Using Mind Genomics® to Identify Essential Elements of a Flower Product

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Abstract. The IdeaMap® software suite and the concept of Mind Genomics® were used to analyze which features of a flower product are influential to consumer perception. By presenting online human subjects with combinations of elements that describe a flower product, a database was created to define how individuals perceive distinct components of an overall flower product. This study was conducted with two separate groups of participants, the first provided by a panelist fielding house and the second administered to an undergraduate introduction to plants and gardening class. The fielding house participants represented various demographic groups throughout the United States and the majority was 40 years of age and older. The undergraduate class participants consisted primarily of white, female students between the ages of 18 and 24 years. Each study participant was exposed to a permutation of flower-based elements derived from six categories: flower color, flower shape, consumer health and wellness, flower fragrance, flower purchase location, and flower use. The results of the two studies illustrated which elements of each flower category appealed to different demographics of the population and were used to identify segments of the population that possessed similar mindsets toward elements of interest and disinterest in regard to a flower product. In both the fielding house and student IdeaMap® studies, the highest and lowest interest values were for elements from the flower fragrance category, indicating that floral fragrance is an important aspect of flowers with respect to current and future consumer satisfaction. Three distinct segments were identified in each study with the segments being primarily concerned with elements involving olfaction, visual, and other attributes of a flower product.

Consumer-assisted selection (CAS) is a strategy to understand the desirable aspects of innovation and change in a plant product through communication and input from the consumer. This type of selection is designed to increase purchasing interest and use of a product or service (<<http://www.plantinnovation.org>>). A primary example of CAS is the cultivation, breeding, and consumption of a perishable food crop like strawberry (*Fragaria* × *ananassa* Duch.). In the past, industry efforts have mainly focused on supply chain traits like berry yield, shipping quality, and size (Qin et al., 2008). Meanwhile traits like berry flavor, aroma, and texture have been widely underused (Duffy,

2007; Ulrich, 2010). From the industry perspective this concept is rational; e.g., a strawberry producer should be concerned with overall structural integrity and the volume to market numbers or the bottom line so to speak. Because strawberry traits selected for by industry breeders are known and can act as dependent variables, the consumer can then be asked which feature of strawberry interests them or would promote higher frequencies of purchase, i.e., CAS. These newly discovered independent variables may be berry color, flavor, aroma, texture, storage, etc. Therefore, allowing a greater number of variables affecting market value and/or sales of a perishable strawberry product through a system like CAS may result in an increased market share for industry members and an increased satisfaction of consumers at large (Colquhoun et al., 2012).

Consumer perception and/or preference for an object, experience, or concept is extremely difficult to assay without introducing cognitive bias (Redelmeier and Dickinson, 2011). In general, bias may lead to inaccurate conclusions about the consumer perception of a product. When an individual understands a question or situation regarding an object,

experience, or concept, cognition and rationalization are conserved mental functions that order or structure an idea and response. Thus, cognition can lead to cognitive bias whether it is founded in heuristics, social influences, and/or individual motivational factors (Gilovich et al., 2002).

Most interactive issues can be addressed by using a modified conjoint analysis approach with a relatively large population of human subjects (Green and Krieger, 1991). This method is a rapid and relatively inexpensive way to assay human perception and/or preference for individual elements that together describe a product. In the modified conjoint analysis performed here, product elements are presented in combinations of terms to determine consumer response to a mixture of ideas. Each element is considered an independent variable. For this reason, the individual elements that motivate the consumer reaction in a positive or negative manner can be determined. This method is called rule developing experimentation (RDE) and uses a software suite (IdeaMap®) as a human interface and data collection system (Moskowitz and Gofman, 2007). The impact of each product element on potential purchasing behavior as well as the affective state of human subjects can be objectively assessed.

Here RDE is applied for the first time to flowers, a terminal plant product with extremely high economic, psychological, and social value. The U.S. Department of Agriculture calculated that the expanded wholesale value of domestic floriculture crops from 15 program states has averaged close to four billion U.S. dollars (USD) per year during the last decade (US-NASS 2011). Additionally, the United States imports a substantial percentage of floriculture crops like cut flowers every year that are not accounted for in the latter statistic (≈500 million USD). The United States is not alone with an interest in flowers as an end product. In 1993 Sir John (Jack) Rankine Goody, famous for his work related to comparative anthropology in literacy, published a book entitled *The Culture of Flowers* (Goody, 1993). In his book, Dr. Goody illustrated that almost every human culture has written about flowers, used flowers in social rituals, or incorporated flower imagery in native art, except a number of African cultures. Interestingly, many of these African cultures refer to flowers by what they produce (e.g., fruit, seeds, dyes, medicine, etc.). Michael Pollan constructed a convincing argument for the innate attraction humans may have toward flowers, much like that of a bee (Anthophila), in his 2001 book *The Botany of Desire* (Pollan, 2001). More recently, flowers have been proposed to function through a positive emotional niche for humans, i.e., flowers influence socioemotional behavior. In theory, flowers effect a positive affective state that in turn increases overall human health and wellness (Haviland-Jones et al., 2005).

Despite the clear fascination humans have with flowers, very little empirical research has been conducted to investigate the biological, psychological, and/or neurological basis for

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this attraction. Here we use psychophysics to explore what aspects of flowers interest various demographic groups and segments of human subjects. Interpretation of these results can provide a framework for defining “the iconic flower,” but goes further to illustrate how the definition is really of iconic flower(s) with variation between definable groups of people.

Materials and Methods

To assay consumers' cognitive perception of a flower product, an effective RDE methodology was used (Colquhoun et al., 2012; Moskowitz, 2012; Moskowitz and Gofman, 2007). This statistical method was created by Moskowitz Jacobs Inc. (<<http://www.mji-designlab.com>>; White Plains, NY) in collaboration with the Wharton School of Business at the University of Pennsylvania (<<http://www.wharton.upenn.edu>>). Modified conjoint analysis methods (Green and Krieger, 1991) used by RDE permitted a grouping of independent variables to be analyzed; this method allowed each variable to affect the other, which would not be possible through a one variable-at-a-time approach (Anderson, 1970).

The overall focus of the studies and the theoretical product that we sought to develop was an ideal flower and/or flower experience from the consumer perspective; therefore, the studies were entitled iconic flowers. To begin the study construction, a welcome screen, two rating questions, 10 demographic questions, and a screen to thank the participants for participating were created in the IdeaMap® software suite. Next, six categories or silos related to a flower and/or flower experience were identified: 1) flower color; 2) flower shape; 3) flower fragrance; 4) consumer health and wellness; 5) purchase location; and 6) flower use. Six elements or word pictures relevant to each category were then developed (e.g., 1: flower color–A1: brilliant white petals). The silos, corresponding elements (Table 1), were uploaded along with the additional screens and questions to the IdeaMap® software suite at <<http://www.ideamap.net>>. The online study was presented to the subjects in the following order: welcome screen, 48 screens of permuted element combinations with both rating questions asked (Fig. 1), 10 demographic questions, and a thank you screen.

To qualify or test our element construction, a pilot iconic flowers study was constructed and administered to personal contacts, colleagues, industry members, and students (the researchers' e-mail list). A total of 338 subjects logged onto the pilot study, and 161 completed experiments were acquired. The findings for this study can be found in the book *Mind Genomics: The New Novum Organum* Vol. 5b authored by Howard R. Moskowitz. Additionally, the pilot study allowed for an educated element design before launching the iconic flowers studies described in this article.

For one of the two studies presented here, a division of Focus Forward, LLC (<<http://www.focusfwd.com>>), Panel Direct

Table 1. General experimental design of category silos and individual elements.²

Category A_Flower Color	
Element A1	Brilliant white petals
Element A2	Explosive, vibrant red petals
Element A3	Blue petals
Element A4	A mixture of many brightly colored flowers
Element A5	Cheery yellow flower petals
Element A6	Pastel flower colors
Category B_Flower Shape	
Element B1	An extremely large flower
Element B2	Delicate sprays of small clustered flowers
Element B3	Beauty is found in symmetrically shaped flowers
Element B4	Rarity is everything
Element B5	Looks good enough to eat
Element B6	Every flower shape imaginable...I like diversity
Category C_Consumer Health and Wellness	
Element C1	Happy is a bright flower
Element C2	Festive flowers mean fun
Element C3	Flowers in the office for better productivity
Element C4	Bring a garden to me
Element C5	Healthy flowers for a healthy home
Element C6	The more flowers...the more oxygen
Category D_Flower Fragrance	
Element D1	Smells sweet as honeysuckle
Element D2	Smells spicy with accents of lavender
Element D3	The subtle fragrance of a traditional rose
Element D4	Cover me with the smell of lilies
Element D5	Smells fresh with a hint of citrus
Element D6	This flower does not make fragrance at all
Category E_Flower Purchase Location	
Element E1	Convenient at your local Home Depot garden center
Element E2	Picked fresh from a home garden
Element E3	Chosen with pride by a local grower
Element E4	Convenient at your local Lowe's garden center
Element E5	Available from a florist
Element E6	Purchased from a local farmers' market
Category F_Flower Use	
Element F1	Flowers that could be used to...decorate a celebration
Element F2	The perfect gift for a friend
Element F3	Best way to say...sorry
Element F4	The perfect gift for a lover
Element F5	A great way to say...thinking of you
Element F6	A great way to say...happy birthday

²Listed are all categories A to F, flower color, shape, health and wellness, fragrance, purchase location, and flower use. Within each of these categories all elements are listed from A1 to F6 for a total of 36 individual elements.

Online (<<http://www.paneldirectonline.com>>), was used to recruit an online panel of study subjects (fielding house subjects) with three screening questions for the first study. We requested a specific demographic split among the fielding house subjects as follows: an approximate 50/50 male-to-female ratio, an even number of individuals from four ethnicities, and a distributive number of subjects in representing a wide range of ages (Fig. 2). The following subject screening question(s) were presented to the fielding house participants before they began the iconic flowers study: s1) please specify your gender; s2) for demographic purposes only, which best describes your ethnic background; and s3) which age group do you belong to? A total of 373 fielding house subjects logged into the iconic flowers study, and 295 subjects completed the study. For the second study, a relatively large, University of Florida (UF), undergraduate gardening class (PG&Y) was enlisted to

completed the same iconic flowers experiment (n = 336). The majority of the UF class was female (64%), belonged in the 18- to 24-year age group (98%), and 59% of the students were white with remaining ethnic groups about equally represented (Fig. 2). The two studies were launched and completed during the spring semester of 2011.

Several steps were pertinent to the success and efficiency of the IdeaMap® studies with the first step as the most ambiguous, category and element design. The second step was a main effects experimental setup with a six-variable, six-level design. Each of the 36 options (elements) appeared five times in 48 permuted combinations. Every respondent evaluated a unique set of 48 combinations with the same 36 elements. Every combination (concept) comprised a minimum of three to a maximum of four elements and a maximum of one element from each category. Therefore, all combinations were incomplete

A

Happy is a bright flower
The subtle fragrance of a traditional rose
Available from a florist

How likely are you to purchase flowers of this type?

1 2 3 4 5 6 7 8 9

Not Likely <-- 1 2 3 4 5 6 7 8 9 --> Very Likely

B

How do flowers of this type make you feel?

1 2 3 4 5

1=Relieved...2=Happy...3=Hopeful...4=Proud...5=Sensible

Fig. 1. Windows® Internet Explorer screen shots of an example of the Iconic Flower IdeaMap® study. (A) An example of a screen with rating question one (interest) and a random combination of elements. (B) An example of rating question two (affective state).

and eliminated collinearity. Note that the original experimental design ensured that all 36 elements were statistically independent of each other. Regression modeling (ordinary least squares) was then used to analyze the data set through the SYSTAT13 software package (<http://www.systat.com>; Chicago, IL). The additive equation was in the form:

$$\text{Rating} = k_0 + k_1 + k_2 \dots k_{36}$$

where k_0 was the additive constant and k_1 – k_{36} were elements 1 to 36, respectively. The additive constant was an expected value of the rating when elements 1 to 36 were all 0. Each subject generated an individual additive constant. Beyond the elements linear contribution to concepts, the regression modeling may have incorporated interactions as well. Also, data quality was assessed by computing the multiple R^2 statistics for the linear equation relating the presence/absence of concept elements to the scalar rating. Values above or below the additive constant for individual or groupings of study participants indicated interest or disinterest in the element presented. Study participants from the fielding house (FH) and PG&Y were separated by gender, age, ethnicity, and residence to determine interest values in the designed elements. In addition, K-Cluster analysis was used (MacQueen, 1967), which was carried out by the software package SYSTAT13 (<<http://www.systat.com>>; Chicago, IL). K-Clustering identified the most appropriate manner to separate objects (data points) into “K” (where “K” is a set value) different segments. This allowed segments of the study populations to be separated with differing priorities or interest values regarding elements presented in the study.

Results

Rule developing experimentation and the IdeaMap® software suite were used to assay human subjects’ interest toward elements specific to certain aspects of a flower and/or

a flower purchasing experience. The six flower aspects, or categories, used were: 1) flower color; 2) flower shape; 3) flower fragrance; 4) consumer health and wellness; 5) flower purchase location; and 6) flower use. Six elements, or word phrases, correlating with each category were then generated, which resulted in a total of 36 independent elements. Examples of elements included, but are not limited to: “A mixture of many bright colored flowers” in the flower color category “Delicate sprays of small clustered flowers” in the flower shape category and “The perfect gift for a friend” for the flower use category (Table 1). The vocabulary and word phrases that make up each element were created by the researchers through dialogue with colleagues, industry members, consumers, and pilot RDE studies. As RDE implies, IdeaMap® is designed to become more advanced through continued experimentation (Moskowitz and Gofman, 2007).

To access the online study, a human subject opened a URL link in Windows® Internet Explorer (Microsoft Inc., Redmond, WA) that led them to a study welcome screen. The welcome screen introduced the study and provided instructions for study completion. The subject then continued to a screen containing three or four individual and independent elements, each from separate categories (Fig. 1). The subject then responded to rating question one (RQ1), “How likely are you to purchase flowers of this type?” (Fig. 1A), an interest question with a nine-point Likert scale (Likert, 1932). Therefore, the subject was forced to make an interest decision based on all elements present in the on-screen combination. The subject was then provided with rating question 2 (RQ2). RQ2, “How do flowers of this type make you feel?” (Fig. 1B), was designed to indicate the affective state that the same elemental combination provoked. RQ2 had a five-point scale with the affective states being: relieved, happy, hopeful, proud, and sensible. The respondent was presented with 48 random combinations and

answered RQ1 and RQ2 for each combination. After the subject completed the element screens, they responded to 10 demographic questions and were presented with a “thank you” screen.

The iconic flower IdeaMap® study was administered to two separate groups of subjects; one group was provided by a panelist fielding house, and the other consisted of students in an undergraduate gardening class. More specifically, the FH subjects were provided by Panel Direct Inc. and represented a distributive example of the U.S. population. The second group was a UF undergraduate, introductory gardening class, PG&Y, and represented a vastly more age-specific population. The hypothesis was that the FH group would provide insight into what flower consumers desired in “today’s” market, whereas the PG&Y group would provide information about what flower consumers desired in “tomorrow’s” market.

The FH and PG&Y subject groups consisted of 295 participants and 336 participants, respectively (Fig. 2). The demographic of FH participants had an about even distribution between genders and four ethnicities (Figs. 2A and 2C). The majority of FH subjects were 40 years old and older, married, lived in a suburban area, experienced flowers “all the time,” were content with the flowers available on the market today, and had purchased flowers before (Figs. 2B and 2D–H). The majority of PG&Y subjects were female, single, and white, between the ages of 18 and 24 years, lived in a suburban or a city area, were content with the flowers available on the market today, and had purchased flowers before (Figs. 2A–E, 2G, and 2H). Interesting to note, the PG&Y subjects demonstrated a more distributive trend when asked how often they experience flowers compared with the FH subjects (Fig. 2F).

After all participants ($n = 295$ FH and 336 PG&Y) finished the iconic flower IdeaMap® study, the analysis was performed to obtain interest values for each presented element. The constant value that appears on most data tables (additive constant) is a calculated percentage of subjects that would answer the interest-based rating question (RQ1) favorably (i.e., seven to nine) if no elements were shown on the screen. The additive constant functions as a baseline indicator of the subject’s overall interest in the topic of the study, introduced with the title of iconic flowers. Interest values are percentages to be added to the constant and give a measure of interest or impact of individual elements compared with the constant, each other, and/or demographic (Moskowitz and Gofman, 2007).

The resulting data from both groups were assembled into a topline interest value arrangement table (Table 2). The elements were sorted from highest interest value to lowest interest value per group. The FH group resulted in an additive constant of 57, whereas the PG&Y group had an additive constant of 53 meaning that FH as a whole was slightly more interested in the topic of the study. The top element for both subject groups as judged by

Fig. 2. A graphical representation of an iconic flower study subject's demographic information. Shown are gender, age, ethnicity, neighborhood of domicile, relationship status, the frequency of visual or olfactory experiences with flowers, whether they were content with the selection of flowers during a purchase, and whether they had purchased flowers before. The y axis is the number of total subjects. Black bars represent the fielding house (FH) subjects; gray bars represent the plants, gardens, and you (PG&Y) student subjects.

the highest overall interest value was an element from the flower fragrance category (Table 1). However, FH had the largest interest value (seven) for the element "The subtle fragrance of a traditional rose," whereas PG&Y had the highest interest value (eight) for the element "Smells fresh with a hint of citrus" (Table 2). The next highest interest value for both groups (five and seven, respectively) resulted in the same element, "explosive, vibrant red petals." FH and PG&Y shared the bottom three elements with all negative interest values. An element from the category of purchase location with the

words "...Lowe's garden center..." was the third lowest interest value, the second lowest interest value was for the element "best way to say...sorry," and the absolute lowest interest value (-10 and -13, respectively) was for an element from the flower fragrance category "This flower does not make fragrance at all" (Table 2).

As illustrated by the difference between overall top elements for each subject group and the similarity of the overall bottom elements (Table 2), the two groups resulted in divergent top and bottom elements for many of the six specific flower categories (Supple-

mentary Table S1). The flower color category provided the only common elements between the two groups with the element "explosive, vibrant red petals" as the highest interest value and the element "pastel flower colors" as the lowest interest value. Every other category such as flower shape, fragrance, use, consumer health and wellness, and purchase location contained at least one disagreement as to individual elements with the highest or lowest interest value (Supplementary Table S1).

For most of the following tables, the two elements that obtained the highest and lowest values of interest are shown for spatial

Table 2. A topline interest value alignment of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects (n = 295 and 336, respectively).²

FH	PG&Y	
	Base size Constant	Base size Constant
	295 57	336 53
The subtle fragrance of a traditional rose	7	Smells fresh with a hint of citrus 8
Explosive, vibrant red petals	5	Explosive, vibrant red petals 7
Rarity is everything	5	A mixture of many brightly colored flowers 6
Happy is a bright flower	4	Smells sweet as honeysuckle 6
Beauty is found in symmetrically shaped flowers	4	Picked fresh from a home garden 5
Flowers that could be used to...decorate a celebration	4	Festive flowers mean fun 5
A mixture of many brightly colored flowers	3	Cheery yellow flower petals 4
Smells sweet as honeysuckle	3	Healthy flowers for a healthy home 4
The perfect gift for a friend	3	Rarity is everything 3
The more flowers...the more oxygen	2	Purchased from a local farmers' market 3
Delicate sprays of small clustered flowers	2	A great way to say...happy birthday 3
Every flower shape imaginable...I like diversity	2	The more flowers...the more oxygen 2
A great way to say...happy birthday	2	Happy is a bright flower 2
Smells fresh with a hint of citrus	2	Every flower shape imaginable...I like diversity 2
Cheery yellow flower petals	2	An extremely large flower 2
Chosen with pride by a local grower	2	Brilliant white petals 2
Looks good enough to eat	2	Blue petals 1
Picked fresh from a home garden	2	The perfect gift for a lover 1
The perfect gift for a lover	1	Beauty is found in symmetrically shaped flowers 1
Flowers in the office for better productivity	1	A great way to say...thinking of you 1
Cover me with the smell of lilies	1	Chosen with pride by a local grower 1
An extremely large flower	1	Looks good enough to eat 0
Healthy flowers for a healthy home	0	Cover me with the smell of lilies 0
Blue petals	0	Pastel flower colors 0
A great way to say...thinking of you	0	The subtle fragrance of a traditional rose 0
Festive flowers mean fun	-1	Smells spicy with accents of lavender 0
Convenient at your local Home Depot garden center	-1	Flowers that could be used to...decorate a celebration -1
Brilliant white petals	-1	Flowers in the office for better productivity -2
Bring a garden to me	-1	The perfect gift for a friend -3
Purchased from a local farmers' market	-1	Bring a garden to me -4
Pastel flower colors	-2	Delicate sprays of small clustered flowers -4
Available from a florist	-2	Convenient at your local Home Depot garden center -5
Smells spicy with accents of lavender	-2	Available from a florist -6
Convenient at your local Lowe's garden center	-2	Convenient at your local Lowe's garden center -7
Best way to say...sorry	-5	Best way to say...sorry -9
This flower does not make fragrance at all	-10	This flower does not make fragrance at all -13

²Data shown are for rating question 1. Total element interest values of all subjects ranked from highest to lowest and split per study. The constant is a calculated value that depicts the percentage of subjects that would respond favorably (7 to 9) if no elements were present, i.e., a study baseline. The interest value is a percentage that is added to the constant for a percentage of subjects, which would be interested or disinterested in the respective element.

considerations (the entire data set is available as a supplemental document). Separation of male subjects from female subjects in each group illustrated that the FH female subjects are generally more interested in flowers than the rest as indicated by the highest additive constant value (FH male constant 53, female constant 61; PG&Y male constant 52, female constant 54) (Table 3). All groups and genders, except for PG&Y males, had two flower fragrance elements in the top two (varying fragrance elements) and bottom two (makes no fragrance element) interest values. FH males associated the highest interest values for the element about a subtle fragrance of rose, FH females were interested by the element "smells sweet as honeysuckle," and PG&Y females were interested in a fresh smell of citrus. The young males from

PG&Y appeared to show the highest interest value for flower color and human wellness elements while showing substantial disinterest in elements for categories like flower shape and use (Table 3).

Because the FH subjects had a majority of participants 40 years of age and older, and the PG&Y subjects were vastly 18 to 24 years of age, the topline comparison between the studies (Table 2) evaluated trends between the aforementioned age groups. Therefore, we separated the data from FH by age and compared the 18- to 24-year age group of FH subjects to almost the entire PG&Y (330 subjects) with the hypothesis that similarities would be observed for the elements interest values. Supporting the hypothesis, a few similarities were observed such as the element with the second highest interest value for both

groups was the flower color element dealing with red petals (Supplementary Table S2). Also, similarities existed at the bottom of the list with the lowest interest values. Elements shared between the two groups that are in a substantially negative value range are the common elements now like "This flower does not make fragrance at all," elements about purchase location like Lowe's and Home Depot, and elements with the word sorry. However, that is where the similarities cease and the disparity begins. One negative (-19) element from the FH subgroup, "purchased from a local farmers' market," was slightly positive to neutral for the PG&Y subjects (Supplementary Table S2). The top elements for each group were dissimilar, i.e., PG&Y showed the fragrance element discussed earlier as the top element, but FH resulted in one of the few situations that the element "rarity is everything" resulted in the highest interest value.

The data were then further separated by ethnicity into four subgroups within the original groups FH and PG&Y: white, black, Latino, and Asian (Supplementary Table S3). Again, the element with the concept of no floral fragrance was found in the bottom two elements with negative interest values in each subgroup except for the Latino subgroup within the FH participants. Comparing white subjects from FH and PG&Y demonstrated a disparity between the two with a flower use element ("the perfect gift for a friend") as the highest interest value (12) for FH and a flower color element as the highest interest value for PG&Y (eight). However, it should be noted that white subjects in PG&Y have the two highest interest values, both at eight, whereas the white subgroup in FH resulted in the higher interest value of 12 for "the perfect gift for a friend" element and a nine for a fragrance element (Supplementary Table S3). Comparing the Latino subgroups between the FH and PG&Y illustrated that FH Latinos are very interested in elements regarding flower fragrance, much like the rest of the study results; however, FH Latinos did not show a disinterest in the element referring to no fragrance like the majority of the results showed. PG&Y Latinos were disinterested (-13) by the "no fragrance" element, but this subgroup was most interested by elements dealing with flower color and purchase location (17 and 13, respectively). Lastly, the FH Asian subgroup demonstrated the highest interest value (11) for the element with the corporate name of Home Depot at the center, which was a rare situation for both studies (Supplementary Table S3).

Separating the FH and PG&Y groups by location of residence resulted in very similar numbers of subjects in each subgroup: FH, suburbs n = 124, urban n = 72; PG&Y, suburbs n = 125, urban n = 59 (Supplementary Table S4). The additive constant value was similar between the suburbs subgroups; however, the additive constant was quite different between the urban subgroups. FH urban subjects displayed a constant value of 33 (i.e., 33% of subjects are already interested in flowers), whereas PG&Y urban subjects

retained an additive constant of 50. Additionally, FH urban subjects showed the highest overall interest value for a fragrance element with a large number of 17 compared with PG&Y urban subjects' highest interest value of 12 (note: for a fragrance element) (Supplementary Table S4). Therefore, a vertical limit difference of five between the two subgroups that displayed a baseline difference of 17 may suggest subjects with overall less enthusiasm for flowers can be interested to a greater level.

One of the demographic questions was, "How often do you see or smell flowers?" The data were separated based on group (FH

and PG&Y) and response to the question: one time per month (1/month), one time per week (1/week), one time per day (1/day), and all the time. Focusing on the additive constant and highest interest values for FH and PG&Y subjects that report association with flowers 1/month and 1/week, it appears the higher the constant, the lower the top interest value (Table 4). PG&Y 1/month subjects have a high additive constant of 71, but the top element interest value is one compared with FH 1/month subjects with a constant of 41 and highest interest value of eight. In contrast, comparing FH and PG&Y subjects that responded with an association to flowers

all the time resulted in similar constant values (55 and 53, respectively), top and bottom interest values (10 and 12, -13 and -20, respectively), and lowest valued element (no fragrance). FH subjects were most interested in the elements "rarity is everything" and "explosive, vibrant red petals," whereas PG&Y was most interested in the elements "an extremely large flower" and "purchased from a local farmers' market" (Table 4). The latter finding for PG&Y was not the study norm.

Lastly, the total data sets for the FH and PG&Y groups were segmented with K-cluster analysis. The segments represent the portion

Table 3. Gender comparison of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH	Male	PG&Y	Male
	Base size		Base size
	Constant		Constant
The subtle fragrance of a traditional rose	7	Explosive, vibrant red petals	9
Beauty is found in symmetrically shaped flowers	7	Festive flowers mean fun	9
Best way to say...sorry	-8	Delicate sprays of small clustered flowers	-9
This flower does not make fragrance at all	-14	Best way to say...sorry	-10
FH	Female	PG&Y	Female
	Base size		Base size
	Constant		Constant
Smells sweet as honeysuckle	7	A mixture of many brightly colored flowers	10
Explosive, vibrant red petals	7	Smells fresh with a hint of citrus	9
This flower does not make fragrance at all	-7	Convenient at your local Lowe's garden center	-10
Available from a florist	-8	This flower does not make fragrance at all	-18

^zThe total sample data were separated by study and gender. The base sizes and constants for each subject population are shown under the general heading in bold. Also, illustrated are the top two and bottom two elements as ranked by interest values.

Table 4. Frequency of visual or olfactory detection of flowers comparison within the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH	PG&Y
How often do you see or smell flowers?	How often do you see or smell flowers?
Base size	Base size
Constant	Constant
Beauty is found in symmetrically shaped flowers	Smells sweet as honeysuckle
Smells fresh with a hint of citrus	Smells fresh with a hint of citrus
This flower does not make fragrance at all	Delicate sprays of small clustered flowers
An extremely large flower	Convenient at your local Lowe's garden center
FH	PG&Y
How often do you see or smell flowers?	How often do you see or smell flowers?
Base size	Base size
Constant	Constant
Flowers that could be used to...decorate a celebration	Smells fresh with a hint of citrus
The perfect gift for a friend	Explosive, vibrant red petals
Festive flowers mean fun	Convenient at your local Lowe's garden center
This flower does not make fragrance at all	Best way to say...sorry
FH	PG&Y
How often do you see or smell flowers?	How often do you see or smell flowers?
Base size	Base size
Constant	Constant
The subtle fragrance of a traditional rose	Blue petals
Smells fresh with a hint of citrus	A mixture of many brightly colored flowers
A great way to say...thinking of you	The subtle fragrance of a traditional rose
Best way to say...sorry	This flower does not make fragrance at all
FH	PG&Y
How often do you see or smell flowers?	How often do you see or smell flowers?
Base size	Base size
Constant	Constant
Rarity is everything	An extremely large flower
Explosive, vibrant red petals	Purchased from a local farmers' market
Available from a florist	Best way to say...sorry
This flower does not make fragrance at all	This flower does not make fragrance at all

^zThe total sample data were separated by frequency of flower detection and listed first by once per month, once per week, once per day, and all the time. The base sizes and constants for each subject population are shown under the general heading. Illustrated are the top two and bottom two elements ranked by interest values.

of respondents that have similar trends of response toward the product elements, symbolically identifying portions of the population who share ideas of the representative features of an “iconic flower” (Moskowitz et al., 2006). First, the data were separated into two segments (Supplementary Table S5) and in a separate analysis to three segments (Table 5). The first analysis resulted in two segments per group that consisted of 93 subjects in Segment 1 and 202 subjects in Segment 2 for FH subjects and 163 and 173 subjects in Segments 1 and 2 for PG&Y subjects, respectively (Supplementary Table S5). Segment 1 from FH and PG&Y had similar constants, interest values, and top and bottom elements. Bottom elements for Segment 1 within both groups (FH and PG&Y) were flower color elements and purchase location elements. Top elements for both groups were flower fragrance elements with very high interest values of 24 and 21, respectively. Therefore, this segment was given the title of the olfaction segment. Segment 2 demonstrated similar comparisons except the interest focused on elements of flower color with fragrance elements of major disinterest, so Segment 2 for both groups was titled the visual segment (Supplementary Table S5).

The data were then segmented further into three K-clusters (Table 5). Segment 1 from both groups remained the olfaction segments, but FH base size reduced to 54 subjects compared with PG&Y at 163 subjects (Table 5). Segment 2 for FH and PG&Y remained the visual segment and this segment too was reduced in base size numbers with 108 and 116 subjects from the respective groups. The third segment resulted in 133 and 57 subjects

from FH and PG&Y, respectively. The elements eliciting the highest interest values were from the health and wellness category for FH and purchase location for PG&Y. Therefore, Segment 3 was entitled the other segment for both groups (Table 5). As a consequence of the segmentation, the subjects are clearly divided into discernible segments of consumers that have very specific interests and disinterests in particular elements that communicate flower aspects (Supplementary Table S5; Table 5).

Discussion

Flowers are clearly drivers of interest and emotion in humans. The exact mechanisms governing this observation are not well known. Very little empirical evidence exists in the literature to support a biological, psychological, or neurological mechanism for the effect flowers have on the human cognitive and affective states. However, examples of this phenomenon are documented in the literature to some degree (Haviland-Jones et al., 2005; Lechner et al., 2005). We have attempted to use RDE and Mind Genomics® (Moskowitz, 2012) to provide empirical data to better understand the consumers’ perception of flowers. Through these methods, three main consumer segments have now been identified in relation to the most influential aspects of flowers that drive individual segment interests.

Two segments of the total consumer population examined are most interested in specific, biological aspects of flowers, i.e., fragrance and color. Meanwhile, a single consumer segment is most interested in flower

aspects associated with human health or flower production means. Focusing on what the consumer experiences, the segment distinctions indicate that olfaction, vision, and cognitive ideals are all very important to flower consumers as they make a purchasing decision. However, individual consumers will value one of these aspects more than others. Understanding what the consumer values the most (e.g., fragrance) and delivering this information to the correct consumer (a member of segment one) may result in the elevated sales of fragrant flowers and an increased perceived experience for the consumer. Additionally, these findings support efforts and investment in research and development of fragrance aspects by the floriculture industry at large.

An inverse relationship exists in the data between the FH subjects and the PG&Y subjects when the segment base sizes are considered. FH Segment 1 (olfaction) consisted of 54 subjects, Segment 2 (visual) was 108 subjects, and Segment 3 (other) encompassed 133 subjects (Table 5). In short, the majority of the FH subjects value human health aspects of flowers over biological features of the flowers themselves. Conversely, the PG&Y Segment 1 (olfaction) consisted of 163 subjects; Segment 2 (visual) had 116 subjects, and Segment 3 (other) encompassed 57 subjects (Table 5). The majority of the PG&Y subjects value fragrance aspects of flowers the most. This inverse olfaction relation between the FH (approximate mean age 40 years) and PG&Y (approximate mean age 20 years) subjects may be in agreement with the observation that the overall sense of smell declines with age (Kaneda et al., 2000). It seems there is a more or less constant percentage of the total population of subjects that are most interested in flower color, but a tradeoff exists between olfaction and the idea of impacting human health with flowers.

The K-cluster analyses (MacQueen, 1967) segmented subjects based on the subject’s data generated from the experiment itself and provided for very interesting and somewhat unique conclusions. In contrast, when subjects are grouped by their ethnicity, new insights are obvious. The FH white subjects demonstrated the most interest (interest value of 12) in an element describing gifting of flowers to a friend (Supplementary Table S3). The FH Latino and PG&Y black subjects were considerably not interested in the same element (interest value of –11 and –16, respectively). Therefore, any marketing with a focus of flowers as a gift for a friend may not stimulate a Latino or a young black individual flower consumer as it would a white (i.e., ethnicity) flower consumer and should therefore be directed to the appropriate audience. Both white and Latino subjects from FH showed similarity with interest in an element stating, the subtle fragrance of a traditional rose (Supplementary Table S3). Interesting to note, Asian subjects from FH responded quite positively toward an element with a Home Depot garden center referenced, which was a rare event in this study. These data indicate

Table 5. Total sample clustered into three segments for the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.²

FH (olfaction)			PG&Y (olfaction)		
Segment		2	Segment		1
	Base size	54		Base size	163
	Constant	43		Constant	50
Smells fresh with a hint of citrus		28	Smells fresh with a hint of citrus		21
Cover me with the smell of lilies		24	Smells sweet as honeysuckle		19
Bring a garden to me		–13	Blue petals		–11
Pastel flower colors		–14	Convenient at your local Lowe’s garden center		–11
FH (visual)			PG&Y (visual)		
Segment		3	Segment		2
	Base size	108		Base size	116
	Constant	50		Constant	53
Cheery yellow flower petals		15	A mixture of many brightly colored flowers		21
A mixture of many brightly colored flowers		15	Explosive, vibrant red petals		15
The more flowers...the more oxygen		–9	Smells spicy with accents of lavender		–18
This flower does not make fragrance at all		–13	This flower does not make fragrance at all		–23
FH (other)			PG&Y (other)		
Segment		1	Segment		3
	Base size	133		Base size	57
	Constant	68		Constant	64
Happy is a bright flower		12	Picked fresh from a home garden		17
The more flowers...the more oxygen		9	Blue petals		11
Smells spicy with accents of lavender		–16	Looks good enough to eat		–18
This flower does not make fragrance at all		–19	Delicate sprays of small clustered flowers		–20

²K-cluster analysis to three total clusters results in the three best fit segments shown. The top two and bottom two elements are illustrated. The heading of each segment is a familiar term for each segment derived by the researchers.

there are ethnic similarities and differences that exist in the perception of flowers, which may suggest these ethnicities are affected differentially from a floral stimulus.

It is obvious that, virtually, each way the data are analyzed (i.e., age, ethnicity, living location, etc.), differences in consumer interests may be found and generalities can be identified. For a generality example, a non-fragrant flower element consistently results in negative interest values for the majority of groups, subgroups, or segments. The use of a widespread, the majority 40 years of age and older, subject group and a centralized, 18- to 24-years-of-age, subject group may have enabled insight into the consumer of today and tomorrow. It will be interesting to support this in future experiments using various categories and elements dealing with flowers in general. At present, this experiment suggests that differences of flower perception are real and abundant between current and future consumers. In addition, the flower concepts of peak interest to both today's and tomorrow's flower consumers are now apparent and can be used or tested in real time.

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Supplementary Table S1. Comparison of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects by top and bottom elements of each category.^z

FH			PG&Y		
		Base size Constant			Base size Constant
		295			336
		57			53
A2	Explosive, vibrant red petals	5	A2	Explosive, vibrant red petals	7
A6	Pastel flower colors	-2	A6	Pastel flower colors	0
B4	Rarity is everything	5	B4	Rarity is everything	3
B1	An extremely large flower	1	B2	Delicate sprays of small clustered flowers	-4
C1	Happy is a bright flower	4	C2	Festive flowers mean fun	5
C4	Bring a garden to me	-1	C4	Bring a garden to me	-4
D3	The subtle fragrance of a traditional rose	7	D5	Smells fresh with a hint of citrus	8
D6	This flower does not make fragrance at all	-10	D6	This flower does not make fragrance at all	-13
E3	Chosen with pride by a local grower	2	E2	Picked fresh from a home garden	5
E4	Convenient at your local Lowe's garden center	-2	E4	Convenient at your local Lowe's garden center	-7
F1	Flowers that could be used to...decorate a celebration	4	F6	A great way to say...happy birthday	3
F3	Best way to say...sorry	-5	F3	Best way to say...sorry	-9

^zThe total sample data were separated by study and element category. The base sizes and constants for each subject population are shown under the general heading in bold. Also, illustrated are the top two and bottom two elements as ranked by interest values for each category of flower elements.

Supplementary Table S2. Age group comparison of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH			PG&Y		
	Age	18-24 years		Age	18-24 years
	Base size	48		Base size	330
	Constant	94		Constant	54
Rarity is everything		5	Smells fresh with a hint of citrus		8
Explosive, vibrant red petals		3	Explosive, vibrant red petals		7
Brilliant white petals		0	A mixture of many brightly colored flowers		6
Smells sweet as honeysuckle		0	Smells sweet as honeysuckle		5
The perfect gift for a friend		0	Picked fresh from a home garden		5
Flowers in the office for better productivity		-1	Festive flowers mean fun		5
An extremely large flower		-1	Cheery yellow flower petals		4
Cover me with the smell of lilies		-1	Healthy flowers for a healthy home		3
Looks good enough to eat		-1	Rarity is everything		3
Every flower shape imaginable...I like diversity		-2	The more flowers...the more oxygen		3
Smells fresh with a hint of citrus		-2	Purchased from a local farmers' market		2
The more flowers...the more oxygen		-2	A great way to say...happy birthday		2
The subtle fragrance of a traditional rose		-3	An extremely large flower		2
The perfect gift for a lover		-4	Blue petals		1
Bring a garden to me		-5	Happy is a bright flower		1
A mixture of many brightly colored flowers		-5	Brilliant white petals		1
Beauty is found in symmetrically shaped flowers		-5	Every flower shape imaginable...I like diversity		1
A great way to say...thinking of you		-5	The perfect gift for a lover		1
Delicate sprays of small clustered flowers		-5	A great way to say...thinking of you		1
Available from a florist		-6	Beauty is found in symmetrically shaped flowers		1
Happy is a bright flower		-6	Chosen with pride by a local grower		0
Blue petals		-7	Cover me with the smell of lilies		0
Flowers that could be used to...decorate a celebration		-7	Looks good enough to eat		0
Festive flowers mean fun		-8	The subtle fragrance of a traditional rose		-1
Cheery yellow flower petals		-9	Pastel flower colors		-1
Healthy flowers for a healthy home		-9	Smells spicy with accents of lavender		-1
Pastel flower colors		-10	Flowers that could be used to...decorate a celebration		-1
Smells spicy with accents of lavender		-11	Flowers in the office for better productivity		-2
Best way to say...sorry		-11	The perfect gift for a friend		-4
Picked fresh from a home garden		-13	Bring a garden to me		-4
Convenient at your local Home Depot garden center		-13	Delicate sprays of small clustered flowers		-5
Chosen with pride by a local grower		-15	Convenient at your local Home Depot garden center		-5
A great way to say...happy birthday		-15	Available from a florist		-6
Purchased from a local farmers' market		-19	Convenient at your local Lowe's garden center		-8
This flower does not make fragrance at all		-19	Best way to say...sorry		-9
Convenient at your local Lowe's garden center		-19	This flower does not make fragrance at all		-14

^zThe total sample data were separated by the 18- to 24-year age group, because this is the dominant group from the PG&Y subjects. The base sizes and constants for each subject population are shown under the general heading. Illustrated are the elements ranked by interest values.

Supplementary Table S3. Ethnicity comparison of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH		White	PG&Y	White
	Base size	91		199
	Constant	54		54
The perfect gift for a friend		12	Explosive, vibrant red petals	8
The subtle fragrance of a traditional rose		9	Smells fresh with a hint of citrus	8
Available from a florist		-5	Convenient at your local Lowe's garden center	-11
This flower does not make fragrance at all		-7	This flower does not make fragrance at all	-16
FH		Black	PG&Y	Black
	Base size	74		43
	Constant	69		80
Looks good enough to eat		8	Explosive, vibrant red petals	2
Flowers in the office for better productivity		7	A mixture of many brightly colored flowers	2
Purchased from a local farmers' market		-13	The perfect gift for a friend	-16
This flower does not make fragrance at all		-24	This flower does not make fragrance at all	-18
FH		Latino	PG&Y	Latino
	Base size	58		54
	Constant	69		51
The subtle fragrance of a traditional rose		15	A mixture of many brightly colored flowers	17
Smells fresh with a hint of citrus		11	Chosen with pride by a local grower	13
The perfect gift for a friend		-11	This flower does not make fragrance at all	-13
Best way to say...sorry		-14	Best way to say...sorry	-18
FH		Asian	PG&Y	Asian
	Base size	76		52
	Constant	43		30
Convenient at your local Home Depot garden center		11	Smells fresh with a hint of citrus	20
Smells fresh with a hint of citrus		8	A great way to say...happy birthday	20
An extremely large flower		-5	An extremely large flower	-3
This flower does not make fragrance at all		-7	This flower does not make fragrance at all	-5

^zThe total sample data were separated by ethnicity and listed as the choices appeared in the demographic questions section of the study. The base sizes and constants for each subject population are shown under the general heading. Illustrated are the top two and bottom two elements ranked by interest values.

Supplementary Table S4. Location of residence comparison of the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH		Suburbs	PG&Y	Suburbs
	Base size	124		125
	Constant	62		61
Flowers that could be used to...decorate a celebration		7	Blue petals	8
Happy is a bright flower		4	Explosive, vibrant red petals	7
Picked fresh from a home garden		-6	Best way to say...sorry	-12
This flower does not make fragrance at all		-16	This flower does not make fragrance at all	-16
FH		Urban	PG&Y	Urban
	Base size	72		59
	Constant	33		50
Smells fresh with a hint of citrus		17	Smells sweet as honeysuckle	12
Explosive, vibrant red petals		15	The subtle fragrance of a traditional rose	10
Best way to say...sorry		-2	Pastel flower colors	-6
This flower does not make fragrance at all		-6	Best way to say...sorry	-8

^zThe total sample data were separated by living location (neighborhood) and listed first by suburban (suburbs) followed by urban environments. The base sizes and constants for each subject population are shown under the general heading. Illustrated are the top two and bottom two elements ranked by interest values.

Supplementary Table S5. Total sample clustered into two segments for the fielding house (FH) and plants, gardens, and you (PG&Y) subjects.^z

FH (olfaction)			PG&Y (olfaction)		
Segment		1	Segment		1
	Base size	93		Base size	163
	Constant	47		Constant	50
The subtle fragrance of a traditional rose		24	Smells fresh with a hint of citrus		21
Smells fresh with a hint of citrus		15	Smells sweet as honeysuckle		19
Pastel flower colors		-9	Blue petals		-11
Bring a garden to me		-13	Convenient at your local Lowe's garden center		-11
FH (visual)			PG&Y (visual)		
Segment		2	Segment		2
	Base size	202		Base size	173
	Constant	61		Constant	56
Explosive, vibrant red petals		8	Blue petals		13
Happy is a bright flower		7	Explosive, vibrant red petals		12
Smells spicy with accents of lavender		-8	Smells spicy with accents of lavender		-12
This flower does not make fragrance at all		-16	This flower does not make fragrance at all		-21

^zK-cluster analysis to two total clusters results in the two best fit segments shown. The top two and bottom two elements are illustrated. The heading of each segment is a familiar term for each segment derived by the researchers.