

DGK Working Group IV – Sensory*

Coherence Between Product Viscosity and Subjectively Perceived Hold and Acceptance of Hair Gels

■ Introduction

Users of styling products may perceive the viscosity of a styling product as a performance indicator. Developers of new styling products face the challenge that products must not only have a styling performance, but additionally a specific viscosity as well. In this paper, the functional connection between the viscosity as an objectively measured physical variable and subjective consumer evaluations for hair gels will be investigated. Within the scope of a standardized consumer test method, four different hair gels were tested for their acceptance and the perceived hold. The hair gels differed only in their viscosity, but not in the objectively measured hold, because all ingredients influencing the hold were kept identical. A clear correlation between the perceived texture with the expected and the perceived hold will be deduced. It will be shown how the perceived texture of the products influences the expectations for the product acceptance as well as for the expected hold (before applying to the hair) and the perceived hold (after application) which is the final evaluation of firmness.

Raw material manufacturers historically have expertise in *in vitro* measurements. Such tests are quick, simple and cost-effective. End user product tests are more time consuming and cost intensive, but needed if one wants to gain results that are valid for the consumers of such products. A highly desirable goal would be to pre-determine the end-user acceptance of a product via selected, simple *in vitro* measurements. So it was the primary target of the present study to investigate

correlations of results of *in vitro* measurements and end user product tests. Further, the study could give some information about the internal and external validity of affective sensory tests.

»Internal validity« is given if measured acceptance differences result from the physico-chemical character of the product and all uncontrollable disturbance variables are standardized or controlled.

Abstract

A study was conducted on hair gels to investigate the functional connection between the product's viscosity and subjective consumer evaluations. Four different hair gels that differed only in their viscosity, but not in the objectively measured hold, were tested for their acceptance and the perceived hold.

One objective of this study was to gain further key learnings about the central-location-test procedure in the field of testing cosmetic products, because it becomes more and more important, and to compare it with the home-use-test procedure.

Key insights: A clear correlation between the performance based on viscosity/texture and the expected and the perceived hold exists for the end-users. The perceived texture of the products influences several consumer relevant aspects including the perceived hold (after application) which is the final evaluation of firmness. Concerning the correlation of the viscosity and the hold of the product it can be deduced that the central-location-test and the home-use-test offer nearly the same results and that one test may be sufficient to get an indication on the product differences relating to the correlation between viscosity and hold.

The measured results are considered to possess »external validity« if they can be generalized to the target population of the test and to consumer behaviour. A clear recommendation for internal validity as a »must« for the accomplishment of end-user tests where the primary goal is to measure responses to different variants are given for coffee products (1). Normally end-user tests in the cosmetic industry are conducted as home use tests (HUT). HUT is a well-established method for consumer's sensory evaluation in cosmetic product development. During such tests consumers use the products at home and fill out the corresponding questionnaires. This test situation is not well controllable and a rather low internal validity can be assumed. To account for the external validity, rather high sample sizes are considered in HUT situations, which is an important cost factor. In the food industry however central location tests (CLT) are widely-used test

procedures (2, 3). The entire test situation is well controllable including the environmental conditions like light, temperature, noise and odour, which is especially important for sensory tests. Latterly in the cosmetic industry the CLT procedure becomes more and more important, too (4). Therefore it is of interest to gain more key learnings about the CLT procedure in the field of testing cosmetic products with end-users and to compare it with the HUT procedure. In this paper the performance (efficiency) of both tests HUT and CLT will be investigated. Both test methods are used to investigate the hair gels in terms of gaining results from the end-users. A clear correlation between the two methods will be deduced and strength and weakness within the context of the end-user hair gel test will be explored. Finally the results of both methods in terms of correlation with the measured viscosity as *in vitro* measurement will be investigated.

■ Methodology

Products

For this experiment, 4 hair gels were prepared that differed only in the viscosity (Table 1). All ingredients that are responsible for the hold of the hair were identical in all four products. All hair gels were in the range of commercially available hair gels with strong hold.

After application on the hair and a waiting period of 20 minutes, all products should have the same firmness – i.e. the only varying factor between the products was the viscosity of the gel before being applied to the hair and unlocking its full potential. All other influencing factors (appearance, colour, scent etc.) which can also affect the subjective evaluation of the hair firmness were kept identical. All products were presented in neutral small jars and marked with a three-digit code. No brand names were mentioned during the entire test.

Ingredients	INCI	Function	Sample D	Sample C	Sample B	Sample A
Water	Aqua		85.9	86.08	86.26	86.44
Carbopol 980 Polymer	Carbomer	Thickener (viscosity influencing agent)	0.5	0.4	0.3	0.2
AMP-95	Aminomethyl Propanol	Neutralization (pH value adjusting) agent	0.4	0.32	0.24	0.16
Luviskol K 90 solution	PVP	Hair fixative	10	10	10	10
D-Panthenol 75 W	Panthenol	Active ingredient	0.3	0.3	0.3	0.3
1,2-Propylen Glycol Care	Propylene glycol	humectant	2	2	2	2
Euxyl PE 9010	Phenoxyethanol, Ethylhexylglycerin	Preservative	0.5	0.5	0.5	0.5
Fragrance			0.4	0.4	0.4	0.4
viscosity [mPa*s] ¹			42000	34000	23100	13600
			high	medium	low	very low
stiffness [cN] ²			62 ± 13	56 ± 8	62 ± 12	49 ± 14

¹ Brookfield DV-II+, 20 rpm, spindle 6, 20s

² 2-point stiffness test on flat tresses (Caucasian hair) with diluted gel (50g gel, 170g water), approx. 1.6g gel on the strand, measured with Texture Analyser TA.XTPlus at 4 defined measuring points (v=120mm/min, depth of bending: 20mm), conditions (drying overnight/ measuring): 20°C+ 65% relative humidity; no significant differences can be shown (Tukey test at $\alpha = 0.05$)

Table 1 Composition and physico-chemical characterization of the 4 hair gels (all ingredient concentrations are percent by weight)

Participants

From November 19th to December 6th, 2010, 61 male consumers participated in the sensory consumer test, which took place in Göttingen, Germany. All participants were pre-recruited by telephone from the isi consumer database. They were between 18 and 50 years old, used hair gel several times per week in damp hair and had matchstick short hair. All participants had to prefer styling products with a strong hold as the test products did belong to this category.

Test design

Consumers were recruited who complied with the recruitment criteria and were invited to a central location test (CLT) at a sensory laboratory. The sensory laboratory is equipped with single-user sensory test booths that allow individual product evaluation in a standardized test situation. Additionally, the shampoo which respondents were asked to use for washing their hair was standardized. The shampoo was sent to the consumers directly after phone-recruitment. The participants washed their hair with this shampoo at home on the test day. All respondents came to the sensory laboratory with freshly washed dry hair, without any additional use of other styling products. They evaluated the products in a sequential monadic approach, only one product within one test session of about 40 minutes and all four products in 4 sessions. The order of products was balanced and randomly assigned to the respondents. This procedure minimized a possible order effect of products.

The assessment of the hair gel followed a three step procedure. In the first step (before application), the gels were evaluated in small jars that were filled with 35 g of gel and the first part of the questionnaire was filled out. In the second step (application on hair), each respondent received a small coded syringe containing 3 g of gel. This weight related to the approximate application amount in real life situation. The hair of the respondents was equally moistened with 2 g of water from a spray bottle to guarantee the water uptake accordingly to short hair in practice. Afterwards, the respondents put the gel onto their hands and

distributed it evenly into their hair. After this procedure, part 2 of the questionnaire (during application) was filled out. After 20 minutes, when the gels had hardened, the last part (after application) was filled out. During all three steps, acceptance questions including the overall liking were asked using a 9-point hedonic scale ranging from »dislike extremely« (score 1) to »like extremely« (score 9). Besides some other sensory questions, questions concerning the hold (expected and perceived) were asked and rated again on a 9-point scale. The data were collected in a sensory laboratory with a computer-assisted web interview using EQUIP® software. Consumers completed the questionnaire by themselves. After the consumers had finished all four CLT sessions they were invited to do a HUT with the same products. The consumers got all four products together with an instruction for the additional HUT, but they did not know that they applied the same products as in the CLT. They were only instructed to do a test with hair gels at home. They applied each of the four gels for exactly 2 days over a HUT period of eight days. Before, during and after the application of the hair gels they filled out the corresponding product questionnaire. The order of products was balanced and randomly assigned to the respondents like it was in the CLT. During all three questioning steps in the HUT, the same questions as in the CLT were asked using the same 9-point hedonic scale.

Statistical analysis

All data were analyzed using analysis of variance, and post hoc differences between means were determined using Duncan test values at $\alpha = 0.05$. Products

that were not significantly different are marked with the same letter in the Figures. Products that were significantly different are marked with different letters. As the results are based on a sample size of 61 respondents and not on the whole market, the findings have to be extrapolated to the population in general, i.e. the result of the statistical test states whether the measured mean score differences are only in this sample or generalizable for the overall market. The results of the statistical tests indicate a probability that two or more samples are rated differently in reality.

Results and Conclusion

Overall acceptance

Analyzing the overall acceptance after application, when the respondents gave their final acceptance scores for the products, no significant differences between all four hair gel products were found for the CLT but for the HUT. In the HUT »Sample D« (highest viscosity) was judged significantly better than »Sample A« (lowest viscosity). Despite not being statistically significant in the CLT, »Sample D« and »Sample C« were evaluated better in tendency than the other two hair gel samples (Table 2). This result shows that the hair gels with a higher viscosity got slightly better acceptance scores compared to the hair gels with a lower viscosity for both the CLT and the HUT.

Expectation of hold and expected liking

Besides the level of liking the products, the coherence of perceived texture and the subjectively deduced expectation of

Sample	D	C	B	A
CLT	5.6	5.6	5.1	5.1
HUT	5.9 a	5.5 ab	5.2 ab	4.9 b

Scale: 1=dislike extremely, 9=like extremely, equal letters indicate that no statistically significant differences exist. Different letters mean that these samples were rated differently.

Table 2 Mean values for overall liking after application for CLT and HUT

hold is a main concern. For the CLT as well as for the HUT it can be seen that the perceived viscosity is strongly correlated with an expected stronger hold and an expected higher liking: The higher the viscosity, the higher the expected hold and the expected liking. Additionally, product »Sample D« and »Sample C« as well as »Sample B« and »Sample A« can be grouped. Both groups of products were perceived significantly differently (Fig. 1).

Interestingly, for sample D (highest viscosity) the application test appears to be a disappointment (Table 3). The comparison of »expected liking before application« and the »overall acceptance after application« shows a decrease in values for the HUT. The same situation occurs for »Sample C« in the HUT. The sensory

CLT	Sample D	Sample C	Sample B	Sample A
expected liking before application	6.3	5.8	5.0	4.7
overall acceptance after application	5.6	5.6	5.1	5.1
significant difference?	Yes	No	No	No
HUT	Sample D	Sample C	Sample B	Sample A
expected liking before application	6.0	6.0	4.9	4.1
overall acceptance after application	5.9	5.5	5.2	4.9
significant difference?	No	Yes	No	Yes

Scale: 1 = dislike extremely, 9 = like extremely

Table 3 Comparison of liking before (expectation) and after application for CLT and HUT

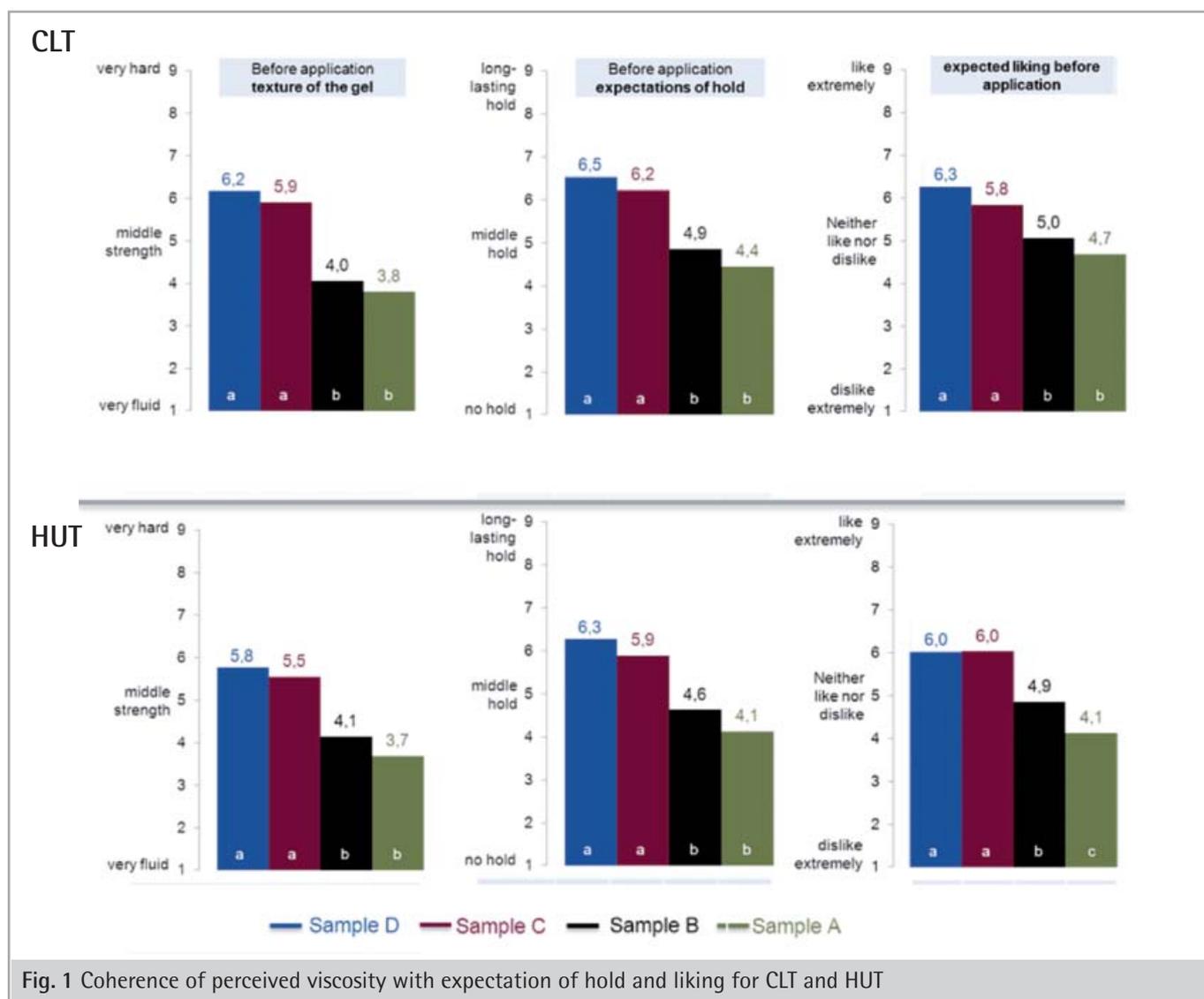


Fig. 1 Coherence of perceived viscosity with expectation of hold and liking for CLT and HUT

experience of the other three samples was rated on a comparable level compared to the expectations prior to testing. Only »Sample A« received slightly higher (CLT) and a significantly higher (HUT) value after testing compared to the expectations prior to testing.

Expected and perceived hold

Based on the test set up and the identical styling polymer inducing the hold it was assumed that the hold for all four products was identical after application and a drying time of 20 min. But according to the shown results before application (expectation), during application and after application (Fig. 2), it was clearly seen that even after application

and drying time the sensation of hold rises with the viscosity. So the factor for the consumers to value a hair gel product was the hold. Additionally a high correlation of 0.98 could be found between the viscosity and the perceived hold after application for both the HUT and the CLT (Fig. 3), which clearly proves that the perceived hold is driven by the product's viscosity.

Based on the results of these tests, it could be deduced that the perceived viscosity before and during the application strongly affected the perceived actual hold after application, even if from an objective point of view the hold should have been and was the same for all four hair gels. From this result it was concluded that the perceived hold after ap-

plication was not inferred independently of other perceptions by the respondents, but rather was influenced by all previously made perceptions. It was seen that the differently perceived hold after application did not influence the overall liking of respondents. This showed that the implicit process of coming to a final overall liking was more or less independent of what the consumers perceived or »believed« that they perceived.

Finally the results of the CLT in comparison with the HUT are explored. First of all it has to be pointed out that the results of the HUT showed a good correlation with the results of the CLT. Because of the standardized test situation it was expected that the results of the CLT are more differentiated in comparison with

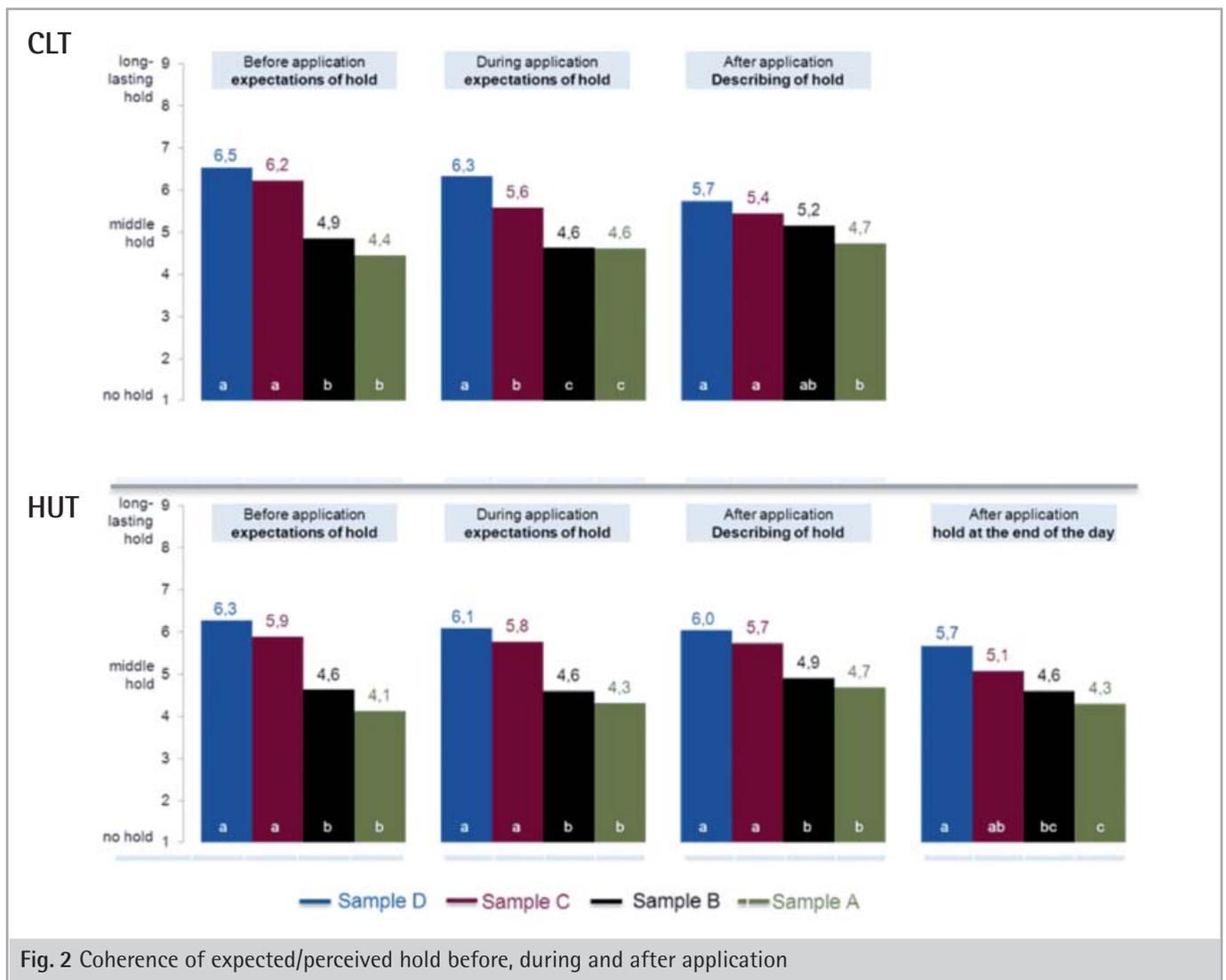


Fig. 2 Coherence of expected/perceived hold before, during and after application

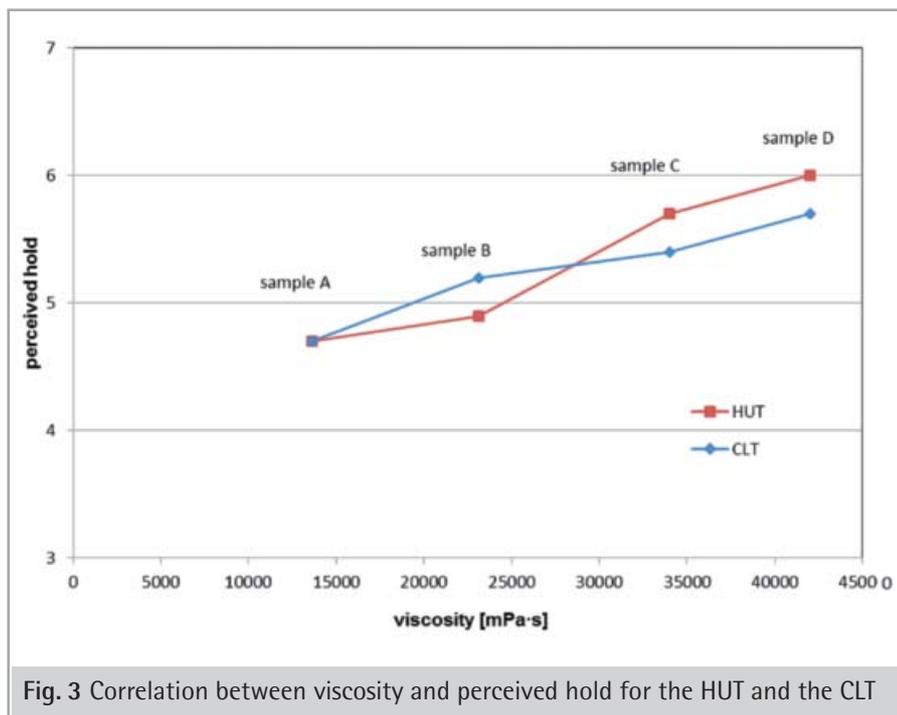


Fig. 3 Correlation between viscosity and perceived hold for the HUT and the CLT

the HUT. The results of the two tests showed however that the HUT offers slightly more distinguishable results. This might be explained by the influence of testing the products at home in the usual manner. Furthermore it is important to mention that the participants of the CLT and the HUT were identical so that there might have been an influence on the results. The judgments are not independent from each other. However, using the same consumers guaranteed the same hair quality in both tests. The consumers already knew the products tested in the HUT. Even if they did not know they were the same, they experienced the products before in the CLT and therefore could get more testing knowledge, i.e. maybe they are more discriminating. This possible influence should be further investigated in

a separate study with independent groups of consumers. Concerning the correlation of the viscosity and the hold of the product it can be deduced that the CLT and the HUT offer the same results and that one test may be sufficient for e.g. product development to get an indication on the product differences relating to the correlation between viscosity and hold.

Every test design has its own profile. The CLT works well in the first development step when several products have to be screened quickly and decisions are necessary for the next development steps. At the end of the development the market potential/ relevance has to be evaluated with the favorite formulas to detect the winning formula. The products had to be evaluated by the consumer in real life situation.

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