J. Cosmet. Sci., **60,** 111–123 (March/April 2009)

The shine problem in hair: Review of imaging methods and measures for luster

P. D. KAPLAN, K. PARK, J. QI, and K. YANG, *TRI/Princeton*

Synopsis

There is a need for both a better understanding of the technical drivers of shiny appearance in hair and for standard methods and measures of shine. To this end, we develop standard treatment methods for changing hair shine and examine a number of image-based measurements of luster. Using psychophysical techniques to get a perceptual reference, we find that available technical measures are difficult to use when trying to quantify the small changes in shine associated with treatment.

INTRODUCTION

Despite its intuitive simplicity (1,2), and years of research (2,3), the technical measurement of shine remains problematic (4–6). In addition to the technical challenges presented by complex illumination, heterogeneous materials, shape, and roughness, the very nature of the "shine" question can be difficult to describe even when the question is asked within a single restricted application. One way to illustrate the complexity of the question is to see how the question itself changes radically with context. For example, the computer graphics professional needs an answer which will enable the production of a realistic image (2), while the vision neuroscientist hunts for biologically realistic computations, essentially image analysis algorithms, that could possibly be similar to those taking place in the mind of an observer; the coating chemist requires answers which will help in the engineering of a surface that will produce, in the observer, a favorable qualitative judgment. While the shine question for each of these practitioners is related, a successful measurement for the computer graphics community may not be at all useful for the cosmetic scientist.

As cosmetic scientists, we are concerned with the often subtle, optical changes produced by thin, nearly transparent layers of particles and films. In this work we restrict our interest to the shine of straight hair.

Two recent advances motivate us to undertake this work. The first is an improvement in the form of a commercially available, special-purpose polarization-imaging system that should enable computation of shine without requiring much signal processing (7). Second, there is an opportunity to extend recent progress by neuroscientists on the nature of shine to hair as a specific substrate. We find both advances to be intriguing and to advance the state of the art, but we also find through the experimental results presented here, that the goal of capturing essence of shine in hair using instrumental techniques remains elusive.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

Polarized imaging provides a straightforward route to separate specular reflections from diffuse reflection because the diffusely reflected photons are, at least in the limit of multiple scattering, unpolarized. As a result, a pair of images, one formed by photons with polarization parallel to the illumination $I_{\|}$ and one perpendicular $I_{\perp}$ can be used to separate the specular, shine image $I_s = I_{\|} - I_{\perp}$ and the diffuse image $I_d = I_{\perp}$. The formulas published in the literature can then be computed without detailed computations on the angle-dependent reflection curve. We have developed both positive and negative product controls using this imaging system and present an analysis of the sensitivity of the technique for measuring distinctions between hair following different treatments.

The new insight from neuroscience uses a simply-computed quantity, the skew of an image intensity histogram, as a technical surrogate for shine. Beyond computational simplicity, this approach reports to be somewhat color independent, a property that could be particularly useful, given the strong lightness dependence of the currently published technical measures of shine (8) Skew, mathematically the third moment of a distribution, is a measure of asymmetry about the mean. The underlying concept is that one might expect image histograms to be more or less normally distributed in the absence of shine; but the pixels in which shine is visible should be far brighter than the rest. Rather than finding peaks and analyzing the intensity, or the counting shiny, skew incorporates both of intensity and extent in a rationally weighted way that has the virtue of being a neuraly plausible computation for the visual system. Brighter pixels count more, and every pixel brighter than the mean that is not balanced by a similar pixel below the mean contributes to the skew. We examine the dependence of skew and other measures such as the Reich-Robbins formula (4) and the TRI formula (9) on the lightness (L* in L*a*b* space) of hair and find this measure to be intriguing.

One key test of any technical measurement is its ability to predict perceptual judgments. We subject all of these measurements to this test by creating a series of hair damage standards and checking by the perceived differences in shine and measuring technical differences. Our finding is that the perceptual differences are clear and consistent, but that none of the technical measures closely follow the pattern of perception for small changes in shine.

MATERIALS, METHODS AND MEASURES

HAIR

All hair used in this work is blended, straight European hair. A list of colors and their measures are found in Table I. Prior to treatment or damage, hair was pre-treated with a cleansing shampoo.

CARE METHODS

For a simple control, a low dose of phenyltrimethicone (0.0125g/g hair) was applied to the hair tress, spread uniformly down the tress by gentle kneading and air dried.

For the conditioner and 2-in-1 formulations, the hair, was pre-wet, treated with 0.15g product/g hair, massaged for 30 seconds and rinsed for 30 seconds. Water supplied at 37°C, 1.6 gallons/minute.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

Table I
Shine Control Sample Description

Sample name	Description	Base color (L*, a*, b*)	Treatment
VU	Virgin	28.2, 5.3, 7.3	Untreated
VP+	Virgin	26.5, 5.4, 7, 9	Phenyltrimethicone
V2:1	Virgin		2:1 Shampoo
VXM	Virgin		Heavy moisturizer
VLI	Virgin		Leave-in conditioner
BU	Bleached	42.9, 10.2, 21.2	Untreated
BP+	Bleached	40.6, 10.7, 21.1	Phenyltrimethicone
B2:1	Bleached		2:1 Shampoo
BXM	Bleached		Heavy moisturizer
BLI	Bleached		Leave-in conditioner

For the negative control, a leave-in product, was not rinsed. All hair tresses were air dried in a conditioned room overnight (21°C and 65% RH).

CARE MATERIALS

The extra moisturizing conditioner is a marketed product with the following ingredient list: water, stearyl alcohol, cyclopenta siloxane, cetyl alcohol, stearamidopropyl dimethylamine, dimethicone, *Vanilla planifolia* fruit extract, *Cocos nucifera* milk (coconut), fragrance, glutamic acid, benzyl alcohol, EDTA, methylchloroisothiazolinone, methylisothiazolinone, citric acid, and Blue 1.

The 2-in-1 shampoo is a marketed product with the following ingredient list: water, ammonium lauryl sulfate, ammonium laureth sulfate, glycol distearate, cocamide MEA, dimethicone, ammonium xylenesulfonate, citric acid, fragrance, panthenol, panthenyl ethyl ether, cetyl alcohol, polyquaternium 10, disodium EDTA, PEG 7M, sodium chloride, sodium citrate, sodium benzoate, methylchloroisothiazolinone, and methylisothiazolinone.

The leave-in conditioner is a marketed product with the following ingredient list: water, cetearyl alcohol, amodimethicone, cetyl esters, behentrimonium chloride, perfume (fragrance), methylparaben, *Persea gratissima* (avocado oil), Trideceth 12, citric acid, *Prunus armeniaca* (apricot kernel oil), cetrimonium chloride, chlorhexidine dihydrochloride, linalool, butylphenyl methylpropional, and citronellol.

DAMAGE METHODS

Both mechanical and UV damage were produced. The mechanical damage was accomplished by performing 20,000 strokes with a mechanical comber. UV damage was produced by exposing hair to a solar simulator (Q-Sun 3100, Q-Lab Corp.) with irradiance of $0.68 W/m^2$, approximately equivalent to noon-day sun at a latitude of 25° 48′ N, similar to Miami. Hair was exposed for 8 hours and then washed and dried as described above in the method labeled care.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

COLOR

Each hair tress was mounted flat and straight on a black board and held in front of the ½ inch port of a Hunterlab Ultrascan XE (diffuse illumination and collection). Five replicate measures were collected for each tress.

LUSTER

Luster meaures were accomplished using the Bossa-Nova Samba in which tresses were pulled straight around a cylinder of 4-inch diameter and illuminated at 10 degrees from vertical with light polarized linearly parallel to the cylinder axis. Each tress was meaured 5 times and the average results are reported.

IMAGE ACQUISITION

Tresses were positioned straight around a 1.25″ diameter cylinder and illuminated with collimated light from a quartz-tungsten-halogen bulb. A Fuji S5 digital camera with 90-mm lens was mounted 32 inches from the tress.With color correction set to 3200K we were able to minimize error in the color apperance of a Macbeth mini color chart. Each image was monitored to ensure color drift of no more than a dE of 2.

TWO-ALTERNATIVE FORCED CHOICE (2AFC) PRESENTATION

An observer sitting at arms length from a monitor was presented with two alternate images and asked to select the shinier image. Each observer was given the same comparision, AB for example, three times with image A on the left and three times with image A on the right. All experiments were conducted using the same monitor. Color blind subjects were excluded from the study.

SKEW

Skew is calculated from the color images $I(x,y,c)$ rather than the black and white polarized light images. Using the method of Motoyoshi (10) we compute lightness image $I_L(x,y) = (1/3)\ \Sigma_{c=r,g,b} I(x,y,c)$, then the mean $\mu = (1/N_x N_y)\Sigma_{i=1,N_x,j=1,N_y}\ I_L(x_i,y_j)$, the standard deviation $\sigma^2 = (1/N_x N_y)\Sigma_{i=1,N_x,j=1,N_y}(I_L(x_i,y_j) - \mu)^2$ and finally the skew $S = (1/N_x N_y \sigma^3)\ \Sigma_{i=1,N_x,j=1,N_y}\ (I_L\ (x_i,y_j) - \mu)^3$.

RESULTS

POLARIZED IMAGING OF CONTROL TREATMENTS

In the first set of measurements reported here, we treat medium brown hair, Virgin and Bleached, with a series of positive and negative shine controls in order to get a handle on

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

the precision and accuracy of the tress imaging measurements acquired with the polarized imaging system. In Figure 1 we see the results as interpreted through the Reich-Robbins metric (4). These results are typical of those interpreted through all implemented methods, including the TRI measurement (9), Guiolet (11), Stamm (3) and Bossa Nova's own formula. The standard deviation of repeated measurements is close to 10% of the mean across a wide range of values for luster. The deviation is primarily due to hair variability rather than the instrumental noise. While it is necessary to comb the hair straight in every case, and careful practice reduces the between measurement variability, the positioning of the hair simply does not allow for better than 10% repeatability from a single tress. In the discussion we will explore the implications of this variability to the design of product comparisons.

POLARIZED AND COLOR IMAGING OF DAMAGE STANDARDS

In the second set of measurements, we studied the damage standards (described in the Materials section) in the polarized imaging system and the color imaging system. The first set of comparisons we plot in Figure 2(a–d). The skew values in Figure 3 are the comparisons of various shine and luster metrics to the overall lightness of the tresses. The remarkable result is that skew seems to vary monotonically with lightness (Figure 3) while the relationship of the other metrics to lightness is complex and non-functional. This result suggests that the generation of skew is related to the optics of fibers and fiber damage. Potential implications of this observation are reviewed in the discussion.

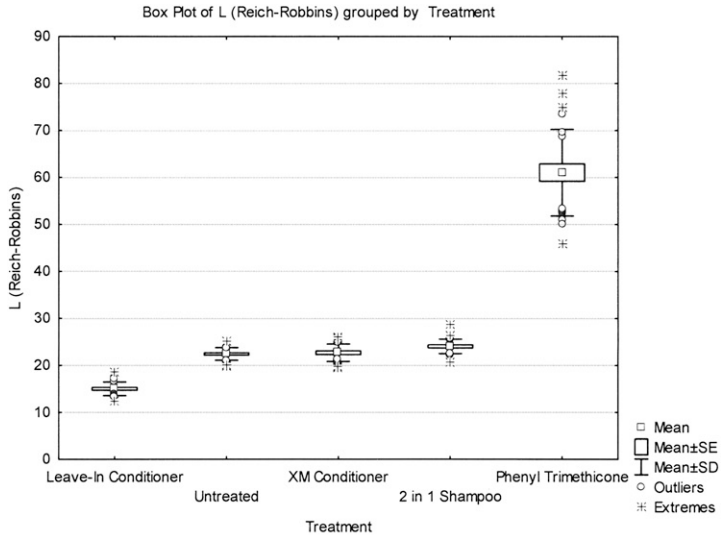
Using the same tresses and the polarization imaging equipment, we monitored the change with standard damage across multiple, natural and artificial, hair colors. Results for medium brown and red hair, using the Reich-Robins metric of luster are shown in Figures 4 and 5. What is puzzling about these results is that the change in luster with source of damage is different for the two hair colors. The pattern of response for all measures and hair types is detailed in Table II.

PERCEPTION TEST

To help explain the different patterns of change with treatment for different hair types, and the differences between measurements, we presented a subset of these images to be judged in the 2-alternative forced choice test described in the methods section. The interpretation of 2-AFC comparisons can be sophisticated and complex when interpreting just noticeable differences and testing the relative significance of multiple tests. In this experiment we focus only on the pattern of judgments which turned out to be clear. For all colors investigated, the UV-treated hair had higher shine that the untreated hair that in turn had higher shine than the comb damaged hair. Results are summarized in Figure 6. When looking at this figure, a contingency chart, note than an undetectable difference would result in a bar being drawn at the center, the 50% line. As the difference becomes more detectable the bar moves away from the center. We have drawn the 95% confidence line. Bars below that line represent comparisons that are perceivably different with confidence exceeding 95%.

Essentially all hair types have the same directional change in perceived shine for each type of damage induced in this experiment.

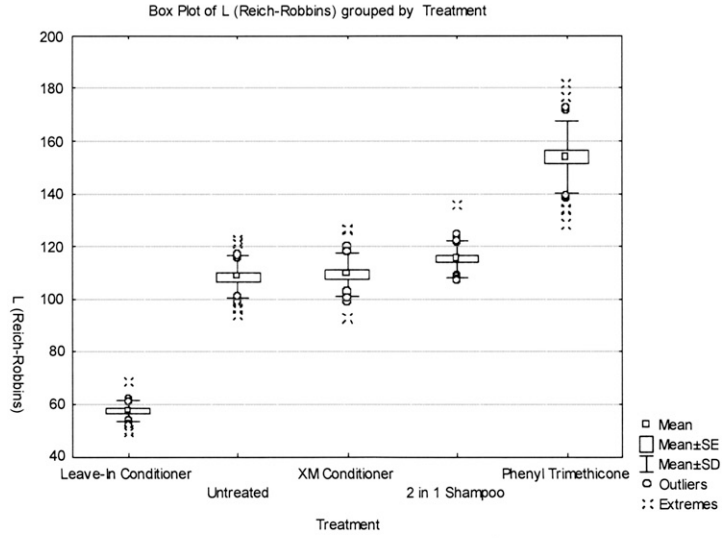
Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)



Statistical Comparison Using Tukey-Kramer HSD

Treatment	N	Mean	Std Dev	Std Err Mean				
Phenyl Trimethicone	25	61.0	9.2	1.8	A			
2 in 1	25	24.0	1.5	0.3		B		
XM Conditioner	25	22.7	1.8	0.4		B		
Untreated	25	22.4	1.3	0.3		B		
Leave-In Conditioner	25	15.0	1.4	0.3				C

a Treatments not connected by same letter are significantly different.



Treatment	N	Mean	Std Dev	Std Err Mean				
Phenyl Trimethicone	25	153.9	13.5	2.7	A			
2 in 1	25	115.3	7.1	1.4		B		
XM Conditioner	25	109.3	8.2	1.6		B	C	
Untreated	25	108.3	8.1	1.6			C	
Leave-In Conditioner	25	57.5	4.2	0.8				D

b Treatments not connected by same letter are significantly different.

Figure 1. Luster of medium brown hair, (a) bleached and (b) virgin, treated with shine controls. In this figure luster is calculated using the Reich-Robbins formula as implemented in the Samba system.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

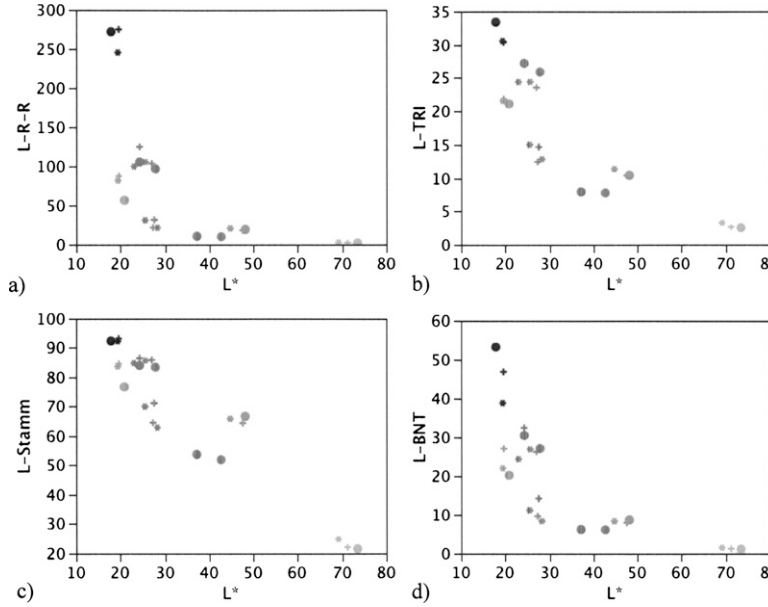


Figure 2. Shine vs color damage standards. Formulas: (a) Reich-Robbins. (b) TRI. (c) Stamm. (d) Bossa-Nova Technologies.

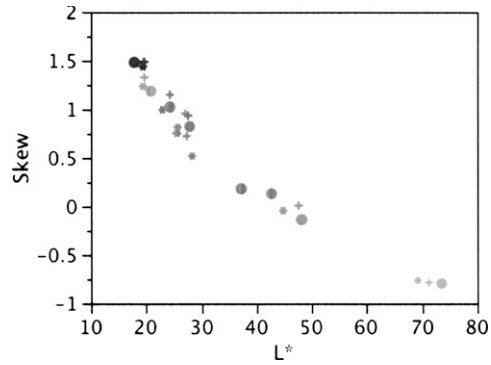


Figure 3. Skew vs color.

DISCUSSION

This work is organized around two goals, the development of control treatments for shine measurements on hair and the validation of these measurements as perceptually relevant.

LUSTER CONTROLS

Measurements of luster using polarized imaging can be accomplished with a repeatability of approximately 10% (variance/mean). Based on actual variances, we have estimated the

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

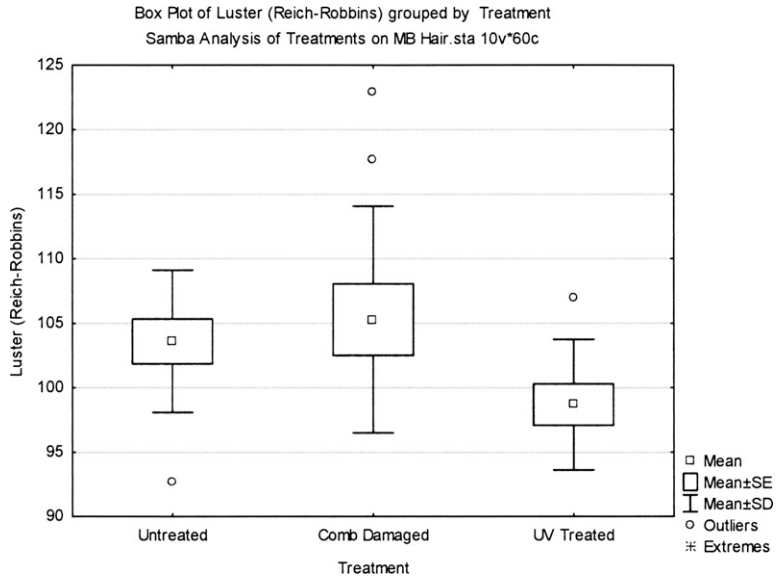


Figure 4. Luster vs damage, medium brown, Reich-Robbins.

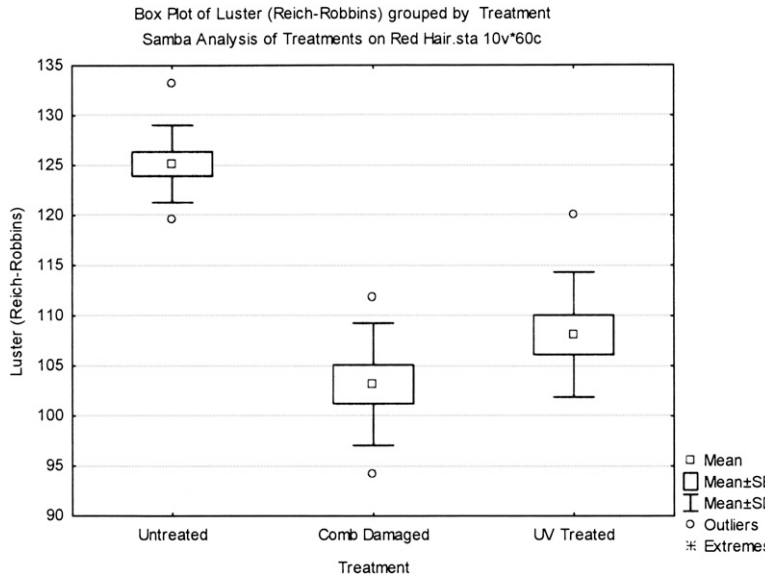


Figure 5. Luster vs damage, red hair, Reich-Robbins.

sample size required to distinguish between treatments. This power calculation is the number of samples required to have an 80% probability of resolving the difference with significance judged by a between-sample *t*-test. The results are shown in Table III. We see that some of the metrics are more sensitive than others and that the comparisons between clean hair before and after use of a wash off product, that is, the shampoo and conditioner controls, are difficult.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

Table II
Luster Results (polarized imaging) on Damaged Hair

Hair type	Metric	Untreated	20000X Comb-damaged	Combed vs untreated	UV + conditioner	Conditioned vs untreated	Combed vs conditioned
Indian	TRI	30.4	30.5	No	33.4		
Med. Brown		23.6	24.4	No	25.9		
Piedmont		2.6	3.2	No	2.5	No	No
Red		27.2	24.4		27.2		
MB bleached		10.4	11.3	No	10.4		No
Dyed black		21.8	21.5		21.1	No	No
Dyed brown		12.4	12.8	No	7.8	No	No
Dyed red		14.6	15.0	No	7.9	No	No
Indian	Stamm	93.2	92.3		92.4	No	
Med. brown		85.9	85.7		83.4	No	No
Piedmont		22.1	24.8	No	21.6	No	No
Red		86.5	84.9		84.1	No	No
MB bleached		64.3	65.8	No	66.6		
Dyed black		84.6	83.7		76.7	No	No
Dyed brown		64.5	62.9		51.9	No	No
Dyed red		71.2	70.0		53.8	No	No
Indian	Reich-	275.0	245.4		272.1	No	
Med. brown	Robbins	103.4	105.4	No	96.6	No	No
Piedmont		2.1	2.7	No	2.0	No	No
Red		124.9	99.8		105.6	No	
MB bleached		17.9	20.4	No	19.2		No
Dyed black		87.4	81.6		56.5	No	No
Dyed brown		21.6	21.4		10.0	No	No
Dyed red		31.6	31.0		10.6	No	No
Indian	Guiolet	13.7	12.0		12.2	No	
Med. brown		6.1	6.0		5.0	No	No
Piedmont		0.3	0.3	No	0.3	No	No
Red		6.4	5.6		5.3	No	No
MB bleached		1.8	1.9	No	2.0		
Dyed black		5.5	5.1		3.3	No	No
Dyed brown		1.8	1.7		1.1	No	No
Dyed red		2.5	2.3		1.2	No	No
Indian	Boosa-Nova	46.9	38.8		53.3		
Med. Brown		26.2	26.9	No	27.1		
Piedmont		1.1	1.4	No	1.1	No	No
Red		32.5	24.4		30.5	No	
MB bleached		7.9	8.2	No	8.6		
Dyed black		27.0	22.0		20.2	No	No
Dyed brown		9.6	8.3		6.1	No	No
Dyed red		14.2	11.1		6.2	No	No

The text in the comparison column indicates if the directional change matches the perceptual results in Figure 6.

LIGHTNESS DEPENDENCE

Technical measures of shine typically produce larger values for dark substrates as absorption tilts the balance between specular and diffuse reflected light towards the specular. This trend is seen in Figures 3 and 4. The report that judgment of shine depends on skew and not on color (10), however, led us to make this comparison as well. We find, in Figure 3,

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

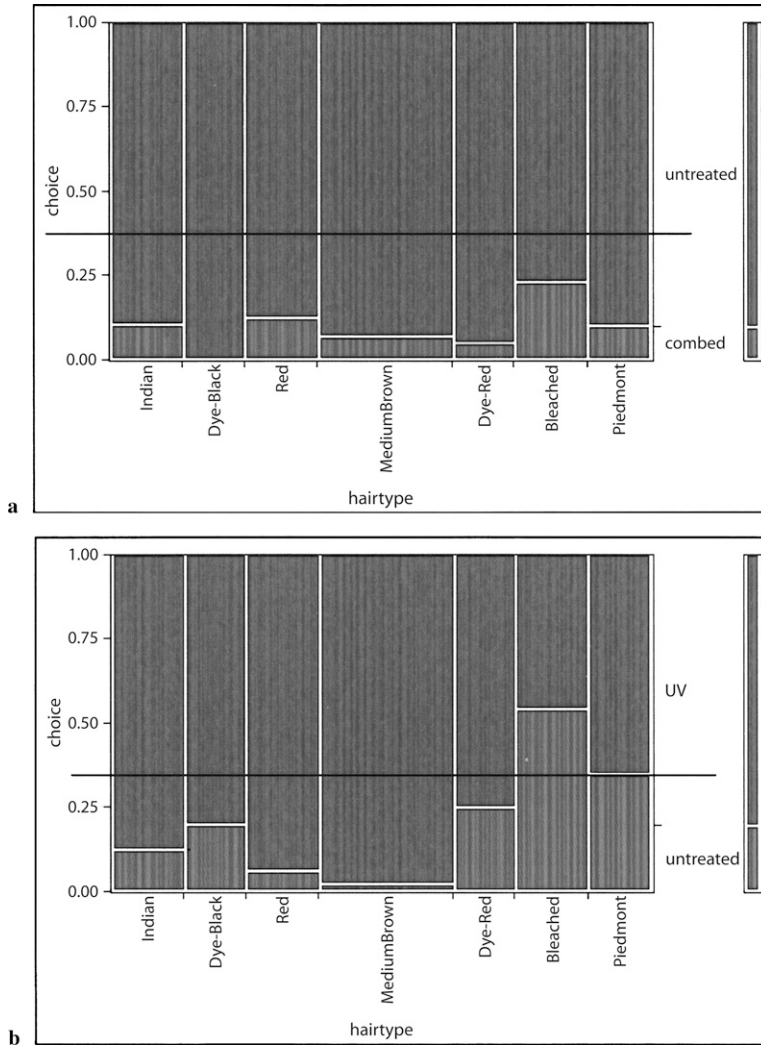


Figure 6. Perception of shine of damaged and treated hair. (a) Choice of shinier tress (combed vs untreated) for various hair colors in 2AFC test. (b) Choice of shinier tress (UV exposed + conditioner vs untreated) for various hair colors in 2AFC test.

that the histogram skew produced by hair varies inversely with the lightness of the hair. The fact that this behavior is single valued, unlike the other measures, leads us to speculate that there is an intrinsic relationship between skew and hair color. We have attempted to model this dependence and use variations from the model as predictors of the small changes in shine with damage and with control treatments to no avail. Skew, however, remains an interesting quantity for future investigations.

PERCEPTUAL CONSISTENCY

The tests of perceptual consistency in this paper are stringent in that all treatments and damage produced only very small changes in tress appearance. It is well established that

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

Table III
Recommended Sample Size for Polarized Light Shine Tests

Comparison		Reich-Robbins		TRI		Stamm		Guiolet		Bosse-Nova Tech.	
		Virgin MB	Bleached MB	Virgin MB	Bleached MB	Virgin MB	Bleached MB	Virgin MB	Bleached MB	Virgin MB	Bleached MB
Untreated	Leave-In conditioner	6	9	6	8	6	6	6	7	6	8
Untreated	XM Conditioner	663	3109	3282	7594	40	272	67	388	115	103
Untreated	2 in 1	19	63	27	109	22	13	22	17	12	25
Untreated	Phenyl trimethicone	6	6	8	6	6	6	6	6	6	6
Phenyl trimethicone	Leave-in conditioner	6	6	6	6	6	6	6	6	6	6
Phenyl trimethicone	XM Conditioner	6	6	8	6	6	6	6	6	6	6
Phenyl trimethicone	2 in 1	7	6	9	6	6	6	6	6	6	6
Leave-In conditioner	XM Conditioner	6	9	6	8	6	6	6	7	6	7
Leave-In conditioner	2 in 1	6	8	6	7	6	6	6	7	6	7
2 in 1	XM Conditioner	24	63	27	110	94	14	84	18	23	277

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

the technical measures of luster perform well for larger changes and for more global comparisons between colors. What we find remarkable about the results reported in Figure 6 is that the human perception is quite reproducible, both in the repeatability of individual comparisons and in the consistency of changes in shine with damage across multiple hair colors.

COMPARISON OF PERCEPTION TO TECHNICAL MEASURES

The change in perceived shine with damage is consistent across the hair types studied. The change in measured luster, however, is not so consistent, neither across hair types nor between types of damage (Table II). Given the lack of consistency, it is difficult to recommend one formula over another for the prediction of perceived change in shine. In this situation, there are only a few ways forward. We could accumulate more experimental results on more hair types with more repeated measures and hope that consistency begins to emerge, or we could begin a search for a new and more relevant measurement.

CONCLUSIONS

We have examined the change in several technical measures of shine with several standard hair treatments and sources of hair damage. We demonstrate the use of several, well-characterized control treatments (Figure 1) and recommend experimental sizes to be used for specific comparisons (Table III). These controls and methods reported in this paper should provide consistent results in the technical measure of shine by polarization imaging. We further have attempted to connect these measurements (Figure 2) to newer work on the origins of perceived shine based on the histogram skew (Figure 3), and while the utility of these methods is not immediately obvious, the fact that this metric gives more systematic variance with hair lightness is intriguing.

Finally, we compare perceptual results on shine comparisons (Figure 6) to technical measures (Figures 3,4; Table II). Much previous work has shown that these measurements are consistent with perception for large changes in shine (7). Here we focus on the small changes associated with between treatment comparisons or damage. We conclude that the problem of quantitatively measuring the physical drivers of hair shine at the level of between treatment comparisons is not well captured by technical measures used here. Based on our preliminary unpublished work and other references (12) we expect that in addition to lightness, color based signals are critical cues for quality of color as well as for shine. Future work will focus on these.

REFERENCES

(1) R. S. Hunter and R. W. Harold, *The Measurement of Appearance* (J. Wiley & Sons, New York, 1987).
(2) K. Ward *et al., Ieee Transactions on Visualization and Computer Graphics*, **13,** 213 (2007).
(3) R. F. Stamm, M. L. Garcia, and E. J. Fuchs, *J. Soc. Cosmet. Chem.,* **28,** 571 (1977).
(4) C. Reich and C. R. Robbins, *J. Soc. Cosmet. Chem.,* **44,** 221 (1993).
(5) R. Dror, A. S. Wilsky, and E. H. Adelson, *J. Vision,* **4,** 821 (2004).
(6) E. H. Adelson, in *Human Vision and Electronic Imaging VI,* B. E. a. P. Rogowitz, Ed. (SPIEE, San Jose, CA, 2001), pp. 221.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

(7) J. M. Lim *et al., J. Cosmet. Sci.,* **57,** 475 (2006).
(8) K. Keis, K. R. Ramaprasad, and Y. K. Kamath, *J. Cosmet. Sci.,* **55,** 423 (2004).
(9) K. R. Ramaprasad, K. Keis, and Y. K. Kamath, *Abstracts of Papers of the American Chemical Society,* **230,** U4294 (2005).
(10) I. Motoyoshi *et al., Nature,* **447,** 206 (2007).
(11) A. Guiolet, J. C. Garson, and J. L. Levecque, *Int. J. Cosmet. Sci.,* **9,** 111 (1987).
(12) S. Nagase, N. Satoh, and K. Nakamura, *J. Cosmet. Sci.,* **53,** 387 (2002).

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)

J. Cosmet. Sci., **60,** 125–133 (March/April 2009)

Approaches to polymer selection for mascara formulation

YELENA LOGINOVA, VIBHA SHAH, GLENN ALLEN,
RALPH MACCHIO, and ALAN FARER, *COTY, Inc.,*
410 American Road, Morris Plains, NJ 07950.

Synopsis

The use of hair-care and hair-styling polymers in mascara formulation is well known. This paper introduces pre-formulative evaluation of film formers which are intended to be applied on eyelashes for mascara development to screen film formers more effectively. The film-forming characteristics of randomly selected hair-styling polymers were evaluated under the influence of pH, temperature, surfactant, and pigment dispersion. The selected polymers included acrylics, polyurethanes, and a pyrrolidone, all of which are used throughout the hair-care and mascara industries. An Erichsen Model 299/300 Pendulum Damping Tester was used to determine film hardness. In analyzing samples by the effect of temperature, the hardest neat polymer, a styrene-acrylate, softened 30% after heating. For most of the other polymers, the hardness was slightly lower compared to the neat polymer. The addition of pigment didn't significantly influence the hardness of one acrylic copolymer and a urethane dispersion, but most of the other polymers exhibited a reduction in film hardness. Various hardnesses were observed with different surfactants and different pH's.

INTRODUCTION

The key to successful mascara formulation is a flexible lash-styling and shape-holding coating. The complex physical-chemical structure of mascara comes from the relationship between waxes, film formers and other functional ingredients. The polymer behavior after interaction with other constituents in mascara formulation unpredictably changes. The empirical way of polymer selection requires a number of mascara batches until the right polymer will be chosen for the particular mascara system.

Traditionally, the selection and testing of polymers for mascara formulations is based on related hair-care and hair-styling technologies, but mascara technology is different than a hydroalcoholic solution of film-forming polymers, aerosol foams and setting hair gels which are used in the majority of hair-styling products.

Although hair-spray technology seems to be not that close to mascara formulation, it could be considered in terms of film formers and testing of their properties.

The essential components of hair styles and hair sprays compared to mascara are presented in Table I.

Reviewing formulations for hair products in comparison to mascara (Table II) shows that mascara development requires special thought for selection of film-forming polymers.

Table II represents the similarities and differences in formulation approaches for these products.

Purchased for the exclusive use of nofirst nolast (unknown)
From: SCC Media Library & Resource Center (library.scconline.org)