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Odile Parizel[a,b,c], Claire Sulmont-Rossé[a], Gilles Fromentin[b], Julien Delarue[c], Hélène Labouré[a], Robert Benamouzig[b], Agnès Marsset-Baglieri[b]

[a] (i) INRA, UMR1324, Centre des Sciences du Goût et de l'Alimentation, F-21000 Dijon, France, (ii) CNRS, UMR6265, Centre des Sciences du Goût et de l'Alimentation, F-21000 Dijon, France and (iii) Université de Bourgogne, Centre des Sciences du Goût et de l'Alimentation, F-21000 Dijon, France

[b] (i) AgroParisTech, CRNH-IdF, UMR914 Nutrition Physiology and Ingestive Behavior, F-75005 Paris, France and (ii) INRA, CRNH-IdF, UMR914 Nutrition Physiology and Ingestive Behavior, F-75005 Paris, France

[c] AgroParisTech, INRA, UMR 1145 Ingénierie Procédés Aliments, F-91300 Massy, France

Corresponding author: Agnès Marsset-Baglieri, UMR 914 Nutrition Physiology and Ingestive Behavior, 16 rue Claude Bernard, F-75 005 Paris - E-mail: agnes.marsset-baglieri@agroparistech.fr – Phone number +331 44 08 86 77

ABSTRACT

Several authors showed that providing choice may increase food liking and food intake. However, the impact of choice may be modulated by assortment's characteristics, such as the number of alternatives or their dissimilarity. The present study compared the impact of choice on food liking and intake under the two following conditions: (1) when choosing a product to consume from among similar products *versus* dissimilar products; and (2) when choosing a product to consume from among pleasant products *versus* unpleasant products. Two experiments were carried out using the same design: the "apple puree" experiment (n=80), where the volunteers choose from among similar products (apple purees varying in texture) and the "dessert" experiment (n=80), where the volunteers choose from among dissimilar products (fruit dessert, dairy dessert, custard, pudding). During the first session, participants rated their liking for 12 products (apples purees or desserts). Then the participants were divided into a "pleasant" group (n=40) in which volunteers were assigned three pleasant products, and an "unpleasant" group (n=40) in which volunteers were assigned three unpleasant products. Finally, all of the volunteers participated in a choice session – volunteers were presented with their three assigned products and asked to choose one of the products, and a no-choice session – volunteers were served with one product that was randomly selected from among their three assigned products. Providing choice led to an increase in food liking in both experiments and an increase in food intake only for the desserts, namely only when the volunteers chose the product to consume from among "not too similar" alternatives. No effect of assortment's pleasantness was observed.

KEYWORDS

Food choice; product assortment; sensory dissimilarity; perceived variety; food intake; food liking

INTRODUCTION

Several authors have demonstrated that choice has a powerful motivating effect: people are more likely to engage in an activity, to succeed in it and to enjoy it if they had chosen it (Patall, Cooper, & Robinson, 2008). According to the self-determination theory, people are naturally inclined to interact with the environment in a way that promotes three psychological needs, the need for competence (i.e., feeling effective), for autonomy (i.e., feeling of being the perceived origin of a behavior) and for relatedness (i.e. feeling connected to others) (Deci & Ryan, 2002). Social contexts that fulfill these needs will thus enhance intrinsic motivation, namely the desire to carry out an activity for self-gratification (as opposed to extrinsic motivation, the desire to carry out an activity for external rewards). Providing choice is one of the most obvious ways to enhance a person's experience of competence and autonomy (Langer, 1975; Ryan & Deci, 2000). Consequently, the self-determination theory holds that choice should result in positive intrinsic motivation, which in turn leads to higher performance and satisfaction (Patall et al., 2008).

Herb Meiselman and his group were one of the very first to explore the impact of choice on food acceptability. In fact, they observed higher liking scores when participants were asked to select three salad dressings to taste among six alternatives (choice condition) than when they were randomly assigned three salad dressings among the six alternatives (no choice condition) (King, Meiselman, & Henriques, 2008). A positive effect of choice on food liking was also observed when participants chose one salad dressing from among two alternatives (King, Weber, Meiselman, & Lv, 2004). However, this study did not reveal any impact of choice on the liking score for pizza or iced tea. More recently, Altintzoglou et al. (2015) observed a positive effect of choice on fish liking when children (11-12 years) chose the fish they wanted to taste from among two alternatives. However, Zeinstra, Renes, Koelen, Kok, and de Graaf (2010b) failed to observe any choice impact on vegetable liking for children (4-6 years).

A survey completed by 242 children (4-12 years) and their parents showed a positive correlation between providing children with a choice and their fruit and vegetable intake (Zeinstra, Koelen, Kok, van der Laan, & de Graaf, 2010a). In fact, choice has been considered to be a contextual factor liable to increase food intake (Nijs, Graaf, Kok, & van Staveren, 2006; Kremer, Derks, Nijenhuis, Boer, & Gorselink, 2012). However, these studies compared a standard meal context with a meal context that was improved not only by providing choice, but also by improving social interaction and the quality of the dining room. Consequently, these studies did not set apart the impact of choice among the impact of other contextual variables. To the best of our knowledge, only two studies have explored the impact of choice *per se* on food intake but provided mixed results. Zeinstra et al. (2010b) did not observe any impact of choice on vegetable intake. This experiment was run with children (Dutch; 4-6 years) who went to a restaurant to have a dinner with their parents. However, Rohlfs Domínguez et al. (2013) observed a 120% increase in vegetable intake when children (Spanish; 4-6 years) were allowed to choose the vegetable that they wanted to consume for their lunch at school from among two alternatives compared to a no-choice situation.

Given the mixed results of the literature, there is a need to explore the conditions in which providing choice impacts food behavior. In fact, the studies reported above were carried out with different age groups (children, adults, elderly), in different contexts (in a laboratory *versus* a real-life situation) and with different food assortments (type of food, number of alternatives). Regarding the latter, it has been established that the impact of choice can be modulated by choice complexity, which depends on the number of alternatives and their dissimilarity (the number of attributes that differentiate the alternatives). A series of studies explored the impact of the number of alternatives on the choice effect. For instance, Rortveit and Olsen (2007) showed a positive relationship between the number of fish alternatives (species, conservation forms, recipes) that the consumer considers when buying and preparing

a meal of fish and consumption frequency of fish. Kahn and Wansink (2004) observed higher consumption quantities when children or adults were served with a bowl including 24 colors of candies than when they were served with a bowl including 6 colors of candies. However, Iyengar and Lepper (2000) observed that participants were less likely to purchase a jam when they were offered a choice from among 24 flavors of jam than when they were offered a choice from among 6 flavors of jam in a grocery store. In fact, Scheibehenne, Greifeneder and Todd (2010) performed a meta-analysis on 63 experiments comparing the impact of small vs large assortments on either self-reported satisfaction with the final chosen option or on whether an active choice was made. The meta-analysis revealed a mean effect of the assortment size of zero, but with considerable variance between studies. In fact, the authors hypothesized that the relationship between the assortment size and the impact of choice on intrinsic motivation and satisfaction should be modulated by some factors such as the ease with which alternatives can be categorized, the degree of similarity between the alternatives and/or the number of attributes that differentiate the alternatives. For instance, Greifeneder, Scheibehenne and Kleber, (2010) observed that increasing the number of MP3-players (from 6 to 30) led to a decrease in satisfaction only when the MP3-players differed in a high number of attributes (9 vs 4).

Regarding the literature, we hypothesized that the impact of choice on food behavior would be modulated by the characteristics of the food assortment (namely, the different food alternatives to choose from). The current experiment focused on two research questions – the impact of the degree of similarity between alternatives and the impact of the level of pleasantness of alternatives – as they may correspond to real-life situation. In fact, in some situations consumers have to select a food from among similar alternatives (e.g., choose a yoghurt from among different flavored yoghurts), whilst in others they have to select a food from among dissimilar alternatives (e.g., choose a starter from among different proposals such

as grated carrots, tomato salad, beetroot…, a common situation in numerous canteens or cafeterias). Furthermore, as providing choice was suggested to improve the consumption of healthy foods, which are not always well-liked (Raghunathan et al., 2006; Zeinstra et al., 2010a), one might wonder whether choice would have a similar impact if consumers were offered a choice first between a group of foods that they liked and then between a group of foods that they liked less. Consequently, the present experiment aimed at comparing the impact of choice on food liking and food intake under the two following conditions: (1) when choosing a product to consume from among similar products such as different preparations of a given food, or among dissimilar products such as different foods from a given food category (i.e. the degree of similarity between alternatives) ; and (2) when choosing a product to consume from among pleasant products or among unpleasant products (i.e. the level of pleasantness of alternatives).

GENERAL METHOD

Experimental design

Two independent experiments (**Figure 1**) were carried out using the same experimental design but different product assortments: the "apple puree" experiment, where the participants chose from among similar products (apple purees varying in texture) and the "dessert" experiment, where the participants chose from among dissimilar products (fruit dessert, dairy dessert, custard, pudding). For each experiment, the participants took part in three sessions. During the first session, they assessed their liking for 12 food products (apples purees or desserts) using a sequential monadic procedure (the order of products presentation was determined by a Williams Latin square design). Then the participants were divided into two groups: a "pleasant" group (n=40) in which volunteers were assigned three pleasant products and an "unpleasant" group (n=40) in which volunteers were assigned three unpleasant

products. Finally, all of the volunteers participated in a choice session and a no-choice session (the order of the sessions was balanced across each group). For the choice session, the participants were simultaneously presented with their three assigned products and asked to choose one of the products. For the no-choice session, the participants were served with one product that was randomly selected from among their three assigned products.

Figure 1 about here

Participants

Two different panels of healthy and normal weight volunteers were recruited (one for the "apple puree" experiment and one for the "dessert" experiment) in Paris and surroundings (France) between October 2013 and May 2014. The recruitment criteria were as follows: aged between 18 and 40 years old; having a normal and stable weight (no weight variation greater than 3 kg during the last three months); scoring lower than 10 on the restraint scale and the disinhibition scale of the Three Factor Eating Questionnaire (Stunkard & Messick, 1985); not taking any drugs liable to have an impact on appetite (*e.g.*, corticoids, antidepressants); not on a diet; non-smoker; not abusing alcohol; neither pregnant nor breastfeeding. The power calculation estimated that 40 subjects were necessary in each group ("pleasant" and "unpleasant") to show a difference of energy intake of 33g (1/3 of a portion) between a choice and a no-choice situations with a power of 0.80. To ensure that the participants were unaware of the real purpose of the experiment (*i.e.*, to determine the impact of a choice *vs.* a non-choice situation), they were told that the experiment was designed to study different recipes of desserts (*i.e.*, false pretense). The experimental protocols were approved by the French Ethics Committee for Research Ile de France VII ("apple puree" experiment: #2013-A00340-45; "dessert" experiment #2013-A01746-39). The participants received financial compensation for their participation.

Products

Two sets of semi-solid products were designed (one for each experiment) to comply with the following criteria: (i) within a set, the difference in energy content between products should not exceed 20 kcal; (ii) within a set, the products should elicit contrasting hedonic responses; and (iii) within a set, the products should be visually different to ensure that participants feel that they have a choice between different products.

Procedure

Participants took part in three weekly sessions during lunch time (in France, lunch is one of the two main meals of the day, usually including a starter, a warm main dish and a dessert). The participants were asked to have the same breakfast for each test day at least three hours before the session and not to eat or drink (except water) until the session. For each session, the participants were first served a main course composed of pasta with tomato sauce (Penne Tomate Basilic, Panzani®). During the first session, they were instructed to eat as much pasta as they desired, and the amount that each participant consumed was recorded. During sessions 2 and 3, the participants were served the amount that they consumed during session 1 and asked to eat the full portion (*i.e.*, each participant consumed the same amount of pasta at the beginning of each session, and this amount was adjusted to each participant's appetite). The sessions were carried out in a room deprived of food references, and the participants sat at individual tables.

Session 1: Liking assessment. After the main course (*i.e.*, pasta) was consumed, the participants were served 30 g of each food product using a sequential monadic procedure. The products were presented in the order determined by a Williams Latin square design. The participants tasted each product and evaluated their liking for the product on a 10-point hedonic scale ranging from "I do not like it at all" (0) to "I like it very much" (10). After each

tasting, the participants were requested to take a 45 s break and rinse their mouth out with plain water.

Group assignment and product selection. After the first session, the participants were divided into two groups: a "pleasant" group and an "unpleasant" group. For the pleasant group, each participant was assigned three "pleasant" products, which were three products that the participant had previously scored between 6 and 9 on the liking scale during the first session. For the "unpleasant" group, each participant was assigned three "unpleasant" products that he/she had previously scored between 1 and 4 during the first session. In addition, the three products that were provided to each participant had similar liking scores (*i.e.*, differed by no more than 2 points on the hedonic scale).

Sessions 2 and 3: choice and no-choice conditions. All of the volunteers participated in a choice session and a no-choice session. The order of the sessions was balanced across the panel of volunteers. After consuming the main dish, the participants evaluated their hunger by rating the item "How hungry do you feel now?" on a 100 mm visual analog scale (anchors: "not at all" and "extremely"). Then, for the choice session, the three assigned products (*i.e.*, pleasant products for the "pleasant" group or unpleasant products for the "unpleasant" group) were displayed in front of each participant in a random order. Participants were asked to choose one of the products without tasting them first. Participants could not see each other's choice to rule out any social influence on choice. For the no-choice session, the participants were served with one product that was randomly selected from among their three assigned products. In both sessions, the participants were allowed to eat as much of the product as they desired. They rated their liking of the product at the first spoonful using a 10-point hedonic scale. The participant's food and water intake were measured by weighing the plates before and after consumption (accuracy: ±1 g).

Data analysis

The quantities consumed of products were converted into energy intake. For each experiment, the hunger score, water intake, liking score at the first spoonful, apple puree intake and dessert intake (both weight and energy) were recorded during the choice and no-choice sessions, then submitted to a linear mixed model with the *group* (pleasant *vs.* unpleasant) and *condition* (choice *vs.* no-choice) as fixed factors, their interaction, and the *participant* as random factor. Statistical analyses were conducted using R and "nlme" package (R Development Core Team, 2006). Means (M) are associated with the standard error of the mean (SEM). The threshold for significance was set to 5%.

EXPERIMENT 1 ON APPLE PUREES

Participants

Eighty healthy and normal weight volunteers were recruited for this experiment according to the recruitment criteria described in the general method. The characteristics of the volunteers are described in the **Table 1.** No significant difference was observed between pleasant and unpleasant groups for age ($t(78)=0.43$, ns), BMI ($t(78)=1.64$, ns) and regarding sex distribution ($\chi^2=0$, ns).

Table 1 about here

Products

A set of 12 apple purees was designed to comply with the criteria described in the general method. Apple purees that varied in texture were designed by modifying an initial apple puree (Pomme Nature en Morceaux, Sans Sucres Ajoutés, Andros®) through three structural parameters: particle size, pulp content and the addition of apple fragments **(Table 2)**. Previous

work already identified particle size and pulp content as key structural parameters to control the texture of apple purees (Espinosa-Muñoz, Symoneaux, Renard, Biau, & Cuvelier, 2012). These products were characterized using a Flash Profile by 10 judges experienced in sensory evaluation (Delarue & Sieffermann, 2004). According to the results, 80% of the descriptors generated by the experts were related to product texture. In addition, the products differed from each other mainly in terms of visual and in-mouth textural characteristics.

Table 2 about here

In a preliminary experiment, 34 participants (a separate group from the participants in the present study) rated their liking for each apple puree. Results from this preliminary experiment confirmed that that all the products within a set elicited distinct hedonic responses: the minimum and maximum hedonic ratings were 2.6 (SEM=0.2) and 8.2 (SEM=0.2) respectively.

Procedure

The experiment followed the procedure described in the general method.

Results

There was no significant effect (of the *group* or the *condition*) on the hunger score or water intake.

Liking assessment (session 1). The three selected apple purees for the "pleasant" group have been rated M=8.1 (SEM=0.1) and the three selected apple purees for the "unpleasant" group have been rated M=2.7 (SEM=0.1). There was an average difference of M=0.7 (SEM=0.1) points between the liking scores of the three apple purees in the "pleasant" group and M=1.0 (SEM=0.1) points for the "unpleasant" group.

Choice and no-choice conditions (sessions 2 & 3). The linear mixed model revealed significant *group* ($F(1,78)=24.4$, $p<0.001$) and *condition* effects ($F(1,78)=20.8$, $p<0.001$) on the liking score at the first spoonful, but there was no interaction effect ($F(1,78)=1.1$; $p=0.30$). As expected, the participants in the "pleasant" group rated the apple purees more highly (M=7.5, SEM=0.1) than the participants in the "unpleasant" group (M=6.2, SEM=0.2), based on liking scores. Furthermore, the participants of both groups gave higher liking scores to the apple puree they consumed when they choose it (M=7.2, SEM=0.2) than when they were served it without choice (M=6.5, SEM=0.2) **(Figure 2A)**. We did not observe any significant effect (of the *group* or the *condition*) on apple puree intake, based on both weight **(Figure 2B)** and energy intake **(Figure 2C).**

Figure 2A, 2B and 2C around here.

EXPERIMENT 2 ON DESSERTS

Participants

Eighty healthy and normal weight volunteers were recruited for this experiment according to the recruitment criteria described in the general method. The characteristics of the volunteers are described in the **Table 3**. No significant difference was observed between pleasant and unpleasant groups for age ($t(78)=-0.08$, ns), BMI ($t(78)=1.14$, ns) and regarding sex distribution ($\chi^2=0$, ns).

Table 3 about here

Products

The set of 12 desserts was designed to comply with the criteria described in the general method. Twelve desserts were selected from 16 desserts available in the French market by a free sorting test carried out by 32 untrained subjects (a separate group from the participants in

the present study). The results allowed us to select the most dissimilar desserts. These desserts consisted in fruit purees, dairy products, custards and puddings, which differ by several sensory modalities (color, texture, flavor) but have similar nutritional content **(Table 4)**.

Table 4 about here

In a preliminary experiment, 64 participants (a separate group from the participants in the present study) rated their liking for each dessert. Results from this preliminary experiment confirmed that that all the products within a set elicited distinct hedonic responses: the minimum and maximum hedonic ratings were 1.6 (SEM=0.2) and 8.7 (SEM=0.1), respectively.

Procedure

The experiment followed the procedure described in the general method.

Results

There was no significant effect (of the *group* or the *condition*) on the hunger score or water intake.

Liking assessment (session 1). The three selected desserts for the "pleasant" group have been rated M=8.1 (SEM=0.1) and the three selected desserts for the "unpleasant" group have been rated M=2.5 (SEM=0.1). There was an average difference of M=0.7 (SEM=0.1) points between the liking scores of the three desserts in the "pleasant" group and M=1.0 (SEM=0.1) points for the "unpleasant" group.

Choice and no-choice conditions (sessions 2 & 3). The linear mixed model revealed significant *group* ($F(1,78)=48.4$, $p<0.001$) and *condition* effects ($F(1,78)=5.5$, $p<0.05$) on the liking score at the first spoonful, but there was no interaction effect ($F(1,78)=0.1$, $p=0.96$). As

expected, the participants in the "pleasant" group rated the desserts more highly (M=7.8, SEM=0.2) than the participants in the "unpleasant" group (M=5.5, SEM=0.3). Furthermore, the participants of both groups gave higher liking scores to the dessert they consumed when they choose it (M=6.9; SEM=0.2) than when they were served it without choice (M=6.3; SEM=0.3) **(Figure 3A).**

The linear mixed model also revealed significant *group* (Weight: $F(1,78)=16.3$, $p<0.001$; Energy: $F(1,78)=18.1$, $p<0.001$) and *condition* effects (Weight: $F(1,78)=9.2$, $p<0.01$; Energy: $F(1,78)=8.5$, $p<0.01$) on dessert intake, but there was no interaction effect (Weight: $F(1,78)=1.3$, $p=0.27$; Energy: $F(1,78)=1.3$, $p=0.26$). The participants in the "pleasant" group ate more of the selected dessert (Weight: M=217, SEM=12 g; Energy: M=231, SEM=12 kcal) than participants in the "unpleasant" group (Weight: M=139, SEM=10 g; Energy: M=145, SEM=10 kcal). Furthermore, the participants consumed more dessert when they had choice (Weight: M=192, SEM=12 g; Energy: M=202, SEM=13 kcal) than when they had no choice (Weight: M=164, SEM=11 g; Energy: M=173, SEM=11 kcal) **(Figure 3B and 3C)**. Therefore, providing choice led to a 17% increase in energy intake compared to not having choice.

Figure 3A, 3B and 3C about here

GENERAL DISCUSSION

Our study shows that providing choice from among similarly liked alternatives increases food liking. It also appears that having a choice affects food intake only when participants chose between different foods within a given category (the "dessert" experiment), but not when they chose between different preparations of a given food (the "apple puree" experiment). Concerning food intake, our findings are in line with previous studies showing that providing choice did not always influence food intake. Zeinstra et al. (2010b) did not observe any

difference in vegetable consumption when children were allowed to choose a vegetable from two alternatives compared to a no-choice situation. However, Rohlfs Domínguez et al. (2013) observed an approximately 120% increase in intake using the same conditions. The discrepancy between these studies may be explained by the fact that the children ate with their parents in a restaurant, which may have influenced their food behavior in the former study, while they ate with their peers in a more familiar context in the latter study. Regardless of the exact reason for this discrepancy, it is notable that both published studies and our data support the idea that the influence of choice on food intake is vulnerable to contextual factors. In the present experiment, two factors may limit the generalizability of the results. Firstly, the present experiment was run with apple purees and desserts that are traditionally eaten at the end of the meal in France. We have chosen these food products for technical reasons, in order to have enough items liable to elicit mixed hedonic responses whilst displaying similar energy content within a set. However, most of the studies described in the introduction were run with a main dish (Zeinstra et al., 2010b; Rohlfs Domínguez et al., 2013). Secondly, the present experiment was carried out with young adults (18-40 years). However, some authors suggested that the impact of choice may be modulated by age, with young children not having developed choice ability as part of their identity (Altintzoglou et al., 2015) and elderly people not devoting enough attention to all alternatives due to reduced cognitive abilities (Frey, Mata, & Hertwig, 2015). In fact, there is a need for further studies to assess the potential influence of the type of food (*e.g.*, main course *vs* dessert *vs* snack), the context of consumption (*e.g.*, in a laboratory *vs* in a real meal situation) and the individual characteristics such as culture or age.

Our study showed an impact of choice complexity on food consumption behavior. Choice complexity was modulated by the number of attributes that differentiated the alternatives, with alternatives varying in only one sensory modality (texture) in the “apple puree”

experiment and several sensory modalities (aspect, flavor, texture) in the "dessert" experiment. We may hypothesize that the participants in the "dessert" experiment perceived a higher degree of variety in their choices than the participants in the "apple puree" experiment. Kahn and Wansink (2004) previously highlighted the influence of the structure of an assortment on the perceived variety of the assortment. These authors also showed that perceived variety of an assortment may modulate the quantity that is consumed when the subject is given the opportunity to choose between several options. There is also a parallel between our study and a study by Rolls et al. (1981) which explored the impact of variety on sensory-specific satiety. They observed that variety had a greater effect on food intake when participants were served yogurts that varied in taste, appearance and texture, than when participants were served yogurts that varied in flavor only (Rolls et al., 1981). In other words, a product assortment should include products that are "not too similar" to be effective in evaluating both choice and variety. However, if the product assortment becomes too complex (*e.g.*, includes alternatives that differ by too many attributes), then people may have difficulty in processing the information, which could elicit frustration and discourage them from eating. The meta-analysis performed by Scheibehenne et al. (2010) on the impact of the size of the assortments revealed a mean effect of an assortment size of zero but with considerable variance, suggesting that some factors (such as the ease with which alternatives can be categorized, the degree of similarity between the alternatives and/or the number of attributes that differentiate the alternatives) may modulate this effect. Consequently, further research is needed to determine the range of difference between products (not too similar but not too dissimilar) required to identify a significant impact of choice on food intake, although it can be already argued that variation in only one sensory modality (texture in this study) is insufficient.

In addition, we did not observe any influence of the relative pleasantness of the product set on choice effect. As food pleasantness is associated with a large inter-individual variability, a strength of our study is that we selected three similarly liked ("pleasant" groups) or similarly disliked ("unpleasant" groups) products for each participant – as such, different products were assigned to different participants. However, there was a discrepancy between the first session and the choice and no-choice session, especially for unpleasant products. Despite the fact that the participants assigned low liking scores to these products in the first session (2.7 and 2.5 for the apple purees and the desserts, respectively), they rated them higher in the choice and no-choice sessions (6.2 and 5.5 for the apple purees and desserts, respectively). On both occasions, the ratings were based on the consumption of a small amount of product (30 g in the first session and the first spoonful in subsequent sessions). However, the participants rated their liking for 12 samples in the first session, while they rated their liking for only one sample in the choice and no-choice sessions (the sample that they consumed). The sequential monadic procedure used in the first session may have led to hedonic contrast, where "good things making less good things even worse" (Zellner, Allen, Henley, & Parker, 2006; Hayes, DePasquale, & Moser, 2011). This effect was not symmetric: for the pleasant products, the scores in the choice and no-choice sessions (7.5 and 7.8 for the apple purees and desserts, respectively) were slightly lower than or equivalent to the scores in the first session (8.1 for the apple purees and the desserts). This may be due to the fact that the products were part of the generally well-liked dessert category. Notwithstanding this limitation, the products assigned to the "unpleasant" group remained significantly less liked than the products assigned to the "pleasant" group. This allows us to conclude that choice has a positive impact on food liking and possibly on food intake, regardless of whether the participants chose a product to consume from among pleasant or less pleasant alternatives.

Finally, in addition to the impact of choice on food intake, we also observed an impact of food pleasantness on food intake in the "dessert" experiment, as the participants consumed greater amounts of pleasant desserts than unpleasant desserts, regardless of whether or not they were offered a choice. However, this effect was not observed in the "apple puree" experiment. While several studies have shown a positive relationship between hedonic ratings and food intake (Yeomans, 1996; De Graaf, De Jong, & Lambers, 1999; Bolhuis, Lakemond, de Wijk, Luning, & de Graaf, 2012), other studies concluded that pleasantness had a limited impact on food intake (Bobroff & Kissileff, 1986; de Castro, Bellisle, & Dalix, 2000). It could be argued that, similar to the effect of having a choice, food pleasantness only has an impact on food intake if the degree of difference between pleasant and unpleasant products is large enough. In our study, there was a difference of 2.3 points between the liking scores of the pleasant and unpleasant desserts, while there was a difference of only 1.3 points between the pleasant and unpleasant apple purees.

CONCLUSIONS

In conclusion, our results confirm that providing choice increases food liking but its influence on food intake is modulated by contextual factors. This effect occurred regardless of whether the participants chose the product to be consumed from among pleasant or less pleasant alternatives. However, the impact of choice on food intake was evident only when the participants chose the product to consume from among "not too similar" alternatives, such as different products from a given food category. We did not observe any effect of choice on food intake when the participant chose the product to consume from among alternatives that varied in only one sensory modality. By considering our results and those from previously published studies, it can be suggested that providing choice or restraining choice may increase the consumption of some foods or limit the consumption of other foods, respectively (see also Altintzoglou et al., 2015). However, before providing recommendations, it is important to

look at the conditions and especially the structure of the assortment (such as the number of alternatives and their degree of dissimilarity), in which providing choice has an impact on food intake.

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TABLE

Characteristics of the volunteers in the "apple puree" experiment

	"Apple puree" panel		
	"Pleasant" group	"Unpleasant" group	Total
n	40	40	80
F(n)	27	26	53
M(n)	13	14	27
Age	24.9±4.9[1]	24.4±4.5	24.6±4.7
BMI	21.9±2.4	21.1±1.7	21.5±2.1

[1] Mean ± SD (all such values)

TABLE 2

Products used in the "apple puree" experiment

	Formulation parameters			**Energy (kcal/100g)**
	Grinding[a]	Added pulp[b]	Apple fragments[c]	
L	1	0	0	56.0
LC	1	1	0	58.9
LF	1	0	1	55.6
LCF	1	1	1	57.6
M	2	0	0	57.0
MC	2	1	0	57.8
MF	2	0	1	57.0
MCF	2	1	1	57.7
Hd	3	-1	0	54.0
HC	3	1	0	58.1
HdF	3	-1	1	56.2
HCF	3	1	1	57.2

[a] an initial apple puree was ground at 3 levels (1: weak; 2: medium; 3: strong).

[b] 1: addition of pulp to ground apple purees; 0: no added pulp; -1: dilution of ground apple puree.

[c] 1: addition of apple fragments to ground apple purees; 0: no added apple fragments.

TABLE 3

Characteristics of the volunteers in the "dessert" experiment

	"Dessert" panel		
	"Pleasant" group	"Unpleasant" group	Total
n	40	40	80
F(n)	28	29	57
M(n)	12	11	23
Age	32.4±5.4[1]	32.5±5.9	32.4±5.7
BMI	22.5±2.2	22.0±1.8	22.2±2.0

[1] Mean ± SD (all such values)

TABLE 4

Nutritional composition of the products used in the “dessert” experiment

	Energy (kcal/100g)	**Protein (g/100g)**	**Carbohydrates (g/100g)**	**Fat (g/100g)**
Pistachio Dessert cream	109.1	2.8	18.0	2.9
Chocolate Dessert cream	117.0	3.3	15.3	4.3
Vanilla Dessert cream	114.9	2.8	19.1	3.0
Creamy rice pudding	113.3	2.4	21.5	2.0
Creamy semolina pudding	105.0	3.5	15.9	3.0
Apple puree	103.7	0.3	25.6	<0.1
Raspberry puree	101.6	0.7	24.7	<0.1
Rhubarb puree	107.8	0.8	26.1	<0.1
Vanilla yogurt	99.1	3.3	15.2	2.8
Raspberry-blueberry yogurt	100.1	2.3	10.9	5.2
Prune yogurt	100.0	3.4	14.4	3.2
Cottage cheese	103.9	5.9	4.6	6.9

FIGURE 1

Overview of the experimental design

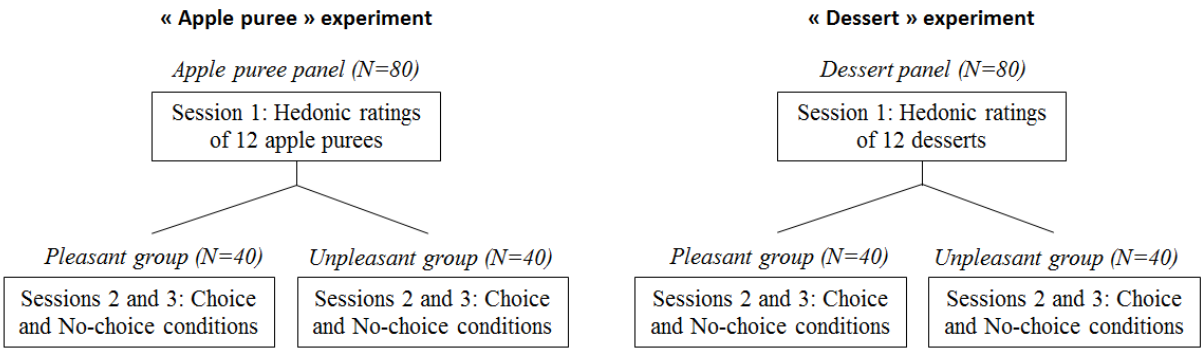

FIGURE 2

"Apple puree" experiment: mean liking score of the consumed apple purees (±SEM) (A), mean quantity of consumed apple purees (±SEM) (B) and mean calorie intake from apple purees (±SEM) (C) for each condition (choice and no-choice) *(the p-values were obtained by three-factor ANOVA. *: p<0.05; **: p<0.01; ***: p<0.001).*

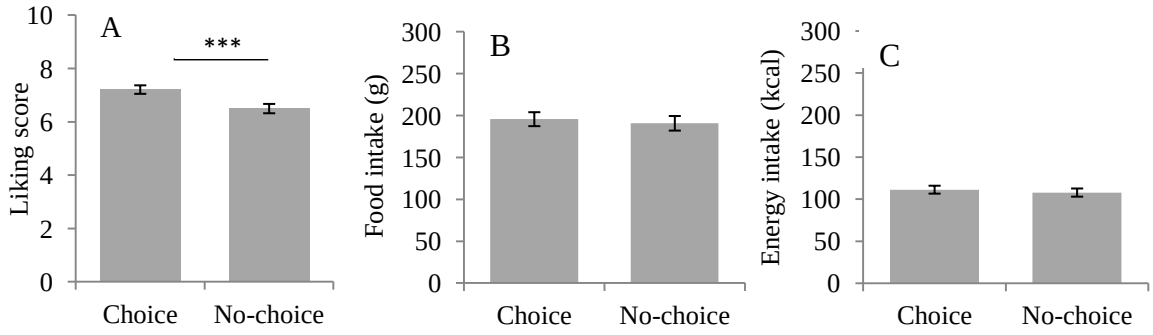

FIGURE 3

"Dessert" experiment: mean liking score of the consumed dessert (±SEM) (A), mean quantity of consumed dessert (±SEM) (B) and mean calorie intake from the dessert (±SEM) (C) for each condition (choice and no-choice) *(the p-values were obtained by three-factor ANOVA. *: p<0.05; **: p<0.01; ***: p<0.001).*