

# The Addition of a Plain or Herb-Flavored Reduced-Fat Dip Is Associated with Improved Preschoolers' Intake of Vegetables

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## ABSTRACT

This quasiexperimental study used a within-subjects experimental design to determine whether adding herbs and/or spices to a reduced-fat dip increased children's willingness to taste, liking of, and consumption of vegetables. Participants were preschool children aged 3 to 5 years who attended a child-care center in Central Pennsylvania in late 2008 and early 2009. First, children's familiarity with and liking of six raw vegetables and five dips (reduced-fat plain, herb, garlic, pizza, and ranch) were assessed. In Experiment 1 (n=34), children tasted a vegetable they liked, one they disliked, and one they refused, with a reduced-fat plain dip and their favorite reduced-fat herb-flavored dip. In Experiment 2 (n=26 or n=27), they rated their liking of celery and yellow squash, with and without their favorite reduced-fat herb dip (pizza or ranch), and their intake of those vegetable snacks was measured. In Experiment 1, the herb-flavored dip was preferred over the plain dip ( $P<0.01$ ), and children were three times more likely to reject the vegetable alone, compared with eating the vegetable paired with an herb dip ( $P<0.001$ ). In Experiment 2, children ate significantly more of a previously rejected or disliked vegetable (celery and squash) when offered with a preferred reduced-fat herb dip than when the vegetable was served alone ( $P<0.05$ ). These findings suggest that offering vegetables with reduced-fat dips containing familiar herb and spice flavors can increase tasting and thereby promote liking, acceptance, and consumption of vegetables, including vegetables previously rejected or disliked.

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**M**OST PRESCHOOL CHILDREN DO NOT MEET recommended intakes for vegetables,<sup>1</sup> with some consuming  $<0.5$  serving/day,<sup>2</sup> and a considerable number not consuming any vegetable on a typical day.<sup>3</sup> These findings are worrisome because vegetables are sources of essential nutrients and contain bioactive compounds that may help reduce the risk of chronic disease.<sup>4-6</sup> Because food preferences and nutrient intakes track during childhood,<sup>7-9</sup> helping preschool children develop a liking for vegetables may create a foundation for long-term, healthy eating habits.

Numerous strategies for increasing children's willingness to taste unfamiliar vegetables and other foods have been tried successfully, including repeated tastings,<sup>10-14</sup> pairing an unfamiliar flavor with a liked one,<sup>15,16</sup> and using peers to influence their food preferences.<sup>17,18</sup> Many children, however, remain wary of tasting new vegetables, even when parents make vegetables available in the home,<sup>19</sup> lead the vegetable exposure,<sup>13,20</sup> or reward them for tasting a vegetable.<sup>20,21</sup> Although children generally dislike sour and bitter tastes,<sup>22,23</sup> their willingness to taste and consume vegetables can be increased by offering vegetables with flavored dips.<sup>24,25</sup> A concern with this approach is that although dips may be conve-

nient for parents, they have the potential to contribute excess energy, fat, and sodium to preschool children's diets.

Enhancing the palatability of vegetables also increases children's consumption of them.<sup>16,26-28</sup> In our study, the palatability of vegetables was enhanced by offering them with reduced-fat dips formulated with added herbs and spices to achieve familiar flavors. Herbs and spices are common to many culinary traditions, and their addition to foods improves palatability and can make unfamiliar foods seem familiar.<sup>15,29</sup>

The purpose of this research was to compare the effects of dips (with and without familiar herb and spice combinations) with serving vegetables alone (without dip) on children's willingness to taste, liking of, and consumption of vegetables. This study was unique in encouraging preschool children to taste both liked and disliked vegetables with a preferred herb-flavored dip low in energy density (1.16 kcal/g). It was hypothesized that serving a palatable reduced-fat dip containing herbs and spices would increase preschool children's willingness to taste and liking of vegetables (Experiment 1), and that children offered a palatable reduced-fat dip containing herbs and spices would consume more vegetables (Experiment 2).

## METHODS

### Study Design and Participants

A within-subjects, quasiexperimental protocol was used to evaluate the effects of herb/spice-flavored, reduced-fat dip on children's willingness to taste, liking of, and consumption of vegetables. Participants were a convenience sample of preschool children ranging in age from 3 to 5 years who attended a local child-care center in central Pennsylvania during late 2008 and early 2009. They were recruited via a letter given to their parents. The Pennsylvania State University Institutional Review Board approved the study procedures, and all parents provided written consent for their child's participation in the study. Parents completed a short questionnaire on marital and employment status, education, family income, and their child's race, general eating habits, and familiarity with certain vegetables. Children were excluded if they had known food allergies.

### Study Protocol

The study protocol was conducted over a 6-week period. First, children's familiarity with and liking of six common vegetables and five dips (reduced-fat plain, herb, garlic, pizza, and ranch) were assessed to identify a vegetable that was liked, a vegetable that was disliked, and a dip that was liked by each participant. Two experiments were then conducted to evaluate the effects of a reduced-fat dip (plain or herb) on preschool children's willingness to taste and liking of vegetables (Experiment 1), and the effects of serving vegetables with and without an herb-flavored dip on their consumption of vegetables (Experiment 2). Each experiment lasted 2 weeks; both were within-subjects experiments, with children receiving all experimental conditions. Children in both experiments visited the tasting station one at a time in a room apart from their classmates.

**Dip and Vegetable Familiarity and Liking.** The familiarity and liking protocol was composed of three sessions: demonstration/practice of a "tasting game," followed by liking assessments of fresh, raw vegetables and reduced-fat herb dips. In the first session, a researcher demonstrated the tasting game using a form of role play. The researcher pretended to taste a piece of realistic-looking, plastic fruit, made a face, and then showed his assessment by choosing one of three cartoon faces: "yummy" (liked), "just okay," or "yucky" (disliked). The validity and reliability of the protocol for assessing children's food preferences were published previously.<sup>30</sup> In studies where this rating scale was used, children provided consistent information about their food preferences,<sup>31,32</sup> and their liking of a food predicted<sup>25,33</sup> or was associated with an increase in<sup>24</sup> their intake of it.

In the second session, children were asked to rate six different vegetables: carrots, cucumbers, celery, green beans, red peppers, and yellow squash. Each sample constituted 1/2 cup (~50 g) of vegetable placed in an unlabeled, 4-oz cup. The tray of vegetables was arranged with three vegetable samples set in front and the other three set behind, and the arrangement on the trays was varied so that half of the children were presented with carrots, cucumbers, and celery in the front row and the other half with those vegetables in the back row to reduce any effect of placement on tasting order. The order in

which the vegetables were tried was recorded. Children reported whether they had eaten the vegetable before and then, after tasting it, categorized it as "yummy," "yucky," or "just okay" by choosing one of the three cartoon drawings of facial expressions. After all of the foods were categorized based on liking, children were asked to order the foods within each category, yielding a complete rank order. For example, if two vegetables were categorized as "yummy," children were asked to select the "yummiest" of those vegetables and so forth. In the third session, liking data for five dips (reduced-fat plain, herb, garlic, pizza, and ranch) were assessed using the procedure described above. A small sample (43 g or 3.5 tablespoons) of each dip was served in a 2-oz cup labeled with a number. Using the same rating scale, children ranked their preference for dips as was done for the vegetables. Two dips (herb and garlic) were determined to be least liked and were eliminated.

**Experiment 1.** Each child participated in two short tasting sessions, tasting three vegetables (one liked, one disliked, and one refused) with a preferred herb dip and plain reduced-fat dip. The vegetables, which had been identified in the familiarity and liking protocol described above, differed for each child and were in keeping with their preferences. Half of the children were given the plain dip and half their favorite herb-flavored dip in the first tasting session, and the order was reversed for the second session, with a 10- to 15-minute break between the sessions. The child was told the names of the vegetables given, encouraged to taste the liked vegetable/dip combination first, and then allowed to choose which vegetable to taste next with the dip. After tasting the combination, the child rated it as "yummy," "just okay," or "yucky." The order in which the samples were tasted and whether the sample was rejected were recorded. Herbs and spices were added to a dip rather than directly on the vegetable because there was concern that the flavor principle present in the dip paired with a vegetable would differ substantially from the flavor principle of herbs and spices added directly to vegetables.

**Experiment 2.** Each child participated in four snack sessions, administered on four different days, to assess the impact of dip condition (with or without the child's preferred pizza or ranch dip) on ad libitum intake of two vegetables. Yellow squash and celery were chosen because parents had indicated that their children were unfamiliar with these vegetables at study entry and because these were the most disliked vegetables in the familiarity and liking session. One condition was tested each day: celery with the preferred dip, celery without dip, steamed squash with the preferred dip, steamed squash without dip. The order in which children received each of these conditions was counterbalanced, such that children were randomized to receive either yellow squash or celery first. After each tasting session, the child rated the sample as "yummy," "just okay," or "yucky." A record was made of the order in which the samples were tasted and whether the sample was rejected. Food weights to the nearest 0.1 g were recorded before and after consumption using digital scales (Mettler-Toledo PR5001 and Mettler-Toledo XS4001S, Mettler-Toledo Inc). The amount of each food item consumed (in grams) was determined by subtracting the postsnack weight from the presnack weight.

**Table.** Rating of vegetables and dips by preschoolers (n=34) in a study to determine whether adding herbs and/or spices to a reduced-fat dip increased children's willingness to taste, liking of, and consumption of vegetables

Condition	Response to Tasting <sup>a</sup>							
	Yummy <sup>b</sup>		Just Okay		Yucky		Refused	
	n	%	n	%	n	%	n	%
Vegetable alone <sup>cd</sup>	11	31	5	15	12	36	6	18
Vegetable plus plain dip <sup>e</sup>	17	49	8	25	6	18	3	9
Vegetable plus herb dip	22	64	6	18	4	13	2	6

<sup>a</sup>Categorical response data for 34 preschool children in Experiment 1 were analyzed with generalized estimating equations for a multinomial distribution. The effects of condition were examined by single degree of freedom contrasts.

<sup>b</sup>Children rated the vegetables and dips by choosing one of three cartoon faces: "yummy" (liked), "just okay," or "yucky" (disliked). The number of children refusing to taste a vegetable, with or without dip, was recorded.

<sup>c</sup>Contrast result: vegetable alone vs vegetable+reduced-fat plain dip (odds ratio 2.5, 95% CI 1.6 to 3.9;  $P<0.001$ ).

<sup>d</sup>Contrast result: vegetable alone vs vegetable+reduced-fat herb dip (odds ratio 4.3, 95% CI 2.8 to 6.5;  $P<0.001$ ).

<sup>e</sup>Contrast result: vegetable+reduced-fat plain dip vs vegetable+reduced-fat herb dip (odds ratio 1.7, 95% CI 1.1 to 2.6;  $P<0.01$ ).

## Preparation of Vegetables and Dips

Fresh vegetables and sample dips\* were prepared by staff members at the Center for Food Innovation at The Pennsylvania State University. The reduced-fat plain dip was formulated from Miracle Whip (Kraft Foods Inc), light sour cream, and 2% milk. The reduced-fat herb dips were formulated from the plain dip with added herbs and/or spices and were labeled "pizza" or "ranch." For the pizza dip, the following herbs and spices were added to the plain dip: basil, oregano, parsley flakes, onion powder, garlic powder, black pepper, Romano cheese powder, cheddar cheese powder, and paprika. For the ranch dip, the following herbs and seasoning were added to the plain dip: onion flakes, parsley flakes, dill, and salt. The 43-g (3.5-tbsp) servings of both the plain and herb dips provided 50 kcal, had a low energy density of 1.16 kcal/g, and contained 4 g fat (of which 1.5 g was saturated fat) and 90 mg sodium.

## Statistical Analyses

The analyses were performed using the Statistical Analysis Software (version 9.1, 2002-2003, SAS Institute Inc). Liking was ordered as "yucky"=1, "just okay"=2, and "yummy"=3, for all multinomial analyses. In Experiment 1, the hypothesis was that offering small samples of a palatable, reduced-fat dip containing herbs and/or spices would increase the children's willingness to taste and their liking of vegetables. Generalized estimating equations with a multinomial distribution and cumulative logit link function (Proc Genmod in Statistical Analysis Software) were used to examine the effects of dip condition (vegetable alone, vegetable with plain reduced-fat dip, and vegetable with herb reduced-fat dip) on the children's liking of each tasted vegetable. This approach accounted for within-subjects correlations and the lack of independence

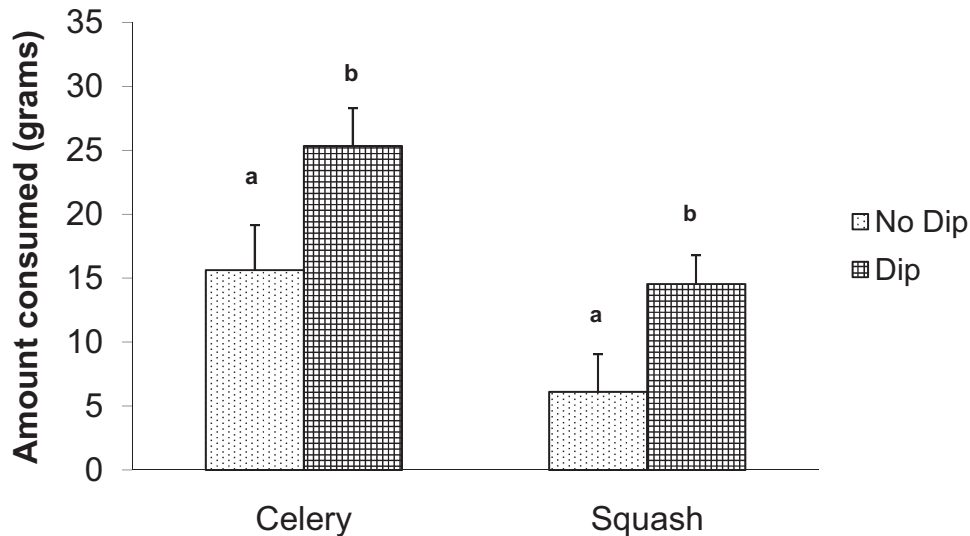
\*The composition of the two dips eliminated during the liking session was as follows: For the herb dip, onion flakes, parsley flakes, dill, and seasoned salt were added to the plain dip; for the garlic dip, garlic powder, seasoned salt, and pepper were added to the plain dip.

present in measurements that were made repeatedly for each child. Generalized estimating equations address the issue of how to analyze categorical data in a within-subjects framework and allow for repeated measures analysis of discrete data using the appropriate multinomial distribution to test hypotheses.<sup>34</sup> Odds ratios (ORs) and 95% CIs were constructed to test the differences between the vegetable alone and the vegetable with the plain dip, between the vegetable alone and the vegetable with the herb dip, and between the vegetable with the plain dip and the vegetable with the herb dip. In Experiment 2, the hypothesis was that providing small samples of a palatable reduced-fat dip containing herbs and/or spices would increase the children's vegetable consumption. A within-subjects, repeated measures analysis of variance was conducted.

## RESULTS

A total of 46 preschool children began Experiment 1. The children were predominately white (40 of 46 children) and lived in households where the parents were married (98%) and employed (mothers, 96%, fathers, 98%). The median household income was \$61,000 to \$80,000, and a majority of parents had a bachelor's degree or greater. The data for 12 children were excluded for the following reasons: three children did not complete all sessions due to prolonged absences, six children tasted the reduced-fat herb dips in the practice protocol but refused to taste them in the experiments, and three children refused to try the reduced-fat herb dips. Therefore, the data from 34 children (18 girls and 16 boys) were included in the final analysis.

Results for Experiment 1 are shown in the Table. Compared with the vegetable alone, significantly more participants indicated they liked the vegetable with plain dip ( $P<0.001$ ) and also liked the vegetable with herb dip ( $P<0.001$ ). There was a preference for the herb dip compared with the plain dip ( $P<0.01$ ). The children were more than twice as likely to reject the vegetable alone, rather than the vegetable paired with the plain dip (OR 2.21, 95% CI 1.08 to 4.53;  $P=0.03$ ); they were three times more likely to refuse to eat the vegetable alone compared with eating the vegetable paired with the herb dip



**Figure.** Amount (grams±standard error) of vegetables eaten with or without a preferred herb dip among preschoolers ( $n=26$  to  $27$ ). In Experiment 2, preschoolers ( $n=27$ ) ate more celery paired with their preferred dip (25.3 g) than ate celery alone (15.6 g) (a vs b;  $P<0.05$ ). Preschoolers ( $n=26$ ) ate more yellow squash paired with their preferred dip (14.5 g) than ate yellow squash alone (6.1 g) (a vs b;  $P<0.05$ ). There was no difference in intake by type of dip (pizza vs ranch).

(OR 3.43, 95% CI 1.60 to 7.33;  $P=0.001$ ). Rejection of the vegetable with dip did not differ by type of dip.

In Experiment 2, subjects included the 34 children who participated in Experiment 1, but seven children did not complete the celery protocol and eight did not complete the squash protocol because they were absent on study days. The Figure shows the amount of vegetable eaten alone or with the preferred reduced-fat herb dip. Children ate more celery with dip than celery alone ( $P<0.05$ ) and also ate more squash with dip than squash alone ( $P<0.05$ ). The quantity of celery eaten increased 62% when it was paired with an herb dip; the quantity of squash eaten increased more than twofold when it was paired with an herb dip. The type of dip (pizza vs ranch) did not affect the amount of vegetable consumed.

## DISCUSSION

Our study found that pairing vegetables with a liked herb dip increased preschool children's acceptance, decreased their rejection, and increased their consumption of novel or disliked vegetables. In as few as four tasting sessions, preschoolers consumed more of a disliked vegetable when it was paired with an herb dip than when it was eaten alone. The results are consistent with other studies of children's vegetable liking and consumption. Among low-income, mostly Hispanic, preschoolers repeatedly exposed to broccoli for 7 weeks as an afternoon snack,<sup>25</sup> those who were bitter-sensitive ate significantly more broccoli when it was paired with a palatable ranch-flavored dip or sauce than when it was eaten alone; ranch-flavored dips did not promote broccoli consumption among children who were insensitive to bitter taste. In another study of preschoolers,<sup>24</sup> children were asked twice weekly for 4 weeks to taste an initially disliked vegetable, with or without a dip. Regardless of whether the children were assigned to a repeated exposure condition (disliked vegetable alone) or a learning condition (eg, disliked vegetable paired with a ketchup-flavored dip), about six exposures were

required to increase vegetable liking. These findings suggest that offering a flavored, palatable dip with a disliked or moderately liked vegetable between four and eight times increases children's acceptance and consumption of vegetables.

Increasing the palatability of vegetables by pairing them with dips raises two issues. First, dips might be expected to contribute extra energy, fat, and sodium to the diets of preschoolers. In the case of energy, data from the National Health and Nutrition Examination Survey show the major sources of energy among 4- to 8-year-old children in 2005-2006 were grain desserts (ie, cakes, cookies, donuts, pies, cobblers, and granola bars), yeast breads, pasta, reduced-fat milk, and pizza.<sup>35</sup> A recent analysis of US national dietary survey data collected between 1989 and 2008 found significant increases in per capita intake of savory snacks, pizza/calzones, and other foods, but no change in per capita intake of dips, among 2- to 6-year-old children.<sup>36</sup> Thus, dips do not presently constitute a major source of energy for this age group. Furthermore, the dips used in this study had a low energy density of 1.16 kcal/g and were served in small portions to control energy intake. Spill and colleagues<sup>31</sup> found that when preschool children enrolled in day care were given a first course at lunch of carrot sticks paired with ranch dip, their intake of ranch dip did not change even though their intake of carrot sticks increased with increasing portion size. Thus, pairing vegetables with a palatable dip may not result in excess dip consumption. The second issue arising from pairing vegetables with dips is whether children who are introduced to a novel vegetable paired with a palatable dip learn to like the vegetable only when it is served with dip. Sullivan and Birch<sup>12</sup> found that when 4- and 5-year-old children tasted a novel food (sweetened, salty, or plain tofu), preference increased for the exposed version only. In other words, experience with one version did not result in a general liking for all three versions of tofu. Our data, however, do not permit conclusions on whether or not children who exhibited a greater preference

for and/or consumption of vegetables with dip would transfer this increased liking to the plain vegetable.

Food and nutrition practitioners can help the staff at child-care centers, kindergartens, and elementary schools enhance children's acceptance and consumption of vegetables by pairing vegetables with small portions of reduced-fat, herb-flavored dips during snack and meal times. When counseling care providers and the parents of preschoolers, food and nutrition practitioners can educate them about portion size, provide recipes for making reduced-fat herb dips at home, and reassure them that multiple tastings of disliked vegetables over a period of several weeks or months<sup>18,24</sup> may be needed to increase children's vegetable intake, especially among picky eaters.<sup>37</sup>

This study had several limitations. First, our study population was a convenience sample from a single child-care facility and consisted mainly of white children living in middle- to upper-income households. Therefore, the findings may not be generalizable to lower-income preschool children of other races and ethnicities in more diverse settings, such as low-income or highly urban neighborhood child-care centers and kindergartens. However, these findings add to the current literature, which has largely examined the impact of dips on vegetable consumption among low-income children participating in the Head Start program.<sup>25</sup> Secondly, Experiment 2 did not include a treatment in which children tasted celery and yellow squash with the plain reduced-fat dip. Including this treatment would have provided a more definitive answer to the question of whether the children's preferred reduced-fat herb dip was mainly responsible for their increased vegetable intake, or whether a dip of any liked and familiar flavor might achieve the same improvement in vegetable intake. Finally, data from nine children (20%) who participated in Experiment 1 were excluded from the analysis because they refused to taste the reduced-fat dips. Some of these children may have been picky eaters or have had a strong fear of sampling a "bad tasting" food.<sup>37,38</sup> In these cases, coercion would not have been helpful, because doing so might have had a long-term negative effect on their liking and intake of vegetables.<sup>39,40</sup>

## CONCLUSIONS

Preschoolers offered vegetables paired with their preferred reduced-fat herb dip (pizza or ranch) were more willing to try vegetables and were less likely to reject them, compared with when they were served the vegetable alone or with a plain reduced-fat dip. Furthermore, they ate more of previously disliked vegetables when the vegetables were paired with their preferred herb dip. Future research is needed to determine the number of tasting sessions that are sufficient to promote long-term consumption of vegetables, the efficacy of pairing vegetables with herb dips as a method of increasing vegetable intake among children of various races and ethnicities, the factors that enable children to shift from eating vegetables with accompaniments like dips to eating vegetables alone, and whether or not herbs and spices incorporated into other accompaniments such as hummus and cheese spreads increase children's vegetable consumption. For parents, child-care providers, and staff at child-care facilities and schools, pairing a vegetable with a liked herb dip is a simple

but useful strategy for increasing children's willingness to taste, liking of, and consumption of vegetables.

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## STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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