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Qualification of an automated device to objectively assess the effect of hair care products on hair shine

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Synopsis

The authors developed and qualified an automated routine screening tool to quantify hair shine. This tool is able to separately record individual properties of hair shine such as specular reflection and multiple reflection, as well as additional features such as sparkle, parallelism of hair fibers, and hair color, which strongly affect the subjective ranking by individual readers. A side-by-side comparison of different hair care and styling products with regard to hair shine using the automated screening tool in parallel with standard panel assessment showed that the automated system provides an almost identical ranking and the same statistical significances as the panel assessment. Provided stringent stratification of hair fibers for color and parallelism, the automated tool competes favorably with panel assessments of hair shine. In this case, data generated with the opsira Shine-Box are clearly superior over data generated by panel assessment in terms of reliability and repeatability, workload and time consumption, and sensitivity and specificity to detect differences after shampoo, conditioner, and leave-in treatment. The automated tool is therefore well suited to replace standard panel assessments in claim support, at least as a screening tool. A further advantage of the automated system over panel assessments is the fact that absolute numeric values are generated for a given hair care product, whereas panel assessments can only give rankings of a series of hair care products included in the same study. Thus, the absolute numeric data generated with the automated system allow comparison of hair care products between studies or at different time points after treatment.

INTRODUCTION

The appearance of hair is determined by the way the hair surface and hair body reflect incident light (1,2). Consumers subjectively take hair shine as a sign of health and beauty. It is therefore of pivotal importance for hair care products to bring hair into a shiny state after treatment. A lot of effort has been put in the past into the development of methods to quantify hair shine, but none of them has yet been able to reflect the consumer's subjective perception properly. The central problem in this case is that hair shine is a complex

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feature composed of several properties such as specular reflection, multiple reflection, sparkle, parallelism of hair fibers, and hair color.

Up to now, hair care products have to be evaluated for their hair shine-promoting properties in time- and resource-intensive panel studies by experienced panelists. Such panel studies provide only relative results, i.e., rankings of the investigated products within a study, which make the comparison of different studies with different products almost impossible. Thus, to make comparison of products across studies possible, an objective quantitative measure of hair shine is required. Furthermore, to be suitable for cosmetic development, any automated quantitative physical method of measuring hair shine has to correlate with panel assessments. This claim can only be met if all properties of hair shine are covered and integrated by an automated physical method.

The authors have developed a new automated tool to quantify hair shine, which records all of the five above-mentioned properties of hair shine separately in a single run. The new tool makes an approximation of automated physical assessments to panel-based rankings of hair shine feasible. This is achieved by the fine tuning of the physical assessments to correlate with panel assessments through individual weighting of the different properties of hair shine.

MATERIAL AND METHODS

HAIR

Commercially available hair tresses of different ethnic origin and color were used. The tresses had a net hair weight of 4.5 g, a total length of 23 cm, and a width of 3 cm. Before application of the test products, the tresses were cleaned by wetting with cold tap water for 15 min and gently washing with a standard shampoo (50% SDS, 1% NaCl, 0.4% sodium benzoate, 0.1% citric acid, and 48.5% distilled water) for 1 min, followed by rinsing with lukewarm tap water for 2 min. To apply test products, 0.2 ml per gram of hair of the respective test products was rubbed in for 1 min, and all rinse-off products were then removed by rinsing the hair strips with lukewarm tap water for 2 min. Subsequently the hair tresses were combed until all knots or fiber crossings were removed. The tresses were then mounted on special carriers, taking care of the parallelism of hair fibers, and equipped with a special slit aperture to avoid reflections from the carrier (Figure 1B).

INSTRUMENTATION FOR HAIR SHINE MEASUREMENT

A newly developed recording device (denoted “opsira Shine-Box”; see Figure 1A) was developed by the authors in cooperation with opsira GmbH, Weingarten, Germany, and Display Metrology & Systems, Karlsruhe, Germany. This device is able to assess multiple components of hair shine in parallel, encompassing specular and diffuse reflection; half-width of specular reflection; sparkle; hair color; and parallelism of hair fibers using the software tool *luca′tool* developed by opsira GmbH. The core detector system of the opsira Shine-Box, the recording camera, is a state-of-the-art and high-grade CCD luminance measurement camera, called *luca,* with a 12-Bit grey-level dynamic. The grey-level dynamic can be expanded by taking several measurements at different exposure times to up to 18 Bit. To reduce thermal noise and thus to improve the data quality, a thermoelectric

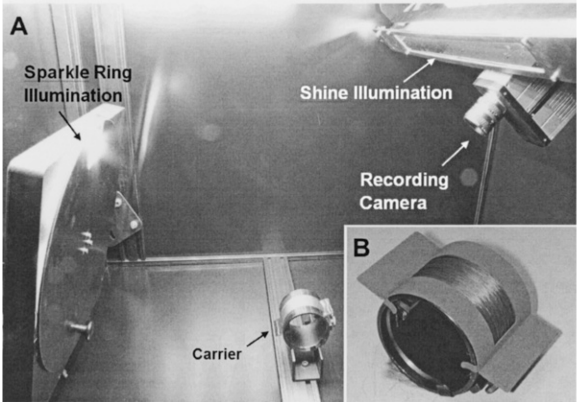

Figure 1. (A) Setup of the Shine-Box with carrier. (B) Details of mounted hair tress on carrier with slit aperture.

cooled CCD camera is used. A further system add-on, called luca.color, enables the mounting of up to ten arbitary different filters between the lens and the camera chip in a motorized filter wheel. The filter wheel can be equipped with color but also with polarization filters. In the opsira Shine-Box setup, the camera is equipped with color filters to be able to measure according to the CIE color-matching functions x(λ), y(λ), and z(λ) to gather the color of the hair tresses. It is also equipped with a horizontal and a vertical polarizer to separate the reflected light coming from the hair into the polarization components. All filters are positioned during one measurement procedure automatically by the operating software of the opsira Shine-Box. To realize the polarization analysis it is also necessary to illuminate by polarized light. This is done by a fixed polarizer in front of the thin and long shine illumination light source. The sparkle illumination is realized with a toroidal fluorescence light source equipped with a motorized ring cover plate blocking 340 degrees of the light source. By the remaining and rotating aperture of 20 degrees, different incident angles to the hair tresses can be adjusted to measure the angular life time and thus the sparkle. The system "opsira Shine-Box" is commercialized by opsira GmbH, Leibnizstrasse 20, D-88250 Weingarten, Germany, (www.opsira.com).

RECORDING PARAMETERS

Objective shine value. On illumination an individual hair either reflects light directly on its surface (surface reflection) or the light enters into the hair and is reflected at the second hair surface (transmission - reflection – transmission, TRT). The light reflected at the first hair surface retains its original optical properties (spectral composition = color, state of polarization) (3), whereas the transmitted and reflected light changes both its spectrum (color) due to absorption effects—mostly via melanin (see Figure 2) and its state of polarization (depolarization inside the hair). In the newly developed device the reflection properties of hair tresses mounted on the cylindrical carrier are recorded using a horizontally polarized light source. To separate first-surface from second-surface reflection, one picture is recorded with a horizontally positioned polarization filter (polarized first-surface component = specular) and one picture is recorded with a vertically positioned polarization filter (depolarized second-surface component = diffuse).

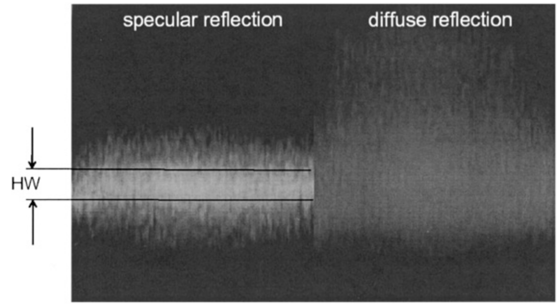

Figure 2. Specular and diffuse reflection of a human hair mounted on the carrier of the Shine-Box. HW denotes the half width of specular reflection, or more precisely, full width at half maximum.

The reflective properties of surfaces are most generally and completely described by the bi-directional reflectance distribution function (BRDF), which is a function of the direction of light incidence, the direction of observation, the wavelength of light, and its state of polarization. Assessment and evaluation of the reflective properties of surfaces can be realized (usually) by motorized scanning of a range of observation directions with a photometric or spectroradiometric receiver for one direction of light incidence. This can be done with complex and bulky high-precision mechanisms called goniophotometers or goniospectroradiometers. An alternative way of scanning the directions of observation without moving parts, which is also realized in the opsira Shine-Box, is given by analysis of the spreading of a point or line source of illumination. The variation of the scattering properties of a flexible specimen with an angle of observation within a fixed plane of observation (in-plane BRDF) can most conveniently be evaluated in a cylindrical geometry (as used in the opsira Shine-Box, see Figure 1B) by analysis of the spread of a linear illumination source. In that configuration, the angle of light incidence and the angle of observation both vary with their position on the circumference of the cylinder, thus generating a wide range of angles between incident and reflected light beams. As a consequence, this cylindrical geometry can be used to evaluate the in-plane BRDF of a roll of hair fibers in one single image of an adequaltely calibrated camera (imaging photometer or colorimeter). From such images, e.g., the sheen (luster) of the hair can be determined, or with some modifications in the geometry of illumination, other characteristics like sparkle can also be measured and evaluated. Using BRDF, it is also possible to determine the half width (HW), or more precisely, *full width at half maximum,* of specular reflection (Figure 2).

The objective shine value or luster (L) is characterized by the equation of Reich/Robbins (4) as

$$L = \frac{RS \times HW_{standard}}{RD \times HW_{specular}} \quad \text{(Eq. 1)}$$

where

- RS is the integrated intensity of specular reflection
- RD is the integrated intensity of diffuse reflection
- $HW_{standard}$ is the half width of an optimally reflecting area (representing the carrier without mounted hair tresses
- $HW_{specular}$ is the half width of specular reflection of the mounted hair tress

Thus, the higher the contrast between specular reflection and its background (i.e., the lower diffuse reflection and the half width of specular reflection), the higher the shine value. By inclusion of the standard half width of a black metal cylinder into the above equation, the calculated objective shine value L has no dimension.

Objective sparkle value. Sparkle effects are characterized by a short *angular lifetime.* The sparkle effect results from a total reflection of the incident light within the hair fiber in the direction of the observer, who perceives this light as a bright spot. The effect strongly depends on the angle of the incident light, the actual geometry of the hair, and the position of the observer. Therefore, hair seems to sparkle due to the movement of the head or the observer. Since dark hair absorbs most of the incident light, sparkle is most prominent with blond hair and contributes to the subjective perception of hair shine.

In the opsira Shine-Box, sparkle is quantified by illuminating hair tresses via a segment of a ring illumination device (see Figure 1A) from slightly different angles (±5.6° and ±2.8°) and recording pictures for each individual illumination angle. According to the definition of sparkle, a sparkle spot must only occur under one illumination angle. To identify sparkle spots using the opsira Shine-Box, means and standard deviations of intensities of corresponding pixels from four pictures (taken under different illumination angles) are calculated, and sparkle spots are defined as pixels with a very high standard deviation (i.e., exceeding a defined threshold of standard deviation). The number of sparkle spots is counted for each individual hair tress and makes up the sparkle value. A typical series of four pictures and the calculated results picture are shown in Figure 3.

Parallelism. To allow an accurate determination of shine and sparkle, a hair tress to be evaluated has to be well combed and parallel. Using the opsira Shine-Box, parallelism is routinely assessed as a quality control, and tresses with insufficient parallelism are excluded from analysis until better parallelism is gained by additional combing. Under ideal conditions of a perfectly cylindrical body (e.g., the carrier without a mounted hair tress), the vertical intensity distribution follows a bell-shaped distribution, and the horizontal intensity distribution at a given position has a constant value. This horizontal and vertical distribution pattern changes when the surface is altered, e.g., by mounting a hair tress on the carrier. To quantify the parallelism of a given hair tress mounted on the carrier, the entire object is divided into a defined number of vertical columns. At each position in a given row, the average horizontal intensity is calculated (Figure 4). Averaging is done to not give individual hairs in a given row too big a weight. In an ideally combed tress, the vertical distribution of the average horizontal intensities of all rows should be identical. In contrast to this, the vertical distribution of uncombed tresses can be expected to be different in each individual row. The variance of intensity distribution between individual rows contains the information about the parallelism and quality of combing.

RESULTS

HAIR SHINE

Correlation of objective shine values with subjective panel results. According to the equation of Reich/Robbins (eq. 1), the objective shine value can be increased by increasing the integrated intensity of specular reflection (RS) in the numerator of the fraction, or by decreasing

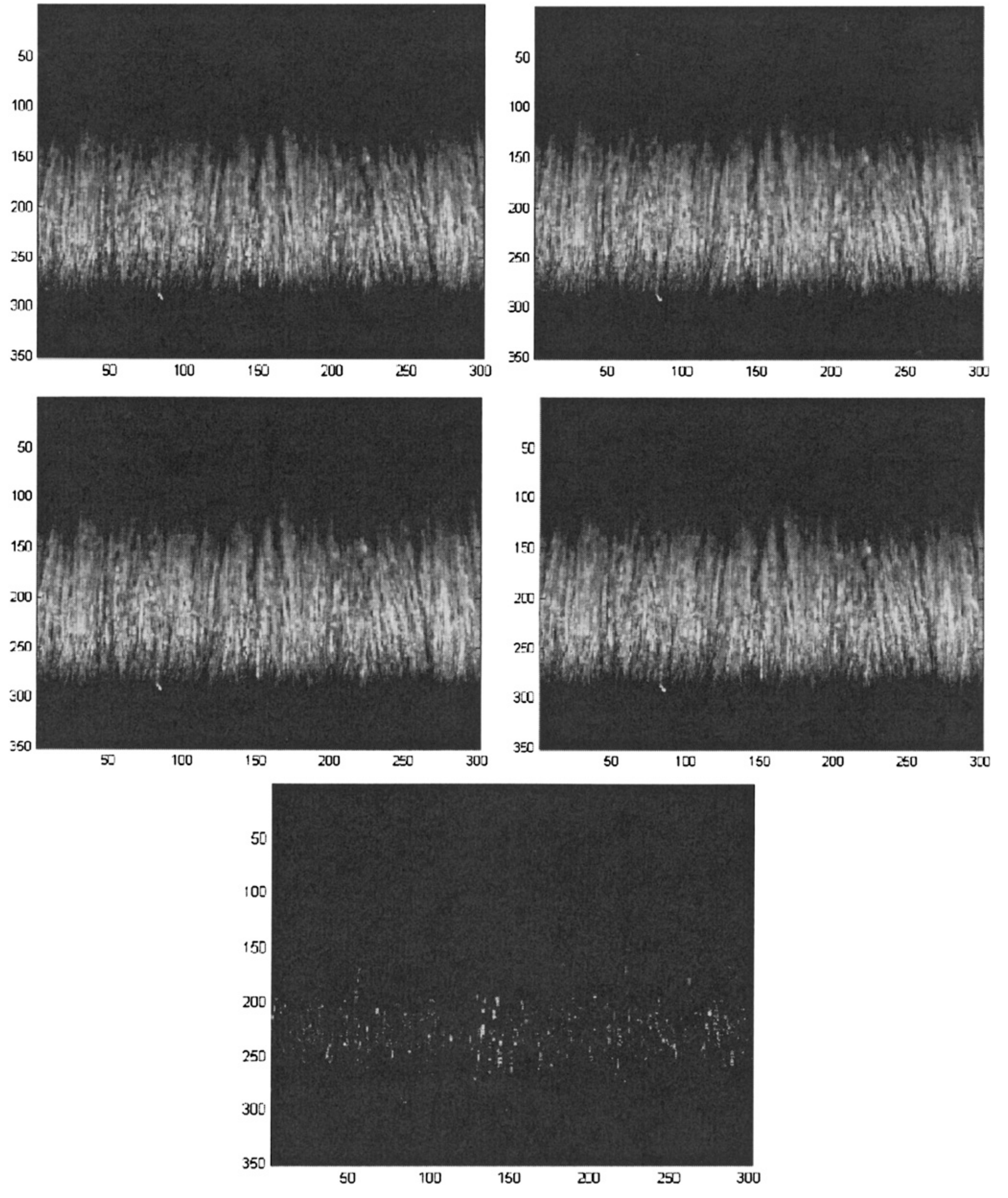

Figure 3. Determination of sparkle. The upper four photographs show the absolute intensities recorded for the same hair tress under four slightly different incident angles. The lower picture shows the standard deviations of the means of all individual pixels from the upper four pictures.

either the integrated intensity of diffuse reflection (RD) or the half width of specular reflection of the mounted hair tress ($HW_{specular}$) in the denominator of the fraction. Figure 5 shows the increase of the objective shine value achieved with a leave-in hair care product (care and style treatment) on blond hair tresses, as well as the effect of treatment on the single components—half width of specular reflection, integral specular reflection, and integral diffuse reflection—that make up the objective shine value according to

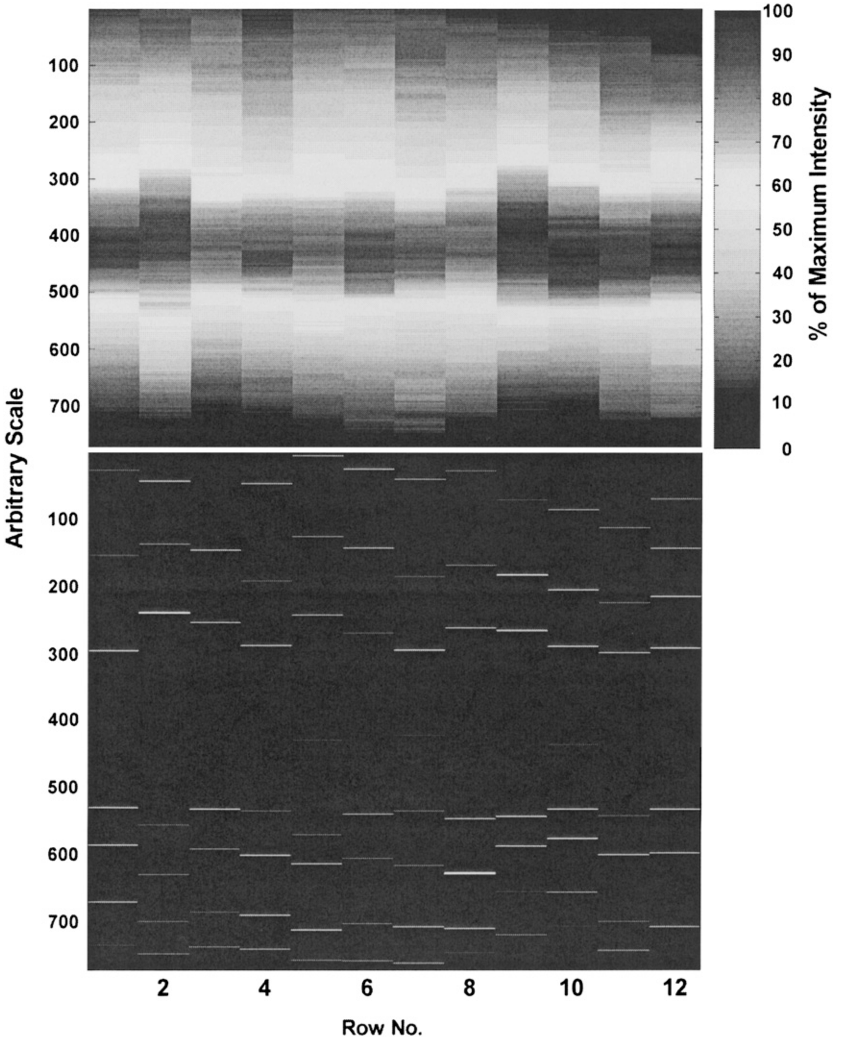

Figure 4. Determination of combing values. To quantify the parallelism of a given hair tress, the entire object is divided into a defined number of vertical rows. At each position on a given row, the average horizontal intensity is calculated (upper panel). To assign a combing value to a given hair tress, vertical positions of iso-intensities (100%, 66%, 50%, 33%, and 25% of maximum intensity) of each individual row are determined (lower panel), and the means ± SDs of vertical position numbers for the respective iso-intensities from all rows are calculated. The combing value is determined as the mean of all standard deviations of the respective iso-intensities. The lower this value, the higher the parallelism of the hair fibers.

Reich/Robbins equation. The increase of the objective shine value in this case is mainly achieved by a reduction (-22%) of the half width of specular reflection ($HW_{specular}$). This is accompanied by a slight reduction (-12%) of the integral specular reflection (RS), which itself is more than compensated by a substantial decrease (-31%) of the integral diffuse reflection (RD). In total, these changes add up to an increase in the objective shine value of 50%.

The appropriateness of the equation of Reich/Robbins (eq. 1) has been correlated with eye-tracking investigations (5) of panelists assessing the shine of hair tresses mounted on

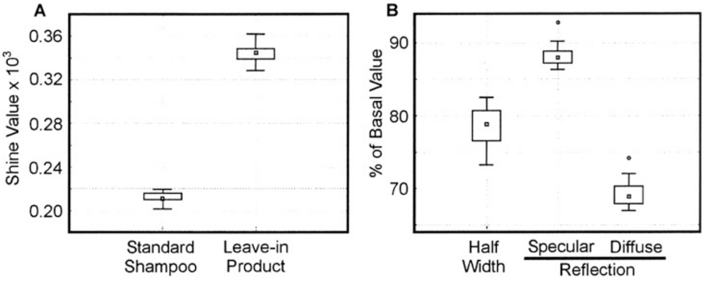

Figure 5. Increase in the objective shine value achieved with a leave-in hair care product on blond hair tresses (A), as well as the effect of treatment on the single components' half-width of specular reflection, integral specular reflection, and integral diffuse reflection (B).

the carrier device. The equation defines that the higher the contrast between specular reflection and its background, the higher the objective shine value. In fact, the eye-tracking data clearly demonstrate that panelists also preferentially focused on the area of highest contrast, i.e., the borders of the specular reflection (data not shown). Thus, objective shine values calculated using the shine box, and subjective rankings of shine made by panelists, are mainly determined by contrast properties around the area of specular reflection.

Panel studies of hair care products can only give ranking results, comparing subjectively one product with another. As a consequence, although measurement of hair shine using the opsira Shine-Box gives quantitative parametric values, comparison of both methods is restricted to rankings. Among nine studies conducted side-by-side using panel assessment of hair care products (≥3 products tested, 2 tresses per product, 30 panelists each) and assessment using the Shine-Box, seven studies gave exactly the same ranking with both methods. An example of the results of one such study is given in Figure 6. In two studies the ranking of two products was different with both methods. Taking panel

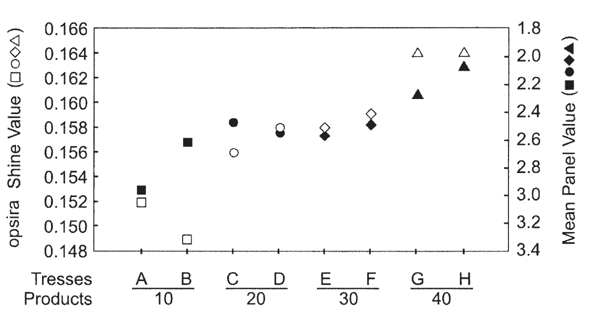

Figure 6. Correlation of objective shine values determined by the opsira Shine-Box and subjective shine values from panelist rankings. Peroxide-bleached hair tresses treated with different shampoos (two tresses per hair care product; four shampoos in total) were assessed side-by-side using the opsira Shine-Box and a panel of 25 independent raters. In the panelist assessment, the tresses were presented in a randomized pair-wise order to the raters. Each tress was presented in different combinations with other tresses at least three times. Mean panel values depicted in the upper and lower panel were derived from the overall rankings. In the case of shine values determined by the opsira Shine-Box, high numeric values represent a higher objective shine. In contrast, higher numeric values of the mean panel values represent a lower subjective shine.

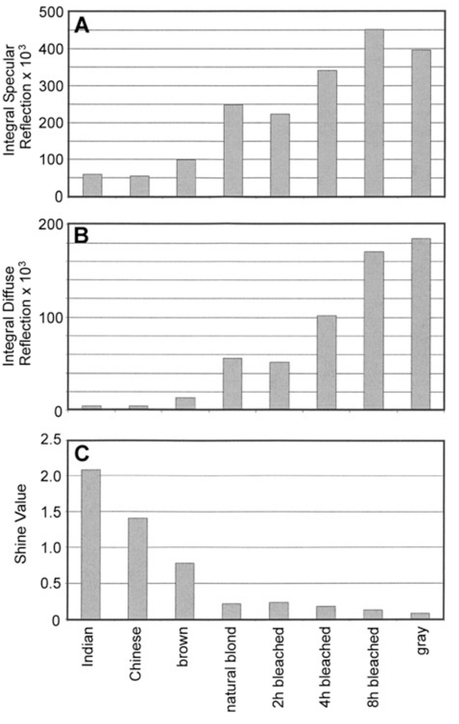

Figure 7. Basal objective hair shine values of hair tresses of different ethnic origin and color. (A,B) Specular and diffuse integral reflection values of hair tresses of different ethnic origin and color. (C) Calculated objective shine values (luster) using the equation of Reich/Robbins.

assessment as the standard of reference, the accuracy of the opsira Shine-Box assessment is >75%. Thus, there is a good agreement between both methods.

Effect of hair color on the objective shine value. To assess the need for stratification on hair color, basal objective hair shine values were determined using hair tresses of different ethnic origin and color. As shown in Figure 7, both components of objective hair shine—specular and diffuse reflection—behave differently depending on the ethnic origin and color of the hair tress investigated. As a general rule, the blonder the hair the better incident light is reflected, resulting in a higher specular component of reflection (Figure 7A). In the same way, blond hair absorbs less light inside the hair, also resulting in higher diffuse reflection as compared with dark hair (Figure 7B). When calculating the objective shine value or luster (L) using the equation of Reich/Robbins (eq. 1), the high specular reflection of blonde hair is more than compensated by the corresponding diffuse reflection, resulting in generally higher objective shine values of dark hair (Figure 7C). Stratification of hair color is therefore a prerequisite to obtain comparable objective shine values in a series of measurements.

Objective shine values are generally higher when using dark hair. In addition to this, the dynamic range achieved by the application of a shampoo is much better with brown hair. As shown in Figure 8, substantial additional effects of shampoos on objective hair shine are seen with brown hair. In contrast, a smaller dynamic range in terms of hair shine is seen with the same hair care products on blond hair. As a consequence, stratification of

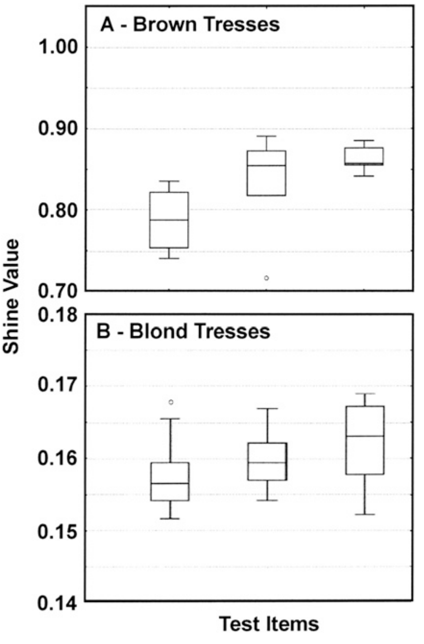

Figure 8. Dynamic range of the change in objective hair shine values of brown (A) and blond (B) hair tresses treated with different hair care products. Brown hair tresses provide a sufficient dynamic range to assess shine-promoting properties of hair care products.

hair color is indispensable for automated assessment of hair care products regarding their effects on hair shine. Brown hair tresses or other tresses that have not been aggressively bleached are the test material of choice in this regard.

Effect of combing on the objective shine value. To assess the effect of parallelism (combing) of hair tresses on the determination of objective shine values using the opsira Shine-Box, the same tresses were mounted on the carrier with different degrees of parallelism. A comparison of recorded shine values and the corresponding combing values shows that the higher the objective shine value the better the parallelism of the analyzed hair tress (data not shown). As a consequence, to assure comparability of results between hair care products, hair tresses have to be excluded from analysis when a sufficient degree of parallelism is not given. In such cases the hair tress has to be recombed until sufficient parallelism is gained.

Reproducibility and sensitivity of objective shine values. Provided a tress is well combed, repeated measurement of shine values at a defined position on a hair tress results in variances of only 0.3–1%. In contrast, measurement at different positions on a well-combed tress may result in in variances of up to 5%, and with leave-in products that cannot be distributed homogeneously over the hair tress, the respective variability may be up to 8% (data not shown). As a consequence, to increase the robustness of measurement, the objective shine value of a hair tress is determined by averaging shine values determined at three or four different positions on a given hair tress. The variability of this averaged objective shine value is approximately 1% in repeated measurements, even if different positions on the hair tress are evaluated in repeat measurements.

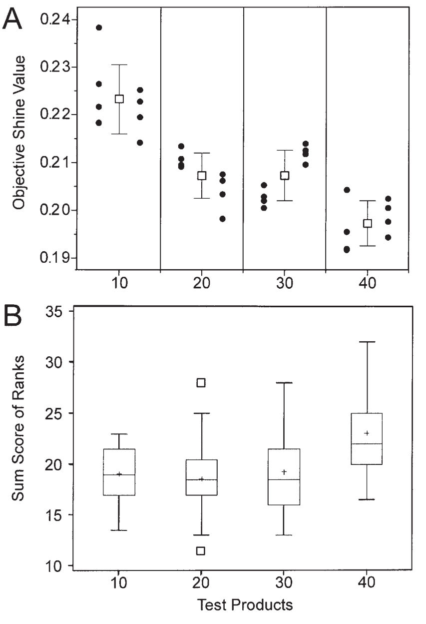

Figure 9. Reproducibility and sensitivity of the assessment of hair shine using the opsira Shine-Box. Hair shine was determined for two individual tresses each per test product (conditioners denoted 10 to 40—rinse-off). (A) Individual objective shine values determined at four different sites per tress (closed circles) as well as the mean ± SD from all eight data points (open squares). Higher values mean better hair shine in this case. (B) Corresponding sum scores of ranks determined for the same treated tresses by 30 independent panelists. Lower sum scores mean better hair shine in this case.

Figure 9 shows data from a side-by-side comparison of four different rinse-off conditioners (denoted 10 to 40) assessed for hair shine using the opsira Shine-Box (Figure 9A) as well as the corresponding ranking results obtained by 30 independent panelists (Figure 9B). It is clearly visible from the picture that two different tresses may give different average shine values, although treated with the same product. There is, furthermore, some scatter of shine values for each individual tress, depending on the site of measurement. Nevertheless, the standard deviation of the mean from all measurements (4 sites per tress × 2 tresses) is rather low, allowing a clear distinction of mean objective shine values generated with different hair care products (high sensitivity). In contrast, the corresponding subjective assessment of the same tresses and test products by panelists gives a similar ranking of hair shine, although with a substantially lower sensitivity.

HAIR SPARKLE

Effect of hair color on the objective sparkle value. To assess the need for stratification of hair color for the assessment of objective sparkle values using the opsira Shine-Box, basal sparkle values were determined using hair tresses of different ethnic origin and color. As shown in Figure 10, hair color has a strong impact on objective sparkle values. In this case, objective sparkle values, as determined using the opsira Shine-Box, are lower as the analyzed hair is darker. Thus, stratification of hair color is essential to produce reliable results and to assure comparability of results between studies.

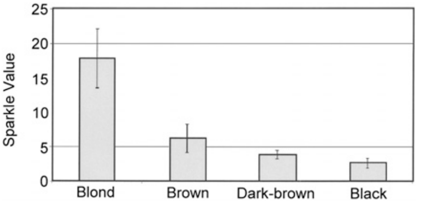

Figure 10. Basal sparkle values determined using the opsira Shine-Box for hair tresses of different ethnic origin and color.

Dynamic range of objective sparkle measurement. The sparkle value of a given hair tress is mainly determined by the geometry of the hair fibers. Therefore, the sparkle value is not substantially changed by a hair care product unless it produces new sparkle spots on the hair fibers. This is normally seen with leave-in products containing glitter particles and also with hair sprays leaving small reflecting droplets on the hair fibers. Most other conventional hair care products have no effects on the objective sparkle value. Figure 11A shows sparkle values of blond hair tresses treated either with a standard leave-in and rinse-off hair care product or a leave-in product containing glitter particles. An increase of the sparkle value is seen only with the product containing the glitter particles. Figure 11C shows sparkle values of blond hair tresses before and after treatment with different styling sprays. In each case, the application of the hair spray led to a significant increase in the objective sparkle value determined with the opsira Shine-Box.

Repetition of sparkle measurements at the same position on a given hair tress may lead to variances of up to 15%. This is most likely due to the fact that even minute changes in the relative position of the circular light source, which cannot be avoided when remounting a carrier, can have profound effects on the resulting sparkle values. The variance of repeated measurements at the same position on a given hair tress is in the same order of magnitude as the variance resulting from sparkle measurements at different positions on a hair tress. Despite this rather high variance, differences in objective sparkle values before and after treatment with certain leave-in products and hair sprays are still high enough to reach a level of significance.

DISCUSSION

The subjective impression of hair shine is composed of several components such as specular and diffuse reflection, as well as additional features such as color, sparkle, and parallelism of hair fibers. All these components are integrated and interpreted by an experienced panelist making his subjective assessment of hair shine. We developed and qualified an automated routine screening tool—the opsira Shine-Box—to detect and quantify differences in hair shine following treatment with hair care (shampoo and conditioner) and/or styling products. This tool is able to separately record individual properties of hair shine such as specular reflection, diffuse reflection, color, sparkle, and parallelism of hair fibers—all information that would also be used by a panelist to assess hair shine.

Previous approaches to capturing hair shine using instrumental techniques were hampered by the rather low sensitivity and specificity of the methods, even in those published studies including polarization imaging (6). Using these previous methods, significant quantitative differences in hair shine could only be detected and correlated with perceptual

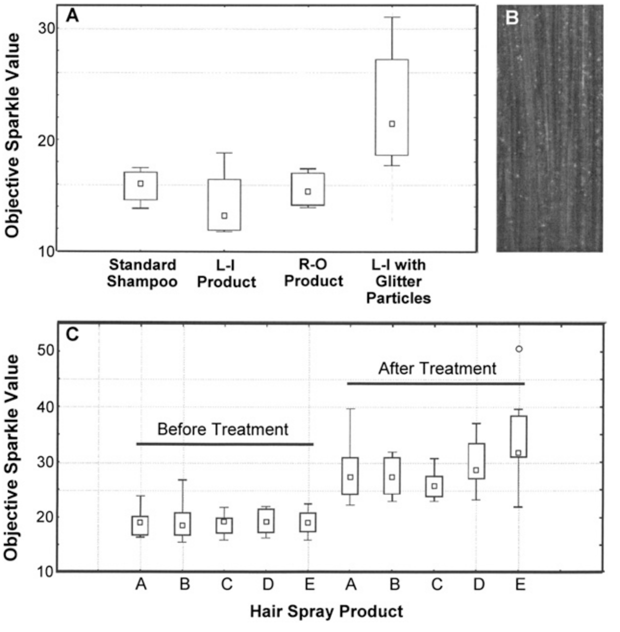

Figure 11. (A) Objective sparkle values determined with the opsira Shine-Box of blond hair tresses treated either with standard leave-in (L-I) and rinse-off (R-O) hair care products as well as a leave-in product containing glitter particles. An increase in the sparkle value is seen only with the product containing the glitter particles. (B) Inset photograph of hair fibers carrying glitter particles after treatment with a leave-in product containing glitter particles. (C) Objective sparkle values of blond hair tresses before and after treatment with different styling sprays.

judgments when comparing extreme situations (e.g., UV-damaged hair with undamaged hair). However, comparisons between undamaged hair before and after use of wash-off products (shampoo and conditioner) were not possible; and even comparisons between undamaged hair before and after use of leave-in styling products were difficult due to the number of samples required to have an 80% probability of resolving the difference with significance (6). Our data using the opsira Shine-Box demonstrate that, with refined physical methods and appropriate stratification, the sensitivity of instrumental techniques to assess hair shine can be substantially increased. In this case, the sensitivity of instrumental techniques to detect differences in hair shine outperforms that of panel assessments and may detect even small differences in hair shine caused by treatment with (wash-off) shampoos, conditioners, and (leave-in) styling products with significance, without losing overall correlation with subjective panel assessments.

To be useful as an analytical tool for the development of hair care products—especially to be employable for claim support—the automated tool has to compete with panel assessments, which are the accepted standard of reference in these cases. Providing stringent stratification of hair fibers for color and parallelism, the automated tool competes favorably with panel assessments of hair shine. In this case, data generated with the Shine-Box are clearly superior to data generated by panel assessment in terms of sensitivity and specificity to detect differences, reliability, and repeatability, as well as workload and time consumption.

The side-by-side comparison of different hair care and styling products with regard to hair shine using the automated screening tool in parallel with standard panel assessment showed that the automated system provides an almost identical ranking and the same statistical significance as the panel assessment. With sufficient stratification of hair tresses, the automated assessment of hair shine could be brought to an excellent correlation with subjective panel assessments. Therefore, the tool is well suited to replace panel assessments for screening purposes during the development phase of hair care products and product claims support.

A further advantage of the automated system over panel assessments is the fact that absolute numeric values are generated for a given hair care product. In contrast, panel assessments can only give rankings of a series of hair care products included in the same study. Thus, the absolute numeric data generated with the automated system allow comparison of hair care products between studies or at different time points after treatment. The latter advantage makes claim supports such as "long lasting shine" much easier than using panel assessments.

The opsira Shine-Box is the first system giving absolute numeric data for hair sparkle and may therefore be employed to support special product claims on increased hair sparkle. However, our data indicate that hair sparkle is mainly determined by the geometry of the hair itself and is not affected by hair care products, unless these products introduce glitter particles onto the hair surface or change the topography of the hair surface (e.g., by hair sprays). Sparkle may increase the subjective impression of hair shine when assessed by panelists, but it has no effect on the determination of the objective absolute shine value determined by the system. As a consequence, certain products producing sparkle effects may require refined algorithms with integrated shine and sparkle values to align the automated results on hair shine with those of panelists.

CONCLUSIONS

We developed and qualified an automated routine screening tool, the opsira Shine-Box, to quantify hair shine. This tool is able to separately record individual properties of hair shine such as specular reflection and multiple reflection, as well as additional features such as sparkle, parallelism of hair fibers, and hair color. A side-by-side comparison of different hair care and styling products with regard to hair shine using the automated screening tool in parallel with standard panel assessment showed that the automated system provides an almost identical ranking and the same statistical significance as the panel assessment. Providing stringent stratification of hair fibers for color and parallelism, the automated tool competes favorably with panel assessments of hair shine. In this case, data generated with the opsira Shine-Box are clearly superior to data generated by panel assessment in terms of reliability and repeatability, workload and time consumption, and sensitivity and specificity to detect differences after shampoo, conditioner, and leave-in treatment. The automated tool is therefore well suited to replace standard panel assessments in claims support, at least as a screening tool.

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