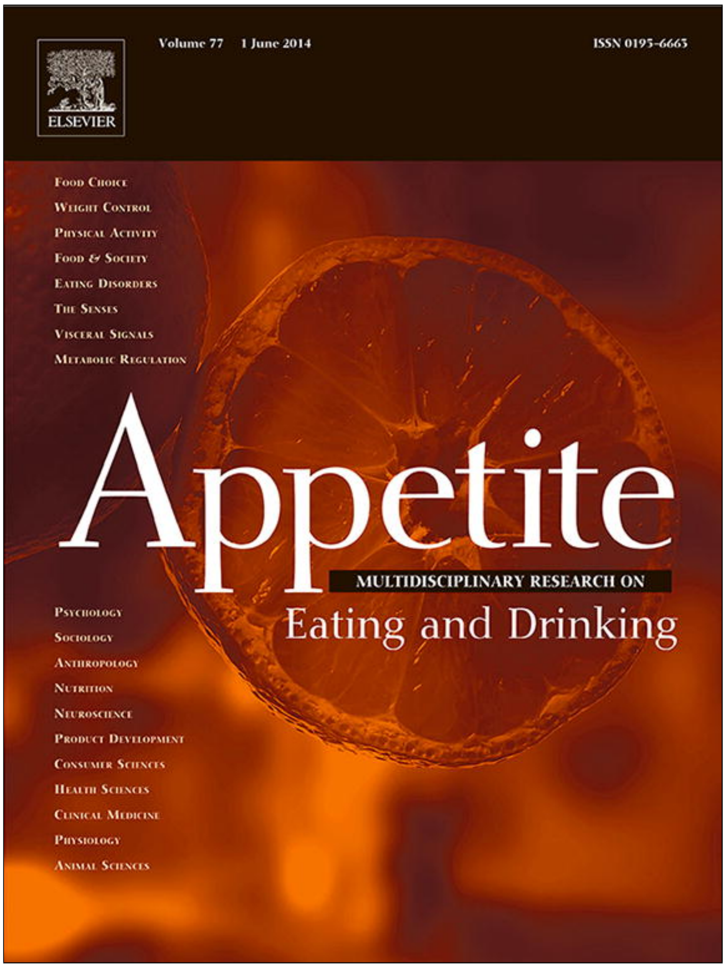
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Research report

Stimulus collative properties and consumers' flavor preferences ☆

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The present work investigated consumers' hedonic response to flavor stimuli in light of Berlyne's collative-motivational model of aesthetic preferences. According to this paradigm, sensory preferences are a function of a stimulus' *arousal potential*, which is determined by its *collative properties*. The relationship between overall arousal potential and hedonic response takes the shape of an inverted "U", reaching an optimum at a certain level of arousal potential. In three independent studies, using different sets of novel beers as stimuli, consumers reported their hedonic response and rated three collative properties: novelty, familiarity and complexity. Relationships between these collative properties and hedonic ratings were explored by polynomial regression. The results revealed patterns in line with Berlyne's predictions (curvilinear relationship) with regard to perceived novelty, whereas mixed results were obtained for familiarity and complexity. Additionally, in two of the studies, the moderating role of relevant consumer characteristics – product knowledge, food neophobia and variety seeking tendency – was investigated. A consumer's degree of product knowledge was found to significantly reduce perceived complexity and novelty, ostensibly reflecting the learning that occurs with previous exposures.

Introduction

Optimal arousal level and consumers' preferences

Consumers often have an ambivalent approach toward new or unfamiliar products. In the food and beverages domain, this has been seen as a reflection of the "omnivore's dilemma" (Fischler, 1990; Rozin, 1976), i.e. the characteristic of humans to be equipped with curiosity toward new and unfamiliar foods (instrumental to a varied diet), but also with an innate fear of them (instrumental to avoid ingesting harmful substances). The net outcome of this apparent paradox may be that consumers prefer products that jointly satisfy both of these contradictory tendencies, i.e. that have an optimal amount of novel elements to generate interest and curiosity, but are familiar enough not to induce fear.

Several "optimum level" theories have been proposed to conceptualize sensory preferences as a function of "arousal" induced by deviations from the familiar (van Trijp & van Kleef, 2008). Although there are some differences between these theories (see Köster & Mojet, 2007, for a review), they are grounded a common tenet of motivation theory: organisms actively look for stimulation, and they try to maintain an optimal level of activation or "arousal" under which they function most effectively.

Among the most prominent theories concerned with optimum arousal level is the collative-motivational model proposed by Berlyne (1967) to account for aesthetic appreciation. According to this theory, all stimuli can induce "arousal" (Berlyne, 1960, 1967, 1970), a state of psychobiological alertness relating not only to both specific and measurable physiological changes (e.g. brain stem activity), but also to behavioral processes such as attention and drive (Berlyne, 1967). A stimulus' arousal potential depends on three classes of properties: *psychophysical properties* (related to the intensity of the stimulus), *ecological properties* (related to biological functions such as thirst, hunger, sex and fear), and, most notably, *collative properties* (Berlyne, 1967). The latter ones are properties that affect the arousal level via the attention process, and are called "collative" because they imply a comparison (a *collation*) of incoming perceptual inputs with previous experiences, as well as an evaluation of similarities and differences between a

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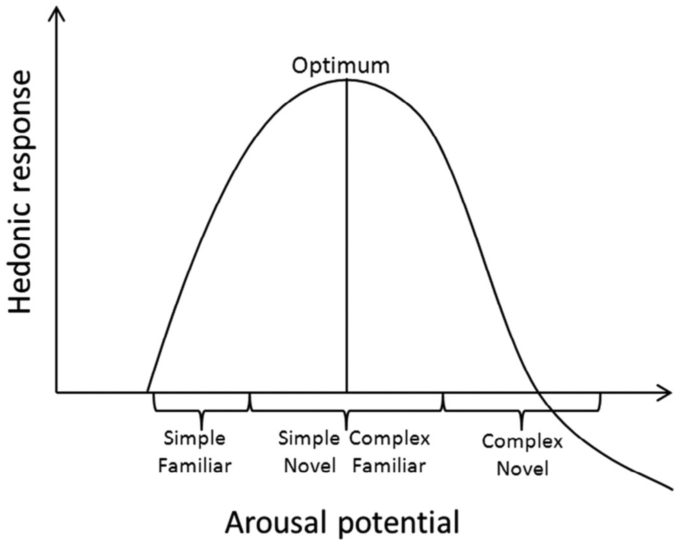

Fig. 1. Relationship between arousal potential and hedonic response (adapted from Berlyne, 1970).

stimulus' different elements (Berlyne, 1967, p. 20). Examples of important collative properties are *novelty* (degree of discrepancy between an experienced stimulus and previously experienced stimuli) and *complexity* (the degree to which different elements in a stimulus tend to co-exist or conflict) (Berlyne, 1967).

According to Berlyne, the relationship between arousal potential and hedonic response takes the shape of an inverted U (Fig. 1) where stimuli with a moderate arousal potential will be preferred.

This model has been widely applied to explain sensory preferences, in most cases using visual stimuli (Blijlevens, Carbon, Mugge, & Schoormans, 2012a; Hekkert, Snelders, & Van Wieringen, 2003; Mielby et al., 2012; Veryzer & Hutchinson, 1998; Whitfield, 1983), and less frequently auditory stimuli (Martindale & Moore, 1989; North & Hargreaves, 1997).

Little is known about whether the theory can be used to explain underlying preference structures in the chemical senses – taste and smell – as well. Acquiring this knowledge would be of both scientific and practical importance, since it could further current understanding of what drive consumers' acceptance of novel foods and thereby provide inputs for successful product innovation. The present research specifically focuses on testing the collative-motivational model on the hedonic appraisal of flavor stimuli. The term "flavor" is here intended as *the complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting* (ISO 5492:2008 – Sensory Analysis: Vocabulary).

Collative properties primarily examined in the present research are *novelty*, *familiarity* and *complexity*. Novelty is a collative property related to the distance between expectation and perception (Berlyne, 1950, 1966, 1970). As an arousal stimulating property, novelty is related to both positive hedonic response (curiosity and exploratory behavior) and negative ones (fear and withdrawal), inasmuch as its relationship with liking should follow an inverse U-shaped relationship (Berlyne, 1950). In particular, a positive appraisal is given when novelty refers to some unexpected feature in familiar material, by something that is in some degree similar and in some degree dissimilar to what is well known to an individual (Berlyne, 1950).

Perceived familiarity refers to whether the stimulus has been encountered before by an individual. For consumer products, familiarity is often associated to typicality, i.e. the degree to which an object is regarded to be representative of a category (Blijlevens et al., 2012a; Hekkert et al., 2003; Veryzer & Hutchinson, 1998). Hence, familiarity can be thought to measure how well a sensory stimulus from a new product fits previously encountered products in the category. This relies on the sensory memories that each individual has stored in his/her memory. If the fit is close, then the categorization will be very fast and the product will be perceived as familiar. On the one hand, perceived familiarity and hedonic response should stand in a positive relationship which stems from the successful preservation of existing knowledge and the ability of the cognitive apparatus to recognize and categorize a previously encountered stimulus (Mandler, 1982; Veryzer & Hutchinson, 1998). On the other hand, very familiar stimuli will lead to boredom and negative hedonic appraisal; hence an inverse U-shaped relationship is predicted. An important methodological remark is that although both novelty and familiarity have to do with an individual's expectations and past experience with a product, they are not two extremes of a single dimension. A novel stimulus is one that has some surprising elements, not necessarily one that has not been encountered before. Less than perfect correlations between novelty and familiarity have been observed empirically in previous studies (Hekkert et al., 2003), suggesting that they underlie slightly different perceptual dimensions and thus should be measured separately. This view is consistent with recent neuroscientific evidence suggesting that separate neural processes underlie perception of familiarity and novelty (in the posterior parahyppocampal gyrus and the anterior half of the hippocampus respectively), both of whom contribute independently to stimulus recognition and memory performance (Daselaar, Fleck, & Cabeza, 2006).

Complexity is another important arousal-inducing property, related to the number of discernible elements within a stimulus and on the degree to which these elements coexist or conflict (Berlyne, 1960, 1966, 1967). Complexity is thus very close to perceived ambiguity of a stimulus and to the cognitive effort necessary for its interpretation. Like novelty, complexity is an arousal-inducing property that can lead to either positive or negative affect (inverse U-shaped relationship). This ambivalence can be explained by research in affective psychology showing that individuals derive positive affective association from successful interpretation of perceived complexity (Mandler, 1982), implying that both very simple and very complex stimuli will frustrate (though for opposite reasons) the satisfaction derived from decoding a stimulus. Perceived complexity has been the focus of attention in flavor research, where it has similarly been defined as the number of separate sensory attributes that make up the total impression a person has of a stimulus (Jellinek & Köster, 1979, 1983; Moskowitz & Barbe, 1977). Although early work on the topic (Jellinek & Köster, 1979, 1983) suggested that perceived complexity is related to chemical complexity (the number of different compounds actually present in a stimulus), subsequent research has determined that this association is not straightforward. An important corpus of work has since documented that perceptual processing of odors in humans is mostly associative in nature (i.e. we tend to perceive complex object odors as unique stimuli, rather than as a muddle of components). Accordingly, the relationship between the chemical complexity and perceived complexity of a flavor is rapidly lost with increasing number of flavor components (Livermore & Laing, 1998). Previous research has demonstrated that odor and taste complexity is a concept which is meaningful and *directly* measurable with untrained subjects (Jellinek & Köster, 1979, 1983; Lévy, MacRae, & Köster, 2006; Moskowitz & Barbe, 1977; Sulmont-Rossé, Chabanet, Issanchou, & Köster, 2008).

Following Berlyne's model, the working assumption is that perceived complexity, familiarity and novelty can jointly be assumed to determine the arousal potential of a flavor stimulus. Thus, we tested the following theory-based hypothesis:

H_1: The arousal potential of a flavor can be determined by its combined degree of novelty, familiarity and complexity, and will be in an inverse U shaped relationship with hedonic response, such as a flavor with a moderate arousal potential (defined in terms of novelty, familiarity and complexity) will be preferred over a flavor with low or high arousal potential.

Relevant individual characteristics

As with any complex behavior, hedonic appraisal is likely to involve a number of factors. In the present studies, we focus on three individual consumers' characteristics relevant to test within the collative-motivational model: product knowledge, variety seeking tendency and food neophobia.

Product knowledge

In addition to the intrinsic qualities of a stimulus, perception of collative properties also depend on the individual ability to decode such stimulus. The latter is in turn dependent on the individual's previous experience with a certain stimulus group, which for consumer products can be thought of as product knowledge. Product knowledge has two main components: familiarity, i.e. the number of experiences accumulated with the products, and expertise, i.e. the ability to perform product related tasks (Alba & Hutchinson, 1987). The importance of product knowledge on consumers' judgments has been well established (Alba & Hutchinson, 1987; Park, Mothersbaugh, & Feick, 1994; Sujan, 1985) and is thus a relevant factor to consider within the collative-motivational model. Knowledge, through exposure, reduces the cognitive effort needed to process a stimulus (Alba & Hutchinson, 1987; Latour & Latour, 2010; Sujan, 1985), allows for a better categorization (Mervis & Rosch, 1984; Rosch & Mervis, 1975; Sujan, 1985) and increases product related memory (Alba & Hutchinson, 1987). Accordingly, product knowledge and expertise are also associated with enhanced memory and higher efficiency in processing chemosensory information (Valentin, Dacremont, & Cayeux, 2010).

Generally speaking, product knowledge increases with every type of exposure to a product (not only direct consumption). However, with regard to flavor preference, it is actual tasting experience that will be most relevant. Research in acquisition of food preferences has shown that repeated exposure is a sufficient condition to modify food likes (Pliner, 1982). The change is usually in the direction of an increase in liking, consistently with Zajonc's mere exposure theory (Zajonc, 1968, 2001). However, recent studies have actually provided suggestive evidence that the direction of the change actually depends on the initial arousal potential of the stimulus, *viz.* appreciation of complex stimuli increases over exposure, while it decreases for simple stimuli (Lévy et al., 2006; Sulmont-Rossé et al., 2008). This is consistent with the so-called Pacer theory (Dember & Earl, 1957), illustrated in Fig. 2, stating that exposure to a stimulus effectively leads to an actual sensory priming that causes a shift in an individual's arousal curve and brings him/her to gradually appreciate more complex products.

Importantly, this happens largely at a nonconscious level (i.e. independent of cognitive appraisal). This aspect should be emphasized because past research has shown that perceptual and conceptual knowledge do not develop symmetrically as a result of product exposure (Latour & Latour, 2010). In other words, an individual's taste acquisition progresses regardless of whether or not he/she meanwhile becomes more aware of specific sensory attributes (Hoeffler & Ariely, 1999) and/or acquires a vocabulary associated with expertise (Latour & Latour, 2010). Additionally, knowledge correlates highly with other constructs such as product interest and involvement (Sujan, 1985), which has also been shown to be influent with regard to how much complexity and

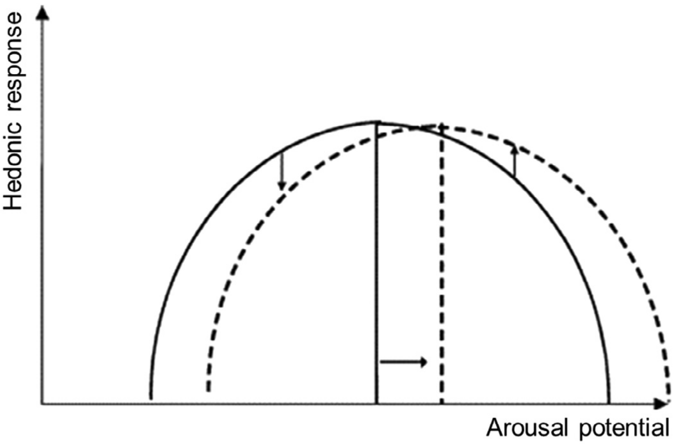

Fig. 2. The shift of an individual optimal arousal potential as effect of exposure to a product (adapted from Lévy et al., 2006).

novelty are sought after in food products (Charters & Pettigrew, 2007).

In the present research, we subscribe to the view that knowledge assessment has more to do with an individual's memory of experience with a given product, rather than objectively defined product class information (Park et al., 1994), and operationalize product knowledge as having three main components: self-assessed product knowledge, product involvement and degree of exposure.

Based on the preceding discussion, we set out to test the following two hypotheses:

H_{2a}: Higher product knowledge will yield a lower perception of complexity and novelty, and lead to a higher perceived familiarity;

H_{2b}: Hedonic ratings for complex and novel stimuli will be higher in highly knowledgeable consumers.

Variety seeking and food neophobia

It has also been suggested that an individual optimum level of arousal will be affected by specific personal characteristics (see, e.g. (Raju, 19802). Among them, of immediate relevance to this research is an individual's propensity to seek or avoid novel food, which is considered a relatively stable personality trait. This aspect has received considerable attention in food-oriented consumer research, for example on the work on food neophobia (Pliner & Hobden, 1992) and variety seeking (van Trijp, Lähteenmäki, & Tuorila, 1992; van Trijp & Steenkamp, 1992). Whether an individual's level of neophobia is a predictor of liking for novel products is a matter of debate. Some authors found that neophobic and neophilic differ in their hedonic response for novel and complex foods (Raudenbush & Frank, 1999), although the overall evidence is not conclusive. The relevance of this aspect for optimal arousal approaches to food preferences has been pointed out by Köster and Mojet (2007), who observed that, *ceteris paribus*, highly neophobic consumers should have a low optimal arousal level, preferring stimuli they are familiar with, whereas variety seekers should prefer more novel and complex stimuli.

Hence, the following two hypotheses are considered in this work:

H_{3a}: Highly neophobic consumers will give lower hedonic ratings than neophilic ones, whereas conversely

Table 1
Overview of the beers used as test stimuli in Study 1.

Beer name	Producer	Beer style	ABV	Main flavor ingredient	Sensory characteristic
Bøgebryg	Bryggeri Skovlyst	Amber ale	5.2%	Beech twigs	Woody
Fynsk Forår	Ørbæk Bryggeri	Pale ale	5.0%	Elderflower	Floral
Enebær Stout	Grauballe Bryghus	Stout	6.0%	Juniper berry	Berry, coffee
Sea-buckthorn	(Experimental)	Pale lager	4.5%	Sea-buckthorn juice (2.5 ml/100 ml)	Berry, sour
Pine	(Experimental)	Pale lager	4.5%	Pine flavor[a] (6.25 μl/100 ml)	Woody
Stjernebryg	Herslev Bryghus	Trappist	8.0%	Anise, coriander, licorice	Spiced, sweet
Thy Pilsner	Thisted Bryghus	Pale lager	4.6%	–	Neutral, hoppy
Valnød Hertug	Rise Bryggeri	Brown ale	7.0%	Walnuts	Nutty

[a] "Pin Thyrol", Firmenich International S. A., Geneva, Switzerland.

H_{3b}: High variety seeking consumers will give higher hedonic ratings than low variety seekers.

Study 1

To test these hypotheses, we conducted three experimental studies, following a consistent structure. It was chosen to use a set of beers as test stimuli. This choice was motivated by our interest in testing Berlyne's theory's ability to predict hedonic response in a realistic beverage – to extend the realms of the theory to a commercially relevant, yet scientifically overlooked stimulus group. Furthermore, beer lends itself very well as a case study: in Denmark, where this work was conducted, beer is a familiar product for which consumers differ largely in their sensory expectations and preferences (Giacalone, Bredie, & Frøst, 2013; Mejlholm & Martens, 2006). In the first study, a set of experimental and commercial beers were tested by a consumer panel from which liking ratings were elicited together with ratings of three collative properties: novelty, familiarity and complexity.

Materials and methods

Stimuli

Eight Danish beers were used as test stimuli. They were selected to span systematically across perceived novelty and complexity, as assessed by pilot work, as well as to represent the flavor diversity in the beer market (Table 1). All beers had special uncharacteristic flavors, except for one sample (*Thy Pilsner*), which was chosen to represent the "prototypical" lager beer. Two of the beers were brewed specifically for this study to represent ingredients very novel to beer (sea-buckthorn and pine). For the commercial beers, care was taken to ensure that all samples came from the same batch in order to minimize inter-sample differences.

Subjects

A total of 135 consumers (93 men and 42 women, $M_{age} = 39.6 \pm 13.5$) took part in Study 1. Prior to the actual study, all participants filled out a questionnaire where they provided information about their demographics and other background characteristics of interest. *Product knowledge* was measured as cumulative score of nine different measures: two Likert items about self-perceived knowledge of beer (*I know a lot about beer, I can easily name and recognize several beer types*), four Likert items related to product involvement (*I am very interested in beer, I often try new beers, I like to take part in beer-related events, I would like to know more about beer*), rated on a 9 points agree-disagree scale. Three measures of consumption frequency (drinking frequency, intake during a typical drinking event, number of different beers consumed per month) were given as multiple choice questions. The degree to which the chosen set of items could be used as a uni-dimensional construct for product knowledge was assessed by computing Cronbach's alpha, which indicated very high reliability ($\alpha = .90$[1]).

Variety seeking with respect to food was operationalized using two well-known psychometric tools. The first is the variety seeking scale (VARSEEK, van Trijp & Steenkamp, 1992), a measure developed specifically for measuring consumers' variety seeking tendency with respect to food. There are eight items constituting this scale, administered as Likert statements. The second is the food neophobia scale (FNS, Pliner & Hobden, 1992). The FNS is a validated paper and pencil measure of the food neophobia trait, consisting of 10 Likert items on which a mean score is calculated (for some of the items the score is reversed).

Subjects signed a declaration that they would not drive right after the test. At the end of the tasting, they were provided with tickets to return home by public transportation. Each of them also received a bottle of premium beer as reward for participating (retail value ≈ 6 €). As further incentive, subjects' names were placed in a lottery to win a gift card (retail value ≈ 150 €). The study was not found to require formal ethical approval by the Danish National Committee on Health Research Ethics.

Experimental procedure

The beer tasting was carried out at central location test facility where approximately 15 consumers per session tasted and evaluated the eight samples one at a time (monadic presentation).

The beer samples were served in 28 cl clear glasses, blind labeled with a 3 digit randomized number. Serving order was randomized to balance for first order and presentation biases (Macfie, Bratchell, Greenhoff, & Vallis, 1989). The serving temperature was 10°C. Water and soda crackers were served as palate cleansers between samples. Each consumer was served approximately 50 ml of each sample, and was instructed to smell, taste and swallow the sample at least once to get the full perception of the beer.

Each beer was evaluated on a separate evaluation sheet, and participants were instructed not to look at their previous scores. Consumers rated liking on a 15 point hedonic scale with the following semantic anchors: 1 = Dislike extremely, 8 = Neither like nor dislike, 15 = Like extremely. Ratings of novelty, familiarity and complexity were elicited via Likert items (*I think the taste of this beer is familiar/novel/complex*) and also scored on 15 point scales (*1 = Completely disagree, 8 = Neutral, 15 = Completely agree*).

Data analysis

A preliminary one-way analysis of variance (ANOVA) was carried out to detect significant difference between the products with regard to the perceived level of all rated properties, using the samples as fixed factors. Tukey's multiple comparison tests

[1] Calculated on available data from all consumers that expressed interest in participating ($N = 305$), not only on those that were later invited to the actual study.

($\alpha = .05$) were carried out to determine significantly different product pairs.

The contributions of the three collative properties to hedonic response (H_1) were explored by nonlinear mixed effect analysis using the *R* package *nlme* (Pinheiro & Bates, 2000) in the *R* language for statistical computing (R Development Core Team, 2011). In particular, the hypothesized curvilinear relationships were assessed by fitting the data to a second degree polynomial regression which included random intercepts for individual beer samples:

$$L_{ij} = \alpha_{0i} + \beta_1 \cdot N_{ij} + \beta_2 \cdot N_{ij}^2 + \beta_3 \cdot F_{ij} + \beta_4 \cdot F_{ij}^2 + \beta_5 \cdot C_{ij} + \beta_6 \cdot C_{ij}^2 + e_{ij};$$

$$\alpha_{0i} = \gamma_{00} + \delta_{0i}; \quad i = 1, \ldots, 8; \quad j = 1, \ldots 135$$

where *L* is the response variable (liking), α_{0i} the intercept (where γ_{00} is the average outcome and δ_{0i} the sample specific-specific effect), $\beta_1, \ldots, \beta_6$ the regression parameters, *N, F, C* the three explanatory variables (novelty, familiarity, complexity), and *e* is the error. *P*-values for regression coefficients were obtained by likelihood ratio tests of the full model with the effect in question against the model without said effect. A backward stepwise model reduction was performed, and the model with the minimum Aikake Information Criterion (AIC) value was eventually retained for interpretation. Marginal and conditional R^2 values for the final model were calculated according to the method described by Nakagawa and Schielzeth (2013).

As a supplement to the regression analysis, each individual response variable was plotted against liking for visual assessment. To ease the interpretation of their relationships, we computed smoothing points using robust locally weighted regression (LOWESS, Cleveland, 1979), a smoothing procedure which accommodates the data for which $y_i = g(x_i) + e_i$, where *g* is a smooth function and the e_i are random variables with mean 0 and constant scale, so that y_i is an estimate of $g(x_i)$. The procedure is "robust" in the sense that it guards against deviant points distorting the smoothed points. This analysis was also carried out in *R* using the routine "lowess", whose complete algorithm is described in Cleveland (1979).

The remaining hypotheses – concerning the effect of product knowledge (H_{2a} and H_{2b}), variety seeking (H_{3a}) and neophobia (H_{3b}) – were tested using ANOVA. To this end, consumers were divided into subgroups according to their level in each of these consumer characteristics. Using the median as divide, each of the three consumer variables was transformed into a categorical variable with two possible levels (Low and High). For each individual response variable, a four-way ANOVA model was computed including the following factors: samples, Product Knowledge, Variety seeking, Neophobia and their two-way interactions with samples.

Results and discussion

Significant differences among the beers were found for all rated properties (Liking: $F_{(7,1072)} = 37.83$, $P < .001$, $\eta_p^2 = .19$; Familiarity: $F_{(7,1072)} = 45.49$, $P < .001$, $\eta_p^2 = .23$; Novelty: $F_{(7,1072)} = 26.72$, $P < .001$, $\eta_p^2 = .15$; Complexity: $F_{(7,1072)} = 42.89$, $P < .001$, $\eta_p^2 = .22$). Descriptive statistics and pairwise comparisons are shown in Table 2.

Table 2
Mean overall ratings (± standard deviation) for liking and collative properties (Study 1). Samples are sorted in descending order of liking. Different superscript letters indicate significant differences (Tukey $P < .05$).

Sample	Liking	Familiarity	Novelty	Complexity
Stjernebryg	10.6^{a} (±3.8)	$8.3^{c,d}$ (±4.0)	9.7^{a} (±3.2)	11.2^{a} (±2.2)
Enebær Stout	10.1^{a} (±3.4)	$9.8^{a,b}$ (±3.6)	7.4^{c} (±3.3)	9.6^{b} (±3.1)
Bøgebryg	9.9^{a} (±3.6)	$9.1^{b,c}$ (±3.9)	$8.0^{b,c}$ (±3.2)	9.3^{b} (±2.7)
Valnød Hertug	9.8^{a} (±3.3)	$7.7^{c,d}$ (±4.0)	$8.7^{a,b,c}$ (±3.8)	9.0^{b} (±2.9)
Fynsk Forår	9.3^{a} (±3.5)	7.1^{d} (±3.9)	$9.0^{a,b}$ (±3.3)	7.7^{c} (±3.1)
Thy Pilsner	6.6^{b} (±3.3)	10.6^{a} (±4.0)	4.8^{d} (±3.6)	5.5^{d} (±3.2)
Pine	6.4^{b} (±4.0)	5.1^{e} (±3.3)	9.8^{a} (±4.4)	7.8^{b} (±3.9)
Sea-buckthorn	6.1^{b} (±3.3)	4.1^{e} (±3.6)	$8.6^{a,b,c}$ (±3.7)	7.1^{c} (±3.2)

Relationship between collative properties and hedonic response (Regression analysis)

Continuing with the previous notation, the regression equation for predicting the hedonic response – obtained after the AIC-based model reduction – was the following:

$$L_{ij} = \beta_1 \cdot N_{ij} - \beta_2 \cdot N_{ij}^2 + \beta_3 \cdot F_{ij} + \beta_5 \cdot C_{ij}$$

Visual inspection of residual plots did not reveal any obvious deviations from homoscedascity or normality. In the regression model obtained (Conditional $R^2 = .35$; $R^2 = .39$; *AIC*: 5440), all linear components of the collative properties significantly positively predicted liking ($b_{Complexity} = .41$, $t_{(1068)} = 12.29$, $P < .001$; $b_{Familiarity} = .34$, $t_{(1068)} = 12.67$, $P < .001$; $b_{Novelty} = .50$, $t_{(1068)} = 4.61$, $P < .001$). The fact that all linear predictors were highly significant is in line with the expected joint effect of familiarity and arousal in driving hedonic response.

Of the quadratic terms, only the one for perceived novelty was found to be significant, and marked a reversal in the directionality of the effect ($b = -.01$, $t_{(1068)} = -2.23$, $P = .02$). This indicates a curvilinear association (inverted U-shaped) between novelty and hedonic response consistent with our main hypothesis (H_1).

The smoothed scatterplots (Fig. 3) confirmed the indications of the regression analyses: hedonic response appears to be linear monotonic function of familiarity and complexity, whereas an inverse U shaped relationship characterizes its relationship with novelty, in further (partial) support of H_1.

Differences between consumer groups (ANOVA)

A significant main effect of product knowledge on familiarity ($F_{(1,848)} = 7.33$, $P = .007$, $\eta_p^2 = .01$), novelty ($F_{(1,848)} = 8.86$, $P = .003$, $\eta_p^2 = .01$), and complexity ($F_{(1,848)} = 4.57$, $P = .03$, $\eta_p^2 = .01$) was found. The direction of the effect was as hypothesized (H_{2a}): consumers with higher product knowledge rated the beers significantly more familiar ($M_{(High\_Knowledge)} = 8.15 > M_{(Low\_Knowledge)} = 7.48$, $P = .01$), less novel ($M_{(High\_Knowledge)} = 7.96 < M_{(Low\_Knowledge)} = 8.59$, $P = .005$), and less complex ($M_{(High\_Knowledge)} = 8.14 < M_{(Low\_Knowledge)} = 8.56$, $P = .04$).

Contrary to our expectations (H_{2b}), however, product knowledge did not significantly affect liking ($F_{(1,848)} = .22$, $P = .63$, $\eta_p^2 = 0$).

A main effect of variety seeking on liking was found ($F_{(1,848)} = 11.41$, $P < .001$, $\eta_p^2 = .01$). Consistently with hypothesis H_{3a}, high variety seeking consumers gave significantly higher overall liking ratings ($M_{(High\_VARSEEK)} = 8.89 > M_{(Low\_VARSEEK)} = 8.37$, $P = .04$).

However, no significant effect of degree of neophobia, and thus no support for H_{3b} was found.

No significant interactions effect were observed.

Study 2

One of the key findings of Study 1 was that perceived novelty was found to be in an inverse curvilinear relationship with liking, as predicted by Berlyne's theory. Nevertheless, the other variables expressing arousal potential, familiarity and complexity showed a linear relation with the hedonic response, which is contrary to Berlyne's theory. We interpreted this as an indication that the stimuli used in Study 1 did not sufficiently cover the arousal spectrum, and tried to replicate and expand the results with a new set of beers.

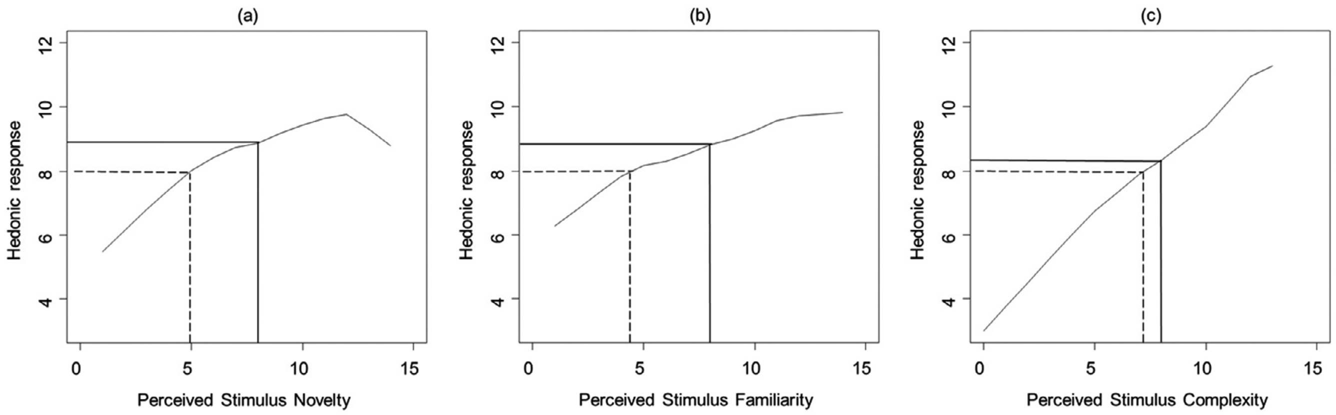

Fig. 3. Robust smoothed values of novelty (a), familiarity (b) and complexity (c) against liking (Study 1). Values at neutral points are also visible (dashed line = neutral point in the hedonic scale; solid line = neutral point in Likert scales for collative properties).

Materials and methods

Stimuli

Unlike in Study 1, the beers for this study were experimentally developed by adding different flavor extracts to two commercially available base beers: *Thy Pilsner* (the familiar lager used in Study 1) and a darker, more bitter lager (*Thy Classic*). After identifying optimal flavor concentrations, eight beers were selected as test stimuli as having very distinct sensory profiles (Table 3).

Subjects

A total of 122 consumers (76 men and 46 women, $M_{age} = 42 \pm 15.9$) took part in the study. Recruiting procedures were in all aspects similar to Study 1. Product knowledge and variety seeking tendency were collected with the same measures used in Study 1. However, only product knowledge and variety seeking tendency were collected from this population. Since no effect was observed in Study 1, it was chosen not to use the food neophobia scale further.

Experimental procedures

Serving size, order, temperature and general testing procedures mirrored those used in Study 1. As in the first study, consumers were asked to give hedonic ratings – on a 15 point hedonic scale – and again gave their ratings for perceived *novelty*, *familiarity* and *complexity*. Additionally, the second study expanded our understanding of the meaning of collative properties by measuring other relevant attributes – *surprisingness*, *typicality*, *traditionality*, *stimulatingness* and *confusingness*. The latter were selected among those terms used to define arousal-inducing properties by Berlyne (1967), and because they had been used in previous food studies trying to characterize novelty and complexity as bundle of separate impressions (Lévy et al., 2006; Sulmont-Rossé et al., 2008). They were given as Likert items (e.g. *This beer tastes familiar*) and rated on a 15 point scale with labeled anchors (*Completely disagree – Neutral – Completely agree*). The order in which the attributes appeared on the ballot was randomized across consumers.

Data analysis

The data analytical approach was the same as in Study 1. Additionally, relationships between liking and other variables were elucidated by principal component analysis (PCA) run on a 976×9 matrix crossing individual consumers and their ratings on all measured properties. Data were mean centered column-wise and scaled to unit variance prior to the PCA computation.

Results and discussion

Significant between-sample differences for all response variables were found (Liking: $F_{(7,968)} = 2.84$, $P = .006$, $\eta_p^2 = .02$; Familiarity: $F_{(7,968)} = 25.98$, $P < .001$. $\eta_p^2 = .16$; Novelty: $F_{(7,968)} = 21.85$, $P < .001$, $\eta_p^2 = .14$; Complexity: $F_{(7,968)} = 16.82$, $P < .001$, $\eta_p^2 = .11$). Post hoc testing was carried out to elucidate pairwise differences (Table 4).

Relationship between collative properties and hedonic response (regression analysis)

The reduced regression model (Marginal $R^2 = .26$, Conditional $R^2 = .27$, *AIC*: 5061.30) obtained is shown below:

$$L_{ij} = \beta_1 \cdot N_{ij} - \beta_2 \cdot N_{ij}^2 + \beta_3 \cdot F_{ij} - \beta_4 \cdot F_{ij}^2 + \beta_5 \cdot C_{ij}$$

Table 3
Beers used as test stimuli in Study 2. ABV was 4.6% in all samples.

Beer name	Beer style	Flavoring added (product identifier)	Concentration	Sensory characteristic of the pure flavor
Thy Pilsner	Pale lager	(None – Reference 1)		–
Perilla	Flavored pale lager	Aromatic water obtained by steam distillation of *Perilla Frutescens* leaves	200 μl/100 ml	Fresh, pungent, bitter, chemesthetic, green, grassy, herbal, apple, acidic
Lemon Lime	Flavored pale lager	Lemon/lime[a] (QL34701)	2 μl/100 ml	Fresh, acidic, sharp
Star Anise	Flavored pale lager	Star Anise[a] (MS-027–152-5)	14 μl/100 ml	Fennel, licorice, tarragon
Thy Classic	Dark lager	(None – Reference 1)		–
Juniper	Flavored dark lager	Juniper berry oil[a] (UJ-740-714-0)	6 μl/100 ml	Spicy, gin, pine, green, fresh, sharp, citrus
Wormwood	Flavored dark lager	Wormwood oil[a] (XR-936-574-1)	20 μl/100 ml	Tart, bitter, wry, acidic, herbal
Rum cocktail	Flavored dark lager	Rum flavor[a] (NN07414)	15 μl/100 ml	Alcoholic, harsh
		Blackberry[a] (059141)	10 μl/100 ml	Sweet, tart, bitter
		Sage[a] (L-059142)	2 μl/100 ml	Herbal, earthy, savory

[a] Givaudan S. A., Vernier, Switzerland.

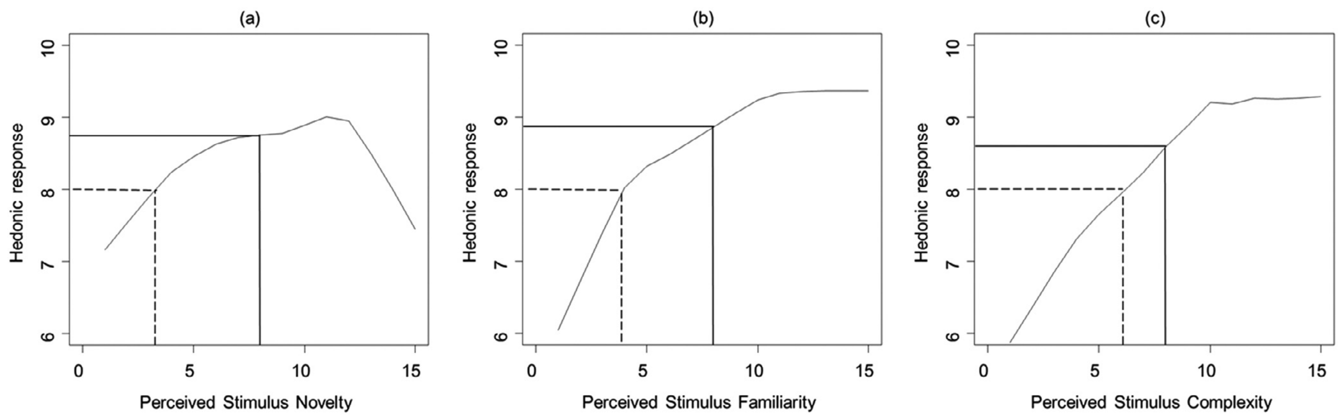

Fig. 4. Robust smoothed values of novelty (a), familiarity (b) and complexity (c) against liking (Study 2). Values at neutral points are also visible (dashed line = neutral point in the hedonic scale; solid line = neutral point in Likert scales for collative properties).

Again, a significant and positive linear relationship between liking and perceived novelty ($b = .40$, $t_{(963)} = 3.42$, $P < .001$), familiarity ($b = .69$, $t_{(963)} = 5.89$, $P < .001$), and complexity ($b = .30$, $t_{(963)} = 8.87$, $P < .001$). These results are in agreement with those of Study 1, indicating that the three properties to a certain degree have an independent effect on consumer preferences, and that the best prediction is obtained when all are considered.

Again, a significant quadratic relationship with novelty in the expected direction was revealed ($b = -.01$, $t_{(963)} = -1.88$, $P = .06$). Importantly, a significant negative value for the familiarity quadratic regressor ($b = -.02$, $t_{(963)} = -2.19$, $P = .03$) was found, suggesting a similar pattern as for novelty.

As in Study 1, the liking ratings were plotted against the collative properties after smoothing. Visual inspection of the curves (Fig. 4) shows some important indications, particularly in the light of Study 1 results (Fig. 3). With regard to novelty, the inverse U shaped trajectory, reaching an optimum at around 10 points, is in good agreement with the findings of Study 1. Familiarity and complexity, however, did not show the linear relationship seen in the first study, but rather saturation curves. This suggests the possibility that a quadratic relationship in Berlyne's terms might have been observed, but that, unlike for novelty, a higher "rejection threshold" is needed for these two collative properties.

Interrelationships between response variables (PCA)

Relationships between all response variables were further explored by PCA. Figure 5 shows the contrast between the groups of variables based on the structure of the PCA loadings. The high percentage of variance explained (especially considering the matrix size) by the first two principal components indicates a strong underlying structure in the data.

Table 4
Mean overall ratings (± standard deviation) for liking and collative properties (Study 2). Samples are sorted in descending order of liking. Different superscript letters indicate significant differences (Tukey $P < .05$).

Sample	Liking	Familiarity	Novelty	Complexity
Lemon Lime	9.0^{a} (±4.0)	7.7^{c,d} (±4.0)	8.2^{b} (±4.5)	8.3^{b,c} (±3.8)
Juniper	8.9^{a} (±3.4)	7.3^{c} (±3.9)	7.8^{b,c} (±3.9)	8.8^{a,b} (±3.4)
Thy Pilsner	8.8^{a} (±3.0)	10.9^{a} (±3.4)	4.1^{e} (±3.2)	5.2^{e} (±3.2)
Rum Cocktail	8.6^{a,b} (±4.0)	5.3^{e} (±3.9)	9.6^{a} (±4.3)	9.3^{a} (±3.5)
Thy Classic	8.4^{a,b} (±3.6)	8.6^{b} (±3.7)	6.2^{d} (±3.7)	7.8^{c} (±3.5)
Star Anise	7.8^{b,c} (±3.8)	5.3^{e} (±4.1)	9.4^{a} (±4.8)	8.6^{a,b} (±3.8)
Wormwood	7.6^{c} (±4.0)	6.6^{d,e} (±4.2)	8.1^{b} (±4.5)	8.7^{a,b} (±3.6)
Perilla	7.6^{c} (±3.7)	7.0^{c,d} (±4.4)	7.1^{c} (±4.6)	7.0^{d} (±3.9)

The first principal component appeared to rank properties by arousal potential as it separated (in order of correlation strength with PC1) *surprisingness* ($r = .88$, $P < .001$), *novelty* ($r = .82$, $P < .001$), *confusingness* ($r = .66$, $P < .001$), and *complexity* ($r = .61$, $P < .001$), from *traditionality* ($r = -.88$, $P < .001$), *familiarity* ($r = -.87$, $P < .001$), and *typicality* ($r = -.86$, $P < .001$). The second component described variation in liking ratings ($r = .88$, $P < .001$) and the attribute *stimulating* ($r = .90$, $P < .001$). Hedonic response thus appeared uncorrelated to either familiarity or arousal, suggesting the possibility of curvilinear patterns in line with those revealed by the regression analysis for familiarity and novelty.

The fact that the PCA plot clearly showed familiarity to be opposed to novelty and complexity is interesting, since regression results showed that, individually, each of these properties was in a positive linear relationship with hedonic response. This may indicate that familiarity, on one side, and arousing properties (e.g. novelty and complexity), on the other, could exert a suppressing effect on each other in their joint contribution to hedonic response, providing additional (indirect) support to H_1.

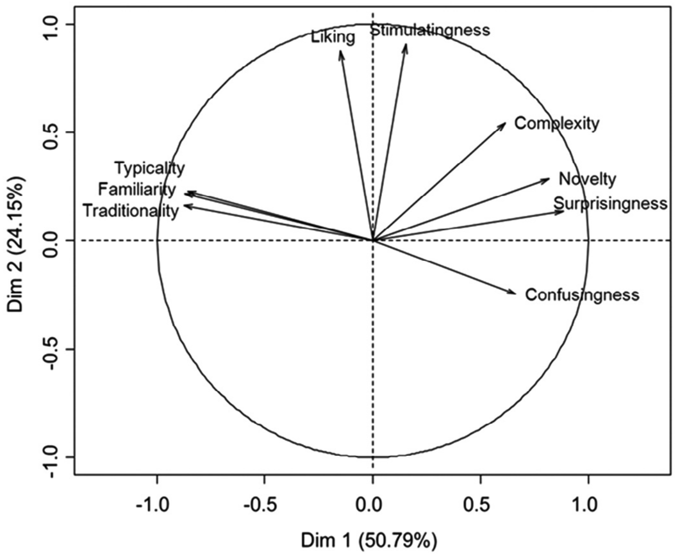

Fig. 5. PCA loadings for liking and collative properties on the first two PCA dimensions.

Table 5
Beers used as test stimuli in Study 3. ABV was 4.6% in all samples.

Beer name	Beer style	Flavoring added (product identifier)	Concentration	Sensory characteristic of the pure flavor
Thy Pilsner	Pale lager	(None – Reference)		–
Cherry	Flavored pale lager	Cherry flavor[a] (10133-33)[a]	4 μl/100 ml	Fruity, sweet
Lemon Lime	Flavored pale lager	Lemon/lime[a] (QL34701)	2 μl/100 ml	Fresh, acidic, sharp
Hop Golding	Flavored pale lager	Hop Golding[a] (L-032083)	14 μl/100 ml	Mild, Classic English hop aroma
Yumberry/Sake	Flavored pale lager	Sake[a] (L-58162)	6 μl/100 ml	Sake (sweet, acidic)
		Yumberry[a] (073728)	6 μl/100 ml	Yumberry (berry, grapefruit)
Abbey	Flavored pale lager	Abbey flavor[a] (L-035410)	30 μl/100 ml	(Multicomponent mixture) Fruity, peppery aroma
Stout	Flavored pale lager	Stout flavor[a] (L-032095)	200 μl/100 ml	(Multicomponent mixture) Roasted malt, coffee
Wheat	Flavored pale lager	Wheat flavor[a] (L020658)	300 μl/100 ml	(Multicomponent mixture) Phenolic, yeasty

[a] Givaudan S. A., Vernier, Switzerland.

PCA also showed that novelty was correlated with properties having both positive (e.g. surprisingness) and negative valence (e.g. confusingness), which confirm the twofold nature of this collative property, providing a semantic substantiation to the curvilinear effect uncovered by the regression analyses. Perceived *familiarity* was, as expected, strongly associated with *traditionality* and *typicality*, indicating that familiarity in response to flavors corresponds to prototypicality or "goodness of example" in a given product category, in agreement with results obtained from visual stimuli (Blijlevens et al., 2012a; Hekkert et al., 2003).

Differences between consumers groups (ANOVA)

With regard to the role of product knowledge, ANOVA results showed a significant effect of product knowledge on all three collative properties (Familiarity: $F_{(1,576)} = 6.78$, $P = .009$, $\eta_p^2 = .01$; Novelty: $F_{(1,576)} = 14.34$, $P < .001$, $\eta_p^2 = .02$; Complexity: $F_{(1,576)} = 15.12$, $P = .001$, $\eta_p^2 = .03$). As expected, knowledgeable consumers perceived the beers as significantly less novel ($M_{(High\_Knowledge)} = 6.67 < M_{(Low\_Knowldge)} = 8.13$, $P < .001$) and complex ($M_{(High\_Knowledge)} = 7.17 < M_{(Low\_Knowledge)} = 8.31$, $P < .001$), and more familiar ($M_{(High\_Knowledge)} = 7.89 > M_{(Low\_Knowledge)} = 6.99$, $P = .01$). These results are fully consistent with the findings of the first study and support our hypothesis H_{2a}.

However, like in Study 1, no main effect of product knowledge on liking ($F_{(1,576)} = 2.34$, $P = .12$, $\eta_p^2 = 0$), and thus no support to H_{2b}, could be found.

The effect of variety seeking on liking observed in Study 1 could not be replicated here ($F_{(1,576)} = .001$, $P = .93$, $\eta_p^2 = 0$), with high and low variety seekers having a nearly identical mean hedonic response ($M_{(High\ VARSEEK)} = 8.39$; $M_{(Low\ VARSEEK)} = 8.40$).

No significant interactions of either product knowledge or variety seeking with samples were observed.

Study 3

A last study with a new set of beer samples was carried out to confirm the quadratic relationship of novelty with hedonic response.

Materials and methods

Stimuli

Eight beers were used as test stimuli. As in Study 2, the beers were experimentally developed by adding different flavors to two commercially available pale lager which served as base beer (Table 5).

Subjects

A total of 103 consumers (76 men and 27 women, $M_{age} = 39.9 \pm 14.6$) took part in Study 3. Recruiting procedures were in all aspects similar to the previous studies.

Experimental procedures

Serving size, order, temperature and tasting procedures were the same as in the previous two studies. In this study consumers were divided into two groups, for which two slightly different ballots were used. One group ($N = 52$) only rated liking and novelty for the beer samples, using the same 15 point scales used in the previous two studies. The other group ($N = 51$) rated liking, novelty and also a set of other variables including collative properties and food related emotions (see Giacalone, 2013 for details). In the context of the present work, only ratings of liking and novelty across groups are considered (no significant between-group differences on either novelty or liking were found). The purpose was to confirm the results obtained in the previous two studies concerning the relationships between perceived novelty and hedonic response.

Data analysis

As in the previous two studies, we used a nonlinear mixed effect model to study the relationship between perceived novelty and hedonic response. The model in this case included only one independent variable (novelty), and again, we added intercepts for different samples as random effects, i.e.

$$L_{ij} = \alpha_{0i} + \beta_1 \cdot N_{ij} + \beta_2 \cdot N_{ij}^2 + e_{ij}; \quad i = 1, \ldots, 8; \quad j = 1, \ldots, 103$$

where L is the response variable (liking), α is the intercept, β_1 and β_2 the regression parameters, N and N^2 the explanatory variables (perceived novelty, linear and quadratic), and e is the error.

Relationship between novelty and hedonic response

In accordance with the previous results, the model (Marginal $R^2 = .03$, Conditional $R^2 = .08$; *AIC*: 4389.97) showed that novelty significantly predicted liking ($b = .38$, $t_{(814)} = 3.18$, $P = .001$), and its quadratic term (N^2) corresponded to a negative slope in the regression line ($b = -.01$, $t_{(814)} = -2.07$, $P = .04$). Again, regression results were supplemented with a visual assessment of the scatterplot smoothed by locally weighted regression. Figure 6 below shows the regression line fitted through the smoothed points, whose curvilinear shape confirmed quite decidedly the findings of the two earlier studies.

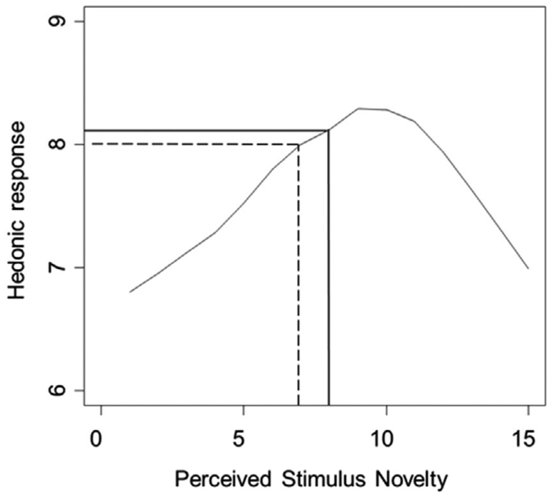

Fig. 6. Robust smoothed values of novelty against liking (Study 3). Values at neutral points are also visible (dashed line = neutral point in the hedonic scale; solid line = neutral point in Likert scale for Novelty).

General discussion

Collative-motivational model: predictive of consumer flavor preferences?

The present research tested Berlyne's collative-motivational model as a framework for predicting consumers' hedonic response to flavor stimuli. Our working hypothesis stated that preference would arise from the combined effect of novelty, familiarity and complexity (H_1), and that the relationship between arousal potential and hedonic response would take the shape of an inverted U.

The results of the first two studies revealed that all measured properties – novelty, familiarity and complexity – had a significant positive effect on hedonic response. The observed negative correlations found between arousing properties (novelty and complexity) and familiarity suggests that they exert an independent effect on hedonic response, mirroring previous findings obtained with visual stimuli (Blijlevens et al., 2012a; Hekkert et al., 2003). These results are in line with the theoretical assumption that flavor preferences are driven by a concurrent need for consistency (preference for familiar stimuli) and a need for stimulation (preference for novel/complex stimuli), and seem to overall support H_1. However, the results also suggested that increasing levels of perceived novelty may be the main determinant of the downward shift in hedonic response, more than complexity as previously hypothesized (Lévy et al., 2006). This was consistently revealed in all three studies by looking at changes in effect direction the significant effect of novelty's quadratic term on hedonic ratings. The expected inverse U shape was not so pronounced, showing that for every change in novelty, liking decreased less after the optimum than it increased before the optimum. This is consistent with the fact that the primary aversion system has a much higher activation threshold than the primary reward system, implying that only very high arousal levels decrease hedonic appraisal (Berlyne, 1967).

The reasons why the same curvilinear relationship was not observed for the other two collative properties – complexity in particular – needs further examination. The most immediate explanation is that for these two properties we failed in spanning the spectrum sufficiently enough to activate the minimum rejection threshold.

However, competing explanations could be brought forth. Complexity, as discussed in the introduction, is related to the perception of many independent components in a stimulus (Berlyne, 1960, 1963, 1967). Its status as arousal inducing property, however, might depend not only on the detectability of individual elements, but also on whether these elements co-exists or conflicts, *viz*. their degree of harmony or congruity. In our studies, even though large inter-sample differences were observed for perceived complexity, it is possible that the samples were still perceived as not incongruent or disharmonic enough to drive hedonic response toward the uncomfortable range where one would reject the stimulus. The apparent lack of correlation between perceived complexity and confusingness (Fig. 5) supports this interpretation. Furthermore, the use of a realistic beverage (instead of an artificial stimulus) might have had a mitigating effect on these less desirable aspects of complexity.

An alternative explanation, of a different nature, is that a context effect might have been responsible for a shift in complexity tolerance. In a recent article, Pocheptsova, Labroo, and Dhar (2010) found that in the context of special occasion products, the task difficulty increases the attractiveness of a product, masking the normal aversion for difficulty. It seems plausible that such masking effect could have been at play in our studies, as participants were informed that they would taste and evaluate "experimental beers". This might have had an impact especially on novice consumers, e.g. causing them to suppress their initial hedonic appraisal (e.g. a preference for simple and familiar flavors) and adopt a more analytical evaluation mode.

For familiarity, the possibility of a limited sample range could be more plausible because it is very hard to create extremely unfamiliar samples for a very familiar product category, such as beer. This is consistent with the idea that evaluation stimulus collative properties are mediated by categorical processing of the product being evaluated, confirming that the group of items to which a stimulus is related plays an important role in hedonic evaluation. As previous studies have indicated, product category can mask the full spectrum, causing familiarity in everyday products to be linearly related to liking (Blijlevens et al., 2012a; Hekkert et al., 2003; Veryzer & Hutchinson, 1998; Whitfield, 1983), whereas conversely, Berlyne's predictions are better observable when abstract stimuli are evaluated. Finding a curvilinear relationship clearly depends on the range of the perceived inter-product differences; thus, a study spanning over more samples or even product categories might have revealed such curvilinear effect of familiarity more pronouncedly, as suggested by Study 2 where indeed a significant quadratic effect was observed. In general, research specifically addressing the masking effect of familiar product category would be an important continuation of the present work.

A few reflections on the practical implications of these findings could be brought forth, particularly with regard to product innovation in the commercial food and beverage industry (but also in other product categories where perception in the chemical senses is important, like perfumery), traditionally experiencing a very high rate of failure for new products (Stewart-Knox & Mitchell, 2003). This research shows that there is an optimal level of "newness" in a flavor stimulus and that hedonic appraisal is maximized in products that deliver moderate novelty (inverted U-shaped relationship). This is in general agreement with previous claims that consumers prefer novel flavors, provided that they are able to relate them to something familiar (Mielby & Frøst, 2010; Tuorila, Meiselman, Cardello, & Lesher, 1998). From a product development perspective, it is important to observe that the imperfect correlation between novelty and familiarity leaves out a ratio of *unshared* variance where product manipulation can occur (Hekkert et al., 2003). For example, an immediately applicable strategy would be relating perceived novelty with physico-chemical composition of the product, and/or with data from a sensory panel. Knowledge of such relationships could then be used to guide flavor optimization toward the identified novelty optimum, thus reducing the risk of consumers' rejection.

Effect of consumers' individual characteristics

Two of the studies also tested hypotheses concerning the role of specific personal characteristics – product knowledge, variety seeking and neophobia – in shaping hedonic response and perception of collative properties.

Based on the mere exposure effect, we hypothesized that knowledgeable consumers would report a lower perceived novelty and complexity, and a higher familiarity (H_{2a}). Evidence in support of this hypothesis was obtained in studies 1 and 2. These results are concordant with previous experiments where product knowledge was directly manipulated through exposure (Lévy et al., 2006; Sulmont-Rossé et al., 2008), and in line with the predictions of the pacer-theory (Dember & Earl, 1957). Results are also in accordance with the expectation that higher product expertise reduces the cognitive effort for decoding a stimulus and allows for an easier categorization (Alba & Hutchinson, 1987; Sujan, 1985).

Another hypothesis was that consumers with high product knowledge would have a higher optimum stimulation level and thus exhibit higher liking ratings (H_{2b}). In the presented studies, product knowledge was not found to have an effect on preference, thus no support for H_{2b} could be found. However, alternative explanations for the null results should not be ruled out. These include limits of the experimental design (e.g. the product range), but also a number of masking factors, both physiological and psychological, that could have been at play to alter preference formation. For example, e.g. sensory acuity of the tasters was found in a previous study to be a more important factor than knowledge alone in explaining flavor preferences (Frøst & Noble, 2002). Additionally, psychological variables such as thinking styles (e.g. holistic versus analytical), which are also known to affect novelty acceptance independently of other factors, might account for the lack of difference in liking ratings between knowledgeable versus novice consumers.

The last two hypotheses related to whether an individual's intrinsic desire for variety would influence the optimal level of arousal and consequently affect hedonic ratings. A significant effect of the variety seeking level in the predicted direction (H_{3a}) was found in Study 1, but the same could not be replicated in Study 2. Level of neophobia was considered in the first study only, revealing no effect on hedonic response, contrary to our hypothesis (H_{3b}).

Overall, these results suggest that product knowledge has implications for flavor perception, whereas variety seeking might have an effect, but not that it certainly will. In general, it seems that the variety seeking and neophobia constructs may be more relevant for other aspects of the product experience, such as actual product choice, than flavor perception *per se*.

Limitations and future research

This study is not without limitations, the first of which is that all the presented studies were conducted with the same product, beer, as test stimulus, and therefore cross-product studies are warranted to ensure that results can indeed be generalized over food product categories.

Furthermore, in this work, we have limited our focus to consumers' responses to flavor. A few remarks are due concerning the degree to which results can be translated to overt behavior (e.g. actual product choice). The flavor of a food is a major component in the experienced quality and is considered the most important driver of repeated purchasing (Bruhn, 2008). Nevertheless, since consumers do not (ordinarily) have the possibility to taste food products before purchase, it follows that in pre-purchase stages, the product appearance will be the key factor upon which consumers will form their expectations, including evaluations about the perceived novelty and other collative properties (Mugge & Schoormans, 2012; see also Garber, Hyatt, & Starr, 2000 for an example of how the color of food packaging color serves as a powerful cue for conferring novelty to food products). Previous research has shown that the relative importance of different sensory modalities changes across stages of product usage (Fenko, Schifferstein, & Hekkert, 2010), and thus the significance of the results cannot be generalized, beyond actual product tasting, to other aspects of product–user interactions.

Furthermore, experimental design limited the interactions between individuals, to maximize subjects' focus on their own flavor perception. This obviously differs from a natural consumption situation, particularly one with social interactions. It is important to stress this aspect, since it is known that social interactions (implicit and explicit) influence both variety seeking and preference, as demonstrated (incidentally, in a study also using beer as stimuli) by Ariely and Levav (2000).

Finally, it should be noted that all three studies were conducted at the same testing facility and with nearly identical experimental procedures. Contextual factors have been long known to have important implications for consumer behavior (Belk, 1975). The relevance for the present discussion is that situational factors have been suggested to exert a moderating effect on the perceived typicality and novelty of a product (Bloch, 1995), and recent results appear to support that claim (Blijlevens, Gemser, & Mugge, 2012b). Systematic investigations of contextual aspects would constitute a promising continuation of the present research and contribute to a deeper integration of the collative-motivational model with general (consumer) behavior theory.

Conclusions

To conclude, the main contribution of this research has been to test a theory of aesthetic preferences – Berlyne's collative motivational model – for predicting consumers' hedonic response to flavors in a realistic beverage. Overall, the obtained results suggest an independent effect of familiarity and arousal on determining hedonic response, in line with the theory's prediction. Empirical evidence for an inverted U-shaped relationship between perceived stimulus novelty and liking was consistently gathered across all studies. The other two collative properties examined, familiarity and complexity, appeared to be more linearly related to hedonic response. One of the studies showed a significant curvilinear relationship with familiarity and suggested that a similar pattern might have been observed with increasing levels of complexity. A number of moderating factors have been discussed as potentially explaining the higher rejection threshold for these two properties, and future research on the topic is warranted. At last, the moderating role of three relevant consumer characteristics – product knowledge, variety seeking and food neophobia – was investigated. A significant main effect of product knowledge on all collative properties was established, but not on hedonic response, possibly indicating that sensory characteristics in this case were more important. No conclusive evidence concerning the effect of variety seeking and neophobia was obtained. Results of one study suggest that these personal characteristics may affect flavor perception, but the possibility of a spurious effect should be ruled out by future research more explicitly addressing the issue.

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