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Abstract: This study investigated the effectiveness of the 'Food Dudes' school-based intervention consisting of rewards, peer-modeling and food exposure on food neophobia and the liking of fruits and vegetables (FV) in a large cohort of children. Five-hundred-sixty children recruited from three schools were assigned to the experimental or control group. For 16 days, children in the experimental group watched motivational videos, were read letters to encourage them to eat FV and received a small reward for eating one portion of both a fruit and a vegetable. The control group was only provided with FV for the same time period. Food neophobia and liking were measured in both groups of children before and after the intervention, and a follow-up measurement was carried out 6 months later. The intervention was effective in reducing food neophobia and, most importantly, a persistent effect was observed 6 months after the intervention as children of the experimental group showed significantly lower neophobia scores than the control group. Additionally, the program was effective in increasing liking for both FV; however, this effect was maintained only for fruit after 6 months.

Cover Letter

UNIVERSITÀ DEGLI STUDI DI MILANO
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DeFENS

Milan, 30 July 2014

Manuscript revision #3 submission to APPETITE

Dear Editor,

The manuscript has been revised according to your minor revisions. In particular, Table 1 has been modified by adding the results of the post hoc test in order to show how mean values within each stimulus and group are differentiated. Modifications are in red font in the revised manuscript. We hope that with this further improvement, the manuscript can be accepted for publication in Appetite.

With kind regards,

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***Response to Reviewers Comments**

1) line 153: omit the n=8 from Cronbach's alpha description, as it is more confusing than providing any information.

AU. Correction done

2) In Table 1, it would be more informative to see which of the means differed significantly from each other (not only the timewise consecutive measurements). This would be more informative to the reader, especially as in the analyses you have time as a factor in your GLM ANOVA model (lines 228-233).

AU. Post hoc test results have been added to table 1 to show how mean values are differentiated within each group and food item. Probably, representing these results in a figure, as we proposed with the first submission of the manuscript, would have been easier and more informative.

School-based intervention with children: peer-modeling, reward and repeated exposure reduce food neophobia and increase liking of fruits and vegetables

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***Highlights (for review)**

- We applied a school-based intervention based on peer-modeling, reward and exposure
- The intervention reduced children's food neophobia in the short and long period
- The intervention increased liking for fruits and vegetables in the short period
- The effect of the intervention was stronger for younger than older children

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Abstract:

This study investigated the effectiveness of the 'Food Dudes' school-based intervention consisting of rewards, peer-modeling and food exposure on food neophobia and the liking of fruits and vegetables (FV) in a large cohort of children. Five-hundred-sixty children recruited from three schools were assigned to the experimental or control group. For 16 days, children in the experimental group watched motivational videos, were read letters to encourage them to eat FV and received a small reward for eating one portion of both a fruit and a vegetable. The control group was only provided with FV for the same time period. Food neophobia and liking were measured in both groups of children before and after the intervention, and a follow-up measurement was carried out 6 months later. The intervention was effective in reducing food neophobia and, most importantly, a persistent effect was observed 6 months after the intervention as children of the experimental group showed significantly lower neophobia scores than the control group. Additionally, the program was effective in increasing liking for both FV; however, this effect was maintained only for fruit after 6 months.

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1. INTRODUCTION

Over the past few decades, there has been a steep rise in obesity worldwide, with one-third of children becoming overweight or obese by the time they are 2 years old. Given that child obesity and its health impacts last into adulthood, preventing obesity from an early age has become a major public health priority in the developed world (WHO, 2012). Data on Italian children show that the prevalence of overweight and obesity is about 30%, indicating an increase of 10%-15% in the last 10 years (Ministero della Salute, 2012). The origins of obesity are manifold and complex: although there are some genetic causes, most of them are related to lifestyle and the dietary habits of the children and their families. Currently, the everyday environment provides a surfeit of inexpensive, energy-dense foods that humans are biologically predisposed to choose over less caloric options (Ostan, Poljsak, Simcic & Tijskens, 2010). At the same time, lifestyles have become increasingly sedentary.

It is well known that regular consumption of fruits and vegetables (FV) is associated with health benefits (Antova, Pattenden, Nikiforov, Leonardi, Boeva, & Fletcher, 2003; Kraak, Story, & Swinburn, 2013). Also, emerging evidence suggests that increasing FV consumption is one of the factors which may assist dietary weight management strategies to prevent obesity (Ledoux, Hingle, & Baranowski, 2010). Despite this, children's consumption of FV is far below the five recommended servings per day (Baranowski, Davis, Resnicow, Baranowski, Doyle, & Lin, 2000; Coulthard, & Blissett, 2009). Increasing FV consumption has been reported as a global public health nutrition priority (WHO, 2003). However, minimal progress has been made in developing effective means to ensure an adequate intake of these foods because FV continue to be among the most disliked foods by children (Skinner, Carruth, Ziegler, & Reidy, 2002; Chapman & Armitage, 2012).

Over the past 30 years, research on children's food habits has identified several variables that can influence their liking and consumption of different foods. According to the social learning

account of Bandura (Bandura, 1977), modeling by significant others can be highly influential in establishing food behavior changes. Models that have been shown to be effective with children include cartoon characters, peers, mothers, unfamiliar adults and teachers. In contexts other than food consumption, research has also shown that children are more likely to imitate a model whose behavior they see being rewarded, who is of the same age or slightly older than themselves or who they like or admire. Children are also more likely to imitate the behavior of multiple rather than single models (Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). Another influential variable for modifying food habits is to induce prolonged exposure to a stimulus. According to Zajonc's "mere exposure" theory (Zajonc, 1968), repeated exposure to a specific food increases the liking and consumption of that food (Wardle, Herrera, Cooke, & Gibson, 2003b; Cooke, Chambers, Añes, & Wardle, 2011). The mechanism by which repeated exposure increases liking is thought to be a "learned safety" behavior (Kalat & Rozin, 1973). This hypothesis proposes that repeated ingestion of an unfamiliar food without negative consequences leads to increased acceptance of that food. The importance of familiarity related to food choices can be explained with reference to Rozin's concept of "neophobia" (Rozin, 1976). Neophobia is a protective mechanism that prevents animals and humans from eating something that could be harmful to them. At the same time, it leads humans to choose familiar and safe foods instead of new and unfamiliar ones (Mustonen, Rantanen, & Tuorila, 2009). Although food neophobia was evolutionarily useful, in a modern society where food safety is guaranteed, it can have a negative effect on food choices, as individuals avoid new food experiences and thus lack dietary variety (Carruth, Skinner, Houck, Moran, Coletta, & Ott, 1998; Nicklaus, Boggio, Chabanet & Issanchou, 2005). This maladaptive behavior may be of particular relevance for children who show a strong neophobic attitude toward food, especially FV (Cooke, Carnell, & Wardle, 2006; Rubio, Rigal, Boireau-Ducept, Mallet, & Meyer, 2008).

For several years, researchers have been focusing on establishing psycho-educational programs aimed at improving eating habits and lifestyles in children. For example, recent studies reported a positive influence of sensory education on French and Finnish children's food-related behavior (Mustonen & Tuorila, 2010; Mustonen et al., 2009; Reverdy, Chesnel, Schlich, Köster, & Lange 2008; Reverdy, Schlich, Köster, Ginon, & Lange, 2010).

The program used in the present paper, the 'Food Dudes' program, is based on the previously mentioned core principles derived from the literature on the determinants of children's food preference, namely modeling, reward and repeated exposure, which encourage children to taste FV. The 'Food Dudes' program has been applied in countries such as Ireland, the United Kingdom and the United States (Horne et al., 2009; Lowe et al., 2004; Wengreen, Madden, Aguilar, Smits, & Jones, 2013) with encouraging findings. The results showed a large and lasting increase in children's FV consumption, which can be generalized to the home setting. This intervention has never been tested in Italy, except Sicily (Presti, Cau, & Moderato, 2013). Therefore, in view of the differences in food habits between the Italian population and British and American people, it might be interesting to apply this program to children with a different food cultural heritage.

The present study is part of a larger research program funded by Regione Lombardia aimed at improving healthy food consumption in primary school-aged children. This research project consisted of the application of the 'Food Dudes' intervention in a large cohort of Italian children and the measurement of the impact of such an intervention on several variables, such as FV intake and liking, food neophobia, nutritional status and food behavior. The specific aim of the present study was to verify the effectiveness of the intervention in reducing food neophobia and increasing liking for FV among children who were exposed to the program compared with a control group of children.

2. MATERIALS AND METHODS

2.1 Participants

Parents were asked to read a short study explanation, to complete an informative questionnaire and to sign a consent form. Only children that returned the consent form completed by one of the parents or a legal guardian were considered for the study. In total 620 consent forms were distributed and 591 were returned, with a response rate of about 90%. Thirty-one children were excluded because the parent's reported that the child suffered from food allergies, followed a specific diet or temporarily assumed drugs that may influence taste and smell perception. A total of 560 children (278 girls and 282 boys) aged 6 to 9 years (mean age: 7.9 ± 1.1) were finally recruited to participate in the study. Thirty classes were enrolled: six 1^{st} graders (4 for the experimental group), nine 2^{nd} graders (4 for the experimental group), eight 3^{rd} graders (4 for the experimental group), and seven 4^{th} graders (3 for the experimental group). Ninety-five percent of them were Caucasian, 70% were normal-weight, 26% were overweight and the other 4% was obese.

Four schools were initially contacted in the metropolitan area of Milan (Italy). One school was not willing to participate in the study. Of the three schools that agreed to participate in the study, one school was selected to be the experimental group and the other two schools served as the control group. The choice of using separate schools for the experimental and control groups derived from the need of avoiding that children from the two groups meet and exchange information about the intervention as well as from the ease in the delivery of the intervention (e.g., provision of FV from the supplier). The schools consisted of three separate buildings, which however belonged to the same primary school complex; they shared the same refectory and had the same class schedule. Children from the experimental (N=374) and control (N=186) groups were matched for gender (X^2=0.67; p=0.41), age (X^2=3.66; p=0.30) and BMI (X^2=0.54; p=0.55). The experimental group received the intervention together with

the provision of FV; the control group received the FV only. This study adhered to the principles established by the Declaration of Helsinki. The protocol was approved by the Institutional Ethics Committee of at the study site.

2.2 Provision of food and vegetables

Both the experimental and the control groups received four different combinations: 1) apple and fennel; 2) pear and radish; 3) grapes and broccoli; 4) miyagawa and carrot. FV were selected based on availability in season, ease of handle and storage. In addition, stimuli were chosen in order to have FV that were familiar for Italian children. A portion (approximately 40 g) of each FV was served raw and provided daily during the 16-day intervention phase. FV were served at 10:30 am, immediately prior to the mid-morning break. The FV were fresh and were cut into standardized pieces of uniform size; they were presented to children at room temperature in plastic cups coded with the word "fruit" or "vegetable".

2.3. Food neophobia and liking evaluation

Children's food neophobia was evaluated using a questionnaire consisting of 8 items: 4 related to neophilic attitudes and 4 related to neophobic attitudes. The questionnaire was developed and adapted for Italian children on the basis of the Food Neophobia Scale proposed by Pliner and Hobden in 1992 (Pliner and Hobden, 1992). Specifically, the items "Ethnic food looks too weird to eat", "I like trying new ethnic restaurants" and "I like foods from different countries" were removed and replaced by the item "I like trying new foods and tastes that are unusual and from other countries". This modification was necessary because a preliminary test showed that children did not properly understand the term "ethnic". For each item, children indicated the degree to which they considered the statement to be true for them using a 5-point facial scale (from left to right: "Very false for me", "False for me", "So-so", "True

for me", "Very true for me"). Thus, for each child, a neophobia score ranging from 8 to 40 was calculated (for neophilic items, the score was reversed). To ascertain that children understood all the items and the scale, the questionnaire was previously tested on a representative group of children (n=30, 16 girls and 14 boys, age range 6-10 years). Internal consistency in this pilot test was evaluated using Cronbach's alpha (α=0.77). The pilot test revealed that the children had difficulty understanding one item with a double negative (i.e., "If I don't know what a food is, I won't try it") and were not familiar with the situation described by the item "At dinner parties, I will try new food." Thus, these two items were slightly modified to eliminate the double negative and to include situations that are more familiar to children (i.e., "When I am at a friend's party, I will try new food"). With these adjustments, children seemed to properly understand the meaning of all of the items. Cronbach's alpha calculated on the whole samples of children (n=560) was satisfactory (α=0.73).

Liking was measured using a 7-point hedonic facial scale (Pagliarini, Ratti, Balzaretti & Dragoni, 2003). At first presentation of each food stimulus, children were also asked to indicate whether they had already tasted it. All items were familiar for more than 93% of children, except for radish, which was known only by 60% of them. Food liking and neophobia evaluations were performed in the classrooms in the presence of a teacher and an experimenter. The number of children in each class ranged from 15 to 25. During evaluations, each child was seated at his or her own table and received a booklet for each evaluation. Before each test, the children received a brief explanation about the use of the scales and how to complete the booklet. The administration method was the same across all age groups of children, except for 6-years-old children for whom the administration was simplified (e.g., questionnaires administered in small groups of 5-6 children and questions read aloud by the experimenter).

2.4 Description of the intervention

The experiment consisted of several phases, which are summarized in **Figure 1**.

2.4.1 Pre-intervention phase (baseline)

This phase lasted 9 days; food neophobia was measured on the first day before the FV were served. During the subsequent 8 days, liking of FV was evaluated twice to investigate possible boredom effects due to mere exposure.

2.4.2 Intervention phase

This phase lasted 16 days, during which the children received each FV combination four times. To encourage the children to eat the FV, the experimental group was subjected to the 'Food Dudes' program, whereas the control group was only exposed to FV. The 'Food Dudes' intervention included three principles: taste exposure (FV distribution), modeling (videos and letters) and rewards (gadgets).

- Videos: the peer modeling videos included six 6-min episodes featuring the heroic 'Food Dudes' who were a group of 12–13-year-old teenagers (two boys and two girls). In each episode, the heroic group of teenagers battle against the evil 'Junk Punks' who plans to take over the world by depriving people of their life-giving FV. To arm themselves for their struggle, the heroes eat (and are observed to enjoy) a variety of FV. By doing this, they encourage all other children to do the same. The videos were shown using a television and video recorder in the classroom.
- Letters: Prior to presenting the intervention video each day, the teacher read aloud a letter addressed to the children from the 'Food Dudes'. The purpose of these letters was to remind the children of the target foods of the day, give general feedback on their consumption

on the previous day and promise rewards for all children who ate their FV at the next snack time.

- Rewards: The rewards were customized 'Food Dudes' items consisting of stickers, pens, pencil cases, rulers, erasers and certificates. These items have been shown to have a wide appeal for primary school children (Lowe et al., 2004). A reward was given only to children who were willing to taste a piece of both the FV of the day. A maintenance phase began immediately after the 16-day intervention. Food Dudes FV containers were provided to encourage parents to supply children with FV in their lunchboxes now that these foods were no longer provided in school. Children who ate FV from their lunchboxes were given a sticker each day to stick onto a wall chart so that they could track their own progress over time and earn a reward whenever they had accumulated sufficient stickers over a specified number of weeks. As maintenance progressed, the rewards were gradually withdrawn and replaced with certificates for children who brought FV from home.

To verify the effectiveness of the program, during the last 4 days of the intervention phase, liking for each FV combination was evaluated in both the experimental and control group. In addition, on the day after the end of the FV serving period, food neophobia was measured.

2.4.3 Six-month follow-up

Six months after the end of the intervention phase, children of both the experimental and the control groups were exposed to the same 4 combinations of FV. At this stage, liking and food neophobia were measured again to verify the effectiveness of the program over the long term.

2.5 Data analysis

The data were first analyzed at baseline to evaluate children's food neophobia and liking before the application of the program. Analysis of variance (ANOVA) was performed considering

Age, *Gender* and their interaction as factors and food neophobia and liking scores as dependent variables. The factor *School* was initially considered in the model. Because no differences were detected in food neophobia or liking scores between the three schools, this variable was not further considered for data analysis.

To evaluate the effectiveness of the program in reducing food neophobia and increasing liking, the data were analyzed through repeated measures GLM ANOVA considering *Time* (pre-intervention, intervention and follow-up) as a within-subject factor and *Group* (experimental, control), *Gender*, *Age* (6-9 years) and *Product* (fruits and vegetables) as between-subject factors. All analyses were conducted with SAS version9.1.3; $p<0.05$ was taken as the level of significance throughout the analyses.

3. RESULTS

3.1. Food neophobia evaluation

3.1.1. Evaluation at baseline

Significant differences were found for *Gender* ($F=4.82$, $p<0.05$) and *Age* ($F=8.67$, $p<0.001$). Boys (M=21.6) were more neophobic than girls (M=20.5). The four age classes differed significantly from each other, and a reduction of the neophobic attitude was observed with increasing age (mean scores: 6 years=23.3, 7 years=21.5, 8 years=20.7, 9 years=18.8). The *Gender by Age* interaction was not significant, as boys were more neophobic than girls in all age groups, although gender-related differences appeared to decrease in older children (**Figure 2**).

3.1.2. Effects of the intervention on food neophobia

The neophobia scores obtained at baseline (pre-intervention, t0), intervention phase (t1) and follow-up (t2) for the experimental and control groups are shown in **Figure 3**.

The ANOVA results revealed that the interaction *Time by Group* had a significant effect ($F=4.54$, $p<0.01$) on food neophobia scores. Before the application of the program (pre-intervention, t0), the mean food neophobia scores for the experimental and control groups were comparable, indicating that children were initially homogeneous in terms of neophobic behavior. After 16 days, a period that coincided with the end of the intervention for the experimental group and the end of the repeated administration of FV for the control group, the scores differed significantly: the experimental group showed significantly lower ratings than the control group ($p<0.01$). At follow-up, the difference between the two groups was still significant ($p<0.01$). If we consider the scores over time within each group of children, food neophobia remained stable over time for the control group, whereas a systematic, significant decrease was observed for the experimental group. In particular, for the experimental group, the scores at intervention and follow-up were significantly lower ($p<0.05$) than those at baseline, indicating that the intervention was effective in reducing neophobic behavior and that this effect had a relatively long-lasting effect. The interaction *Time by Group by Gender* was not significant, whereas the interaction *Time by Group by Age* had an effect on food neophobia scores ($p<0.05$). In particular, in the experimental group, scores gradually decreased over time for children aged 6-8 years, whereas there was a significant increase in food neophobia scores at 9 years. This result suggests that young children appear to benefit slightly more from the intervention than do older children.

3.2 Liking evaluation

3.2.1 Evaluation at baseline (t0')

A significant effect of *Age* ($F=10.75$, $p<0.001$) on liking score was found. Nine-year-old children ($M=4.3$) had significantly lower ($p<0.001$) liking scores than all other groups (mean

scores: 6 years=4.7; 7 years=4.9; 8 years years=4.7), which in turn had comparable liking scores.

A significant effect was found for *Product category* ($F=717.44$, $p<0.001$), as fruits ($M= 5.5$) were preferred over vegetables ($M=3.8$). There were no significant effects of the main factor *Gender*, or the interactions *Age by Gender* and *Age by Gender by Product category* on liking scores.

3.2.2 Evaluation of intervention effectiveness

Liking scores averaged by type of FV at the pre-intervention stage (t0', t0''), the intervention stage (t1) and follow-up (t2) for the experimental and control groups are shown in **Figure 4**.

ANOVA results showed a significant effect of the interaction *Time by Group by Product* ($F=52.95$, $p<0.0001$). At baseline (t0' and t0''), the experimental (red and green solid lines) and control (red and green dotted lines) groups were comparable in terms of liking for both FV. After the intervention (t1), hedonic scores were significantly higher for the experimental group versus the control group for both fruits ($p<0.0001$) and vegetables ($p<0.0001$). These results demonstrate the effectiveness of the program in increasing children's liking in the short term. At follow-up (t2), the liking scores of the experimental group were still higher than those of the control group but only for fruits ($p<0.0001$).

As shown in Figure 4, hedonic scores for the control group decreased systematically over time, suggesting that taste exposure alone had little impact in increasing liking. This finding appeared to be confirmed by the fact that hedonic scores for both FV and for both groups of children (control *vs* experimental) decreased significantly over the two liking evaluations at pre-intervention (t0' and t0''). However, for the control group an increase of vegetables liking was seen at follow-up. This was mainly due to an increase of liking for the two most disliked items, namely broccoli and radish (Table 1). For the experimental group, liking scores

increased significantly ($p<0.0001$) after the intervention for both stimuli. Liking remained stable after 6 months for fruit but decreased significantly for vegetables ($p<0.0001$).

The interactions *Time by Group by Age* and *Time by Group by Gender* were considered in the ANOVA model to verify whether the program was more effective for younger or older children or for girls or boys. Only the interaction *Time by Group by Age* was significant ($F=4.70$, $p<0.001$); in particular, liking scores of the experimental group after the intervention and at follow up were higher than those of the control group only for younger children (6-8 years). Thus, as already verified for food neophobia, younger children appeared to benefit more from the intervention than did older children.

3. DISCUSSION

This study investigated whether and how the application of the 'Food Dudes' multi-component school-based intervention, consisting of rewards, peer-modeling and repeated exposure to FV, influenced the liking of such food, in addition to food neophobia, in a large cohort of Italian children aged between 6 and 9 years. The main findings of the study were that the intervention is effective in reducing food neophobia and, most importantly, that this effect is also observed over the long term (6 months). Additionally, the program was successful in increasing liking FV, although the effect was more pronounced for fruit.

A number of studies have been published in the last decade concerning the effectiveness of school-based interventions in modifying food consumption in children; this is due to the increasing risk of obesity worldwide. It has been suggested that proper education at school and at home may decrease the consumption of junk food and increase the consumption of more healthy foods, such as FV (Reverdy et al., 2008).

Evidence from a meta-analysis study conducted on 21 school-based interventions showed that multi-component programs are more effective than single-component programs in increasing

food acceptance among children (Evans, Maeghan, Cleghorn, Greenwood, & Cade, 2012). Most of the single-component interventions are based on repeated exposure, which has been shown to be effective in increasing liking and intake with infants, preschoolers and schoolchildren (Wardle, Cooke, Gibson, Sapochnik, Sheiham, & Lawson, 2003a, Wardle 2003a; Wardle et al. 2003b). However, there is evidence that when exposure is associated to another reinforcement (e.g., reward), the intervention has a more durable effect (Cooke et al., 2011). Reverdy et al. (2008) used an approach consisting of sensory lessons provided at school to French children aged 8-10 years. They found that neophobia scores decreased as a function of education; however, the effect was only temporary. The same intervention was used by Mustonen and Tuorila (2010) in Finland with children aged 8-11 years. In this case, the program was extended to include further sensory lessons to deepen children's knowledge of food. With this improved version of the program, a stronger decrease was observed in food neophobia but only for younger children.

Results of the present study confirm that the combination of several approaches appears to be more effective in motivating children to try new foods and appreciate FV. This hypothesis is supported by the reduction of liking scores during the two measurements at baseline (t0' and t0'') and by the systematic decrease of liking over time in the control group. These results are likely to be ascribed to boredom effects that arise due to exposure alone. Indeed, it has been reported that repeated tasting may induce an increased feeling of boredom when participants are exposed to the same stimuli over a short period and that the monotony may lead to a temporary decrease in the consumer's acceptance for the food (Olsen, Ritz, Kraaij, & Möller, 2012; Sulmont-Rossè, Chabanet, Issanchou, & Köster, 2008). Also, the fact that liking of vegetables for the control group increased at follow-up and reached initial (baseline) values suggests that exposure have less effect in increasing liking when a food is initially well accepted (all fruits and carrot and fennel), whereas it might be more successful with very

disliked items (all vegetables, especially broccoli and radish). Initial liking and familiarity of the stimulus are, indeed, strong determinants of repeated exposure effectiveness (Sulmont et al., 2008).

The outcome of a higher liking degree for fruits than vegetables observed in the present study is well known and confirmed by previous reports indicating that vegetables are among the least favored food among children (Skinner et al., 2002; Perez-Rodrigo et al., 2003; Cooke & Wardle, 2005). This pattern of preferences is consistent with the evidence for innate tendencies to prefer sweet tastes and to dislike bitter tastes (Birch, 1999). Indeed, most fruit is sweet, whereas vegetables are often perceived as bitter due to specific compounds (*e.g.*, glucosinolates) that are found in cruciferous vegetables (e.g., broccoli, cauliflower and kale) (Forestell & Mennella, 2007).

A further interesting finding of the present study was the greater program effectiveness with younger children. Similar results were reported by Mustonen and Tuorila (2010) and Reverdy et al. (2008), who found that children older than 9.5 years were less susceptible to neophobia reduction than younger children after exposure to a sensory education program. Accordingly, Loewen and Pliner (1999) observed that the evolution of neophobia after exposure to food stimuli was different depending on whether children were older or younger than 9 years old, most likely because children around this age develop a different neophobic reaction due to different optimal levels of arousal. Therefore, the age of 9 years appears to be a critical period in a child's life with respect to food behavior development regardless of his/her country of origin, as similar patterns can be found in Italian, French, Finnish and Canadian children. Furthermore, this outcome is in agreement with the strong age effects we observed for both food neophobia and liking at baseline. More specifically, we found that 9-year-old children are less neophobic than younger children, most likely because experience with food increases with age, and this makes older children more willing than younger children to taste new food.

At the same time, the age of 9 years seems to be critical in relation to food appreciation, as 9-year-old children gave lower liking scores for FV than did younger children. This result is in line with the findings of Pagliarini, Gabbiadini & Ratti (2005), who reported age-related differences in children's food preferences for several foods served at the school canteen, including FV. Accordingly, Cooke & Wardle (2005) reported that the number of liked foods decreases with increasing age. We hypothesize that this behavior is due to the acquisition of a more critical attitude toward food with increasing age as a consequence of exposure to a more varied diet, although this apparently contradicts the finding of increased neophilia among older children in the present study. However, it is important to note that the increase in the willingness to try new foods that comes with increasing age does not necessarily mean that these foods are also more liked.

Gender-related differences were also found at baseline for food neophobia, with boys being more neophobic than girls. There is little evidence in the literature for gender-related differences in neophobia scores in children. To our knowledge, only two studies have investigated the impact of gender on food neophobia in children. Koivisto & Sjöden (1996) found gender-related differences in 9-year-old children, with girls being more neophilic than boys. Accordingly, Reverdy et al. (2008) reported a marginal effect of gender on food neophobia, with girls being more neophilic than boys.

In conclusion, our data suggest that the ‘Food Dudes’ school-based intervention can have positive effects on Italian children’s food attitude, reducing food neophobia and increasing liking for both FV. With the exception of vegetables liking, these effects were maintained at 6 months after the intervention. It may be advisable to perform several iterations of the intervention to maintain a high level of liking for vegetables. Additionally, our data indicate that exposure should be associated with other approaches (*i.e.*, peer modeling and rewards) when applying interventions with children. The results from our study confirm previous

findings indicating that a suitable age for the commencement of school-based programs could be 8 years or even earlier, as younger children appear to be more likely to change their food behavior than older children. Early intervention is also likely to maximize health benefits because eating habits in childhood are strongly predictive of those in adulthood. Finally, the 'Food Dudes' program has been applied with encouraging results in countries such as Ireland, UK and US, which have important culture-related differences as compared with Italy. The positive outcome of the present study seems to indicate that this multi-component intervention based on food exposure, peer-modeling and reward can be successfully applied to primary school children regardless of the culture heritage and the specific dietary habit of a population.

One of the strengths of the present paper is that it is an ecological study conducted in an actual mealtime situation. The naturalistic environment is an important point to consider when studying factors linked to food behavior, especially with children. Moreover, the relatively large sample of children makes us confident about the adequate power of the study design. One weakness of this study is that we involved 6-year-old children in our measurements and, despite children of that age can perform hedonic test reliably (Guinard, 2001), some problem may arise in understanding the food neophobia task. In this context, the administration procedure was slightly modified for 6-year-old children in order to make the task easier for them. Examples of administration methods adapted for younger children (e.g., questionnaires administered in an individual instead of collective setting and questions read aloud by an experimenter) are present in the literature and have shown a positive result when validating questionnaires among children as young as 5 years old (Rubio et al., 2008). Finally, one obvious weakness is that we did not measure children's actual consumption of FV, thus we cannot conclude that the decreased neophobia and increased liking would have translated in an actual higher FV intake by children. However, since liking is one of the most important

423 determinants of children's food consumption (Birch, 1999), it is likely that an increase in FV
424 intake would have been associated with the program.
425
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Figures caption

Figure 1. Phases of the experiment.

Figure 2. Food neophobia score (range 8-40) ± SEM according to gender and age at baseline measurement.

Figure 3. Food neophobia score (range 8-40) ± SEM for experimental and control groups, at pre-intervention, intervention phase and follow-up.

Figure 4. Liking score (range 1-7) ± SEM for fruit and vegetable, for experimental and control group, at pre-intervention (t0', t0''), intervention phase (t1) and follow-up (t2).

Figure 1 REV2

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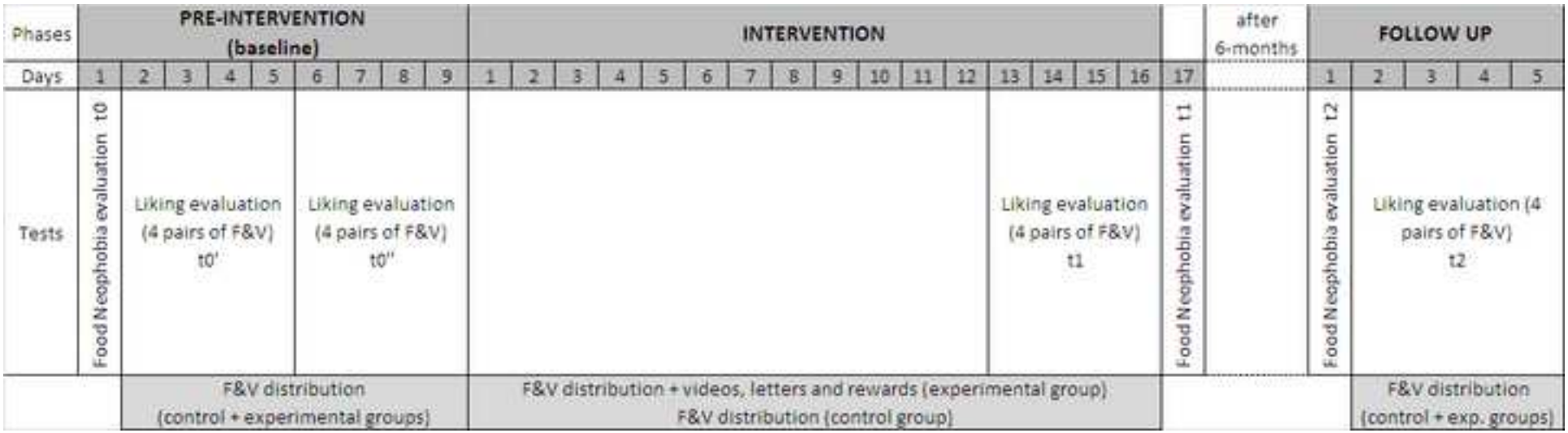

Figure 2

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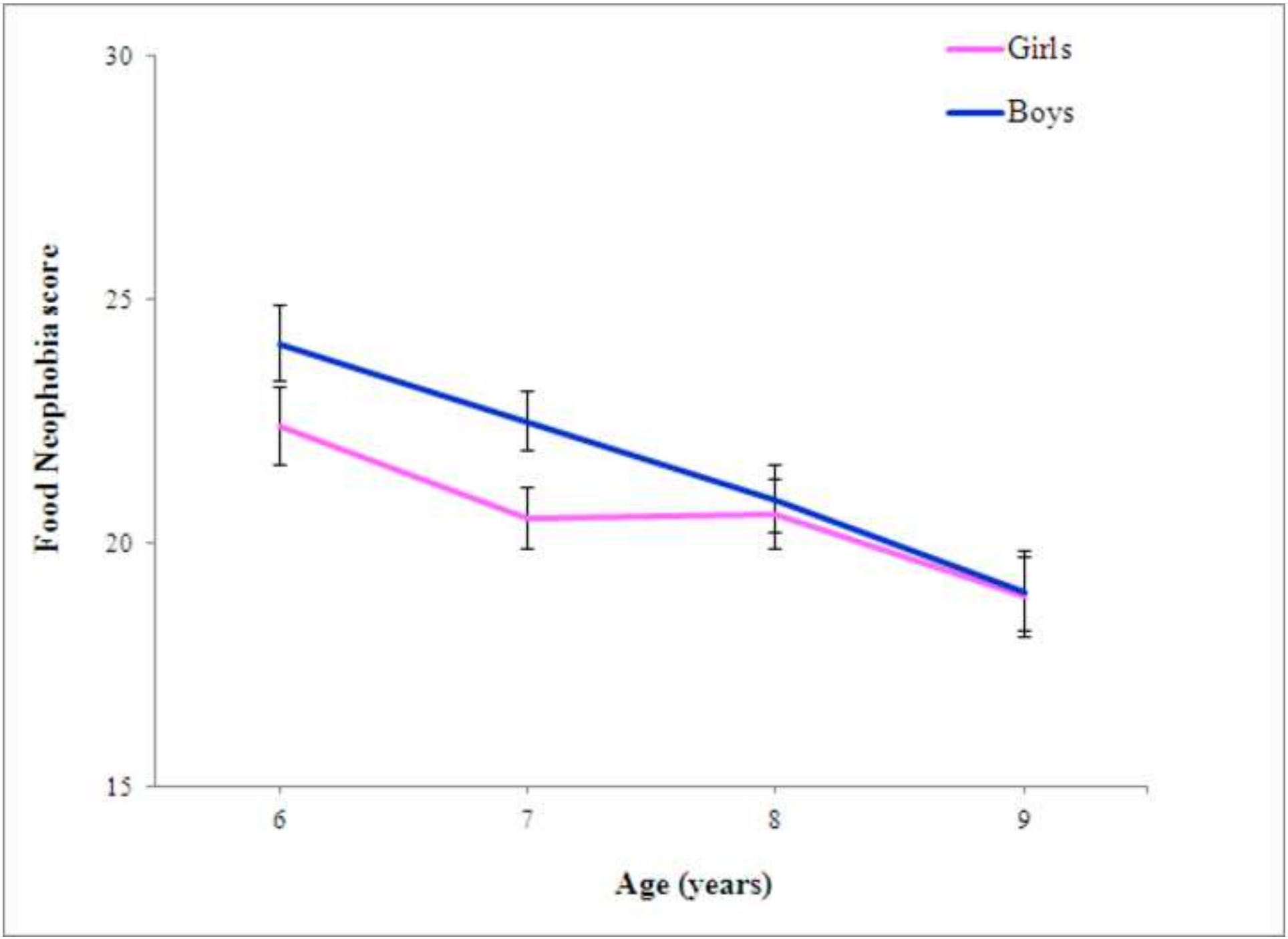

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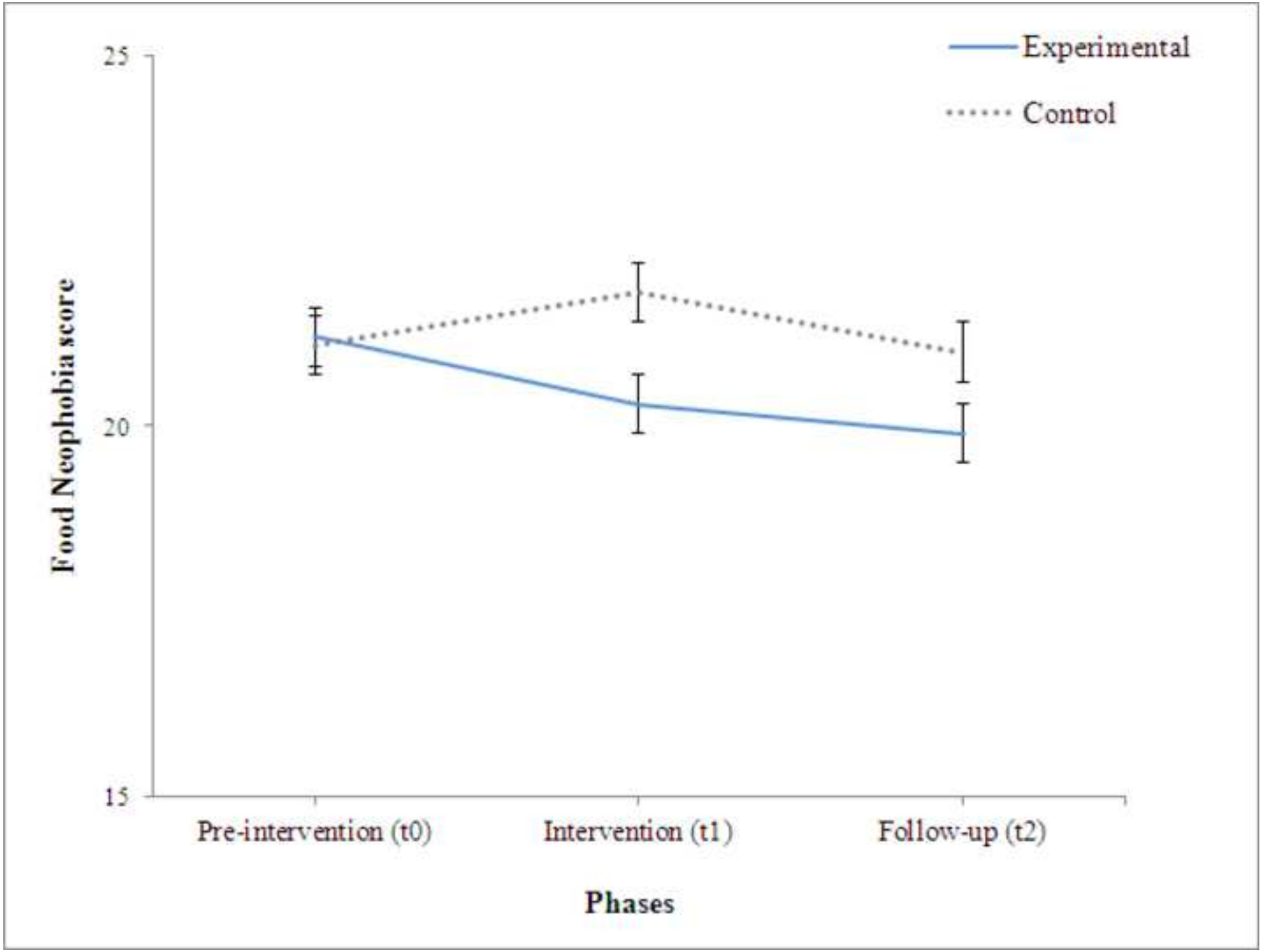

Figure 4

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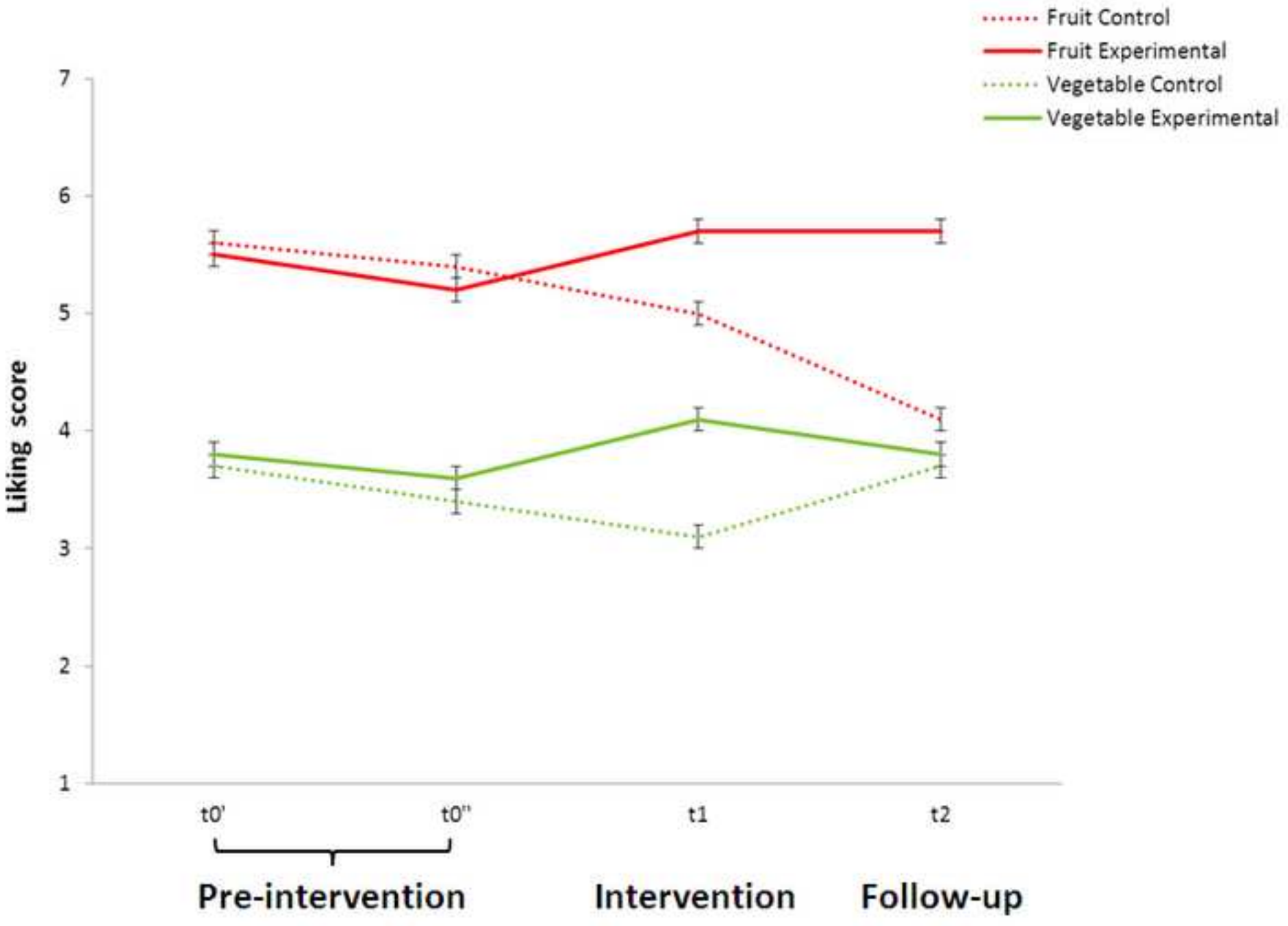

Table(s)

Table 1. Liking scores (range 1-7, SEM=0.1 for all values) for each food item provided to both the experimental and control groups at pre-intervention (t0', t0''), intervention phase (t1) and follow-up (t2). Average liking scores by row with different letters are significantly different ($p<0.05$).

Product	Group	Program phases			
		t0'	t0''	t1	t2
Apple	Experim.	6.0 ^{ab}	5.8 ^{a}	6.1 ^{b}	5.9 ^{ab}
	Control	6.0 ^{c}	5.6 ^{b}	5.4 ^{b}	4.2 ^{a}
Grapes	Experim.	5.9 ^{b}	5.5 ^{a}	5.6 ^{ab}	5.8 ^{b}
	Control	5.8 ^{b}	5.6 ^{b}	5.5 ^{b}	3.9 ^{a}
Miyagawa	Experim.	5.0 ^{b}	4.2 ^{a}	5.4 ^{c}	5.8 ^{d}
	Control	5.0 ^{c}	4.4 ^{b}	3.9 ^{a}	3.8 ^{a}
Pear	Experim.	5.4 ^{a}	5.3 ^{a}	5.5 ^{a}	5.3 ^{a}
	Control	5.7 ^{b}	5.6 ^{b}	5.4 ^{b}	4.0 ^{a}
Broccoli	Experim.	2.5 ^{b}	2.2 ^{a}	2.8 ^{b}	3.3 ^{c}
	Control	2.4 ^{b}	2.0 ^{a}	1.9 ^{a}	3.7 ^{c}
Carrot	Experim.	5.7 ^{ab}	5.5 ^{a}	5.8 ^{b}	5.4 ^{a}
	Control	5.2 ^{b}	5.4 ^{b}	4.3 ^{a}	4.5 ^{a}
Fennel	Experim.	4.4 ^{b}	3.8 ^{a}	4.7 ^{b}	3.9 ^{a}
	Control	4.1 ^{b}	3.9 ^{ab}	3.7 ^{a}	3.7 ^{a}
Radish	Experim.	2.6 ^{a}	2.5 ^{a}	2.9 ^{b}	2.5 ^{a}
	Control	2.9 ^{b}	2.5 ^{a}	2.3 ^{a}	3.7 ^{c}