

## **New methods for the in-vivo assessment of skin smoothness and skin softness**

SIDNEY WEINSTEIN *NeuroCommunication Research Laboratories, Inc., West Kenosia Ave., Danbury, CT 06810.*

*Received June 3, 1977.*

### **Synopsis**

TWO SYSTEMS are described for the ASSESSMENT, IN VIVO, of SKIN SOFTNESS and SKIN SMOOTHNESS. Tests of validity and reliability are reported, as well as examples of their use in the evaluation of typical cosmetics employed for softening and smoothing skin. A system is described for the assessment of the effectiveness of shaving creams or razors by measuring closeness of shave.

### **INTRODUCTION**

Blank (1) observed in 1952 that one of the factors which is responsible for skin softness is its moisture content. However, it is clear there are skin treatments which utilize procedures other than moisturization to soften the skin (2).

The term "softness" is also frequently and uncritically used as though synonymous with the term "smoothness," when applied to skin. Yet it is not difficult to distinguish these two terms subjectively and, more importantly, operationally.

Numerous systems have been employed in evaluating the efficacy of various skin treatments in softening and smoothing the skin. Some employ essentially judgmental approaches, *e.g.*, rating scales (3–5). Others, which employ objective systems such as "surfometry" (6), require skin surface biopsies, a procedure which severely limits practical application and which is based upon the assumption of obtaining consistency of intracorneal adhesion.

Skin hardness has been measured (7) by causing "a stylus visibly to scratch the skin." This method requires drawing a stylus repeatedly across the skin, with increasing force applied, until the scratch is visible by its "ability to scatter light." The hardness, defined by the minimal force required to scratch, is detected by an individual's ability to detect the scattering of light. In addition to the indirect nature of using scattering of light, this method also seems to have limited practical utility. Surface topography, utilizing a "silicone rubber replica" of the skin, has also been employed as a means of measuring skin smoothness (7). The disadvantages of a series of procedures which first require making replicas of the skin and then the determination of a surface profile by stylus displace-

ment studies are obvious in routine measures of skin smoothness to assess new cosmetic preparations.

### INDENTATION AS A METHOD OF DETERMINING SKIN SOFTNESS

The development of a device for assessing skin softness was initiated by consideration of what consumers operationally do when asked which of various body parts are soft or hard. The majority were found first to prod their faces, palms, etc., with, for example, the tips of their index fingers, a pencil, etc. When questioned concerning what they were attempting to determine, a typical remark was "to see how deep the pencil would go." These observations are not dissimilar to industrial measurements made of hardness of materials.

We therefore designed an instrument comprising a piston, within a cylinder (Figure 1), whose vertical movements are detectable in  $10^{-4}$ -in. units.

The body part to be tested is kept immobile by velcro straps and the tip of the piston is brought to rest very lightly on a section of skin. After a load is placed on the piston, the depth of indentation of the skin, which is measured continuously, asymptotes at about 3 sec. Repeated measures are taken at slightly different areas, since testing the same site has the tendency to modify the skin's elasticity at that point; varying the testing site at points around a 1-cm circle gives consistent readings.

#### SKIN SOFTNESS: VALIDITY

We applied the device to inert substances varying in softness, *e.g.*, paper, wood, soap, glass, toothpaste, etc., and found that degrees of indentation conformed to our concep-

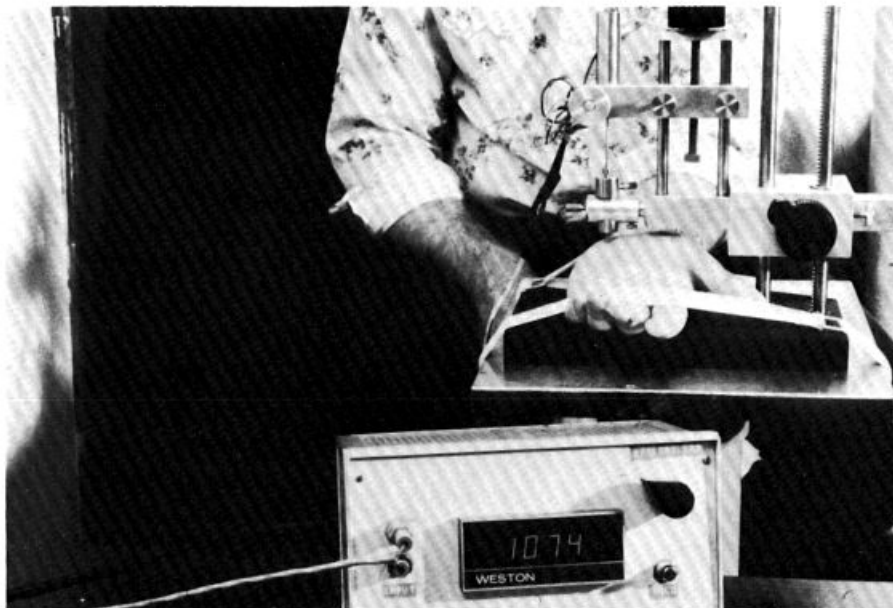


Figure 1. The device for assessing skin softness

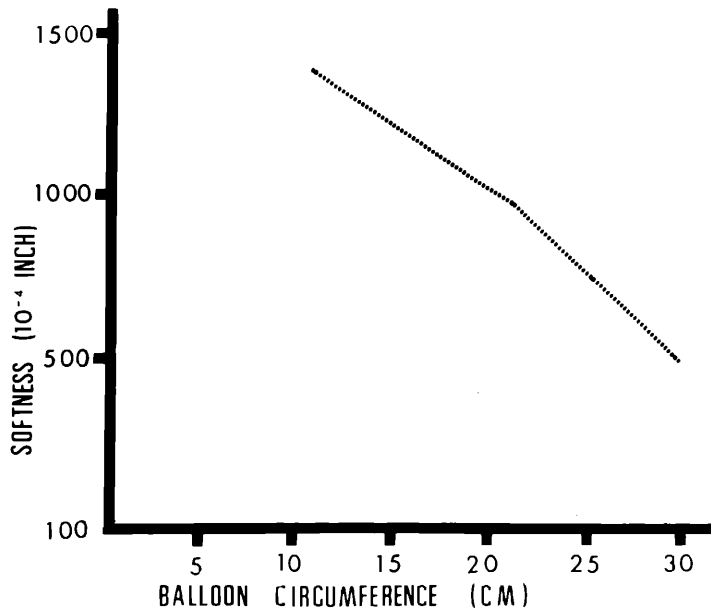


Figure 2. Softness of surface of a balloon inflated to varying degrees

tion of softness. We next employed a quantitative index obtained by testing rubber toy balloons inflated to varying degrees. Figure 2 shows the inverse linear relationship of degree of indentation to the circumference of the balloon. As the balloon is inflated, its turgidity becomes greater, and the degree of indentation diminishes linearly with the increase in circumference.

#### EXPERIMENT I: SKIN SOFTNESS

Our first study assessed the effects of both immersion in water and application of a skin lotion on softening the glabrous skin of the fingers.

#### *Subjects*

Thirty-two subjects, men and women between the ages of 25 and 54, were randomly assigned, 16 to the Water and 16 to the Lotion Group.

#### *Procedures*

There were four measures taken in each subject: two preceding and two following the treatment. Following the first test (Pre 1), a retest (Pre 2) was given from 1 to 10 min later. The treatment (Water or Lotion) was then applied, followed by two retests (Post 1) and (Post 2). In subjects with whom water was used as the treatment, a finger, usually the middle one, was immersed in tepid water for 5 min. After it was removed, the excess was gently shaken off and the first posttreatment testing initiated. In those subjects with whom lotion was used, the glabrous surface of the middle phalanx of one finger was covered with lotion that was rubbed into the skin for 1 min. Following four additional minutes during which the lotion remained on the skin, any visible excess was gently removed with cotton wool and the first posttreatment test applied. In both

Table I  
Summary of Analysis of Variance of Skin Softness Following Application of Lotion or Water

Source	df	MS	F
Between subjects	31	7,485.85	
Between treatments	1	1,458.00	<1
Between subjects in same treatment group	30	15,373.56	
Within subjects	96	1,328.52	
Between trials	3	12,943.64	14.19**
Interaction treatment × trial	3	2,203.64	2.42*
Interaction pooled subjects × treatment × trial	90	912.17	

\* $p < 0.07$ .

\*\* $p < 0.001$ .

Note: The terms "*df*, *MS*, and *F*" refer to "degrees of freedom, mean square, and F-ratio" respectively; *df* indicates the number of units involved in the comparison; *MS* is the "error term" and reflects the variance of the variable concerned; the *F* ratio determines the level of statistical significance according to published tables.

groups (Water and Lotion) the second posttreatment test (Post 2) was given 5 min after Post 1.

#### Results: Experiment I

Table I gives the results of an analysis of variance comparing the effects of Treatment (Water or Lotion), Trials (2 Pre and 2 Post) and their interaction.

It can be seen that the four trials differed quite significantly and that the interaction of treatment and trial indicated a trend toward significance.

Follow-up *t* tests demonstrated that the slight decrease in softness between the means of both pretreatment trials was not significant; however, the differences between Pre 2 and Post 1 and between Pre 2 and Post 2 were both significant for the average of the two treatments (Table II). The correlation between the measures of softness taken before treatment (between Pre 1 and Pre 2) was 0.754 (30 *df*,  $p < 0.0005$ ), indicating good test-retest reliability.

Figure 3 shows that there was a significant, immediate increase in softness for both treatments; however, although the degree of softness was maintained in the Lotion Group, it dropped in the Water Group. The *t* tests between the means for the two groups for Pre 1, Pre 2, Post 1 and Post 2 Trials were: 0.73, 0.46, 0.55, and 2.79 respectively. Only the Post 2 means differed significantly ( $p < 0.005$ ).

Table II  
*t* Tests Between Trials for Water and Lotion Treatment Groups

Between Trials	Water	Lotion	Combined Water and Lotion
Pre 1—Pre 2	0.67	1.87	1.80
Pre 2—Post 1	4.34*	4.24*	6.07*
Pre 2—Post 2	1.34	4.58*	4.19*

\* $p < 0.0005$ .

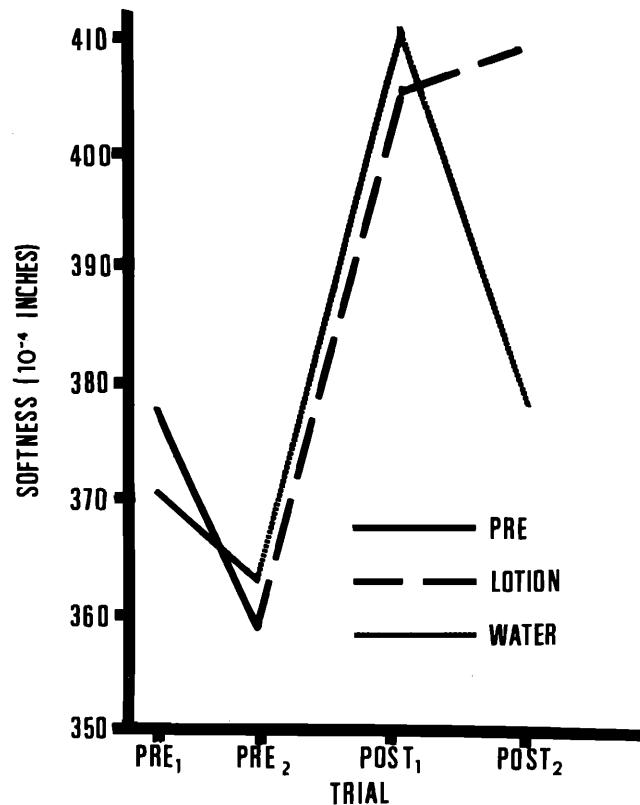


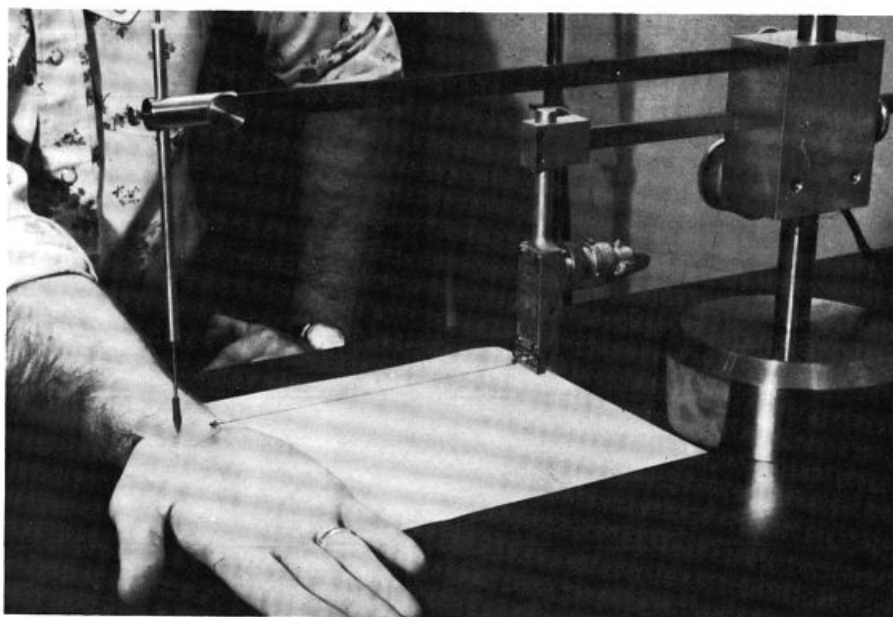
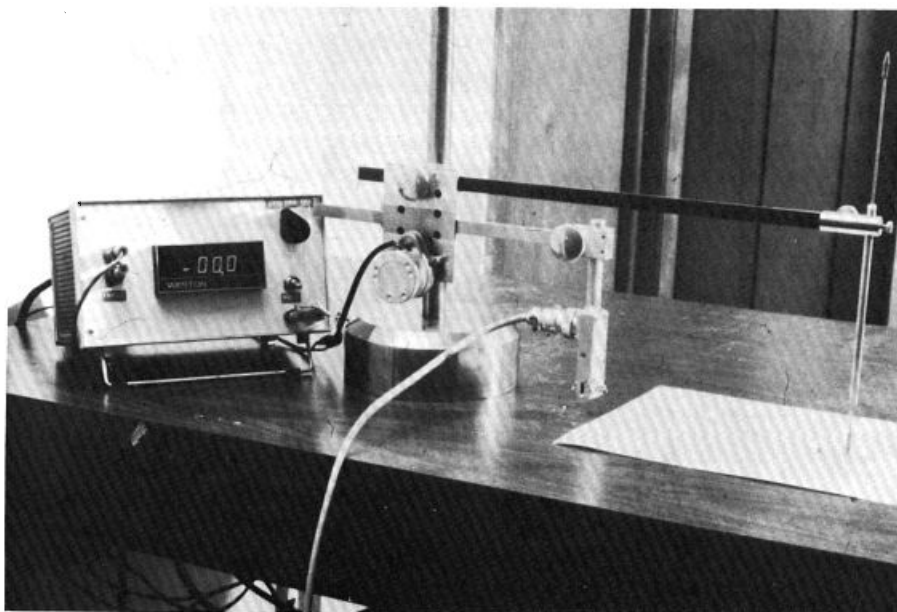
Figure 3. Skin softness in two groups treated prior to and following treatment with lotion or water

#### *Discussion: Experiment I*

It is clear that soaking in water or applying a lotion has an immediate effect in enhancing skin softness. After 5 min, however, the effect of the water had dropped significantly, whereas that of the lotion had remained. Apparently, the moisturization effect produced by the water had been dissipated in 5 min whereas that induced by the lotion lasted at least that long, as measured by this technique.

#### MEASUREMENT OF COEFFICIENT OF FRICTION AS A METHOD OF DETERMINING SKIN SMOOTHNESS

We applied the concept of the coefficient of friction in producing a device which assesses the smoothness of skin (Figures 4A and 4B). The device comprises a sled of deglazed thermoplastic drawn by a constant-speed (5 mm/min) motor. The force required to move the sled over skin is measured by a force transducer; the resultant voltages from the transducer are amplified and fed to a digital voltmeter, calibrated to read in grams. A rod with a small ball-bearing point rests constantly upon the sled, which is placed upon the area of skin to be tested. The skin and sled are kept horizontal. Measures of the maximum forces required to move the sled are continuously made and recorded. Several, e.g., ten, determinations can be made in the space of a few



Figures 4A and 4B. The device for assessing skin smoothness

minutes and prove to be quite consistent for the same degrees of smoothness. The mean of the determinations is used as the index of smoothness.

#### SKIN SMOOTHNESS: VALIDITY

To assess the validity of the system, we employed five grades of sandpaper varying in roughness in grains per linear inch as follows (from rough to smooth): 320, 360, 400, Purchased for the exclusive use of nofirst nolast (unknown)  
From: SCC Media Library & Resource Center (library.sconline.org)

Table III  
Mean Forces and Coefficients of Friction for Five Grades of Sandpaper

Sandpaper Grains/inch	Force		Coefficient of Friction	
	(g)	SD	C.F.	S.D.
600	5.127	0.076	0.470	0.007
500	7.621	0.110	0.699	0.010
400	9.809	0.112	0.899	0.010
360	11.577	0.155	1.062	0.014
320	12.052	0.130	1.106	0.012

500, 600. Ten determinations were taken of the force required to move the sled over each grade. Table III gives the means of the forces, the coefficient of friction and their standard deviations (Figure 5).

It can be seen that there is a linear relationship between the roughness of the sandpaper and the forces or coefficients of friction obtained. The S.D.'s are only about 1 per cent of their respective means.

The question of whether the system assesses changes in the actual smoothness of skin or the topical lubricating aspect of the lotion, etc. (skin slip), is of interest. We therefore retested the forces and coefficients of friction for the five grades of sandpaper after first applying hand lotion to each sandpaper and then removing it with paper towelling. The changes in force (Pre- to Postlotion) required to pull the sled for the five sandpapers (320 to 600) were:  $-0.02$ ,  $0.01$ ,  $0.00$ ,  $0.09$  and  $-0.57$ ; and the changes (and percentage changes) of the coefficients of friction were:  $-0.001$  (0.9 per

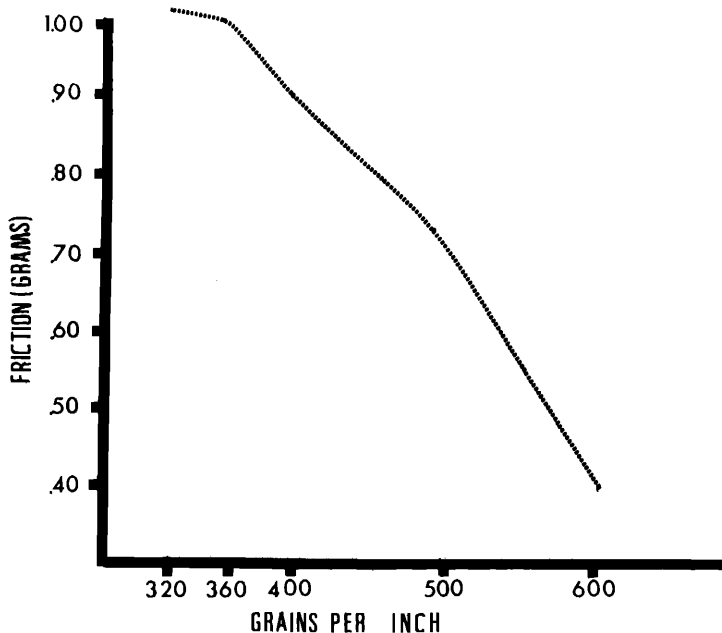


Figure 5. Roughness of five grades of sandpaper assessed by smoothness device

cent), 0.000 (0 per cent), 0.000 (0 per cent), 0.011 (1.3 per cent) and  $-0.076$  (6.9 per cent).

Thus it can be seen that the application of lotion had, at most, a miniscule effect on all but the very smoothest of sandpapers.

#### SKIN SMOOTHNESS: EXPERIMENT II

##### *Reliability*

Twenty subjects of both sexes, ranging in age from 24–55, were tested twice for the smoothness of their palms with a 10-min delay between tests. The Pearson Product Moment Correlation was 0.947,  $p < 0.0005$ , indicating extremely high retest reliability.

##### *Subjects*

Twenty-seven men and women between the ages of 25 and 54 were randomly divided into three groups of nine each and assigned to a Water, Lotion, or Bath Solution group.

##### *Procedure*

A pretreatment measure was taken before application of Lotion (A), Bath Solution (B), or Water (C). Immediately following the conclusion of the treatment, the first post-treatment measure was taken (Post 1) and, following an additional 10 min, we recorded the second posttreatment measure (Post 2).

In all groups, one finger (usually the middle) was treated and the middle phalanx tested. For the Water and Bath Solution Groups, the finger was immersed in tepid solutions for 5 min. The Lotion was applied and rubbed over the glabrous skin of the middle phalanx for 1 min and then permitted to remain for an additional 4 min. The excess was then removed with rolling traverses of paper towelling and the visible excesses were removed by gentle rubbing with cotton wool. In all groups, a hair dryer was then employed to blow warm air to dry the skin until it visibly appeared dry.

##### *Results: Experiment II*

Table IV gives the summary of an analysis of variance for these data.

It can be seen that there was a significant effect of trials. The  $t$  tests between Pre and Post 1 and between Post 1 and Post 2 were 1.13 and 1.59, indicating no significant differences between these conditions overall. However, the result of the  $t$  test between

Table IV  
Summary Analysis of Variance for Skin Smoothness Following Treatment with Water, Bath Oil or Lotion

Source	df	MS	F
Between subjects	26	67.74	
Between treatments	2	113.18	1.77
Between S's in same treatment group	24	63.96	
Within S's	54	10.82	
Between trials	2	36.06	3.76*
Interaction treatment $\times$ trial	4	12.72	1.32
Interaction pooled s's $\times$ treatment $\times$ trial	48	9.62	

\* $p < 0.05$ .

Note: See footnote to Table I for definition of statistical symbols.

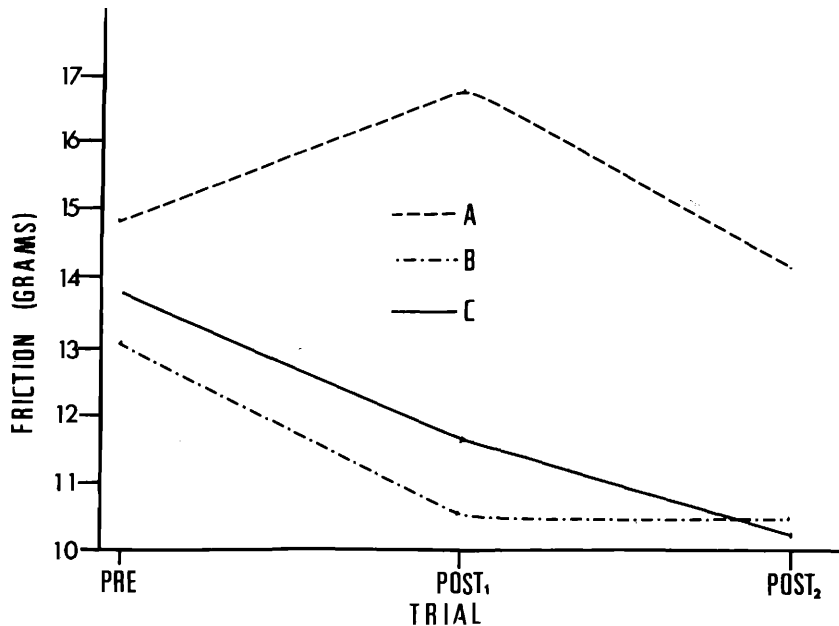


Figure 6. Skin smoothness in three groups tested prior to and following treatment with Lotion (A), Bath Solution (B) or Water (C)

Pre and Post 2 was 2.73 ( $p < 0.01$ ), showing that all treatments combined were effective 10 min after treatment.

Since Figure 6 demonstrates apparent differential effectiveness of the treatments, we looked for *post hoc* trends. We compared the changes in smoothness from pre- to post-treatment for all three treatments. The results indicate a strong tendency for the Water and Bath Solution treatments to produce more skin smoothness immediately after treatment than does the Lotion treatment.

#### EXPERIMENT III: EFFECT OF THREE TREATMENTS ON SOFTENING AND SMOOTHING SKIN

##### Subjects

Twenty subjects, 6 men, 14 women, aged 18 to 55 were tested.

##### Procedure

The glabrous skin of the second phalanx of the index, middle and ring fingers of the preferred hand was selected for treatment and testing.

*Pretreatment test.* The three fingers were randomly used for the three treatments and were tested in random order. In all cases, softness was measured before smoothness.

*Treatments.* The three treatments were: (a) soaking the finger for 5 min in a cup of tepid Bath Solution, (b) soaking another finger for 5 min in the same volume of tepid Water and (c) rubbing a small amount of skin Lotion on the finger. Following 5 min of each treatment, the finger was wiped dry and the excess Lotion removed.

*Posttreatment tests.* The tests were repeated on each finger in the same order: smooth-

Table V  
Percentage Increase in Skin Softness After Three Treatments

S	Age	Sex	Lotion	Water	Bath
1	23	M	20	7	24
2	23	M	1	24	22
3	21	F	51	79	22
4	43	F	22	26	32
5	32	F	39	1	13
6	47	F	14	11	34
7	44	F	12	22	4
8	42	F	5	12	6
9	34	F	2	33	38
10	20	M	13	9	19
11	19	F	16	0	0
12	26	M	36	5	18
13	22	F	19	18	48
14	25	M	31	15	26
15	18	F	10	8	8
16	41	M	33	4	19
17	33	F	14	3	-10
18	56	F	6	6	0
19	23	F	13	40	42
20	18	F	33	24	20
Mean			19.5	17.3	19.4

Note: "-" means a decrease in softness.

ness then softness. After testing was completed for a finger, the second finger was treated and then tested and finally the third finger was treated and tested.

#### Results: Experiment III

*Softness.* Softness was measured as a percentage change in degree of indentation. The mean percentage change in softness for each treatment is given in Table V.

A Friedman Analysis of Variance was computed to evaluate the relative efficacy of the three treatments ( $\chi^2 = 1.68$ ,  $p > 0.05$ ). The mean relative ranks (from 1-3: low to high effectiveness) were 1.78 for Water, 2.18 for Lotion and 2.05 for Bath Solution.

In view of the lack of significant differences among the treatments, we computed the number of individuals whose skin was softened, remained the same, or made harder by the treatment. Table VI gives the distribution of subjects and the  $\chi^2$  for each treatment.

Table VI  
Distribution of Subjects Whose Skin Softness Changed After Each Treatment

Treatment	Softness			Total	$\chi^2 - 2$ df
	Better	Same	Worse		
Water	19	1	0	20	34.13*
Lotion	20	0	0	20	39.80*
Bath	17	2	1	20	23.98*

\* $p < 0.001$ .

Table VII  
Mean Percentage Increase in Skin Softness After Three Treatments in Men and Women

Sex	Treatments		
	Lotion	Water	Bath Solution
Men	22.3	12.8	25.6
Women	18.2	20.2	18.3
Difference	4.1	7.4	7.3

It can be seen that all treatments were highly effective in softening the skin over the period employed.

We divided the group into men and women and compared the relative effectiveness of the treatments for each subgroup. Table VII gives the mean increase in skin softness after each treatment for men and women.

It can be seen that men showed a greater softening effect than women for Lotion and Bath Solution: the opposite was true for Water.

In order to assess the effectiveness of the treatments as a function of the initial state of softness of the skin, we divided the group (median split) into those whose initial skin condition was relatively hard and relatively soft.

Table VIII gives the increase in skin softness for these two subgroups.

It can be seen that for Lotion, subjects in the group with relatively soft skin had a slight advantage (3.2%) over those with harder skin in improving their status. However, for Water and for Bath Solution, those with initially harder skins improved much more than those with softer skins. Indeed, whereas the ratio between the groups for Lotion was only 1.18, the ratios between groups was 2.24 for Water and 2.62 for Bath Solution. This difference between groups of different initial status of skin hardness indicates that those with hard skin are affected much more positively after Bath Solution or Water than after Lotion.

*Smoothness.* The effects for smoothness were measured as a percentage change in the force (in grams) required to move the sled across the skin. Table IX gives the subject number, age, sex and mean percentage increases in smoothness as a function of the three treatments.

The mean increase in smoothness showed that Bath Solution produced a greater mean percentage change (11.6) than Water (7.3) or Lotion (6.7). A Friedman Analysis of Variance was computed to evaluate the relative efficacy of the three treatments ( $\chi^2 = 1.90$ ,  $p > 0.05$ ). The mean relative ranks (from 1–3: low to high effectiveness) were 1.85 for Water, 1.90 for Lotion and 2.25 for Bath Solution.

Table VIII  
Mean Percentage Increase in Skin Softness in Subjects with Relatively Hard or Soft Skin

Pretreatment Condition	Lotion	Water	Bath
Relatively Soft	21.1	10.3	11.2
Relatively Hard	17.9	23.1	29.3
Difference	3.2	12.8	18.1

Table IX  
Percentage Increase in Skin Smoothness After Three Treatments

S	Age	Sex	Lotion	Water	Bath Solution
1	23	M	22	5	0
2	23	M	1	15	6
3	21	F	1	16	10
4	43	F	0	9	19
5	32	F	22	14	21
6	47	F	9	0	7
7	44	F	4	0	0
8	42	F	10	0	31
9	34	F	0	0	0
10	20	M	20	14	43
11	19	F	20	16	24
12	26	M	0	35	22
13	22	F	15	17	29
14	25	M	25	37	39
15	18	F	0	0	0
16	41	M	8	0	0
17	33	F	0	-13	17
18	56	F	0	-9	-36
19	23	F	-14	0	-6
20	18	F	-5	0	0
Mean			6.7	7.3	11.6

Note: "-" means decrease in smoothness.

In view of the lack of significant differences among the treatments, we computed the number of individuals whose skin was smoothed, remained the same, or roughened by the treatment. Table X gives these distributions and the  $\chi^2$  which evaluates them.

It can be seen that Lotion and Bath Solution were significantly effective in improving the skin smoothness of a majority of the group, whereas Water had no such significant effect.

We divided the group into men and women, and compared the relative effectiveness of the treatments for each group. Table XI gives the mean increases in skin smoothness as a function of each treatment for men and women.

It can be seen that men showed a greater skin smoothing effect than women for all three treatments. In order to assess the effectiveness of the treatments as a function of

Table X  
Distribution of Subjects Whose Skin Smoothness Changed After Each Treatment

Treatment	Smoothness			Total	$\chi^2 - 2 \text{ df}$
	Better	Same	Worse		
Water	10	8	2	20	5.17
Lotion	12	6	2	20	7.56*
Bath Solution	13	5	2	20	9.22**

\* $p < 0.05$ .

\*\* $p < 0.01$ .

**Table XI**  
Mean Percentage Increase in Skin Smoothness After Three Treatments in Men and Women

Sex	Treatments		
	Lotion	Water	Bath Solution
Men	12.6	17.6	19.3
Women	4.4	2.8	8.3
Difference	8.2	14.8	11.0

**Table XII**  
Mean Percentage Increase in Skin Smoothness in Subjects with Relatively Rough or Smooth Skin

Pretreatment Condition	Lotion	Water	Bath Solution
Relatively Smooth	8.7	3.5	9.9
Relatively Rough	4.7	9.8	13.3
Difference	4.0	6.3	3.4

the initial state of smoothness of the skin, we divided the group (median split) into those whose initial condition was relatively rough and relatively smooth. Table XII gives the mean increase in skin smoothness for these two groups.

It can be seen that for Water and Bath Solution the subjects with initially rougher skin benefitted more than those with smoother skin; the opposite was true for Lotion.

*Relationship between smoothing and softening.* We computed a series of Pearson Product Moment Correlation Coefficients to determine the degrees of change for our two measures as affected by the three treatments. (See Table XIII.) It can be seen that the degrees of skin softening and smoothing were highly correlated ( $p < 0.001$ ) after all treatments employed.

Interview data indicated that those individuals who showed little or no effect from the treatments as measured by us tended to utilize hand lotions very frequently, thus making efficacy of the 5-min treatment employed by us relatively minor.

#### *Summary: Experiment III*

We found that: 1) Water significantly softens the skin. 2) Lotion significantly softens and smooths the skin. 3) Bath Solution significantly softens and smooths the skin. 4) These effects are nondifferential among the three treatments. 5) The effects of smoothing and softening the skin were highly related after all the treatments. 6) Men benefited more than women for skin smoothing after all treatments, and for skin softening after Lotion and Bath Solution. 7) a—Those whose skin was initially relatively

**Table XIII**  
Correlations ( $r$ ) Between Percentage Smoothing and Softening for Each Treatment

Treatment	$r$
Lotion	0.87
Water	0.86
Bath Solution	0.87

harder benefitted more than those with initially softer skin after treatment with Water or Bath Solution, b—Those whose skin was initially relatively rougher benefitted more than those with initially smoother skin after treatment with Water or Bath solution, c—Lotion, paradoxically, benefitted those with initially softer and smoother skin more than those with harder and rougher skin.

#### EXPERIMENT IV: EFFECTS OF EPIDERMABRASION

One question which is frequently raised in dealing with assessing the skin softening and smoothing effects of various products is whether the measuring instruments are subject merely to the artifactitious result of measuring the properties of the *product* rather than the treated *skin per se*. Thus, we described above (under Skin Smoothness: Validity) the changes found in friction of sandpaper following application and removal of skin lotion. If the lotion were acting as a mere topical lubricant, then sandpaper would be found to be smoother. However, we were able to demonstrate no change in the smoothness of sandpaper, while enhancement of smoothness in skin was obtained, demonstrating that we are indeed measuring the effect of lotion on the skin.

Another approach to the question, which deals with this aspect of validity, is to utilize epidermabrasion. This system employs “deliberate, physical removal of the *stratum disjunctum* and other keratin excrescences of the *stratum corneum*” (2) by means of a nonmedicated “polyester fiber web.”

The purpose of this study was to determine whether physical abrasion of part of the *stratum disjunctum* would result in measurably increased smoothing and softening of skin as measured by us.

We studied one subject, a Caucasian female, aged 48. We took two successive measures of softness and smoothness of three regions on her forehead: left, central and right. Following these two pretreatment tests, we left one region untreated, applied a cotton ball soaked with tepid Water to another region for 5 min and rubbed Lotion on the third region for 1 min. Following the minute of Lotion application we waited 4 additional minutes and then removed the visible excess with a cotton ball. Finally, we continuously applied the fiber web to the entire forehead for 30 sec in a circular motion, and retested all sites for smoothness and softness.

#### *Results: Experiment IV*

*Effects of water and lotion.* The Water-treated site showed an immediate, dramatic increase in softness in contrast to the negligible changes for Lotion-treated or Untreated sites. By contrast, Lotion produced an immediate, very large increase in smoothness, whereas Water resulted only in a moderate change, and the Untreated site in no change in smoothness.

*Effects of epidermabrasion.* The differential results of epidermabrasion superimposed on Untreated, Lotion-treated, and Water-treated skin were not entirely expected. Smoothness and softness measures were not changed by epidermabrasion over the sites previously treated by Water or Lotion. However, the greatest enhancement for both the smoothness and softness measures was obtained when the abrasion was done on the formerly untreated site.

*Discussion: Experiment IV*

If Lotion or Water had only topical, surface-lubricating effects which our devices detect, then the removal of surface Lotion and the drying of the surface of the skin would have diminished the softening and smoothing effects. The fact that epidermabrasion did not diminish (or enhance) the results when applied to these treated sites indicates that the effects were already incorporated into the stratum corneum and that the instruments were indeed measuring actual changes in the skin and not merely artifacts of local surface lubrication.

This fact is further brought home by the finding that the Untreated site showed that epidermabrasion alone resulted in considerably softer and smoother skin after only one 30-sec treatment.

We thus conclude that our devices are measuring changes in skin and not mere artifacts of surface lubrication and further that, once treated topically, epidermabrasion does not diminish the effect by the removal of the potential surface lubricant.

## EXPERIMENT V: AN EVALUATION OF SHAVING

In view of the demonstrated ability of the smoothness evaluation system to assess the enhancement in the smoothness of the skin, we applied a different probe to determine whether we could evaluate the effectiveness of shaving creams or razors in producing close shaves. We produced a new sled (a fine metal mesh) which enables the hair shafts to penetrate it.

The experiment comprised determining the degree of smoothness of the face in a man who hadn't shaved for 24 and 48 hr. We measured his facial smoothness immediately

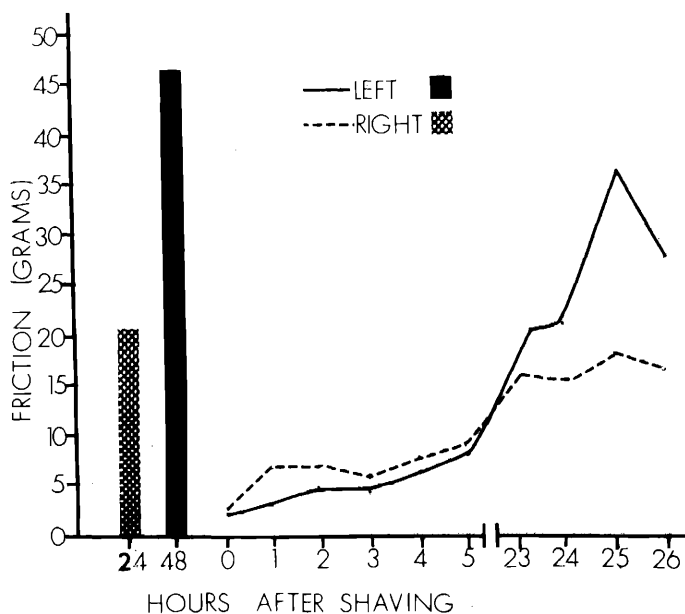


Figure 7. Facial smoothness prior to and following shaving

following shaving and after 1, 2, 3, 4, 5, 23, 24, 25 and 26 hr. The results, which are rather clearcut, are depicted in Figure 7.

This indicates that there is differential hair growth on the two sides of the face, which is monotonic with time. The growth of hair can be measured almost hourly and the effectiveness of shaving can be assessed.

#### COMPARISON OF SMOOTHING AND SOFTENING SKIN

The series of correlations (see above) has demonstrated that three skin treatments produced smoothing and softening effects on the skin. This finding should not be of surprise. However, since the methods are operationally distinct, one can conceive of producing a smooth skin, *e.g.*, by mechanically removing surface roughness, but not necessarily by softening it. Conversely, one might be able to soften a surface, leave it rough, or indeed, even roughen it additionally in the process. Comparison of the results of Experiments I and II illustrated that such a dissociation may have indeed occurred.

Thus, Figure 3 shows that water had an immediate softening effect which was dissipated after 5 min while the lotion maintained its effect. Figure 6, however, shows that even 10 min after treatment and after forced drying with heated air, the Water Treatment group still showed significant smoothness.

We believe moisturization of the stratum corneum to be one major cause of smoothing and softening the skin; epidermabrasion is another. We are, therefore, considering a study to assess the direct effects of varying *degrees* of moisturization or epidermabrasion on the smoothing and softening of the skin.

#### CONCLUSIONS

We have described the development of two systems for assessing, *in vivo*, the softness and smoothness of skin. These methods have high retest reliability, precision and validity, and can be applied on various skin surfaces to determine the effectiveness of skin treatments in softening or smoothing the skin. The system for assessing skin smoothness has also been adapted to measure the degree of facial smoothness as a function of efficacy of shaving creams or razors. The two systems are capable of assessing the beneficial effects of various skin treatments and must be considered measures of separate effects.

#### ACKNOWLEDGMENTS

The author wishes to thank Dr. Norman Orentreich and his staff for helpful criticisms of this report, and for suggesting study of the potential artifact of lotion as an external lubricant. Dr. Orentreich suggested the study of the effect of lotion on sandpaper and the study of the softening and smoothing effects of epidermabrasion. We are grateful to the Orentreich Medical Group for making available a sufficient supply of Buf-Puf, a polyester fiber web, to study the effects of epidermabrasion on softening and smoothing skin. Most of the tests and analyses were capably done by Peter Filosi, Curt

Weinstein and David Canestrari, and the author wishes to express his gratitude to them.

#### REFERENCES

- (1) I. H. Blank, Factors which influence the water content of the stratum corneum, *J. Invest. Dermatol.*, **18**, 433(1952).
- (2) N. Orentreich and N. P. Durr, "Epidermabrasion: Physical Mechanical Abrasion of the Epidermis," *A scientific exhibit at 33rd annual meeting, Amer. Acad. Dermatol.*, 1974, Chicago, Illinois.
- (3) G. Imokawa, K. Sumura and M. Katsumi, Study on skin roughness caused by surfactants: I. a new method in vivo for evaluation of skin roughness, *J. Amer. Oil Chem. Soc.*, **52**, 479(1975).
- (4) G. Imokawa, K. Sumura and M. Katsumi, Study on skin roughness caused by surfactants: II. correlation between protein denaturation and skin roughness. *J. Amer. Oil Chem. Soc.*, **52**, 483(1975).
- (5) G. Imokawa and T. Takeuchi, Surfactants and skin roughness, *Cosmetics and Toiletries*, **91**, 32(1976).
- (6) R. Marks and A. D. Pearse, Surfometry, a method of evaluating the internal structure of the stratum corneum, *Brit. J. Dermatol.*, **92**, 651(1975).
- (7) J. K. Prall, Instrumental evaluation of the effects of cosmetic products on skin surfaces with particular reference to smoothness, *J. Soc. Cosmet. Chem.*, **24**, 693(1973).