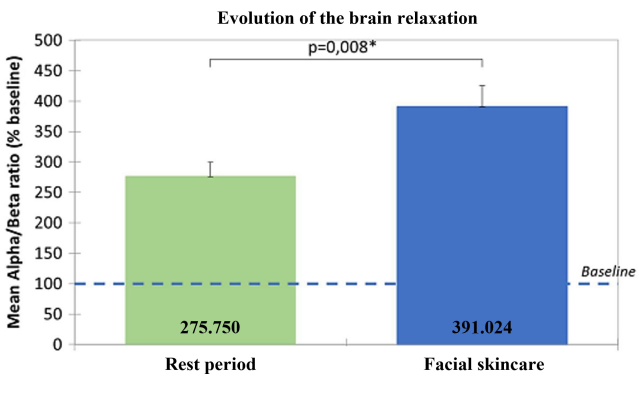


FIGURE 1 Evolution of the Alpha/Beta brainwaves ratio before and after both experimental sessions. The cerebral relaxation was improved after both sessions compared to the initial state indicated by the baseline (dashed line in blue). However, physiological well-being was higher in the group that received facial skincare ($n = 32$) than in the group that rested within the same duration ($n = 31$). Values are depicted as means ± sem. *significant ($p < 0.01$).

Respiratory rate measurements

RR decreased for both groups after their respective session compared to the initial state before the start (Figure 3). However, a statistically significant difference was observed between the two groups ($t = 2.473$; $p = 0.016$). The

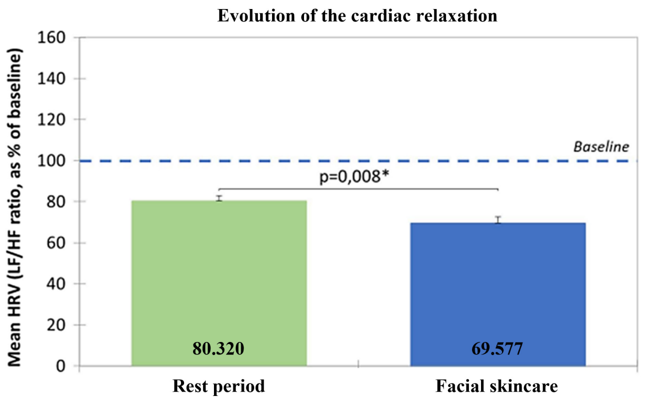


FIGURE 2 Evolution of the heart rate variability before and after both experimental sessions. The cardiac relaxation was improved after both sessions compared to the initial state indicated by the baseline (dashed line in blue). However, physiological well-being was higher in the group that received facial skincare ($n = 32$) than in the group that rested within the same duration ($n = 31$). Values are depicted as means ± sem. *significant ($p < 0.01$).

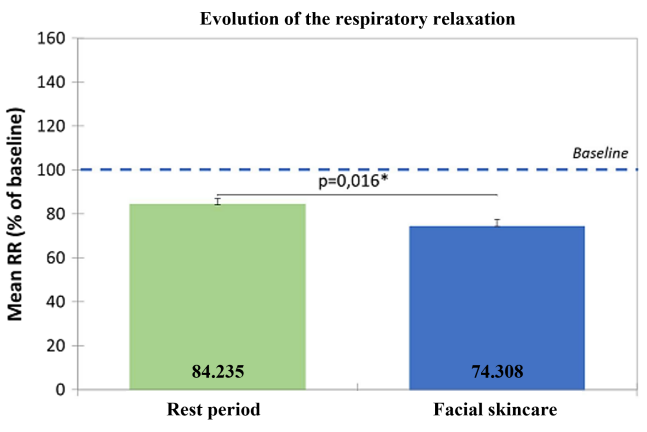


FIGURE 3 Evolution of the respiratory rate before and after both experimental sessions. The respiratory relaxation was improved after both sessions compared to the initial state indicated by the baseline (dashed line in blue). However, physiological well-being was higher in the group that received facial skincare ($n = 32$) than in the group that rested within the same duration ($n = 31$). Values are depicted as means ± sem. *significant ($p < 0.05$).

group that received the facial skincare showed a decrease of approximately 26% in RR. In contrast, the group that rested showed a decrease of approximately only 16%. This result reflects a 12% superiority in respiratory relaxation provided by facial skincare compared to a moment of rest within the same duration.

Electromyography recordings

The muscular tension decreased for both groups after their respective session compared to the initial state before the start (Figure 4). However, a statistically significant difference was observed in the two groups ($t = 3.454$; $p = 0.001$). The group that received the facial skincare showed a decrease of approximately 36% in muscular tension. In contrast, the group that rested showed a decrease of approximately only 23%. This result reflects a 17% superiority in muscular relaxation provided by facial skincare compared to a moment of rest within the same duration.

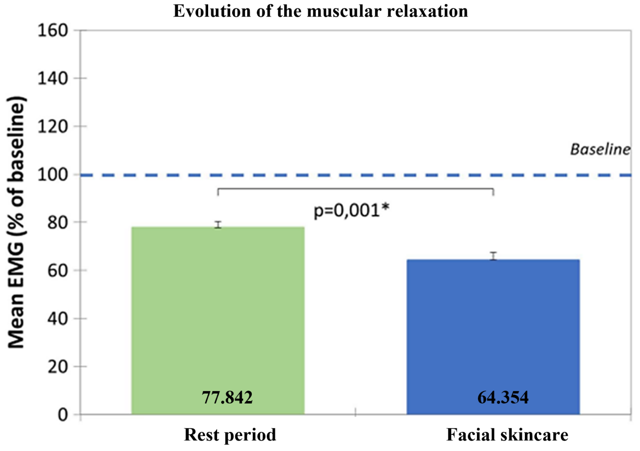


FIGURE 4 Evolution of the muscular tension before and after both experimental sessions. The muscular relaxation measured in the upper back trapezius was improved after both sessions compared to the initial state indicated by the baseline (dashed line in blue). However, physiological well-being was higher in the group that received facial skincare ($n = 32$) than in the group that rested within the same duration ($n = 31$). Values are depicted as means ± sem. *significant ($p < 0.001$).

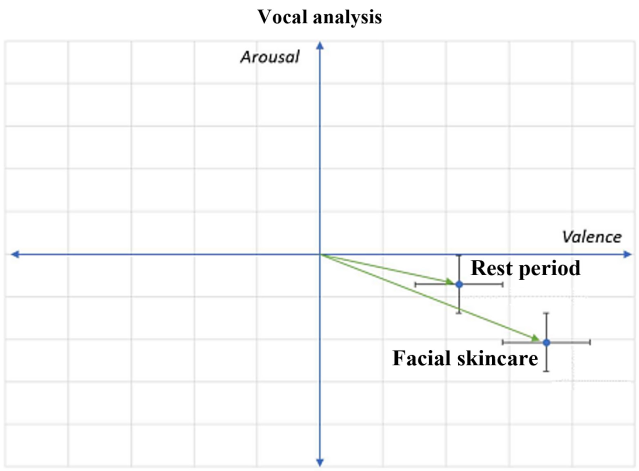
Subjective dimension and verbal/non-verbal parameters

Prosody evaluation

A positive valence was observed for both groups, which is associated with emotions related to pleasantness (Figure 5). Moreover, both groups displayed negative arousal, reflecting a de-activation process. Therefore, this two-dimensional analysis indicates that both groups perceived their respective session as pleasurable and relaxing moments. However, the statistical analysis revealed that these emotions were elicited more markedly in the group that received the facial skincare compared to the resting group within the same duration ($t = 3.278$, $p = 0.002$ and $t = 2.044$, $p = 0.045$ for valence and arousal, respectively).

Semantic analysis

According to the factorial analysis of correspondence (Figure 6), the two main statistical dimensions represented 81.2% of the total variance, hence an accurate account of the evolution of *verbatim* related to the two questions for both groups after their respective session. Moreover, according to the factorial analysis of correspondence, each of the two main dimensions corresponds to a distinct factor: type of question (i.e.



Parameter	t	p
Valence	3,278	0,002 **
Arousal	2,044	0,045 *

FIGURE 5 Prosody analysis after both experimental sessions. On average, participants' positive valence and deactivated state were elicited after both sessions. However, the state of psychological relaxation and positive emotions was better perceived by the group that received facial skincare ($n = 32$) compared to the group that rested within the same duration ($n = 31$). A statistically significant difference was observed for both valence ($p < 0.01$) and arousal ($p < 0.05$).

question 1 vs. 2) for dimension 1 and the group that received the facial skincare versus the one that rested for dimension 2. This statistical discrimination between parameters revealed that produced *verbatim* was accurate and specific to each modality. According to question 1 answers, both groups reported a relaxation state. However, the *verbatim* used to express it was completely different between both groups, as there was no overlapping in the specific terms distribution. This result reflects that the perception of the relaxation induced by facial skincare is clearly distinct from that experienced during resting. The distribution of the specific terms used in the question 2 answers was less sparse between both groups, as a little overlapping was observed. However, a statistical difference persisted. The terms « enjoyed », « nice », and « pleasant » were specifically related to the emotions perceived by the group that received the facial skincare. These positive feelings were absent in the reference group.

Discrete emotions characterization

Among all the positive items presented by the EmoChar (Figure 7), « relax » and « pleasure » were those associated with the higher score in the group that received the facial skincare. Only the first term was related to an elevated score in the case of the reference group while staying statistically significantly lower than the treated group. In comparison, a low score was observed for the item « awakening » in both groups, without a statistically significant difference between them. The terms « sensual », « tender », and « fun » were under the average score. However, their scores were statistically significantly higher in the treated group than in the group that rested. The item « self-esteem » was also under the average score; however, the difference between both groups was not statistically significant. Finally, when all the scores were gathered in the graph dispatching the positive emotions proposed by the EmoChar, a greater overlap was observed from the profile displayed by the treated group.

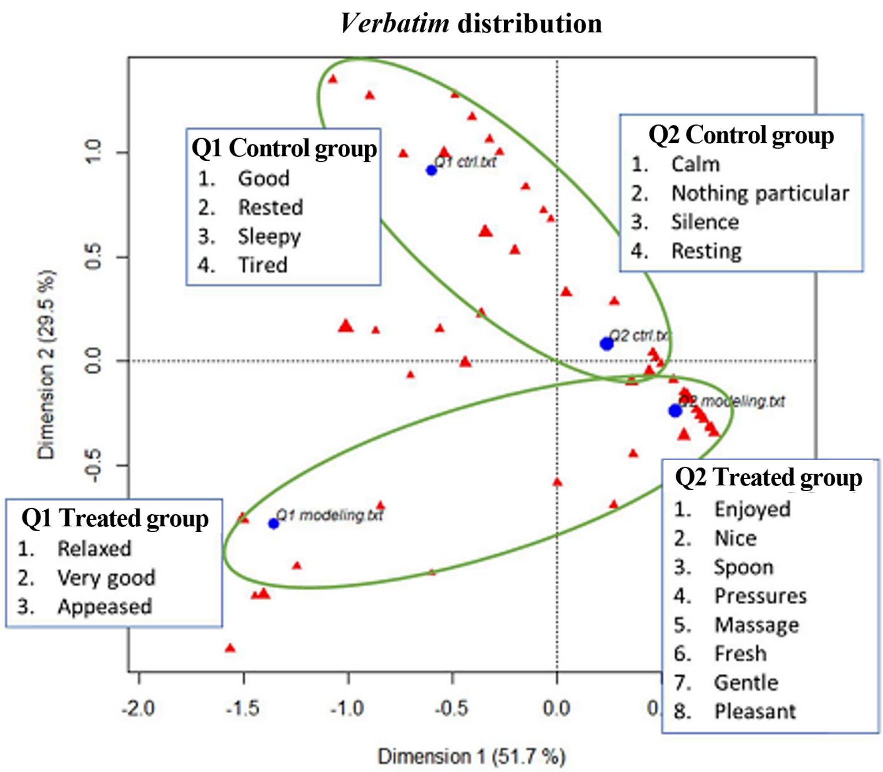
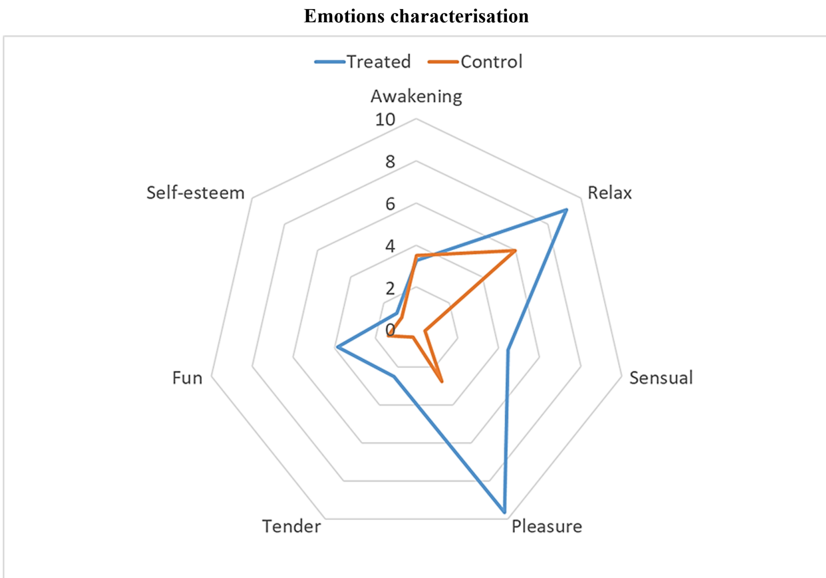


FIGURE 6 Semantic analysis after both experimental sessions. The *verbatim* distribution is represented as a factorial analysis of correspondence after asking two questions following both sessions. The first question (Q1) asked was 'How are you feeling now?' and the second (Q2) was 'What did you like during this relaxation phase?'. Verbal corpuses corresponding to the two questions are represented as blue dots, and the distribution of main specific terms according to the two main dimensions are represented as red triangles. Boxes list the specific terms in order of statistical significance ($p < 0.05$), and green ellipses illustrate the semantic space associated with each group of participants. The specificity of each *verbatim* can be understood from the specific terms listed in corresponding boxes, revealing notably a more positive state after the facial skincare compared to the rest period within the same duration.



	Awakening	Relax	Sensual	Pleasure	Tender	Fun	Self-esteem
Treated	3,26	9,13	4,45	9,68	2,48	3,84	1,19
Control	3,52	6,01	0,40	2,76	0,41	1,36	0,89
p	NS	**	***	***	**	**	NS

FIGURE 7 Discrete emotions characterization. Verbal and non-verbal cues were collected to assign a score to different positive emotions perceived after both experimental sessions. A high score for the term « relax » and a low score for the term « awakening » were determined in both conditions. However, the relaxation perceived was 1.5 fold more important for the treated group than the reference group. The superiority associated with the perception of positive emotions was also observed in other terms, such as « sensual », « tender », and « fun ». A statistically significant difference was observed for all terms, except the terms « awakening » and « self-esteem ». ** significant ($p < 0.01$), *** significant ($p < 0.001$), NS, not significant.

DISCUSSION

According to the WHO, well-being is complex because it covers multiple dimensions [38]. It must be noted that well-being has two components [9, 39]. First is the hedonic aspect, where well-being is considered to be the emotional tone of the subject as he experiences it immediately, without self-reflection or self-conception. Second is the eudemonic aspect, which results from a self-reflective and representational process, as it involves the judgement made by the subject about his self-achievement. In the case of facial skincare, it is the first aspect of well-being that is mostly experienced because it affects the feeling of a person subject to a punctual pleasant emotion [40].

However, emotional well-being is not a one-dimensional state, and it is a complex phenomenon that manifests itself through three forms of expression: verbal, non-verbal, and physiological [41]. Therefore, combining different measures from these three components is necessary to achieve a reliable inference of emotional well-being. If the first two components are widely evaluated in the cosmetic field [42], investigations on the physiological dimension will be rarer. This study is original because it deciphers the fingerprint of a facial skincare experience on these three dimensions of emotional well-being. Furthermore, since the physiological well-being induced by facial skincare is closely linked to a soothing effect, it was interesting to compare its profile with that of a biological reference, such as the resting state.

Emotion results from the communication between neurons within our brains, and this communication induces brainwaves by producing synchronized electrical pulses, which can be detected using EEG. Schematically, Alpha brainwaves reflect the deactivated state of the nervous system, while Beta brainwaves dominate during its state of activity. Alpha to Beta brainwaves power ratio is commonly used because its increase is associated with a rising state of relaxation [43]. Our measurements demonstrated a higher capacity of facial skincare to induce cerebral relaxation compared to a resting period. These results contradict those of Jodo et al., [17] who reported the absence of statistically significant differences in brainwave recordings between these two conditions. This discrepancy led us to investigate another nervous activity to define the neurophysiological profile of these two types of relaxation.

HRV refers to fluctuations in the duration of the interval between heartbeats at a millisecond scale, which allows us to infer the influence of both orthosympathetic and parasympathetic nervous branches on cardiac activity [28]. One of its markers involves the frequency parameters. Schematically, the low-frequency component of the HRV reflects the influence of both sympathetic branches. In contrast, the high-frequency component provides information on the activity of the parasympathetic pathway. It must be noted that the diminution of the LF/HF ratio is associated with improving the state of relaxation. Compared with a resting period, our results showed a significantly greater decrease in these frequency parameters of the HRV after facial skincare, indicating its superiority in triggering the parasympathetic influence on cardiac activity. Similarly, facial skincare reduced muscular and respiratory activity significantly more than the resting period. Knowing that the parasympathetic action is physiologically responsible for the diminution of activity in these organs, these results corroborate the superiority of facial skincare in enhancing the influence of this nervous branch on physiological relaxation compared to a resting period within the same duration. These data contradict those of Hatayama et al., [18] who observed a reduced parasympathetic influence after facial skincare, reflecting cardiac stimulation rather than relaxation. However, our findings align more with recent studies on a head massage compared to a resting period. They concluded that both conditions increased physiological relaxation using HRV measurements, while the head massage had a significantly higher effect [44]. This led us to question the possible mechanisms involved in the induction of relaxation in such a cosmetic context. The superiority of facial skincare over rest could be attributed to the direct effect of massage in generating a shift from orthosympathetic activity to parasympathetic activity [45]. However, this is not the only difference observed with the resting state condition. Indeed, a psychological aspect should be considered, given the distinct emotional profile obtained from both experimental groups.

The results derived from the verbal analysis were correlated to those obtained from non-verbal evaluation, as the valence and arousal measured from the voice were comparable to the feelings verbally expressed. The emotion assessed using the verbal and non-verbal analyses reflects the perception of relaxation both after the facial skincare and the resting period. However, the evaluation of the prosody indicated that the magnitude of the perceived relaxation was higher in the group that received the facial skincare. Moreover, the semantic analysis enables us to specify the nature of this perceived relaxation. This perception was associated with pleasure for the treated group, while it was associated with calmness for the group that rested. Therefore, the *verbatim* produced by the two groups revealed that the relaxation induced by the facial skincare was perceived with positive emotions, while that induced by rest tended towards neutral emotions. The EmoChar tool combines verbal and non-verbal assessments and supports both previous analyses. Contrary to the case of a rest period, the relaxation induced by facial skincare was strongly associated with pleasure and other positive terms such as « sensual », « tender », and « fun, » even with a more modest magnitude. These latter observations question the contributive part of positive emotions in the level of physiological relaxation compared to their absence. Indeed, the cardiac, respiratory, and muscular relaxations induced by facial skincare were 13%, 12%, and 17% higher, respectively, than the relaxation induced by the resting period. This superiority increased to 42% in the case of cerebral relaxation. Therefore, heterogeneity between the results was observed for cerebral relaxation on the one hand and the relaxation for the other organs on the other hand. It is consequently possible that the difference in the kind of emotions induced by the two different procedures (facial skincare versus rest) could explain the heterogeneity of the physiological differences when comparing both experimental conditions. Since the brain is the seat of emotion, it is legitimate to consider the involvement of positive emotions in its relaxation, which may enhance the parasympathetic activity, thereby contributing to greater relaxation of targeted organs.

We prevented olfactory interference as an influencing factor in this study. As previously described, the sense of smell influences human electrophysiological and psychological activities [46, 47]. However, cosmetic products used during the facial skincare session were devoid of any synthetic fragrance. Another possibility is that physiological relaxation may have started earlier during the facial skincare than during the resting period. In fact, in the first case, a quicker shift in the participant's mood from the initial state of mind to a state more favourable to relaxation could be expected. Indeed, our preliminary study showed an increase in parasympathetic control over cardiac activity within the first 5 min of facial skincare (data not shown). However, these considerations are speculative and await further experimental investigations.

There are several limitations related to the scientific coverage of the impact of positive emotions on ANS [14]. One of them pointed out the lack of gathering multiple physiological measures, preventing the observation of a specific ANS activity. Indeed, the collection of data from different targeted organs allows us to look at how these positive emotions modulate the ANS, beyond simply knowing if it is the case. This study is the first to highlight the specific signature of well-being induced by facial skincare by establishing an extensive physiological profile, completed with its emotional characterization. We hope this work will pave the way to deciphering the physiological and emotional mechanisms, and the non-pathological markers involved in well-being associated with the cosmetic procedure.

CONCLUSION

Our results have shown that facial skincare has both physiological and psychological benefits which are two cardinal components of hedonic well-being. Although transient, facial skincare modulates parasympathetic activity, which leads to physiological relaxation. This neuromodulation is potentially enhanced by positive emotions induced by facial skincare. In addition, this study provides insights into the specific profile of well-being induced by facial skincare compared to the one induced by a biological reference represented by the resting period.

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CONFLICT OF INTEREST STATEMENT

The funder provided the cosmetic products and facial skincare. The funder did not play any role in data collection and analysis. The decision to publish was decided between the funder and all the partners.

ORCID

Sara Bouhout https://orcid.org/0000-0001-9853-987X

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