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Abstract

The study assessed the impact of a hedonic intervention on the energy intake of mid-afternoon snacks consumed by children at home. Before the intervention (T1), after (T2), and two months later (T3), a booklet was sent to 187 children aged 7-11 y inviting them to describe their snack consumptions. After T1, children were randomly assigned to an experimental group (N=94) who received hedonic boxes to stimulate the sensory, psychosocial and interpersonal pleasure of consuming healthy foods, or to a control group (N=93) who received boxes targeting table decoration. Between T1-T2, a significant decrease in energy intake was observed in the experimental group but not in the control group; the intervention decreased the amount of food eaten but did not change their average nutritional quality. Effects among 'heavy' eaters were larger than among 'light' eaters. Promoting conscious sensory experiences may favor children's epicurean pleasure, which could help reducing energy intake.

Keywords: home-based intervention, nutritional quality, energy intake, pleasure from eating

1. Introduction

In France, children's eating habits are excessive in fat and sugar, and 77% of children aged 6 to 17 years do not reach the consumption of at least 5 servings of fruit per day (Santé publique France, 2017). The excessive consumption of high-fat/high-sugar foods is particularly true for French children's mid-afternoon snacks. Indeed, a food survey indicated that 17% of the total energy intake of children up to 10 years of age comes from mid-afternoon snacks and that the food items most consumed by them are fatty, sweet foods such as pastries, cakes and biscuits (Anses, 2017a). According to this survey, 25% of sugar consumed by children of this age range comes from mid-afternoon snacks (Anses, 2017a). Mid-afternoon snacking, defined as an eating occasion between lunch and dinner (Bellisle, 2014), is recommended for children because it contributes to diversifying their feeding, especially through the consumption of fruits and dairy products (Francou & Hébel, 2017). However, the real intake does not meet the nutritional recommendations (Francou & Hébel, 2017), and the most consumed foods are dense in energy and low in micronutrient content, which could lead to later health problems. In particular, dietary sugars are associated with an increase in obesity when consumed as an excess source of calories and with an increase in the risk of diet-related diseases (Prinz, 2019). In this context, it seems relevant to identify levers to guide children's mid-afternoon snack choices toward healthier foods of lower energy value.

One way to improve children's food choices consists of informing them about the health benefits of food products. Some studies showed that a nutritional message led 7-11-year-old children to choose healthier snacks (Marette et al, 2016; Poquet et al, 2019). However, health messages may have counterproductive effects on food choices (Miller et al., 2011). Some authors showed that children aged 9-11 y rated "a new health drink" as less pleasant and said they would be less likely to ask their parents to buy it than the same drink with a simple message "a new drink" (Wardle & Huon, 2000), suggesting that health and taste might be considered

contradictory by children (Baranowski et al., 1993). Using an experimental design, Poquet et al. (2019) showed that dyads of mothers and their child chose and consumed, for their mid-afternoon snack, healthier food items when they were labeled with the Nutri-Score (the French front-of-pack labeling system) than without any information. However, even if the nutritional quality of the snacks was significantly improved with the Nutri-Score, the liking decreased for the children as well as for the mothers, suggesting a "hedonic cost" associated with the change in favor of healthier choices, questioning the sustainability of the behavioral changes induced by nutritional labels.

Faced with the contrasting effects of health/nutrition information on children's food choices and liking, some authors have investigated whether pleasure of eating could be an alternative lever to improve children's appetence for healthier and lower energy-dense foods. It has been shown that pleasure from eating is not *per se* a threat to healthy food choices. In an experimental study involving French children aged 6-11 y, Marty et al. (2017) showed that children with hedonic-based attitudes toward foods were more likely to choose healthy food options (e.g., fruits) from a buffet than children with more nutrition-based attitudes. Cornil & Chandon (2016) revealed that focusing on sensory pleasure through multisensory imagery led 5-year-old children to choose smaller portions of chocolate cake or soft drink than in a nonfood (control) sensory imagery condition. The reduction of the portion size was confirmed in another study with children aged 7-11 y, with a reduction for palatable food but not for healthier food (Lange et al., 2020). Food sensory imagery, which consists of creating a vivid mental image of the sensory experience of eating, may lead to the selection of smaller portions, acting as a reminder that eating pleasure does not increase with portion size. In a review, Marty et al. (2018) conceptualized three dimensions of pleasure from eating: the sensory dimension (e.g., pleasure from the sensory sensations), the interpersonal dimension (e.g., social context of eating) and the psychosocial dimension (e.g., cognitive representations). These authors argued that hedonic

interventions mobilizing these three dimensions (for instance, by focusing on sensory properties of healthy foods, by stimulating social re-appropriation of healthy foods through shared cooking recipes, and by creating positive expectations for healthy foods, respectively) may constitute alternative levers to promote healthy eating behaviors in children. Recently, a scoping review (Bédard et al., 2020) confirmed the potential of intervention strategies using eating pleasure, and highlighted the need for evidence-based interventions to more properly assess how eating pleasure may be an ally in healthy eating promotion.

Based on the literature, a home-based intervention targeting the three dimensions of pleasure from eating as defined by Marty et al. (2018) has been developed, and its impact on the nutritional quality of mid-afternoon snacks chosen by mother-child dyads in the laboratory has been tested (Poquet et al., 2020). One main result of this study revealed the relationship between food liking and perceived healthiness in children increased significantly and became positive after the hedonic intervention, suggesting higher positive attitudes toward healthy foods for the children who had received the hedonic intervention. Because food choices are based in part on whether someone evaluates a food positively or negatively (i.e., food attitude) (Aikman et al., 2006), this result may constitute the first step in a behavioral change in favor of healthier choices. The aim of the present study, which is the second part of the abovementioned study (Poquet et al., 2020), was to assess the impact of a home-based pleasure-oriented intervention on the nutritional value of mid-afternoon snacks spontaneously consumed by children in an ecological setting, i.e., at home in their familial environment. According to the previous results of Cornil & Chandon (2016), we hypothesized that the pleasure-oriented intervention would lead to a decrease in energy intake.

2. Materials and methods

General design

The study took place in Dijon (France) from February to June 2018. The full procedure has been described in detail in the previous paper by Poquet and collaborators (2020). This procedure aimed to examine the effect of a pleasure-oriented intervention on a mid-afternoon snack chosen within a predefined offer of food items in laboratory sessions (data reported in Poquet et al., 2020) and on snacks consumed at home (the present data). For the laboratory sessions, participants were asked to choose, among a set of 10 food items, two food items for their mid-afternoon snack. For home consumptions, they had to note the foods and beverages consumed at home in the afternoon by completing three snack record booklets, one in February before the intervention (T1), a second one in April after the intervention (T2) and a last one in June (T3) (see Section 2.2 below).

One snack record booklet was delivered to each child and to each mother. It is important to note that the children were asked to describe their consumption of mid-afternoon snacks as precisely as possible in their booklet, while the mothers were asked to describe their own consumption of mid-afternoon snacks in their booklet. Since the main focus of the study targeted the child's consumption, only data on children's consumption are reported in the results.

After T1, the participants (n=189) were randomly assigned to an experimental (n=95) or a control group (n=94) by an experimenter who was not present during the sessions (i.e., blind procedure). In the experimental group, the participants successively received three boxes at home, each mobilizing three dimensions of pleasure from eating to stimulate the pleasure of consuming healthy foods. The participants assigned to the control group successively received three boxes targeting the table decoration at home (see details in 2.3).

At T3, a questionnaire was also sent to each participant in which they were invited to indicate their weight and height and to answer questions about their perception and appreciation of the

content and the activities present in the separate boxes (results not presented here). Only results from booklets filled in by children are reported in the present paper.

2.1. Participants

Participants were recruited from a population registered in the Chemosens Platform's PanelSens database, an internal database gathering the contact information of adults having already participated and/or wishing to participate in scientific studies. This database has been declared to the relevant authority (Commission Nationale Informatique et Libertés – CNIL – n°1148039). Participants were also recruited from a consumer recruitment company. The inclusion criterion used for children was a grade level of 3rd, 4th, or 5th grade.

The study was reviewed and approved (Opinion number No 17-426) by the ethics evaluation committee of Inserm (IRB00003888). An information sheet was sent to each mother and each child, in which they were told that the study aimed to better understand the food choices of mothers and their child. The participants were informed that they would participate in two laboratory sessions to choose food products for their own mid-afternoon snacks (see Poquet et al., 2020 for details), that they would receive three boxes at home and that they would have to fill in different questionnaires at home and in the laboratory. Written informed consent was obtained from mothers and their child before their participation in the study.

2.2. Snack record booklets

In February (T1), April (T2) and June (T3), a snack record booklet was delivered to children and another one to mothers (results not shown here), inviting them to precisely describe each beverage and each food item consumed, respectively by children and by mothers, between the end of the lunch and up to the diner on the two weekend days following the receipt of the booklet. Saturday and Sunday were selected because during the week, many children in France

are involved in extracurricular activities after school, during which the mid-afternoon snack is provided by their local municipality, not by their family.

Among the 95 participants of the experimental group, 71 snack record booklets have been completed and returned at T1 (no return n=24), 70 at T2 (no return n=1), and 54 at T3 (no return n=16). Among the 94 participants of the control group, 63 snack record booklets have been completed and returned at T1 (no return n=31), 63 at T2 (no return n=0), and 53 at T3 (no return n=10). The attrition rate was similar in both groups (between recruitment and T1 $Chi^2=0.09$, p=.76, T2 $Chi^2=0.09$, p=0.76 and T3 $Chi^2=0.00$, p=1.00 respectively).

In each booklet, participants were asked to indicate as precisely as possible when each beverage and food item were consumed. The instructions specified that the participants had the possibility to indicate "no consumption" if so. If an unusual event had disrupted the consumption, the participants had the possibility to specify the nature of this event. In the snack record booklet, participants were asked to report the quantities consumed. A guide was included in the snack record booklets to help them to precisely indicate the portion size of each product using photographs of a validated manual of portion sizes (Le Moullec et al., 1996). The guide was composed of pictures corresponding to 21 food items belonging to several categories of food, such as fruits, cereal products, dairy products, fatty-sweet products, and fatty-salty products. The guide's instructions specified that the food items presented in the guide were examples to help them assess the portion size consumed. There were two or three different portion sizes for a given food. The participants could choose a portion size corresponding to one of the pictures, an intermediate portion between two pictures, or a portion size below the first picture or above the last picture. Thus, the value of the estimated portion size could range from 1 to 5 or from 1 to 7. The instructions specified that the use of the guide was not required for food items available in individual portions (e.g., yogurt, apple). For those products, the participants were asked to indicate the number of portions consumed and their weight for solid foods (e.g., for

flask of stewed apple, yogurt) and the volume corresponding to beverages. For other food items, such as chocolate, it was asked to indicate the weight of the chocolate bar. Finally, for spread, jam or honey, the number and type of spoons (teaspoon, big spoon) had to be reported. At T1, it was indicated that the snack record booklets had to be filled in and returned before opening the first box. The fact that the mothers were also asked to complete their snack record booklets for their own consumption and to follow the procedure engaged them in the observance and the supervision of the instructions, notably for the return of the booklets using mail back. This last point clearly could not have been under the responsibility of the children.

2.3. Description of the intervention

The exhaustive content of the experimental and control boxes has been previously described (Poquet et al., 2020). In short, in the experimental group, the participants received at home three boxes targeting each of the three dimensions (sensory, interpersonal and psychosocial dimensions) of pleasure from eating to stimulate the pleasure of consuming healthy foods (Marty et al., 2018). The first box targeted fruits, the second cereal products, and the third dairy products of good nutritional quality. These three categories of foods have been chosen because they are highly recommended by the French National Nutrition and Health Program (PNNS) for children's mid-afternoon snacks (INPES, 2004). Each box contained one card about the five senses describing the sensations and feelings experienced through the different senses when consuming fruits, cereal products or dairy products. These cards referred to the sensory dimension of the pleasure from eating. Each box also contained one kitchen utensil and one recipe associated with a culinary challenge inviting the child, with the help of his or her mother, to use the kitchen utensil present in the box to make a cooking recipe and to post photographs of their culinary creation on a dedicated blog. The culinary challenge referred to the interpersonal dimension of pleasure from eating by involving the dyad in a common activity, which may act as a source of commensal pleasure. Each box finally contained two infographics

about the history and the origin of two foods belonging to the target category (e.g., banana and apple, wheat and oat, or milk and yogurt). At the bottom of each document, a quiz and a game (crossword puzzle and labyrinth) were proposed to engage children in the intervention while entertaining them. These infographics targeted the psychosocial dimension of pleasure from eating by bringing knowledge on foods to modify participants' representations by stimulating positive expectations and thus increase their attraction to fruits, cereal products and dairy products. It is worth noting that the content of these boxes never targeted nutritional or sanitary benefits related to the consumption of the recommended food categories for mid-afternoon snacks.

Each dyad of the control group also received three boxes at home. These boxes were aimed at involving participants in table decoration activities without any direct reference to foods. The content of each box was chosen according to the same scheme as for the experimental group, i.e., with an object (drinking straw, paper napkin, crumb collector, place mat, ice cube molds) and two infographics. The children were invited to participate in creative challenges and to post photographs of their activities on a dedicated blog, different from the blog dedicated for the experimental group.

2.4. Statistical analysis

From the booklets, we considered that all food intakes that were recorded between 3:30 p.m. and 6:30 p.m. to be included in the present analysis. This time slot was selected because it overlaps what is usually reported for mid-afternoon snacks in French children (INPES, 2004). This actually represented 83.4% of children's consumption of snack booklets. A dietician entered the caloric value of each beverage and food item consumed by using the French national dietary database: the 2017 CIQUAL (Centre d'Information sur la Qualité des Aliments - Centre for Information on Food Quality) (Anses, 2017a). This table provides the energy content and

nutritional composition for more than 2800 foods representative of those consumed in France. When the children precisely indicated the brand of the food consumed, we used the nutritional values available on the labels. The energy brought by each beverage and food item consumed by the children was calculated according to the quantity consumed. For each day, the total energy intake (kcal), the total weight intake (g), and the percentage of total energy provided by fat, saturated fatty acids and sugars were thus calculated. Then, for each child, the median of each of these variables over the two days of recording was calculated at T1, T2 and T3.

Each variable, i.e., energy intake, weight, fat, saturated fatty acid and sugar, was considered separately. A mixed model was used to assess group, time and group x time interaction effects on each variable, and to account for repeated measurements. A decrease in energy intake of the snacks was expected only in the experimental group. Thus, significant group x time interactions were hypothesized.

To further examine the effects of the intervention and the role of baseline intake (i.e., energy intake/weight/fat/saturated fatty acid/sugar at T1), children were categorized into low and high initial levels of each outcome via a median split performed on the full sample at T1. This allowed us to examine the difference between subgroups of the effects of the intervention. Existing research on the effects of pleasure-based interventions has found that such interventions work better when people are hungry (Bédard et al., 2020; Lange et al., 2020). Therefore, a significant group x time x initial level interaction was expected, with an intervention effect particularly effective for ‘heavy’ eaters. Thus, interactions with the initial level (i.e., ‘light’ eaters and ‘heavy’ eaters) were added to the previous mixed model.

BMI was calculated and transformed into age- and sex-standardized z-scores (z-BMI) based on the WHO growth reference for school-aged children (de Onis et al., 2007).

Additional non-parametric analyses are also available in Web Appendix1.

Statistical analyses were performed using R version 3.6.1 (2019) and significance was set at $p<0.05$.

3. Results

3.1. Participants

Table 1 summarizes the sociodemographic characteristics of the control and experimental groups. These characteristics were compared using either Student t tests or Chi-square tests. The two groups of children were balanced for gender, age and grade level. The BMI z score was marginally different between groups ($p = 0.047$), with children in the experimental group having a slightly lower mean z-score than those in the control group. However, in both groups, the mean z-BMI was not different from 0, meaning that, on average, the groups were normal weight. There was no significant difference between the two groups in terms of mothers' educational level and household monthly net income.

Insert Table 1 here

3.2. Effect of the intervention

Energy intake. First, it was checked that the medians at T1 were not significantly different between experimental and controls groups (316 and 335 respectively, Wilcoxon test, p=0.27, see Web Appendix 1) to rule out any potential randomization bias.

Insert Figure 1 here

As shown on the left panel of Fig.1 ('all children'), different patterns of energy intake can be described in the control group and in the experimental group. As expected, the mixed model showed a significant group x time interaction (p=0.03, see Table 2). Specifically, between T1 and T2, a significant decrease in energy intake (mean= -69.1 kcal, se=24.2) was observed in the experimental group (t=-2.83, p=0.005), whereas the variation in the control group was not significant (t=0.93, p=0.35), with a significant difference between control and experimental groups (t=-2.62, p=0.01). Between T1 and T3, a significant decrease (mean= -66.3 kcal, se=29.9) was also described in the experimental group (t=-2.59, p=0.01) and the variation was not significant in the control group (t=-0.63, p=0.53), with a non-significant difference between control and experimental groups (t=-1.36, p=0.18).

One outlier in the experimental group at T1 was found, with energy intake higher than 1300 kcal. Additional analyses were conducted without this child, confirming that the conclusions were similar, with a marginal group x time interaction (F(2, 235)=2.78, p=0.06), resulting in a significant decrease between T1 and T2 and between T1 and T3 only in the experimental group (t=-2.40, p=0.02 and t=-2.17, p=0.03), and in a significant difference in decrease between groups between T1 and T2 (t=2.36, p=0.02) but not between T1 and T3 (t=1.05, p=0.29).

To go further, the role of baseline energy intake was examined. Interestingly, a significant interaction group x time x initial level of intake was observed ($F(2, 232)=5.06$, $p=0.007$). As illustrated in Fig.1, for the 'light' eaters, no significant difference between experimental and control groups was found regarding the variation between T1 and T2 ($t=0.15$, $p=0.88$). By contrast, for the 'heavy' eaters, a significant difference was observed ($t=-2.73$, $p=0.007$), with a stronger decrease in energy in the experimental group than in the control group. No difference was found between 'light' eaters and 'heavy' eaters regarding difference between experimental and control groups in variation between T1 and T3 ($t=0.17$, $p=0.86$).

Insert Table 2 here

Weight, Fat, Saturated fatty acid and Sugar. The medians for all children of the control group and the experimental group are illustrated in Fig.2. For weight, as indicated in Table 2, the interaction group x time was only marginal ($p=0.09$), and the interaction group x time x initial level was not significant ($p=0.18$). For the remaining outcomes, no interaction was significant, neither in the full sample nor after splitting according to the initial level of fat, saturated fatty acid, or sugar intake.

Insert figure 2 here

4. Discussion

To the best of our knowledge, this study was the first attempt to assess the impact of a pleasure-oriented intervention implemented at home on global energy intake and on the energy

specifically brought by fat, saturated fatty acids and sugars of mid-afternoon snacks spontaneously consumed by children in their familiar environment. The originality of the present study was that it occurred in a natural setting: namely, the participants of both the experimental and the control groups received the boxes at home without supervisor, and the outcomes targeted (energy intake, weight intake and nutritional quality) were derived and assessed from the mid-afternoon snacks they spontaneously chose and consumed in their own family environment. In this context, we found that the hedonic intervention, by mobilizing different dimensions of pleasure from eating (Marty et al., 2018), had a significant effect on the caloric intake of the snacks spontaneously consumed by children. As expected, a significant decrease in energy intake was observed in the experimental group immediately after the intervention and two months later, and this decrease was significantly different than the variation observed in the control group, which was not significant. In sum, this study seems to highlight lower caloric intake for mid-afternoon snacks in children who received a hedonic intervention supposed to stimulate the pleasure of eating healthy foods, and not in children who received an intervention dealing with table decoration. Notably, the intervention decreased the amount of food eaten but not the average nutritional quality of the snacks, as no significant differential effect of the intervention was obtained in the control group and in the experimental group on the remaining outcomes (fat, saturated acid fat and sugar).

Interestingly, to go further, the results also indicated that a significant decrease in the energy intake was observed in the experimental group compared to the control group only for children with high initial caloric intake. This result is in line with recent studies on the effects of pleasure-based interventions, which found that such interventions work better when people are hungry and would have otherwise chosen a very large portion because these are the people who realize that eating a very large portion is not optimal from a purely hedonic standpoint (Bédard et al., 2020; Cornil & Chandon, 2016; Lange et al., 2021).

To shed light on the nature of the intervention effect, the main analysis on energy intake was completed by the analysis of weight intake and of the percentage of energy provided by fat, saturated fatty acid and sugar to disentangle whether the potential effect was explained by a decrease in the portion of the snacks eaten (potentially reflected in a weight decrease) or by the choice of healthier snacks (changes in the nutritional quality of the intake). The results indicated only a marginal interaction between group and time for weight. No significant effect was observed for the other variables. Thus, one could be tempted to conclude that the decrease in caloric intake observed in the experimental group and not in the control group might be due to a reduced intake or lower portion sizes after the intervention, more than a radical change in favor of healthier snacks. In sum, the intervention decreased the amount of food eaten but not the average nutritional quality of the snacks, with larger effects among 'heavy' eaters than among 'light' eaters. However, additional studies are clearly needed to confirm this.

How can we interpret the decrease in caloric intake in the experimental group? The decrease in caloric intake of snacks consumed by children observed after the hedonic intervention may be interpreted in connection with the theoretical framework of Cornil & Chandon (2016). Specifically, the authors found that 5-year-old children exposed to a food sensory imagery condition chose smaller portions of palatable food after being invited to imagine the multisensory pleasure derived from foods compared to children in a nonfood (control) sensory imagery condition. The authors suggested that this result may occur because sensory imagery prompts children to evaluate portions based on their expected sensory pleasure and to take better into account the phenomenon of "sensory-specific satiation", corresponding to the gradual reduction of the pleasure derived from the consumption of food. Thus, sensory imagery would lead children to choose smaller portions because they would expect a higher pleasure with smaller portions than with larger portions. The reduction of the portion size of a palatable food after having imagined the multisensory pleasure derived from foods was confirmed in older

children aged from 7 to 11 years (Lange et al., 2020). In our study, one could argue that this phenomenon occurs in the children involved in the pleasure-oriented intervention whom sensory imagery could be stimulated by the different activities (i.e., the recipe, the culinary challenge and the infographics) present in the boxes and that the children would then put into practice during their mid-afternoon snack. As described by Cornil & Chandon (2016), we could assume that the anticipation of the pleasure of eating foods triggered by the hedonic intervention might encourage children to choose smaller quantities of mid-afternoon snacks, which in turn induced a global decrease in their caloric intake. In the present study, the point is that the hedonic intervention occurs in the natural setting of children respecting de facto their food habits/preferences. This is quite new since most of the previous studies were conducted in the laboratory, and food choices were made among a predefined list of products that may not be fully equivalent to children's food habits (i.e., Cornil and Chandon, 2016; Lange et al., 2020; Marette et al., 2016; Marty et al., 2017). Specifically, in the study of Poquet et al. (2020), the selection of snacks was predetermined by the experimenters in order to present snacks of various nutritional qualities (Nutri-Score ranging from A to E). The number of food items chosen by the participants was also predefined (2 per participant). This was radically different from what happened in the present study, where the children were simply asked to report what and how much was eaten at home during the afternoon if any. No additional instruction concerning the quantity or the quality of the snacks was given. The children were clearly free to eat what/how much they wanted to. Therefore, in these two-separate controlled versus spontaneous contexts (lab session in Poquet et al, 2020 versus. home protocol here), the conditions and the outcomes are not strictly comparable, and one can expect different effects of the hedonic intervention. Nevertheless, it is worth noting that we did not see any effect of the intervention on the quality of snacks consumed at home (i.e., qualitative dimension of snack intake) since no significant effect has been observed on the nutritional variables (fat, saturated

fatty acid and sugar percentage of total energy intake), which is in line with what was observed in the lab protocol (Poquet et al., 2020). One could argue that the hedonic intervention seems to act more on food intake (i.e., quantitative dimension), as reflected in the significant decrease in caloric intake observed here only in the experimental group, an aspect that could not be seen in the lab session (Poquet et al., 2020) as the food was prepackaged and therefore presented in fixed quantities. Nevertheless, in Poquet et al. (2020), a relevant effect of the hedonic intervention was observed on children's attitudes, resulting in more positive attitude towards healthy foods in children from the experimental group but not in the control group; this attitudinal shift was interpreted as the first step in a change in favor of healthier choices.

The results of our study seem to corroborate in a natural setting the hypothesis of Cornil and collaborators (2016) on the positive influence of anticipation of sensory pleasure from eating on the quantitative dimension of food choices in children. Another point is that the pleasure-oriented intervention, by emphasizing the pleasure from eating, avoids any stigmatization of *a priori* unhealthy foods but alternatively proposes caring guidance to stimulate pleasure of eating healthy foods. This guidance, by stimulating sensory awareness, may have favored children's sensitivity to her or his internal sensations and conscious sensory experience of eating, which may explain why children have consumed fewer calories for their mid-afternoon snacks.

As described above, the hedonic intervention was supposed to stimulate different dimensions of pleasure to favor, in turn, the enjoyment of eating healthy foods for mid-afternoon snacks in children. We have described just above how the sensory dimension of the intervention may have led children to consume lower energy intake for their snacks, by reconnecting the child to her or his internal sensations through the conscious sensory experience of eating, and thanks to the anticipation of food enjoyment which lead them to favor smaller portion size as shown before (Cornil & Chandon, 2016; Lange et al., 2020). Not only the sensory dimension but also the interpersonal and social dimensions may have been activated by the hedonic intervention.

Specifically, the different infographics about the history and origin of the foods, the activities (quiz, crossword puzzle and labyrinth, etc.) as well as cooking recipe cards, culinary challenges involving the co-participation of the parent and the child may have increased children's attraction to the foods targeted in the intervention. This interpretation is in line with a recent experimental study showing that images in which healthy food products are shared induced more enjoyment than images in which the same foods were eaten alone (Maldoy et al., 2020). Even if in the present study we did not actually observe a radical shift from unhealthy to healthy foods for the mid-afternoon snacks, it could be assumed that the commensality and interpersonal pleasure shared by the children and their mothers in the hedonic intervention group may have reinforced their attention toward foods and their sensory properties, which in turn may have strengthened the conscious sensory experience of eating and epicurean pleasure.

The present study has several limitations. First, we cannot exclude misreporting when children fill in the snack record booklets. However, there is no reason that these errors differed between groups and/or at the separate time points. To reduce the error risk while reporting the snacks consumed by the children, precise instructions were given in the snack record booklets. The vocabulary used and the presentation of the snack record booklets were chosen to be appropriate for children. Second, our sample consisted of children whose mothers had a quite high level of education (see Table 1). Thus, one can wonder if similar results would be obtained with children from lower socioeconomic levels. Third, we evaluated the nutritional value of the snacks with a limited number of variables. However, this focus was justified by nutritional quality data for mid-afternoon snacks mostly consumed by French children, showing that they are particularly high in sugars and energy (Anses, 2017b). Finally, only assumptions might be put forward on the exact nature of the mechanism of the hedonic intervention effect, since there were no process measures, and it is well known that effects may be multifactor determined. For instance, one could argue that it is difficult to conclude that any effects were brought about by an

increased focus on hedonic pleasure, as no measures of hedonic pleasure were taken. It is also possible that other aspects of the intervention were responsible for the effects. For example, a desire to experiment with the new recipe and utensil may have made children more likely to select snacks with a higher water or fiber content, which may have meant they filled up more quickly on fewer calories. Nevertheless, all things being equal, the fact that no significant decrease in caloric intake was observed in the control group strengthens the relevance of the hedonic intervention. Moreover, it is worth noting that the intervention never emphasized the nutritional quality of the foods or the heathy values of the food targeted in the intervention. The intervention was a hedonic intervention aimed at stimulating the different dimensions of pleasure of eating (Marty et al., 2018): by creating positive expectations, favoring commensality and stimulating curiosity, enthusiasm and taste for the targeted foods. Therefore, even if an effect of social desirability cannot be excluded, it may not be linked with health or nutritional considerations since these considerations were never explicitly highlighted in the intervention.

Further research is needed to confirm these effects and to more properly assess whether a pleasure-oriented intervention could be effective for children from low socioeconomic families and/or for children with different weight statuses. Again, the question of the relevance of a hedonic intervention for different eating situations (e.g., breakfast, lunch, etc.) and in different food cultures remains open.

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Table 1 Sociodemographic characteristics of the participants in the control group and the experimental group.

		Control *n* = 63	Experimental *n* = 70
Child gender (%)	(Chi²=0.01, p=0.91)		
Female		47.6	48.6
Male		52.4	51.4
Child age (years): mean (standard deviation)*		9.3 (0.9)	9.5 (0.8)
Child grade level (%)	(Chi²=1.59, p=0.45)		
3rd grade		44.4	34.3
4th grade		30.2	38.6
5th grade		25.4	27.1
Child's z-BMI (standard deviation)**		0.2 (1.3)	-0.3 (1.1)
Mothers age (years): mean (standard deviation)		39.3 (4.4)	40.3 (4.5)
Mother education (%)	(Chi²=0.16, p=0.92)		
Lower than advanced level (A-level) qualification		9.5	8.6
Advanced level (A-level) qualification		22.2	20.0
Higher than Master 2		68.3	71.4
Household monthly net income (%)	(Chi²=2.06, p=0.56)		
< 2000 €		15.9	25.7
< 3000 €		28.6	25.7
< 4000 €		34.9	28.6
≥ 4000 €		20.6	20.0

* Data were available for 58 children in the control group and for 69 children in the experimental group due to incoherent values.

** Data were available for 38 children in the control group and for 45 children in the experimental group due to missing values for weight and height or age.

Table 2 Mixed model for each outcome (energy intake, weight, percentage of total energy provided by fat, saturated fatty acid and sugar): Fisher statistic (F) and p-value (p) for group effect (gr), time effect (t), group x time interaction (gr x t), where initial level is the two-level factor obtained by median split at T1. Fisher statistic and p-value for gr x t x level are obtained in a second model where group x time x initial level interaction is added.

	gr		t		gr x t		gr x t x level[a]	
Outcome	F	p	F	p	F	p	F	p
Energy intake	0.11	0.74	2.78	0.06	**3.44**	**0.03**	**5.06**	**0.01**
Weight	0.06	0.80	0.60	0.55	2.41	0.09	1.75	0.18
Fat	0.46	0.50	1.52	0.22	0.31	0.74	1.76	0.17
Saturated fatty acid	0.11	0.74	0.87	0.42	0.05	0.95	1.82	0.16
Sugar	0.05	0.82	4.18	0.02	1.14	0.32	0.81	0.45

[a] Interaction added in a second mixed model

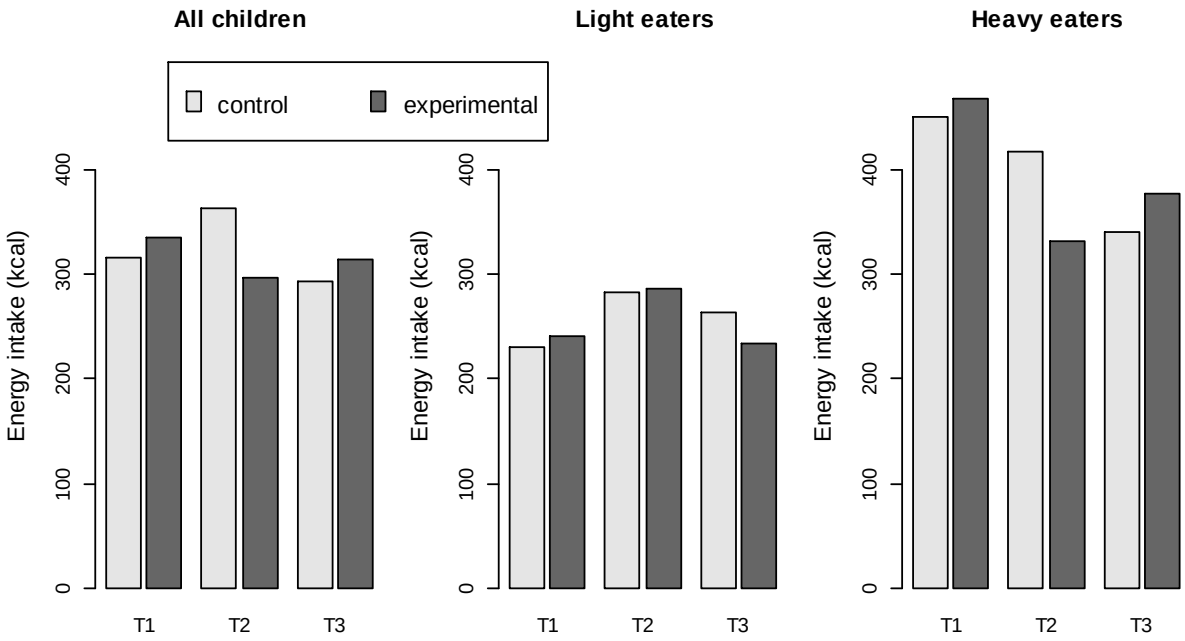

Figure 1. Energy intake (medians), at T1, T2 and T3, in the control group and in the experimental group, for the children taken together (all children), for the same children split into two groups, low initial level (light eaters) and high initial level (heavy eaters), according to a median split performed on energy intake at T1.

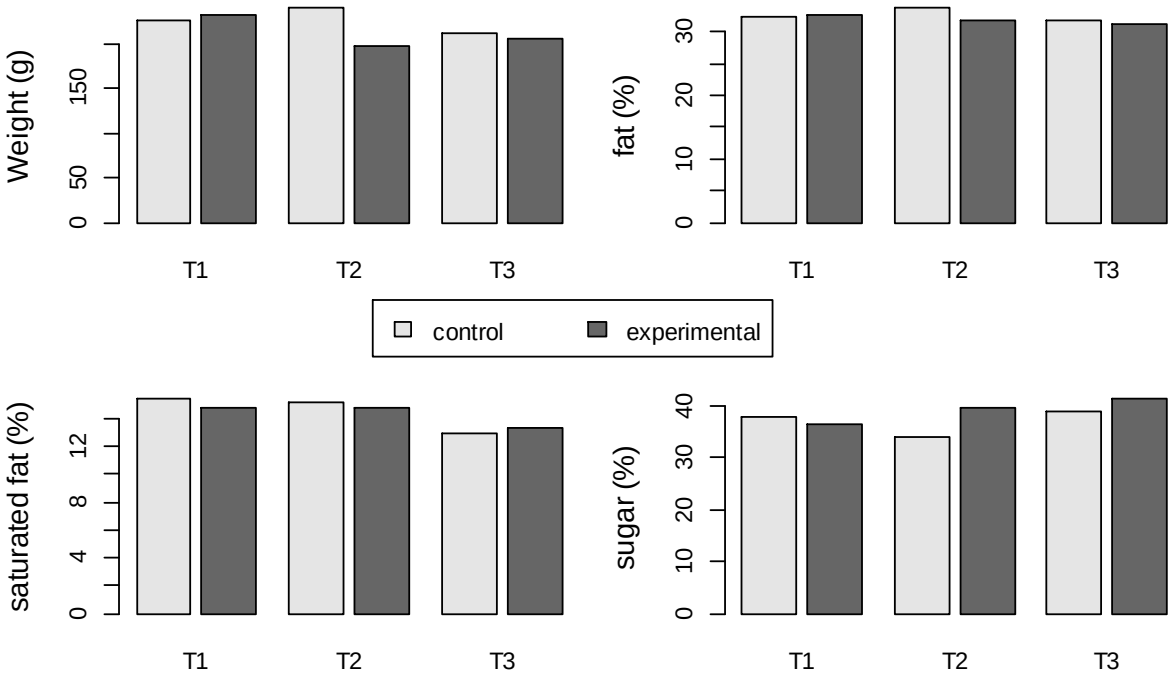

Figure 2. Weight, fat, saturated fat and sugar percentage of total energy (medians) in the control group and in the experimental group at T1, T2 and T3 for all children.