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**MONOTONOUS CONSUMPTION OF FIBRE-ENRICHED BREAD
AT BREAKFAST INCREASES SATIETY AND INFLUENCES
SUBSEQUENT FOOD INTAKE**

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ABSTRACT

This study aimed to observe the influence of the monotonous consumption of two types of fibre-enriched bread at breakfast on hedonic liking for the bread, subsequent hunger and energy intake. Two groups of unrestrained normal weight participants were given either white sandwich bread (WS) or multigrain sandwich bread (MG) at breakfast (the sensory properties of the WS were more similar to the usual bread eaten by the participants than those of the MG). In each group, two 15-day cross-over conditions were set up. During the experimental condition the usual breakfast of each participant was replaced by an isocaloric portion of plain bread (WS or MG). During the control condition, participants consumed only 10 g of the corresponding bread and completed their breakfast with other foods they wanted. The results showed that bread appreciation did not change over exposure even in the experimental condition. Hunger was lower in the experimental condition than in the control condition. The consumption of WS decreased energy intake while the consumption of MG did not in the experimental condition compared to the corresponding control one. In conclusion, a monotonous breakfast composed solely of a fibre-enriched bread may decrease subsequent hunger and, when similar to a familiar bread, food intake.

Keywords

Dietary fibre, weight loss, monotony, variety, staple foods, bread, food intake, satiety, satiation, breakfast

Introduction

Several studies have shown that a high-fibre diet may increase satiety and decrease energy intake (for recent studies see Lyly et al., 2009; Schroeder, Gallaher, Arndt, & Marquart, 2009; Willis, Eldridge, Beiseigel, Thomas, & Slavin, 2009). Several mechanisms have been put forward to explain the lower hunger/energy intake following the ingestion of dietary fibre (Burton-Freeman, 2000; Heaton, 1973; Howarth, Saltzman, & Roberts, 2001; Tunland & Meyer, 2002). Dietary fibre increases chewing, which is thought to reduce the rate of ingestion (Heaton, 1973). It increases saliva and gastric juice production and therefore increases gastric volume (Norton, Anderson, & Hetherington, 2006; Rolls & Roe, 2002). Furthermore, the gel-forming capacity of soluble fibre increases gastric distension (Burton-Freeman, 2000). This distension is involved in producing satiation during a meal (de Graaf, Blom, Smeets, Stafleu, & Hendriks, 2004) and satiety between meals (Wang et al., 2008). Fibre decreases nutrient absorption in the intestine and thus reduces the metabolisable energy from available food (Baer, Rumpler, Miles, & Fahey, 1997; Wisker, Maltz, & Feldheim, 1988). Fibre, particularly soluble fibre, also increases chyme viscosity, thereby slowing transit time in the small intestine which triggers the secretion of Glucagon Like Peptide-1 (Reimer & McBurney, 1996), of cholecystokinin, of ghrelin (Weickert et al., 2006) and of peptide YY (Reimer et al., 2010).

The aim of the present experiment was to assess whether replacing the usual breakfast of normal bodyweight participants by an isocaloric portion of fibre-enriched bread over several days would affect subsequent satiety and food intake. At first sight, it was expected that a fibre-enriched breakfast would reduce hunger sensation during the

morning and decrease food intake during subsequent meals. However, it was unclear whether or not this effect would persist over several days (e.g. over repeated consumption) of fibre-enriched bread. In fact, several studies have shown that repeated monotonous consumption of a food induces a decrease in pleasure for that food (Rolls & de Waal, 1985; Schutz & Pilgrim, 1958; Siegel & Pilgrim, 1958). Thus, the repeated consumption of fibre-enriched bread may lead to a reduction in pleasure, which in turn may have an adverse effect on subsequent food intake. This question is obviously of particular interest to those who wish to promote better weight management through the consumption of “functional” food such as fibre-enriched foods.

This study was conducted using two types of fibre-enriched sandwich bread. In both types, the quantity of fibre was about five times higher than in a traditional French baguette. The ratio of soluble/insoluble fibre was similar between the two breads but the source of the fibre differed. One bread (White Sandwich - WS) was formulated to look like white sandwich bread because French consumers are used to eat white bread (75% of the bread eaten in France in 2009 was white bread). The other (Multigrain - MG) bread actually looked like a multigrain bread with inclusions and was less familiar to French consumers. The choice of exposing participants to sandwich bread at breakfast was motivated by the work of de Castro (2007) who observed that a high level of carbohydrate consumed during the morning reduced total food intake for the rest of the day.

The present experiment aimed to assess whether or not the effect of monotonous consumption of fibre-enriched bread could influence subsequent satiety and food intake, and whether such an effect depended on the type of bread eaten by the participants.

88 **Materials and methods**

89 ***Design***

90 The two types of bread were tested in a between-subject design. For each group,
91 the study consisted in two periods of 15 days. In one period, the experimental
92 condition, the participants' breakfast consisted exclusively of fibre-enriched bread (*i.e.*
93 WS or MG, depending on the group). For each participant, the quantity of bread
94 consumed provided an energy intake that was similar to that of the participants' usual
95 breakfast according to food diaries (see below). In the other period, the control
96 condition, participants ate a small portion of fibre-enriched bread (10 g) and then
97 completed their breakfast with the food of their choice. The quantity of fibre in such a
98 small portion was negligible, but it allowed controlling for a possible effect of repeated
99 exposure to the sensory characteristics of the bread that was independent from the effect
100 of the fibre. For each condition, liking, hunger and food intake were measured and
101 recorded at regular intervals (see below).

102 ***Participants***

103 Participants were recruited by a local advertisement. All were bread eaters. To
104 participate, candidates had to be aged between 20 and 45, have a Body Mass Index
105 (BMI) between 19 and 25 kg/m² and be in the habit of eating breakfast, including at
106 least one solid food, every day. Candidates also had to obtain a restriction score equal
107 to or below 9 (Stunkard & Messick, 1985). Finally, any candidates with food allergies,
108 or who were undergoing medical treatment, or who smoked more than five cigarettes a
109 day were excluded. The characteristics of both groups are presented in Table 1.

Individual informed consent was obtained before the experiment. The protocol was approved by the ethics committee of Dijon, France (CPP-Est-I). Participants received a €100 fee for their participation.

Breads

The bread WS was enriched with fibres from wheat bran and formulated to look like a white sandwich bread. The bread MG was enriched with fibres from other cereals (oat, rye) and formulated to look like a multigrain bread with inclusions. Both breads were provided by Gustalis (Longvic, France). Their composition is shown in Table 2.

Prior to the study, a Flash Profile (Dairou & Sieffermann, 2002) was carried on the two breads and on four branded breads belonging to the same product range with 32 participants different from the participants of the present study. Results showed that the sensory characteristics of WS and MG breads were similar to the ones of the branded breads. Specifically, the WS bread was characterized by a light colour, a soft texture and a slightly sweet taste, while the MG bread was characterized by a slightly darker colour and a larger number of inclusions corresponding to the grain particles. Given the habits of French participants and the results of the Flash Profile, the WS bread corresponded more to a "white bread" while the MG bread corresponded more to a "multigrain bread".

Procedure

Food diaries

Before the study, participants recorded and weighed all foods and beverages consumed at three consecutive regular breakfasts eaten at home (precision required was

± 1g). These diaries were then analysed using Bilnut software (S.C.D.A. Nutrisoft, Cerelles, France) in order to calculate the usual energy intake for each participant at breakfast and subsequently to determine the amount of bread (WS or MG) to be consumed by each individual during the experimental period.

Phases of exposure

For each group (WS or MG), there were two periods of a fortnight each. During the experimental condition, participants were required to consume the equivalent in bread (WS or MG) of their usual energy intake. Participants were requested to eat the bread plain, without butter or jam in order to avoid inter-individual differences. In fact, without this constraint, some participants would have chosen to eat the bread with jam, others with butter (or margarine) or with both jam and butter. In addition to the bread, the participants were allowed to drink their usual beverage (e.g. coffee or tea). It should be noted that in the experimental condition, the mean breakfast intake of dietary fibre was not different between the WS group (M=14.9; σ =6 g) and the MG group (M= 21.6; σ =10 g). During the control condition, participants were required to consume 10 g of WS or MG bread at each breakfast. They could complete their breakfast with their usual food and drink choices.

The participants received their daily bread ration in separate freezing bags. They were instructed to thaw the bread by placing it at room temperature the evening before consumption. Breakfasts were eaten at home and participants were instructed not to share their rations with other family members. They were also instructed to consume all the bread provided at breakfast. In order to check compliance, participants were asked to bring back their freezing bags each time they came to the laboratory for new

supplying. Six participants (5 for the bread MG; 1 for the bread WS) brought back a small portion of non-eaten bread during the first days of the experiment but after further discussion, they adapted themselves to the ration.

At each breakfast, participants were required to give a hedonic rating for the bread at the first mouthful. Participants were also asked to rate their sensation of hunger before breakfast, immediately after breakfast, at 10 am and at noon. These assessments were made on visual analogue scales of 10 cm anchored at each end ("Extremely unpleasant" / "Extremely pleasant" and "I am not hungry at all" / "I am extremely hungry", respectively). On the second, sixth, tenth and fourteenth day of each phase of exposure (D2, D6, D10, D14), participants were also required to record and accurately weigh all foods and beverages consumed during the day (Clatronic KW204 scale, Kempen, Germany, precision required: 1 g).

Data analysis

The grades on the scales were converted into scores from 0 to 10 by measuring the distance between the left anchor and the mark made by the participant. The food diaries filled in during the two periods were analysed using Bilnut software (S.C.D.A. Nutrisoft, Cerelles, France) to determine the total energy intake per meal and per day (breakfast, lunch and dinner).

The evolution of various parameters (hunger, pleasure, energy, carbohydrate, fat and protein intakes) during the periods was modelled using a linear mixed model with *condition* as a fixed effect, and *exposure* and *participant* as random effects. For the random element, an appropriate correlation structure was sought to account for possible correlations between measurements taken at different times for a given participant. A

compound symmetry (CS) correlation structure was chosen because it led to the lowest Akaike criterion (AIC) for most of the parameters. Only linear factors were retained in the final models (Table 3), as the quadratic factors ($exposure^2$ and $exposure^2 \times condition$) were not significant. Statistical analyses were performed using the MIXED procedure of SAS software (SAS Institute Inc., Cary, NC, USA).

Results

Effect of repeated consumption of a fibre-enriched bread at breakfast on the hedonic liking of this bread

Fig. 1 shows the evolution of liking scores during consumption of the first mouthful of bread at breakfast, according to the condition and the bread consumed. Marginal ANOVA obtained with the general linear model did not reveal any *condition* effect for the WS bread (Table 3). No difference in liking for the first mouthful of bread at breakfast between the experimental condition and the control condition for the WS bread (experimental condition: $M = 5.1$, S.D. = 2.6; control condition: $M = 4.9$, S.D. = 2.6) was observed. In contrast, a significant *condition* effect was observed for the MG bread: participants appreciated this bread less in the experimental condition ($M = 5.1$, S.D. = 2.7) than in the control condition ($M = 6.0$, S.D. = 2.7). As, in both conditions, participants gave their hedonic rating at the first mouthful, this difference may be related to what they have to eat. So, their expectations were lower when they had to eat a large quantity than when they had to eat just a mouthful. Liking for the breads did not decrease over repeated consumptions: in fact regardless of the bread consumed, the

exposure effect was not significant. Moreover, the *exposure*condition* interaction was not significant.

Effect of repeated consumption of a fibre-enriched bread at breakfast on subsequent sensation of hunger

Fig. 2 shows the evolution of the sensation of hunger at four times of the day: before breakfast, after breakfast, at mid-morning and at noon, for both the WS and MG bread. For the WS bread, ANOVA did not reveal any significant condition effect before breakfast: the sensation of hunger in the experimental condition ($M = 4.9$, S.D. = 2.7) was not different from that in the control condition ($M = 5.0$, S.D. = 2.7). In contrast, a *condition* effect was observed immediately after breakfast, at 10 am and at noon. At each of these times, the sensation of hunger was rated lower in the case of the experimental condition (after breakfast: $M = 1.0$, S.D. = 1.5; at 10 am: $M = 1.7$, S.D. = 1.7; at noon: $M = 4.4$, S.D. = 3.9) than for the control condition (after breakfast: $M = 2.0$, S.D. = 2.2, at 10 am: $M = 2.7$, S.D. = 2.5; at noon: $M = 5.2$, S.D. = 2.8). A significant *exposure* effect was also observed for measurements at 10 am and at noon, showing an increase in hunger ratings at both of these times over subsequent days of the study.

For the MG bread, a condition effect was observed before breakfast: the hunger rating was slightly lower in the experimental condition ($M = 5.3$, S.D. = 2.4) than in the control condition ($M = 5.6$, S.D. = 2.8). This effect was nonetheless slight compared to the significant *condition* effect observed at 10 am and at noon. Once again, at each of these times, the sensation of hunger was rated lower in the experimental condition (at 10 am: $M = 2.4$, S.D. = 2.4; at noon: $M = 6.0$, S.D. = 2.7) than in the control condition (at

10 am: $M = 3.5$, S.D. = 2.7; at noon: $M = 6.8$, S.D. = 2.1). An *exposure* effect was also observed for the evaluations before breakfast, immediately after breakfast and at noon, showing a decrease in hunger ratings just before and just after breakfast over subsequent days of the study on the one hand, and an increase at noon on the other.

Effect of repeated consumption of a fibre-enriched bread at breakfast on energy intake throughout the day

Fig. 3 shows the evolution of the total energy intake at breakfast and for the rest of the day during each period of exposure (D2, D6, D10 and D14). For intake at breakfast, marginal ANOVA did not reveal any significant *condition*, *exposure* or *exposure*condition* effect, regardless of the group considered (Table 3). The energy intake for the experimental condition (WS bread: $M = 392$ kcal, S.D. = 173; MG bread: $M = 393$ kcal; S.D. = 148) was not different from the energy intake for the control condition (WS bread: $M = 394$ kcal; S.D. = 241; MG bread: $M = 354$ kcal; S.D. = 207). These results therefore demonstrated that at breakfast, energy intake for the experimental condition was equivalent to the energy intake for the control condition, during which participants supplemented the required consumption of 10 g of bread with their usual food and beverage choices.

Regarding the energy intake calculated for the rest of the day, data analysis revealed a significant *condition* effect for both the WS bread and the MG bread, but these effects were opposite (Table 3 and Figure 3). In fact, for the WS bread the experimental condition reduced energy intake for the rest of the day compared to the control condition (mean 4 days values $M = 1263$ kcal; S.D. = 120 and $M = 1424$ kcal; S.D. = 120 respectively). In contrast, for the MG bread the experimental condition

increased energy intake for the rest of the day compared to the control condition ($M = 1408$ kcal; S.D. = 85 and $M = 1261$ kcal; S.D. = 85 respectively). The *exposure* and *exposure*condition* effects were not significant for either type of bread. The same pattern of results was observed when intakes were analysed per meal (lunch, dinner) (data not shown).

Discussion

In accordance with the hypotheses, replacing the participants' breakfast with a monotonous consumption of fibre-enriched bread (WS or MG) led to a decrease in the sensation of hunger during the morning. However, the decrease in hunger coincided with a decrease in subsequent energy intake for the WS bread, but an increase in energy intake for the MG bread. Results also showed that repeated consumption of these types of bread at breakfast did not lead to decreased liking for the breads over the course of the study, even in the experimental condition.

Data in the literature has shown that repeated - monotonous - consumption of a food generated a decrease in intake and/or in liking for that food (Cabanac & Rabe, 1976; Rolls & de Waal, 1985; Zandstra, de Graaf, & van Trijp, 2000). For instance, Cabanac and Rabe (1976) observed a reduction of 25 to 50% in food intake when normal weight subjects were given a complete liquid diet everyday, at each meal, for three consecutive weeks. In an unpublished study conducted in our laboratory, ten unrestrained participants of normal weight ate the same food exclusively - ravioli - at every meal for three consecutive days (for breakfast, lunch and dinner). The results showed a significant reduction in overall food intake (-33% on the third day) compared

267 to a control situation. Zandstra et al. (2000) observed that consumption of a savoury
268 sauce once a week for ten consecutive weeks resulted in a decrease in the amount of
269 sauce consumed, even though the participants could combine the sauce with the food of
270 their choice. Concurrent with this decrease, Zandstra and colleagues (2000) observed a
271 decrease in hedonic liking for these sauces. However, several authors have observed
272 that repeated consumption of “staple foods” did not affect their hedonic liking
273 (Hetherington, Pirie, & Nabb, 2002; Kamen & Peryam, 1961; Meiselman, de Graaf, &
274 Lesher, 2000). The FAO defines staple foods as foods that are eaten regularly and in
275 such quantities as to constitute the dominant part of the diet and supply a major
276 proportion of energy and nutrient needs. Staple foods are generally cereal products that
277 constitute a major part of a diet and are culture-specific (e.g., bread in France, rice in
278 Southeast Asia). Meiselman et al (2000) focused on the evolution in liking for a food
279 which is initially highly palatable - chocolate - compared to a moderately palatable food
280 belonging to the *staple food* category - buttered bread - over the course of repeated
281 consumption (once a day for 22 days). The results showed that liking for chocolate
282 decreased greatly over the course of subsequent consumption, while liking for buttered
283 bread remained close to its initial level. Consequently, Meiselman and colleagues
284 suggested characterising staple foods as “staple components of a diet [that] are resistant
285 to monotony effects”. Due to their predominance in a population’s diet and to their
286 resistance to the monotony effect, it has been suggested that staple foods could be used
287 to fight against certain food disorders. Bouis (2000) and Welch and Graham (2004)
288 suggested enriching staple foods with macronutrients in order to combat nutritional
289 deficiencies caused by under-nutrition. Conversely, improving the nutritional quality of
290 staple foods could be a useful means to prevent and/or treat diabetes and obesity (Franz

et al., 2002; Thompson et al., 2005). The present study confirmed that repeated consumption of a large quantity of bread did not induce lassitude for bread. These results substantiate the advantages of bread as a way to improve the nutritional quality of diets for French people.

The decrease in hunger after the consumption of the two breads and the lower intake after the WS bread could be attributed to the presence of dietary fibre. In fact, some studies have shown that repeated consumption of a fibre-enriched food can lead to a reduction in energy intake and weight in obese patients (Rössner, Von Zweigbergk, Öhlin, & Rytting, 1987; Stevens et al., 1987). Pasman and colleagues (Pasman, Saris, Wauters, & Westerterp-Plantenga, 1997) showed that the consumption of orange juice containing a guar gum supplement (soluble fibre) for a week led to a decreased sensation of hunger, resulting in reduced energy intake, compared to a control situation where participants received orange juice without added fibre. In accordance with these results, we observed that replacing a standard breakfast with an isocaloric amount of WS bread led to a decreased sensation of hunger during the morning and a reduction in subsequent energy intake. In contrast, while replacing breakfast with an isocaloric amount of MG bread also led to a decreased sensation of hunger, this decrease did not result in a reduced caloric intake. On the contrary, in the experimental condition for this bread, participants slightly increased their caloric intake during subsequent eating events.

The difference between the effect of WS and MG bread consumption on subsequent food intake, albeit a similar decrease in hunger sensation in both conditions, underlines the fact that measurement of the sensation of hunger (as performed here with visual analogue scales) does not always predict actual food intake. A number of studies

have shown relationships between measurements of hunger and food intake (e.g. de Castro & Elmore, 1988) but Mattes (1990) noted that rating the sensation of hunger is a learned rather than an innate reflection of the systems that control appetite. Beyond this methodological aspect, several hypotheses can be proposed to explain why the decreased sensation of hunger induced inconsistent reductions in energy intake.

One possible explanation relates to the nature of the fibre used to formulate WS and MG bread. In fact, some authors evidenced that the origin of fibre might play a role in the decrease in hunger sensation or caloric intake. For example, Hlebowicz et al. (2007) did not observe any difference in hunger ratings after ingestion of cereal bran flakes, wholemeal oat flakes or corn flakes. On the contrary, Willis et al. (2009) observed that participants were less hungry after ingestion of a preload of muffins with resistant starch or corn bran than muffins with barley oat. Furthermore, some authors observed that an ingestion of fibre led to a dissociation between hunger and food intake (e.g., Schroeder et al., 2009) whereas others observed that a decrease in hunger sensation led to a decrease in subsequent energy intake (e.g., Lee et al., 2006). Another possible explanation to explain the differential effect of the two breads on energy intake could be related to the difference in liking between the experimental and the control conditions that was observed for the MG bread but not for the WS bread. It is possible that having to eat a relatively large amount of the MG bread induced a feeling of "discomfort" among participants. Participants may then have compensated for this "discomfort" by increasing their subsequent food intake. A last explanation relates to cognitive associations related to the appearance of the bread. Participants may have associated the MG bread with a high fibre-content (in fact, it was formulated to look like multigrain bread), and, in turn, to low caloric foods. Thus, it is possible that

subjects ate more on the rest of day as they erroneously believed that they had a low energy breakfast when they had MG bread in comparison to WS bread. However, those hypotheses deserve further evaluation. A better understanding of the physiological and/or psychological mechanisms responsible or not of the decrease of subsequent food intake after fibre ingestion could be a challenge for future studies.

Conclusion

The present study indicates that the consumption of a monotonous enriched-fibre bread decrease the subsequent sensation of hunger without affecting liking for bread. However, while this decrease in hunger led to a decrease in subsequent food intake for the more familiar bread, it did not for the less familiar one. This underlines the importance of developing healthy staple foods that are not too different from the foods we are used to; otherwise they may not lead to the expected beneficial effects.

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463 Table 1: Characteristics of the participants

	WS Group (n=16)	MG Group (n=22)
Gender (male / female)	8 / 8	12 / 10
Age (mean \pm sem years)	25.9 \pm 1.2	30.2 \pm 1.5
BMI (mean \pm sem kg.m ⁻²)	22.8 \pm 0.5	22.3 \pm 0.4
Restriction score (mean \pm sem)	4.6 \pm 0.5	4.5 \pm 0.4

464 Restriction score was determined by the “Three Factors Eating Questionnaire” (Stunkard &
 465 Messick, 1985).

466

467 Table 2: Energy content and composition of the two types of bread.

	WS Bread	MG Bread
Energy content (kcal/100g)	211.4	228.8
Carbohydrates (g/100g)	37.7	36.8
Lipids (g/100g)	3.2	3.8
Proteins (g/100g)	8.0	11.8
Dietary fibre (g/100g)	10.4	12.8
Ratio soluble/insoluble fibre	30/70	33/67

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Table 3: Hedonic score, hunger and food intake (*F* and *p* values) for the WS group and the MG group. Significant effects are in bold characters.

Parameter	Time of measurement	Factors	WS Group		MG Group	
			<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Hedonic score	First mouthful	Condition	1.81	0.20	56.82	<0.001
		Exposure	0.00	0.98	1.19	0.27
		Condition×Exposure	1.05	0.31	3.58	0.06
Hunger	Before breakfast	Condition	0.29	0.60	4.45	0.05
		Exposure	3.53	0.06	6.03	0.01
		Condition×Exposure	3.04	0.08	0.02	0.90
	After breakfast	Condition	69.7	<0.001	3.26	0.08
		Exposure	0.07	0.78	11.81	<0.001
		Condition×Exposure	3.28	0.07	3.36	0.07
	At 10 am	Condition	49.90	<0.001	39.32	<0.001
		Exposure	11.27	0.009	2.70	0.10
		Condition×Exposure	0.56	0.45	0.15	0.63
	At noon	Condition	14.77	0.002	20.73	<0.001
		Exposure	6.08	0.01	4.16	0.04
		Condition×Exposure	0.22	0.64	1.56	0.21
Food Intake	Daily	Condition	4.56	0.05	10.69	0.004
		Exposure	4.31	0.04	0.44	0.51
		Condition×Exposure	1.81	0.18	2.22	0.14
	Breakfast	Condition	0.01	0.93	3.68	0.07
		Exposure	0.07	0.79	1.01	0.32
		Condition×Exposure	0.22	0.64	0.23	0.63
	Lunch	Condition	2.79	0.12	0.34	0.57
		Exposure	4.49	0.04	0.07	0.80
		Condition×Exposure	0.22	0.64	0.34	0.56
	Dinner	Condition	5.57	0.03	3.02	0.09
		Exposure	0.84	0.36	0.02	0.88
		Condition×Exposure	0.71	0.40	1.46	0.23
	Snack	Condition	0.02	0.89	2.70	0.11
		Exposure	0.23	0.63	1.05	0.31
		Condition×Exposure	0.86	0.36	2.87	0.09
	Daily <i>minus</i> Breakfast	Condition	4.61	0.05	5.89	0.02
		Exposure	0.34	0.56	0.19	0.66
		Condition×Exposure	0.43	0.51	1.85	0.18

Condition levels: experimental and control.

FIGURES CAPTIONS

Fig. 1. Evolution of bread liking scores during the control condition (hatched line) *versus* the experimental condition (full line) for each type of fibre-enriched bread (white sandwich bread – WS – on the left; multigrain bread – MG – on the right). Results are expressed as mean and SEM.

Fig. 2. Evolution in hunger sensation before breakfast, after breakfast, at 10 am and at noon during the control condition (hatched line) *versus* the experimental condition (full line) for each type of fibre-enriched bread (white sandwich bread – WS – on the left; multigrain bread – MG – on the right). Results are expressed as mean and SEM.

Fig. 3. Evolution of the energy intake at breakfast and during the rest of the day (total daily energy intake *minus* Breakfast energy intake, Table 3) during the control condition (hatched line) *versus* the experimental condition (full line) for each type of fibre-enriched bread (white sandwich bread – WS – on the left; multigrain bread – MG – on the right). Results are expressed as mean and SEM.

FIGURE 1

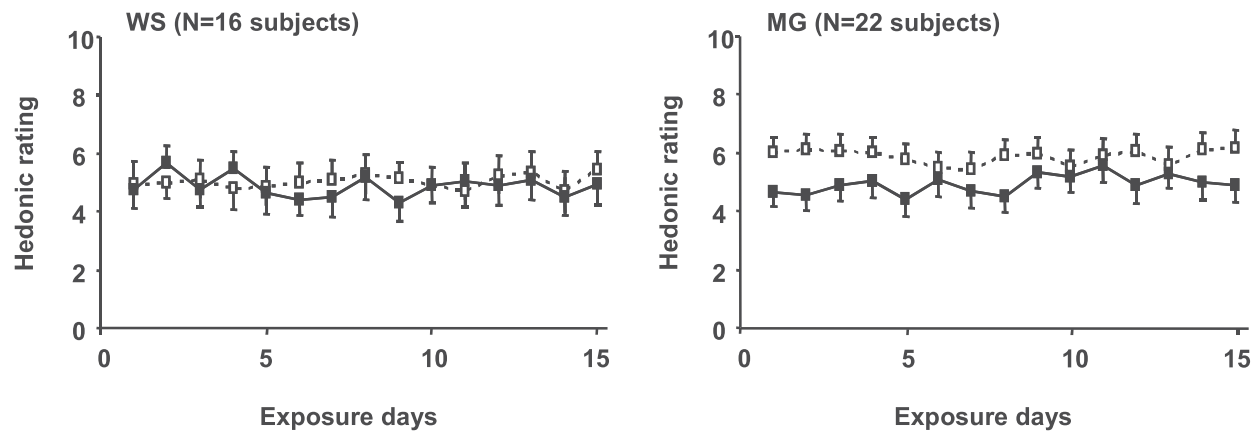
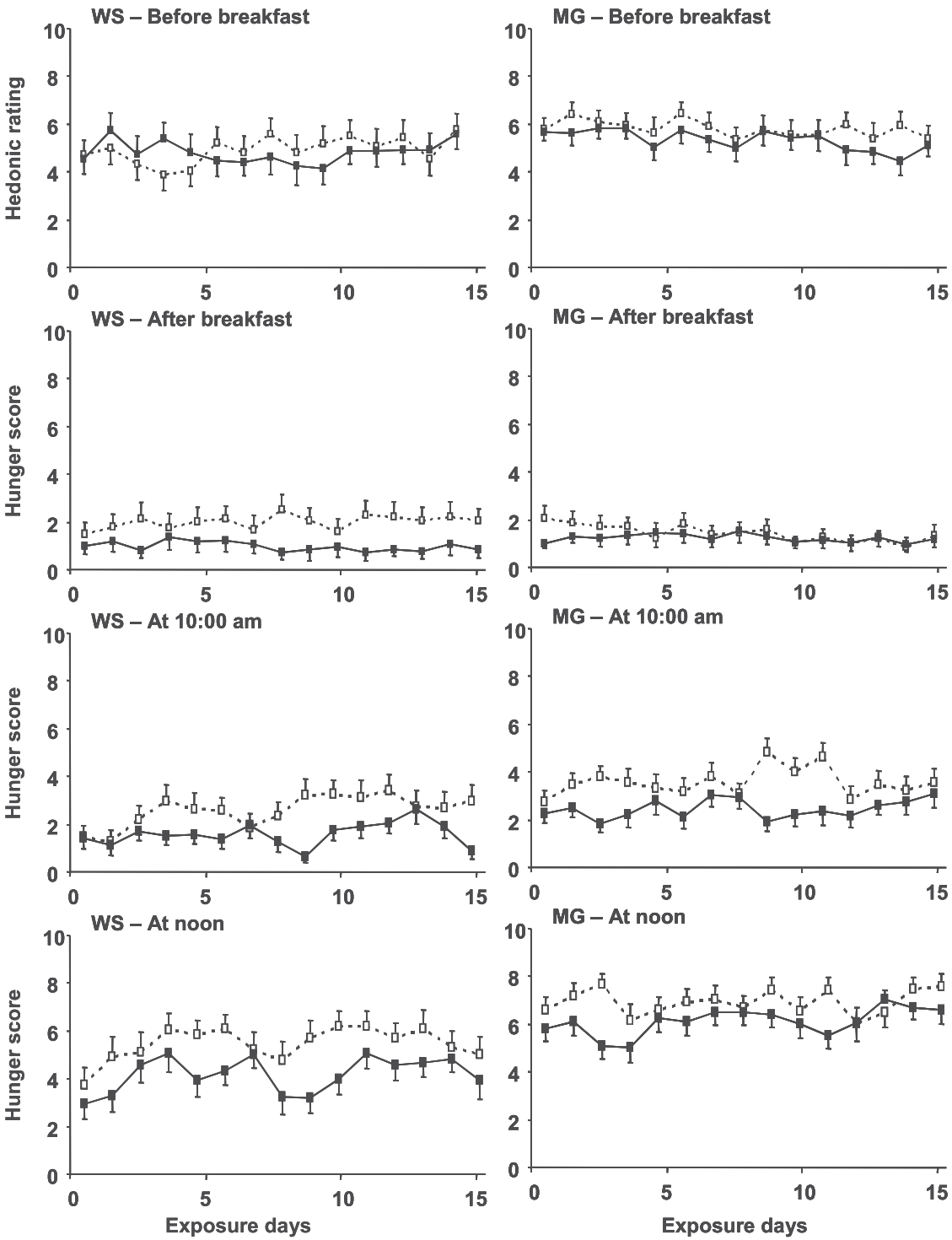
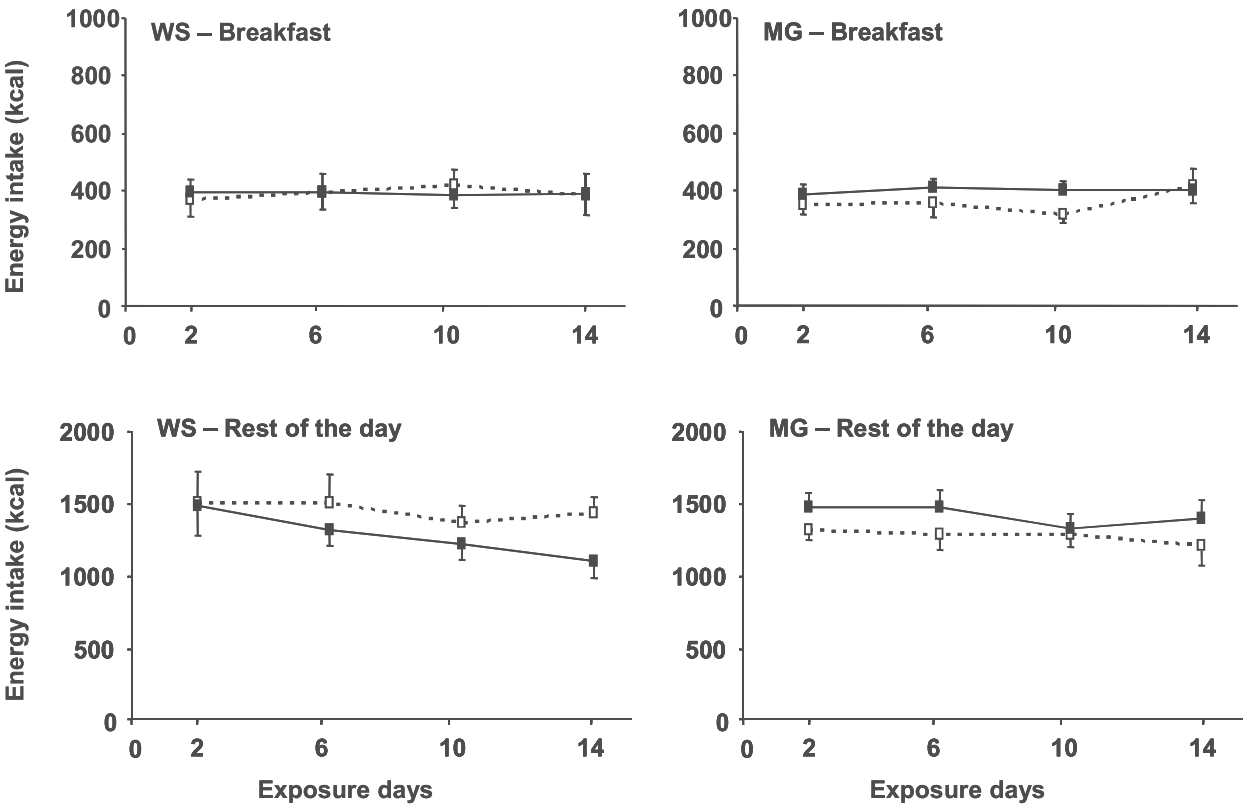


FIGURE 2



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FIGURE 3



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