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Research report

The root of the problem: increasing root vegetable intake in preschool children by repeated exposure and flavour flavour learning ☆

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ABSTRACT

Children's vegetable consumption falls below current recommendations, highlighting the need to identify strategies that can successfully promote intake. The current study aimed to investigate the effectiveness of flavour–flavour learning as one such strategy for increasing vegetable intake in preschool children. Children (N = 29) aged 15 to 56 months were recruited through participating nurseries. Each received a minimum of six and maximium eight exposures to a root vegetable puree with added apple puree (flavour–flavour learning) alternating with six to eight exposures to another with nothing added (repeated exposure). A third puree acted as a control. Pre- and post-intervention intake measures of the three purees with nothing added were taken to assess change in intake. Follow-up measures took place 1 month (n = 28) and 6 months (n = 10) post-intervention. Intake increased significantly from pre- to post-intervention for all purees (~36 g), with no effect of condition. Magnitude of change was smaller in the control condition. Analysis of follow-up data showed that intake remained significantly higher than baseline 1 month ($p < 0.001$) and 6 months ($p < 0.001$) post-intervention for all conditions. Children under 24 months ate consistently more across the intervention than the older children (≥24 m) with no differences found in response to condition. This study confirms previous observations that repeated exposure increases intake of a novel vegetable in young children. Results also suggest that mere exposure (to the food, the experimenters, the procedure) can generalise to other, similar vegetables but the addition of a familiar flavour confers no added advantage above mere exposure.

Introduction

Habitual vegetable consumption provides many known health benefits (Bazzano, 2006; He, Nowson, & MacGregor, 2006; Hung et al., 2004; Joshipura et al., 2001; Serdula et al., 1996; World Cancer Research Fund/American Institute for Cancer Research, 2007) and yet intake remains much lower than recommendations (The NHS Information Centre, 2012), particularly in children (Magarey, Daniels, & Smith, 2001; National Obesity Observatory, 2012; Yngve et al., 2005). The eating habits we develop during childhood often persist into later life (Nicklaus, Boggio, Chabanet, & Issanchou, 2005) suggesting the development of interventions targeting children, that aim to increase vegetable intake, may serve to maximise the potential health benefits of improving diet.

Studies that have explored approaches to promoting vegetable consumption in young children have so far identified several potential strategies. These range from providing larger portion sizes (Rolls, Roe, & Meengs, 2010) to serving vegetables by stealth, incorporated within meals in order to hide their presence (Caton, Ahern, & Hetherington, 2011; Spill, Birch, Roe, & Rolls, 2011). In addition offering children tangible rewards and social praise has also been successful in increasing both liking for and consumption of novel vegetables (Cooke et al., 2011; Cooke, Chambers, Añez, & Wardle, 2011).

A method that has proven particularly effective in increasing children's preference for vegetables is simple repeated exposure. Grounded in the mere exposure effect (Zajonc, 1968), repeated exposure works by building familiarity with a novel stimulus. Zajonc (1968) suggested that animals initially respond to all novel stimuli with fear or avoidance. He goes on to explain that preference for a stimulus object can be developed simply by repeatedly presenting that stimulus to an individual and consequently increasing familiarity with it. Therefore, foods that we are frequently exposed to become liked. The success of mere exposure via familiarisation is that experience with the stimulus produces no negative affect which

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could result in damaging associations to be formed and actually acts to decrease preference (Zajonc, Markus, & Wilson, 1974). This idea is consistent with the 'learned safety' hypothesis in food preference development, proposed by Kalat and Rozin (1973). They demonstrated that repeated experiences with a food with no negative post-ingestive outcomes can increase preferences for previously novel or disliked foods. There is growing evidence that repeated exposure can successfully increase children's liking and acceptance of a novel food or flavour. There is also evidence to suggest that this effect can generalise, promoting acceptance of other new foods (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Loewen & Pliner, 1999) particularly when children are repeatedly and frequently exposed to a variety of new foods and flavours (Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008). Recent research has produced favourable results with increases in liking and consumption of vegetables across ages (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Wardle et al., 2003).

A review of dietary learning by Brunstrom (2005) has suggested that associative conditioning can also play an important role in the development of food preferences, allowing us to learn about the properties of different foods and shaping the choices we make about what foods to consume. Much of this has focussed on flavour–nutrient learning (FNL) where associations are formed between the flavour of a food and its post-ingestive consequences. Ingestion of foods that lead to positive outcomes, such as feeling satiated, result in an increase in the hedonic value of those foods and acceptance of those flavours. Another proposed mechanism for establishing flavour preferences is flavour–flavour learning (FFL). Instead of being regulated by post-ingestive feedback FFL occurs when associations are established between a flavour cue and another, already liked flavour. Repeated pairings of these two flavours result in a positive shift in liking for the target flavour even when it is presented on its own. Similarly, pairings with a disliked or aversive flavour reduce liking for the conditioned flavour. A number of recent studies have attempted to apply the principles of FFL to promote vegetable liking and consumption in children. Havermans and Jansen (2007) presented primary school children (average age of 5 years) with unsweetened and sweetened vegetable juices across six pairs of conditioning trials. Using this method they were able to demonstrate an increase in preference for those juices that had been paired with a sweet taste when compared with those that had not. However, this increase in preference did not translate to an increase in intake. Additionally the number of children who completed the study was low, with only 13 of the 21 children recruited taking part in all of the conditioning trials. More recent studies involving preschool-aged children have been successful in increasing children's intake of a novel vegetable by pairing it with a sweet taste (Caton et al., 2013; Hausner, Olsen, & Moller, 2012; Remy, Issanchou, Chabanet, & Nicklaus, 2013). These experiments performed in three different European countries used near identical designs and the same products to compare FFL with FNL and repeated exposure. Children were assigned to one of the three conditions and received up to 10 exposures to a novel artichoke puree of a corresponding recipe. In the FFL condition this consisted of an artichoke puree paired with a 3.6 g of sugar per 100 g. The results of all three studies showed a significant increase in intake of a plain artichoke puree offered post-intervention in the FFL condition suggesting that FFL had taken place. It is important to note, however, that all three studies also found no advantage in using FFL to increase vegetable consumption over a simple repeated exposure method (Caton et al., 2013; Hausner et al., 2012; Remy et al., 2013).

The technique of pairing vegetables with flavours that are liked by children is one that UK mothers already use to encourage consumption, often in the form of dips and sauces (Caton et al., 2011). The extent to which this is helpful in developing a preference for vegetables is yet to be established experimentally, although a recent study was unable to demonstrate increased liking or intake when compared with repeated exposure (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012). Instead Anzman-Frasca et al. (2012) suggested that these kinds of pairings may serve to encourage initial tastes of new or disliked vegetables. To date, the success of FFL interventions has relied upon pairings of vegetables with a sweet taste. Although not always explicitly stated, a sweet taste is likely to be chosen as the unconditioned stimulus because of the pleasure response associated with it (Booth, Higgs, Schneider, & Klinkenberg, 2010). Children have an innate preference for sweet tastes, and it therefore follows that adding sweetness will likely enhance preference, perhaps especially for vegetables which are bitter. However, this conflicts with health messages to reduce added sugars in the diet (Department of Health, 2013). If effective, employing naturally sweet ingredients such as fruit or pureed fruits may be more attractive to parents as a technique for increasing children's vegetable consumption.

There is growing evidence that repeated exposure offers an effective strategy for promoting vegetable intake in children, however, research in support of FFL is limited suggesting further investigation is needed. Given that the mere exposure effect is predicated upon a lack of negative consequence over time, adding an already liked flavour to a novel vegetable might facilitate preference and acceptance. The addition of a sweet taste may assist in reducing the intensity or bitterness of vegetable flavours which may in turn encourage initial intake and increase the opportunity for taste exposure.

The aim of the present experiment was to test the hypothesis that adding sweetness via fruit puree to a novel, target vegetable would be more effective than simple repeated exposure in increasing liking and intake of the target.

Method

Participants

Parents of preschool children aged 12–60 months were recruited through local day care nurseries in the West Yorkshire area, UK. Initial contact was made with nurseries via email or telephone, and managers were given details of the study. If managers expressed interest in taking part further meetings were held with staff teams at the nurseries to ensure they understood and were comfortable with the purpose of the study, and consent forms were distributed to parents.

Of the 15 nurseries that were approached, four agreed to take part and three successfully completed the intervention. Through these three nurseries, 42 children aged 15–56 months were recruited. Participants were screened for food allergies (as reported by parents) and inclusion in the study required children to attend nursery for at least 2 days per week. The study was approved by the Institute of Psychological Sciences (University of Leeds) ethics committee (12-0018).

Procedure

A within-subjects design was employed. Three target vegetables were identified as being relatively novel to preschool children and neutrally liked based on the results of a previous study (Ahern et al., 2013); celeriac, swede and turnip, and these were counterbalanced across conditions and then counterbalanced across participants. A summary of the procedure is shown in Fig. 1. Children's baseline intakes of the repeated exposure (RE) versions of all three vegetable purees were measured before the intervention (see Table 1 for puree recipes). They received up to 200 g of each vegetable puree on three separate days at their usual snack time. Children were initially offered a single pot containing 100 g of puree and were asked