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1 **Effect of a pleasure-oriented intervention conducted at home on the energy intake of**
2 **mid-afternoon snacks consumed by children**

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29

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31

32 **Abstract**

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

44

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

46

47 **1. Introduction**

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

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

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

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

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

104 Based on the literature, a home-based intervention targeting the three dimensions of pleasure
105 from eating as defined by Marty et al. (2018) has been developed, and its impact on the
106 nutritional quality of mid-afternoon snacks chosen by mother-child dyads in the laboratory has
107 been tested (Poquet et al., 2020). One main result of this study revealed the relationship between
108 food liking and perceived healthiness in children increased significantly and became positive
109 after the hedonic intervention, suggesting higher positive attitudes toward healthy foods for the
110 children who had received the hedonic intervention. Because food choices are based in part on
111 whether someone evaluates a food positively or negatively (i.e., food attitude) (Aikman et al.,
112 2006), this result may constitute the first step in a behavioral change in favor of healthier
113 choices. The aim of the present study, which is the second part of the abovementioned study
114 (Poquet et al., 2020), was to assess the impact of a home-based pleasure-oriented intervention
115 on the nutritional value of mid-afternoon snacks spontaneously consumed by children in an
116 ecological setting, i.e., at home in their familial environment. According to the previous results
117 of Cornil & Chandon (2016), we hypothesized that the pleasure-oriented intervention would
118 lead to a decrease in energy intake.

119 **2. Materials and methods**

120 **General design**

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

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

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

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

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

146 *2.1. Participants*

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

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

161 *2.2. Snack record booklets*

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

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

169 Among the 95 participants of the experimental group, 71 snack record booklets have been
170 completed and returned at T1 (no return n=24), 70 at T2 (no return n=1), and 54 at T3 (no return
171 n=16). Among the 94 participants of the control group, 63 snack record booklets have been
172 completed and returned at T1 (no return n=31), 63 at T2 (no return n=0), and 53 at T3 (no return
173 n=10). The attrition rate was similar in both groups (between recruitment and T1 $\chi^2=0.09$,
174 $p=.76$, T2 $\chi^2=0.09$, $p=0.76$ and T3 $\chi^2=0.00$, $p=1.00$ respectively).

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

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

200 *2.3. Description of the intervention*

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

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

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

233 *2.4. Statistical analysis*

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

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

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

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

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

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

265 Statistical analyses were performed using R version 3.6.1 (2019) and significance was set at
266 $p < 0.05$.

267

268 **3. Results**

269 *3.1. Participants*

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

278 *Insert Table 1 here*

279

280 3.2. Effect of the intervention

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

284

285

Insert Figure 1 here

286 As shown on the left panel of Fig.1 ('all children'), different patterns of energy intake can be
287 described in the control group and in the experimental group. As expected, the mixed model
288 showed a significant group x time interaction ($p=0.03$, see Table 2). Specifically, between T1
289 and T2, a significant decrease in energy intake (mean= -69.1 kcal, $se=24.2$) was observed in the
290 experimental group ($t=-2.83$, $p=0.005$), whereas the variation in the control group was not
291 significant ($t=0.93$, $p=0.35$), with a significant difference between control and experimental
292 groups ($t=-2.62$, $p=0.01$). Between T1 and T3, a significant decrease (mean= -66.3 kcal,
293 $se=29.9$) was also described in the experimental group ($t=-2.59$, $p=0.01$) and the variation was
294 not significant in the control group ($t=-0.63$, $p=0.53$), with a non-significant difference between
295 control and experimental groups ($t=-1.36$, $p=0.18$).

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

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

310 *Insert Table 2 here*

311
312 *Weight, Fat, Saturated fatty acid and Sugar.* The medians for all children of the control group
313 and the experimental group are illustrated in Fig.2. For weight, as indicated in Table 2, the
314 interaction group x time was only marginal ($p=0.09$), and the interaction group x time x initial
315 level was not significant ($p=0.18$). For the remaining outcomes, no interaction was significant,
316 neither in the full sample nor after splitting according to the initial level of fat, saturated fatty
317 acid, or sugar intake.

318 *Insert figure 2 here*

319

320

321 **4. Discussion**

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

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

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

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

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

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

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

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

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

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

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

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

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

468

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

	Control <i>n</i> = 63	Experimental <i>n</i> = 70
Child gender (%) (Chi ² =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 (%) (Chi ² =1.59, p=0.45)		
3 rd grade	44.4	34.3
4 th grade	30.2	38.6
5 th 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 (%) (Chi ² =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 (%) (Chi ² =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

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

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

548

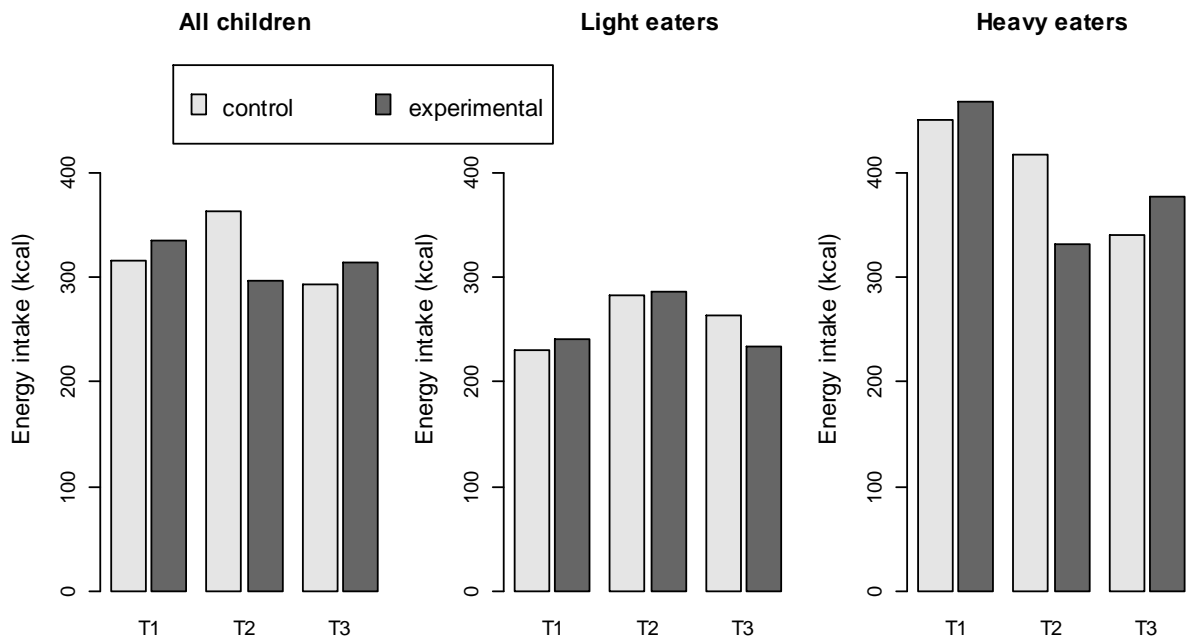
549 **Table 2** Mixed model for each outcome (energy intake, weight, percentage of total energy
 550 provided by fat, saturated fatty acid and sugar): Fisher statistic (F) and p-value (p) for group
 551 effect (gr), time effect (t), group x time interaction (gr x t), where initial level is the two-level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

554

Outcome	gr		t		gr x t		gr x t x level ^a	
	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

555 ^a Interaction added in a second mixed model

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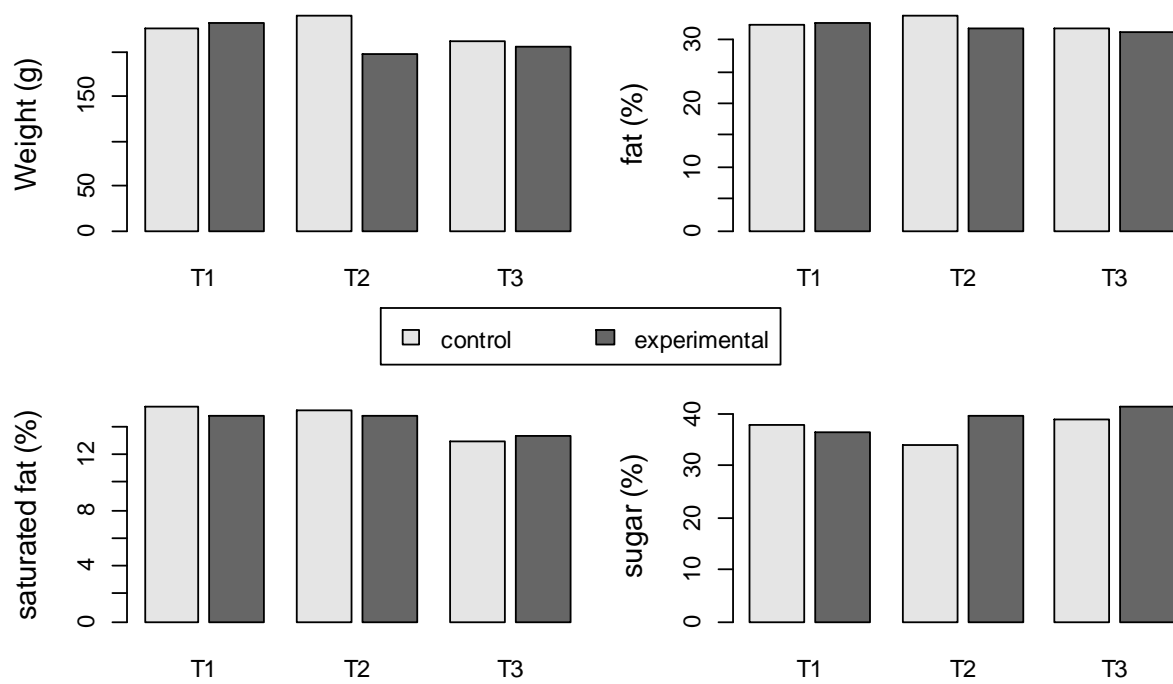


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558 **Figure 1.** Energy intake (medians), at T1, T2 and T3, in the control group and in the
 559 experimental group, for the children taken together (all children), for the same children split
 560 into two groups, low initial level (light eaters)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

562

563



564

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