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What's in a scent? Meaning, shape, and sensorial concepts elicited by scents.

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Abstract

When selecting an ambient scent to be diffused in a store, one can focus on pleasantness of the scent, congruency of the scent with product category, or a variety of concepts that can be the basis for congruency between scent and other atmospheric elements. However, more information is needed concerning the concepts from which congruency could be sought. This paper studies the strength and direction of 19 bipolar concepts related to meaning, perceived shape and sensory attributes elicited by 32 scents. Factor analysis indicates that the concepts can be grouped into 4 factors: an angelic, an energetic, a shape, and a depth factor. Cluster analysis indicates that the 32 scents can be grouped based on differences in strength as well as direction of the elicitations. The results indicate that certain concepts do co-occur and that a classification of scents based on their similar elicitations of concepts might be of value.

Practical applications

The results illustrate that the current classification of scents in terms of notes (e.g., floral, fresh, woody, herbal) does not imply that scents present in the same category of notes elicit the same concepts. A new classification based on the elicited concepts is thus advised since this classification will better answer the needs of retailers when choosing a correct ambient scent. In particular, a retailer will then be able to choose the scent that will elicit the concepts he or she wishes to communicate. The results of this study provide a first insight into which concepts and factors need to be measured and which clusters of scents can be expected to arise.

Keywords: ambient scent, associations, crossmodal correspondences

Introduction

Ambient scents have been proven to affect responses to a store's environment and the products sold in this store, even if these products may not have an intrinsic scent of their own (Gulas and Bloch 1995; Parsons 2009). Due to the proven substantial impact of ambient scents on consumers' shopping behavior (Spangenberg et al. 1996, Doucé and Janssens 2011), ambient scents are being used by a number of retailers and companies (Doucé and Janssens 2011).

When selecting which ambient scent to diffuse in a store environment, the scent literature indicates that the scent should be pleasant to produce the desired positive consumer reactions (Spangenberg et al. 1996). Second, congruency between the scent and the product category (Bone and Jantrania 1992; Bosmans 2006) also seems essential for the effects on consumer reactions to be positive.

In addition, Gulas and Bloch (1995) mentioned that the congruency between the ambient scent and the other atmospheric elements in the environment could also be important. Indeed, when present in a store environment, a person not only perceives one (olfactory) sensory cue but a multitude of sensory cues. In line with conceptual processing fluency theory, congruency between 2 or more cues allows a person to process these cues more easily. This ease of processing might result in a positive affective state, which might consequently be attributed to the cues themselves (Winkielman et al. 2003). Congruency between a scent and another atmospheric cue can be achieved in different ways. For example, atmospheric cues can be matched based on a holiday such as Christmas music and scent (Spangenberg et al. 2005) or on the arousal they trigger, such as high- versus low-arousing music and scent (Mattila and Wirtz 2001).

Retailers and researchers need more information regarding this type of congruency between a scent and other atmospheric cues in order to predict favorable outcomes in terms of customers' approach behavior. In particular, more information is needed with respect to the specific concepts in which this congruency between 2 cues of an ambient scent and the surrounding environment could be sought.

In this paper, we therefore explore the strength and direction of a selection of concepts being elicited by 32 scents belonging to different types of scent groups. By reviewing a large, diverse group of scents, we aim to identify which concepts appear to exhibit similar elicitations, in terms of strength or direction, for all scents or for a particular group of scents. In light of the scent to be used, retailers or researchers could consequently have more information regarding which concepts might be important to take into account.

Concepts elicited by scents

Input for the chosen concepts was found in previous literature (Crisinel et al. 2012), in which gustatory stimuli were evaluated on different concepts with respect to meaning, such as weak versus strong, and sensory attributes, such as loud versus quiet or round versus angular.

The first group of concepts to be considered is thus general concepts, with respect to meaning. In particular, the general attitudes defined by Osgood et al. (1957) to measure the concepts of potency (weak versus strong), activity (active versus passive), and evaluation (bad versus good) are included. The elicited meaning with respect to masculinity versus femininity will also be explored, since it was also included in the study of Crisinel et al. (2012).

The second type of concept to be considered is the sensory attributes mentioned by Crisinel et al. (2012). The possibility of these sensory concepts to be elicited by a scent is rooted in research concerning crossmodal correspondences. Spence (2011) defines

crossmodal correspondence as “a tendency for a feature or attribute in a sensory modality to be matched or associated with a sensory feature or attribute in another sensory modality.” As stated by Deroy et al. (2013), olfactory experiences are regarded as a domain that is particularly rich in crossmodal associations, since attributes from all sensory modalities can be easily and naturally applied to this domain. For example, fruity scents seem to be associated consistently with high-pitched notes (Belkin et al. 1997, Crisinel and Spence 2012). Furthermore, olfaction experiences are regarded as experiences that are difficult to verbalize and consequently communicate (Deroy et al. 2013; Jacquot et al. 2016). As stated by Deroy et al. (2013) when people describe scents they most often refer to the pleasantness or intensity of the scent. Understanding which crossmodal correspondences are elicited by scents might thus aid in communicating the olfactory experience by means of metaphorical transfer (Deroy et al. 2013).

A specific group of crossmodal correspondences refers to the association between scents and sharp versus rounded shapes (Seo et al. 2010; Hanson-Vaux et al. 2013). For instance, Seo et al. (2010) and Hanson-Vaux et al. (2013) indicate that a lemon scent is associated with angular shapes, whereas a vanilla scent is associated with rounded shapes. Their results further indicate that congruency between a scent and a shape modulates the perceived pleasantness of the scent and increases the amplitude of olfactory event-related potentials in the human brain (Seo et al. 2010). According to Hanson-Vaux et al. (2013), however, these links between scents and visual stimuli are a more piecemeal domain. The links between scents and shapes are labelled as contingent crossmodal correspondences, which cannot yet be labelled as robust, since they currently lack evidence in terms of consistency and universality (Deroy et al. 2013).

In this study, we will therefore focus on 2 types of crossmodal correspondences. First, we will further explore crossmodal correspondences between the olfactory cue and shapes by

using a direct measurement (a round versus a sharp visual shape) as well as an indirect measurement (words that are composed of rounded versus angular consonants and vowels). Second, we will also assess a set of possible crossmodal correspondences between the olfactory sense and the visual, tactile, and auditory senses, since crossmodal correspondences can be expected to arise between the olfactory sense and the other senses for a variety of attributes (Deroy et al. 2013).

We thus focus on exploring which general attitudes and crossmodal correspondences are being elicited by an olfactory cue (ambient scent). In particular, we investigate the strength and direction of the elicitation of 19 bipolar concepts (consisting of 2 opposites, such as “cold versus hot” and “a round shape versus an angular shape”) relating to meaning or sensory attributes being elicited by 32 scents. An exploratory factor analysis on the concepts and an exploratory cluster analysis on the scents were conducted to determine whether certain concepts co-occur and whether certain scents can be regarded as eliciting similar concepts in terms of direction and/or strength.

Materials and Methods

Stimuli

A total of 32 scents were selected from an assortment of scents available at Scents, an olfactory marketing firm in Belgium. These ambient scents are used by the firm’s clients, which represent approximately 700 Belgian and European companies that are primarily active in the event, fashion, hospitality, and interior design sectors.

The 32 scents were chosen to represent 4 scent categories of the Fragrance Wheel (floral notes, fresh notes, woody notes, and oriental notes; Edwards, 2014) and several blends, such as coffee, feminine perfume, and masculine perfume. The choice to include scents from

different categories as well as a number of blended scents was motivated by the intention to conduct an exploratory cluster analysis on the scents. By including more than one category of scents, the cluster analysis could indicate whether the strength and direction of the elicited concepts will be relatively stable for all categories or if differences will be found between categories. An example is whether all scents with woody notes elicit the concept of masculinity, while all scents with floral notes elicit the concept of femininity. More specifically, from the available scents, 15 scents with fresh notes, 5 scents with floral notes, 2 scents with woody notes, 3 scents with oriental notes, and 7 blended scents were included in this study. In Table 1, the chosen scents and their respective dominant type of notes are shown.

TABLE 1: SELECTED SCENTS

Fresh notes	apple, apricot, banana, bergamot, black cherry, grapefruit, kiwi, lemon, melon, mint, orange, peach, red fruit, rosemary, strawberry
Floral notes	jasmine, lavender, lily of the valley, rose, waterlily
Woody notes	pine, wood
Oriental notes	cinnamon, sandalwood, vanilla
Blends	chocolate, coffee, green tea, new car ambient, new car noble, masculine perfume, feminine perfume

For the blended scents, the scent selection was based upon the possible choice that a retailer might have to make between 2 or more scents. For instance, a masculine perfume sample labelled Hendrik and a feminine perfume sample labelled Dreams were selected. The Hendrik scent was described as a fruity scent with cinnamon and sandalwood facets and was based on a Hugo Boss perfume. The Dreams scent was described as a green, fruity scent containing aspects of Muscat and black currant. Further elements include white musk, vanilla, jasmine, lilies, and violets. The possible differences found between the masculine perfume scent and the feminine perfume scent might be important for retailers that are specifically interested in distributing an ambient scent based on a perfume.

The motivation is analogous for the blended scent pair of “new car ambient” and “new car noble.” A car retailer might be faced with choosing which ambient scent is most appropriate for a type of car and which crossmodal correspondences or meaning might be at play for that particular scent. For instance, the noble version, which contains walnut and leather notes, may be more appropriate when directed at usage for higher-end cars.

The last group of blended scents refers to the practice of using the smell of coffee in the hospitality sector, such as in Dunkin’ Donuts and Starbucks (Chebat and Michon 2003). In this study, alternatives to the coffee scent, such as the scent of chocolate and the scent of green tea, are included.

Measurement of Concepts

As mentioned in the introduction, input for the chosen concepts was found in previous literature (Crisinel et al. 2012), in which the stimuli were of a gustatory nature. A measurement tool consisting of 19 bipolar concepts were presented on semantic differentials. The 19 concepts can be distributed into 3 distinct categories: a) concepts related to meaning

(referred to as “meaning of scent”); b) concepts related to the crossmodal correspondences with respect to shape (referred to as “shape of scent”); and c) concepts related to the other crossmodal correspondences besides shape that are related to the visual, tactile, and auditory senses (referred to as “sensorial crossmodal profile of scent”).

In contrast to the study of Crisinel et al. (2012), in which a 9-point scale was used, we chose to construct a 100-mm visual analogue scale (VAS). This was done because of the transitivity hypothesis with regard to crossmodal correspondences between odors and contingent features (Deroy et al. 2013). The transitivity hypothesis indicates that a crossmodal correspondence between stimuli B and C might exist because there are crossmodal correspondences between stimuli A and B as well as between stimuli A and C. According to the transitivity hypothesis, however, this would predict that the mediated correspondence (B to C) would be weaker than the direct correspondences (A to B and A to C). By using a more refined measurement tool, specifically a 100-mm VAS instead of a 9-point scale, these mediated (weaker) correspondences might be easier to detect.

The participants were thus asked to indicate their evaluation on a 100-mm semantic differential. The participant’s response was consequently a score ranging from 0 to 100, representing their position on the 100-mm line, with a midpoint of 50 being a neutral answer. In Table 2 the 19 pairs of concepts are listed.

TABLE 2: CONCEPTS MEASURED

Pairs of concepts measured by VAS		
	First word (left side of VAS)	Second word (right side of VAS)
Meaning of scent		
	active	passive
	bad	good
	weak	strong
	feminine	masculine
Shape of scent		
	star (shape)	spot (shape)
	decter	bobolo
	kiki	bouba
	ruki	lula
	takete	maluma
Sensorial crossmodal profile of scent		
	bright	dim
	cold	hot
	fragile	sturdy
	high	low
	light	dark
	light	heavy
	loud	quiet
	rough	smooth
	shallow	deep
	soft	hard

The semantic differential was a 100-mm line with the first word of the pair on the left side and the second word of the pair on the right side. The midpoint of 50 was indicated by a small vertical line. The lower the score was and below 50, the more the participant's evaluation was in line with the first and left word of the pair. The higher the score was and above 50, the more the participant's evaluation was in line with the second and right word of the pair.

The 3 recurring attitudes across cultures, as defined by Osgood (Osgood et al. 1957), as well as the pair "feminine versus masculine" were included to assess the *meaning of scent*. The first attitude defined by Osgood was evaluation and is measured by the adjective pair "bad versus good". As such, this adjective pair might be seen as a prerequisite of a particular scent's perceived pleasantness. The adjective pair "weak versus strong" was included for the second attitude of potency. The third attitude, activity, was measured by the adjective pair "active versus passive".

In order to measure the *shape of scent*, literature concerning the class of crossmodal correspondences referred to as sound symbolism (Spence 2011) as well as previous research measuring the shape of scents (Hanson-Vaux et al. 2013) was consulted. The field of sound symbolism originated from research done in 1929 by Köhler (Spence and Gallace 2011). Köhler demonstrated that people matched the nonsense word “baluma” with a globular, rounded shape, whereas the nonsense word “takete” was matched with a straight-edged, angular shape. Since then, numerous studies have proven that people associate certain vowels and consonants with abstract shapes (Ramachandran and Hubbard 2001). In line with previous research concerning the shape of scents (Hanson-Vaux et al. 2013) as well as crossmodal research concerning the linkages between other senses and shapes (Gallace et al. 2010; Ngo et al. 2011; Crisinel et al. 2012), we chose to include 2 types of measurement. On the one hand, a direct measurement of the shape elicited was included by using the 2 most commonly used graphics to map crossmodal correspondences with shapes (an organic, spot-like shape versus an angular, star-like shape). This pair of shapes is the only pair of concepts which is measured by use of graphics and not by words.On the other hand, 4 commonly used word pairs—“decter versus bobolo”, “kiki versus bouba”, “ruki versus lula”, and “takete versus maluma”—were chosen to measure the shape of each scent indirectly. The first word of each pair of nonsense words makes use of the consonants and vowels linked to angular shapes, whereas the second word makes use of rounded consonants and vowels (Gallace et al. 2010).

In contrast to previous research, in this study, all 4 word pairs and the shape pair were included. This allows for an evaluation and comparison of the existence and strength of the direct crossmodal correspondence (olfactory cue to visual shape) with the existence and strength of the indirect crossmodal correspondence (olfactory cue to words that are, in turn, crossmodally linked to a visual shape). Second, a shapescore based on the assessment of all 5

pairs could also be constructed to assess whether this shapescore might be a more robust or reliable measurement of the shape of scent.

The third category of concepts refers to the *sensorial crossmodal profile of scent*. As mentioned before, the sensory concepts were derived from a range of sensory attributes measured in previous crossmodal research (Crisinel et al. 2012). For the current study, only concepts referring to the visual, tactile, or auditory sense were included. Concepts referring to the olfactory sense were not included because of the nature of crossmodal correspondences. In particular, crossmodal correspondences refer to the tendency of *a* sensory modality to be matched or associated with *another* sensory modality (Spence 2012). In this case, this is the tendency of an olfactory cue to be matched with features in the other senses. Concepts referring to the taste sense, such as not sweet versus very sweet, were not included. Crisinel et al. (2012) stated that the crossmodal associations concerning taste might be of particular, and perhaps primary, relevance to food product marketers, since applications can be found in the naming, labelling, and packaging of food products.

Procedure

Due to the large number of scents and concepts, we decided to construct "scent groups," which limited the number of scents to be evaluated by each participant. Each scent group consisted of 4 of the 32 scents included in this study. As a result, there were a total of 8 scent groups.

The data collection method and procedure were in line with the ethical procedures dictated by the university in question. In particular, an ethical approval was obtained from the Ethical Committee University Hasselt chaired by prof. dr. Ivo Lambrichts for a larger-scaled project including the study described in this paper. Details with regards to this approval (e.g.,

list of members of the committee) are made available to the Editor and can be requested. Participants were – prior to starting the study – given a briefing and could at that moment decide whether they wished to participate and gave their verbal consent to participation in the study. Since this study does not involve medical research, this study is not subjected to the Declaration of Helsinki for Medical Research involving Human Subjects.

The participants were 284 bachelor students (150 men and 134 women; $M_{age} = 19.82$). Each participant was randomly assigned to a particular scent group and was thus only asked to rate the 4 scents that belonged to that scent group. Before starting the study, the participants were given a written instruction to be read.

In the instruction the scale used (i.e., 100 millimetre VAS) was explained by an example. The example illustrated to the participant how to respond (i.e., by a small vertical line on the VAS scale) as well as how to interpret the words or shapes presented on both sides of the scale. In particular, the pairs were explained as representing each other's antonym and that – in case of confusion - the exact meaning of a word could thus be derived as the opposite meaning of the second word.

In the briefing the participants were also instructed to sniff each scent and rate it on the 4 meaning concepts, the 5 shape concepts, and the 10 sensorial concepts. Each scent was presented to the participants on a cotton-tipped stick in a dark glass bottle. The participants were instructed that they could sniff the scent bottle as often as they felt necessary while rating that scent. The order in which the scents were rated was randomized.The composition of each scent group and the number of participants that were assigned to them are shown in Table 3. The number of participants for each scent group ranged from 32 participants to 40 participants.

TABLE 3: COMPOSITION OF SCENT GROUPS AND NUMBER OF PARTICIPANTS

Scent group 1 (n=37)	**Scent group 2 (n=37)**	**Scent group 3 (n=40)**	**Scent group 4 (n=39)**
chocolate peach masculine perfume wood	feminine perfume red fruit rosemary vanilla	banana cinnamon lavender lemon	apple coffee mint rose
Scent group 5 (n=33)	**Scent group 6 (n=33)**	**Scent group 7 (n=33)**	**Scent group 8 (n=32)**
bergamot new car ambient new car noble pine	grapefruit green tea kiwi melon	apricot black cherry orange strawberry	jasmine lily of the valley sandalwood waterlily

Analytical approach

We first ascertained whether the mean of each scent on each concept was significantly different from the midpoint of the scale, 50.

With respect to the shape, for each scent, we calculated a shapescore using the ratings of the scents on the “star versus spot” concept (the visual representation of the shapes) as well as the 4 nonsense word pairs (words using consonants and vowels linked to roundness versus angularity). Cronbach’s alpha was calculated for each scent to assess whether the 5 concepts may indeed be grouped together into a shapescore. For 30 of the 32 scents, Cronbach’s alpha was above 0.7. The scores ranged from 0.707 (lavender) to 0.936 (orange). Only for 2 scents Cronbach’s alpha score was below 0.7: apple (0.582) and cinnamon (0.583). Thus, for these 2 scents, the interpretation of the shapescore should be done with caution.

After analyzing the individual ratings of the scents on the 19 measured concepts and the calculated shapescore, an exploratory factor analysis was performed on the 19 measured concepts. The goal was to determine whether certain concepts co-occur and thus to further understand which concepts interact with each other. In line with the approach concerning

exploratory factor analysis on pooled data by Georgas, Van de Vijver, Weiss, and Saklofske (in Georgas et al. 2003), we first performed separate exploratory factor analyses on each of the scent groups. Since the results were relatively robust in indicating which concepts co-occurred as well as the number of components, an exploratory factor analysis was performed on the entire data set.

The third type of analysis we used was exploratory cluster analysis. Based on the results of the exploratory factor analysis, the 32 scents were subjected to an exploratory cluster analysis to study which scents are alike in eliciting the strength and/or direction of the concepts.

Finally, to facilitate reading throughout this paper, the measured concepts are formulated as one word. For instance, the “shallow versus deep” concept was renamed ShallowDeep. The order of the 2 words indicates whether the word is linked the lower or the higher end of the scale.

Results

Ratings of Scents

For each concept, a summary of the mean scores of the scents compared to the midpoint of the scale can be found in Table 4 and Figure 1.

First, we will discuss each group of concepts (meaning, shape, and sensorial crossmodal profile) and the strength and direction of the elicitations of these concepts by all 32 scents. Additionally, we will also examine the associations or relationships between groups of concepts that could have been expected. In particular, a relationship can be expected between the concepts of meaning and the concepts of shape. In a separate section, we discuss whether these relationships were indeed found.

Second, we will discuss the elicitation of concepts on an individual scent level and consequently discuss scents that had interesting concept elicitation profiles.

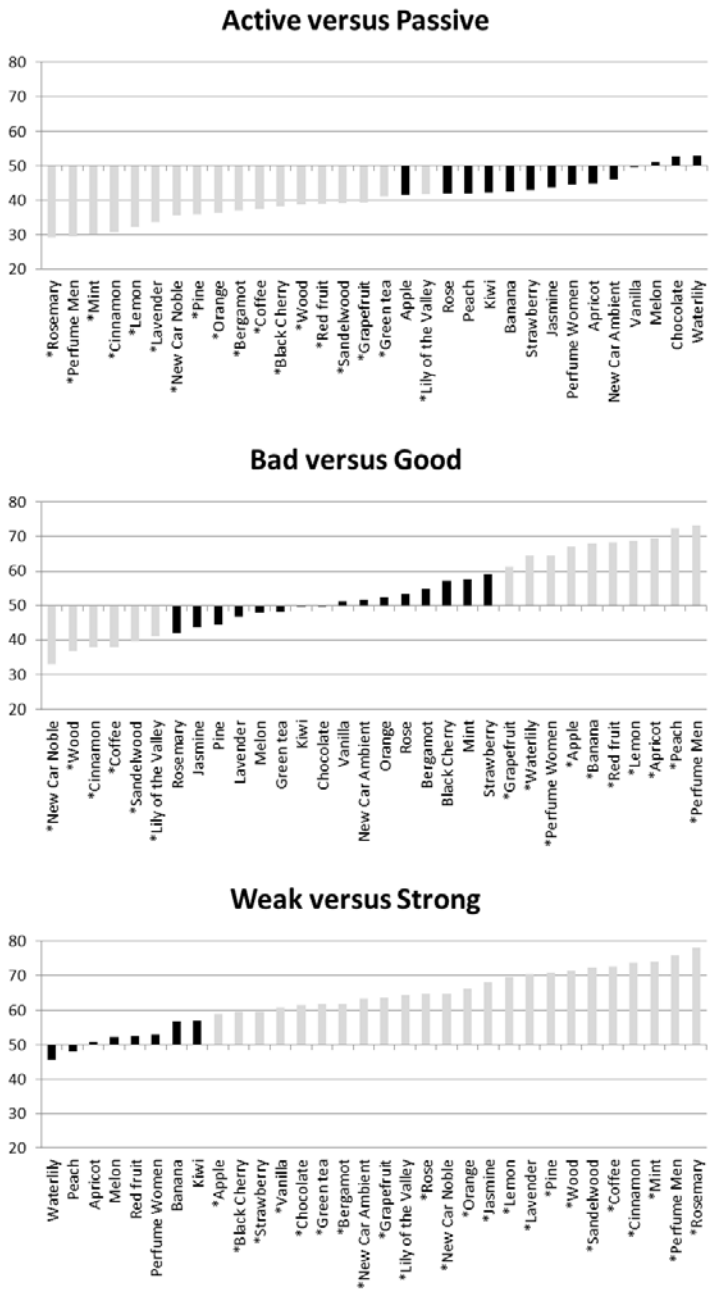
TABLE 4: RATINGS OF SCENTS

		Meaning of scent				Shape of scent					
		Active Passive	Bad Good	Weak Strong	Fem. Masc.	Shape score	Star Spot	Decter Bobolo	Kiki Bouba	Ruki Lula	Takete Maluma
		x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)
Fresh	Apple	41.54 (28.12)	67.26 (24.19)	58.82 (26.47)	30.10 (20.76)	62.21 (15.41)	67.19 (21.35)	59.59 (23.12)	49.13 (29.80)	62.90 (25.46)	64.82 (22.02)
	Apricot	44.94 (26.28)	69.55 (21.22)	50.70 (24.69)	31.31 (24.72)	62.10 (17.54)	63.21 (17.94)	63.00 (25.60)	49.88 (30.87)	62.58 (27.50)	66.67 (24.57)
	Banana	42.60 (23.90)	67.98 (22.92)	56.75 (22.29)	31.33 (20.03)	64.11 (18.92)	63.78 (19.42)	66.23 (24.16)	61.80 (25.46)	65.73 (24.27)	62.55 (28.77)
	Bergamot	37.00 (21.61)	54.82 (22.78)	61.76 (18.70)	42.36 (22.04)	50.85 (18.20)	45.55 (24.20)	49.97 (23.48)	50.97 (24.82)	55.85 (23.85)	51.94 (24.29)
	Black cherry	38.30 (23.56)	57.09 (28.26)	59.45 (22.78)	47.48 (24.58)	56.52 (24.57)	56.72 (25.83)	51.27 (30.56)	61.42 (26.08)	53.82 (30.65)	55.30 (30.18)
	Grapefruit	39.33 (21.82)	61.18 (16.88)	63.58 (15.84)	41.21 (23.32)	49.79 (15.13)	50.93 (20.28)	46.85 (21.02)	47.67 (22.01)	49.52 (19.12)	53.09 (19.23)
	Kiwi	42.30 (22.09)	49.61 (24.29)	57.03 (20.21)	43.30 (20.25)	56.28 (18.79)	60.30 (22.03)	55.00 (25.66)	51.24 (22.65)	55.33 (23.70)	55.21 (23.46)
	Lemon	32.28 (21.88)	68.70 (20.93)	69.43 (16.61)	43.50 (21.29)	44.71 (19.56)	41.08 (21.34)	46.58 (27.40)	38.50 (25.15)	49.48 (28.27)	47.70 (26.08)
	Melon	51.06 (21.32)	47.85 (22.09)	52.18 (19.25)	47.42 (24.20)	52.05 (18.94)	57.30 (23.14)	47.00 (25.46)	51.58 (25.99)	56.30 (24.31)	54.21 (26.67)
	Mint	30.15 (23.14)	57.59 (25.35)	73.97 (19.77)	55.49 (25.47)	42.47 (20.95)	36.87 (26.86)	40.59 (27.57)	42.05 (25.70)	47.28 (26.27)	47.67 (26.91)
	Orange	36.27 (23.17)	52.48 (25.55)	66.27 (17.60)	45.18 (22.01)	44.81 (22.81)	48.14 (24.47)	41.52 (26.17)	46.76 (27.23)	46.24 (26.00)	46.15 (26.93)
	Peach	42.11 (23.91)	72.46 (19.59)	48.03 (25.64)	26.78 (25.14)	69.83 (16.85)	70.90 (19.21)	65.43 (25.10)	53.62 (29.61)	71.51 (22.86)	68.89 (23.96)
	Red fruit	38.92 (25.54)	68.38 (22.68)	52.43 (23.56)	33.35 (17.40)	61.87 (17.48)	62.40 (21.31)	64.16 (22.18)	49.54 (29.74)	67.62 (22.14)	67.35 (23.08)
	Rosemary	29.31 (26.58)	41.97 (28.92)	78.03 (15.98)	61.17 (22.25)	30.31 (16.28)	28.09 (16.35)	28.94 (22.34)	40.58 (27.70)	27.86 (18.21)	28.61 (18.20)
	Strawberry	42.94 (28.08)	59.00 (29.00)	59.67 (25.04)	42.97 (26.40)	59.50 (21.84)	65.03 (24.15)	57.70 (30.64)	56.21 (32.77)	55.97 (32.94)	63.06 (29.59)
Floral	Jasmine	43.72 (21.55)	43.72 (27.83)	68.19 (24.47)	48.78 (29.29)	42.49 (22.76)	39.17 (23.02)	43.94 (26.50)	41.50 (24.56)	43.38 (27.80)	48.44 (27.13)
	Lavender	33.63 (19.46)	46.88 (26.90)	70.38 (17.92)	49.70 (26.37)	48.19 (16.86)	44.61 (22.36)	47.68 (25.56)	52.05 (23.19)	42.18 (24.89)	52.20 (25.73)
	Lily of the valley	41.81 (21.62)	41.09 (20.43)	64.38 (20.60)	50.06 (25.82)	44.55 (21.88)	45.34 (28.66)	41.59 (24.61)	46.88 (25.53)	44.22 (25.07)	45.13 (24.63)
	Rose	41.92 (25.81)	53.41 (25.68)	64.74 (18.79)	38.05 (28.14)	57.73 (18.31)	58.71 (26.22)	59.26 (23.60)	55.69 (24.36)	57.67 (26.35)	58.79 (25.01)
	Waterlily	52.91 (19.19)	64.53 (21.17)	45.47 (15.93)	25.53 (21.52)	64.40 (16.95)	67.28 (21.18)	65.34 (22.72)	58.88 (23.44)	62.84 (25.77)	63.35 (26.05)
Woody	Pine	35.88 (23.08)	44.48 (26.73)	70.91 (16.29)	56.64 (23.46)	40.44 (18.31)	38.12 (23.29)	32.21 (20.62)	43.00 (24.06)	43.24 (24.43)	43.81 (23.41)
	Wood	38.81 (28.46)	36.84 (24.64)	71.43 (23.45)	59.00 (19.23)	38.88 (18.46)	31.52 (19.12)	36.92 (24.84)	43.38 (25.21)	40.78 (26.25)	41.19 (25.43)
Herbal	Cinnamon	30.78 (23.29)	38.05 (26.01)	73.85 (18.44)	60.80 (19.96)	46.05 (14.63)	47.61 (21.64)	43.92 (24.70)	57.68 (23.31)	42.70 (24.13)	43.38 (25.26)
	Sandalwood	39.25 (23.38)	39.59 (26.47)	72.44 (16.95)	50.53 (25.62)	44.93 (23.30)	41.38 (28.41)	45.50 (30.56)	46.00 (27.97)	45.88 (30.48)	49.22 (29.17)
	Vanilla	49.51 (24.74)	51.27 (25.09)	60.78 (20.62)	53.53 (23.90)	60.07 (16.83)	63.31 (20.15)	59.49 (22.66)	62.65 (21.25)	56.32 (24.90)	60.35 (23.71)
Blends	Chocolate	52.65 (27.89)	49.65 (27.55)	61.35 (24.83)	51.46 (24.95)	56.89 (16.70)	56.16 (23.84)	56.62 (23.66)	56.73 (23.58)	55.38 (24.23)	54.19 (24.02)
	Coffee	37.49 (24.18)	38.08 (25.24)	72.62 (18.27)	66.92 (20.28)	47.75 (20.63)	44.23 (25.68)	52.46 (28.78)	58.69 (25.64)	42.28 (23.53)	43.54 (27.14)
	Green tea	41.09 (20.62)	48.24 (20.48)	61.61 (19.67)	44.39 (21.53)	48.06 (16.35)	49.23 (22.51)	46.91 (20.54)	43.64 (20.34)	47.88 (24.81)	53.06 (23.23)
	New car ambient	46.00 (20.05)	51.64 (24.97)	63.42 (20.58)	55.61 (28.29)	43.06 (17.88)	40.47 (24.10)	43.91 (23.21)	46.30 (23.37)	44.52 (26.09)	43.45 (23.31)
	New car noble	35.55 (22.42)	32.91 (22.21)	64.85 (23.92)	65.30 (25.16)	38.78 (18.97)	39.91 (25.57)	35.91 (23.88)	44.58 (26.55)	33.70 (22.71)	39.79 (26.60)
	Masculine perfume	29.41 (22.44)	73.41 (18.82)	75.84 (14.83)	66.41 (31.59)	48.89 (22.35)	51.90 (29.06)	43.70 (27.43)	46.11 (24.88)	48.59 (27.56)	52.73 (27.44)
	Feminine perfume	44.62 (20.38)	64.54 (19.13)	53.00 (24.98)	33.54 (27.45)	60.67 (18.13)	59.21 (24.15)	61.97 (24.31)	53.86 (25.79)	64.51 (22.39)	62.51 (23.01)

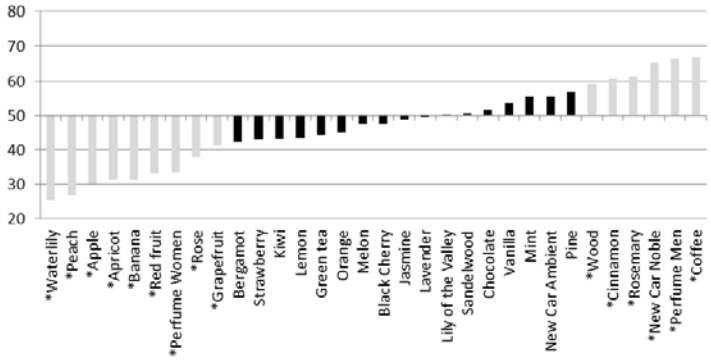
		Sensorial profile of scent									
		Bright Dim	Cold Hot	Fragile Sturdy	High Low	Light Dark	Light Heavy	Loud Quiet	Rough Smooth	Shallow Deep	Soft Hard
		x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)	x̄ (s)
Fresh	Apple	32.00 (23.83)	61.77 (25.00)	47.64 (22.59)	39.08 (23.02)	33.59 (21.08)	39.51 (25.48)	49.64 (29.53)	69.69 (20.89)	56.67 (22.34)	36.21 (24.98)
	Apricot	37.15 (21.90)	59.36 (25.22)	44.67 (24.39)	50.48 (24.23)	36.70 (22.30)	39.09 (24.90)	59.52 (20.57)	65.30 (20.20)	50.42 (21.03)	33.64 (25.90)
	Banana	39.93 (23.22)	67.53 (19.74)	51.13 (18.77)	50.98 (20.47)	41.08 (22.77)	44.68 (24.18)	52.25 (20.87)	63.28 (20.50)	54.73 (22.20)	36.33 (26.17)
	Bergamot	37.42 (20.11)	50.00 (21.61)	52.58 (22.49)	37.79 (20.59)	43.94 (20.36)	51.36 (23.85)	52.09 (20.19)	56.97 (18.26)	57.45 (21.52)	49.94 (23.51)
	Black cherry	36.15 (20.62)	53.45 (27.63)	56.52 (23.73)	45.45 (24.22)	47.64 (25.71)	52.76 (25.15)	53.97 (22.56)	52.94 (28.92)	52.00 (22.28)	44.27 (28.12)
	Grapefruit	39.94 (16.47)	51.06 (20.43)	55.85 (20.19)	43.91 (16.89)	42.67 (19.23)	49.61 (21.03)	50.42 (19.34)	53.18 (17.00)	57.24 (18.97)	48.79 (20.35)
	Kiwi	42.85 (21.67)	49.67 (17.96)	55.27 (20.90)	47.55 (19.56)	46.06 (22.68)	53.94 (21.38)	48.64 (21.63)	52.76 (22.15)	54.06 (21.44)	47.33 (23.61)
	Lemon	28.30 (18.99)	49.30 (25.17)	58.08 (24.68)	37.28 (20.28)	31.20 (18.75)	43.25 (23.76)	43.83 (21.86)	56.80 (23.33)	55.13 (24.76)	58.78 (26.30)
	Melon	48.12 (20.98)	48.48 (19.83)	48.48 (20.53)	51.70 (20.24)	48.15 (22.01)	48.33 (19.81)	54.82 (21.90)	54.06 (21.73)	54.39 (19.92)	45.48 (21.51)
	Mint	35.46 (27.49)	29.13 (20.47)	60.21 (25.39)	29.05 (20.98)	41.64 (27.70)	54.49 (27.95)	44.31 (26.69)	54.05 (28.37)	68.49 (20.92)	65.67 (24.58)
	Orange	45.27 (21.18)	54.12 (20.61)	60.73 (23.41)	41.85 (21.43)	48.42 (24.87)	57.88 (23.13)	51.61 (20.97)	44.78 (24.92)	57.88 (23.57)	55.91 (25.16)
	Peach	32.81 (22.49)	65.30 (22.05)	41.46 (18.62)	41.35 (19.88)	32.11 (21.97)	34.14 (24.26)	59.08 (23.78)	65.11 (23.01)	58.43 (21.91)	28.51 (24.07)
	Red fruit	39.68 (20.34)	68.68 (19.82)	48.89 (24.40)	40.24 (22.15)	38.22 (22.10)	38.76 (22.29)	50.86 (19.05)	60.43 (21.61)	51.76 (19.99)	34.49 (20.89)
	Rosemary	48.19 (28.65)	28.08 (24.90)	72.75 (21.22)	32.92 (27.72)	50.89 (25.72)	67.56 (25.46)	38.58 (28.21)	36.31 (26.08)	64.92 (23.67)	77.67 (17.16)
	Strawberry	46.48 (27.52)	53.30 (28.60)	56.70 (21.33)	47.52 (25.12)	45.79 (25.78)	51.06 (23.88)	43.15 (24.40)	53.06 (26.71)	54.00 (21.83)	47.94 (28.84)
Floral	Jasmine	47.75 (26.21)	47.59 (22.52)	59.44 (25.07)	40.00 (21.32)	52.00 (25.51)	60.59 (23.73)	53.53 (26.13)	42.81 (24.59)	53.56 (20.58)	60.28 (27.28)
	Lavender	46.20 (24.30)	50.80 (23.40)	60.60 (21.05)	42.25 (21.42)	43.98 (22.96)	56.48 (23.55)	52.08 (21.51)	47.68 (25.19)	63.48 (21.17)	55.40 (26.77)
	Lily of the valley	48.66 (23.97)	40.94 (21.09)	56.94 (23.12)	46.75 (20.85)	46.22 (24.71)	56.31 (22.69)	54.56 (22.92)	42.94 (21.83)	52.59 (17.48)	60.97 (22.41)
	Rose	38.56 (25.42)	52.92 (27.45)	48.64 (24.20)	39.15 (23.95)	41.46 (24.78)	49.36 (25.46)	54.72 (24.58)	58.41 (25.92)	51.67 (22.12)	42.62 (26.13)
	Waterlily	33.97 (17.16)	53.78 (25.58)	33.56 (18.52)	47.91 (23.17)	37.47 (23.84)	37.63 (21.04)	61.16 (19.41)	64.69 (21.46)	49.34 (17.52)	32.00 (20.91)
Woody	Pine	53.97 (24.57)	47.91 (26.16)	67.27 (20.27)	39.76 (24.45)	59.12 (25.13)	62.12 (23.09)	44.48 (27.00)	40.33 (23.81)	62.79 (20.42)	59.58 (23.62)
	Wood	50.62 (27.66)	38.30 (23.98)	72.30 (20.78)	33.11 (24.20)	55.89 (27.68)	68.32 (26.35)	38.24 (25.78)	31.22 (23.93)	61.70 (24.57)	71.41 (22.02)
Herbal	Cinnamon	60.18 (20.08)	55.83 (24.85)	67.33 (23.05)	41.90 (25.53)	67.63 (19.68)	68.88 (18.95)	38.56 (21.99)	38.05 (26.21)	64.53 (20.81)	61.28 (25.68)
	Sandalwood	51.75 (24.95)	49.34 (21.75)	59.91 (23.55)	40.75 (18.98)	52.66 (25.45)	57.63 (26.90)	44.38 (21.32)	43.72 (24.91)	57.63 (22.81)	62.25 (24.23)
	Vanilla	50.54 (23.32)	64.68 (23.93)	48.27 (25.19)	51.95 (23.28)	49.65 (22.63)	50.19 (27.43)	52.43 (23.38)	54.70 (23.59)	54.14 (23.13)	44.76 (29.08)
Blends	Chocolate	59.54 (24.88)	58.95 (26.81)	65.92 (25.03)	49.78 (24.95)	64.43 (23.83)	65.81 (24.91)	42.62 (26.03)	42.32 (26.13)	58.00 (21.90)	48.57 (30.81)
	Coffee	73.26 (17.30)	64.23 (22.58)	71.92 (16.57)	41.18 (25.94)	70.28 (15.36)	72.90 (16.50)	39.33 (22.80)	29.59 (19.53)	64.77 (24.56)	62.23 (26.07)
	Green tea	43.48 (19.24)	49.24 (19.59)	56.15 (19.51)	40.03 (16.44)	51.39 (18.85)	56.70 (19.72)	45.76 (20.50)	49.45 (22.88)	52.76 (18.62)	52.88 (19.75)
	New car ambient	48.15 (23.74)	55.30 (20.06)	61.85 (20.30)	41.58 (21.72)	53.18 (21.12)	58.45 (23.42)	50.56 (19.33)	43.64 (20.20)	55.39 (22.65)	59.30 (22.05)
	New car noble	57.27 (22.75)	41.97 (22.26)	68.39 (20.09)	44.73 (25.25)	63.67 (21.43)	62.55 (24.93)	41.12 (25.55)	34.42 (22.34)	55.39 (21.72)	66.00 (22.69)
	Masculine perfume	35.86 (23.12)	62.54 (25.62)	62.24 (26.25)	30.57 (18.35)	43.95 (25.35)	44.54 (28.02)	43.08 (24.02)	53.92 (28.37)	61.75 (23.21)	52.62 (30.32)
	Feminine perfume	35.76 (16.59)	59.65 (18.69)	45.43 (22.28)	48.54 (21.28)	38.08 (19.54)	42.32 (20.23)	52.19 (21.96)	58.00 (22.88)	53.86 (21.84)	37.30 (20.02)

Mean score and standard deviation of each scent for each concept. Significant differences from the midpoint of the scale (50) are indicated by a grey coloured cell ($p < .05$).

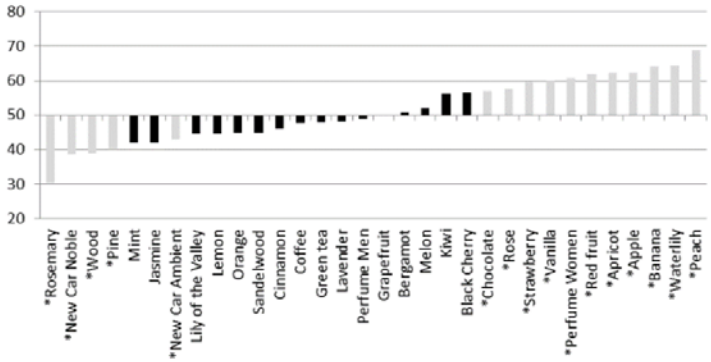
FIG. 1. RATINGS OF SCENTS



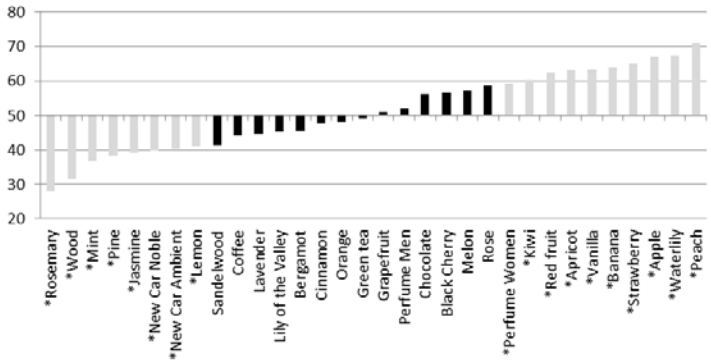
Feminine versus Masculine



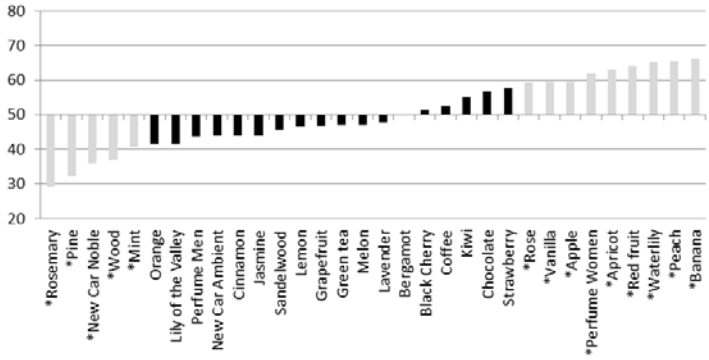
Shapescore (Angular versus Round)



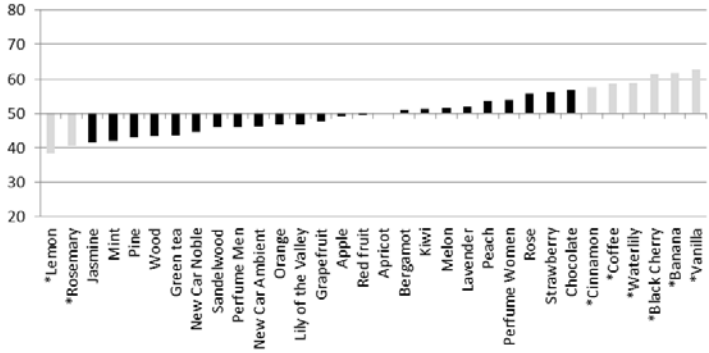
Star versus Spot



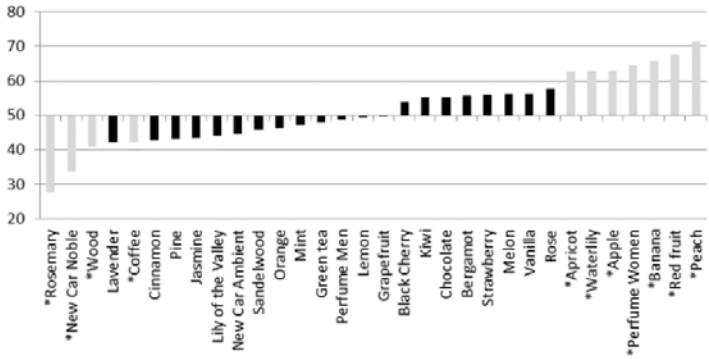
Decter versus Bobolo



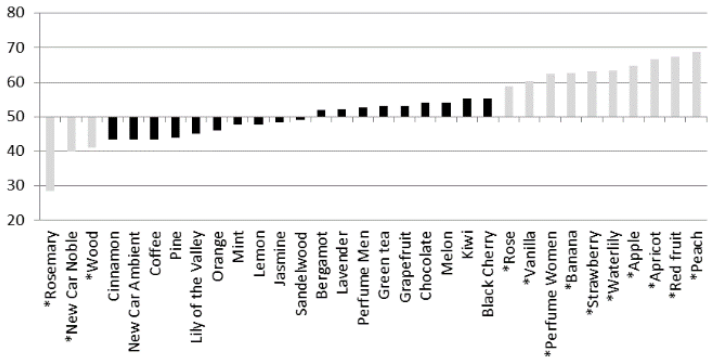
Kiki versus Bouba



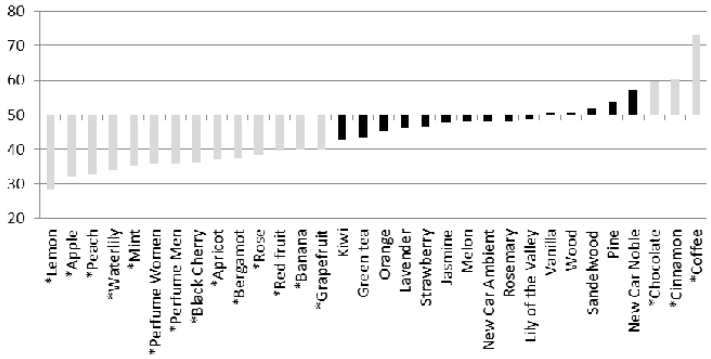
Ruki versus Lula



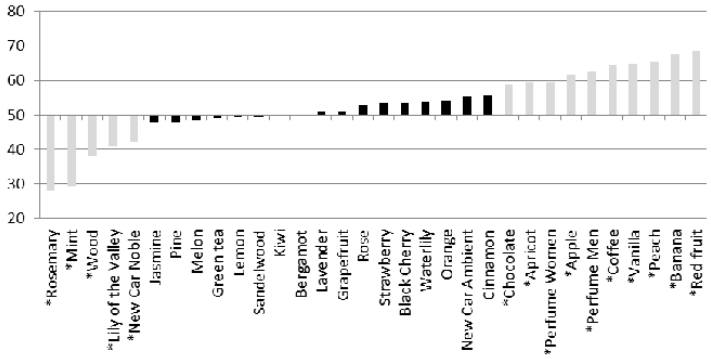
Takete versus Maluma

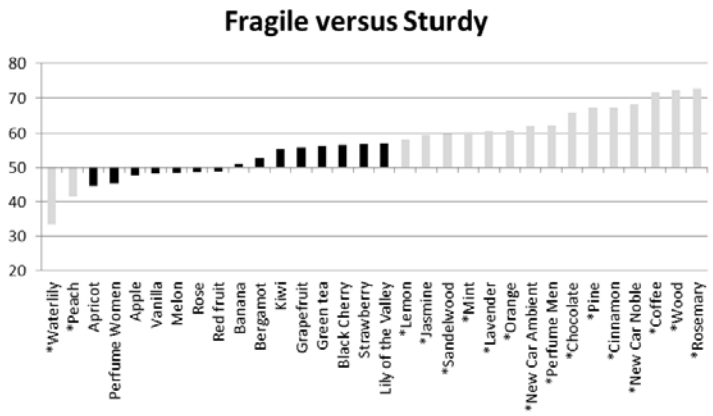


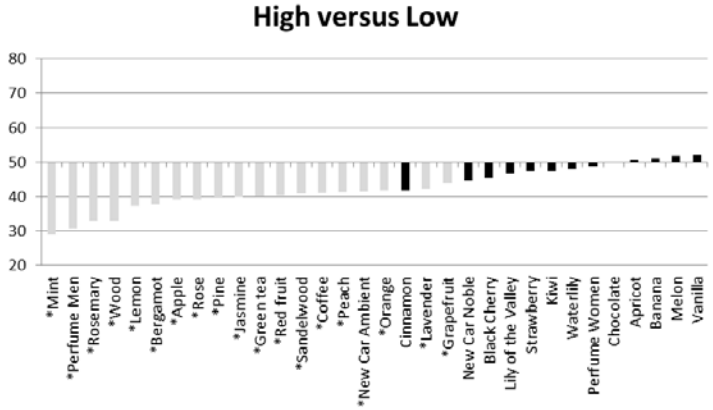
Bright versus Dim

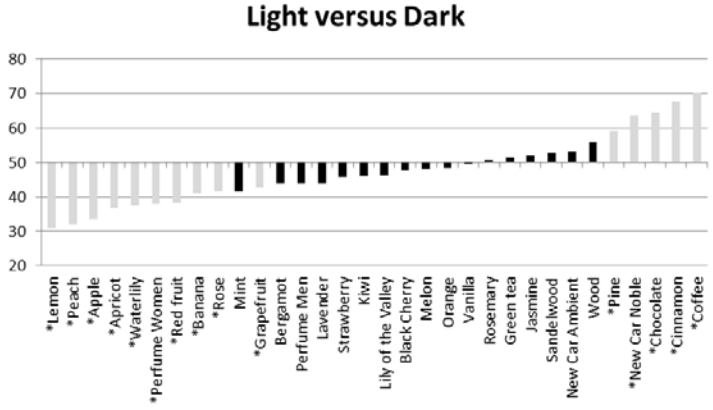


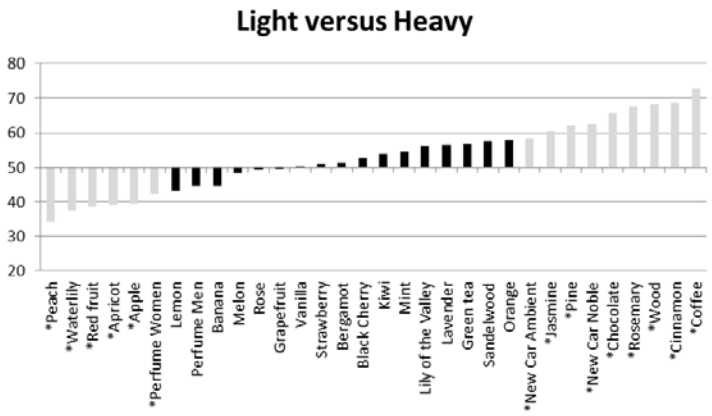
Cold versus Hot

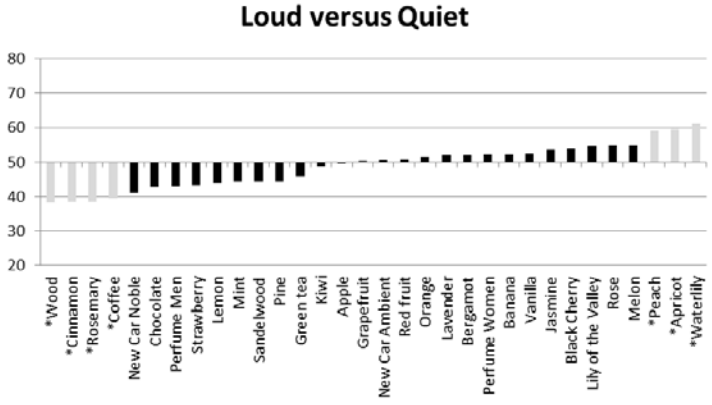


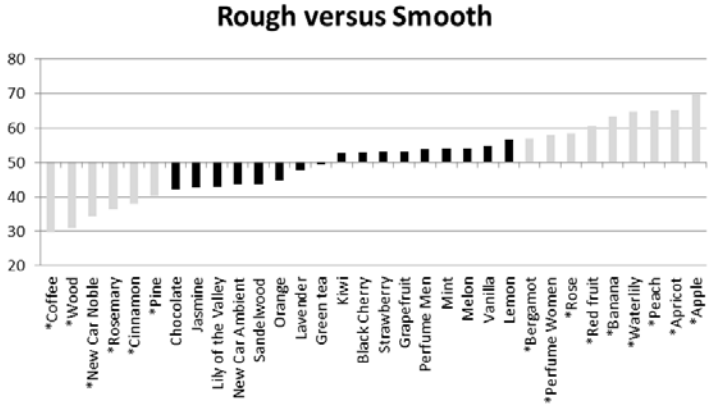

Fragile versus Sturdy
80
70
60
50
40
30
20
*Waterlily
*Peach
Apricot
Perfume Women
Apple
Vanilla
Melon
Rose
Red fruit
Banana
Bergamot
Kiwi
Grapefruit
Green tea
Black Cherry
Strawberry
Lily of the Valley
*Lemon
*Jasmine
*Sandelwood
*Mint
*Lavender
*Orange
*New Car Ambient
*Perfume Men
*Chocolate
*Pine
*Cinnamon
*New Car Noble
*Coffee
*Wood
*Rosemary

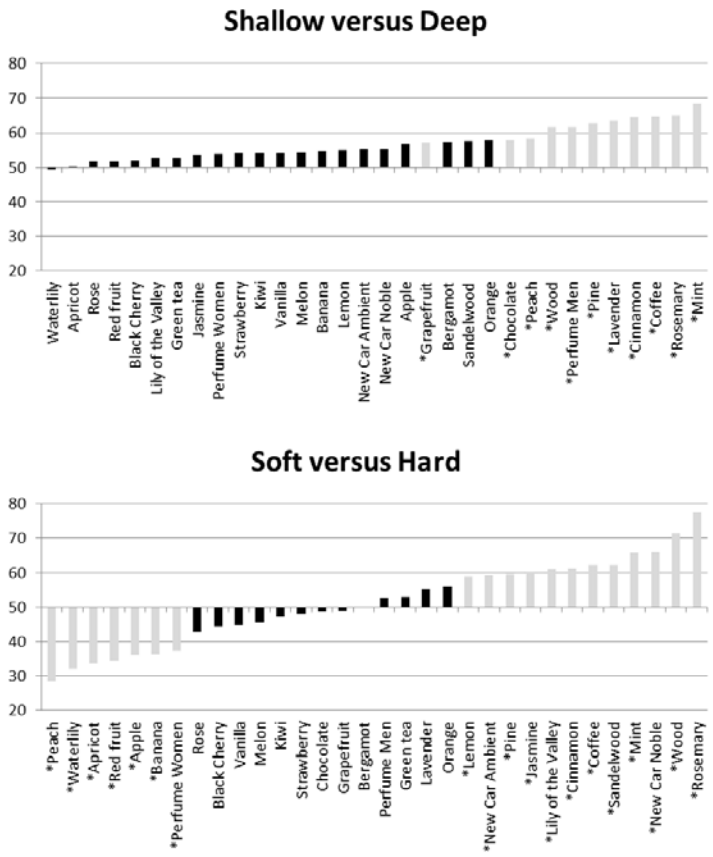

High versus Low
80
70
60
50
40
30
20
*Mint
*Perfume Men
*Rosemary
*Wood
*Lemon
*Bergamot
*Apple
*Rose
*Pine
*Jasmine
*Green tea
*Red fruit
*Sandelwood
*Coffee
*Peach
*New Car Ambient
*Orange
Cinnamon
*Lavender
*Grapefruit
New Car Noble
Black Cherry
Lily of the Valley
Strawberry
Kiwi
Waterlily
Perfume Women
Chocolate
Apricot
Banana
Melon
Vanilla


Light versus Dark
80
70
60
50
40
30
20
*Lemon
*Peach
*Apple
*Apricot
*Waterlily
*Perfume Women
*Red fruit
*Banana
*Rose
Mint
*Grapefruit
Bergamot
Perfume Men
Lavender
Strawberry
Kiwi
Lily of the Valley
Black Cherry
Melon
Orange
Vanilla
Rosemary
Green tea
Jasmine
Sandelwood
New Car Ambient
Wood
*Pine
*New Car Noble
*Chocolate
*Cinnamon
*Coffee


Light versus Heavy
80
70
60
50
40
30
20
*Peach
*Waterlily
*Red fruit
*Apricot
*Apple
*Perfume Women
Lemon
Perfume Men
Banana
Melon
Rose
Grapefruit
Vanilla
Strawberry
Bergamot
Black Cherry
Kiwi
Mint
Lily of the Valley
Lavender
Green tea
Sandelwood
Orange
*New Car Ambient
*Jasmine
*Pine
*New Car Noble
*Chocolate
*Rosemary
*Wood
*Cinnamon
*Coffee


Loud versus Quiet
80
70
60
50
40
30
20
*Wood
*Cinnamon
*Rosemary
*Coffee
New Car Noble
Chocolate
Perfume Men
Strawberry
Lemon
Mint
Sandelwood
Pine
Green tea
Kiwi
Apple
Grapefruit
New Car Ambient
Red fruit
Orange
Lavender
Bergamot
Perfume Women
Banana
Vanilla
Jasmine
Black Cherry
Lily of the Valley
Rose
Melon
*Peach
*Apricot
*Waterlily


Rough versus Smooth
80
70
60
50
40
30
20
*Coffee
*Wood
*New Car Noble
*Rosemary
*Cinnamon
*Pine
Chocolate
Jasmine
Lily of the Valley
New Car Ambient
Sandelwood
Orange
Lavender
Green tea
Kiwi
Black Cherry
Strawberry
Grapefruit
Perfume Men
Mint
Melon
Vanilla
Lemon
*Bergamot
*Perfume Women
*Rose
*Red fruit
*Banana
*Waterlily
*Peach
*Apricot
*Apple



Mean score of each scent for each concept ordered according to their value and asterisks as well as grey coloured bar indicating significant differences ($p < .05$) from the midpoint of the scale (50).

Meaning of scent

Of the 4 meaning concepts, the concept of WeakStrong resulted in 24 scents being significant different from the scale's midpoint, with all scents labelled as a strong scent. Thus, none of the 32 scents in this study was considered to be weak.

A similar conclusion can be drawn for ActivePassive, in that all 18 scents were significantly different from the midpoint of the scale and corresponded to the active side of the scale. Thus, no passive scents were found.

When evaluating the ratings of both ActivePassive and WeakStrong together, the results reveal that all scents that were neutral on WeakStrong were also neutral on ActivePassive, except for the scent of red fruit. A correlation between ActivePassive and WeakStrong might thus be expected.

Shape of scent

The first result, based on the ratings for the 5 measured shape concepts as well as the calculated shapescore, was that more scents were significantly round than were significantly angular. This could indicate that it is easier to find a round scent than an angular scent.

For the concepts measured as well as the shapescore, it can be concluded that the nonsense words KikiBouba only resulted in 8 of the 32 scents being significantly different from the midpoint. The concept resulting in the most scents being significant different from the midpoint (18 scents) was StarSpot. Additionally, the distance between the lowest and highest scores for StarSpot was almost double ($\bar{x}$(rosemary) = 28.09 and $\bar{x}$(peach) = 70.90) that of the distance for KikiBouba ($\bar{x}$(lemon) = 38.50 and $\bar{x}$(vanilla) = 62.65). These results can be linked to the transitivity hypothesis (Deroy et al. 2013). In particular, the correspondences between shapes and the nonsense words are embedded in the theory of

sound symbolism (Spence 2012), whereas the correspondences between shapes and scents have been proven by previous literature (Hanson-Vaux et al. 2013) in which the same StarSpot concept was used. Consequently, the correspondence between a shape and a nonsense word can be seen a direct correspondence between A (shape) and B (nonsense word), and the correspondence between a shape and a scent is also a direct correspondence between A (shape) and C (scent). The transitivity hypothesis then states that a mediated correspondence between B (nonsense word) and C (scent) could be found or expected. If it is found, however, the expectation is that this mediated correspondence will be weaker than the direct correspondences. The transitivity hypothesis can thus be offered as an explanation for why the StarSpot concept—which measures a direct correspondence—indicates more scents being either round or angular than the mediated correspondence measured by the nonsense words KikiBouba.

Another interesting trend can be seen with respect to KikiBouba: a significant difference from the midpoint for 2 scents (black cherry and cinnamon), despite the other shape concepts not having a difference from the midpoint. We also found a difference for 2 scents (coffee and lemon), whereas only one other concept offers a difference. For coffee, the concept of RukiLula was even in the opposite direction, indicating that coffee is round in terms of KikiBouba and angular in terms of RukiLula. For the other 4 scents, for which differences in KikiBouba could be found, the indicated direction was, although less extreme, in the same direction as the other shape concepts. KikiBouba could thus be seen, on the one hand, as a concept capable of detecting a difference for certain scents when the other concepts do not detect a difference. On the other hand, KikiBouba can also be regarded as a concept confirming the direction found in the other shape concepts, but less extreme or with less strength.

Regarding the calculated shapescore, the results indicate that the shapescore and the StarSpot concept indicated the same result for 14 scents. For 4 scents, the StarSpot concept did indicate a difference (kiwi, lemon, jasmine, and mint) but the shapescore —which includes the ratings on the nonsense words—did not. This could imply that, for these scents, their (mediated) correspondences with the nonsense words are even weaker, resulting in a less extreme shapescore. For the scents of rose and chocolate, on the other hand, StarSpot and some or all of the nonsense word pairs did not indicate the scents to be round or angular, whereas the shapescore did give significant results, indicating that both scents are round. The shapescore can thus be seen as a useful tool for indicating the combined influence of the visual correspondence and the nonsense-words correspondence, but caution should be used.

Meaning in relationship to shape

In this section, we discuss 2 types of relationships involving the meaning of the scent and the shape of the scent. First, the expected relationship between the degree of perceived roundness versus angularity and the elicitation of the concept “bad versus good” are addressed. Second, we also address how the shape of the scent has an expected relationship with the degree to which the scent is perceived as being feminine or masculine.

Based upon previous research indicating that people prefer rounded shapes over angular shapes (Bar and Neta 2006; Seo et al. 2010; Gómez-Puerto et al. 2016), a link between the rating on BadGood and the shape concepts could thus be expected. In particular, we expected rounded scents to also be rated as good scents, and angular scents to be rated as bad scents. By means of the StarSpot concept as well as the shapescore, the following relationships could be found. First, if a scent was rated as being good, and thus was significantly different from the midpoint and above 50 on BadGood, then this scent was either

labelled as a round scent or a neutral scent. On the contrary, if the scent was labelled as being bad, then this scent was either an angular scent or a neutral scent. Second, with respect to the opposite direction: if a scent was labelled as round, it was either labelled as a good scent or a neutral scent on BadGood. Additionally, if the scent was labelled as angular, then this scent was either a bad scent or a neutral scent on BadGood. Finally, if a scent is neutral with respect to its perceived shape on the StarSpot concept or the calculated shapescore, then this gave no indication concerning its rating on BadGood, indicating that a scent which is neutral in its perceived shape can be bad, good, or neutral on BadGood. In conclusion, we can indeed state that a relationship could be found between the scent ratings on StarSpot and the shapescore and ratings of a scent on BadGood. Furthermore, the relationship found is in line with the expectation that rounded scents will be evaluated as better than angular scents.

With respect to the concept of feminine versus masculine, one might also expect a relationship with the shape concepts. In particular, one might expect a relationship between rounded scents and feminine scents, on the one hand, and angular scents and masculine scents, on the other hand. The results indeed provide support for this expectation, since the feminine scents either had round or neutral shape concepts, whereas the masculine scents had either angular or neutral shape concepts. The only exception found was the scent of coffee, which was labelled as a masculine scent but had 2 shape concepts (KikiBouba and RukiLula), indicating contradicting results concerning the perceived shape of coffee.

Sensorial crossmodal profile of scent

The first remarkable result is that no low or shallow scents were found. Of particular interest, the other sides of these concepts—in particular, deep for the ShallowDeep concept and high for the HighLow concept—proved to behave differently. Of the 32 scents, 19 scents

were labelled as high, thus resulting in the remaining 13 scents being neutral. For ShallowDeep, 21 of the 32 scents were considered to be neutral, with the remaining 11 scents labelled as deep scents. Consequently, in contradiction to the behavior of the scents on the meaning concepts, specifically that no weak scents but 24 strong scents and no passive scents but 18 active scents were found, the behavior of the scents on ShallowDeep indicates that—at least for this sensory concept—an absence of scents on one side of the concept did not imply that most of the scents would be perceived as representing the other side of the concept.

The concept for which the least differences were found was LoudQuiet. For this concept, only 7 scents were different from the midpoint of the scale. However, both sides of the scale were represented. Apricot ($\bar{x}$ = 59.52), peach ($\bar{x}$ = 59.08), and waterlily ($\bar{x}$ = 61.16) were considered to be quiet scents. Cinnamon ($\bar{x}$ = 38.56), coffee ($\bar{x}$ = 39.33), rosemary ($\bar{x}$ = 38.58), and wood ($\bar{x}$ = 38.24) were considered to be loud scents. It is noteworthy that this concept—for which the lowest number of scents different from the midpoint was found and both sides of the scale were represented—was the only concept with respect to the auditory sense.

The sensory concepts resulting in the most scents being significantly different from the midpoint were SoftHard (19 scents, of which 7 were soft scents and 12 were hard scents) and HighLow (19 scents, all labelled as high scents). With respect to the sensory concepts included in this study, it can thus be stated that not all of the sensory concepts resulted in the same number of scents being different from the midpoint. This could indicate that crossmodal correspondences between an olfactory cue and the visual, tactile, and auditory senses might not exist for all possible combinations in the same strength or in the same direction. For instance, a representation on both sides of the scale might not be found for all concepts.

Individual ratings of the scents

Concerning the perceived meanings of the scents, kiwi and melon can be labelled as meaningless, since they did not differ from the midpoint of the scale for any of the 4 measured concepts. The scents of grapefruit, wood, cinnamon, coffee, new car noble, and masculine perfume, on the other hand, differed from the midpoint in all 4 of the measured concepts. These scents are particularly meaningful.

Concerning the individual ratings of each scent on the shape concepts, banana and waterlily were consistently perceived as round on all of the concepts. Peach had the highest or second-highest rating on all of the shape concepts, except for KikiBouba, and could thus be labelled as a round scent. Other scents that could be labelled as being round are: apple, apricot, red fruit, and feminine perfume. The most angular scent was rosemary, since it had the lowest or second-lowest rating on all shape concepts. The scents of wood and new car noble were angular on all concepts expect for KikiBouba. A number of scents were also neutral on all shape concepts. In particular, 9 of the 32 scents did not differ from the scale midpoint on any of the 5 measured concepts or on the calculated shapescore. The neutral scents were bergamot, grapefruit, melon, orange, lavender, lily of the valley, sandalwood, green tea, and masculine perfume.

Referring to Hanson-Vaux et al. (2013), 4 of the 32 scents in this study (lemon, vanilla, apple, and apricot) had already been tested regarding their correspondence to StarSpot through the use of a 9-point scale. The angularity of the lemon scent and the roundness of the vanilla scent on StarSpot were confirmed by the results of this study. Apple and apricot were not significantly different from the midpoint of Hanson-Vaux et al. (2013) but did indicate a bias to the rounded side of the scale. In this study, the apple and apricot scents were indeed significantly different from the midpoint, indicating that these scents were round. The 100-mm VAS used in this study, compared to the 9-point scale used in the study of Hanson-Vaux

et al. (2013), might suggest that a more refined scale is needed to be able to detect certain crossmodal correspondences for certain scents.

With respect to the sensorial crossmodal profile of the scents, peach and coffee were significantly different from the midpoint for all 10 concepts. On the other hand, the scents of kiwi and strawberry were neutral on all 10 concepts, while the scent of vanilla only differed on ColdHot ($\bar{x}$ = 64.68, indicating that vanilla is a hot scent) and the scent of green tea was only different on HighLow ($\bar{x}$ = 40.03, indicating that green tea is a high scent).

When reviewing the individual ratings of the scents on *all* of the concepts, several scents had an interesting profile.

First, the scent of melon did not differ from the midpoint for any of the 19 measured concepts or the calculated shapescore. This could indicate that the scent of melon is neutral with respect to crossmodal correspondences and meaning. The scent of kiwi only differed from the midpoint for StarSpot, indicating that it only elicits the crossmodal correspondence of round figures, but no other crossmodal correspondences or specific meanings. Other scents that can be described in a few words are green tea (labelled as active, strong, and high but neutral on the other concepts), orange (active, strong, sturdy, and high), strawberry (round and strong), and vanilla (round, strong, and hot).

Second, the set of 32 scents revealed that some scents can be labelled as complicated and rich in eliciting crossmodal correspondences. The scent of peach was different for all of the measured concepts and the calculated shapescore, expect for KikiBouba, ActivePassive, and WeakStrong. Whereas the rating on KikiBouba was not surprising when compared to the other scents, most scents were indicated to be active or strong. However, the peach scent, although different on all of the other concepts, was neutral for these 2 concepts. Another complicated scent was coffee. This scent exhibited differences for all meanings and sensorial

crossmodal profile concepts. Additionally, coffee was different for 2 shape concepts that indicated opposite directions, thus not consistently labelling coffee as round or angular. Cinnamon is the third scent that can be regarded as complicated, with differences for all of the meaning concepts, 8 of the 10 sensory crossmodal profile concepts, and one shape concept.

Our last analysis of the individual ratings of the scents concerned the blended scents. As discussed, certain pairs of blended scents were selected to allow comparison between the profiles of these scents.

For the feminine versus masculine perfume, the most apparent difference was in their perceived shape. The masculine perfume scent was perceived to be neutral on all shape concepts, while the feminine perfume scent was mostly considered a round scent. The 2 scents, of course, differed on FemininemMasculine, which supports that the masculine perfume was perceived as masculine while the feminine perfume was perceived as feminine. With respect to meaning, the masculine perfume scent was considered to be active and strong, while the feminine perfume scent was considered to be neutral. In conclusion, the differences between the feminine and masculine perfume scents did not, evidentially, only lie in their perceived masculinity or femininity.

The new car scents (new car ambient and new car noble) were almost always in the same direction, with the ambient version being less extreme than the noble version. New car noble also differed from the midpoint on more concepts than new car ambient. When choosing between these 2 scents, car manufacturers should thus be aware that they both exhibit similar profiles but with one being more extreme than the other.

The final group of blended scents to compare included coffee, chocolate, and green tea. Coffee was by far the most complicated scent of the three. Chocolate can be considered as an alternative to coffee, since they had the most in common with each other, with chocolate

having less extreme ratings than those of coffee. Green tea and coffee only had 3 concepts in common (active, strong, and high), while green tea and chocolate were only similar in the fact that they were both labelled as strong scents.

Exploratory Factor Analysis

As discussed in the analytical approach section, exploratory factor analyses were performed on the entire data set. The Kaiser–Meyer–Olkin measure of sampling adequacy (Kaiser 1974) was 0.923, and Barlett's test of sphericity (Bartlett 1954) was significant, indicating that factor analysis was appropriate. Based on the scree plot, 4 components were retained and Varimax rotation was performed. The 4 components accounted for 63.0% of the variance.

In Table 5, the factor loadings of each concept on each component are presented. The concepts were allocated to a component based upon the following rule: the negative or positive loading of a concept on this component should be greater than an absolute value of 0.550, and the concept should also have no negative or positive loading on another component higher than an absolute value of 0.350. If a concept did not comply with this rule, then it was not allocated to any of the 4 components. Consequently, the concepts ColdHot, SoftHard, and LoudQuiet could not be assigned to a single component.

TABLE 5: ROTATED COMPONENT MATRIX

	Component			
	1	2	3	4
ActivePassive	.030	.068	.802	-.019
BadGood	-.677	.379	-.016	.132
WeakStrong	.311	-.235	-.625	.260
FemininemMasculine	.639	-.327	-.145	.038

StarSpot	-.288	.736	.137	.011
DecterBobolo	-.245	.788	.098	-.069
KikiBouba	.151	.617	.148	-.189
RukiLula	-.332	.709	.135	.113
TaketeMaluma	-.279	.765	.066	.067
BrightDim	.835	-.053	.121	.054
ColdHot	-.269	.454	.206	.346
FragileSturdy	.636	-.176	-.458	.119
HighLow	.072	.148	.723	-.054
LightDark	.851	-.075	.066	.099
LightHeavy	.789	-.178	-.143	.105
LoudQuiet	-.440	.123	.513	.179
RoughSmooth	-.731	.302	.201	.093
ShallowDeep	.163	-.035	-.161	.846
SoftHard	.591	-.474	-.347	-.011

The component to which a concept is allocated is indicated by a light grey coloured cell. These concepts are allocated to that component because their loading on this component is higher than +/-.550 while they do not have a loading higher than +/-.350 on another component. If a concept does not fulfil these requirements it is not assigned to any of the components.

The first component had positive loadings on the concepts FemininemMasculine, BrightDim, FragileSturdy, LightDark, and LightHeavy. It also had negative loadings on the concepts BadGood and RoughSmooth. Thus, the results suggest that, with respect to scents, the labels good, feminine, bright, fragile, light (in terms of luminance), light (in terms of weight), and smooth will probably co-occur. These concepts might be more linked to angelic features. On the other hand, their “darker”, more demonlike and opposite features will probably also co-occur. In other words, if a scent is labelled as bad, there is a probability that this scent will also be labelled as masculine, dim, sturdy, dark, heavy, and rough. Given the composition of this component, it might be labelled as the angelic factor which indicates whether a scent is more an angellike scent having more lighter or feminine like features or whether a scent is more an demonlike scent having more darker or masculine like features.

The second component had positive loadings on *all* of the shape concepts. Consequently, this component can be labelled as the shape factor. This result is not surprising, given that the shapescore calculated based on these 5 concepts had a Cronbach's alpha of above 0.7 for 30 of the 32 scents. Interestingly, the expected relationships of the shape of the scent with the concepts BadGood and FemininеMasculine were not confirmed in this exploratory factor analysis. Although the loadings of these concepts were not the highest, the positive loading of BadGood and the negative loading of FemininеMasculine were in the expected direction.

For the third component, 3 concepts were assigned: a negative loading of WeakStrong and positive loadings of ActivePassive and HighLow. This suggests correlations among strong, active, and high scents. This component can thus be labelled as the energetic factor. Consulting the individual ratings of the scents, 18 active scents, 24 strong scents, and 19 high scents were found. Of these scents, 12 scents were the same across all 3 concepts. Thus, 12 scents were simultaneously active, strong, and high. Additionally, these 3 concepts were the only concepts with a high number of scents that differed from the midpoint on one side of the scale. In other words, no passive, weak, or low scents were found.

The last component only consisted of one concept: ShallowDeep. This concept was, besides WeakStrong, ActivePassive, and HighLow, the only other concept that did not find scents present on both sides of the scale. However, the number of scents that differed from the midpoint—in particular, the 11 scents that were labelled as deep scents—was much lower than for the concepts WeakStrong, ActivePassive, and HighLow. Only 8 of the 32 scents had an overlap between this concept and WeakStrong, ActivePassive, and HighLow. Given that only deep scents were found, this component is labelled as the depth factor.

Crisinel et al. (2012) subjected the same concepts—except for the StarSpot concept—and an additional 4 taste concepts to an exploratory factor analysis. However, the stimuli in

that study were gustatory samples. A comparison between the factors and their composition indicates the following. First, Crisinel et al. (2012) found that the nonsense word pairs loaded on 2 different factors, whereas in this study, the nonsense words clearly all loaded high on one factor, which includes the concept StarSpot. Second, given that we only allocated concepts to one factor in this study, whereas Crisinel et al. (2012) allowed concepts to be allocated to more than one factor, only the concepts that Crisinel et al. (2012) allocated to one factor could have their compositions compared. A pair of concepts arose. First, the concepts ActivePassive, BrightDim, and LoudQuiet were present in the same factor when using gustatory samples. In this study, these concepts did not co-occur in the same factor when olfactory samples were used. The second set of concepts comprised LightHeavy, LightDark, and FragileSturdy. In both studies, these concepts co-occurred in the same factor.

Exploratory Cluster Analysis

Based upon the 4 factors of the exploratory factor analysis, the 32 scents were subjected to an exploratory cluster analysis using their ratings on the 4 factors. The goal of the cluster analysis was to explore whether scents belonging to the same scent category in terms of fresh notes, floral notes, woody notes, herbal notes, and blends were also present in the same cluster with respect to their ratings on 16 of the 19 concepts measured in this study. Since the concepts ColdHot, SoftHard, and LoudQuiet could not be attributed to a single factor in the exploratory factor analysis, the ratings on these concepts were not taken into account. Using Ward linkage and by inspecting the dendrogram, 4 clusters are presented in Table 6. Table 7 presents the means of each cluster for the 4 factors.

TABLE 6: DISTRIBUTION OF SCENTS IN CLUSTERS

	1	2	3	4
Fresh notes	bergamot grapefruit lemon orange mint	rosemary	apple apricot banana peach red fruit	kiwi black cherry melon strawberry
Floral notes	jasmine lavender lily of the valley		waterlily	rose
Woody notes		pine wood		
Herbal notes	sandalwood	cinnamon		vanilla
Blends	green tea new car ambient masculine perfume	coffee new car noble	feminine perfume	chocolate

TABLE 7: MEANS OF CLUSTERS ON FACTORS

	Cluster			
	1	2	3	4
Angelic factor	49.63	63.35	36.51	49.07
Shape factor	46.41	40.76	62.30	56.80
Energetic factor	36.41	33.87	45.76	44.60
Depth factor	57.78	62.35	53.60	54.04

Mean of the cluster is based on the ratings of the scents belonging to the specified cluster on the items belonging to the specified factor. For example the mean of cluster 1 on the angelic factor is based on the ratings of the scents belonging to this cluster (i.e., bergamot, grapefruit, lemon, orange, mint, jasmine, lavender, lily of the valley, sandalwood, green tea, new car ambient and masculine perfume) on the items belonging to the angelic factor (i.e., BadGood, FemininemMasculine, BrightDim, FragileSturdy, LightDark, LightHeavy and RoughSmooth).

The first cluster consists of scents present in 4 of the 5 scent categories. The mean of this cluster ($\bar{x}$ = 49.63) does not indicate that any particular extreme ratings are to be expected on the angelic features. The shape factor indicates a bias toward shape-neutral scents, while the mean of the energetic factor ($\bar{x}$ = 36.41) shows that these scents are probably strong,

active, and high scents. The depth factor also indicates that deep scents can also be present in this cluster. An analysis of the individual scent ratings indicates that most of the scents in this cluster are indeed neutral in shape, active, strong, high, and/or deep. Of the 12 scents in this cluster, 4 of the 12 scents had all 5 characteristics in common (neutral in shape, active, strong, high, and deep), while 5 of the 12 scents had 4 characteristics in common.

The second cluster did not contain any scents with floral notes. For this cluster, the angelic features seemed to indicate that these scents are bad, masculine, dim, sturdy, dark, heavy, and rough. The individual ratings indeed demonstrate that the 4 scents with the lowest scores on the concept of BadGood are present in this cluster (new car noble, wood, cinnamon, and coffee). The shape factor also seems to indicate that the scents in this category are angular, which is supported by the shapescore of 4 scents of this category being significantly and almost exclusively regarded as angular (rosemary, new car noble, wood, and pine). The energetic factor indicates that these scents tend to be active, strong, and high, while the deep factor indicates that these scents might also be labelled as deep. Of the 6 scents in this cluster, the individual ratings indicate that 4 scents are active, strong, high, and deep (pine, wood, rosemary, and coffee), while the other 2 scents have 3 of the 4 characteristics.

The third cluster consists of 6 scents with fresh and floral notes and one blended scent (feminine perfume). However, the presence of this blended scent was not surprising, since the feminine perfume is described by the distributor as a green, fruity scent that contains aspects of Muscat and black currant. This cluster can be described as round scents with angelic features, such as feminine, good, bright, fragile, light (in terms of luminance and weight), and smooth. An in-depth analysis of the individual ratings of these scents does indicate that these scents are similar, in that they are all significant in the direction of the angelic feature for the concepts FemininemMasculine, BadGood, BrightDim, LightDark, and RoughSmooth. In other words, they are all feminine, good, bright, light, and smooth. Furthermore, the individual

ratings of these scents indicate that they are also the roundest scents, based on their shapescores, and the most feminine scents, based on their ratings on the FemininemMasculine concept. Furthermore, these scents were not particularly regarded as energetic or deep.

The last cluster is composed of scents that were probably neutral or not extreme on the BadGood, FemininemMasculine, BrightDim, FragileSturdy, LightDark, LightHeavy, and RoughSmooth concepts. Furthermore, they tended to lean toward the concepts of roundness, energetic, and deep. However, the expectation was that their individual ratings would also not be extreme in these concepts. The individual ratings indeed support these expectations, since no extreme ratings were found. Additionally, the scents of melon and kiwi, which were neutral on almost all concepts, can be found in this cluster.

Discussion

The study presented in this paper aimed to identify which general concepts of meaning and which crossmodal correspondences tend to be elicited by a scent. The elicitations were reviewed in terms of direction as well as strength, in light of the concepts (which concepts tend to co-occur) and the scents (which scents tend to exhibit the same patterns of elicitation).

An in-depth analysis of the results of the individual scents did suggest that some of the 19 measured bipolar concepts might indeed co-occur. Exploratory factor analysis confirmed that 16 of the 19 bipolar concepts could be exclusively allocated to one factor. A total of 4 factors was found: an angelic factor for which concepts such as good, feminine, bright, light in terms of both luminance and weight, smooth, and fragile co-occur, as do their opposites masculine, dim, dark, heavy, rough, and sturdy; a shape factor, for which the direct and the indirect measurements of the perceived roundness versus angularity of the scent co-occur; an

energetic factor for which concepts such as strong, active, and high co-occur; and a depth factor indicating the perceived deepness of the scent.

The found factors indicate that choosing one concept as a subject of congruency might also mean that the retailer or researcher should be aware of other concepts that are most likely to also be elicited. For instance, if a retailer wishes to match the femininity of the store with a feminine ambient scent, the retailer should be aware that this scent could also elicit concepts related to luminance, weight, or tactile perception. However, if the store is quite dark in luminance, then the elicitation of brightness by the feminine ambient scent might not be desired or might even lead to a sense of incongruence between the ambient scent and the store's environment.

Furthermore, the individual results of the scents indicated that only one side of the bipolar scale was elicited for 4 of the concepts. In particular, the concepts HighLow, WeakStrong, ActivePassive, and ShallowDeep either elicited a neutral scent on their concept or a high, strong, active, or deep scent, respectively. Of these concepts, 3 concepts—HighLow, WeakStrong, and ActivePassive—also seem to co-occur, since the energetic factor is solely represented by these 3 concepts. ShallowDeep was the only concept in the depth factor. Finding a low, weak, passive, or shallow scent seems to be less likely, since no scent representing these concepts was found in this study. Further research with more scents is needed to confirm or disconfirm this outcome.

Besides the co-occurrence of concepts, this study also tried to identify whether certain scents tend to belong to certain scent groups based upon the direction and/or strength of the concepts these scents elicit. The individual results of the 32 investigated scents indeed indicated that not all of the scents elicited the same concepts, in direction or strength. While certain scents tended to be neutral for most of the concepts (melon, kiwi, green tea, orange,

strawberry, and vanilla), other scents tended to be significantly different from this neutral midpoint for most of the concepts (peach, coffee, and cinnamon).

The exploratory cluster analysis resulted in 4 clusters, representing 4 types of scents. The first cluster consists of scents that are strong, active, high, and deep but are neutral or not extreme in their perceived shape or angelic features. The second cluster includes scents that represent darker angelic features and are angular, active, strong, high, and deep. The third cluster represents scents that are lighter in angelic features and rounder but not particularly energetic or deep. The last cluster consists of scents that did not elicit any extreme rating for any of the factors. Of the 7 scents belonging to this cluster, 4 scents were indeed neutral for most of the concepts (melon, kiwi, strawberry and vanilla).

The results of the cluster analysis point to the following important conclusion: different scents indeed elicit different concepts in direction as well as in strength. Consequently, it is important to understand which types of scents exist and how these scents can be defined in terms of the concepts they elicit. The current definition of scents in terms of fresh, floral, woody, or herbal notes seems to not entirely capture the identity of scents. In particular, the results of this study point to the probability that scents in the same class of notes are not necessarily more similar in elicited concepts, compared to scents in a different class of notes. For example, the results of this study indicate that the 2 herbal scents of vanilla, belonging to cluster 4, and of cinnamon, belonging to cluster 2, are less similar to each other than the herbal scent of vanilla is with the fresh scent of melon, since these scents both belong to cluster 4. The clusters, as defined by their scores on the factors, can thus inspire a new or complementary classification of scents. Moreover, a classification of scents based upon the concepts these scents elicit might be of particular interest and/or of higher added value to retailers trying to choose the correct scent to diffuse throughout their retail

environment. More research is needed and advised to confirm and further refine the found factors and clusters.

This research also has a number of limitations. Although the sample size of the study presented in this paper is in line with its exploratory nature, more observations are recommended to be able to generalize. A second limitation is the predominantly young student sample used in this study. Since the scent impressions of young people and elderly differ different results could be expected. Therefore, further research should attempt to collect a more representative sample of participants.

Further research into this topic could also be directed at exploring additional angles. For example, no unpleasant scents were included in the study presented in this paper. Although from a practical point of view a retailer would not consider diffusing an unpleasant scent, from a theoretical point of view including unpleasant scents could be an interesting venue for further research. Another interesting topic of further research could be to alter the intensity level of the same scent in order to understand whether the strength of an elicitation might be correlated to the strength of the scent itself, or might even result in eliciting the opposite direction of a concept.

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