Liking and exposure

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Liking and exposure: first, second and tenth time around

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Abstract

The future liking may be poorly predicted from hedonic ratings in first exposure. The stability of hedonic ratings as a function of differences in number of exposures was studied. 80 subjects (70 females; age 17-59 years, mean 25.5, minimum 17, maximum 59, standard deviation 6.7 years) performed hedonic rating of 9 different stimuli (vanilla flavored yogurts), all of which were different in sensory properties. Yogurts varied systematically in three experimental factors: total protein, sugar and vanilla flavor concentration. In first exposure yogurts high in sweetness and with low vanilla intensity were rated as most liked. Subjects were divided in two equal groups of 40 persons and exposed to the stimuli different numbers of times: two and ten. There were no significant differences in changes of liking ratings between the two groups. Results indicate that liking of yogurts, traditionally eaten for breakfast in Denmark, measured by groups is relatively stable over exposures. However, summarizing results over groups covers that there are large individual differences in changes of liking ratings. 11.6% of the 720 analyzed changes in liking ratings were larger that 7.5 cm, corresponding to half the size of the scale.

Keywords

Hedonic rating; Liking; Exposure; Vanilla yogurt

Introduction

Hedonic judgments can be performed by a number of different methodologies. Hedonic ratings provide measurements of subjects' or consumers' liking for a product. This can be performed using either a continuous line scale with appropriate anchors at specific points on the scale, or by hedonic categorization, where each possible category is labeled by a word or a phrase (e.g. like very much etc.). The liking of a food product based on a single exposure is often used as a decision tool in product development. However, some research indicates that future liking and final choice is not well predicted in first exposure. The stability of food preferences over a number of sessions is low. It has been found that on average one third of subjects changed their preference in a repeated exposure [1]. Köster and colleagues have discussed and explored stability of preferences in a number of experiments. Their finding led them to suggest that the repeatability of hedonic methods rather should be judged on basis of the stability of the change in preference of different, but comparable populations, rather than on the reliability of repeated measurements in the same population [2].

A number of different psychological theories attempt to explain changes in preference and choice behavior. Köster and colleagues [2] briefly reviewed a number of contributions in the field. Several theories have been suggested, among them, 'Mere exposure theory' [3, 4] which predicts that experience with stimuli leads to increased liking for them. The explanation for the increased liking is 'Dissipation of Neophobia' (fear of novel stimuli or experiences). This would lead to a general increase in hedonic ratings for all products after some exposures. Another theory is 'Optimal Arousal Theory'[5], which predicts that experience with stimuli lead to either increased or decreased liking. The outcome depends on how high the arousal potential of the initial experience is compared to a person's optimal arousal level. A high arousal potential will lead to increased liking, and low arousal potential will lead to decreased liking. Furthermore, 'Pacer' theory [6] predicts that

people learn to appreciate more complex stimuli during experience. Exposure to stimuli which are slightly more complex than optimal leads to an increase in the person's optimal arousal level.

Another factor influencing changes in and liking and food choice is variety-seeking behavior, *i.e.* people have an intrinsic desire to choose other products after having tried one. It has been found that variety-seeking is product specific. It is more likely to occur for products where a relatively large number of well-liked alternatives are available [7]. Furthermore, variety-seeking tendencies are positively affected by consumers' degree of involvement with the product category [7]. Differences in variety-seeking behavior may also differ between different types of meals, and consequently then also for different meal components. Variety-seeking in breakfast meals may very well be lower than other meals.

With this in mind we set out to explore changes in hedonic ratings in two similar groups of subjects, which were exposed to the same samples (vanilla flavored yogurt) a different number of times. In Denmark yogurts are usually consumed as part of the breakfast. In connection with a study to investigate how naïve subjects perceive *'Creaminess'* in vanilla flavored yogurts, we also asked subjects to rate their liking of the vanilla yogurts in different experimental sessions. Two groups of subject were formed. Both groups performed hedonic ratings of vanilla yogurts in an initial session (session 1). One group subsequently performed rating of *'Creaminess'* under different conditions in 8 more sessions over the following 15 days, and finally performed hedonic ratings in a tenth session 16 days after the initial hedonic rating session. The results from the *'Creaminess'* study will not be reported here. Another group did not take part in the *'Creaminess'* study, and returned only once for a second hedonic rating session, 17 days after their initial hedonic rating session. The set-up

allows comparison of differences in hedonic ratings of the two groups as a function of number of exposures (either two or ten times) to samples.

Materials and Methods

Samples – Vanilla flavored yogurts

Nine vanilla flavored stirred yogurts were produced in a 2x2x2 factorial design and a center sample. The following three factors were varied in the design: total protein, sugar and vanilla flavor. Table 1 lists the factors and their levels, together with abbreviations for vanilla yogurts applied throughout the text. Three different levels of a microparticulated whey protein concentrate (Arla Foods Ingredients, Nr. Vium, Denmark) to different levels of total protein were added. Sweetness was varied by adding three different levels of food grade Sucrose. Vanilla intensity vas varied by adding three different levels of a vanilla flavor (Symrise #225 340). The fat level of all yogurts was 0.3% milk fat. The yogurts were produced according to standard methods for manufacture of stirred yogurt (blending, pre-pasteurization (65°C), homogenization (200bar), pasteurization (95°C for 5 min), cooling (42°C), inoculation (YC-183, Chr. Hansen A/S, Denmark), incubation (below pH value 4.6), cooling (22°C), mixing, filling and final cooling (below 10°C)). The fermentation conditions were kept constant (final pH value 4.10-4.30). All yogurts were stored at 4°C for 6-10 days before sensory tests.

Table 1. Samples: Vanilla flavored yoghurts. Abbreviations used in the text. Levels of experimentally varied factors.

Product abbreviation	Total protein content w/w (%)	Added sugar content w/w (%)	Added Vanilla Flavour level g / kg
A-P1-S1-F1	4.80	4	0.15 (low)
B-P1-S1-F3	4.80	4	1.5 (high)
C-P1-S3-F1	4.80	6	0.15 (low)
D-P1-S3-F3	4.80	6	1.5 (high)
E-P2-S2-F2	5.10	5	0.825 (medium)
F-P3-S1-F1	5.40	4	0.15 (low)
G-P3-S1-F3	5.40	4	1.5 (high)
H-P3-S3-F1	5.40	6	0.15 (low)
I-P3-S3-F3	5.40	6	1.5 (high)

Naïve subjects

80 subjects (70 females; age 17-59 years, mean 25.5, minimum 17, maximum 59, standard deviation 6.7 years) were recruited among students and employees at the Royal Veterinary and Agricultural University. Subjects were divided into two equal groups of 40 persons before exposure to yoghurt samples.

Descriptive analysis

Sensory descriptive analysis was performed under normal lighting with yoghurt (approx. 100 ml) in transparent containers with lids. A panel consisting of 10 external paid panelists was used for the evaluation. All panelists had passed screening tests according to ISO-standards [8], and had

previous experience with sensory evaluation. Sensory sessions took place in the sensory laboratory at the Royal Veterinary and Agricultural University, which comply with international standards for test rooms [9]. In three training sessions panelists were trained on the products, and descriptors were chosen after suggestions from the panel leader on the basis of consensus among the panelists. Each training session lasted approximately one and a half hour (In the third training session panelists evaluated a subset of the samples for sensory evaluation in the sensory evaluation booths). A total of 19 descriptors were used for the descriptive analysis. Those are listed in Table 2, together with definitions by reference material and original Danish terms. The use and definition of the meta-descriptor '*Creaminess*' was allowed to be individual for each panelist, as part of the scope of the experiment was to investigate what '*Creaminess*' consists of. During the first training session, panelists were instructed that they should use their own definitions for '*Creaminess*' in their evaluation of the products.

Panelists rated descriptors on a horizontal 15 cm unstructured line scale. For the majority of the descriptors, scales were anchored at the left end with "a little" (in Danish: "lidt") and at the right end with "a lot" or (Danish: "meget"). A few descriptors were anchored differently. Oral viscosity and Viscosity by spoon were anchored with "thin" and "thick (Danish: "tynd" and "tyk" respectively). Breakdown was anchored with "slow" and "fast" (Danish: "langsom" and "hurtig" respectively). Descriptive analysis was performed in triplicate over three separate sessions, and in randomized order within each replicate. All samples were kept at 13°C for one hour before sensory sessions. Samples were served only one sample at a time to panelists and were taken out less than 1 minute before serving. For all evaluation sessions a computerized score collection software (FIZZ, Biosystemes, France) was used.

Table 2: Sensory descriptors: applied abbreviations, definition by reference material, and original words in Danish

Descriptors (abbreviations in plots)	**Definition (reference, if any)**	**Original terms in Danish**
Appearance		
White		Hvid farve
Yellow		Gul farve
Grainy		Grynethed
Flavour (Retronasal aroma and basic tastes)		
Vanilla	One vanilla pod in 0.5 L in yogurt*	Vanille
Coconut	Drops of coconut essence in yogurt*	Kokosnød
Caramel	Drops of caramel essence in yogurt*	Karamel
Yogurt	Plain Yogurt*	Yoghurt
Cream	18% fat cream (Arla Foods, Denmark)	Fløde
Sour		Sur
Sweet		Sød
Texture and mouth feel		
Floury	Table spoon wheat flour in 0.5 L yogurt*	Melet
Oral viscosity (O-Viscosity)		Viskositet i mund
Smoothness		Glathed
Breakdown	Rate of breakdown of yogurt in mouth	Nedsmeltning
Astringent		Astringerende
Fatty after mouth feel (Fatty-AMF)	Rated after expectoration	Fedtet eftermundfylde
Dry after mouth feel (Dry-AMF)	Rated after expectoration	Tør eftermundfylde
Manipulation by hand		
Viscosity by spoon (Sp-Viscosity)	Stir spoon in yogurt with hand and evaluate resistance	Viskositet med ske
Metadescriptor		
Creaminess		Cremethed

* All yogurts for reference materials was 1.5% fat un-homogenized plain stirred yogurt from Thise Dairy, Roslev Denmark.

Hedonic rating

In groups of 10 persons, all naïve subjects performed the test in the sensory laboratory at the Royal Veterinary and Agricultural University. Tests were performed under normal lighting with yogurt (approx. 100 ml) in non-transparent containers with lids. Samples were marked by three digit

random numbers. Subjects removed the lid before tasting, and consumed the yogurts through a 12 mm plastic straw. Subjects marked their liking rating on a 15 cm continuous scale with three verbal anchors at different positions (1; 7.5; 14 cm) on the scale. Anchors were ’don’t like at all (kan slet ikke lide)’; ‘neither like nor dislike (kan hverken lide eller ikke lide)’; ’like really well (kan lide rigtig godt)’. Serving order of the 9 samples was balanced over subjects, and for each individual was reversed in their second liking rating session compared to first session. All samples were kept at 13°C for one hour before sensory sessions. Samples were served only one sample at a time to panelists and were taken out less than 1 minute before serving. For all evaluation sessions a computerized score collection software (FIZZ, Biosystemes, France) was used.

Statistical analysis of data

Data from descriptive analysis was analyzed by analysis of variance and multivariate data analysis (ANOVA-Partial Lest Squares Regression (ANOVA-PLSR)). Mixed model ANOVA for individual descriptors was performed with products (n=9) as fixed factors and panelists (n=10) as random factors. This method is commonly applied for data from descriptive analysis [10]. ANOVA-PLSR is a multivariate regression method where the effect of design factors on the response variables (here: the sensory descriptors) is evaluated [11, 12]. The method avoids multicollinearity problems by modeling latent variables representing the main variance common for the variables. The method evaluates effects of the experimental design variables on sensory properties. Here it is used as a graphical alternative to ANOVA. Mean ratings over panelists from each replicate was used for ANOVA-PLSR. For multivariate analyses cross validation was performed, leaving out one replicate at a time [13]. Jack-knifing with replicates served as the validation tool for all multivariate analysis, comparing the perturbed model parameter estimates from cross-validation with the estimates for the full model [14].

Liking ratings were analyzed by analysis of variance, using yogurts and exposure group as fixed factors. Between-subjects effects were nested in exposure groups, and treated in mixed model analysis of variance. Individual changes as a function of exposure was performed by analyzing differences in liking between first and second exposure and first and tenth exposure for the two groups respectively. 95% confidence intervals were calculated for mean liking ratings for all products, groups and exposures.

Results

Descriptive analysis

Analysis of variance showed that 18 of 19 descriptors varied significantly over samples. Table 3 list mean ratings for these, together with confidence intervals of mean values. ANOVA-PLSR showed, as expected, that three latent variables span the systematic sensory variance in the yogurts. Figure 1 is correlation loading plots, showing variable correlations for the two first latent variables. The main variance (first and second latent variables) is a combination of Protein level and Sugar level. The third latent variable (not shown) mainly relates to vanilla flavor. The effect of experimental design variables on the sensory properties was not straight-forward. The effect of sugar was not only on 'Sweetness'. The viscosity of the samples decreased slightly as a function of increased sugar level, while the 'Smoothness' level, 'Breakdown' rate, and 'Vanilla' increased (confer table 3). Furthermore, increase in protein level not only increased the viscosity, but also decreased the 'Smoothness' and 'Breakdown', and increased 'Floury' and 'Grainy'. Increases in vanilla flavor concentration not only increased 'Vanilla' intensity but also affected the 'Sweetness' positively. Although the effect of the experimental design variables on sensory properties was not straight-forward, the sensory properties were systematically related to the samples design. The Jack-knife perturbation and estimation of model parameter stability showed that all the 9 samples where

1 Table 3: Mean values (over panellists and replicates), Confidence Intervals (CI) values (P<0.05) for all samples and significant descriptors.

Products	Appearance			Flavour					
	White	Yellow	Grainy	Vanilla	Caramel	Yogurt	Cream	Sour	Sweet
A-P1-S1-F1	12.1	2.9	4.3	4.4	2.8	9.4	3.9	9.1	5.8
B-P1-S1-F3	10.0	4.8	2.5	7.4	5.9	7.4	4.6	9.1	7.8
C-P1-S3-F1	11.5	2.8	2.9	6.3	5.6	7.1	4.7	6.4	10.6
D-P1-S3-F3	9.5	5.5	2.9	9.5	7.5	5.2	5.1	6.1	11.4
E-P2-S2-F2	10.6	3.8	7.6	6.8	6.1	6.6	4.8	7.9	7.6
F-P3-S1-F1	10.1	4.6	8.4	4.6	3.4	8.7	4.0	8.1	6.1
G-P3-S1-F3	8.5	6.4	8.9	7.1	5.3	7.7	4.6	8.5	7.0
H-P3-S3-F1	10.9	3.2	5.5	6.8	6.2	5.8	5.7	5.5	10.9
I-P3-S3-F3	7.9	7.4	8.9	9.8	7.1	5.0	6.1	4.6	11.9
95% CI	0.7	0.7	0.9	1.3	1.3	1.0	0.8	1.0	1.0

2

3 Table 3 continued

Products	Texture and Mouth feel							Manipulation by hand	Meta-descriptor
	Floury	O-Viscosity	Smoothness	Breakdown	Astringent	Fatty-AMF	Dry-AMF	Spoon-Viscosity	Creaminess
A-P1-S1-F1	4.5	8.5	8.7	8.0	7.9	4.7	8.6	9.4	6.9
B-P1-S1-F3	3.8	6.8	8.4	9.0	7.7	4.2	9.4	8.2	7.2
C-P1-S3-F1	2.2	7.0	11.3	9.4	5.9	6.2	7.3	8.3	8.7
D-P1-S3-F3	3.1	5.9	11.1	10.2	5.2	5.4	6.3	6.8	8.4
E-P2-S2-F2	3.9	10.6	8.3	5.5	6.4	7.4	6.6	11.2	9.0
F-P3-S1-F1	5.3	10.9	6.3	5.6	7.2	6.4	7.0	11.1	7.3
G-P3-S1-F3	5.6	12.2	7.1	4.6	6.6	8.3	6.2	11.6	9.1
H-P3-S3-F1	3.2	9.7	10.2	7.3	6.6	7.6	6.5	10.4	10.8
I-P3-S3-F3	3.7	10.0	9.6	6.4	4.5	8.0	4.7	10.7	10.8
95% CI	0.9	0.9	1.0	1.0	1.0	1.1	1.2	0.8	1.0

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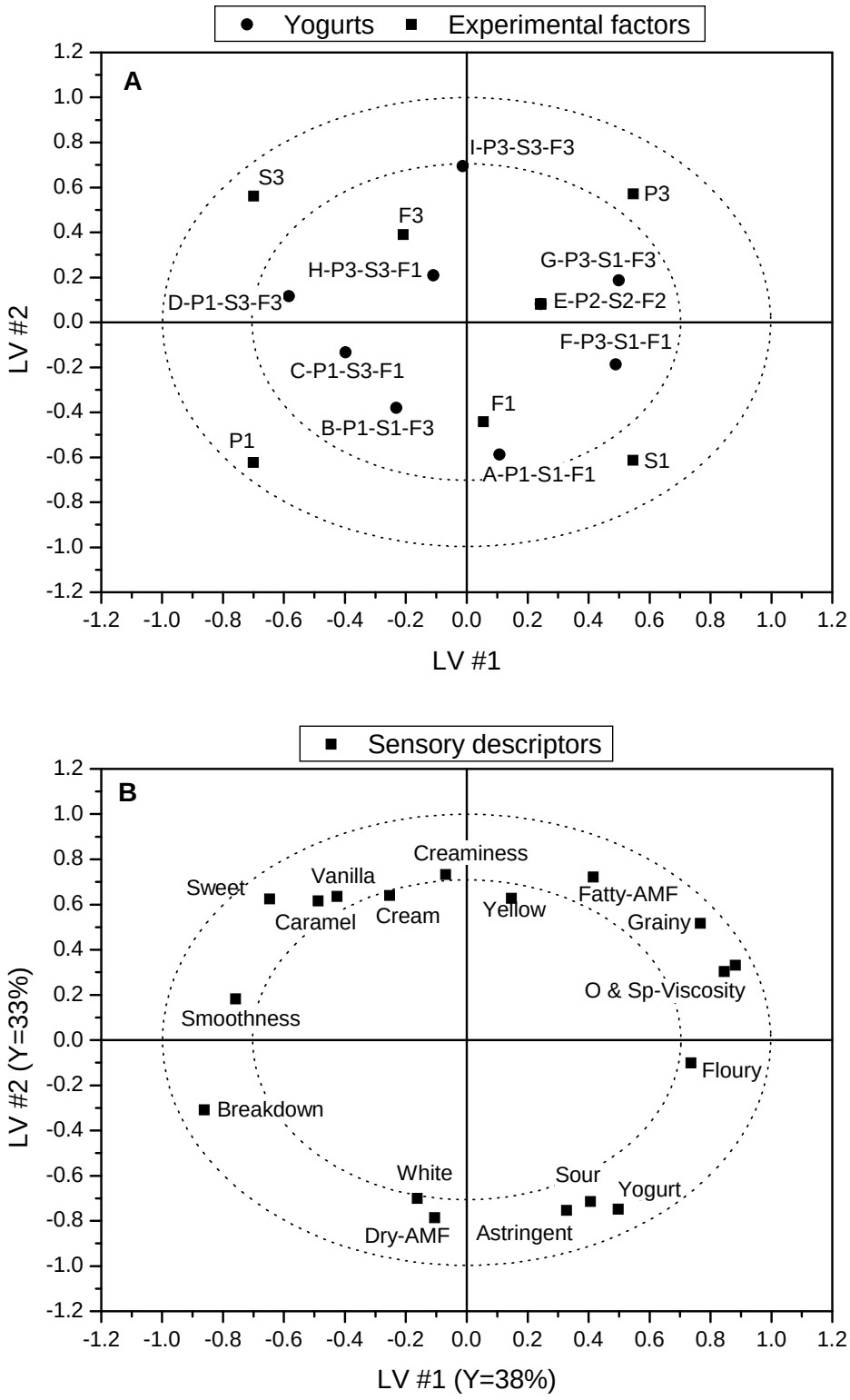

Figure 1 ANOVA-PLSR correlation loading plots for latent variables 1 and 2. A: Samples and experimental design variables. B: Sensory descriptors. The inner and outer circles represent 50% and 100% explained variance, respectively.

unique and significantly different in their sensory properties (confer also table 3 for mean ratings for all descriptors). Thus, the descriptive analysis demonstrated and explained the effects of experimental factors on sensory properties.

Hedonic ratings

Figure 2 show mean ratings for samples averaged over groups of subjects in the first exposure.

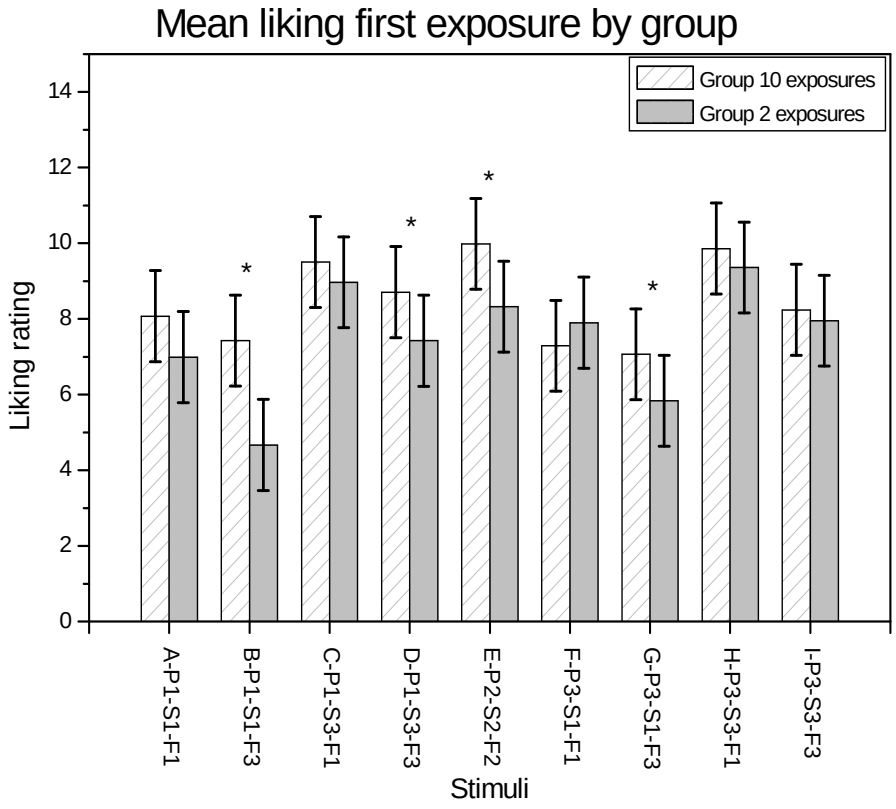

Figure 2 Mean liking ratings in first exposure averaged over the exposure groups of 40 subjects. Error bars indicate 95% confidence intervals. Samples with * are significantly different in liking rating between the two groups (95% confidence intervals).

Analysis of variance showed that there were significant differences in liking ratings for the 9 vanilla flavored yogurts ($F(8, 624) = 11{,}68$, $p<0.0001$). The pattern of liking as a function of the experimentally varied factors is highly systematic. Yogurts H-P3-S3-F1, C-P1-S3-F1, and E-P2-S2-P2 were liked best by the subjects, *i.e.* the sweetest products with low vanilla flavor intensity were liked most, together with the center sample. Slightly less liked were samples I-P3-S3-F3, D-P1-S3-F3, F-P3-S1-F1, and A-P1-S1-F1, showing that a combination of high sweetness and high vanilla flavor intensity, or low sweetness and low flavor intensity were liked equally. The least liked products were B-P1-S1-F3 and G-P3-S1-F3, showing that a combination of low sweetness and high vanilla flavor intensity was not appreciated as much. There were no differences in liking as a function of protein level. It should be noticed that there was a nearly-significant difference in liking ratings between the two exposure groups ($F(1, 78) = 3.28$, $p=0.076$), as well as a nearly significant Yogurt*Exposure group interaction ($F(8, 624) = 1.75$, $p=0.084$. Estimates of covariance parameters show that the Subject(Exposure group) variance (4.69) was relatively large compared to the residual variance (10.32). With the least conservative estimate of significant differences between samples (CI 95%), differences in liking ratings for 4 samples (B-P1-S1-F3, D-P1-S3-F3, E-P2-S2-F2, G-P3-S1-F3) were observed. For all these samples liking ratings were lower in the two exposures group. Explanations for these minor group differences can only be speculative. Sessions for the two groups took place on two consecutive days. Still, all samples served on those two days were produced in the same batches and all test procedures were exactly the same.

Analysis of variance of changes in liking ratings between first and last exposure showed a significant effect of samples ($F(8, 624) = 2.58$, $p=0.009$), but no effect of number of exposures ($F(1, 78) = 0.73$, $p=0.40$), and no Yogurt*Exposure group interaction ($F(8, 624) = 1.44$, $p=0.18$)

Estimates of covariance parameters show that the Subject(Exposure group) variance (2.04) was relatively small compared to the residual variance (21.15). Figure 3 show differences in ratings averaged over the two groups. Two yogurts had a significant increase in liking rating in the second exposure group: B-P1-S3-F1, and C-P1-S1-F3. B-P1-S3-F1 was exceptionally low rated in the first exposure by the two exposures groups, which can partly explain the large increase to the second rating. Stimuli I-P3-S3-F3 was the only one rated significantly higher in the last exposure by the ten exposures group. The overall effect of eight more exposures on liking ratings is not significant for these two groups of 40 subjects.

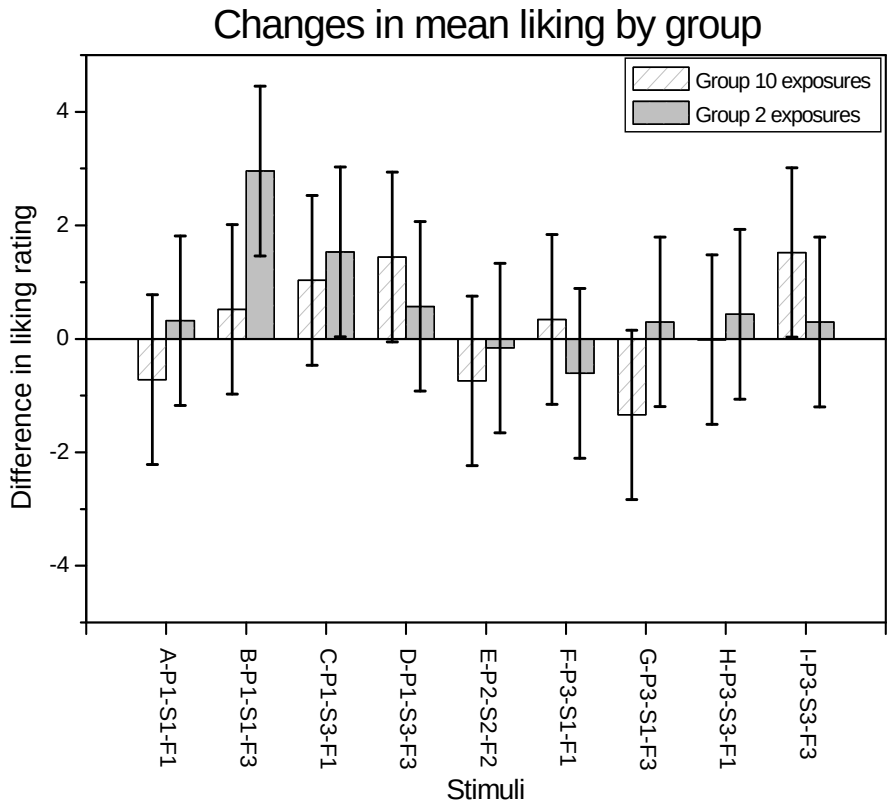

Figure 3 Mean differences in liking rating between exposures by exposure groups (40 subjects each). Differences are calculated as last minus first exposure, so positive differences indicate increases in liking ratings. Error bars show 95% confidence intervals.

However, reporting group results cover that there were large individual differences in changes in likings. Careful scrutiny of changes in liking ratings showed a wide and random distribution. For 11.6% of the 720 observations of changes in liking rating the differences were larger than 7.5 cm, corresponding to more than half of the total scale length. Analysis of variance showed a highly significant Exposure*Subject interaction ($F(78, 624) = 1.87$, $p<0.0005$). This interaction effect indeed underlines individual differences abundant in changes of liking as a function of exposure.

Discussion

The results show that for these systematically varied vanilla yogurts with this population the most liked ones were the sweet ones with low vanilla flavor intensity, irrespective of viscosity level. It is not an unusual observation that in a group of products, the sweeter ones receive best liking ratings. This allows the conclusion that even though it is a convenience sample of subjects, they were not unrepresentative in their liking rating patterns. The close to significant difference between the two exposure groups in their first liking ratings was unexpected and unfortunate. No evident reason for the difference in liking ratings between the two groups can be found. The lack of significance in changes of liking rating between the two groups in their last exposure indicates that stability of liking is high, even over a relatively high number of exposures. However, the interaction effect between exposure and subjects in changes of liking ratings show that a substantial number of ratings were highly unstable. This may be caused by individual differences in variety-seeking tendencies among subjects. Still, the overall liking ratings did not change significantly from first to last exposure by groups. The results indicate that liking for yogurt may be relatively stable. In Denmark yogurts are mainly consumed for breakfast. Variety-seeking behavior is likely not as pronounced in breakfast meals, as they are with foods intended for consumption at other times of the day (lunch, dinner, snacks etc.). Variety-seeking is generally expected to be low for breakfasts,

as captured by the following quote: “After all at breakfast many high variety seekers eat the same things every morning and at dinner even the lowest variety seekers almost never eat the same things every day [9]”. In the current experiment liking ratings were measured in laboratory settings in order to control unwanted effects of the environment. However, the measurements may not be particularly predictive of behavior in more natural settings. More research will be needed to answer questions about stability of liking ratings for meal components in more complex and ecologically valid meal situations.

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