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Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children

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Objective: To measure children's consumption of, and liking for, fruit and vegetables and how these are altered by a peer modelling and rewards-based intervention.
Design: In this initial evaluation of the programme, children's consumption of fruit and vegetables were compared within and across baseline and intervention phases.
Setting: Three primary schools in England and Wales.
Subjects: In total, 402 children, aged from 4 to 11 y.
Intervention: Over 16 days, children watched six video adventures featuring heroic peers (the Food Dudes) who enjoy eating fruit and vegetables, and received small rewards for eating these foods themselves.
Main outcome measures: Fruit and vegetable consumption was measured (i) in school at lunchtime and snacktime using a five-point observation scale, with inter-rated reliability and weighed validation tests; and (ii) at home using parental recall. A questionnaire measured children's liking for fruit and vegetables before and after the intervention.
Results: Consumption during the intervention was significantly higher than during baseline at lunchtime and at snacktime ($P<0.001$ in all instances). Consumption outside school was significantly higher during the intervention on weekdays ($P<0.05$) but not weekend days. Following the intervention, children's liking for fruit and vegetables also showed a significant increase ($P<0.001$).
Conclusions: The peer modelling and rewards-based intervention was shown to be effective in bringing about substantial increases in children's consumption of, and expressed liking for, fruit and vegetables.
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Contributors: CFL and PJH were the principal investigators; they devised the intervention, the central experimental design, and provided the theoretical underpinning. They directed the overall programme and contributed to data analysis and interpretation, and to the writing of the paper. KT supervised the data analysis, drafted the paper and contributed to programme development and implementation; data collection, analysis and interpretation; and staff training. MB and CE contributed to programme development and implementation; data collection, analysis and interpretation; staff training; and editing of the paper. The measures were designed by CFL, PJH, KT, MB, and CE. Valerie Hughes assisted with data collection and programme implementation and Charlotte Hardman assisted with data analysis. Chris Whitaker advised on statistical analyses.
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Introduction

Research indicates that eating a diet rich in fruit and vegetables protects against many illnesses including cardiovascular disease, stroke, and cancer (Gaziano *et al*, 1995; Gillman *et al*, 1995; Key *et al*, 1996; Steinmetz & Potter, 1996). A common recommendation is that adults and children over 2 y of age should eat at least five portions of these foods daily (eg US Department of Health and Human Services, 1996; Williams, 1997; Department of Health, 2000). However, in the UK and USA, as in many other Western countries, average consumption levels of fruit and vegetables are far lower than these (Subar *et al*, 1995; Williams, 1997), and most children fail to meet the recommendation (Krebs-Smith *et al*, 1996; Department of Health, 2000). Given that there is evidence to show tracking of eating habits through childhood and adolescence (Kelder *et al*, 1994; Singer *et al*, 1995), attempts to bring about long-term increases in national consumption may be most beneficial when targeted at the young.

School-based programmes have the potential to be a very effective way of intervening since they enable large numbers of children to be targeted simultaneously. Although several such programmes have been developed in recent years, the increases in consumption they have achieved have been minimal, generally falling short of even a single daily additional portion per child (Domel *et al*, 1993; Foerster *et al*, 1998; Nicklas *et al*, 1998; Perry *et al*, 1998; Baranowski *et al*, 2000; Reynolds *et al*, 2000). And even where such minimal changes have proved statistically significant, it is unclear that they are clinically significant (see Huon *et al*, 1999; Cliska *et al*, 2000). It would appear either that children's consumption of fruit and vegetables is particularly resistant to change, or that the methods employed to influence their eating patterns so far have not been well directed.

A central problem with the multicomponent interventions used in the above studies is that many of the individual elements that make them up have not been shown to influence eating behaviour reliably, either on their own or in combination with other constituent components. For example, skills development (eg in areas such as food preparation) features in all these programmes (Nicklas *et al*, 1997; Foerster *et al*, 1998; Perry *et al*, 1998; Reynolds *et al*, 1998; Baranowski *et al*, 2000). However, although the importance of such skills may be consistent with some theoretical accounts of behaviour change (eg see Baranowski *et al*, 1993), there is no experimental evidence to show that they actually contribute to changes in eating behaviours. Other such elements for which efficacy has yet to be convincingly demonstrated include changing outcome expectancies (Reynolds *et al*, 1998), the use of promotional materials (Nicklas *et al*, 1997; Foerster *et al*, 1998; Perry *et al*, 1998; Reynolds *et al*, 1998), and provision of nutritional information (Perry *et al*., 1998; Reynolds *et al*., 1998, see also Shannon & Chen, 1988; Contento *et al*, 1992). Indeed, there is evidence (Gibson *et al*, 1998; see also Wardle, Cooke *et al*, 2003) that greater nutritional knowledge among parents and children does not necessarily lead to higher consumption of healthy foods on the part of the children. In fact, warning children about the dire effects on their future health prospects of not eating healthy food, or just telling them that a food is 'healthy', may well even reduce their acceptance of such food (Gibson *et al*, 1998; Wardle & Huon, 2000; Wardle, Cooke *et al*, 2003).

It would appear then that in many of these interventions, substantial time and resources may have been directed at providing components that have little positive impact, and may even have detrimental effects, on children's actual eating behaviour. This provision may also have been at the cost, perhaps, of components that do influence behaviour—for there is evidence to suggest that not all aspects of school-based multicomponent interventions are implemented (Perry *et al*, 1998; Baranowski *et al*, 2000). A better approach might be to focus on techniques that have been shown to have a reliable effect on children's eating behaviours, and ensure that they are used in ways that will maximise their efficacy. Research to date points to three factors likely to be of help in this undertaking: taste exposure, modelling, and rewards.

There is substantial evidence to indicate that the repeated tasting of particular foods or flavours leads to increased consumption of and expressed preference for those foods or flavours (Birch & Marlin, 1982; Birch *et al*, 1987, 1998; Sullivan & Birch, 1990; Wardle, Cooke *et al*, 2003, Wardle, Herrera *et al*, 2003). It would seem then that an effective way to increase children's consumption of fruit and vegetables would be to ensure that they repeatedly taste these foods. How might this be achieved? One possible way is to use observational learning or 'modelling'. That is, children, who are given the opportunity to watch 'models' eating fruit and vegetables, are more likely to go on to eat these foods themselves. Models that have been shown to be effective with children include cartoon characters (Harris & Baudin, 1972; Woolner, 2000), peers (Birch, 1980; Greer *et al*, 1991; Dowey, 1996; Hendy & Raudenbush, 2000; Hendy, 2002), mothers, unfamiliar adults (Harper & Sanders, 1975), and teachers (Hendy & Raudenbush, 2000). Other factors also contribute to the likelihood of children's imitation. Hendy and Raudenbush (2000), for example, found that teachers were ineffective as models when they consumed particular novel fruits without commenting, but were effective when they made it clear through their overt enthusiastic remarks that they were enjoying eating these fruits. However, when the female participants were in the presence of peers who ate and enthusiastically commented on competing novel fruits, the teacher's influence as a model was eliminated. These results suggest that the effects of teacher role modelling may be attenuated in intervention programmes where peers model incompatible behaviours (eg by eating other snacks rather than fruit and vegetables). Research has also shown, in contexts other than that of food consumption, that children are more likely to imitate a model whose behaviour they see being rewarded (Flanders, 1968), or who is of the same age or slightly older than themselves (Brody & Stoneman, 1981), or who they like or admire (Bandura, 1977). They are also more likely to imitate the behaviour of multiple rather than single models (Fehrenbach *et al*, 1979).

Another way to influence children to taste fruit and vegetables might be to use rewards. The findings of research in this domain are more controversial. It has been argued that rewarding an individual for engaging in a particular task undermines his/her intrinsic motivation for that task (eg see Deci *et al*, 1999). Indeed, some studies have reported that when access to a reward is made contingent upon the consumption of a particular food, children's preference for that food decreases (Birch *et al*, 1982, 1984; Newman & Taylor, 1992). However, there is also a large body of research testifying to the efficacy of rewards (eg see Dickinson, 1989; Cameron *et al*, 2001). A number of studies, for example, have employed them successfully to encourage food consumption among children with feeding difficulties (Bernal, 1972; Hatcher, 1979; Siegel, 1982; Riordan *et al*, 1984; Handen *et al*, 1986) and to increase children's healthy snack choices (Stark *et al*, 1986; Baer *et al*, 1987). This evidence indicates that, when used appropriately, rewards can be very effective at altering behaviour such as children's food consumption. It is important, however, that the rewards should be highly desirable (ie that they are potent reinforcers) and that they should signal to the child that they are for behaviour that is both high status and enjoyable (eg see Dickinson, 1989; Lowe *et al*, 1998; Cameron *et al*, 2001).

Drawing upon the literature on children's learning and imitation, the intervention devised for the present study combined peer modelling and rewards to influence children to repeatedly taste fruit and vegetables and to sustain their consumption of these foods over time. The principal components of the intervention were: (i) peer modelling videos, featuring four hero figures (the 'Food Dudes') who eat and enjoy a variety of fruit and vegetables, and (ii) a set of Food Dude rewards such as stickers, pencils, and erasers, that were awarded to children for eating target amounts of the fruit and vegetables presented to them.

The programme and materials were designed to maximise the effectiveness of the intervention. For example, because it has been shown that groups of peers can exert considerable influence (Harris, 1995, 1998), the programme was designed for use by whole schools rather than by individuals. The aim here was to establish a peer group culture that actively supported (ie by supplying further models and rewards of its own) the eating of fruit and vegetables. Also, because there is evidence to indicate that individuals' own verbalisations and rules can give rise to behaviour patterns that are very resistant to change (Lowe, 1979, 1983; Lowe *et al*, 1987; Catania *et al*, 1989), programme materials were designed specifically to encourage children to refer to fruit and vegetables in ways that would help maintain their consumption. Thus, for example, in the peer modelling video, the Food Dudes repeatedly illustrated, and/or commented on, both the immediate and long-term positive consequences of eating fruit and vegetables (eg by referring to the nice taste of these foods, how enjoyable it is to eat them, and how eating them leads to success and health). These verbalisations were designed to be easily learned and repeated by the children themselves (eg sometimes they took the form of 'catch phrases' or songs). It is important for efforts to alter and sustain food consumption that children's expressions of aversion to fruit and vegetables (eg 'Fruit and vegetables are rabbit food', 'They taste horrible'), which are an all-too-common feature of school culture, are supplanted by positive rules such as 'I'm going to eat my fruit because it tastes good', or 'I'm going to eat my vegetables because they'll make me strong'.

Previous studies have shown that this type of intervention is very successful at increasing fruit and vegetable consumption in 5–6-y-old children in the classroom and in the home and in 2–4 y olds in the nursery; that these increases are maintained is shown by follow-ups taken up to 15 months after the intervention (Horne *et al*, 1995, 1998; Dowey, 1996; Lowe *et al*, 1998; Woolner, 2000, see also Tapper *et al*, 2003). However, these studies were carried out with relatively small numbers of children and only with children up to the age of 6 y. With one exception (see Woolner, 2000), the interventions were implemented by researchers. In contrast, this paper describes a 'whole-school' intervention that we have developed for use with all primary school children ranging in age from 4 to 11 y old. In addition, the programme was designed to be implemented entirely by school staff themselves rather than by researchers. This study, which is the first in a series that will report on the effectiveness of the programme, details the new whole-school intervention procedures and outcome measures that focus on tight specification of behavioural contingencies and objective measures of food consumption. We provide here an initial assessment of the programme's impact on the fruit and vegetable consumption of 402 children in three primary schools in different parts of the UK.

Method

Ethical approval

Ethical approval for the study was granted by the School of Psychology Ethics Committee, University of Wales, Bangor.

Participants

The programme was evaluated in three British schools: in Bangor, North Wales (105 pupils aged 4–11 y), in Harwell, Oxfordshire (134 pupils aged 4–11 y), and in the Salford area of Manchester (163 pupils aged 5–11 y). Each school was selected by its local health promotion unit or education authority to represent either lower or higher than average levels of deprivation, as assessed by free meal entitlement. Deprivation levels were below the national average (17%) in the Bangor and Harwell schools (10 and 6%, respectively), and were well above average in the Salford school (31%). The children were predominately of Caucasian ethnic origin.

Study design and food presentation

The programme in each school generally began with an 8–12-day baseline phase followed by a 16-day intervention phase. At 'snacktime' (immediately prior to mid-morning break) throughout the baseline and intervention phases, children were presented with a 'snackpack' that contained two 20 g portions of either fruit or, on alternate days, raw vegetables; in each school, four different fruits (eg kiwi, melon, dried apricot, prune) and four different vegetables (eg carrot, swede, celery, mangetout) were presented in a fixed cycle. Each particular food was presented three times at baseline, and four times during the intervention.

At lunchtime, as part of their meal, children who had school lunches received a whole fruit weighing (after the subtraction of any core or peel weight) approximately 80 g or, on alternate days, a 60 g portion of cooked vegetables; four different fruits (eg apple, banana, pear, satsuma) and four different cooked vegetables (eg carrots, peas, sweetcorn, green beans) were presented in a fixed cycle. Each type of vegetable was presented once during baseline, and at least twice during the intervention. Each type of fruit was presented once (Bangor and Harwell) or twice (Salford) during baseline, and at least twice during the intervention.

There were some children at all the schools who did not have the school meals but took packed lunches and they were presented with either a whole fruit (all schools) or, on alternate days, a 40 g portion of raw vegetables as at snacktime (Bangor and Harwell) or, in the case of Salford, of mixed salad (eg lettuce leaves, tomato, baby sweetcorn, sugarsnap peas). At Salford, each of two salad types was presented twice during baseline and four times during the intervention. (For further details of procedures and results, see Lowe *et al*, 2002.)

Intervention

Materials. The peer modelling videos were six 6-min episodes featuring the heroic 'Food Dudes' who were a group of 12–13-y olds, two boys and two girls. In each episode, the Food Dudes battle against the evil 'Junk Punks' who plan to take over the world by depriving people of their life-giving fruit and vegetables. To arm themselves for their struggle, the Food Dudes eat (and are seen to enjoy) a variety of fruit and vegetables. They urge all other children, in speech and in song, to keep the 'Life Force' strong by doing the same.

The rewards were customised Food Dude items consisting of, for example, stickers, pens, pencil cases, rulers, and erasers. Previous pilot testing in other schools showed that these items had a wide appeal for primary school children. In addition, a series of letters addressed from the Food Dudes to the children were read to the class by the teacher. The purpose of these letters was to provide the children with praise and encouragement and to remind them of what they had to do in order to win a Food Dude Prize.

In the Salford school, Homepacks were also introduced. The primary aim of these was to encourage children to eat fruit and vegetables at home as well as at school and to help parents become actively involved in the programme. The Homepacks, which were delivered to parents by their children, included suggestions about ways of reaching the '5-a-day' target, and tips to encourage children to eat more fruit and vegetables. Each also included a 'sticker card', plus stickers, for the parents to give to the children when they consumed a sufficient quantity and variety of fruit and vegetables at home.

Procedures. In the baseline phase, the foods were simply presented to the children at snacktime and lunchtime each day and consumption was recorded. The procedure was the same during the intervention, except that at snacktime the teacher read out a Food Dude Letter to the children every day, and then, on at least 2 days out of 3, showed them an episode of the Food Dude Video (six episodes in all were shown over the course of the intervention). The teacher, or another member of staff, gave children a small reward (eg a sticker) when they ate some of the fruits or vegetables, and a more potent reward (eg a pen, a pencil, a pencil case, on which was printed the Food Dude logo) when they ate a whole serving. Members of staff supervised the children during the snacktime and lunchtime periods to ensure that food was either eaten or left and not, for example, given to another child or dropped on the floor.

Measures

Lunchtime and snacktime consumption. On a daily basis, the amount of each portion of fruit and vegetables that each child consumed was visually estimated and rated on a five-point scale by independent raters. At snacktime, approximately 10% of ratings were validated against actual weight of food consumed (weight preconsumption minus postconsumption). Cohen's κ coefficient (weighted by the difference between the points on the scale) was used to assess agreement between weighed and rated measures; coefficients ranged from 0.96 to 0.99. At lunchtime inter-rater measures were taken for approximately 40% of the sample. Cohen's κ coefficient (weighted as described above) was again used to assess agreement between each pair of raters in each school; coefficients ranged from 0.86 to 0.98. Consumption of lunchtime salad (Salford) was determined by weighing each child's postconsumption salad waste. (Consumption of raw vegetables by children with packed lunches at Bangor and Harwell was not measured.)

Home consumption. In the Salford school, children's consumption of fruit and vegetables at home was assessed using a parental 24-h food recall procedure in which interviews were conducted with a subset of 47 parents (each paid £25 for participating) during the first week of baseline and the last week of the intervention (4–5 days in each phase). These parents were assigned to one of two groups that were matched with respect to free school meal entitlement, age, and sex of children concerned. Both groups reported what their children consumed over a period of 4–5 days: the first group beginning on a Saturday, the second group on a Thursday. In order to limit social desirability effects, parents were asked to record and report on all foods and drinks consumed rather than just fruit and vegetables.

Prior to the start of each set of interviews, parents were sent information about the procedure, a 'size-of-serving' card, and a food diary with daily subdivisions related to time of day. Parents were asked to record discreetly, under the appropriate daily subdivisions in the food diary, everything they saw their child eat and drink, and as soon as possible after the consumption occurred. The ‘size-of-serving’ card illustrated photographically what, for reporting purposes, parents should quantify as a ‘serving’ (usually a heaped-tablespoon size amount). Parents were telephoned daily by a researcher who, using a standardised interview, asked them what their child had eaten at home on the previous day.

Liking

Children’s liking for 16 different fruits and vegetables (which included all those presented in the study at snacktime and lunchtime) was assessed using questionnaires administered by class teachers. The questionnaires contained a photographic illustration of each food beneath which was a five-point rating scale. For 4–7-y olds, the scale consisted of a series of five faces (ranging from very happy to very unhappy), while for 7–11-y olds it consisted of a set of verbal descriptions (‘I like it a lot’, ‘I like it’, ‘It’s OK’, ‘I don’t like it’, ‘I hate it’). The children could also indicate if they had never tried an item. The baseline measure was taken either just before or during the baseline phase; the intervention measure was taken towards the end of the intervention phase, or just after it.

Results

Consumption at lunchtime and snacktime

For each child, separate means were computed for consumption of fruit and vegetables at snacktime and lunchtime: during the first presentation of each food at baseline (B1), at the final presentation of each food at baseline (B2), at the first presentation during the intervention (I1), and at the final presentation during the intervention (I2). Children with missing data at any of these points were excluded from the calculations for that particular food category and context (eg a child absent from the school when apples were presented at lunchtime at B1 was excluded from the calculation of mean consumption of fruit at lunchtime at B1, B2, I1, and I2). In those schools where there was just one presentation of each food at baseline (ie of vegetables at lunchtime in all three schools, and of fruit at lunchtime in the Bangor and Harwell schools), only one baseline mean (B1) was calculated. In the case of children with lunchboxes, measures were taken of their consumption of the additional fruit presented to them, and of their consumption of the salads (Salford only), but not of the additional raw vegetables.

Figure 1 shows, for children in all three schools, how much (ie mean percentage) of the fruit and vegetable servings they consumed in the baseline and intervention phases. Snacktime fruit consumption (open squares) in all three schools averaged 51% at first baseline and 45% at the final baseline measure, while lunchtime fruit consumption (filled triangles) at Salford averaged 33 and 21%, respectively. Following

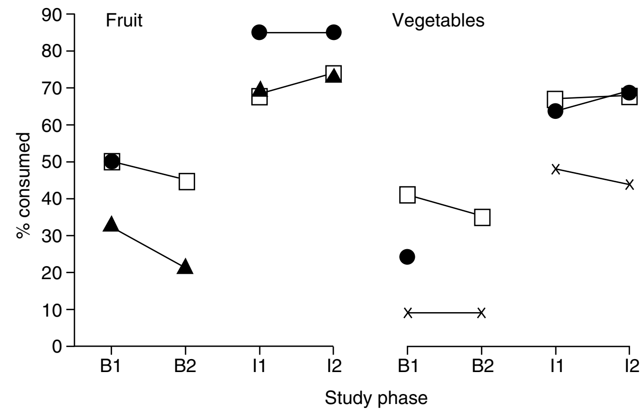

Figure 1 The mean percentage of food consumed during the baseline and intervention phases. The left-hand side of the figure shows data relating to fruit presented at lunchtime in the Bangor and Harwell schools (●), the Salford school (▲) and snacktime in all three schools (□). The right-hand side shows cooked vegetables presented at lunchtime in all three schools (●), salad presented at lunchtime in the Salford school (×) and raw vegetables presented at snacktime in all three schools (□).

the introduction of the intervention, snacktime consumption (open squares) averaged 68% (first intervention measure) and then 74% (final intervention measure). Similarly, lunchtime consumption (filled triangles) at Salford averaged 69% and then 73%. Fruit consumption at lunchtime in the Bangor and Harwell schools (filled circles) averaged 51% in baseline and 85% in the intervention.

The results for vegetable consumption were similar, with snacktime consumption at all three schools (open squares) averaging 41% then 35% during the baseline phase, and 67% then 68% during the intervention. Consumption of cooked vegetables at all three schools (filled circles) averaged 24% in baseline, then 64 and 69% during the intervention. Salad consumption at the Salford school (crosses) averaged 9% during baseline, then 48 and 44% during the intervention phase.

Where there was more than one baseline mean (ie for snacktime fruit and vegetables in all three schools and for lunchtime fruit and salad in the Salford school), a series of three-way mixed analysis of variance tests were employed to compare levels of consumption over time during baseline with levels of consumption over time during intervention. In each case, the independent variables were time (first presentation, final presentation), phase (baseline, intervention) and age (4–7 and 7–11 y). Only results relating to the phase variable are reported.

For snacktime fruit, across all three schools, the results showed a significant main effect of phase, $F(1, 265) = 329.61$, $P < 0.001$, and a significant interaction between time and phase, $F(1, 265) = 44.02$, $P < 0.001$. This confirms what Figure 1 indicates, namely, that consumption was significantly higher overall in the intervention (with a mean of 71%) than in the baseline phase (48%), and that it declined over the course of baseline (51 to 45%), but increased during the intervention (68 to 74%). There were no significant interactions between phase and age, $F(1, 265) = 1.17$, NS, or between time, phase, and age, $F(1, 265) = 0.04$, NS, indicating that this pattern of results applied to both 4–7- and 7–11-y-old children.

In the case of lunchtime fruit consumption in the Salford school, there was a significant main effect of phase, $F(1, 77) = 269.82$, $P < 0.001$, and a significant interaction between time and phase, $F(1, 77) = 17.35$, $P < 0.001$. As Figure 1 shows, consumption was significantly higher during intervention (71%) than at baseline (27%), but showed a decline during baseline (33 to 21%) while remaining relatively stable during the course of the intervention (69 to 72%). There were also significant interactions between phase and age, $F(1, 77) = 21.19$, $P < 0.001$, and between time, phase, and age, $F(1, 77) = 9.34$, $P < 0.005$. Two analysis of variance tests were, therefore, carried out using data for 4–7- and 7–11-y olds. In each case, the independent variables were time and phase. The data for 4–7-y old children showed a significant main effect of phase, $F(1, 32) = 170.24$, $P < 0.001$, but no significant interaction between time and phase, $F(1, 32) = 0.56$, NS. In contrast, the data for 7–11-y old children showed a significant main effect of phase, $F(1, 45) = 91.14$, $P < 0.001$, and a significant interaction between time and phase, $F(1, 45) = 29.96$, $P < 0.001$. The means indicated that consumption by 4–7-y olds remained relatively stable across both the baseline phase (19 and 15%) and the intervention phase (76 and 76%), while consumption by 7–11-y olds showed a decline during baseline (43 to 26%) and an increase during the intervention (64 to 71%).

For snacktime vegetables, there was a significant main effect of phase, $F(1, 283) = 337.73$, $P < 0.001$, and a significant interaction between time and phase, $F(1, 283) = 15.35$, $P < 0.001$. Again, this confirms that the intervention significantly increased vegetable consumption (ie from 38% in baseline to 68% in the intervention phase) and that consumption declined during baseline (41 to 35%), but remained stable, although at a much higher level, during the intervention (67 to 68%). There was also a significant interaction between phase and age, $F(1, 283) = 7.11$, $P < 0.01$, but no significant interaction between time, phase, and age, $F(1, 283) = 0.16$, NS. As the means show, there was a larger difference between baseline and intervention for 7–11-y olds (39 to 72%) than for 4–7-y olds (36 to 60%).

The lunchtime salad results from the Salford school showed a significant main effect of phase, $F(1, 23) = 21.13$, $P < 0.001$, but no significant interaction between time and phase, $F(1, 23) = 1.15$, NS. Consumption was significantly higher during the intervention compared to baseline (46 and 9%, respectively) and remained fairly stable during both phases. There was no significant interaction between phase and age, $F(1, 23) = 2.73$, NS, or between time, phase, and age, $F(1, 23) = 1.71$, NS, indicating that this pattern of results applied to both 4–7- and 7–11-y old children.

Lunchtime vegetable consumption in all three schools, and lunchtime fruit consumption in the Bangor and Harwell schools were analysed using two-way mixed analysis of variance tests with time (B1, I1, I2) and age (4–7 and 7–11 y) as independent variables. The results for lunchtime vegetable consumption in all three schools showed a significant main effect of time, $F(1, 79) = 174.21$, $P < 0.001$ and no significant interaction between time and age, $F(1, 79) = 1.21$, NS. Three *post hoc* *t*-tests (with significance levels adjusted to 0.02), showed that consumption was significantly higher at I1 and I2, compared to B1 ($t = 11.25$, $P < 0.001$ and $t = 13.20$, $P < 0.001$, respectively). The increase between I1 and I2 was not significant ($t = 1.98$, $P < 0.051$). Lunchtime fruit consumption in the Bangor and Harwell schools also showed a significant main effect of time, $F(1, 15) = 9.84$, $P < 0.01$, and no significant interaction between time and age, $F(1, 15) = 1.26$, NS. Two *post hoc* *t*-tests (with significance levels adjusted to 0.025) showed that consumption was significantly higher at I1 and I2 compared to B1 ($t = 12.65$, $P < 0.001$ and $t = 10.78$, $P < 0.001$, respectively).

Lunchtime and snacktime: subset analysis

Additional analyses were conducted in order to determine how the overall consumption means were constituted, that is (a) whether in baseline, there were children who ate little, a moderate amount, or a great deal of the fruit and vegetables presented, and (b) how consumption in these different groups was affected by the intervention. In order to maximise the sample sizes for these analyses, in each case only one baseline score and one intervention score was computed for each child. The data used for these calculations were the child's consumption of each food at its final presentation during the baseline/intervention phase. If the child was absent on any of these days, the datum for the previous presentation of that food was employed. Each data set was then split into five subsets according to the amount each child consumed during the baseline phase: either 0–19, 20–39, 40–59, 60–79, or 80–100%. (Data relating to lunchtime salad consumption were not included due to the small sample size.)

This breakdown is shown on the *x*-axis (percentages in parentheses) of Figure 2, which shows that a large percentage of children were consuming less than 20% of the foods provided to them at baseline (hatched bars). For vegetables, 58% of the children ate an average of only 3% at lunchtime and 41% ate an average of just 4% at snacktime. In the case of fruit, 31% of the children ate an average of just 2% at lunchtime and 29% ate an average of 3% at snacktime. In contrast, only a small proportion of children were consuming over 80% of the foods, ranging from 7% for lunchtime vegetables to 18% for snacktime fruit.

Figure 2 also shows how the children's consumption in each of these subsets was altered by the intervention. It shows that children consuming the least at baseline (ie less than 20%) showed the largest increases in consumption at

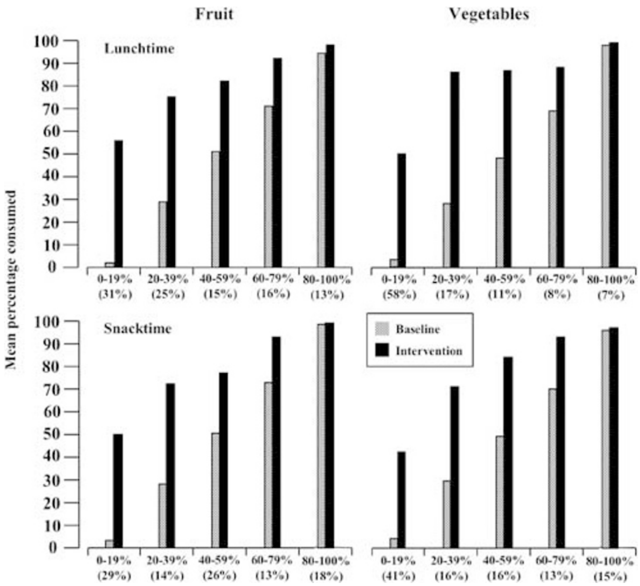

Figure 2 Results broken down into five subsets based on the children's initial consumption of fruit and vegetables (ie in baseline) ranging from 0–20 to 80–100%. The figures in parentheses on the *x*-axis show the percentage of children falling into each of the five categories. The mean percentage of fruit and vegetables consumed by each subset at lunchtime and snacktime is shown for baseline (hatched bars) and for intervention (filled bars).

intervention (filled bars). (The one exception to this was lunchtime vegetable consumption where the children eating between 20 and 39% showed the biggest gain; from 28 to 86%.) The increases for the poorest eaters went from 2 to 56% (equivalent to an increase of approximately 43 g) for lunchtime fruit, from 3 to 50% (28 g) for lunchtime vegetables, from 3 to 50% (19 g) for snacktime fruit, and from 4 to 42% (15 g) for snacktime vegetables. Those who were already consuming 80–100% in baseline showed little change and, clearly, there is a 'ceiling' effect that limits the increase that can be shown in this and other subsets. (It should be noted that although many of the children in this study requested and consumed extra servings of fruit and vegetables over and above the portions that had been presented, this additional consumption was not recorded.)

Home consumption (Salford school)

The parental recall data relating to fruit and vegetables consumed outside of school were recoded into standardised portions based on UK government recommendations for primary school children (Department for Education and Employment, 2000). Depending on the particular fruit or vegetable, these ranged from approximately 40 to 100 g for fruit and 40 to 85 g for vegetables and were comparable with the portion size recommendations provided by the National Cancer Institute in North America (Heimendinger *et al*, 2001). All portions were coded in half portion increments and, in order to be consistent with nutritional recommendations, tubers (eg potatoes, yams) were excluded, while fruit juice and pulses were recorded as a maximum of one portion per day.

Owing to missing data, one weekday (ie Monday or Wednesday) and one weekend day (ie Sunday) at both baseline and intervention were used as the basis for calculations. This resulted in a sample size of 39 for the weekday data and 36 for the weekend data. For each child, the total number of portions of fruit consumed and the total number of portions of vegetables consumed for the weekday and for the weekend day for both the baseline and intervention phases were then calculated.

On weekdays, the mean number of fruit portions consumed averaged 1.00 (s.d. = 1.07) at baseline and 1.21 (s.d. = 1.41) during the intervention, while the mean number of vegetable portions consumed averaged 0.68 (s.d. = 0.81) at baseline and 1.23 (s.d. = 1.55) during the intervention. On weekend days, the mean number of fruit portions consumed averaged 1.94 (s.d. = 1.95) at baseline and 2.01 (s.d. = 2.37) during the intervention, while the mean number of vegetable portions consumed averaged 1.22 (s.d. = 1.69) at baseline and 1.53 (s.d. = 1.56) during the intervention.

Separate analyses were conducted for the weekday and weekend data using two three-way mixed analysis of variance tests. In each case, the independent variables were study phase (baseline, intervention), food (fruit, vegetables), and age (4–7 and 7–11 y). For the weekday data, the results showed a significant main effect of study phase, $F(1, 37) = 4.42$, $P < 0.05$, indicating that significantly more portions of fruit and vegetables were consumed during the intervention compared to the baseline. There were no other significant main effects or interactions. For the weekend data, the results showed no significant main effect of study phase, $F(1, 34) = 0.41$, NS, nor any other significant main effects or interactions.

Estimated overall daily increase in fruit and vegetable consumption

In order to relate the results of the present study to nutritional targets and to the results of previous interventions, estimates were made of the total daily increase in children's consumption of fruit and vegetables in terms of both portions and grams. For the purpose of the present study, and in line with nutritional recommendations (Department for Education and Employment, 2000; Heimendinger *et al*, 2001), a child's portion of fruit or vegetables was estimated to weigh, on average, approximately 60 g. (This is also consistent with the recommended daily vitamin and mineral intakes for 10-y-old children, which are around 70% of those recommended for adults, see Expert Group on Vitamins and Minerals, 2000.) Thus, the lunchtime fruit presented to the children in this study (with an average weight of 80 g) was coded as 1.33 portions, the lunchtime vegetables (with an average weight of 60 g) as 1 portion and the snacktime fruit and vegetables (with an average weight of 40 g) as 0.67 portions. Owing to the declining trend in levels of consumption during baseline (see Figure 1), estimates of the increases in consumption were based, wherever possible, on data collected at B2 and I2. Where no B2 data were available (ie in the case of lunchtime vegetables) the data collected at B1 were employed. Where B2 data were available for just one school (ie in the case of lunchtime fruit consumption), the data from this school only were employed. Thus for snacktime fruit and vegetable consumption, and for lunchtime vegetable consumption, data from all three schools were employed. For lunchtime fruit consumption, only data from the Salford school were employed. For estimates of home consumption, the weekday data collected at the Salford school were employed, with portions also converted to grams. The data were split according to the child's school year in order to provide separate estimates for 4–7- and 7–11-y olds. Table 1 shows that children aged 4–7 y increased their overall daily consumption of fruit and vegetables by 153 g, the equivalent of 2.54 portions, while children aged 7–11 y showed an increase of 131 g, or 2.18 portions.

Liking

The liking scores for each child were computed at baseline and at intervention. If a child indicated that he/she had not tried a particular fruit or vegetable, that individual's score for that food was omitted from the analysis. Those children who had rated less than four fruits or four vegetables were excluded from the analysis leaving a sample size of 303.

On a scale of 1 (highly disliked) to 5 (highly liked), the overall mean fruit ratings were 3.81 (s.d. = 0.79) at baseline and 4.22 (s.d. = 0.78) at intervention, while the overall vegetable ratings were 3.31 (s.d. = 0.99) at baseline and 3.65 (s.d. = 0.99) at intervention. The data were analysed using a four-way mixed analysis of variance with study phase, food, age, and gender as independent variables. The results showed significant main effects of food, $F(1, 299) = 105.27$, $P<0.001$, and study phase, $F(1, 299) = 118.81$, $P<0.001$, together with significant interactions between phase and age, $F(1, 299) = 4.68$, $P<0.05$, and between phase, food, and gender, $F(1, 299) = 3.94$, $P<0.05$. Six *post hoc t*-tests, with significance levels adjusted to 0.007, were employed to test for differences between baseline and intervention liking for fruit and vegetables (combined) by each of the two age groups and, separately, for fruit and for vegetables by both girls and boys. The results confirmed that in each case, liking was significantly higher at intervention than at baseline ($P<0.001$ in all instances).

Discussion

This study provides information on two key domains. First, it provides robust measures of children's consumption of fruit and vegetables when these are made freely available over time in a school environment. Second, it shows how these baseline consumption patterns are transformed by the introduction of the Food Dude intervention.

By the end of baseline, children consumed only 24% of the lunchtime cooked vegetables, 9% of the salad (Salford only), and 35% of the snacktime vegetables; consumption of fruit at lunchtime ranged from only 21% (Salford) to 51% (Bangor and Harwell), and at snacktime was 45% across all three schools (see Figure 1). These percentages are averaged across all children in the schools, however, and disguise the fact that many children consumed even less. For example, consumption of vegetables ranged from as little as 0 to 19% for 58% of the children at lunchtime and for 41% of them at snacktime; the corresponding figures for fruit were 31% at lunchtime and 29% at snacktime (see Figure 2). Despite the initial low levels of consumption in baseline, there was no evidence of improvement either over time or with repeated presentations of the foods. Indeed, if anything, consumption of both fruit and vegetables declined over the course of the baseline phase.

As soon as the intervention was introduced, however, there was an immediate and very substantial increase in consumption that was sustained throughout the intervention phase. This was true regardless of the food type presented (fruit, raw vegetables, cooked vegetables, salad), the school, the context (snacktime, lunchtime), or the age of the child (4–7 and 7–11 y). These immediate increases also occurred regardless of the differing durations of baselines or the differing numbers of previous food presentations. This

Table 1 Estimated increases, following the intervention, in the number of portions (s.d.'s in parentheses) and grams of fruit and vegetables consumed per weekday by children aged 4–7 and 7–11 y

	Lunchtime		*Snacktime*		*Home*		
Age group (y)	*Fruit*	*Vegetables*	*Fruit*	*Vegetables*	*Fruit*	*Vegetables*	*Total*
4–7	0.81 (0.42)	0.41 (0.29)	0.21 (0.21)	0.18 (0.19)	0.62 (1.95)	0.31 (1.05)	2.54
	49 g	25 g	13 g	11 g	37 g	19 g	153 g
7–11	0.60 (0.60)	0.48 (0.31)	0.19 (0.19)	0.24 (0.21)	0.00 (1.01)	0.67 (1.55)	2.18
	36 g	29 g	11 g	14 g	0 g	40 g	131 g

consistency of effect, shown in all six functions presented in Figure 1, and the sudden reversal of declining or stable baseline trends, indicate that it was the intervention that was the determining factor in bringing about these increases in consumption of fruit and vegetables and not simply the continued presentation of the foods. Although this study did not include follow-up measures, we are currently preparing a paper reporting on a study in which follow-up measures were conducted at 4 months. We are also in the process of conducting research in which follow-up measures will be taken at 6- and 12-month intervals. In addition, it should be noted that the present findings are supported by those of other studies that have conducted controlled investigations of this type of programme (Horne *et al*, 1995; Dowey, 1996; Horne *et al*, 1998; Lowe *et al*, 1998; Woolner, 2000) which show that the effects are maintained up to 15 months after the intervention.

In terms of the quantities of additional fruit and vegetables consumed, very large increases were shown by those children who ate least at the outset. For example, those children who fell into the 0–19% consumption bracket in baseline (see Figure 2) went from eating an average of just 2% of their fruit and 3% of vegetables at lunchtime during baseline to 56 and 50%, respectively, of these foods during the intervention. These are very substantial increases, of the order of 15–27-fold, in the consumption levels of those very children who, from a nutritional standpoint, need them most.

Analysis of the parental recall data indicates that children's consumption of fruit and vegetables during the intervention weeks also showed a significant increase at home. This increase occurred for fruit and for vegetables among both 4–7- and 7–11-year olds. Over weekends, the increase was smaller and failed to reach statistical significance (there were only 36 participants in the group). Since most of the intervention was delivered at school during weekdays, the lesser effects at the weekend may have been the result of a lack of appropriate cues (such as being reminded of the positive consequences of eating fruit and vegetables). If this were the case, it may be possible to increase weekend consumption in future by incorporating specific weekend activities into the homepack. It is also important to note, however, that further work is needed to experimentally validate the parental recall measure.

The study also showed that following the intervention, there was an increase in children's reported liking of a range of fruit and vegetables. This is important for a number of reasons. Firstly, stated food preference has been shown to be positively related to consumption (Birch, 1979). An increase in liking may therefore be associated with relatively stable changes in consumption. However, other authors have suggested that the use of rewards may have differential effects on consumption and liking (Wardle, Herrera *et al*, 2003). In other words, rewards may increase consumption but fail to increase liking, and thus result in changes in consumption that are not maintained once rewards are no longer delivered. This did not appear to be the case in the present study where the intervention not only increased children's consumption of fruit and vegetable but also increased their liking of them.

Estimates of the increases in fruit and vegetable consumption, in terms of both grams and portions, showed that they were likely to be clinically significant. The increases were estimated to be 153 g or 2.54 portions per weekday for 4–7-y olds, and 131 g or 2.18 portions per weekday for 7–11-y olds. Thus, these increases move children nearer to the recommended intake of at least five portions a day. Furthermore, the increases reported by the present study may be conservative estimates given that, in calculating the numbers of portions, it assesses portion size as approximately 60 g, which may be larger than the portion size that is appropriate for children aged 4–11 y.

Similarly, it is difficult to compare the present findings with those from other studies because of the variation among the latter in their specification of what constitutes 'a child's portion'. For example, some researchers report using standardised 'portions', but do not provide details of the average gram or volume equivalents (eg Perry *et al*, 1998), while others refer to 'servings' that they define as the amount 'usually' put on the child's plate (eg Baranowski *et al*, 2000). Nevertheless, the increases in consumption observed in the present study do seem to compare favourably with those observed in previous research. For example, in experimental schools (ES) relative to control schools (CS), increases obtained at final follow-up were 0.1 'servings' in the original Georgia Gimme 5 Programme (+0.3 fruit in ES, +0.2 vegetables in CS; Domel *et al*, 1993), 0.2 'servings' in the modified Georgia Gimme 5 Programme (−0.2 vegetables in CS; Baranowski *et al*, 2000), no increase in the number of 'servings' in the New Orleans Gimme 5 Programme (+0.37 fruit and vegetables in ES and CS; Nicklas *et al*, 1998), 0.62 individualised portions of fruit (average portion size not specified) in the Minnesota 5 A Day Power Plus Programme (baseline data not reported; Perry *et al*, 1998), 0.89 portions (based on guidelines provided by the National Cancer Institute; see Heimendinger *et al*, 2001) in the Alabama High 5 Project (+0.59 fruit and vegetables in ES, −0.3 fruit and vegetables in CS; Reynolds *et al*, 2000), and 0.5 and 0.7 'servings' in the 5 A Day Power Play Programmes in California (+0.2 fruit and vegetables in 'school only' ES, +0.4 fruit and vegetables in 'school and community' ES, −0.3 fruit and vegetables in CS; Foerster *et al*, 1998). The increases observed in the present study (2.54 and 2.18 portions for 4–7- and 7–11-y olds, respectively) were considerably higher than all these.

It should also be noted that, unlike many of the studies described above (ie Domel *et al*, 1993; Nicklas *et al*, 1998; Baranowski *et al*, 2000; Reynolds *et al*, 2000), the present study did not rely on self-reports to measure consumption, but employed observations validated by weighed measures and established inter-rater reliability procedures. Consumption at home was assessed by parental report. This is important since self-report measures are subject to a number of inaccuracies and biases. In particular, children have been shown to have difficulties in remembering what they have eaten and in estimating serving sizes (Livingstone & Robson, 2000), and to overestimate their consumption of fruit (Lytle *et al*, 1998). And even where the self-report methods employed have shown moderate agreement with observations, the validation has been conducted in the absence of an intervention designed to increase consumption (Domel *et al*, 1994; Lytle *et al*, 1998). Given the fact that health interventions have been shown to bring about an increase in social desirability bias (Herbert *et al*, 1995; Kristal *et al*, 1998), the self-report data from studies that include interventions may not just be inaccurate but may systematically overestimate these interventions' benefits.

What distinguishes the present study's intervention, and may account for its greater effectiveness in comparison with previous approaches, is its use of a combination of peer modelling with a systematic programme of rewards in which the behavioural contingencies are tightly specified. Although modelling and rewards have been used in other interventions aimed at increasing children's consumption of fruit and vegetables (Perry *et al*, 1998; Baranowski *et al*, 2000), they may not have been used to a maximum effect. For example, in the Gimme 5 programme (Baranowski *et al*, 2000), parents were encouraged to model desired behaviours for their children. However, research (see Introduction) shows that peers are more effective models for children than adults. It is also possible that many parents simply failed to model the desired behaviours for their children. As for the reward component of the Gimme 5 programme, this was limited to just two prizes that children received for collecting a sufficient number of points. Perhaps crucially, points were awarded for what the authors term 'dietary change goals' (p 98) and for the completion of home assignments rather than, as in the present study, for actual changes in food consumption. In addition, the latter of these prizes was contingent upon team points rather than individual points earned. For these reasons, it seems likely that the Gimme 5 reward system would not be very effective in changing children's eating behaviour.

In the 5-a-Day Power Plus Program (Perry *et al*, 1998), the modelling element took the form of a comic book. It is not clear to what extent children read the comic book and how effective this might be in comparison to the Food Dude videos. The use of rewards in their programme was also limited. The authors report that teams competed to eat fruit and vegetables during the intervention and that both individuals and teams were rewarded with small prizes at the end of the programme. In addition, children were entered into a prize draw for their participation in home activities. Thus again, the rewards may not have been employed most effectively, that is, they were sometimes contingent on team rather than individual performance, they were presented after a long delay from initial food consumption, and they were not always used to reward eating behaviours *per se*.

In contrast, in the present programme, the techniques of modelling and rewards were employed in ways designed to maximise their efficacy. For example, the modelling element, consisting of the Food Dude videos, was designed to promote imitation through the use of older 'hero' children as models, and these videos were watched many times by all the children in the study. The rewards were available on a daily basis for eating fruit and vegetables and were contingent on the individual's behaviour rather than on group behaviour. In most cases, they were delivered to the children very soon after they had eaten and care had also been taken to ensure that all the rewards were effective and had a wide appeal for the children participating. In addition, the videos created a context in which these Food Dude-labelled rewards were given added potency.

In the present programme, the aim of both the system of rewards and the videos was to ensure that children repeatedly tasted the foods so that they came to like their tastes and find the foods rewarding in their own right. A number of studies have shown that repeated taste exposure to particular foods increases consumption and/or expressed liking for them (Birch & Marlin, 1982; Birch *et al*, 1987; Sullivan & Birch, 1990; Wardle, Herrera *et al*, 2003). Thus, in the present programme, once children 'acquire the taste' for the fruits and vegetables, these foods provide their own intrinsic rewards to supplement and, in time, perhaps entirely replace the programme's extrinsic rewards. The effectiveness of the present study's extrinsic rewards in increasing consumption and liking of fruit and vegetables is consistent with the findings of many other studies that have used rewards to alter food consumption and choice (Bernal, 1972; Hatcher, 1979; Siegel, 1982; Riordan *et al*, 1984; Handen *et al*, 1986; Stark *et al*, 1986; Baer *et al*, 1987; Hendy, 2002; Wardle, Cooke *et al*, 2003).

On the other hand, some authors have claimed that the provision of extrinsic rewards has a detrimental effect on food preferences (Birch *et al*, 1982; Newman & Taylor, 1992). As Wardle, Herrera *et al* (2003) have observed, the reasons for these discrepancies remain to be systematically investigated. There is, however, a body of evidence pointing to some of the factors that may be involved. First, context and method of reward delivery are almost certainly critical. Since rewards serve not just as rewards but also as sources of symbolic input, the 'meanings' that the reward procedure conveys to the child may well determine its outcome (Lowe, 1979; Horne & Lowe, 1996). If, as in the Newman and Taylor (1992) study, food A is designated as being the reward for eating food B, children may take this as an indication that food B is less favoured by the experimenter and others. It is unsurprising then if, when asked in preference tests which food is better, they express less of a liking for food B than they did previously.

Perhaps even more negative in impact, however, is the use of procedures that carry coercive meanings and associations for the child. For example, in the study by Birch *et al* (1982), children were told 'Drink this juice and then you can (ride the tricycle)' (p 129). In another study by Birch *et al* (1984), children were told 'You need to drink more fruit shake to get a movie ticket' or 'You didn't drink enough yet; drink some more to get your movie ticket' (p 435). The impact of children's prior experience of such contingencies should not be overlooked. They may have previously encountered contingencies verbalised in this way by their parents, who may have used such injunctions, perhaps with considerable attendant emotion, to persuade their children to eat foods they strongly disliked or to engage in unpleasant tasks, thereby leading to their children's devaluing of these foods and their increased resistance to eating and learning to like them (Lepper *et al*, 1982).

The context in which rewards were delivered in the present study was designed to avoid coercive or negative associations of the forms outlined above. The programme avoided negative messages about other foods or the health consequences of eating badly and focused instead on the intrinsic virtues and enjoyment of eating fruit and vegetables, extolled by the Food Dudes in the videos and letters. Rewards were presented as indicators of the children's positive achievements in, for example, keeping the 'Life Force' strong. In addition, teachers and parents were asked to use the rewards as marks of achievement and to accompany them with positive encouragement and praise. Like the present study, much other research also indicates that rewards do not have negative effects when they convey positive messages about, for example, the individuals' achievement and competence (Cameron *et al*, 2001; see also Hendy, 2002; Wardle, Cooke *et al*, 2003).

It may also be important to ensure that the rewards used are potent. If consequences for eating particular foods are provided that are not valued by many of the participants, and particularly if they are combined with coercive instructions, then we should not expect to see improvements in eating patterns and may even observe a decline in stated preference such as has been reported by Birch *et al* (1982) and Newman and Taylor (1992).

It might be argued that even if rewards do not lead to a decline in food preferences, they may nevertheless be omitted from interventions and that instead there should be a focus on taste exposure. After all, if taste exposure on its own succeeds in increasing preference for foods, why include rewards? The problem lies, however, in how one manages to secure the requisite repeated taste exposures, particularly in real-world environments such as schools or homes. Even those experimental procedures that do set out to investigate taste exposure alone have been obliged to use instructions, social rewards (eg encouragement and praise), and/or modelling to get the children to taste the foods repeatedly (see Wardle, Cooke *et al*, 2003, Wardle, Herrera *et al*, 2003). As Wardle, Cooke *et al* (2003) acknowledge 'in real-world interventions it is doubtful that one would want to eliminate entirely a potentially rewarding positive social context' (p 160). It is certainly the case that simply presenting fruit and vegetables repeatedly to children, as was done in the baselines of the present study (and see Horne *et al*, 1995, 1998; Dowey, 1996; Lowe *et al*, 1998; Woolner, 2000), does not guarantee that the children will repeatedly taste these foods. In an earlier study, when children were shown Food Dude videos with instructions and encouragement to eat fruit and vegetables but were not given any rewards for doing so, the effects on consumption were negligible; rewards alone, without the video, did have substantial effects, but the best results were yielded by a combination of video and rewards (Lowe *et al*, 1998).

This evidence suggests a hypothesis that runs directly counter to the notion that rewards for eating particular foods produce decrements in preference and consumption of these foods. Given that the success of interventions requires that foods should be tasted repeatedly and that we eliminate negative messages and coercive instructions from our procedures, we should ensure that children are effectively rewarded, in association with as many tastings as possible, for eating these foods. The better the rewards, both social and tangible, for eating particular foods and the more trials on which they are presented, the greater will be the subsequent increase in liking and consumption of those foods. This is a hypothesis that merits further investigation.

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