

Perceived access to fruits and vegetables associated with increased consumption

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Abstract

Objective: To examine the association between fruit and vegetable access in the community and change in fruit and vegetable consumption among participants in community-based health promotion programmes.

Design: Fruit and vegetable consumption and perceived access to fresh fruit and vegetables were measured by self-administered questionnaires at programme start, end and 1-year follow-up. Community produce availability was determined by grocery store assessments measuring the display space devoted to fruit and vegetable offerings, as well as price, variety and freshness. A total of nine communities were studied; 130 participants completed the fruit and vegetable portions of the questionnaires and could be linked to grocery store assessments.

Results: Participants made modest but significant increases in fruit and vegetable consumption from programme start to end: the average increase was 2·88 (95% CI 1·52, 4·25) servings weekly; the average increase from start to follow-up was 2·52 (95% CI 1·09, 3·95) servings weekly. Greater perceived access to fruits and vegetables was significantly associated with higher increases in fruit and vegetable consumption from programme start to programme end. Greater availability of produce was associated with greater increases in fruit and vegetable servings from programme start to programme end as measured by store assessments.

Conclusions: Environmental factors, such as access to fruits and vegetables, can modify the effects of community interventions. Interventions with the goal of increasing fruit and vegetable consumption should consider focusing on increasing access to fresh fruits and vegetables in target communities. Similarly, researchers may want to study access as an intervention, not just a contextual variable.

Keywords
Environment
Access
Fruits
Vegetables
Community-based programme

It is a widely accepted opinion that Americans eat too few fruits and vegetables and that this nutrition deficit contributes to the prevalence of overweight and obesity^(1–3). Many interventions in recent years have been aimed at increasing the consumption of fruits and vegetables. In the USA, the government has intervened with a public health campaign, Healthy People 2010, intended to improve nutrition and increase physical activity among its residents.

The national Healthy People 2010 objectives for fruit and vegetable consumption are to:

1. Increase the proportion of persons age 2 years and older who consume at least 2 servings of fruit daily (US target 75%).
2. Increase the proportion of persons aged 2 years and older who consume at least 3 servings of vegetables daily, with at least one-third being dark green or deep yellow vegetables (US target 50%)^(4,5).

Additionally, it is the recommendation of the National Cancer Institute that Americans eat 5 or more fruits and vegetables each day for better health⁽⁶⁾.

Despite government-sponsored public information outreach and consequent increased awareness among Americans, most still do not eat the recommended amounts of fruits and vegetables⁽⁷⁾.

Of the various reasons proposed to explain the US nutrition deficit, one important reason is access to produce within the communities in which people live. Many researchers hypothesize that the presence of healthy food choices in the environment may influence eating behaviours positively^(8–15). The vast majority of research that has focused on youths' access to fruits and vegetables has found that access, whether at home or at school, does increase children's healthier food choices⁽¹⁶⁾. One study even found this to be true when no educational or home component was involved⁽¹¹⁾.

Although it is widely accepted that the environment can play a large role in enhancing or detracting from individuals' healthy choices, few studies have examined the relationship between community access to fruits and vegetables, through supermarkets, local grocers and farmers' markets, and levels of fruit and vegetable consumption.

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Most nutrition studies focusing on environment have been confined to the school and home environments. However, in a separate but related field, physical activity research has taken into account broader environmental correlates, such as walking paths, the built environment, lighting and other potential contributors to healthful activities^(17–25).

The purpose of the present evaluation was to examine whether adult and youth participants in community-based programmes made and sustained healthy lifestyle changes around nutrition and physical activity. This study is unique in that it examines the effect of fruit and vegetable access as it fosters or amplifies the effect of other diet-related interventions.

The present study examined participant survey results from community-based programmes supported by The Colorado Trust's Colorado Healthy People 2010 Obesity Prevention Initiative. Although other programmes were part of this initiative, the programme participant data used in the current analysis came from only those programmes reporting moderate to high programmatic emphasis on fruit and vegetable consumption. The analyses presented herein explore the change in individual intake of fruits and vegetables. They also demonstrate the association between individual intake and access to fruits and vegetables in the communities in which the programmes were implemented.

Methods

Intervention

The Colorado Trust, a grant-making foundation, established the Colorado Healthy People 2010 Initiative (the Initiative) to 'help Coloradans learn about and take steps to lead healthier, longer lives, and to decrease health disparities among different populations'⁽²⁶⁾. The 4-year Initiative was designed to aid Coloradans in achieving Healthy People 2010 objectives while also paying attention to local priorities. The state was divided into five regions; each with a different focus. In two of the regions, community-based programmes were designed and funded with a focus on increasing physical activity (north-western Colorado) and preventing diabetes (south-eastern Colorado). None of the interventions included in the present study aimed at altering access to fruits and vegetables in their communities.

Because all of the interventions were community-inspired and community-based, they varied in content, duration and intensity. Some programmes sought to educate individuals about making healthy nutritional choices while grocery shopping, teaching label reading and interpretation, while others provided cooking classes or encouraged local restaurants to mark healthier meal options on menus. Most programmes lasted from 4 to 16 weeks, although some enrolled participants for the length

of the grant. Target populations varied as well and included employees, older adults, high-risk individuals and general community members, both adults and youths.

Surveying participants

Self-administered questionnaires were completed by participants when they started a programme, finished a programme and one year after programme end. The questionnaire comprised several question sets designed to measure the outcomes of participant interest as well as participant characteristics that were hypothesized to influence behaviour change.

Participant confidentiality was protected through a replicable process wherein each individual constructed their own unique identifier (ID) and recorded it on their survey. All participants over 18 years of age completed a consent form, and those under 18 had a parent or guardian complete the form. Respondent contact information was entered into a database to allow survey tracking, but could not be linked to survey responses. The entire evaluation was approved by an external institutional review board (IRB), the Western Institutional Review Board. As necessary, inter-IRB agreements were reached at those sites that had their own IRB.

Programme staff gave eligible participants the programme start surveys. In some cases, they collected them after completion and submitted them to the evaluator. In other cases, they gave participants a postage-paid envelope in which to send their completed survey directly to the evaluator. At programme end, for some programmes staff administered the survey to their participants; for others, the evaluator mailed a survey directly to participants at the appropriate time interval. For follow-up, the evaluator mailed a programme follow-up survey one year after programme completion to all participants who had completed a programme end survey. Respondents were given incentives for their participation. These varied depending on the programme, but in most cases were the equivalent of \$US 10 at programme start, \$US 10 at programme end and \$US 25 at follow-up.

Over the course of the Initiative, about 8550 participants were served by the programmes that had a moderate or high emphasis on increasing fruit and vegetable consumption. The evaluation began in the second year of the Initiative. For a few programmes that served a large number of participants, a sampling strategy was employed in which only groups enrolled in certain months were invited to participate in the evaluation. Thus, about 1850 participants were eligible to complete a survey at programme start. Of those, 1075 completed a consent form and a survey at programme start. Of those, 684 also completed a programme end survey, while 380 also completed a follow-up survey. Not all surveys were able to be linked from programme start, end and follow-up because respondents did not always put their ID on the surveys, or did not use the same ID on each survey

(although the instructions were identical at all time periods). A total of 290 surveys could be linked from start to end to follow-up, with 266 actually having completed the fruit and vegetable consumption questions on their surveys at all three time periods (24.7% of those who did a programme start survey). Of these participants (for whom outcome results are reported), there were 130 participants who lived in communities where fruit and vegetable access was measured (for whom the association between access and behaviour change is reported).

Measures

The question set from the Youth Risk Behavior Survey⁽²⁷⁾ was chosen to assess fruit and vegetable consumption in the surveys for both adults and youths. Respondents were asked how often they had consumed various fruit and vegetable products in the last 7 d. The categories from which they could choose a response were assigned a number of servings per week, as shown below:

I did not [consume any] during the past 7 d	0 servings
1 to 3 times during the past 7 d	2 servings
4 to 6 times during the past 7 d	5 servings
1 time per day during the past 7 d	7 servings
2 times per day during the past 7 d	14 servings
3 times per day during the past 7 d	21 servings
4 or more times per day during the past 7 d	28 servings

To calculate the approximate number of fruits and vegetables consumed per week, the answers to the following questions were summed:

1. The number of 100% fruit juices consumed in the last 7 d.
2. The number of fruits consumed in the last 7 d.
3. The number of potatoes consumed in the last 7 d.
4. The number of times green salads were consumed in the last 7 d.
5. The number of times carrots were consumed in the last 7 d.
6. The number of times other vegetables were consumed in the last 7 d.

Perceived access to fresh fruits and vegetables was measured by a question included on the follow-up survey, 'How easy or difficult is it for you to get fresh produce (fruits and vegetables)?', with the following response scale: 1 = very difficult, 2 = somewhat difficult, 3 = somewhat easy, 4 = very easy.

Although a variety of existing grocery store assessments were examined, none measured directly the availability of fruits and vegetables, so an assessment was created by the evaluators. This assessment measured the amount of display space devoted to produce (including fresh, packaged, frozen and canned produce, and frozen, canned and bottled juice), the total varieties of produce available, and the price of the produce. Display space devoted to fresh

produce was measured by the depth and width of the various display spaces, while display space devoted to other types of produce (frozen, canned, etc.) was measured in a linear fashion, to reflect the typical display set-ups in Colorado grocery stores. The total types of fresh fruits and vegetables was counted; for example, if there were five kinds of apples (e.g. Granny Smith, Gala, Fuji, Braeburn and Red Delicious), each was counted as a separate variety. Evaluators made a subjective assessment of the general freshness of the produce on display, i.e. 'the proportion of produce that was fresh (not over-ripe or wilted)' using the following scale: all fresh, nearly all fresh, most fresh, some fresh, most not fresh. Finally, two types of price assessment were made. A 'produce basket' consisting of 1 lb of apples, 1 lb of potatoes, a 64-oz carton of orange juice, a 12-oz can of apple sauce, a 14-oz can of green beans and a 20-oz package of frozen corn was priced, using the minimum price for each. A minimum price for fresh produce was calculated as the lowest price per 16 oz of any type of fresh fruits or vegetables available.

This assessment was performed in twenty-four communities in north-western and south-eastern Colorado. In communities where there was only one grocery store or market, the assessment was conducted at that site. In communities with more than one supermarket, the assessment was conducted in two randomly selected markets. If the community had a natural food grocery store or specialty market (such as Whole Foods or Wild Oats), one of the assessments was conducted at this type of market.

A programme's emphasis on the outcome, fruit and vegetable consumption, was partially derived from the evaluators' assessments of the programmes' final reports to the funder. These assessments were all validated by the programmes' technical assistance (TA) providers who had been designated to them throughout the initiative. TA providers assigned levels of low, medium and high outcome emphasis on fruit and vegetable consumption to each of their designated programmes.

Data analysis

Data were analysed using the SPSS[®] statistical software package (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequencies, means and standard errors, were run on the variables used in the analyses.

Dependent *t* tests were used to test changes in fruit and vegetable consumption from programme start to programme end or from programme start to 1-year follow-up.

Associations of changes in fruit and vegetable consumption with the perceived access to fresh produce and the grocery store assessment factors were tested by linear mixed modelling which adjusted for nesting of participants within programmes or communities. Fruit and vegetable consumption at programme start was included as an adjustment factor in all the models. In addition, the models included whether or not the participant was an adult or youth and the respondent's gender.

Results

As shown in Table 1, programme participants were primarily White, Anglo females. Nearly 80% of respondents were female, while 93% were White and 92% were non-Hispanic. The age of participants varied widely; 8% were

youths under 18 years of age, over a quarter (27%) were aged 18–34 years, while 12% were 65 years of age or older.

It is the recommendation of the National Cancer Institute that Americans eat 5 or more fruits and vegetables each day for better health⁽⁶⁾. As Table 2 shows, only 11% of participants were consuming a total of 35 or more fruits and vegetables weekly (the equivalent of 5 fruits or vegetables daily) at programme start; by programme end, 18% were doing so, and by follow-up, 15% of evaluation participants were consuming 35 or more weekly fruit and vegetable servings. The average number of fruits and vegetables consumed per week by evaluation participants at programme start was 18.51, or an average of 2.64 per day. The average number of fruits and vegetables eaten per week by programme end was 21.39, an average of 3.06 per day, a statistically significant increase of 2.88 (95% CI 1.52, 4.25) servings per week. At follow-up, the average number of fruit and vegetable servings per week was 21.03, still statistically significantly higher by 2.52 (95% CI 1.09, 3.95) servings per week compared with programme start.

As shown in Table 3, a majority of evaluation participants (55%) felt it was 'very easy' to obtain fresh fruits and vegetables; 13% reported it was 'somewhat' or 'very difficult' to do so.

Greater perceived access to fruits and vegetables was significantly associated with higher increases in fruit and

Table 1 Participant characteristics (*n* 266)

	<i>n</i>	Percentage who answered	Percentage of total
Age (years)			
<18	20	7.6	7.5
18–24	16	6.1	6.0
25–34	54	20.6	20.3
35–44	36	13.7	13.5
45–54	56	21.4	21.1
55–64	48	18.3	18.0
65+	32	12.2	12.0
Not answered	4		1.5
Gender			
Female	206	79.5	77.4
Male	53	20.5	19.9
Not answered	7		2.6
Ethnicity			
Not Hispanic	223	91.8	83.8
Hispanic	20	8.2	7.5
Not answered	23		8.6
Race			
White	212	92.6	79.7
Not White	17	7.4	6.4
Not answered	37		13.9

Table 2 Participants' fruit and vegetable consumption (*n* 266)

	<i>n</i>	%	Mean	95% CI	<i>P</i> *	SE
Weekly fruit and vegetable servings at start						
Less than 35	238	89.5	18.51	17.08, 19.94		0.73
35 or more	28	10.5				
Weekly fruit and vegetable servings at end						
Less than 35	218	82.0	21.39	19.81, 22.98		0.81
35 or more	48	18.0				
Weekly fruit and vegetable servings at follow-up						
Less than 35	226	85.0	21.03	19.46, 22.61		0.80
35 or more	40	15.0				
Change in fruit and vegetable servings from start to end						
0 or less	114	42.9	2.88	1.52, 4.25	0.0228	0.69
1–6	65	24.4				
7 or more	87	32.7				
Change in fruit and vegetable servings from start to follow-up						
0 or less	128	48.1	2.52	1.09, 3.95	0.0103	0.73
1–6	64	24.1				
7 or more	74	27.8				

*Change from start to end and from end to follow-up tested with two-sided independent *t* tests.

Table 3 Perceived ease of obtaining fruits and vegetables (*n* 266)

How easy or difficult is it for you to get fresh produce (fruits and vegetables)	<i>n</i>	Percentage who answered	Percentage of total	Mean	SE
	260			3.39	0.05
Very difficult	8	3.1	3.0		
Somewhat difficult	26	10.0	9.8		
Somewhat easy	83	31.9	31.2		
Very easy	143	55.0	53.8		
Not answered	6		2.3		

vegetable consumption from programme start to programme end ($P=0.011$, see Table 4). The association neared statistical significance for increases from programme start to follow-up ($P=0.079$).

Grocery store assessments measured several aspects of the community availability of fruits and vegetables. Table 5 shows the descriptive statistics for the factors measured using the community as the unit of analysis. The average total square metres of display space devoted to fresh fruits and vegetables was 132m². The average minimum price of a 'basket of produce' was \$US 12.43.

As shown in Table 6, for almost all of the factors measured, increased availability of produce was associated with greater increases in fruit and vegetable servings from programme start to programme end. Participants in communities with grocery stores with greater display space devoted to fresh fruits and vegetables had greater increases, on average, in fruit and vegetable consumption from programme start to programme end. Likewise, participants in communities with grocery stores that had more varieties of produce had greater average increases in weekly servings of fruits and vegetables. Participants who lived in communities in which there was more than one grocery store increased their fruit and vegetable consumption by 7.27 (2.90, 11.64) servings per week more from programme start to end, on average, than participants in communities in which there was only one grocery store. Those who lived in communities where organic produce was available made greater increases, on average, in fruit and vegetable

consumption from programme start to end than did those who lived in communities where no organic produce was available. None of these factors was associated with increases in fruit and vegetable consumption from programme start to follow-up.

The average price of produce was associated with increases in fruit and vegetable consumption; the greater the price of the produce, the greater the increase, on average, in fruit and vegetable consumption, from programme start to end, and from programme start to follow-up.

Discussion

The present study showed across the age span of programme participants that the vast majority of these predominantly White, Anglo females began their healthy lifestyle programmes eating well below the recommended weekly average of fruits and vegetables. Only about one in ten were eating an average of 5 fruits and vegetables daily at programme start. The programmes included in the present study aimed at increasing individual participants' consumption of fruits and vegetables.

By programme end, about two in ten were eating the recommended amounts of fruits and vegetables. The change programme participants made in their fruit and vegetable consumption, albeit small, was statistically significant. Although the proportion of people meeting the dietary standards dropped off to 15% at the 1-year

Table 4 Association of perceived access to fresh produce with change in fruit and vegetable consumption (n 260)

	Association with change from start to end				Association with change from start to follow-up			
	β	95% CI	SE	P^*	β	95% CI	SE	P^*
Perceived access to fruits and vegetables†	2.08	0.50, 3.66	0.79	0.011	1.53	-0.18, 3.23	0.87	0.079

*Linear mixed modelling, adjusted for nesting of participants within programmes, target population (youths or adults), sex and fruit and vegetable consumption at programme start.

†1 = very difficult, 2 = somewhat difficult, 3 = somewhat easy, 4 = very easy.

Table 5 Grocery store characteristics

Characteristic	Communities assessed (n 9)	
	Mean	SE
Total square metres of fresh fruit and vegetables	132	41
Total linear metres of frozen, canned, bottled, cartons of fruits, vegetables and juices	10	2
Total number of varieties of fresh fruit and vegetables	119	22
Number of stores in community*	0.67	0.17
Freshness of produce†	0.86	0.07
Availability of organic produce‡	0.56	0.24
Minimum price of produce basket§	12.43	0.39
Minimum price of fresh produce	0.80	0.06

*0 = one store; 1 = more than one store.

†0.00 = some; 0.50 = most; 0.75 = nearly all; 1.00 = all; a scale point of 'most not fresh' was never used.

‡0 = in no stores; 1 = in one store; 2 = in two stores.

§In \$US; basket comprises 1 lb of apples, 1 lb of potatoes, a 64-oz carton of orange juice, a 12-oz can of apple sauce, a 14-oz can of green beans and a 20-oz package of frozen corn.

||In \$US; lowest price per 16 oz – any type.

Table 6 Association of grocery store assessments with change in fruit and vegetable consumption (*n* 130)

Produce assessment	Association with change from start to end			Association with change from start to follow-up				
	β	95% CI	SE	P^*	β	95% CI	SE	P^*
Total square metres of fresh fruit and vegetables	0.02	0.00, 0.04	0.01	0.0137	0.01	0.00, 0.03	0.01	0.1635
Total linear metres of frozen, canned, bottled, cartons of fruits, vegetables and juices	0.46	0.12, 0.80	0.17	0.0092	0.12	-0.22, 0.46	0.17	0.4696
Total number of varieties of fresh fruit and vegetables	0.04	0.01, 0.07	0.01	0.007	0.02	-0.01, 0.05	0.01	0.1533
Number of stores in community†	7.27	2.90, 11.64	2.21	0.0013	3.69	-0.65, 8.03	2.19	0.0947
Freshness of produce‡	9.01	0.20, 17.81	4.45	0.045	5.18	-3.38, 13.74	4.33	0.2337
Availability of organic produce§	4.57	0.76, 8.38	1.92	0.0191	2.71	-1.01, 6.42	1.88	0.152
Minimum price of produce basket	3.61	1.32, 5.89	1.15	0.0022	1.67	-0.59, 3.93	1.14	0.1467
Minimum price of fresh produce¶	16.61	2.82, 30.41	6.97	0.0187	14.54	1.21, 27.87	6.74	0.0328

*Linear mixed modelling, adjusted for nesting of participants within programmes, target population (youths or adults), sex and fruit and vegetable consumption at programme start.
 †0 = one store; 1 = more than one store.
 ‡0.00 = some; 0.50 = most; 0.75 = nearly all; 1.00 = all; a scale point of 'most not fresh' was never used.
 §0 = in no stores; 1 = in one store; 2 = in two stores.
 ||Basket comprises 1 lb of apples, 1 lb of potatoes, a 64-oz carton of orange juice, a 12-oz can of apple sauce, a 14-oz can of green beans and a 20-oz package of frozen corn.
 ¶Lowest price per 16 oz – any type.

follow-up, the change in the number of servings from start to follow-up also was statistically significant.

Studies of single-programme interventions also have found sustained increases in fruit and vegetable consumption. Two studies focusing on school-based interventions found sustained increases at a 4-month follow-up⁽²⁸⁾ and a 2-year follow-up⁽²⁹⁾, while one study in a community clinic serving low-income women showed sustained change at a 12-month follow-up⁽³⁰⁾. All three concluded that multi-component interventions showed greater promise for sustaining individual behavioural change. A study of callers to a Cancer Information Service found, in both the pilot and replication, that educational outreach showed a sustained increase in fruit and vegetable consumption at 4-month follow-up^(31,32).

In general, behaviour change is difficult to effect, whether because of a lack of individual motivation, counterproductive environmental and social influences, or a lack of follow-through^(33–37). Because of the challenges inherent in improving individual nutrition, public health advocates may be interested in the fact that participants were able to not only increase their intake of fruits and vegetables but sustain the increase for at least a year following their participation in a programme. Because the programmes in the present study were wide-ranging in terms of methodology, duration and frequency, they do not lend themselves to a programmatic prescription. But because the study also included data on perceived environment as well as community factors, more can be known about what may help and hinder this type of individual behaviour change.

Little attention has been given to the perceived environment in nutrition studies. Instead, studies of environmental correlates have looked at the influence on consumption of having different types of foods (healthful and unhealthful) in the immediate environment, such as the school, home or workplace⁽³⁸⁾. The present study included a survey question specifically asking programme participants how easy or difficult access to fruits and vegetables was for them. Greater perceived access was associated with higher increases in fruit and vegetable consumption at both programme end and follow-up, although significantly so only at programme end.

In addition, each of the communities was assessed by the researchers for the quality and quantity of fruit and vegetable access. Many environmental factors in the community were shown to be influential. The number and size of the fruit and vegetable offerings was associated with increased intake. In addition, the quality or attractiveness of the produce itself was associated with increased intake, as measured by variety, the preponderance of fresh produce among the non-canned varieties, and the presence of organic produce. Price was also assessed, as previous research has shown it to be a contributing factor in individual food choices^(12,39,40). Contrary to the authors' hypothesis that less expensive

produce would be associated with increased consumption, the study found that, in fact, increased cost was associated with increases in participants' fruit and vegetable consumption. This could be explained by the fact that higher prices in Colorado are often found in those grocery stores that offer more variety, more organic produce and higher-end healthful food items. A more produce-rich state might show different associations between variety and cost. Additionally, higher prices and greater variety may be indicators of more affluent communities, so individual access might be greater for those who can afford fruits and vegetables, as opposed to often less-expensive, energy-dense, processed foods.

Although none of the programmes aimed at changing the availability of produce in the community, they did seek to change their participants' predilection toward choosing fruits and vegetables from among all available options. Thus, availability may have been important in the individual's capacity to alter eating behaviours. The study's findings suggest that there is an association between access to produce and greater changes in individual consumption.

The strengths of the present study include the size and type of sample; results are drawn from a wide range of programmes that incorporated programming aimed at increasing fruit and vegetable consumption. The 'community-based setting' for each of the programmes included in the evaluation may lead to more generalizable results that have real-world applications. In addition, a relatively long follow-up period was examined by asking for fruit and vegetable consumption one year after programme end.

Limitations include the cross-sectional, multi-purpose nature of the study. An experimental design was not employed; rather, participants in funded interventions were enrolled. The funded programmes that included a fruit and vegetable component in their programming varied in terms of target population, intervention duration, frequency of contact and type of contact. An unidentified portion of the sample was self-selected, meaning there is some selection bias in the results not accounted for in the measures.

Conclusions and applications

Participants increased their fruit and vegetable consumption at programme end and at the 1-year programme follow-up. There was a correlation between participant outcomes and community factors. Increase in individual fruit and vegetable consumption was positively correlated with communities that had ready access to fresh fruits and vegetables. Environmental factors, such as access to fruits and vegetables, can modify the effects of community interventions. It may be useful for interventions with the goal of increasing fruit and vegetable consumption to focus on increasing access to fresh fruits and vegetables in the target communities. Similarly, researchers may want to study access as an intervention, not just a contextual variable.

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