Food Quality and Preference 63 (2018) xxx–xxx

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Hedonic contrast effects in multi-product food evaluations differing in complexity

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ARTICLE INFO

Keywords:
Contrast effect
Hedonic testing
Multi-products

ABSTRACT

To satisfy budgetary requirements there is often a need to test multiple flavored products at the same time, thereby inducing contrast effects to the research results. This paper discusses the results of a series of hedonic tests carried out at ACCE International, each involving multi-flavored product evaluations with a sequential monadic design, and representing five different food categories: soy beverages, cereals, potato chip snacks, dessert puddings and salad dressings. In order to investigate the hedonic contrast effect, products representing different levels and character of flavoring were tested together in one test in two possible configurations: plain with flavored products and flavored with flavored products. The authors found a negative contrast effect on sensory acceptability testing when plain and flavored products were tested in one session. Specifically, when a plain product was presented after a flavored product, the plain product received significantly lower acceptability ratings than when it was presented before the flavored product. A positive contrast effect was observed for the flavored product when it was presented after the plain product, resulting in an increased acceptability score for the flavored product however, the effect was small. When two flavored products were tested together the results were less consistent. One category (puddings) showed no contrast effect, whereas two other categories (chips and salad dressing) both displayed a negative contrast effect.

Emphasis is placed on the practical aspects of dealing with multi-flavor product testing including recommendations for test design optimization in commercial studies.

1. Introduction

Contrast effect is defined as a special case of context effect in which the perceived degree of difference between stimuli is exaggerated as a result of that relationship (ASTM International Standards Worldwide, 2017). Contrast effects have always been acknowledged in sensory product testing hence the implementation of sample balance and rotation (MacFie, Bratchell, Greenhoff, & Vallis, 1989; Wakeling & MacFie, 1995). Contrast effects have been reported in the literature for many different response types including perceived intensity (Lawless, Horne, & Spiers, 2000; Mattes & Lawless, 1985; Schifferstein & Frijters, 1992), sensory difference tests (Lee and O'Mahony, 2007), and odor evaluation (Madigan, Ehrlicman, & Borod, 1994). Researchers have shown that the perceived intensity of a stimulus may be rated as stronger in the context of weak stimuli and weaker in the context of strong stimuli. Hedonic judgments have been shown susceptible to contextual and sequential biases as well (Kamenetzky, 1959; Sakai, Kataoka, & Imada, 2001; Schifferstein, 1995; Schifferstein & Kuiper, 1997; Zellner, 2001; Zellner, Allen, Henley, & Parker, 2006; Zellner, Hoer, & Feldman, 2014). Stimuli were judged "less good" when they were presented after "better" context stimuli and judged better when they were presented after "not so good" stimuli. The former has been called a negative contrast whereas the latter a positive contrast (Parker, Bascom, Rabinovitz, & Zellner, 2008).

A number of theoretical models have been offered to explain how contextual stimuli and expectations affect product perception, namely: assimilation, contrast, general negativity and assimilation-contrast (Anderson, 1973; Cardello, 1994; Cardello & Sawyer, 1992; Carlsmith & Anderson, 1963; Deliza & Macfie, 1996; Zellner & Cobuzzi, 2008). Zellner (2001) has shown that hedonic contrast was observed when sensory or hedonic expectations were created by having consumers physically tasting context stimuli prior to a test stimulus, whereas assimilation was found in most studies in which sensory or hedonic expectations were created by product labelling or by giving verbal product information to the consumers prior to testing.

This research set out to better understand the contrast effects on hedonic judgments that occur when testing products representing different flavor variants for consumer acceptance in new product

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http://dx.doi.org/10.1016/j.foodqual.2017.06.016
Received 20 June 2016; Received in revised form 25 June 2017; Accepted 25 June 2017
Available online 27 June 2017
0950-3293/

development, reformulation and competitive benchmarking applications.

Testing multiple products and/or multiple flavor variants in the same test by the same respondents is not a preferred practice due to the possibility of altering product effects. However, the general understanding is that using a balanced design would compensate for these effects and this approach is a common practice due to budget and timing restrictions. Although many researchers have investigated and reported contrast effects, systematic consumer studies involving contrast effects in multiple food product evaluations across different product categories and representing different levels of flavor complexity are not reported in the literature. ACCE International fielded a series of five tests, each involving multi-flavored product evaluations for five different food categories (soy beverages, cereals, potato chip snacks, dessert puddings and salad dressings), in order to thoroughly understand the hedonic contrast effects induced in such tests. Products were tested together in one session in two configurations: plain with flavored products and flavored with flavored products. There were two products (A and B) within each flavor type (i.e. plain and/or flavored). For the purpose of this research the plain products were defined as having very little or no flavoring, and therefore displaying a rather plain, bland flavor profile. The flavored products were defined as having generally more flavoring and displaying a distinctive and generally more complex flavor profile. It was hypothesized that the plain with flavored configuration would give rise to significant contrast effects, while the flavored with flavored configuration would result in no contrast effects (Table 1).

2. Study objectives

The primary objective of this research was to investigate the contrast effects (Table 1) in multi-flavored sensory evaluations for five different food categories. The secondary objective was to explore the impact of flavor order on the overall difference between the two products tested for each flavor, in terms of direction and magnitude, based on overall liking scores. This information would be of great importance in a commercial multiple product test setting since it greatly influences both test designs and the conclusions drawn from such tests. The 9-point hedonic scale was selected to rate the overall acceptance of the test products. The overall liking measure is one of the most important components of sensory product testing to determine the hedonic status of a product when testing new product formulations, competitive assessments and benchmarking against historical consumer acceptance rating information for the product.

3. Materials and methods

3.1. Experimental design and procedure

The five tests were carried out at different times over a 3-year period by different groups of respondents (Tables 2a and 2b). For each of the 5 product categories, 200 respondents were recruited from a large respondent database, with a gender/age split typical for the categories. All respondents were regular users of the test products and flavors for the categories for which they were recruited.

Pre-recruited respondents were invited to participate in a Central Location Test (ACCE International, Mississauga, Canada) to evaluate 4 samples (two pairs) within a specific product category. All product categories included 2 product pairs. Each product pair included two products (A and B) for each of the two flavor types that were tested. Thus, the products in the pairs are always called product A and product B (Ref. Tables 3–5), regardless of the product category. Two pairs of products tested together represented either one pair of plain and flavored products (soy beverage, cereal, potato chip snack categories), or two pairs of one pair of flavored products (puddings and salad dressing categories). The test products for each category were pre-experimentally classified by sensory experts as different in terms of flavor palatability. For each category, the presentation of the products was rotated between the two pairs (i.e. plain and flavored or flavored and flavored) and within each pair (fully balanced). The products were presented blind (no brand identification) in a sequential, monadic design. Product evaluations for each category were completed in one day. Respondents tested all 4 products on the same day during a one hour session. Respondents were informed that they would be evaluating 4 products and the products were introduced in a generic way using the flavor names i.e. chocolate pudding, vanilla pudding etc. Respondents completed self-administered questionnaires and rated each product for overall liking and liking of other product attributes (n = 10–14 product attributes) using the 9-point structured hedonic scale with verbal labels (1 = dislike extremely, 9 = like extremely). To control for potential biases, the overall liking question was always asked at the beginning of the four questionnaires and prior to the attribute liking questions (Earthy, MacFie, & Duncan, 1997). Additionally, the balanced sample presentation order "equalized' potential bias of the attributes in the first order questionnaire. All data were collected electronically through ACCE's questionnaire software ACCE-IT™.

3.2. Data analysis

All analyses were conducted within each flavor pair, comparing the overall liking ratings for each product, when the flavor pair was presented in the first and second position.

Two-way analysis of variance (SAS 8, Proc. GLM) was used to determine the main effects of product (A vs. B), flavor order (i.e. first or second order), and interactions between product and flavor order, for each of the five product categories, based on the overall product ratings (Table 3).

To further examine the strength and consistency of contrast effects, mean overall liking ratings of the first and second order product scores were tested for difference depending on flavor order using one–way ANOVA (Tables 4 and 5).

4. Results

The results in Table 3 showed that for all product categories except for Soy Milk, the product main effect was significant for the plain and flavored product pairs. This result indicated that significant differences existed between product A and product B for all test flavors except the Vanilla Soy Beverage pair, regardless of the flavor order. The flavor presentation order main effect tested the difference between the first and the second order of presentation of the flavor pair. When considering the flavor order main effect for the cereal, soy beverage, and potato chip categories, there was always a significant effect for the plain flavor. This result indicated that for all three categories significant

Table 1
Summary of the hypothesized contrast effects for consideration in multi- flavored product evaluations.

Configuration	First Pair	Second Pair	Expectations	Contextual Effects/Bias
Flavored vs Plain	Flavored	Plain	Plain products will be rated much lower when seen after flavored ones	Contrast
Plain vs Flavored	Plain	Flavored	Flavored products will be rated much higher when seen after plain ones	Contrast
Flavored vs Flavored	Flavored	Flavored	No change in ratings	No contrast

Table 2a
Plain and flavored product pairs.

Category	Products/Flavors (two products for each flavor type)	Number of Respondents	Gender	Age Range (Years)
Cereal	Original (Plain) vs. Honey Nut	N = 200 users of Plain and Honey Nut breakfast cereal in the past 7 days	65% females 35% males	18–65
Soy Beverage	Original (Plain) vs. Vanilla	N = 200 users of Plain and Vanilla soy beverage (at least once every two weeks)	55% females 45% males	25–49
Potato Chip Snack	Original (Plain) vs. BBQ	N = 200 users of Plain/Regular and BBQ chip snacks in the past month	50% females 50% males	18–65

differences existed for the plain flavor ratings depending on whether it was presented in the first or second position. There was no significant flavor order effect for the flavored products in the plain-flavored configuration i.e. for Honey Nut cereal or BBQ potato chips, except for a marginally significant effect ($p \le 0.10$) for Vanilla Soy Milk. These results indicate that the order effect was more pronounced for the plain product pairs.

When considering the flavor order main effect for the flavored-flavored configuration (i.e. puddings and salad dressings), the results were less consistent. There was no significant flavor order effect for either vanilla or chocolate puddings in the pudding category, but there was a significant flavor order effect for the Caesar dressing products in the flavored-flavored configuration against the Italian dressing products.

There were no significant interaction effects ($p < 0.05$) between product and flavor order for any of the five categories tested, indicating that the comparative liking of the products within the flavor pair was consistent regardless of the flavor order.

To thoroughly investigate contrast effects, the first order product means were examined for both the flavor presentation orders: first and second (Tables 4 and 5). It was hypothesized that the first order product scores would show clean, unadulterated (by the product order) contextual effects depending on which flavor was presented first.

Table 4 shows the product overall liking ratings for the cereal and soy beverage products. For these products, plain versus flavored represented a relatively large distance on the flavor complexity continuum. Based on the first order product ratings, there was strong evidence for the emergence of a negative contrast effect for the plain products. This negative contrast effect was evident from significantly lower overall liking ratings for the plain products when these products were presented after flavored products (Table 4). For example, for the cereal category, when the plain product pair was presented before the Honey Nut flavored product pair, the first order overall liking rating for Product A was 6.58 and significantly lower (4.72) when it was presented immediately after the Honey Nut flavored pair of products (Fig. 1A). The decrease in overall liking ratings was also evident for the second order of product A however, the magnitude of the decrease was smaller. For example, the second order overall liking rating for Product A when it was presented before the Honey Nut flavored products was 6.06 and showed a significant decrease (5.26) when presented after the flavored products. The same pattern in acceptance changes was observed for the second product (Product B) for the cereal category, and for both plain products for the soy beverage pair (Figs. 1A and 2A).

A different pattern of changes in acceptance scores was observed for the flavored pair of products when they were tested with the plain products (Table 4, Honey Nut & Vanilla Pairs). The overall change in acceptance scores observed for both flavored products was generally much smaller than that for the plain products, and in the opposite direction i.e. the acceptance scores of the flavored products generally increased when they were presented after the plain products, thus showing a positive contrast effect. In most cases this increase was generally not significant, however the pattern was clear for both cereal and soy beverage categories (Figs. 1B and 2B).

Table 5 shows product overall liking ratings for the potato chip snack, salad dressings and pudding category. The potato chip snack category, for which the Regular and BBQ flavor pairs were tested together, was initially categorized as a plain-flavored configuration along with the cereal and soy beverage categories. However, the overall amount of the contrast effect induced for the original (plain) flavor was much smaller for this category than that observed for the soy beverage and cereal product tests (Fig. 3A). The Regular chips showed a much smaller decrease in acceptance when tested after BBQ flavored chips than that observed for both the plain beverage and cereal. The change in overall liking scores due to flavor order was significant for the first order product scores only, this was true for both products (A and B).

The BBQ flavored chips generally showed a slight increase in overall liking scores (except for the first order for product A) when they were presented after the Regular (plain) chips however as for all other categories, this change was not significant (Fig. 3B Table 5).

For the products selected from the salad dressing and pudding categories, the test flavors represented a smaller distance on the flavor complexity continuum than the flavors investigated for the products from the other three categories. The salad dressing product test with the Italian and Caesar flavor pairs showed a pattern of overall liking changes similar to that which occurred for the potato chip product test. Based on the first order product ratings, the Caesar dressings showed a significant decrease in overall liking when presented after the Italian products. For example, product A was rated 7.62 when the Caesar flavor was presented in the first order and received a significantly lower score of 6.58 when it was presented after the Italian flavor. Similar changes could be noticed for product B. The Italian salad dressings showed a small decrease in overall liking ratings when this flavor was presented in the second order (except for the second order of product A), after the Caesar dressing (Fig. 4A). These changes were not significant for both products A and B. For the pudding product test, the products received a small decrease in the overall liking ratings or showed a negligible increase when each flavor was presented in the second order, and the change was not significant (Figs. 5A and 5B).

The second objective of this study was to investigate the effect of the contrast on the direction and magnitude of the difference in overall liking ratings between the two test products within each product pair.

Table 2b
Flavored product pairs.

Category	Products/Flavors (two products for each flavor type)	Number of Respondents	Gender	Age Range (Years)
Salad Dressing	Caesar vs. Italian	N = 200 users of pourable salad dressings in the past 3 months	100% females	18–65
Pudding	Vanilla vs. Chocolate	N = 200 users of refrigerated RTE Vanilla & chocolate puddings (at least 2 times/month)	100% females	25–54

Table 3
P-values for product effect, flavor order effect & product * flavor interaction.

Category	Flavor Pairs	Product Main Effect (Product A vs Product B)		Flavor Order Main Effect (First vs Second Presentation Order)		Product * Flavor Order Interaction Effect	
		F-value	p-value	F-value	p-value	F-value	p-value
Cereal	Plain Pair	**13.08**	**<.001**	**66.1**	**<.001**	1.71	0.19
	Honey Nut Pair	**20.58**	**<.001**	1.99	0.16	1.22	0.27
Soya Beverage	Plain Pair	**27.95**	**<.001**	**90.15**	**<.001**	0.66	0.42
	Vanilla Pair	1.54	0.22	2.77	0.072	0.44	0.51
Potato Chip Snack	Plain Pair	**22.14**	**<.001**	**7.9**	**0.005**	0	0.95
	BBQ Pair	**32.34**	**<.001**	0.35	0.55	0.16	0.69
Salad Dressing	Caesar Pair	**110.86**	**<.001**	**5.17**	**0.018**	0.63	0.43
	Italian Pair	**18.69**	**<.001**	1.88	0.17	0.26	0.61
Pudding	Vanilla Pair	**19.67**	**<.001**	0.70	0.40	0.29	0.59
	Chocolate Pair	**8.06**	**0.005**	1.52	0.22	3.2	0.08

Table 4
Mean product acceptability scores when plain and flavored product pairs were presented in the first and second order, as well as the overall product ratings, pooled over product order and flavor order, for cereal and soy beverage categories.

Cereal Plain vs Honey Nut							
Product	Product Order	Plain Pair Scores			Honey Nut Pair Scores		
		Plain seen first	Plain seen second	Change due to flavor order	Honey Nut seen first	Honey Nut seen second	Change due to flavor order
Product A	Tried First	6.58 a	4.72 a	-1.86 s	7.40 a	7.60 a	0.20 ns
	Tried Second	6.06	5.26	-0.80 s	7.16	7.62	0.46 s
	Total	5.66 A			7.45 A		
Product B	Tried First	5.98 a	3.82 a	-2.16 s	7.06 a	7.04 b	-0.02 ns
	Tried Second	5.76	4.24	-1.52 s	6.60	6.70	0.10 ns
	Total	4.95 B			6.85 B		
Soy Beverage Plain vs Vanilla							
Product	Product Order	Plain Pair Scores			Vanilla Pair Scores		
		Plain seen first	Plain seen second	Change due to flavor order	Vanilla seen first	Vanilla seen second	Change due to flavor order
Product A	Tried First	7.34 a	5.16 a	-2.18 s	7.28 a	7.62 a	0.34 ns
	Tried Second	7.02	5.28	-1.74 s	5.52	5.56	0.04 ns
	Total	6.2 A			6.5 A		
Product B	Tried First	6.52 b	4.3 b	-2.22 s	6.96 a	7.34 a	0.38 ns
	Tried Second	5.52	4.44	-1.08 s	6.06	6.56	0.50 ns
	Total	5.20 B			6.73 A		

S indicates significantly different product scores ($p \leq 0.05$) due to flavor order (i.e. first and second order of flavor).
NS indicates not significantly different product scores ($p \leq 0.05$) due to flavor order (i.e. first and second order of flavor).
Means followed by different letters within each column (i.e. within flavor order) indicate a significant difference between product A and B, for the first order product means (lowercase) and total product means (uppercase) ($p \leq 0.05$).
N Tried First/Tried Second = 50.
N Total = 200.

The first order ratings (i.e. first order within product and flavor, n = 50) were compared with the overall ratings (n = 200) for product A and B in each product test, to examine if the magnitude and direction of the difference between two products changed due to product and flavor order. As expected, the total overall liking ratings for all products were lower than the first order ratings due to both product and flavor order. However, for all five categories the direction of the difference between each of the two test products within each pair was the same for the first order and total ratings. For example, for the cereal product test, the same conclusion as to which product was liked more, could be gained from the first order product ratings (product A = 6.58a and product B = 5.98a) as for the overall product ratings (product A = 5.66A vs. product B = 4.95B). Based on the first order product ratings product A was directionally better liked than product B.

Table 5
Mean product acceptability scores when product pairs were presented in the first and second position, as well as the overall product ratings, pooled over product order and flavor order, for the snack, salad dressings and dessert pudding categories.

Plain Chips vs. BBQ Chips							
		Original Pair			BBQ Pair		
Product	Product Order	Original seen first	Original seen second	Change due to flavor order	BBQ seen first	BBQ seen second	Change due to flavor order
Product A	Tried First	7.24 a	6.46 a	-0.78 s	7.80 a	7.64 a	-0.16 ns
	Tried Second	6.94	6.72	-022 ns	6.92	7.14	0.22 ns
	Total	6.84 A			7.38 A		
Product B	Tried First	6.62 b	5.80 a	-0.82 s	6.86 b	6.96 b	0.10 ns
	Tried Second	5.90	5.76	-0.14	6.02	6.22	0.20 ns
	Total	6.02 B			6.51 B		
Caesar Salad Dressing vs. Italian Salad Dressing							
		Caesar Salad Dressing Pair			Italian Salad Dressing Pair		
Product	Product Order	Caesar seen first	Caesar seen second	Change due to flavor order	Italian seen first	Italian seen second	Change due to flavor order
Product A	Tried First	7.62 a	6.58 a	-1.04 s	6.82 a	6.20 a	-062 ns
	Tried Second	6.82	7.26	0.44 ns	5.04	5.34	0.30 ns
	Total	7.07 A			5.85 B		
Product B	Tried First	6.28 b	5.08 b	-1.20 s	6.92 a	6.44 a	-0.48 ns
	Tried Second	4.22	4.18	-0.04 ns	6.74	6.52	-0.22 ns
	Total	4.94 B			6.66 A		
Vanilla Pudding vs. Chocolate Pudding							
		Vanilla Pudding Pair			Chocolate Pudding Pair		
Product	Product Order	Vanilla seen first	Vanilla seen second	Change due to flavor order	Chocolate seen first	Chocolate seen second	Change due to flavor order
Product A	Tried First	7.20 a	6.96 a	-0.24 ns	6.42 b	6.54 a	0.12 ns
	Tried Second	6.58	6.72	0.14 ns	6.26	6.32	0.06 ns
	Total	6.87 A			6.38 B		
Product B	Tried First	6.46 b	6.40 a	-0.06 ns	7.18 a	6.66 a	-0.52 s
	Tried Second	6.02	5.62	-0.40 ns	7.00	6.54	-0.46 ns
	Total	6.13 B			6.84 A		

S indicates significantly different product scores ($p \leq 0.05$) due to flavor order (i.e. first and second order of flavor).
NS indicates not significantly different product scores ($p \leq 0.05$) due to flavor order (i.e. first and second order of flavor).
Means followed by different letters within each column (i.e. within flavor order) indicate a significant difference between product A and B, for the first order product means (lowercase) and total product means (uppercase) ($p \leq 0.05$).
N Tried First/Tried Second = 50.
N Total = 200.

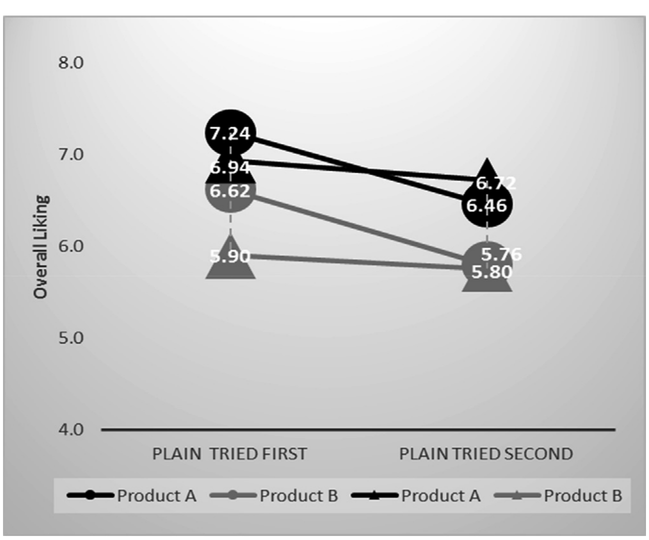

Fig. 1A. Plain Flavored Cereal Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

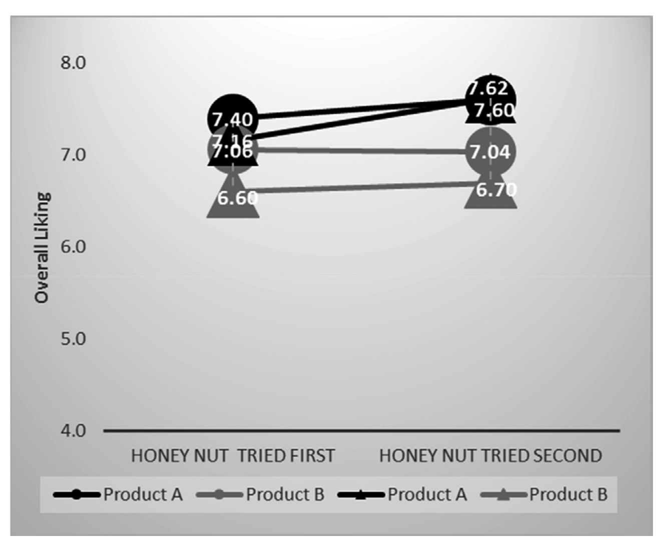

Fig. 1B. Honey Nut Flavored Cereal Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

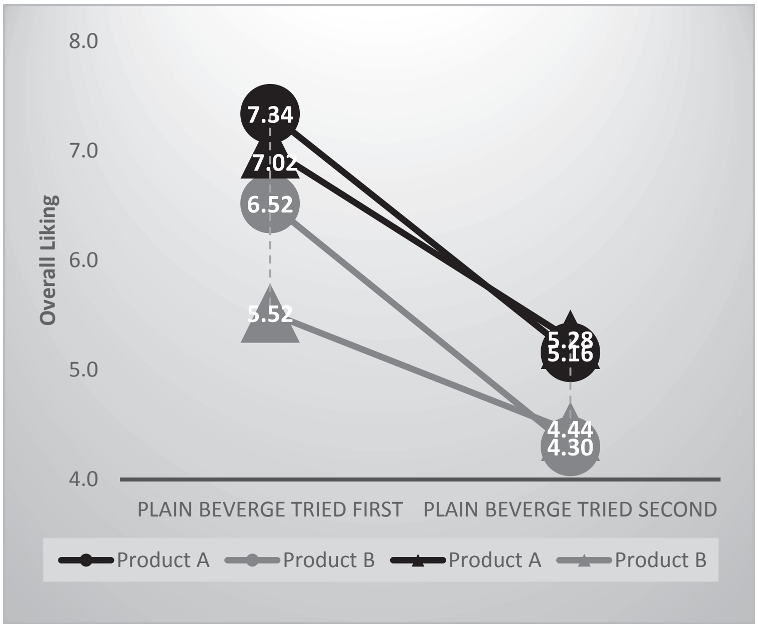

Fig. 2A. Plain Flavored Soy Beverage Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

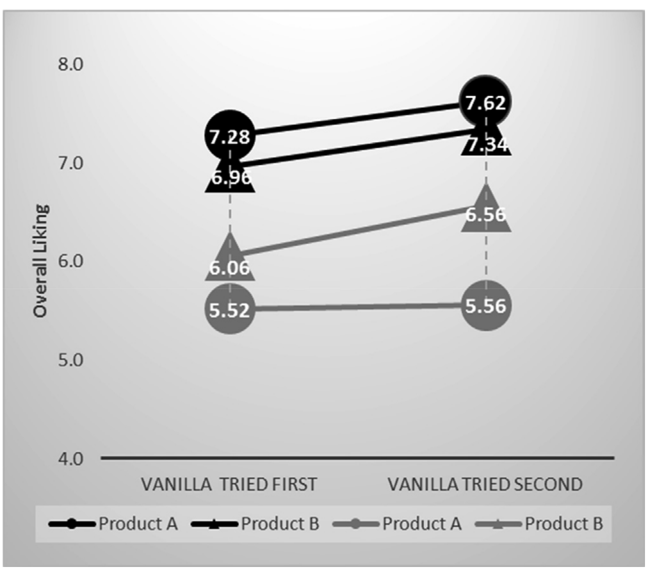

Fig. 2B. Vanilla Flavored Soy Beverage Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

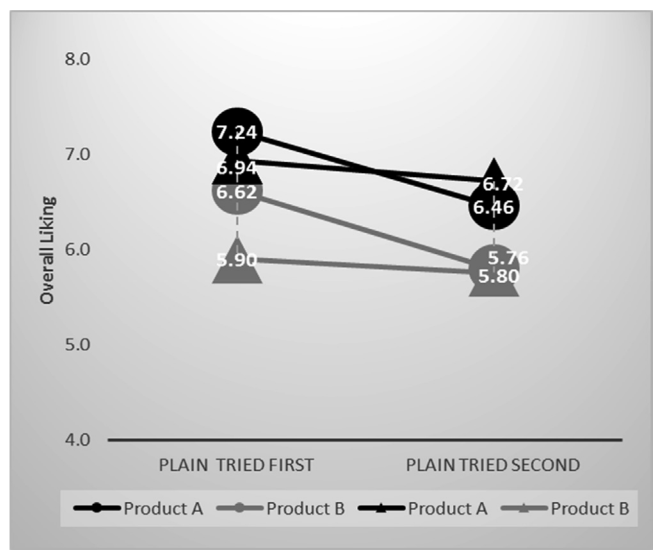

Fig. 3A. Plain Potato Chips Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

Although the overall ratings were reduced and showed a significant difference between the products (as opposed to directional difference for the first order product ratings), consumers were consistent in their liking of product A more than product B. These results were consistent across all five categories.

5. Discussion and conclusions

Based on this study, there was a negative contrast effect occurring for multi-flavor sensory testing in a sequential, monadic design, when plain products were presented following flavored products. The evidence was especially strong when the test flavors represented a large difference on the flavor complexity continuum i.e. when very plain variants were tested with distinctive flavored variants. Designs balanced for flavor presentation did not prevent the contrast effect from occurring in this configuration. The plain products showed a negative contrast effect as noted by a substantial decrease in overall liking ratings when they were served after the flavored products. However, the magnitude of contrast was not consistent for all tests. For example, the potato chip snack test, which involved plain and flavored products, showed a much smaller amount of contrast than either the soya beverage or the cereal products tested. The difference in the magnitude of contrast effect could be attributed to the fact that the regular potato chips were not necessarily perceived to be plain, unflavored products since they were salted, and respondents may have considered them to be high in flavor. In contrast both the plain cereal and soy beverage products had plain, bland flavor profiles. Thus, the distance between the two flavors on the flavor complexity continuum was smaller for the potato chip snack product test than for the cereal or soy beverage product tests, inducing a smaller amount of contrast for the potato chips. This result agrees with findings reported by Schifferstein (1995), who claimed that contextual shifts in hedonic judgments were found only if the stimuli differed substantially along the hedonic dimensions. Zellner, Brett, and Parker (2002), Zellner, Rohm, Bassetti, and Parker

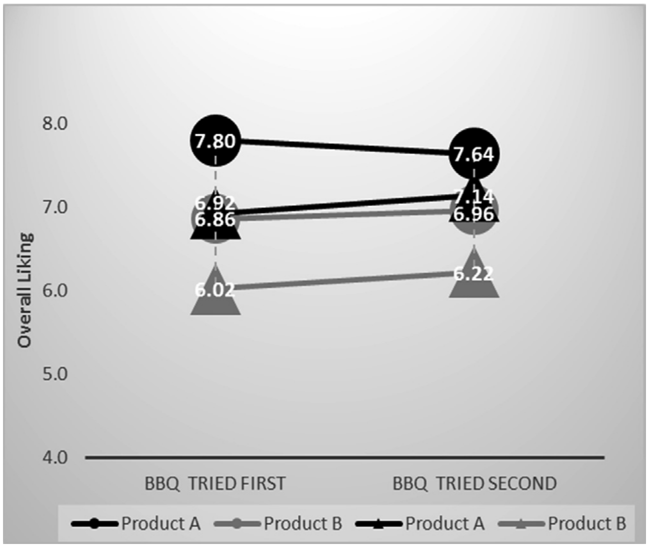

Fig. 3B. BBQ Potato Chips Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

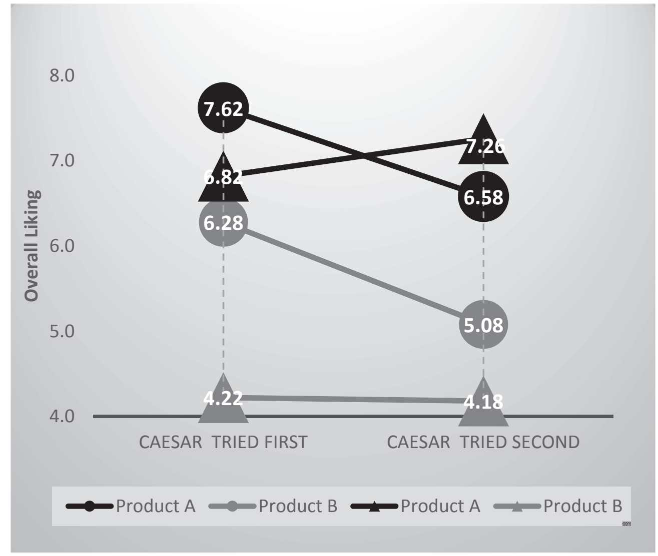

Fig. 4B. Caesar Salad Dressing Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

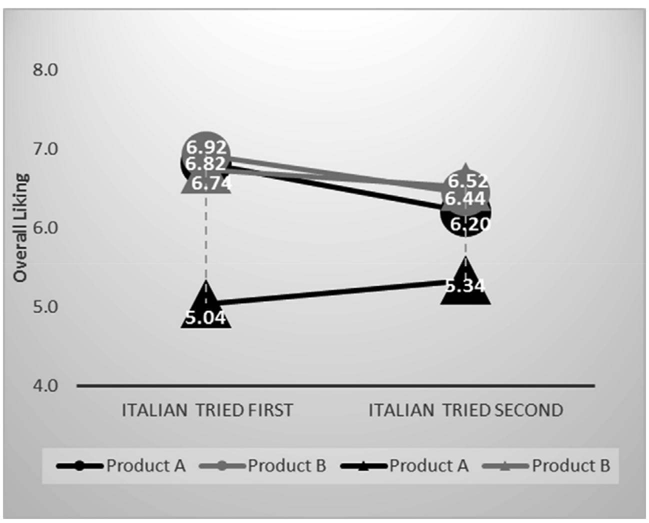

Fig. 4A. Italian Salad Dressing Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

(2003) indicated that the degree of hedonic contrast between the stimuli depends on whether or not they belong to a common category. She showed that products representing different categories, when tested together, were more likely to induce a contrast effect than products from the same category.

Based on the results of this study, it is very apparent that when plain product variants are presented with flavored product variants they may be subject to a significant disadvantage. Therefore, for multi-flavor studies involving products with very different flavor profiles i.e. when very plain products are tested with flavored products, the best practice would be to evaluate the different flavors in separate sessions and with different respondents (i.e. using a flavor monadic design rather than a sequential monadic design). However, in the event of budget limitations which is often the case, these authors believe that it is reasonable to present the plain products prior to the flavored products. If presented in the first position, the plain products would not be subjected to a significant decrease in overall liking and the complex flavored products would not be overly distorted from being presented in the second order due to the positive contrast effect.

For product tests representing flavored and more complex flavor profiles (flavored-flavored configurations), the results were less consistent. The Caesar flavor for the salad dressing product test showed a significant decrease in overall liking when it was presented after Italian dressing. This result was surprising and disproved our hypothesis that the flavored-flavored configuration would not induce a contrast effect. As expected in the hypothesis the contrast effect was not evident for the pudding product test, as both vanilla and chocolate puddings received a small decrease (or showed a negligible increase) in overall liking ratings when the flavors were presented in the second order. The decrease was not significant and fairly consistent for both flavors. Since both flavors showed a similar shift in overall liking, when presented in the second order, the total overall liking change was sufficiently balanced for both flavors, hence using a balanced design counterbalanced the total effects for both flavors. The fact that the contrast effect did not appear for the pudding product test could have been attributed to a small distance between the two flavors (vanilla and chocolate) on the flavor complexity continuum i.e. both flavors represented similar perceived flavor complexity. It was not clear why the significant contrast effect emerged for the Caesar flavor in the dressing product test. Since both Caesar and Italian flavors represented fairly complex flavor profiles, the expectation was to see a pattern similar to the pudding product test. The different pattern could be attributed to the fact that, although both chocolate and vanilla puddings differed in flavor, they represented the same sweet flavor category and showed similar texture and intensity. In contrast, the Caesar and Italian salad dressings, although both representing a savory flavor category, were quite different not only for flavor but also for texture and overall intensity. Caesar dressing represented a cultured dairy flavor profile, whereas Italian dressing a more herb/vinegary/oily profile. Thus, the two salad dressing flavors could have been perceived by consumers as being less homogenous and more different in perceived complexity then the pudding flavors. It is also worth noting that one of the Caesar dressings received the lowest hedonic score amongst all products (Product B: overall 4.94, and 4.2 when tried second), whereas the other Caesar product in the pair was one of the most liked products overall (Product A: overall 7.07 and 7.26 when tried second, Figs. 4A and 4B). This made the hedonic distance between the two products (A, B) in the Caesar pair the greatest of all test pairs in all categories. On the contrary, the hedonic distance between the two products within both the vanilla and chocolate pudding pairs was one of the smallest. This may suggest that in the case of multiple products tested within a complex flavor (in the current study two products A, B), a hedonic contrast may emerge due to the hedonic differences amongst the products within

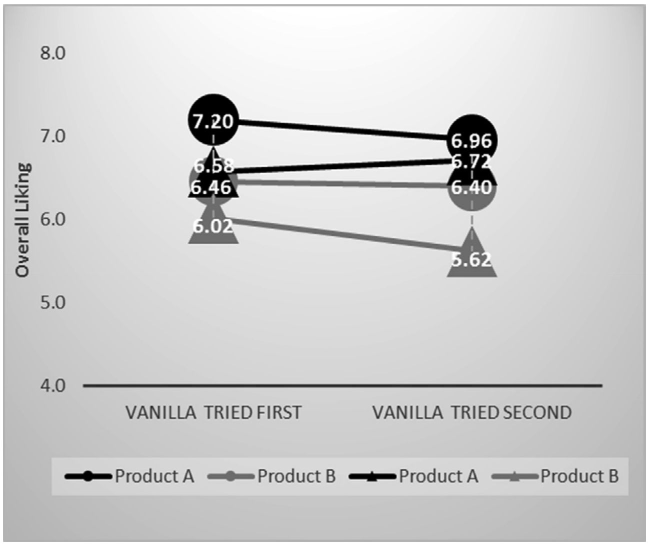

Fig. 5A. Vanilla Pudding Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

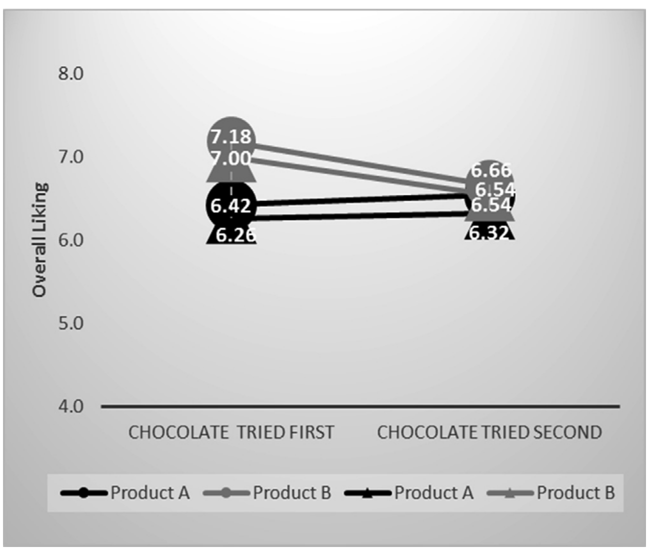

Fig. 5B. Chocolate Pudding Tried First and Second forProduct A and Product B at first (circle) and second order (triangle).

each flavor. However, further research is needed to confirm this finding.

Over the last few decades, researchers have learnt a great deal about the network of brain areas that are involved in the construction of both the sensory-discriminative and hedonic aspects of our multisensory flavor experiences. Levy, MacRae, and Koster (2006) discussed the importance of perceived complexity, a 'collative property', on the development of liking upon repeated exposure. The results of their study were in line with the optimal arousal psychological theory (Berlyne, 1970) that a repeated exposure to more complex stimuli would enhance liking of these stimuli, whereas more exposure to simple stimuli would eventually lead to diminished liking. These authors further explained that there is an optimum complexity level (at the individual level), which upon exposure to a more complex product will shift in the direction of this higher complexity. They predicted that a product which was most liked initially (thus delivering to the optimum arousal level) would not be the one that would be the most liked upon exposure, and a product that appeared too complex initially (i.e. higher than the initial optimum arousal level therefore less liked), would grow in liking upon exposure and stay longer on the market. Although not tested under repeated exposure conditions in this research, the salad dressing products could possibly cause different psychological reactions at the initial optimum arousal level than the more homogenous pudding products.

Fleming (2013) indicated that people have different amounts of the various taste receptors, and overall PROP taste sensitivity varies widely between different populations. In addition, the perception of certain flavors is programmed according to how they are usually consumed. For example, in the west, vanilla is associated with sweet foods therefore enhancing the perception of sweetness, whereas in East Asia vanilla is predominantly associated with savory dishes. Thus, the way that consumers respond to a product in North America is not necessarily the same as in other parts of the world. In Japan, milder and less complex flavors are typically more liked. It would be interesting to explore whether the plain vs. complex paradigm shown in this study would hold amongst Japanese consumers.

Another opportunity to investigate would be the effect of simple and complex texture variants on overall liking. People generally prefer food with a textural contrast. For example, combining a smooth and crispy texture in a product or a dish is generally preferred over the product/dish which is too uniform in texture. Would texture differences induce similar contrast effects in overall liking as those observed for flavor? Additionally, would the product texture differences impact the contrast effects observed for flavor? Flavor is multisensory; several interacting sensory systems—taste, smell, and mouthfeel—together comprise "flavor" making it a cognitively constructed percept rather than a bottom-up sensory one (Dijksterhuis, 2016). Odor, taste, texture, temperature, and pain all contribute to the perception and memory of food flavor (Mojet & Köster, 2016). Interestingly enough, all test products in the current study represented similar texture except for the salad dressing category (dairy Caesar vs. oily Italian dressing). The two salad dressing flavors represented similar perceived flavor complexity, thus no contrast effect was expected, yet a significant contrast effect emerged for the Caesar flavor. Would differences in texture of the Italian and Caesar salad dressing cause the emergence of contrast effect for these products? There is a potential possibility of interactions between flavor and texture, however, more research is needed to better understand these results.

The second objective of this study was to explore the impact of flavor order on the overall difference between the products, in terms of direction and magnitude. Based on the results, the contrast effect induced by flavor order did not alter the direction of the difference in acceptance between the products tested. This is evident by the agreement between the monadic and overall means, which was consistent for all five product tests. This agreement indicated that multi-flavored product studies provide accurate product comparison information when the total means, pooled over the product and flavor orders, are considered. However, to assess actual product overall liking performance, monadic product ratings, unaltered by the product or flavor orders, should always be examined. Furthermore, multiple product food evaluations involving different flavor variants should always include thoughtful examination of product and flavor order effects to reveal the potential impact of these psychological effects on the perceived hedonic response.

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