LEXICON DEVELOPMENT FOR LIP PRODUCTS USING DESCRIPTIVE SENSORY ANALYSIS

by

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Abstract

The cosmetic industry is growing rapidly, and one popular category is lip products. Women consider lip products a necessity and many would not leave home without it. Though the bigger cosmetic companies may have internal cosmetic lexicons, they are not available in the public domain. The purpose of this study was to develop a lexicon for descriptive sensory testing of lip products. Lip balms, lip glosses, and lipsticks were tested in this study. In part 1 (EXPERIMENT 1), two focus groups were conducted to understand women's perceptions of lip products, and also to elicit desirable and undesirable characteristics in the products. The women's idea of a perfect lip product was: clear/sheer/neutral color, smooth, not sticky, moisturizing and flavorless/tasteless**.** In part 2 (EXPERIMENT 2), a lexicon was developed for the lip products. Attributes were categorized under "Initial Texture", "Initial Appearance", "After Appearance" and "After Texture." In part 3 (EXPERIMENT 3) of the study, the lexicon was validated by testing various lip products using lexicon developed in part 2. The analysis of variance (ANOVA) results by product type indicated that the lexicon was able to differentiate among the lipsticks, lip balms and lip glosses. The lexicon was further able to show similarities and differences within a product type. Principal component analysis and cluster analysis, which are both multivariate techniques, validated the inferences from the univariate analysis (ANOVA). The two panelist groups (three panelists from the lexicon development panel – group 1, and three new panelists – group 2) showed no differences ($P > 0.05$) in attribute evaluations for all the samples tested. The lexicon developed in this study could be used to identify similarities and differences in other lip products such as lip plumper, lip liners and multi-use products. The authors hope that this research is extrapolated to other aspects of the personal care industry, such as hair care and skin care, and can aid in product development, product optimization, and claim substantiation.

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Dedication

This is dedicated to my family. Your support, enthusiasm and love have made this possible. I'm not sure if I have ever felt as close with you than when I have been so far away. Thank you for always being there for me, telling it to me like it is, and pretending to understand what "sensory" actually is!

CHAPTER 1 - Review of Literature

A history of cosmetics

Overview

Evidence of some form of cosmetic use can be found as far back as the Stone Age. These early cosmetic purposes were more as a protection against nature's elements, as opposed to a beautification process. Oils, clays and paints were used for protection from burns, cold, and irritation. Various religions used cosmetics as a way to remove evil spirits though incense or paint the body to ward off evil. As the years progressed and society became more civilized, the reasons for using cosmetics changed. Now used more for beautification and attraction than anything else, cosmetics are found to improve self-esteem, protect skin, prevent aging, and any other number of emerging uses (Mitsui 1997).

Since the function of cosmetics is constantly changing, so too is the definition. The Food and Drug Administration defines a cosmetic as "(1) articles intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, and (2) articles intended for use as a component of any such articles; except that such term shall not include soap" (FDA 2004). Cosmetics are classified by their use, area of application, composition and structure. Groups include skin care, body care, hair care, oral care, and fragrances (see Table 1.1).

Lipstick

Lipstick has had a long and illustrious life. Dating back to 5,000 BC, lipstick has had affiliations with Satan, prostitutes, and warriors entering battle. It is prominent in the history of the Ancient World, the Middle Ages and Renaissance, and the 19th and 20th centuries. As recent as 1924, lipstick was a concern for the New York Board of Health. It was thought that men who kissed women wearing lipstick were going to be poisoned (Ogilvie and Kristensen-Bach 2001).

Table 1.1 Classification of Cosmetics (Mitsui 1997)

Classification	Usage	Main Products
Skin care cosmetics	Cleansers	Face cleansing, creams and foams
	Conditioners	Lotions, packs, massage creams
	Protectors	Milky lotions, moisture creams
Makeup cosmetics	Base Makeups	Foundations, face powders
	Point Makeups	Lipstick, blushers, eye shadow, eye liners
	Nail Care	Nail enamels, nail polish removers
Bath cosmetics	Bath	Soaps, liquid cleansers, bath preparations
	Suncares and suntans	Sunscreen creams, sun oils
	Antiperspirants and Deodorants	Deodorant sprays
	Bleaching, Depilatory	Bleaching creams, depilatory creams
	Insect repellents	Insect repellent lotions and sprays
Hair care cosmetics	Cleansing	Shampoos
	Treatments	Rinses, hair treatments
	Hair styling	Hair mousses, hair liquids, pomades
	Permanent waves	Permanent Wave lotions (Agent No.1, No.2)
	Hair colors and bleaches	Hair colors, hair bleaches, color rinses
Scalp care cosmetics	Hair growth promoters	Hair growth promoters, hair tonics
Oral care cosmetics	Treatments	Scalp treatments
	Toothpastes	Toothpastes
	Mouthwashes	Mouthwashes
Fragrances	Fragrances	Perfumes, Eau de Colognes

The act of wearing lipstick has had multiple connotations throughout history, from sexual relations to social status to morality (Merskin 2007). Lipstick is now a mainstream cosmetic and, to some women, a necessity. The purpose of lipstick is to give life to the face and protect lips from drying (Anon 2003; Mitsui 1997). The belief that

makeup enhances attractiveness has made the cosmetic industry one of the most profitable and successful industries in the world (Mulhern *et al.* 2003). Many women will not leave home without wearing lipstick and consider it the most important makeup item (Merskin 2007). It has been found that both men and women prefer faces with makeup significantly more than the same face without makeup (Mulhern *et al.* 2003).

Lipstick, which is a stiff oil-wax base, is an extremely popular cosmetic in developed countries. The base is combined with a staining dye, dissolved into oil with suspended color pigments, and then placed in a mold. Over the years the rigidity of this process has lessened to allow for a greater variety of colors, hues, and lusters (Balsam and Sagarin 1972).

The psychology of make-up

Studies have shown that female faces with make-up are judged by men and women to be more attractive than those without make-up, and that the standard of beauty is consistent across age, race, and gender (Mulhern 2003; Fink and Neave 2005). One study concluded that men found women who wore makeup to be "more frivolous, less talkative, more anxious, less conscientious, and more interested in the opposite sex" (Fink and Neave 2005). With the assumption that proper application of foundation, eye makeup and lipstick can cause symmetry of features, properly "made up" faces are seen more favorably. Women may be subconsciously applying makeup as away to align their features and be viewed as more attractive (Nash *et al.* 2006). Facial symmetry can convey emotional and psychological health for both men and women. Studies have shown that full, defined lips denote youth, health and attractiveness, whereas thin, unadorned lips denote "fragility and senility." The most desired human attribute is flawless skin, since any apparent infection may subconsciously indicate a reduced reproductive ability (Fink and Neave 2005).

When looking for a product to buy, studies have shown that fun, descriptive names of cosmetics resonate positively with women. Most of these names are based on food, beverages and romance. These names, such as "Truly Toffee" and "Raisin Hell", feed into the beauty ideal (Merskin 2007). Companies spend enormous amounts of time and money creating product names that will lure the consumer to not only buy their product,

but to choose it over a competitor's product. Since the consumer decision-making process is random and not always logical, the perfect name has to penetrate the walls around a person's psyche. Studies have shown that consumers prefer fancy names over generic names. If an appealing name is presented, the consumer will react positively toward the product. Skorinko *et al.* (2006) found that consumers preferred color swatches with fancy names more than generic names, even if the name did not describe the color (i.e. "moonlight").

Cosmetic sales, trends and marketing

Color cosmetics are considered to be essential beauty items – one of the few affordable and non-invasive beauty treatments. As of 2005, global make-up sales reached $23.8 billion, an increase of 5.0% from 2001 (Datamonitor 2006a). The U.S. color cosmetic market had increased sales of 3.4% from 2004 and reached $5.2 billion dollars in 2005. Makeup products constituted 18% of the global cosmetic market, and market forecasters predict the U.S. make-up market will reach $6.1 billion by 2010, which will be an increase of 19.2% since 2005. The U.S. is the largest consumer of color cosmetics. Though 21.7% of global make-up sales are from the U.S., increased global sales are mainly because of the emerging presence in such markets as Eastern Europe, India, and Latin America (Datamonitor 2006b; Horne 2005; Kumar 2005). Eastern Europe has shown steady growth for five consecutive years to reach annual sales increases of 10.2% per year (Horne 2005). Within the many sectors of the cosmetic industry, lip products are the third largest division (Datamonitor 2006b). Mass market lipstick represents the largest segment of lip products in the United States, accounting for 51.1% of the market value (Datamonitor 2001)

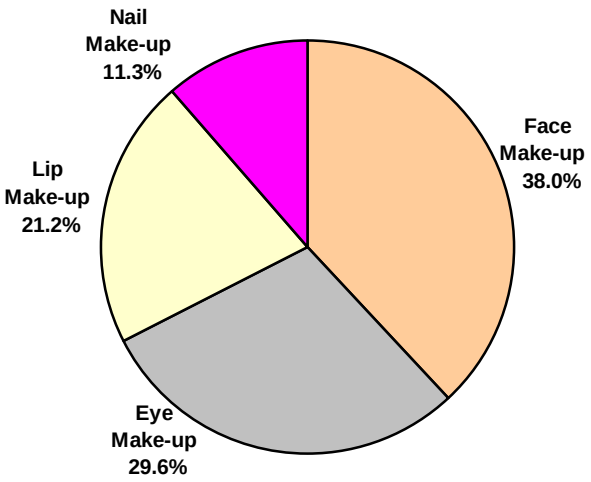

Fig 1.1 United States Make-Up Market Segmentation, 2005 (Datamonitor 2006b)

While some geographic areas have shown growth, certain other areas, such as Japan and the US, have showed negative or negligible growth. The purchase of lower-cost and quality cosmetics by consumers has affected global color cosmetic sales as a whole (Horne 2005). To maintain growth, consumers must be encouraged to purchase higher-cost and quality cosmetics. The most dynamic region for cosmetics is China. Cosmetic and toiletry sales have grown 20-25% from 2000-2005. Though current per capita cosmetic spending is only $4, sales are projected to reach $9.6 billion by 2010 (Feller 2005).

The cosmetic industry is highly dependent upon trends. Because of the trend toward smoky eyes and glossy lips, lip gloss sales increased by 8.9% in 2004 from the previous year (Horne 2005). Global lipstick and lip liner sales decreased from 2001-2006, mostly because of western consumers' who have begun to favor lip glosses. Lipsticks and lip liners are still popular in Eastern Europe and Latin America, but the $9.9 billion dollar industry is still in decline (Prance 2007).

Organic and natural cosmetics have seen growth in recent years, similar to the organic food market. It is difficult to quantify organic cosmetic sales because of a lack of a standard definition for organic cosmetics. Sales for all organic and natural cosmetics and toiletries increased 32.5% in 2005 from 2004, reaching sales of $744 million. Manufacturers have increased the use of vitamins, minerals, berries, aloes, and extract in

their products as well (Kumar 2005). It is estimated that US organic and natural cosmetics will reach $5.8 billion in 2008 (Caldwell 2006).

Cosmetics formulation

Regulations

When lipstick use was reaching a peak in the 1920s, safety regulations were not in effect to protect the women who used lipstick. A common lipstick recipe of the time period included crushed insects as a main ingredient. The Pure Food and Drug Act of 1906 initially included cosmetics under its auspices. However, in order for the bill to pass, lawmakers were pressured by the National Pure Food and Drug Congress to remove the cosmetic provision. The popularity of lipstick exploded in the 1930s during the Great Depression. This popularity propelled politicians, such as President Franklin Roosevelt, to take action against cosmetic safety and health regulations at both the federal and state level. Even with this momentum, it took five separate bills, over 40 significant changes, and two years of debate for an act to be passed. Finally, in 1936, the cosmetic provision was passed, thereby strengthening the 1906 Pure Food and Drug Act to once again include cosmetics. The Federal Trade Commission in the 1950s developed guidelines and restrictions for appropriate claims made by lipstick manufacturers (Federal 2004; Schaffer 2007).

Many agencies and organizations exist to regulate and monitor the safety of cosmetics to consumers, including the Cosmetic Ingredient Review (CIR) and the Research Institute for Fragrance Materials (RIFM) (Kumar 2005). Basic guidelines include criteria for skin irritation, sensitization, phototoxicity, photosensitization, eye irritation, and toxicity.

Active and vehicle ingredients

Cosmetic ingredients are separated into two groups: *active ingredients*, those which affect the skin's appearance, and *vehicle ingredients*, those which do not affect the skin's appearance, but are necessary in the product "recipe" (Loney 2006). A newly-developed term, cosmeceutical, implies an active ingredient which provides a drug-like or medicinal benefit to the user (FDA 2006). The cosmeceutical industry had global sales of $2.8 billion in 2001 (Kumar 2005).

Emollients and lubrication

Emollients are ingredients that supply lubrication for products to prevent the feeling of dryness by replacing natural lipids (Parente *et al.* 2005). Emollients give the applied surface a smooth, soft feeling, and flexibility. The lubrication imparted by moisturizers is highly correlated with consumer satisfaction (Kraft and Lynde 2004). Common liquid emollients include mineral oil, sunflower oil, squalane, dimethicone, and cyclomethicone (Parente *et al*. 2005). In lip products, emollient ingredients include vasoline, lanolin, shea butter, and cocoa butter, all of which consist of a fatty ester – the combination of a fatty acid and an alcohol (Loney 2006).

Natural emollients, such as essential fatty acids like linoleic acid, promote good skin health (Alfaro *et al*. 2000). Certain physicochemical properties affected by emollients are consistency and spreadability. Kraft and Lynde (2004) divided emollients into five categories: 1) astringent emollients (dimethicone), 2) dry emollients (isopropyl palmitate), 3) fatting emollients (glyceryl stearate), 4) protective emollients (isopropyl isostearate), and 5) protein rejuevenators (collagen, elastin, keratin).

Bases, oils and waxes

Bases are essential for providing the correct application and longevity to lipstick. One compound alone cannot achieve the desirable characteristics of uniform dispersion, smooth application, resistance to breakage, and soft application; so a combination of oils, fats, and waxes must be included in the formulations (Balsam and Sagarin 1972).

Mineral and castor oils have been utilized in the production of lipstick, each with its own benefits. Mineral oils are mainly used to enhance the glossiness of a lipstick. They are not good carriers for color and tend to smear and run off too easily. Castor oils have a high viscosity and leave a soft film on the lips (Marti-Mestres *et al.* 1999). Castor oil's molecular complexity decreases the tendency for lipstick to smear and run off (Balsam and Sagarin 1972).

Waxes are included to provide structure to the lipstick and preserve the solid state until 50°C. The ideal wax will "not bleed or sweat, but will allow smooth, easy application of color with minimum pressure against the lips" (Balsam and Sagarin 1972). Common cosmetic waxes include animal waxes, such as beeswax (traditional stiffening

agent), and vegetal waxes such as carnauba (natural vegetable wax, high melting point) and candelilla (lower melting point than carnauba) (Castro 2006; Balsam and Sagarin 1972; Marti-Mestres *et al.* 1999).

Humectants and occlusion

Another type of moisturizing agent, humectants, is different from emollients in that they promote moisture retention by attracting water to themselves (Purist 2006). Honey, glycerin, propylene glycol and gelatin are some substances with humectant characteristics (Kraft and Lynde 2005). The most effective humectants are polyols, with glycerol being the most effective (Rawlings *et al.* 2004). Occasionally, humectants have been known to increase transepidermal water loss (TEWL). TEWL occurs when water migrates from deep epidermal layers into the *stratum corneum* (or skin) and is evaporated. To prevent TEWL, humectants are combined with an occlusive agent. These agents create a hydrophobic barrier over the skin to prevent any transepidermal water loss. Common occlusive agents are petroleum jelly, lanolin, mineral oil, and silicones (i.e. dimethicone) (Kraft and Lynde 2005). Buraczewska *et al.* (2007) conducted a study using an artificial silicone barrier on skin to measure the amount of TEWL. This barrier was designed to duplicate the occlusion effects found in creams and lotions. Results from the study indicate that the barrier was effective in reducing TEWL.

Color

With the plethora of lip products available today, colors are also a deciding factor for purchase by consumers. Closely monitored by the FDA, color additives in cosmetics must meet stringent governmental guidelines and not exceed the maximum amount allowed. The two categories of color additives are 1) subject to certification – derived mainly from petroleum, and 2) exempt from certification – derived mainly from minerals, plants, and animals (FDA 2006). Lipstick color is derived from pigments. A pigment itself is made up of lake pigments and color pigments (Mitsui 1997). Lake pigments, which are organic in nature, are common in lipstick because of their ability to prevent bleeding of the color (FDA 2006). Lipsticks also contain "pearls" which reflect light to create a pearlescent effect. This is produced when a thin layer of color is placed on mica platelets (Castro 2006).

Natural cosmetic ingredients

Preservatives are added to cosmetics to prevent unwanted microbial growth, such as fungi and bacteria. Preservatives must be added to ward off malodor and putrefaction caused by microorganisms, and to prevent product deterioration (Mitsui 1997). One particularly strong ingredient in the organic personal care industry is fruit, along with herbs and vitamins such as C and E (Caldwell 2006). The α-tocopherol isomer of Vitamin E has been shown to reduce facial lines and wrinkles by reducing transepidermic water loss (Alfaro *et al.* 2000).

Types of lip products

Within the lip product category of cosmetics, there exists a multitude of products for every possible need. There are lipsticks, lip balms, and lip glosses. For lipsticks, there are matte finishes, crème finishes, sheers/stains, shimmers, frost and long-lasting colors (Johnson 1999). Table 1.2 shows the effects each of these finishes (and their ingredients) have on the eventual outcome of the product once they are applied. The various textures of lip products can drastically affect the appearance of a woman's face, particularly when applied with eye makeup (Mulhern *et al.* 2003).

Lipstick

Mitsui (1997, p. 386) describes the optimal conditions and characteristics for lipsticks. These include non-irritating to lips; no unpleasant taste or aroma; smooth application without smearing and stay looking good for desired amount of time; retain form without breakage, deformation or softening, non-sweating/non-blooming; and should not change color over time.

Consumer expectations for lipsticks parallel the criteria stated by Mitsui (1997): easy application, good color coverage, natural look, moist feel, not drying, no bleeding, should not change color, and no cracking or peeling. Table 1.3 details the requirements of a "good" lipstick. The chemistry behind lipsticks is very tricky and if certain standards are not followed or formulas are imbalanced, undesirable conditions can occur. One such problem is blooming (also known as syneresis or sweating), in which high temperatures cause parts of liquid in the formulation to separate and materialize on the surface. Blooming is a result of crystal lattices formed by the waxes during the molding process.

There is a fine line between crystallinity and amorphousness. To combat this problem, manufacturers must modify the wax lattice (Dweck 1981). Aeration, pinholing, laddering, crackline/chipping, deformation, cratering, streaking, sweating, and mushy failure are possible problems that occur during moulding. The laddering effect is caused by improper temperature or filling rate causing the lipstick to have several layers resembling a ladder. Cratering shows "dimples" on the lipstick surface, caused by oils either in the formula or in the manufacturing process. Mushy failure occurs when the lipstick formula does not contain enough structure to support the lipstick mould (Dweck and Burnham 1981)

Table 1.2 Lipstick finishes, ingredients and their effects (Johnson 1999)

Finish	**Effective Ingredients**	
Matte	High wax content, high pigment, low emollients; more texture than shine	
Crème	Balance of shine and texture	
Gloss	High shine, low color	
Sheer/Stain	High oil content, medium amount of wax, low color	
Shimmer	Extra glimmer	
Frost	Bismuth compound to "pearlize" the finish	
Long-lasting	Silicone oil	
Ingredient	**Example**	**Effect**
Waxes	Beeswax, carnauba wax, candelilla wax	Ease of application; gives lipstick it's shape
Oils/Fats	Mineral oil, lanolin, petrolatum	Consistency, lubrication, spreading*
Pigments	Dyes, Bromo acid	Provides color
Emollients	Aloe Vera, Vitamin E	Moisturizes; smooth and soft

*Marti-Mestres *et al.* 1999

Lipsticks are a mixture of various amounts of oils, waxes, and pigments. The variety is critical to the determination of which type of lipstick is made; a formula with high wax, low oil, and high pigment content will create a long-wear lipstick, whereas a product with less wax and more oil will create a glossier finish for a shorter duration (Williams and Schmitt 1992).

Table 1.3 Requirements of a good lipstick*

1. Vigorous and smearproof coloring effect
2. Shiny but not greasy
3. Non-sweating and non-blooming
4. Good thixotropy so as to deposit color with a minimum of pressure
5. Retention of form and consistency up to 55C, and usability at low temperatures without crumbling or embrittlement
6. Stable to moisture, light and oxidation
7. Non-irritant and non-toxic
8. Neutral in odor and taste

*Developed by Nowak and Holzer (Balsam and Sagarin 1972).

Lip gloss

Consumer expectations for lip glosses differ slightly from those of lipsticks. They want lip glosses to be easy to apply, give a wet and shiny look, sheer color, moist feel, and not drying. The basic components of lip gloss are similar to lipsticks in the addition of oils, waxes, and pigments. The main difference is that the oils and waxes are varied to a greater degree than the pigment, as glosses do not impart the same amount of color as lipsticks (Williams and Schmitt 1992). As previously mentioned, lip gloss has shown the largest increase in sales and, as a result, the number of lip glosses currently available is rapidly expanding.

Lip balms

Lip balms are usually petroleum-based products used to keep lips moist and to aid in healing chapped or sore lips. Shea butter is an alternative to petroleum's lubricating properties. Instead of the balm sitting on the lips and providing only surface moisturization benefits like petroleum, products with shea butter actually enhance the "moisture retention capacity of skin cells on the lips." This is unlike lip glosses and lipsticks, which serve only cosmetic purposes (McGuigan 2007; Riverside 2006). Lip balms provide lubricating properties by imparting a film on the lips, and are mainly used as a protective barrier against adverse environmental conditions (Marti-Mestres *et al.*

1999). Many types of lip balms exist, including flavored/unflavored, medicated, sun protected, natural and organic, to serve any need.

One particular theory exists about lip balms containing addictive ingredients. This myth has been proven false. Those who use lip balm regularly become used to the feel of soft, moisturized lips. Without that lubricant, users may lick their lips more consistently, in turn causing their lips to dry out and precipitate the need for the balm (McGuigan 2007).

Why study lip products?

Previous studies

The American Society for Testing and Materials (ASTM) developed guidelines for analyzing skin creams and lotions. This includes terminology, descriptive panel selection and training, and test procedures. Attributes were divided into three categories: pick-up, rub-out, and afterfeel. Terms included amount of peaking, firmness, spreadability, wetness, appearance-gloss and moisture. Evaluation procedures were developed for each attribute. Samples should be applied to designated areas of the panelist's forearm. Prior to application, the skin should be washed with cleansing soap. Skin type and age should be considered for testing consistency. Skin temperature, environmental conditions, and sample amounts should be regulated (1997).

Civille and Dus (1991) used descriptive analysis to evaluate tactile properties of skin care products. Attributes were divided into four categories: appearance, pick-up, rub-out, and residual appearance and tactile feel. All categories had detailed protocols to follow for consistent evaluations. Each attribute had references representing several intensity levels on a 10-point scale. Use of these references reduced variability among the panelists. This research is useful to support consumer data, to correlate instrumental measures, and to substantiate claims.

Lee *et al.* (2005) developed a lexicon for aqua creams (lotions and creams) and subsequently trained the panel to test these products. Twenty-six terms were selected for the final terminology. They were grouped into five categories: appearance, pick-up, rub-out, 2 min after-feel and 10 min after-feel. Attributes included gloss, transparency, firmness, spreadability, silkiness, coolness, adhesiveness, absorbency, and amount of

residue. Panelists underwent training to test 12 aqua creams. Differences were found for all the attributes.

Marti-Mestres *et al.* (1999) conducted descriptive analysis with 15 panel members to evaluate texture attributes of four lip balms with varying ingredients. Two had different waxes, one had silicone oil, and one had petrolatum. A 10-point intensity scale was used. The procedure included an even and consistent application of each lip balm in which the application attribute intensity was evaluated (0 = dry, thin, 10 = thicker residues). Attributes present immediately after application included waxy, greasy, and sticky. The two lip balms with different waxes had a strong effect on the texture and consistency of the balms. No effect was evident from the balms with either silicone oil or petrolatum.

Sensory Methodologies

Qualitative methodologies. Focus groups are a useful tool to for understanding consumer behavior. Consumer likes, dislikes and vocabulary can be extracted from these discussions. They can aid in product development, product optimization, marketing and advertising (Resurreccion 1998). It is important that researchers understand the characteristics consumers expect in a category in order to translate those attributes into options that improve the product (Chambers and Smith 1991). A multitude of different industries utilize this technique to explore the consumer psyche. Studies include guidelines for nutrition education displays, understanding probiotic cultures, describing mayonnaise characteristics, peanut butter, etc. (Chambers *et al.* 2004; Bruhn *et al.* 2002; Cardinal *et al.* 2003; McNeill *et al.* 2000). The insights gained from focus groups can serve as a final check for a major study or extensive research to make sure the information is as comprehensive as possible (McNeill *et al.* 2000).

Quantitative methodologies. Lexicons are common tool used for describing products. Definitions and references are also employed to further illustrate the product's characteristics. The purpose of a lexicon is four-fold: to collect a product frame of reference, generate the terms, review references and examples, and to develop a final descriptor list. Once a lexicon is developed, descriptive analysis is conducted using the lexicon. Depending on the descriptive method, an intensity rating is given to each

attribute in each sample. Attributes are generally rated in order of appearance (Drake and Civille 2002).

An accurate lexicon is one which can be replicated at a different time and place. Attributes are defined and referenced for easy reproducibility (Drake and Civille 2002; Meilgaard *et al*. 2007). Numerous lexicons have been developed for a variety of products and procedures: e.g. Johnsen *et al.* (1988) for peanut flavor. Civille and Dus (1990) for handfeel properties; Drake *et al.* (2001) for cheddar cheese; Day 'N Kouka *et al.* (2004) for soymilks; Galan-Soldevilla *et al.* (2005) for floral honey; and Lee and Chambers (2007) for green tea;

Data analysis. When conducting quantitative studies, the appropriate statistical analysis procedure varies according to objectives, sample size, test design and type of study (Meilgaard *et al.* 2007). Descriptive analysis data of aqua creams was analyzed through univariate analysis (Analysis of Variance), factor analysis (principal component analysis and cluster analysis (Lee *et al.* 2005). PCA is generally conducted to identify the smallest number of components which describe the highest amount of variability (Meilgaard *et al.* 2007). For the aqua creams, PC1 was driven by oiliness, adhesiveness, and thickness on one end; and transparency, wetness, coolness, and spreadability on the other end. The second PC was mostly defined by stickiness and gloss (Lee *et al.* 2005).

Rationale

Sensory research is dominated by food products. With this booming industry at the forefront, other important consumer product categories are overlooked. The personal care industry is very lucrative, particularly in cosmetics. Women consider lip products a necessity. It is important to understand what properties exist in a lip product for a woman to choose one product over another. The lexicon developed in this research explores the appearance and textural attributes of lip gloss, lip balms and lipsticks, to see which attributes are similar and which are different between the groups. Companies who develop personal care products, including skin creams, lotions, cosmetics and foundation, might be able to utilize this lexicon and associated analysis procedures. Changes necessary during the product development and optimization process can be clarified

through this objective testing method. Once the lexicon is modified to meet the company's objectives, it can be a very useful tool.

Objectives

Without a lexicon, the ability to test product samples and make appropriate product development and optimization choices is limited. A lexicon does not currently exist for lipsticks, lip glosses, and lip balms. The objectives of this study were to generate a common or universal lexicon, including attributes and intensities, and establish a descriptive analysis procedure for evaluating lip products using the developed lexicon.

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CHAPTER 2 - Detailed Materials and Methods

This study was divided into three experiments: Experiment 1- Conducting focus groups to elicit characteristics of lip products from the consumer's perspective, Experiment 2- Development of a lexicon for lip products using descriptive sensory analysis, and Experiment 3- Testing lip products using the newly-developed lexicon. Approval from Kansas State University's institutional review board for human subjects research was obtained before conducting the study.

Experiment 1 – Focus group study to elicit desirable and undesirable characteristics of lip products

Focus Group Panelists

The focus groups consisted of 14 women, ages 18-60. Recruitment was conducted by phone interviews. The main criterion was that the participants were female and used at least one lip product every day (see detailed focus group screener, Appendix A). Each participant was asked to bring her current lip products to use as examples and to help generate discussion.

Focus Group Methodology

Participants checked-in five minutes prior to the focus group start time. The women were given a name tag and two sticky notes. A trained moderator from the Sensory Analysis Center at KSU conducted both sessions. The moderator had been trained by the RIVA Institute (Rockville, MD) and had conducted more than 100 focus groups prior to conducting these groups. The focus groups lasted 1 ½ hours. Each focus group session was audio-recorded and a note-taker was present. The focus groups where held in a room designed for focus groups that was well lit and was temperature, humidity, and noise controlled. The discussion took place around a large round table. Table 2.1 shows a general outline of the guide followed by the moderator. Panelists were asked to list five positive characteristics of a lip product and five negative characteristics; a description of the panelist's ideal lip product; and brand names of products that they feel would accurately represent the lip product spectrum.

Table 2.1 Focus Group Moderator's Guide

I. Introduction

- Purpose, guidelines, and restrictions
- Each panelist- name and favorite cosmetic

II. General Questions

- When you think of cosmetics, what comes to mind?
- What types of cosmetics do you wear? Why do you wear cosmetics?

III. Specific Questions

- What types of products do you wear on your lips? Why?
- How often do you apply lip products?
- Do you mix and match?

IV. Activity 1

- Thinking about your lips after you have applied a lip product:
- List characteristics that you think describe a "good" lip product- attributes that are favorable
- List characteristics that you think describe a "bad" lip product- attributes that are undesirable in a lip product
- *(Moderator lists the pros and cons in two columns on a white board)*

V. Activity 2

- Imagine you work in Research & Development for a cosmetic company; design your perfect lip product. Take into consideration price, packaging, characteristics, benefits, and flavor.

VI. Activity 3

- If you were to put together a group of 8-10 lip products that would accurately reflect the entire range of balms, glosses and lipsticks, what would they be?
- *(Moderator- write an attribute, then a lip product that reflects each end of the intensity range)*

Some topics were probed to gain a deeper understanding of a particular response, while other topics remained general (see Appendix B for a detailed moderator's guide). Each person was compensated monetarily for their participation in the focus group.

Experiment 2 – Lexicon development for lip products

Samples and Sample Preparation

Fifteen lip products were selected from three lip categories: balms, glosses, and lipsticks. Different colors, brands, packaging, price points (quality), and claims were used to achieve a range of products. Retail prices ranged from under one dollar to almost $9.00. Table 2.2 details each product along with relevant information. All samples were commercially available and were purchased at a local Wal-Mart. Products were stored at room temperature (~20C) and kept out of direct sunlight.

Table 2.2 Descriptions for products used in lexicon development

Product Type	Product Description	Color	Flavor
Gloss	N.Y.C. Kiss Gloss, Fresh Flavor, Super Shine (Del Laboratories, Uniondale, NY)	Clear	Cool Mint
Gloss	Neutrogena Moisture Shine Lip Smoother, Cooling Hydragel, SPF 20 (Neutrogena Corporation, Los Angeles, CA)	None	None
Gloss	L'Oreal Colour Juice; Sheer Juicy Lip Gloss (L'Oreal USA, New York, NY)	Peek-a-boo Clear	None
Gloss	Rimmel Sweet Jelly Sheer Lipgloss (Rimmel London, New York, NY)	Pink	None
Gloss	Maybelline Shine Seduction Glossy Lipcolor (L'Oreal USA, New York, NY)	Blissful Blush	None
Lipstick	Maybelline Moisture Extreme with SPF (L'Oreal USA)	Pink Cloud	None
Lipstick	Almay Hyracolor Lipstick with SPF; refreshing hydration (Almay, Inc., New York, NY)	Clear	None
Lipstick	Cover Girl Incredifull Lip Color (Procter & Gamble, Hunt Valley, MD)	Baby Girl	None
Lipstick	Love My Lips (Bari Cosmetics Ltd., Greenwich, CT)	Frosted Pink Pearl	None
Lipstick	L'Oreal Colour Riche (L'Oreal USA)	Golden Splendor	None
Balm	Carmex with EZ-on applicator (Carma Laboratories Inc., Franklin, WI)	None	None
Balm	Bonne Bell Lip Smacker (The Bonne Bell Company, Lakewood, OH)	None	Raspberry Melon
Balm	Classic ChapStick (Wyeth Consumer Healthcare, Madison, NJ)	None	Original
Balm	Blistex Medicated Lip Balm with SPF 15 (Blistex, Inc., Oak Brook, IL)	None	None
Balm	Softlips with SPF 20 (The Mentholatum Co., Inc., Orchard, Park, NY)	None	Cherry

Panelists

Six highly trained panelists from The Sensory Analysis Center at Kansas State University (Manhattan, KS) were selected to participate in this study. Each panelist had a minimum of 120 hours of training and each had more than 1,500 hours of descriptive analysis experience on a variety of products, including personal care products.

Terminology Development

Seven sessions of 1 ½ hours were used for development of the lexicon. These sessions occurred in a climate- and noise-controlled room. During this time, application and evaluation techniques for each attribute were also developed. The lexicon on appearance and texture attributes only. Flavor and aroma characteristics, which can vary widely especially in flavored products, were considered too broad for this study.

The general lexicon development procedure was adopted from the flavor profile method (Caul 1957; Keane 1992). Research from other lexicon or terminology development studies was also used as guidelines (Lee *et al.* 2005; Retiveau *et al*. 2005; Vara-Ubol *et al.* 2006; Lee *et al.* 2007). All terms, definitions, references, and protocols were decided through consensus among the panelists. The panelists discussed several categories of attributes, and many terms within each category. Panelists eliminated redundant terms. Each attribute had three references representing a high, medium and low intensity.

The trained panel also developed evaluation techniques for each attribute. Attributes were evaluated either on paper, in container, or on the forearm. For paper, a 1″ × 1″ grid was made using Microsoft Excel 2000 on tan colored paper (Item #10286-3; Hammermill® International Paper, Memphis, TN). Panelists stroked the lip product across this grid to measure opacity. For the forearm, one backward-and-forward stroke of the product was used to evaluate most of the appearance and texture attributes. These procedures allowed for a consistent testing technique that was followed during subsequent testing.

Experiment 3 – Descriptive analysis of some lip products to validate the lexicon

Samples and Sample Preparation

Twelve samples were tested over a four day period. As shown in Table 2.3, the selected samples represented different qualities, appearance attributes (in package), prices, claims and brands. Products were purchased from the local Wal-Mart and Dillard's Department Store (Manhattan, KS). Samples were kept in their original packaging, wrapped in aluminum foil to conceal their identity, and labeled with a three-digit random code. References were prepared no more than 24 hours before testing.

Table 2.3 Test products for descriptive analysis

Product Type	Brand	Name	Color	Applicator	Claims	Price Point[a]
Gloss	L'Oreal[e]	Colour Juice (#220)	N/A	Squeeze tube	Sheer juicy lip color	Mid[b]
Gloss	Bonne Bell[e]	Lip Lites	N/A	Wand	N/A	Low[c]
Gloss	Lancome[f]	Juicy Gelee	N/A	Pot/tub	Crystal clear lip gloss	High[d]
Gloss	Max Factor[e]	MAXalicious Glitz (#810)	Vegas Nights	Wand	N/A	Mid
Lipstick	Almay[e]	Hydracolor (#555)	N/A	Bullet	Refreshing hydration, SPF 15	Mid
Lipstick	Rimmel[e]	Rich Moisture (#321)	Diva Red	Bullet	N/A	Low
Lipstick	Clinique[f]	Colour Surge (#302)	Metallic Sand	Bullet	N/A	High
Lipstick	Revlon[e]	Renewist Lipcolor (#120)	Coming up Roses	Bullet	SPF 15	Mid
Balm	Neutrogena[e]	Lip Nutrition, Moisture Balm	N/A	Pot/tub	Daily softener, subtle shine	Mid
Balm	Softlips[e]	Lip protectant/ sunscreen	N/A	Stick	Smooth conditioning balm for softer, healthier lips	Low

Product Type	Brand	Name	Color	Applicator	Claims	Price Point[a]
Balm	Estee Lauder[f]	Tender Lip Balm (#TLB04)	Tender Berry	Squeeze tube	SPF 15	High
Balm	Blistex[e]	Lip Infusion Sheer Liquid Balm	N/A	Rolling Tip	SPF 15, deep hydration, no waxy feel	Low

[a] The price points represent the varying perceived qualities of the samples.

[b] Mid-level prices are from $4-$9; available for purchase from mass market merchandisers

[c] Low-level prices are less than $4; available for purchase from mass market merchandisers

[d] High-level prices are above $10. In this study, these products were purchased at a department store and were not available from mass market merchandisers.

[e] Purchased at Wal-Mart

[f] Purchased at Dillard's Department Store

Test Design and Evaluation Procedure

Six highly trained descriptive panelists participated in testing lip products. Three panelists previously participated in the lexicon development of lip products (Experiment 2) and three did not. Subsequent analysis was to be conducted to compare the two subgroup performances. If there were no differences between the old and new panelists, then the lexicon would be easily reproducible to an outside source.

A William's Latin Square design was developed using SAS® version 9.1 (SAS Institute Inc., Cary, N.C., USA) to determine the serving order. The six panelist numbers were put into a hat and three were selected. These three panelists had "6" added to their order number. This allowed three panelists to test samples 1-6 and three panelists to test 7-12 on the first day. The process was repeated for each day. Each panelist received a sample different from the other panelists at each time point (Appendix C). All data was collected using Compusense® Data Collection Software (2005, version 4.6; Compusense Inc., Guelph, Ontario).

Samples were rated individually on a 15-point intensity scale with 0.5 increments, where 0 = none/low and 15 = extremely/high. Between samples panelists cleaned the used area on their hands and forearms with Equate Pop-Ups (Fragrance Free, Alcohol Free, Hypoallergenic, Wal-Mart stores, Inc., Bentonville, AR). Any carryover effects

were minimized by using this approach since each sample could be evaluated in a clean area.

Two, one and a half hour orientation sessions were conducted prior to the four-day test period. Before testing, panelists washed their hands and forearms (up to their elbows) with lukewarm water using Ivory Liquid Hand Soap. After washing, each panelist's forearm was marked with a 2″ × 1 ½″ template indicating the test area. The lip product lexicon developed in Experiment 2 was used for this test (Table 2.4).

Table 2.4 Lip product sensory attributes, definitions, references and intensities on a 15-point scale used by descriptive panel

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Initial Texture		
Smoothness	Evenness of the sample; absence of grains, clumps, lumps, etc.	Pillsbury Creamy Supreme (Strawberry) Frosting = 3.0 Johnson & Johnson 24-hour Moisturizer = 15.0
Spreadability	The ease in which the product can be manipulated on the surface of the forearm.	Pillsbury Creamy Supreme (Strawberry) Frosting = 5.0 Chapstick (Classic) = 9.0 Johnson & Johnson 24-hour Moisturizer = 13.0
Drag 1	The amount of pressure required for application of product on clean skin.	Johnson & Johnson 24-hour Moisturizer = 1.0 Chapstick (Classic) = 6.0 Zinc Oxide = 12.0
Drag 2	The amount of pressure required for application of product.	Johnson & Johnson 24-hour Moisturizer = 1.0 Chapstick (Classic) = 5.0 Zinc Oxide = 12.0
Tackiness	The degree to which fingers adhere to the product; amount of adhesiveness.	Johnson & Johnson Baby Oil = 0.0 Post-it Note = 7.5
Waxiness	The degree to which the product has a texture similar to paraffin.	Chapstick (Classic) = 4.0 Nestle Butterscotch Chips = 6.0
Initial Appearance		
Color Intensity 1	Intensity of the color of the product on the forearm.	White (R: 255, G: 255, B: 255) = 0.0 Light Pink (R: 255, G: 163, B: 163) = 3.0 Mid-Pink (R: 255, G: 75, B: 75) = 7.5 Burgundy (R: 176, G: 0, B: 0) = 11.0 Black (R: 0, G: 0, B: 0) = 15.0

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Shininess	The amount of gloss or shine perceived on the surface of the product.	Porter Paints #6890-1 Antique White Flat Finish = 0.0 Porter Paints #6890-1 Antique White Eggshell Finish = 2.0 Porter Paints #6890-1 Antique White Satin Finish = 5.0 Porter Paints #6890-1 Antique White Semi-Gloss Finish = 8.0 Porter Paints #6890-1 Antique White Gloss Finish = 12.0
Wet	The appearance of looking wet; opposite of dry.	Crabtree & Evelyn Lip Balm (Picture) = 2.0 Vaseline (untouched) = 5.0 Johnson & Johnson Baby Oil = 14.0
Glittery	Sample composed of individual reflective particles that have a sparkling effect.	Maybelline Shine Seduction (Picture) = 10.0 Philosophy Sugar Cookie Lip Shine (Picture) = 12.0
Pearl-like	A soft, reflective luster reminiscent of a pearl or mother-of-pearl; gives depth.	Love My Lips #403 (Picture) = 2.5 Three pearls (picture) = (5.0) Mother of Pearl Elephant Pin (Picture) = 12.0
Waxy Appearance	The degree to which the product looks like paraffin.	Vaseline (untouched) = 5.0 Crabtree & Evelyn Lip Balm (Picture) = 7.5
Coverage	The amount of testing surface covered by the product.	Aquafina Lip Oil (Picture) = 6.0 N.Y.C. Ultra Last Lip Wear #419B (Picture) = 7.5 Chapstick (Classic) (Picture) = 15.0
Opacity	The degree of opaqueness of the product.	Transparency 100% = 0.0 Transparency 75% = 2.5 Transparency 50% = 5.0 Transparency 25% = 9.0 Transparency 0% = 15.0

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Color Intensity 2	Intensity of the color of the product in the original container.	White (R: 255, G: 255, B: 255) = 0.0 Light Pink (R: 255, G: 163, B: 163) = 3.0 Mid-Pink (R: 255, G: 75, B: 75) = 7.5 Burgundy (R: 176, G: 0, B: 0) = 11.0 Black (R: 0, G: 0, B: 0) = 15.0
After Appearance[c]		
Feathering	The movement of product from lips into the surrounding skin lines.	
After Texture[c]		
Tackiness	The degree to which a finger adheres to the product; amount of adhesiveness	Johnson & Johnson Baby Oil = 0.0 Posit-it Note = 7.5
Degree of Absorption	Degree of absorption of product into the forearm.	Pillsbury Creamy Supreme (Strawberry) Frosting = 2.0 Chapstick (Classic) = 8.0 Johnson & Johnson 24-hour Moisturizer = 12.0
Amount of Residue	A measure of the effect on the skin after the product is applied.	Johnson & Johnson 24-hour Moisturizer = 2.0 Chapstick (Classic) = 8.0 Pillsbury Creamy Supreme (Strawberry) Frosting = 12.0
Type of Residue	None, film, oily, waxy, greasy, chalky	

[a] References were prepared approximately 24 hours prior to testing each day.
[b] Intensity ratings are based on a 15-point numerical scale with 0.5 increments.
[c] This effect needs to be measured at times in accordance with each study's objectives and products.

During orientation, the panelists were able to try the products in any order they chose. They practiced evaluating the product following the order and protocol stated in the definition and reference sheet developed in Experiment 2. These sessions helped familiarize the panelists with the test products, definitions, attributes, references, order of evaluation and evaluation techniques. Ten texture attributes and 10 appearance attributes were evaluated. Please refer to Table 2.5 for an illustration of the order of evaluation and evaluation techniques for the attributes.

Table 2.5 Descriptive analysis attribute order of evaluation and evaluation techniques

Order of Evaluation	Evaluation Technique
Initial Texture	
Smoothness	Apply to thumb, move forefinger across thumb surface to gauge the intensity of smoothness.
(New application)	
Spreadability	Spread product onto forearm using product applicator. If a pot/tub, use a plastic knife to scoop out designated amount. Apply the product to one spot on skin. Spread back-and-forth ONCE with finger.
(Start 10 minutes)	
Drag 1	Apply ONE stroke of the product in ONE direction (linearly) on clean skin (evaluate product to skin drag)
Drag 2	Apply ONE stroke of the product in SECOND direction (linearly) to product already on skin (evaluate product to product drag).
Tackiness	Tap middle finger on product; measure the degree to which the finger adheres to the product.
Initial Appearance (New application)	
Color Intensity 1	
Shininess	
Wet	Apply product with ONE back-and-forth stroke to designated spot on forearm. Evaluate these 6 attributes (initial appearance) from only that application. Do not apply again.
Glittery	
Pearl-like	
Waxy Appearance	

Order of Evaluation	Evaluation Technique
Coverage	Apply one back-and-forth stroke of the product to beige/flesh-colored PAPER in designated 2″ × 1 ½ ″area. Measure the intensity according to the proportion of area covered by the product (NOT a measure of opacity).
Opacity	Using the swipe from "coverage", evaluate the opacity.
Color Intensity 2	Look at product in original container.
After Texture (10 minutes)	
Tackiness	Tap finger on product; measure the degree to which the finger adheres to the product.
Degree of Absorption	With blotting paper, blot product on forearm. *Determine the amount of product on the paper.* The higher the amount of product on paper, the lower the Degree of Absorption intensity.
Amount of Residue	With blotting paper, blot product on forearm. *Determine the amount of product left on the skin.*

Data Analysis

Data was analyzed by Analysis of Variance (ANOVA) using PROC GLM in SAS®. Panelists were treated as random effects to remove the variability due to panelists. Post-hoc mean separation was carried out by using Fisher's least significant difference (LSD). Significant differences were determined at the 5% level of significance. ANOVA was run to compare the consistency of the two panel subgroups and to compare the product types (balm, gloss, and lipstick). A nested design was implemented to analyze the subgroups using SAS®. Principal Components Analysis (PCA) was conducted on the descriptive panel data (Unscrambler®, 2004, version 9.0; Camo A/S, Oslo, Norway) to evaluate relationships among the sensory attributes of the lip product samples. PCA is a multivariate technique for exploring relationships among quantitative variables. Relationships were evaluated using multivariate statistical analyses. PCA was used to reduce the dimensionality of the attributes in order to show the relationship between the attributes and the samples. Correlation among the attributes was also illustrated by PCA so that similar attributes could be combined into one attribute for subsequent analysis.

Cluster analysis using PROC CLUSTER with Ward's method was conducted with SAS® version 9.1 (SAS Institute Inc., Cary, N.C., USA). A hierarchical tree diagram illustrated the groupings of the lip product samples. The clusters were based on the similarities of each sample's sensory characteristics. This was conducted to validate the PCA and illustrate true, meaningful groups.

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CHAPTER 3 - Development of a sensory lexicon for lip products

Abstract

The purpose of this study was to develop a lexicon for descriptive sensory testing of lip products. Lip balms, lip glosses, and lipsticks were tested in this study. In part 1 (EXPERIMENT 1), two focus groups were conducted to understand women's perceptions of lip products, and also to elicit desirable and undesirable characteristics in the products. The women's idea of a perfect lip product was: clear/sheer/neutral color, smooth, not sticky, moisturizing and flavorless/tasteless**.** In part 2 (EXPERIMENT 2), a lexicon was developed for the lip products. Attributes were categorized under "Initial Texture", "Initial Appearance", "After Appearance" and "After Texture." In part 3 (EXPERIMENT 3) of the study, the lexicon was validated by testing various lip products using lexicon developed in part 2. The analysis of variance (ANOVA) results by product type indicated that the lexicon was able to differentiate among the lipsticks, lip balms and lip glosses. The lexicon was further able to show similarities and differences within a product type. Principal component analysis and cluster analysis, which are both multivariate techniques, validated the inferences from the univariate analysis (ANOVA). The two panelist groups (three panelists from the lexicon development panel – group 1, and three new panelists – group 2) showed no differences ($P > 0.05$) in attribute evaluations for all the samples tested. The lexicon developed in this study could be used to identify similarities and differences in other lip products such as lip plumper, lip liners and multi-use products.

Keywords: lip products, lexicon development, qualitative research, descriptive analysis

Practical Applications

This lip product lexicon will benefit cosmetic companies in product development and optimization, quality control, and marketing with accurate definitions, accessible references, and reproducible protocols and techniques. The lexicon and evaluation techniques may be extrapolated to skin care products, such as lotions, creams, and masques; hair care, such as shampoos, conditioners, masques, styling aids; and other cosmetic products, such as foundation, eyeshadow, and eyeliners.

Introduction

Color cosmetics are considered by women to be essential beauty items – one of the few remaining affordable, non-invasive beauty treatments. As of November 2005, global cosmetic sales were ~$32.7 billion.

Increases in global sales are fueled, in part, by emerging markets such as Eastern Europe, India, China and Latin America. Eastern Europe has shown sales growth for five consecutive years for an average annual increase of 10.2% (Horne 2005). As of 2006, lip products were the third largest segment of cosmetics (Datamonitor 2006). The most dynamic region for cosmetics is China, where cosmetic and toiletry sales have grown 20-25% during 2000-2005. Though current per capita cosmetic spending in China is only $4, sales are projected to reach $9.6 billion by 2010 (Feller 2005). Lipsticks and lip liners are still popular in Eastern Europe and Latin America, but the $9.9 billion dollar industry is declining, being replaced by lip glosses, which increased sales by 8.9% in 2004 (Horne 2005; Prance 2007).

Textural differences in lipsticks, lip balms, and lip glosses are because of their formulation and ingredients. Over 10,000 raw materials are listed in the dictionary of the Cosmetics, Toiletries and Fragrance Association (Castro 2006). Ingredients include waxes (for shape and application), oils (including olive oil, mineral oil, petrolatum, etc.), pigments, and emollients.

Extensive research on women and color cosmetics has been conducted, connecting make-up application to self-esteem, confidence and beauty (Ogilvie and Kristensen-Bach 2001). The conclusion to these studies is the belief that image and beauty are enhanced through color cosmetics (Mulhern *et al*. 2003). Aside from the outward appearance reflecting inner confidence, it is important to understand what causes women to choose a certain product over another.

Several sensory lexicons have been proposed for skin creams and lotions (Civille and Dus 1991; ASTM 1997; Lee *et al.* 2005). Lee *et al.* (2005) developed a lexicon for aqua cream. In general, 26 attributes were used to describe the various creams and lotions, including categories of attributes associated with ‘appearance’, ‘pick-up’, ‘rub-out’,

'after-feel (2 min)', and 'after-feel (10 min)'. Several of those lexicons included terminology, definitions and references with intensities for those products.

Some of those terms may be appropriate for lip products, but no application of descriptive sensory analysis was found applied to lip products. Large companies have most likely developed internal lip product lexicons to evaluate their products. However, this information is not available in the public domain. Thus, the main objective of the present study was to develop a lexicon (appearance and texture) for lip products which could be used for a wide range of products. The entire study was done in three parts. Experiment 1 was conducted using focus groups to understand the reasons why women purchase and wear lip products, and what attributes are desirable and undesirable in those products. The attributes and products suggested in the focus groups could help establish a framework for development of sensory descriptors of lip products. A lexicon in experiment 2 of the study was developed by a trained sensory panel. The lexicon was validated by descriptive analysis (experiment 3) of some lip products.

Experiment 1- Focus group study to elicit desirable and undesirable characteristics of lip products

Materials and Methods

Focus group recruitment and demographics

All participants were finale and had to have used at least two types of lip products. Filler questions were included so the applicant would be unsure what the tested product was to be and their answers would be as honest as possible (Resurreccion 1998).

Participants ranged in age from 18-60. Each participant was asked to bring her own lip products that she currently used as examples and to help generate discussion. Approximately one half of the participants used their lip products more than once per day; approximately one-third used lip products about once per day. The remaining participants used lip products less than once per day, but more than once a week. The majority of the women purchased a new lip product less than once a month.

Focus group methodology

Two, 90-minute focus groups were conducted by a trained moderator The Sensory Analysis Center at Kansas State University (Manhattan, KS). A trained moderator from the Sensory Analysis Center at KSU conducted both sessions. The moderator had been trained by the RIVA Institute (Rockville, MD) and had conducted more than 100 focus groups prior to conducting these groups. Each focus group session was audio-recorded and a note-taker was present. The discussions were held around a large round table in a room designed for focus groups that was well lit and was temperature, humidity, and noise controlled.

The moderator's guide began with general questions about make-up use, then became more specific with questions about lip products and why the women use products on their lips. The women were asked to list five positive characteristics of a lip product and five negative characteristics; a description of the panelist's ideal lip product; and brand names of products that they felt would represent the lip product spectrum.

Results and Discussion

Lip Product Characteristics

The idea of a perfect lip product varied from person to person, but the main theme was a clear/sheer/neutral color, smooth, not sticky, moisturizing and flavorless/tasteless lip product. This parallels the consumer expectations for a lip gloss as observed by Williams *et al*. (1992). Some women wanted a long-lasting color that does not smear or rub off. Lasting color is a desired property of a lipstick and not rubbing off is a popular consumer expectation along with easy application; natural look; moist feel; no bleeding, cracking or peeling; an acceptable flavor/fragrance; and lasting at least three to four hours (Williams *et al.* 1992).

Positive characteristics of lip products according to the focus groups included color [good], glossy, long-lasting, moisturizing, shimmer, glide and slipperiness (Table 3.1). Some women did not want any aroma or flavor whatsoever, while the majority did not mind if the product had an aroma or flavor as long as it was pleasing (which can vary from woman to woman).

Table 3.1 Positive and negative attributes of lip products by focus group participants

Positive Attributes		Negative Attributes	
Color	Flavor	Crusty	Gritty feel
Glossy	Feels comfortable	Waxy residue	Gooey/gummy
Cannot feel it on lips	Slipperiness	Sticky	Longevity
Proper thickness	No drag/ easy glide	Too thin, too thick	Dull
Long-lasting	Applicator- wand, tube, bullet	Stains lips	Flavor/smell
Moisturizing	Aroma	Drying	Color
Reasonable price	Smooth	Smell or taste	Messy
Not gritty	Shimmer	Not true to color	Feathering
		Bleeding	Cracking

Undesirable lip product traits (Table 3.1) mentioned by both groups were sticky and drying. Additionally, anything that was gritty, crusty, gooey/gummy, dull, staining, or drying was not desired. The women tended to think that lipsticks were the most likely to crack or "feather", so most would put a gloss on top of the color. It was mentioned that some lip balms would accumulate an undesirable waxy residue after consistent use.

Suggested Categories for Describing Lip Products

Lip product categories suggested by the participants included appearance, texture and after removal. A list of these categories with associated attributes is shown in Table 3.2. In the 'after removal' category, attributes would be evaluated after wiping off the product, rubbing off the product, or once it has disappeared on its own. The product can leave a faded color on the lips ("staining"), remove the moisture from the lips and cause a pruning effect ("drying"), or leave a desirable feeling ("moisturizing").

Table 3.2 Potential categories and terms generated by the focus group for the descriptive panel

Appearance	Texture	After removal
Glossiness	Grittiness	Stain
Shimmer	Waxy	Drying
Amount of Color	Thickness	Moisturizing
Sheerness/Opaqueness	Stickiness	
	Viscosity	

Experiment 2- Lexicon development for lip products

Materials and Methods

Panelists

Six highly trained panelists from The Sensory Analysis Center at Kansas State University (Manhattan, KS) were selected to participate in this study. Each panelist had over 120 h of general descriptive analysis training and over 1,500 hours of descriptive sensory experience, including testing non-food products such as skin cream, lotions, soaps and perfumes.

Samples and sample preparation

Fifteen lip products were selected from various lip categories: balms, glosses, and lipsticks. Different colors, brands, packaging, price points (quality), and claims were used to achieve a range of products. Retail prices ranged from under one dollar to almost nine dollars. Table 3.3 details each lip product used for development of the lexicon along with some relevant information about the products. All samples were commercially available and purchased locally. Products were stored at room temperature (~20C) and kept out of direct sunlight.

Development of Definitions and References

Seven sessions of one and a half hours each were utilized for development of the lexicon. These sessions occurred in a climate- and noise-controlled room. During this time, application and evaluation techniques for each attribute developed. The lexicon focused on appearance and texture attributes only. Flavor and aroma characteristics, which can vary widely especially in flavored products, were not considered for this study.

Table 3.3 Sample descriptions for products used in lexicon development

Product Type	Product Description	Color	Flavor
Gloss	N.Y.C. (New York Color) Kiss Gloss, Fresh Flavor, Super Shine (Del Laboratories, Uniondale, NY)	Clear	Cool Mint
	Neutrogena MoistureShine Lip Soother, Cooling Hydragel, SPF 20 (Neutrogena Corporation, Los Angeles, CA)	None	None
	L'Oreal Colour Juice; Sheer Juicy Lip Gloss (L'Oreal USA, New York, NY)	Peek-a-boo Clear	None
	Rimmel Sweet Jelly Sheer Lipgloss (Rimmel London, New York, NY)	Pink	None
	Maybelline Shine Seduction Glossy Lipcolor (L'Oreal USA, New York, NY)	Blissful Blush	None
Lipstick	Maybelline Moisture Extreme with SPF (L'Oreal USA)	Pink Cloud	None
	Almay Hydracolor Lipstick with SPF 15; refreshing hydration (Almay, Inc., New York, NY)	Clear	None
	Cover Girl Incredifull Lip Color (Procter & Gamble, Hunt Valley, MD)	Baby Girl	None
	Love My Lips (Bari Cosmetics Ltd., Greenwich, CT)	Frosted Pink Pearl	None
	L'Oreal Colour Riche (L'Oreal USA)	Golden Splendor	None

Product Type	Product Description	Color	Flavor
Balm	Carmex with EZ-on applicator (Carma Laboratories, Inc., Franklin, WI)	None	None
	Bonne Belle Lip Smacker (The Bonne Belle Company, Lakewood, OH)	None	Raspberry Melon
	Classic ChapStick (Wyeth Consumer Healthcare, Madison, NJ)	None	Original
	Blistex Medicated Lip Balm with SPF 15 (Blistex, Inc., Oak Brook, IL)	None	None
	Softlips with SPF 20 (The Mentholatum Co., Inc., Orchard Park, NY)	None	Cherry

The general lexicon development procedure was adopted from the flavor profile method and has been used in other lexicon or terminology development studies (Caul 1957; Keane 1992; Lee *et al.* 2005; Lee and Chambers 2007; Retiveau *et al.* 2005; Vara-Ubol *et al.* 2006). The ASTM International document on Standard Practice for Descriptive Skinfeel Analysis of Creams and Lotions (E 1490-92 1997)was used as a guide for panel training, orientation and testing for the lexicon development in this study. This included sample preparation, skin preconditioning, preparation of test area and sample application. The panelists discussed several categories of attributes and many terms within each category. Initial terms and categories suggested are detailed in Table 3.4.

Table 3.4 Initial list of lexicon terms generated by the descriptive panel

Initial Appearance	Initial Texture	Appearance (After application)	Texture (After application)
Shine, Glossiness	Stickiness, Tackiness	Shine	Stickiness, Tackiness
Frosted	Moisturizing	Glossiness	Moisturizing
Wet Look	Greasiness	Wet Look	Greasiness, Oiliness
Degree of Absorption	Oiliness	Degree of Absorption	Dryness
Shimmer	Spreadability	Feathering	Spreadability
Opacity	Waxy		Waxy
Intensity of Color	Firmness, thickness		Firmness

All terms, definitions, references, and protocols were decided through consensus among the panelists. Panelists eliminated redundant terms. Some attributes had references representing a high, medium and low intensity.

Any products in stick form or with an applicator were applied as directed (shown in Table 3.6). Products in pots/tubs were scooped out with a plastic knife and applied the same way as lipsticks, wand applicators, or squeeze tubes. It was decided that testing should be done primarily on the inside forearm or fingertips and a few attributes evaluated on paper. Table 3.6 explains the evaluation techniques. If the products were to be applied to the panelist's lips, only one product could be tested each day to obtain a true analysis. Any more than one product would result in the panelist wiping their lips to remove the product, thereby creating a false environment for the next sample. The inside forearm had a longer area to apply the products. Prior to testing, the forearm was marked with a 2″ × 1 ½ ″ template (Fig. 3.1). This allowed specific areas for testing and three products could be tested on each arm.

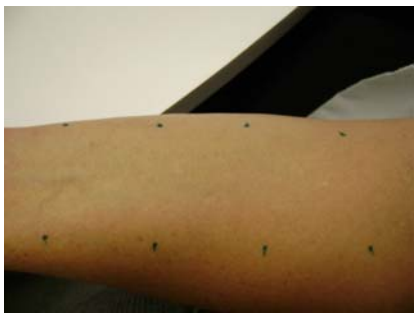

Figure 3.1 Forearm marked for test evaluations

The panel also developed evaluation techniques for each attribute. Attributes were evaluated either on paper, in container, or on the forearm. For paper, a 1″ × 1″ grid was made using Microsoft Excel 2000 on tan colored paper (Item #10286-3; Hammermill® International Paper, Memphis, TN). The panelists felt it was easier to see color variations on beige paper as opposed to white. Panelists stroked the lip product across this grid to

measure opacity. For the forearm, one back-and-forth (forward and backward) stroke of the product across the forearm was used to evaluate most of the appearance and texture attributes. These procedures allowed for a consistent testing technique that was followed during subsequent testing.

Results and Discussion

Redundant terms from the initial lexicon (Table 3.4) were eliminated. The final lexicon consisted of four evaluation categories and 20 terms. The categories were 'Initial Texture', 'Initial Appearance', 'After Texture' and 'After Appearance', as shown in Table 3.5. The 'initial' attributes were evaluated immediately following application to the forearm; 'after' attributes were evaluated 10 minutes after application. This time period is subject to change according to future study's objectives. Each attribute consisted of at least two references representing a high, medium, and/or low intensity. For easier duplication of the lexicon and consistency, pictures were used for several references, including color intensity, shininess, wet, glittery, pearl-like, waxy appearance, coverage and opacity. These reference pictures can be found in Appendix D.

Table 3.5 Lip product sensory attributes, definitions, references and intensities on a 15-point scale developed by the descriptive panel

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Initial Texture		
Smoothness	Evenness of the sample; absence of grains, clumps, lumps, etc.	Pillsbury Creamy Supreme (Strawberry) Frosting = 3.0 Johnson & Johnson 24-hour Moisturizer = 15.0
Spreadability	The ease in which the product can be manipulated on the surface of the forearm.	Pillsbury Creamy Supreme (Strawberry) Frosting = 5.0 Chapstick (Classic) = 9.0 Johnson & Johnson 24-hour Moisturizer =13.0
Drag 1	The amount of pressure required for application of product on clean skin.	Johnson & Johnson 24-hour Moisturizer = 1.0 Chapstick (Classic) = 6.0 Zinc Oxide = 12.0

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Drag 2	The amount of pressure required for application of product.	Johnson & Johnson 24-hour Moisturizer = 1.0 Chapstick (Classic) = 5.0 Zinc Oxide = 12.0
Tackiness	The degree to which fingers adhere to the product; amount of adhesiveness.	Johnson & Johnson Baby Oil = 0.0 Post-it Note = 7.5
Waxiness	The degree to which the product has a texture similar to paraffin.	Chapstick (Classic) = 4.0 Nestle Butterscotch Chips = 6.0
Initial Appearance		
Color Intensity 1[d]	Intensity of the color of the product on the arm (after application)	White (R: 255, G: 255, B: 255) = 0.0 Light Pink (R: 255, G: 163, B: 163) = 3.0 Mid-Pink (R: 255, G: 75, B: 75) = 7.5 Burgundy (R: 176, G: 0, B: 0) = 11.0 Black (R: 0, G: 0, B: 0) = 15.0
Shininess	The amount of gloss or shine perceived on the surface of the product.	Porter Paints #6890-1 Antique White Flat Finish = 0.0 Porter Paints #6890-1 Antique White Eggshell Finish = 2.0 Porter Paints #6890-1 Antique White Satin Finish = 5.0 Porter Paints #6890-1 Antique White Semi-Gloss Finish = 8.0 Porter Paints #6890-1 Antique White Gloss Finish = 12.0
Wet	The appearance of looking wet; opposite of dry.	Crabtree & Evelyn Lip Balm (Picture) = 2.0 Vaseline (untouched) = 5.0 Johnson & Johnson Baby Oil = 14.0
Glittery	Sample composed of individual reflective particles that have a sparkling effect.	Maybelline Shine Seduction (Picture) = 10.0 Philosophy Sugar Cookie Lip Shine (Picture) = 12.0

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Pearl-like	A soft, reflective luster reminiscent of a pearl or mother-of-pearl; gives depth.	Love My Lips #403 (Picture) = 2.5 Three pearls (picture) = (5.0) Mother of Pearl Elephant Pin (Picture) = 12.0
Waxy Appearance	The degree to which the product looks like paraffin.	Vaseline (untouched) = 5.0 Crabtree & Evelyn Lip Balm (Picture) = 7.5
Coverage	The amount of testing surface covered by the product.	Aquafina Lip Oil (Picture) = 6.0 N.Y.C. Ultra Last Lip Wear #419B (Picture) = 7.5 Chapstick (Classic) (Picture) = 15.0
Opacity	The degree of opaqueness of the product.	Transparency 100% = 0.0 Transparency 75% = 2.5 Transparency 50% = 5.0 Transparency 25% = 9.0 Transparency 0% = 15.0
Color Intensity 2	Intensity of the color of the product in the original container.	White (R: 255, G: 255, B: 255) = 0.0 Light Pink (R: 255, G: 163, B: 163) = 3.0 Mid-Pink (R: 255, G: 75, B: 75) = 7.5 Burgundy (R: 176, G: 0, B: 0) = 11.0 Black (R: 0, G: 0, B: 0) = 15.0
After Appearance[c]		
Feathering	The movement of product from lips into the surrounding skin lines.	
After Texture[c]		
Tackiness	The degree to which a finger adheres to the product; amount of adhesiveness	Johnson & Johnson Baby Oil = 0.0 Posit-it Note = 7.5
Degree of Absorption	Degree of absorption of product into the forearm.	Pillsbury Creamy Supreme (Strawberry) Frosting = 2.0 Chapstick (Classic) = 8.0 Johnson & Johnson 24-hour Moisturizer = 12.0

Sensory Attribute	Definition	Reference[a] and Intensity[b]
Amount of Residue	A measure of the effect on the skin after the product is applied.	Johnson & Johnson 24-hour Moisturizer = 2.0 Chapstick (Classic) = 8.0 Pillsbury Creamy Supreme (Strawberry) Frosting = 12.0
Type of Residue	None, film, oily, waxy, greasy, chalky, sticky	

[a] References were prepared approximately 24 hours prior to testing each day.
[b] Intensity ratings are based on a 15-point numerical scale with 0.5 increments.
[c] This effect needs to be measured at times in accordance with each study's objectives and products.
[d] Attributes in **bold** indicate an attribute with picture references.

The panelists also developed specific protocols for evaluating each attribute (Table 3.6). Because skin is so variegated, certain attributes may yield very different results. The panelists found the some attributes could not be effectively evaluated using only the forearm. Smoothness was evaluated by rubbing the thumb and forefinger together to detect any graininess. Coverage and opacity were evaluated on beige paper using one forward-and-backward stroke. Panelists looked at the product in it's original container/state to determine the value for color intensity 2.

"Initial" attributes were evaluated immediately. Once the product was spread onto the forearm, the panelists evaluated the remaining Initial Texture attributes and the Initial Appearance attributes. After-appearance or after-texture attributes were evaluated 10 min after application to show potential product changes over time. That time period would change depending on a study's objectives. Ten minutes was used in this study to provide an example and to accommodate the number of samples to be tested each day. During orientation, panelists mentioned that the most dramatic difference in attributes was observed within the first five minutes. However, attributes such as "feathering" or "bleeding" would require a longer observation time.

This lexicon has both similarities and differences to the lexicon developed by Civille and Dus (1991). There are four categories and associated evaluation techniques. Both lexicons include wetness, gloss, spreadability, amount of residue and type of residue.

Definitions and protocol for these attributes are different because of the products being tested. The intensity scale used in this study was a 15-point scale with 0.5 increments. Civille and Dus used a 10-point scale with verbal anchor points. Accounting for possible variables helps to maintain panelist consistency and reduce panelist subjectivity.

Table 3.6 Descriptive analysis attribute order of evaluation and evaluation techniques

Order of Evaluation	Evaluation Technique
Initial Texture	
Smoothness	Apply to thumb, move forefinger across thumb surface to gauge the intensity of smoothness.
(New application)	
Spreadability	Spread product onto forearm using product applicator. If a pot/tub, use a plastic knife to scoop out designated amount. Apply the product to one spot on skin. Spread back-and-forth ONCE with finger.
(Start 10 minutes)	
Drag 1	Apply ONE stroke of the product in ONE direction- drag linear- on clean skin (evaluate product to skin drag)
Drag 2	Apply ONE stroke of the product in SECOND direction to product already on skin (evaluate product to product drag).
Tackiness	Tap middle finger on product; measure the degree to which the finger adheres to the product.
Waxiness	Rub finger across the product applied to the forearm.
Initial Appearance (New application)	
Color Intensity 1 Shininess Wet Glittery Pearl-like Waxy Appearance	Apply product with ONE forward and backward stroke to designated spot on forearm. Evaluate these 6 attributes (initial appearance) from only that application. Do not apply again.
Coverage	Apply one back-and-forth stroke of the product to beige/flesh-colored PAPER in designated 2″ × 1 ½ ″ area. Measure the intensity according to the proportion of area covered by the product (NOT a measure of opacity).
Opacity	Using the swipe from “coverage”, evaluate the opacity.

Order of Evaluation	Evaluation Technique
Color Intensity 2	Look at product in original container.
After Appearance (time should be specified for a given study)	
Feathering	Observe any feathering.
After Texture (time should be specified for a given study)	
Tackiness	Tap finger on product; measure the degree to which the finger adheres to the product.
Degree of Absorption	With blotting paper, blot product on forearm. *Determine the amount of product on the paper.* The higher the amount of product on paper, the lower the Degree of Absorption intensity.
Amount of Residue	With blotting paper, blot product on forearm. *Determine the amount of product left on the skin.*
Type of Residue	None, film, oily, waxy, greasy, chalky (ONE or MORE)

Experiment 3- Descriptive analysis of some lip products to validate the lexicon

Materials and Methods

Panelists

Six highly trained panelists from The Sensory Analysis Center at Kansas State University (Manhattan, KS) participated in this study. Three of these panelists participated in the lexicon development (Experiment 2) and three did not. After testing, analysis of these two subgroups would be conducted to see whether differences exist. All panelists had over 120 hours of training and 1,500 hours of descriptive analysis experience.

Samples, sample preparation, and protocol

Four products were selected from three lip categories: balms, glosses, and lipsticks. Different brands, packaging, applicators, price points (quality), benefits and claims were utilized to achieve the most representative group. Table 3.7 provides the details of the samples along with basic relevant information. All samples were covered with aluminum foil and labeled with a three-digit random code. When testing, the panelists removed the lip/cap to each product and applied in accordance with the specific attribute protocol. Fragrance-free, alcohol-free Equate® Pop-Ups (Wal-Mart, Bentonville, AR) were used to wipe arms/fingers between samples. Panelists followed the specific testing protocol for each attribute developed in Experiment 2 (Table 3.2.4).

Test Design

Twelve samples were tested with two replications. Each session had six panelists and six products. Therefore, a 6×6 William's Latin square design was used to randomize the serving order. Each panelist saw a different product than the other panelists at each time point. The randomization ensured that each sample was tested times each session among the panel. The second replication had a new randomization. Data was collected using Compusense® *five* (ver. 4.6, 2004, Compusense, Inc., Guelph, Ontario, Canada), a computerized data collection system.

Data Analysis

Data was analyzed by Analysis of Variance (ANOVA) using PROC GLM. Post-hoc mean separation was carried out by using Fisher's least significant difference (LSD). Significant differences were determined at the 95% confidence level. Principal Component Analysis (PCA) was conducted on the descriptive panel data (Unscrambler®, 2004, version 9.0; Camo A/S, Oslo, Norway) to evaluate relationships among the sensory attributes of the lip product samples. PCA is a multivariate technique for exploring relationships among quantitative variables. Relationships were evaluated using multivariate statistical analyses. PCA was used to reduce the dimensionality of the attributes in order to show the relationship between the attributes and the samples.

Correlation among the attributes was also illustrated by PCA so that similar attributes could be combined into one attribute for subsequent analysis. Cluster analysis using PROC CLUSTER with Ward's method was also conducted with SAS® version 9.1 (SAS Institute Inc., Cary, N.C., USA). The clusters were based on the similarities of each sample's sensory characteristics.

Table 3.7 Test products for descriptive analysis

Product Type	Brand	Name	Color	Flavor	Applicator	Claims	Price Point[a]
Gloss	L'Oreal	Colour Juice (#220)	N/A	Berry Burst	Squeeze Tube	Sheer juicy lip color	Mid[b]
	Bonne Bell	Lip Lites	N/A	Cream Pop	Wand	N/A	Low[c]
	Lancome	Juicy Gelee	N/A	Fruit Punch	Pot/tub	Crystal clear lip gloss	High[d]
	Max Factor	MAXalicious Glitz (#810)	Vegas Nights	N/A	Wand	N/A	Mid
Lipstick	Almay	Hydracolor (#555)	N/A	Cherry	Bullet	Refreshing hydration, SPF 15	Mid
	Rimmel	Rich Moisture (#321)	Diva Red	N/A	Bullet	N/A	Low
	Clinique	Colour Surge (#302)	Metallic Sand	N/A	Bullet	N/A	High
	Revlon	Renewist Lipcolor (#120)	Coming up Roses	N/A	Bullet	SPF 15	Mid
Balm	Neutrogena	Lip Nutrition, Moisture Balm	N/A	Mango	Pot/tub	Daily softener, subtle shine	Mid
	Softlips	Lip protectant/ sunscreen	N/A	Cherry	Stick	Smooth conditioning balm; softer, healthier lips	Low
	Estee Lauder	Tender Lip Balm (#TLB04)	Tender Berry	N/A	Squeeze Tube	SPF 15	High
	Blistex	Lip Infusion Sheer Liquid Balm	N/A	N/A	Rolling Tip	SPF 15, deep hydration, no waxy feel	Low

[a] The price points represent the varying perceived qualities of the samples.
[b] Mid-level prices are from $4-$9; available for purchase from mass market merchandisers.
[c] Low-level prices are less than $4; available for purchase from mass market merchandisers.
[d] High level prices are above $10. In this study, these products were purchased at a department store and were not available from mass market merchandisers.

Results and Discussion

Product Type Comparisons

The three product groups (balm, gloss, stick) were analyzed at 95% confidence levels and were found to be significantly different ($P \leq 0.05$) for 18 of the 19 attributes evaluated (Table 3.8). Lip balm and lip gloss were similar for smoothness, wet, waxy appearance and opacity. Attributes similar for lip gloss and lipsticks were spreadability, drag 1, drag 2, waxiness and pearl-like. Tackiness and coverage were scored similarly for lip balms and lipsticks. Lipsticks were significantly higher ($P \leq 0.05$) than lip gloss and lip balm in color intensity 1 and 2, opacity and amount of residue. The high number of color pigments and waxes contribute to the intense color (Williams and Schmitt 1992). The high percentage of oils present in lip gloss contributed to the high tackiness intensity scores. Our data indicates that the lexicon is able to differentiate among the three product types used in the study.

Table 3.8 Lip product type comparisons based on mean intensity scores

Attribute	Product Type		
	Balm	Gloss	Lipstick
Smoothness	10.04a	9.54a	7.89b
Spreadability	10.07a	8.29b	8.76b
Drag1	4.49b	6.45a	6.63a
Drag2	3.82b	5.78a	5.77a
Tackiness	3.13b	5.32a	3.42b
Waxiness	1.73a	1.14ab	0.97b
Color Intensity	2.90c	4.22b	7.87a
Shininess	8.89b	11.92a	7.76b
Wet	5.68a	6.66a	1.91b
Glittery	0.48b	1.57ab	2.15a
Pearl-like	0.30b	3.26a	3.39a
Waxy Appearance	0.64b	0.50b	1.16a
Coverage	9.79ab	7.72b	10.20a
Opacity	3.19b	3.67b	7.33a
Color Intensity 2	3.89c	6.49b	10.57a

Attribute	Product Type		
	Balm	Gloss	Lipstick
Feathering[NS]	1.26	1.48	1.49
Tackiness (After)	2.72b	4.92a	2.89b
Degree of Absorption	5.79a	5.46a	6.43a
Amount of Residue	3.90c	5.22b	7.36a

a, b, c- Means with same letter within a row are not significantly different at the 95% confidence level

[NS] Not significant

Scores are based on a 15-point intensity scale with 0.5 increments

The four lip balm products were statistically different for most of the attributes evaluated (Table 3.9). Normally we would expect the balms to have similar characteristics, but the results indicated otherwise. This might be because of the applicator type or formulation. For instance, Blistex Lip Infusion had the highest scores for smoothness and spreadability, but the lowest scores for drag 1, drag 2, tackiness and waxiness. These scores were possibly because of the "roller ball" applicator. Estee Lauder was significantly higher ($P \leq 0.05$) compared to the other lip balms for 'wet.' This formula was very fluid and in a squeeze tube, suggestive of a lip gloss not a balm.

When testing products of the same type, it would be expected that the products would share similar characteristics. However, all the lip glosses were significantly different ($P \leq 0.05$) from each other for all attributes, except shininess and feathering. With the high amount of oils and waxes present in lip gloss formulations, similar intensity scores shininess would be expected. Again, formula variations could account for the differences in attributes such as smoothness, tackiness, wet and opacity.

The four lipsticks had the lowest scores among all the products for smoothness possibly because of the presence of particulate material. Opacity and color intensity were different for the lipsticks. Though their formulas and applicators may be the same, the amount of color pigments were not, which affected these attributes. Our results indicate that the lexicon was able to differentiate within a product type, and could be used for other lip products (plumpers, lip liners, multi-use) not addressed in this study.

Table 3.9 Mean intensity scores for descriptive analysis lip product testing

Attribute	Neutrogena	Estee Lauder	Softlips	Blistex	Max Factor	Lancome	Bonne Bell	L'Oreal	Rimmel	Almay	Revlon	Clinique
Smoothness	9.96 abc	9.46 bc	9.67 abc	11.08 a	8.83 cd	10.63 ab	9.00 cd	9.71 abc	8.54 cd	7.63 d	7.79 d	7.58 d
Spreadability	9.21 bc	9.04 bc	9.63 b	12.42 a	8.08 bc	7.67 c	9.29 b	8.13 bc	9.00 bc	8.96 bc	8.29 bc	8.79 bc
Drag 1	5.75 def	5.21 f	5.13 f	1.88 g	7.58 a	6.79 abc	5.96 cdef	5.46 ef	6.25 bcde	6.67 abcd	6.96 ab	6.63 abcd
Drag 2	5.13 bc	4.88 bc	4.08 c	1.21 d	6.96 a	6.13 ab	4.96 bc	5.08 bc	5.50 b	5.58 ab	5.88 ab	6.13 ab
Tackiness	3.96 c	5.67 a	1.88 e	1.00 f	5.04 ab	5.79 a	4.83 b	5.63 a	3.17 d	3.42 cd	3.54 cd	3.54 cd
Waxiness	2.67 a	1.25 bc	2.58 a	0.42 d	1.25 bc	1.54 b	0.75 cd	1.00 bc	0.71 cd	1.04 bc	1.13 bc	1.00 bc
Color Intensity	2.47 e	8.19 a	0.00 g	1.00 f	7.25 b	3.54 d	4.67 c	1.42 f	8.00 ab	7.96 ab	8.13 ab	7.38 ab
Shininess	11.25 a	12.25 a	1.08 d	10.96 a	11.46 a	12.54 a	11.29 a	12.38 a	7.04 c	7.21 c	8.04 bc	9.17 b
Wet	6.29 c	10.17 a	0.42 d	5.83 c	6.13 c	6.88 bc	5.33 c	8.29 ab	1.88 d	1.71 d	1.83 d	2.21 d
Glittery	1.54 c	0.29 d	0.00 d	0.08 d	3.58 b	0.29 d	2.00 c	0.42 d	0.29 d	0.46 d	3.17 b	4.67 a
Pearl-like	0.38 f	0.75 ef	0.00 f	0.08 f	3.21 c	0.79 ef	8.83 a	0.21 f	1.38 de	2.29 cd	2.33 cd	7.54 b
Waxy Appearance	1.42 a	0.00 e	0.83 abc	0.29 cde	0.92 abc	0.13 de	0.67 bcd	0.29 cde	1.46 a	0.96 ab	1.13 ab	1.08 ab
Coverage	8.71 cde	7.25 de	14.33 a	8.88 cde	7.63 de	8.08 cde	8.50 cde	6.67 e	10.33 bc	9.75 bcd	8.96 cde	11.75 b
Opacity	2.92 de	7.67 b	1.21 ef	0.96 f	3.79 cd	2.54 def	6.67 b	1.67 ef	4.83 c	7.08 b	7.78 b	9.63 a
Color Intensity 2	5.42 e	9.25 c	0.04 g	0.83 g	9.58 c	7.38 d	5.92 e	3.08 f	10.21 bc	10.17 bc	10.67 ab	11.25 a
Feathering	1.42 a	1.92 a	0.00 b	1.71 a	1.92 a	1.54 a	1.50 a	1.42 a	1.75 a	1.63 a	1.58 a	1.00 ab
Tackiness	3.17 bc	5.58 a	1.13 d	1.00 d	4.25 b	5.63 a	3.96 b	5.83 a	2.29 c	2.38 c	3.50 b	3.38 bc
Degree of Absorption	5.67 bcd	4.92 cd	8.13 a	4.46 d	4.46 d	5.83 bcd	6.04 bc	5.50 bcd	6.42 bc	6.42 bc	6.50 b	6.38 bc
Amount of Residue	3.29 fg	6.50 bc	2.42 g	3.38 fg	5.92 cd	4.92 de	5.96 cd	4.08 ef	7.75 ab	7.67 ab	7.83 a	6.21 c

a,b,c,d,e,f,g - Means with the same letter within a row are not significantly different at the 95% confidence level

Scores are based on a 15-point intensity scale with 0.5 increments

Principal Component Analysis (PCA) was conducted to illustrate the positions of each lip product in relation to the sensory attributes. In Figure 3.2, principal component 1 (PC1) and principal component 2 (PC2) accounted for 78% of the total variation in the total data set. The four lipstick samples seemed to be related to 'opacity', 'color intensity', 'drag', 'coverage', 'pearl-like', 'degree of absorption' and 'amount of residue'. Due to the high amounts of waxes, oil, pigments and emollients in lipsticks, spreadabilty scores were expected to be higher. The relatively low spreadability scores compared to the lip balms may be a result of applicator type (Johnson 1999).

The lip glosses were associated with wet, shine, tackiness and smoothness. Lip glosses tend to have lower amounts of wax and higher amounts of oil compared to lipsticks and lip balms. These ingredients give the lip glosses a shiny/wet look (Johnson 1999; Williams and Schmitt 1992). Intensity scores for Bonne Bell Lip Lites and L'Oreal Colour Juice may be credited to the application method: L'Oreal's and squeeze tube may have deposited more product compared to Bonne Bell's wand applicator to such an extent as to affect the overall scores.

Both Blistex and Softlips differed in the coverage attribute. Blistex Lip Infusion has a silver-ball rolling tip that deposits product sporadically on the skin/paper. If the rolling ball is not coated properly or saturated enough, a spotty application will occur. The Softlips balm has a normal Chapstick®-type applicator. This allows the product to be evenly and consistently applied, thereby obtaining optimal coverage.

The overlap between the lip glosses and lip balms may be attributed to the application process. Though consumers associate a lip gloss with transparent color, wet and shiny, manufacturers may not feel similarly (Williams and Schmitt 1992). For example, Estee Lauder labels their product as a balm, but the appearance and applicator (very liquid, squeeze tube) suggests a similarity to a lip gloss. The PCA shows Estee Lauder grouped with the lip glosses and characterized by shine, wet, smoothness and tackiness.

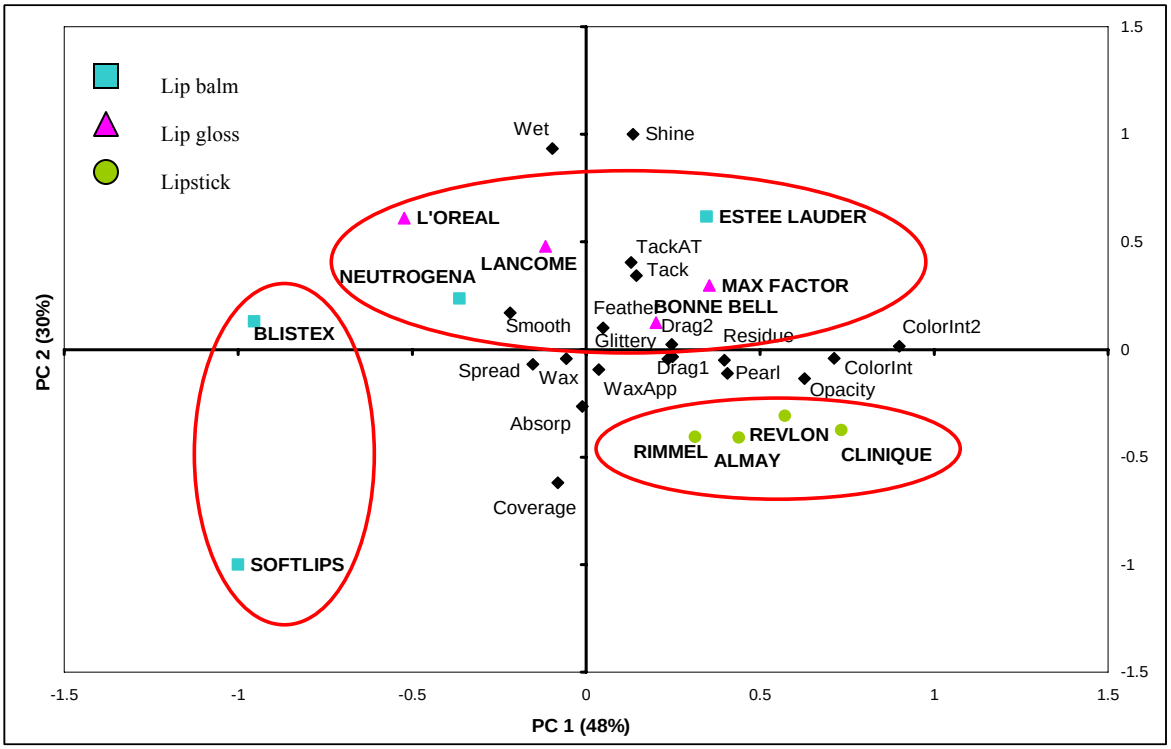

Figure 3.2 Lip product profiles using principal component analysis

Cluster analysis indicated three main groups of products. The groups are shown by the circles on the PCA map (Fig. 3.2). The four lipstick samples are associated closely enough to be in the same cluster. Blistex and Softlips were in another cluster. The third group contained the four lip glosses as well as two lip balms whose traits were more similar to that of a gloss rather than a balm. Overall, the main separattions were in the lip balms. Neutrogena and Estee Lauder had attributes more suggestive of a gloss than a balm.

Panelist Group Comparisons

As previously stated, the descriptive analysis panel consisted of three panelists from the lexicon development panel (G1) and three who were not involved in the development (G2). To analyze and compare the performance of the two groups, a nested design was utilized. This provided an error term that took the effect of each individual panelist into consideration. Mean comparisons were also conducted using Fisher's LSD (Table 3.10).

At 95% comparison level ($\alpha = 0.05$), no significant differences were found between the groups.

Table 3.10 Group performance comparisons based on mean intensity scores

Attribute	Group[a]		P-value
	G1	G2	
Smoothness	9.23[b]	9.08	0.8571
Spreadability	9.22	8.86	0.6869
Drag1	5.91	5.80	0.9003
Drag2	5.38	4.87	0.5861
Tackiness	3.51	4.40	0.3191
Waxiness[c]	0.43	2.13	***0.0894***
Color Intensity	4.80	5.19	0.4241
Shininess	9.35	9.76	0.7552
Wet	3.81	5.69	0.3477
Glittery	0.69	2.11	0.0953
Pearl-like	2.39	2.24	0.7760
Waxy Appearance	0.27	1.26	0.4176
Coverage	9.19	9.28	0.9612
Opacity	4.84	4.62	0.8297
Color Intensity 2	7.31	6.66	***0.0645***
Feathering	1.84	0.98	0.1446
Tackiness (After)	3.24	3.77	0.5219
Degree of Absorption	5.64	6.15	0.5547
Amount of Residue	5.16	5.83	0.5074

[a] G1 indicates the three panelists who participated in the lexicon development panel; G2 are three panelists who did not

[b] Scores are based on a 15-point scale with 0.5 increments

[c] Attributes in **bold** indicate p-values near 0.05.

Color intensity 2, waxiness and glittery were significant ($P \leq 0.10$) for the two groups. More training on the evaluation of these attributes might be useful. Waxiness did not have a picture reference, and therefore the scores might have been less precise. This indicates that, overall, the attributes work for panelists with different lexicon familiarity. Chambers and Smith (1993) were able to show that panelists with more experience did not perform differently than those with less experience when provided with the same orientation time.

Limitations

A few limitations existed that should be addressed for future studies. Age and skin type were not taken into account. As people age, their skin becomes less elastic. This could have had an effect on spreadability, drag 1 and drag 2 attributes. Using the forearm as the test site was the best solution for testing numerous products per session. However, not applying the products to their intended surface (lips) automatically limits the results. Though a range of products was selected, 12 products is not representative of all the lip products. No organic, natural or vegan products were tested. Their ingredients could have different textural and appearance attributes.

Conclusions

Summarily, the focus groups provided a starting point for lexicon development. Using suggested attributes among others, a lip product lexicon was developed. Descriptive testing using the lexicon was conducted to validate and verify the accuracy of the lexicon. Overall, the lexicon worked well in distinguishing between lip glosses, lip balms and lipsticks. The four lipstick samples were grouped together and had similar mean scores. Scoring overlap occurred for the glosses and balms possibly due to either applicator type or labeling. The variation and leniency regarding label standards for lip balm and lip gloss creates confusion for both descriptive panelists and consumers. This study tested a wide range, but limited number of samples in the lip product category. It did not include specialty products, such as lip plumpers, which might provide additional attributes.

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CHAPTER 4 - Conclusions and future research

Overall, the lip product lexicon was validated through descriptive testing. The appearance and texture attributes were comprehensive enough to show distinctions between the lip glosses, lip balms and lipsticks. The detail and strictness of the application techniques helped to ensure consistency in the panelist's evaluations. Data analysis showed the lipsticks grouped together and exhibited similar characteristics. Similar scores between the lip balms and lip glosses indicated that some balms had characteristics more commonly associated with a gloss.

This study was intended as the basis or starting point for numerous future studies. The attributes and application techniques developed in this study would require modifications to meet each study's particular objectives. The references were selected in an effort to be universal and easily duplicated. If this lexicon was to be replicated in the future with a different panel, depending on that study's time frame, fewer samples could be tested each day over an extended period of time. Applying the lip product to the panelist's lips would be the optimal application technique. This would serve to more realistically duplicate real-world uses of lip products.

Consumer testing could be conducted on a small group of lip products or prototypes. Test designs would most likely be hedonic in order to gauge the consumer's liking of any product or package characteristics. Again, the type and location of the product application would depend on the study's objectives.

This lexicon focused solely on appearance and textural attributes, so aroma, flavor and color could be studied in the future. New lip products are emerging every season, and companies are trying to impress the consumer with new packaging, new flavors, new colors and new formulas. This study tested a fraction of the available lip products. Lip plumpers, multi-use products (i.e. lip gloss and/or blush) and lip liners are also increasing in popularity. Potentially, each category could be tested individually with the broadest range of products. If so, some tweaking of the lexicon would be necessary to address each category's specific attributes. For example, additional attributes for lip plumpers may include 'tingle' or 'sensation'.

Portions of this research might be extrapolated to other product areas, such as skin care (lotions, creams, masques), hair care (shampoos, conditioners, masques, styling aids) and other make-up products (foundation, eyeshadow, eyeliner). Attributes would be similar, but references, intensities and applications would have to change to meet the study's objectives.

Appendices

Appendix A - Focus Group Screener

Lip Products Focus Group Screener

THE SENSORY ANALYSIS CENTER 532-7924

The Sensory Analysis Center on the campus of Kansas State University is conducting a research study. Would you like to see if you qualify?

1. Please indicate into which of the following categories you fit?

(1) Under 18 ....…….. Discontinue

(2) Age 18 to 24 .....… CONTINUE

(3) Age 25 to 30 .....… CONTINUE

(4) Age 31 to 40.....…..…. CONTINUE

(5) Age 41 to 50.....…… CONTINUE

(6) Age 51 to 60 .....…. Discontinue

(6) Age 61 to 65 .....…. Discontinue

(7) Over 65.....… Discontinue

Age group tally:
18-30:
31-50:
(no more than 8 per group)

Your session will occur on Wednesday, August 29 from 1:30-3:00 or Thursday, August 30 from 5:10-6:40.

Would you be available to participate?

If YES…….CONTINUE

2. Do you have any known food or cosmetic allergies?

(1) YES…….Discontinue

(2) NO…….CONTINUE

3. How often do you consume the following food products? ***(Doesn't matter)***

a) Apples
Once/ day Once/ week Once/ month Less than once/ month

b) Beef
Once/ day Once/ week Once/ month Less than once/ month

c) Tomatoes
Once/ day Once/ week Once/ month Less than once/ month

4. Please tell me the lip products you wear on a daily basis.

_____	_____
_____	_____
_____	_____
_____	_____

*****Discontinue if they do not say a lip product*****

MUST say <u>at least</u> one lip product, including **LIP GLOSS, LIPSTICK, OR LIP BALM** Preferably a mixture of 2 or more types of products.

5. Do you or any member of your immediate family work for a market research firm or food manufacturing company?

(1) YES…….Discontinue

(2) NO……..CONTINUE

6. Do you feel comfortable talking in front of a group of 10 people?

(1) YES…….CONTINUE

(2) NO……..Discontinue

Thank you, you DO qualify to participate in this project. **<u>The focus group topic is "lip products", so we ask that you bring all of the lip products you currently use.</u>** Each focus group session will last approximately 1 ½ hours.

Session 1 ---- Wednesday, August 29th, 2:00-3:30

Session 2 --- Thursday, August 30th, 5:10-6:40

Please check in at Justin Hall room 145 at least 5 minutes before your scheduled time. You will receive a reminder phone call or postcard. Thank you and have a nice day.

Interviewer: Please mark individual on quota sheet immediately

Appendix B - Detailed Moderator's Guide

Topic: Lip Products

OVERALL OBJECTIVE: To understand what attributes are favorable and unfavorable to consumers when purchasing lip products.

SECONDARY OBJECTIVE: To develop a list of attributes, products, and brands which is a representative selection of all lip products.

Welcome & Introduction: (10 minutes)

1. Hi, my name is Lauren and I would like to thank you for participating in this research project. You have been invited here to talk about cosmetic lip products.
2. This focus group session will last no more than 90 minutes. You were selected to participate in this discussion for a reason, so your thoughts are welcome and appreciated. Please be open and honest about your feelings and opinions. Your responses will not affect me or anyone else, and there are no right or wrong answers.
3. Your opinions are necessary for this research, and I need to hear everyone's point of view. Please share your experiences and opinions even if they differ from other people's.
4. This study will contain only your opinions. Your answers will not be linked to you specifically.
5. This session is being videotaped and audio-recorded. Please speak loudly, clearly and one at a time. No side conversations, please.
6. Since no one has met, let's begin our discussion by each saying our first name and our favorite cosmetic.

I. General Questions: (10 minutes)

1. When you think of cosmetics, what comes to mind?
2. What types of cosmetics do you wear?
3. How often do you wear cosmetics?

4. How long do you spend putting on cosmetics?
5. Why do you wear cosmetics?
6. What do you think of the makeup/cosmetics process?
7. What would make the process more enjoyable?

II. Specific Questions: (10 minutes)

1. What types of products do you use on your lips? Why?
2. How often do you apply lip products?
3. Do you mix and match?
4. How much does advertising affect your decisions on buying lip products?
5. How important is brand?

III. Intervention: (15 minutes)

Let's take a minute to think about what a "good" lip product is to you once it is applied. Is it flavor, color, smoothness, glossiness?…just think about certain characteristics that are favorable to you. On the **purple** paper, please write down five things that you would find in a good lip product.

Now, I want you to think of aspects of lip products that are negative in your mind. On the **blue** paper, please write down five of these.

Discussion:

Go to white board- list the positive and negatives

Note: the similarities between responses

IV. Change in lip products: (10 minutes)

1. How has you lip product routine changed as you have gotten older?
2. What are some benefits you have seen to today's products versus yesterday's?

V. Intervention: (15 minutes)

I want you to imagine you work in research & development for a cosmetic company, and it's your job to create the perfect product for YOU. Think about the characteristics this lip product would have…how it would be applied…any flavoring…any health benefits…particularly how it would feel on your lips. Please write down your perfect lip product in as much detail as you can.

Discussion:

On white board, make sections for:

Price
Package
Attributes
Benefits
Flavor

Place responses in applicable section.

Try to narrow down terms (if numerous) to create the "perfect" lip product.

VI. Product Range

If you were to put together a group of 8-10 lip products that could accurately reflect the entire range of balms, glosses, and lipsticks, what would they be?

VII. Close: (5 minutes)

Is there anything else you would like to add that would help me better understand your opinions about lip products?

Before we leave, I'd just like to summarize some of the main points of our discussion:
Main points:

Thank you so much for your valuable opinions and insights. Your participation is very much appreciated. Have a great day!

Appendix C - William’s Latin square test design

William's Latin Square Test Design SAS® Code

```
title 'Latin Square Design';
proc plan seed= 145646;
factors rows = 6 ordered cols = 6 ordered / noprint;
treatments tmts = 6 cyclic;
output out = g
    rows cvals = ('J1' 'J2' 'J3' 'J4' 'J5' 'J6') random
    cols cvals = ('OR1' 'OR2' 'OR3' 'OR4' 'OR5' 'OR6') random
    tmts nvals = (1 2 3 4 5 6) random;
quit;

Proc tabulate;
    class rows cols;
    var tmts;
    table rows, cols*(tmts*f=6.) / rts = 8;
run; quit;
```

Testing Day 1, Rep 1

	Cols					
	OR1	OR2	OR3	OR4	OR5	OR6
	Tmts	Tmts	Tmts	Tmts	Tmts	Tmts
Rows	Sum	Sum	Sum	Sum	Sum	Sum
J1	8	7	12	10	11	9
J2	4	5	1	6	3	2
J3	1	2	3	5	4	6
J4	9	12	10	8	7	11
J5	5	4	2	3	6	1
J6	12	9	11	7	8	10

Testing Day 2, Rep 1

	Cols					
	OR1	OR2	OR3	OR4	OR5	OR6
	Tmts	Tmts	Tmts	Tmts	Tmts	Tmts
Rows	Sum	Sum	Sum	Sum	Sum	Sum
J1	2	3	5	4	6	1
J2	11	10	7	12	8	9
J3	12	7	8	9	10	11
J4	1	6	3	2	5	4
J5	10	11	12	7	9	8
J6	3	2	4	5	1	6

Testing Day 3, Rep 2

	Cols					
	OR1	OR2	OR3	OR4	OR5	OR6
	Tmts	Tmts	Tmts	Tmts	Tmts	Tmts
Rows	Sum	Sum	Sum	Sum	Sum	Sum
J1	10	11	12	8	9	7
J2	7	12	8	10	11	9
J3	3	2	4	1	6	5
J4	6	1	3	5	4	2
J5	5	4	1	3	2	6
J6	8	9	11	12	7	10

Testing Day 4, Rep 2

	Cols					
	OR1	OR2	OR3	OR4	OR5	OR6
	Tmts	Tmts	Tmts	Tmts	Tmts	Tmts
Rows	Sum	Sum	Sum	Sum	Sum	Sum
J1	1	5	4	2	6	3
J2	6	1	5	4	3	2
J3	9	12	7	11	8	10
J4	10	8	9	12	11	7
J5	11	10	8	9	7	12
J6	2	3	6	1	4	5

Appendix D - Descriptive analysis reference pictures

Figure D.1

Color Intensity

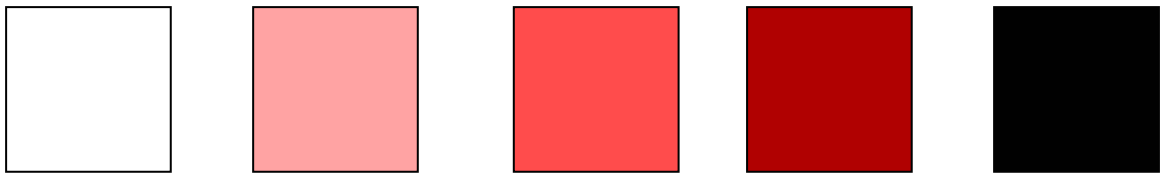
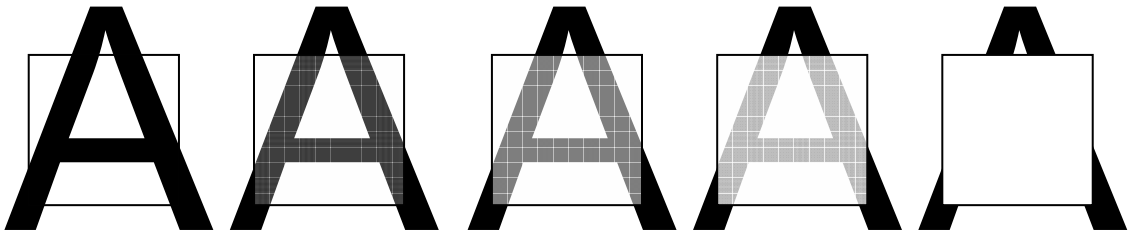


Figure D.2

Opacity



0.0 2.5 5.0 9.0 15.0

Figure D.3

Wet = 2.0
Waxy = 7.5

Figure D.4

Glittery = 10.0

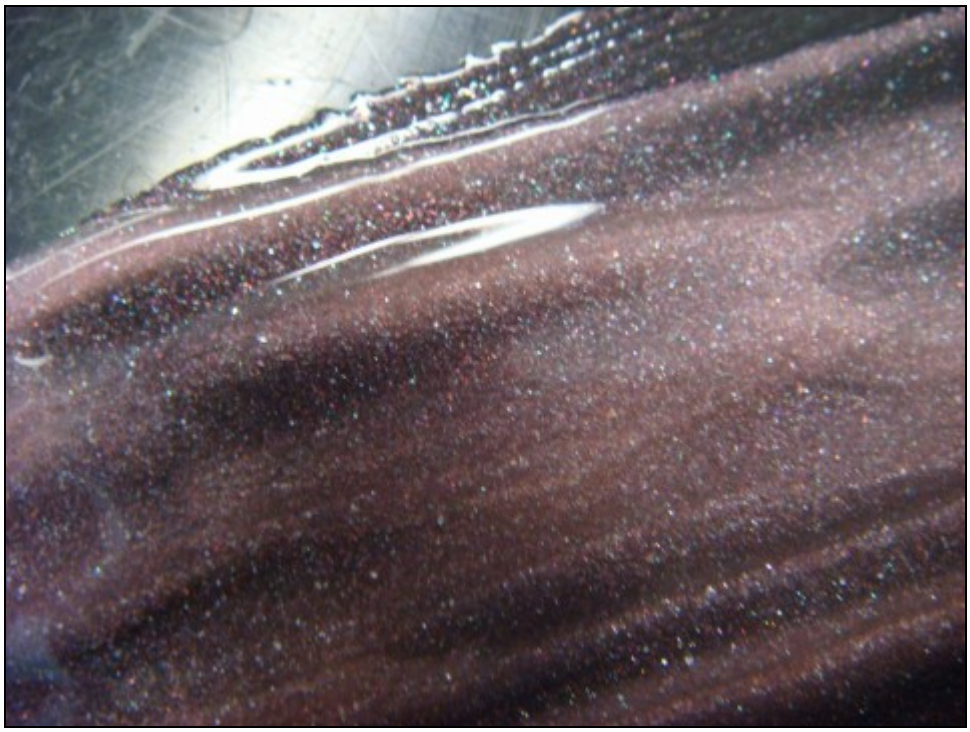


Figure D.5

Pearl-like = 2.5

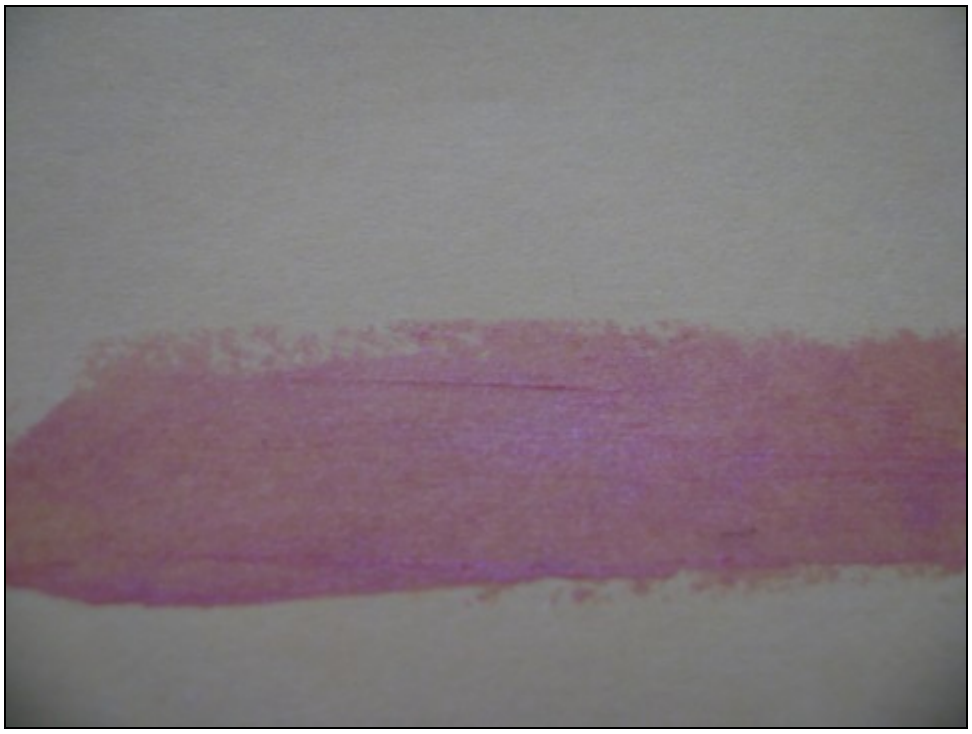


Figure D.6

Pearl-like = 5.0

Figure D.7

Pearl-like = 12.0

Figure D.8

Coverage = 6.0

Figure D.9

Coverage = 7.5

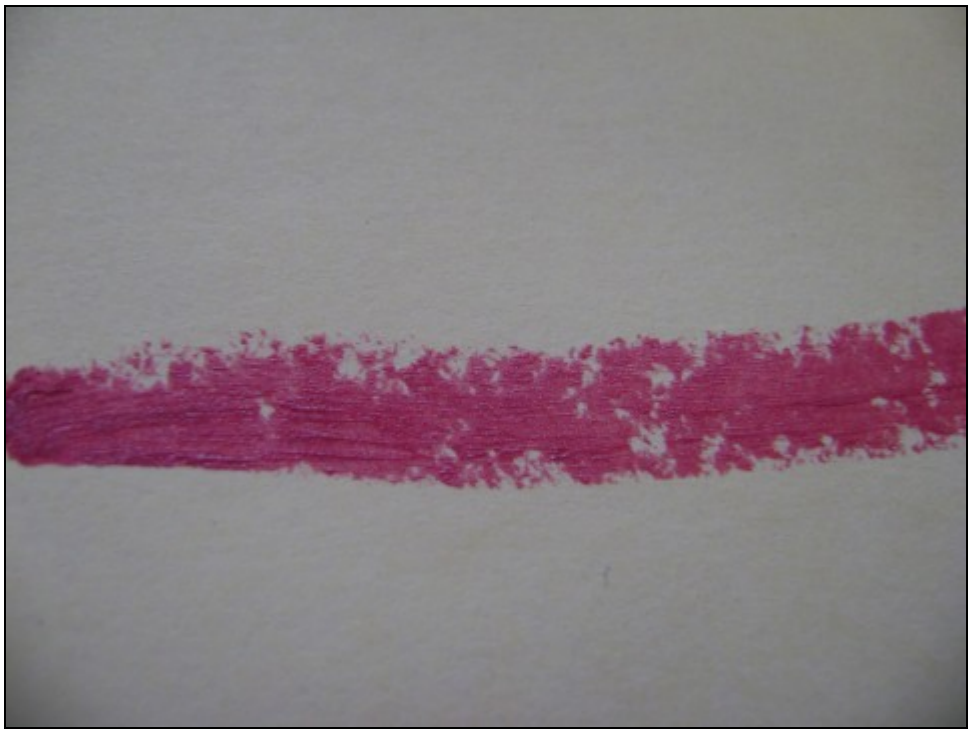
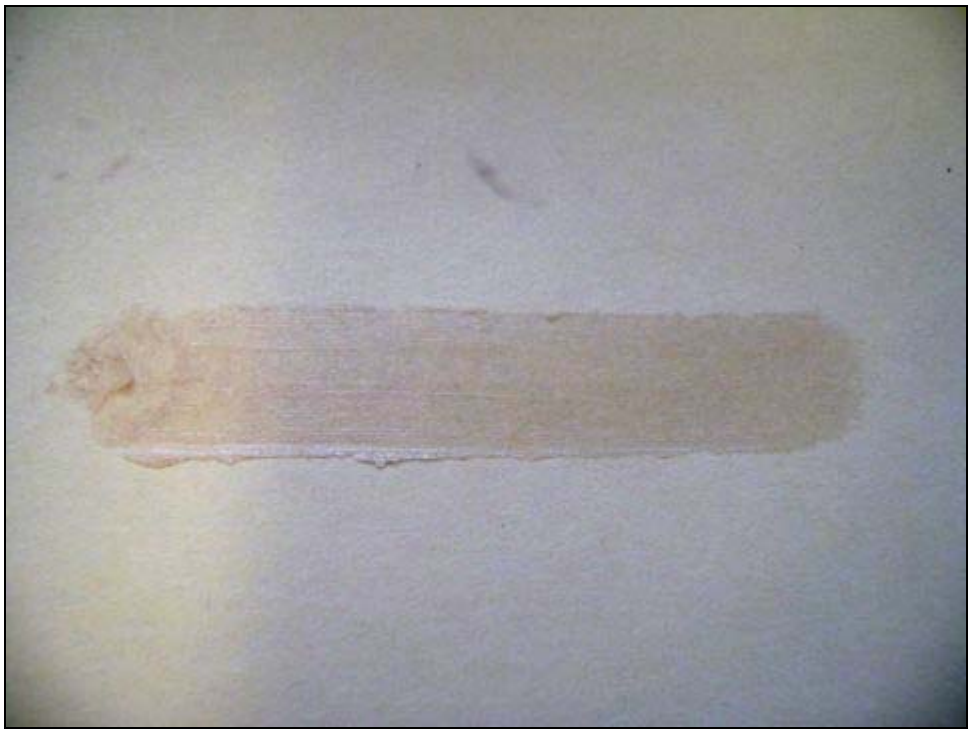


Figure D.10

Coverage = 15.0



Appendix E - SAS® code and analysis for descriptive analysis of lip products

Proc GLM

```
M 'LOG;CLEAR;OUTPUT;CLEAR;';
data step1;
INPUT  Panelist$ Sample$ Rep$ Smooth Spread Drag1 Drag2 Tack Wax ColorInt Shine
Wet Glittery Pearl WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp
Residue;
datalines;
(data has been removed)
;
proc glm;
class Panelist  Sample  Rep;
model    Smooth Spread Drag1  Drag2 Tack Wax ColorInt Shine Wet Glittery Pearl
WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp Residue = Panelist
Sample Rep PANELIST*REP SAMPLE*REP PANELIST*SAMPLE /ss3;
test h = SAMPLE e = SAMPLE*REP;
means SAMPLE ;
means SAMPLE /lsd e = SAMPLE*REP;
run;
/*Proc sort; by sample Panelist;
proc means;
 var Smooth--Residue;
 by sample Panelist;
run;
Proc sort; by sample;
proc means;
 var Smooth--Residue;
 by sample;
run;
Proc sort; by sample rep;
proc means;
 var Smooth--Residue;
 by sample rep;
run;*/
/*proc means;
 var Smooth--Residue;
 by group;
run;
```

Cluster Analysis

```
title 'Lip Products- Cluster Analysis';
data step1;
input Sample$ Smooth Spread Drag1 Drag2 Tack Wax ColorInt Shine Wet Glittery Pearl
WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp Residue;
datalines;
(data has been removed)
;
proc cluster data = step1 outtree=treew method=ward pseudo rmsstd;
id sample; run;
title2 'ward- lip products';
proc tree data=treew;
id sample; run;
```

Panelist Group Comparison Code

```
data lipprod;
input Group$ Panelist$ Sample$ Rep$ Smooth Spread Drag1 Drag2 Tack Wax ColorInt
Shine Wet Glittery Pearl WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp
Residue;
datalines;
(data has been removed)
;
proc glm;
class Group Panelist Sample Rep;
model Smooth Spread Drag1 Drag2 Tack Wax ColorInt Shine Wet Glittery Pearl
WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp Residue = sample rep
sample*rep group panelist(group)/ss3;
test h=group e=panelist(group);
means group/lsd e=panelist(group);
run; quit;
```

Product Type Comparison Code

```
dm 'log;clear;output;clear;';
DATA LIPPROD;
INPUT Category$ Sample$ Panelist$ Rep$ Smooth Spread Drag1 Drag2 Tack Wax
ColorInt Shine Wet Glittery Pearl WaxApp Coverage Opacity ColorInt2 Feather TackAT
Absorp Residue;
DATALINES;
(data has been removed)
;
PROC GLM;
CLASS Category Sample Panelist Rep;
MODEL Smooth Spread Drag1 Drag2 Tack Wax ColorInt Shine Wet Glittery
Pearl WaxApp Coverage Opacity ColorInt2 Feather TackAT Absorp Residue =
Category Sample Panelist Rep SAMPLE*rep(CATEGORY)/ss3;
TEST h=category e=SAMPLE*rep(CATEGORY);
means category/lsd e=SAMPLE*rep(CATEGORY);
run; quit;
```