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Change & Maintaining Change in School Cafeterias: Economic and Behavioral-Economic Approaches to Increasing Fruit and Vegetable Consumption

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Abstract

Developing a daily habit of consuming fruits and vegetables (FV) in children is an important public-health goal. Eating habits acquired in childhood are predictive of adolescent and adult dietary patterns. Thus, healthy eating patterns developed early in life can protect the individual against a number of costly health deficits and may reduce the prevalence of obesity. At present, children in the United States (US) under-consume FV despite having access to them through the National School Lunch Program. Because access is an obstacle to developing healthy eating habits, particularly in low-income households, targeting children's FV consumption in schools has the advantage of near-universal FV availability among more than 30 million US children. This chapter reviews economic and behavioral-economic approaches to increasing FV consumption in schools. Inclusion criteria include objective measurement of FV consumption (e.g., plate waste measures) and minimal demand characteristics. Simple but effective interventions include (a) increasing the variety of vegetables served, (b) serving sliced instead of whole fruits, (c) scheduling lunch after recess, and (d) giving children at least 25 minutes to eat. Improving the taste of FV and short-term incentivizing consumption of gradually increasing amounts can produce large increases in consumption of these foods. Low-cost game-based incentive program may increase the practicality of the latter strategy.

Introduction

There are indisputable health benefits of a diet rich in fruits and vegetables (FV). They are high in water and have a high nutrient-to-calorie ratio, thereby providing important vitamins, minerals, fiber, and phytochemicals important to human health (Darmon et al., 2005). Phytochemicals such as carotenoids, polyphenols, and flavonoids are noteworthy as antioxidants and anti-inflammatory agents contributing to health. Diets rich in fruits and vegetables are associated with reduced risk of chronic health conditions and mortality from all causes (Ovesen, 2005). For example, an additional serving of FV consumed per day is associated with a 5% reduced risk of mortality (Wang et al., 2014). Higher intakes of a *variety* of FVs is important in lowering the risk of cardiovascular disease (Dauchet et al., 2006; Hu et al, 2014; Savica et al., 2010), asthma (Hosseini et al., 2017), and cognitive decline in the elderly (Jiang et al., 2017).

The contribution of FV consumption to obesity is more difficult to evaluate. The cause of obesity is multifactorial and FV consumption is often confounded with behaviors that impact body weight (e.g., physical activity; Grosso et al., 2017; Hobbs et al., 2014). Most, but not all, studies of adults reveal an inverse association between FV consumption and either being overweight or gaining weight over time (Ledoux et al., 2011). However, simply eating more FV will not reduce weight (Fulton et al, 2016); FV consumption must *displace* consumption of other foods to achieve an energy deficit (Mytton et al, 2014; Smith-Warner et al., 2000). The high fiber and water content of FV can produce satiety supporting that energy deficit goal. Experimental trials manipulating FV intake without changing other dietary behaviors are rare (Whigham et al., 2012). In an exception to this rule, Tapsell et al. (2014) randomized overweight adults to energy-deficit groups who either consumed standard or double-sized portions of vegetables. Weight loss was positively correlated with proportion of energy consumed as vegetables; supporting the position that the satiety induced by FV consumption helps to displace the intake of higher-energy foods and leads to weight loss (Newby, 2009).

The same general patterns appear to be true of children, although less empirical evidence is available. Overweight children and adolescents consume less fruit and more french fries than normal-weight children (Lorson et al., 2009). Early childhood patterns of eating FV appear to be important. For example, children who consumed few FV in early childhood were more likely to be severely or morbidly overweight in later childhood than were their peers who often consumed FV from an early age (Fletcher et al., 2017). However, what is true of adults is also true for children – if FV intake is to reduce the risk of obesity, these foods must displace consumption of energy-dense nutrient-poor foods (Looney & Raynor, 2012).

In sum, there are many lifespan health-benefits to motivate policy makers to explore ways to increase children's FV consumption. Additional motivation is provided by longitudinal studies, which suggest eating habits developed in childhood continue into adolescence (Lytle et al. 2000) and beyond (Freedman et al., 2001). Therefore, effective interventions designed to increase habitual FV consumption in children can impact public health for decades to come.

Unfortunately, few US children consume the USDA-recommended five or more servings of FV each day (Coulthard & Blissett, 2009; Kim et al., 2014). Recent National Health and Nutrition Examination Surveys suggests US children consume less than half of the recommended amount of vegetables, and this number is even lower when white potatoes were excluded (Kim et al., 2014; Storey & Anderson, 2016). Rendering the picture more-dire is the possibility that parents and children over-estimate their FV consumption in these surveys (cf. Brug & Van Assema, 2001).

Elementary schools are an ideal setting in which to begin addressing this behavioral deficit impacting public health. Over 30 million US children eat school-provided lunch (USDA, 2016) and National School Lunch Program (NSLP) guidelines require that FV be available as part of reimbursable meals in the school, every day. Thus, the minimum requirements are in place for behavior change – large numbers of children with frequent low- or no-cost access to FV. At present, however, most children who participate in the NSLP under-consume these foods (Cullen & Dave, 2017).

This chapter begins by evaluating the naturally occurring economic factors that have conspired to reduce FV consumption among US children. In response to these factors, the National School Lunch Program recently redesigned public-school lunches. Larger portions and a greater variety of FV are now on the menu. Below, we survey the limited evidence evaluating the efficacy of this policy change. The remainder of the chapter provides a non-comprehensive survey of studies using traditional-economic (e.g., price changes) or behavioral-economic (e.g., defaults) strategies to positively influence healthy eating in elementary schools. We conclude with policy recommendations supported by the studies reviewed.

Change vs. Believable Change

Because the studies appearing in this chapter were reviewed with policy recommendations in mind, our inclusion criteria were stricter than is the norm. Studies exclusively using self-report measures are not reviewed because of the likelihood of social desirability bias; i.e., a tendency to stretch the truth about our actions in order to make it appear that we conform to, or exceed social norms (Eckmanns et al., 2006; Nichols & Maner, 2008; Orne, 1962). Just as people tend to under-report their energy and fat intake (Archer et al., 2013; Heitmann et al., 2000) and over-report their physical activity and healthy-eating episodes (Nix & Wengreen, 2017; Shuval et al., 2015), parents and children may over-report how many FVs they consume each day. While some self-report measures may be validated against directly observed levels of consumption (e.g., Lytle et al., 1993), these validations are not established in the context of intervention research, where children are exposed to the intervention and inherent demand characteristics can induce prevarication in a direction that exaggerates the intervention effect. We agree with Archer et al. (2015) that basing policy advice on potentially biased self-report data is ill advised.

Our review also avoids studies in which obvious demand characteristics might be expected to increase healthy eating. For example, demand characteristics may exist when a teacher, or other adult, administers the intervention and then obtrusively measures the child's behavior. In such cases, it may be clear to the child what the adult wants (eat your FV), and the child may feel compelled to comply with the authority figure's apparent wishes (Eckmanns et al., 2006). Those familiar with the Stanley Milgram experiments[1] will recall how demand characteristics can increase conformity to the expectation of an authority figure.

The present review also favored studies that measured FV more than once or twice because the health benefits of this behavior can only be realized if it becomes a temporally extended pattern of behavior. Finally, we preferred studies that used objective measures of FV consumption (e.g., weights of plate waste). Taking FV from the cafeteria line is important, but if these foods are not consumed, then this benefits the farming industry, but not public health. Where objective measurement was impossible (e.g., human observers were used to record what children consumed), we favored studies that evaluated and established good ($\geq$85%) inter-observer agreement scores. Doing so reduces the probability of experimenter expectancies biasing the data collected, particularly when human observers are not blinded to the study design.

[1] In Milgram's experiments, adult participants were led to believe they were administering electric shocks to a "learner" when he made errors. Most participants complied with the experimenter's expectation that shocks be administered, and many administered what they believed to be potentially lethal shocks.

Economic Factors Influencing FV Consumption

A core microeconomic principle is the law of demand: All else being equal, as the price of a commodity increases its consumption will decline. We are all familiar with this law when applied to gasoline. As the price increases, we drive a little slower, make a few less discretionary trips, and carpool more often. The demand law is well established under controlled laboratory condition both with humans and nonhuman animals (Bickel & Madden, 1999; Kagel, Battalio, & Green, 1995).

When applied to food, the law of demand predicts that if the price of FV increases, its consumption will decline. And, indeed, since 1980 the inflation adjusted price of FVs has risen (Monsivais & Drewnoski, 2007). The decline in FV consumption predicted by this price increase is compounded by a concurrent decrease in the price of unhealthy foods (Wright & Aronne, 2012). Because unhealthy foods can substitute for the satiety-producing effects of eating FV, this increase in the *relative* price of FV is expected to produce a large decrease in FV consumption (Madden, 2000).

As FV prices were increasing and processed food decreasing, there were other economic factors influencing FV consumption. As more women entered the workforce, home-cooked meals declined in frequency, often replaced by prepared foods (e.g., TV dinners) and eating out in restaurants (Nicklas et al., 2004). These alternatives to the home-cooked meal are much less likely to include FVs (Boutelle et al., 2007). To overcome the concerns of parents about the well-being of their children, restaurants and prepared food producers prolifically advertised (Story & French, 2004) highlighting their convenience, taste, and establishing the appearance of a new social norm for the family meal.

Changes in price may help explain why children consume fewer FVs at home, but it does not explain why they eat so few FVs at school. Nearly all low-income children in the US have access to free FVs as part of their school-provided meals. Even for children whose parent pay for school lunch, the price of the lunch is a non-factor in the child’s decision to eat the FVs –

since the child did not pay for the FVs, the monetary price is irrelevant. Instead, relative *non-monetary* price factors are important. That is, if foods are available that are better tasting, more attractively packaged, or easier to eat, then they are more competitive in the marketplace of children's dietary decision-making. Support for this comes from schools in which unhealthy foods are available in the cafeteria or in vending machines. These are the schools at which FV consumption tends to be lowest (Kubik et al. 2003). In sum, price, relative price, and the availability of more convenient, better promoted, and better tasting alternatives to FV have combined to reduce children's consumption of these healthy foods at home and at school.

Impact of Changes to the US National School Lunch Program

The National School Lunch program (NSLP) seeks to address this deficit in FV consumption by creating a food oasis in which healthy foods are available for the millions of children who take lunch in school cafeterias. Schools participating in the NSLP receive cash subsidies and commodity foods from the USDA if they offer lunch to all children, provide free or reduced-price lunch to eligible children, and serve meals that meet specific nutritional requirements. These requirements were updated in 2010 under the Healthy, Hunger-Free Kids Act (USDA, 2012). The legislation better aligned what was served in schools with the recommendations found in the Dietary Guidelines for Americans (Health.gov, 2010).

Under the Act, school lunches were redesigned to include more whole grains, a wider variety of FV, larger portions of FV, less saturated fat, gradually reduced sodium levels, and meal sizes that met age-specific calorie limits. With respect to FV, schools were to serve students a minimum of 0.5 cups of fruit and 0.75-1 cup of vegetables each day; more than doubling the FV offered prior to the Act. The most salient initial effect of the policy change was an increase in the amount of FVs that were thrown away rather than consumed. This garnered the policy change some rather bad press (e.g., Watanabe, 2014). Concerns about the increased cost of providing school lunches that were being thrown away led, in 2015, to implementation of the USDA's "Offer vs. Serve" policy (USDA, 2013). Under this amendment to the Act, children must select a serving of fruit, vegetable, *or* a mix of the two.

The impact of these policy changes is not yet well established. In an experimental study conducted before the roll-out of the Act, when children were served larger portions of FV each day, the fraction of children eating FVs increased by 20%, but there was also a dramatic increase in food waste (Just and Price, 2013a; see also Byker et al., 2014). Because of the latter, the schools had to spend an additional $1.72 in food costs to encourage one additional child to eat one additional serving for one day, thus making the approach less cost effective than other approaches.

Since the roll-out of the new school lunches there have been only four peer-reviewed studies evaluating its effect. The studies paint a mixed picture (see review by Cullen & Dave, 2017). Where some studies reported an increase in one category of fruit (e.g., diced fruit cups served with juice) no study reported an increase in total fruit consumption. The effects of the policy change on vegetable consumption have also been mixed. Some studies report an increase in total vegetable consumption (Cohen et al., 2014; Schwartz et al., 2015 but inconsistently across years in the latter study), where others report no change (Cullen et al., 2015) or a decrease in vegetable consumption (Amin et al., 2015).

Thus far, no studies have examined FV consumption after the "Offer vs. Serve" policy was implemented. Anecdotal observations of children in the cafeterias in which we have worked suggest the policy change has dramatically decreased the number of children taking vegetables; indeed, some schools have liberally interpreted the guideline to mean that all children are served fruit, with vegetables available for those who request a serving. These findings suggest additional measures will be needed to increase FV consumption to the levels needed to positively impact public health.

Education & Messaging

From a classical economics perspective, if perfect knowledge of the costs and benefits of an action are known, the rational decision-maker will optimize his behavior (Rice et al., 2017). This perspective underlies public-information campaigns which assume consumers make suboptimal menu choices because they are not fully aware of the health benefits of adhering to the Dietary Guidelines for Americans. From this perspective, children given more perfect knowledge of the health benefits of eating FV should consume more of these foods.

From a behavioral-economic perspective, however, nutrition-education interventions are likely to have limited effects because they point to utilitarian benefits that are of little interest to a present-biased consumer. To unpack this position, consider what are the consequences experienced by a child who is convinced to take a bite of vegetables. As these foods are often disliked (e.g., Brug et al., 2008; Cooke & Wardle, 2005), the immediate consequence is an aversive taste and an unfamiliar food texture in the mouth (Lautenschllager & Smith, 2007). These consequences were not mentioned in Health class, but they are immediate and highly salient when FV are consumed. Thus, the immediate consequences of tasting vegetables are often negative.

The benefits of FV consumption most often discussed in Health classes are to be experienced in the distant future, probabilistically, and only if a consistent pattern of FV consumption occurs. Because children steeply discount the value of delayed consequences (Green et al., 1996; Read & Read, 2004), these promised outcomes will be nearly valueless, and will factor little into their dietary decision-making. Instead, consistent with decades of research on choice between substitutable commodities (e.g., Herrnstein 1970; Madden & Perone, 1999), the *immediate* relative consequences of eating healthy and unhealthy foods (i.e., their tastes and textures) will play a dominant role. Again, this is a difficult marketplace in which to compete. Where the taste and texture of vegetables are often disliked, the competition foods have been engineered for taste, texture, and ease of consumption (e.g., Zampini & Spence, 2004).

Although education may be the most common component of school-based interventions, very little objective data are available to evaluate if this strategy increases FV consumption. The vast majority of education-based interventions evaluate only self-reported FV consumption. Those that objectively measure consumption typically implement multi-component interventions that make it impossible to evaluate the unique contribution of education to positive outcomes (e.g., Perry et al., 1998, 2004). Two exceptions are the education-alone interventions evaluated by Wardle et al. (2003) and Auld et al. (1999). The former arranged very brief educational opportunities and found no positive impact on FV intake. The latter provided more substantive education opportunities. This approach did not increase FV consumption above baseline levels, but it appeared to protect children against the declines in consumption observed in control schools. Beyond these two studies, we identified only one education-based multi-component study that objectively measured FV consumption and did not either incentivize this behavior (incentives are known to positively influence FV consumption, see below) or arrange a school garden. Despite substantial amounts of nutrition education, Reynolds et al. (2000) found no increase in objectively measured FV consumption; although self-reported intake increased (see Beccarelli et al., 2016 for comparable results).

Education-based interventions that include school gardening opportunities also rarely objectively measure FV intake, but when they do have such measures the outcomes are mixed. Three studies revealed no positive effect of school gardens on objectively measured FV consumption (Christian et al., 2014; Ratcliffe et al., 2011; Wright & Rowell, 2010) and one reported a significant decrease in skin carotenoid levels (a biomarker of carotenoid-containing FV consumption; Beccarelli et al., 2016). Where a fifth study showed more promising outcomes (Parmer et al., 2009), the direct-observation methodology was open to experimenter bias[2].

[2] Children were allowed to take as many FV as they wanted from the cafeteria line. The observer, who was not blind to study design, did not record the amount taken as children exited the cafeteria line (only whether some FV were

An alternative approach to education is motivational point-of-purchase messaging such as signs or videos in the cafeteria. These messages are designed to highlight the benefits of eating FV, and to do it in a way that child will find entertaining. For example, Wansink et al. (2012) used such fun messaging when they labeled carrots as “X-ray vision carrots”. This small change produced a 66% increase in the fraction of children choosing carrots from the cafeteria line. However, a longer-term evaluation of the labeling reported somewhat smaller increases in taking (20%), suggesting perhaps that some children were dissatisfied with the actual vision-enhancing effects of the carrots (Wansink et al. 2011). In another study, pictures of vegetable super heroes were featured on the school salad bar and/or a nearby video display, along with the “super powers” that each vegetable promotes (Hanks et al., 2016). While the combination of these messages more than doubled the fraction of children taking vegetables, this and the Wansink et al. studies are limited in that vegetable *consumption* was not reported. Given the low-cost and potential impact of these interventions, it will be important for future studies to measure FV consumption, lest programs that further increase FV waste be disseminated.

Another point-of-purchase approach omits health-benefit messaging, but instead simply prompts children to take a serving of FV from the cafeteria line. In a study conducted before the NSLP revisions, asking every child if he/she would like a serving of fruit increased its consumption by 86% (Schwartz, 2007). This finding is interesting in light of the above-referenced reports that fruit consumption has not increased under the revised NSLP. Perhaps children are more likely to consume a freely chosen food than a food placed on their tray by mandate. Now that the USDA “Offer vs. Serve” policy is in place, the replicability of the Schwartz finding should be evaluated, as should the efficacy of prompting children to take vegetables as they move through the cafeteria line. If increased consumption proves robust with

taken). After lunch, the observer estimated if half or more of the FV were consumed; but without a measure of the amount taken, there was no way to estimate this fraction (Sondra Parmer, personal communication, July 13, 2016).

fruit and vegetable prompts, it would be an effective no-cost intervention that could be widely disseminated in schools.

A promising choice-preserving nonverbal-prompt is to embed a picture of vegetables in one of the compartments of children's lunch trays. This conveys the message that this area of the tray is for vegetables, which may simultaneously displace other, less healthy, foods from being placed in that area of the tray. One study implementing this approach found that it increased vegetable consumption by about 4 grams (Reicks et al, 2012). While this is a modest increase (about half a baby carrot), it suggests a low-cost intervention that may enhance the beneficial effects of other, concurrently deployed interventions designed to increase healthy eating in schools.

Another mechanism that may underlie the impact of prompts is social norms; i.e., the tendency to behave in accord with the actions of others in the in-group (Bikhchandani et al., 1992). These effects are particularly salient when children observe high-status peers participating in the activity. Applied to FV consumption, one study enlisted the help of four slightly older peers in a laboratory setting and randomized the reaction of these older peers when tasting a new food (Greenhalgh et al. 2009). Children observing a positive reaction in these peers were more likely to consume the new food themselves, while children observing a negative reaction to the novel food were more likely to refuse it; both of these effects proved to be long-lasting. These results suggest an important target for FV interventions: If FV consumption can be increased among the older children attending the school (e.g., 4th and 5th graders), younger children may be more likely to adhere to this social norm.

Variety, Substitutes, & Defaults

Some evidence suggests that children will consume more FV if they are offered a wider variety of these food from which they can choose (Adams et al., 2005). Children vary in which specific FVs they enjoy or are willing to eat, so when more options are available there is, in theory, an increased probability of consumption. Increasing the variety of FVs offered also increases the possibility of benefitting from a complementary relation between two of these foods. For example, children may be more likely to consume broccoli if served with lettuce, as consuming them together (in a salad) simultaneously reduces the bitter taste of the broccoli and improves the crunchiness of the lettuce. One study reported that providing a larger variety of FV during lunch increased consumption of fruit by 28% and vegetables by 19% (Hakim & Meissen, 2013). Another found that each additional FV option offered increased the fraction of children eating at least one serving of fruits or vegetables by 12% (Just et al., 2012). Most of this increase was fruit consumption, with some evidence suggesting that offering more fruit options decreased vegetable consumption.

This displacement of consumption of a less preferred food (vegetables) by a more preferred food (fruit) is, again, in accord with decades old quantitative models of choice between substitutable goods (Herrnstein, 1970). When different goods serve the same function, they can substitute for one another. Children raised in homes that rarely serve unhealthy foods consume more FV than those in which substitutes are readily available (Ong et al., 2017). Thus, an economic-inspired approach to increasing vegetable consumption at school is to serve these foods without concurrent competitor foods. For example, USDA's Fresh Fruit and Vegetable Program provides FVs in the classroom prior to lunch as a mid-morning snack. Children generally consume these foods in the classroom (e.g., Jamelske & Bica, 2014) but positive effects on total at-school consumption of FV are less clearly established (Huang et al., 2013).

A similar strategy, and one that takes no classroom time away from academics, is to serve vegetables as a first course, before serving other foods in the cafeteria. In one study, this doubled the consumption of vegetables (Spill et al., 2010) and similarly impressive increases have been observed when raw vegetables are made available to children while waiting in the cafeteria line for their meal (Elsbernd et al., 2016; Redden et al., 2015). A similar tactic is to serve fruit as dessert, after the main course. When Zellner and Cobuzzi (2016) piloted this technique in a two-day pre-post comparison study, the percentage of children consuming all of their kale salad increased by 175% relative to pre-intervention levels. In addition, where 40% of children consumed no kale salad when fruit was served with the meal, all children took at least one bite of the salad when fruit was provided as dessert.

Behavioral economists have found that defaults can have a large impact on decision-making (Johnson & Goldstein, 2003). A default intervention opts the consumer into a choice unless they take action to opt out. The classic example is the very larger increase in organ donors after a policy change that made organ donation the default option (Johnson & Goldstein, 2003). Consistent with the philosophy of *Libertarian Paternalism,* the consumer can opt out of the default option, but must take action to do so. In practice, few consumers opt out of the default option unless it is highly non-preferred. Defaults appear to work through an endorsement effect (i.e., the consumer trusts the agency who set the default option) or a status-quo bias (i.e., reluctance to change because opting out may result in a loss, relative to the status quo).

Applied to the cafeteria, a policy might be implemented in which children are served white milk by default, but they can request chocolate milk. While O'Bryan et al. (2017) found that default placement of lettuce and tomatoes on hamburgers nearly tripled the fraction of college students who ate them, the effects of adding default servings of FV to school lunch has produced less encouraging results (Cullen & Dave, 2017). Defaults may have limited, or no impact when the consumer has a strong aversion to the default option. For example, Wansink and Just (2016) reported that 87% of children opted out of a default serving of apples when french fries were the alternative choice.

Decreasing Price

As noted above, the law of demand holds that when the price of a commodity increases, consumption of that commodity should decrease. The converse is also true. If the price of FV were to decrease, then consumption of these foods should increase. Because elementary school children do not decide, as a consumer, to spend their own money on FV, we must look to non-monetary variables that affect price.

It is helpful to conceptualize price as a cost-benefit ratio. Doing so clarifies that there are two ways to reduce price: decrease the cost (e.g., from $2.50 to $1.50 per gallon) or increase the benefit (improved mileage, reduced emissions). Both of these price-impacting manipulations should alter consumption. The next section of this chapter will discuss methods for increasing the benefits of FV consumption. Here we discuss FV cost reductions.

When we purchase gasoline, we do not work at the gas station for several hours in exchange for a tank of gas. Instead, we use money as a medium of exchanging our past efforts (at our jobs) for gasoline. Thus, effort expended to procure a commodity may be conceptualized as a cost. Applied to FV consumption, a school-based intervention might take steps to reduce the procurement costs of obtaining a serving of FV. This cost-decreasing strategy, in part, underlies the smart-lunchroom interventions in which healthy foods are placed in convenient locations. These placements reduce search and travel costs, and may have a social-norm function (i.e., we place these foods here because consumers frequently choose them). Although the smart-lunchroom approach has been widely adopted in cafeterias, little empirical research has evaluated its effect on objectively measured FV consumption in elementary schools.

On the positive side, one study of the smart-lunchroom arrangement reported that fruit consumption increased by at least 32% and vegetable consumption by at least 43% (Hanks et al., 2013). However, in that study employees prompted children to take a serving of FV and, as noted above, prompting alone can increase FV consumption. Thus, it is difficult to evaluate the independent contribution of the smart-lunchroom design on FV consumption in the Hanks et al. (2013) study. In a one-day study of increasing the convenience of the salad bar, Adams et al. (2016) reported an impressive five-fold increase in FV consumption. Evaluating the long-term impact of this intervention will be important, because a 4-month evaluation of smart-lunchroom techniques revealed an increase in FV taking but not consumption (Cohen et al., 2015).

An alternative cost-decreasing approach is to reduce the handling costs of FV. For example, the time, effort, and mess incurred in peeling an orange represent a high price on consuming this food. Likewise, young children pay large handling costs to eat whole fruits such as apples, which are difficult for children with loose teeth or limited gapes, making it harder to bite into the fruit. When elementary-school cafeterias reduced these costs by serving sliced instead of whole apples, consumption increases by 62% (McCool et al., 2006). In a similar study, Wansink et al. (2013) offered sliced apples when children requested them, and this increased the apples served by ~60%; consumption was not reported for elementary-school children. Less encouraging, in a one-day study, Swanson et al., (2009) reported that approximately 8% more children ate sliced oranges, but there was no effect on apple consumption.

Anecdotally, we have noted that, for hygiene or freshness reasons, FVs are often served in packages that children must open in order to eat their contents. For example, baby carrots and apple slices are served in small plastic pouches that young children find difficult to open. This packaging makes it easier for food service employees who don't have to slice apples and mix them with lemon juice to prevent browning, but they appear to be increasing the price of these foods and, according to the law of demand, decreasing their consumption. Likewise, for schools to ensure that they are serving children the minimum amounts of FV required under the NSLP, they prepare measured servings in plastic cups with lids. Relative to the tater tots and corn dogs that appear on their plate and may be consumed without opening anything, including cutlery, these cups must be opened. Thus, the prices of FV appear to be inadvertently increased by concerns about hygiene and remaining in compliance with federal mandates.

A final cost-decreasing strategy that elementary school cafeterias can employ is to reduce the opportunity costs of eating FV. Opportunity costs refer to that which is forgone when one chooses to spend income on a particular commodity. In the cafeteria, time is income and it is fixed each day. Time spent consuming FV is, in some schools, time not spent at recess.

Scheduling lunch to occur after recess removes this potential opportunity cost, and in one study this scheduling change increased FV consumption by 54% (Just & Price, 2015). A related strategy is to increase children's income – give them more time to eat lunch. Setting a fixed amount of time to eat, with no one released to recess earlier, appears to have a beneficial effect on FV consumption. In one study, children given < 20 minutes to eat consumed 12% fewer vegetables than children given ≥ 25 minutes to eat (Cohen et al., 2016).

Increasing Benefits

As children are temporally myopic discounters of future events, interventions designed to increase the *immediate* benefits of FV consumption are anticipated to produce robust effects. As the literature on repeated tasting of FV suggests, if children can be induced to consume FV a sufficient number of times, their liking of these foods can increase (Anzman-Frasca et al. 2012; Lakkakula et al., 2011).

One approach to increasing the immediate benefits of FV consumption is to improve their taste. At least two studies have evaluated the impact of this approach on objectively measured FV consumption. Cohen et al. (2012) had chefs train cafeteria staff in two middle-schools, helping them to prepare better tasting FV offerings. Relative to control schools, vegetable consumption increased by 200% but fruit intake was unchanged. In a larger and more comprehensive evaluation of chef-prepared meals, Cohen et al. (2015) used plate-waste methods to objectively measure FV consumption in low-income elementary- and middle-schools. Three months into the intervention, more children attending the chef schools were taking vegetables, but there was no increase in vegetable consumption; likewise, there was no change in fruit taking or consumption. By the end of the seven-month study, children attending the chef schools were consuming ~82% more fruit and ~115% more vegetables than they did during baseline. Adding a smart-lunchroom arrangement to the chef-schools did not enhance the efficacy of this program.

The other, and most often employed, approach to increasing the benefits of FV consumption is to provide an incentive contingent upon eating these foods. This contingent-reinforcement approach has been extensively investigated in other areas of clinical research, where behavior-change is difficult; most notably in the treatment of substance use disorders. Early research showed that incentivizing cocaine abstinence could produce quit rates that were substantially higher than treatment as usual (e.g., Higgins et al., 1994; Silverman et al., 1996) and a large body of research now reveals incentives are among the most effective approach to encouraging abstinence from cigarettes and illicit drugs, and for encouraging weight loss and medication adherence (see Bickel, Moody, & Higgins, 2016 for review).

These findings are relevant for at least two reasons. First, children, like substance-dependent adults, steeply discount the delayed consequences of their behavior (Madden et al., 1997); thus, there is good reason to expect incentives can improve difficult-to-change behavior in impulsive populations. Second, sustained drug abstinence and FV consumption are critical to improving public health in their respective domains. Thus, those contingencies of incentive delivery that have proven most effective, and most cost-effective in treating substance-dependence might profitably be imported into school-based FV incentive programs (Roll et al., 1996; Pierce et al., 2006).

While incentives have a proven record of health behavior change, they are not without controversy (e.g., Pink, 2011). When designed to influence children's behavior, teachers and parents may object to the cheating that incentives can induce (Just & Price, 2013b) and may object philosophically to paying children to engage in positive behaviors such as healthy eating. Within the social and economic sciences, one of the most common objections to the use of incentives is variously referred to as the "overjustification," "boomerang," or "crowding out" effect. Such terms refer to a possible decline to below-baseline levels when the incentive is suspended (Lepper, Greene, & Nisbett, 1973). According to, self-determination theory (Deci & Ryan, 2011), this effect occurs because intrinsic motivation to engage in the behavior is “crowded out” by extrinsic incentives. When the latter are suspended, the intrinsic benefits of the behavior are no longer sufficient to maintain it.

Applied to healthy eating, incentives can increase FV consumption, but when the intervention ends the overjustification effect predicts children will consume less than they did before. Several thoughtful discussions have accompanied meta-analyses of the overjustication effect, and some of these are relevant to the topic at hand (Cameron et al., 2001; Cerasoli et al., 2014; Gneezy et al., 2011). These authors suggest incentives can be appropriate for simple behaviors that are not inherently enjoyable (e.g., abstaining from a preferred drug), and for which creative problem-solving is not required. Given children’s frequent disliking of vegetables, and the simplicity of eating them, incentivizing FV consumption may be appropriate. Incentives can be a powerful tool in convincing children to repeatedly taste FV. Doing so allows them to contact foods that they already like, or to develop a liking of foods they once feared (i.e., to identify new intrinsic sources of motivation).

Several studies illustrate the powerful effects that brief incentive-based interventions can have on healthy eating in elementary schools. Just and Price (2013b), for example, employed small monetary incentives to encourage FV consumption in 15 schools. Consistent with the substance-abuse treatment literature (e.g., Silverman et al., 1999) larger incentives ($0.25) produced larger increases in consumption of FV, and consistent with the temporal myopathy of youth providing the incentive immediately produced a larger effect than providing the same reward in two weeks. Across schools and the variety of incentives and delays they employed, the number of children eating fruits or vegetables at lunch increased by 82%.

Long-duration incentive-based interventions typically include other intervention components, which makes it difficult to isolate the unique contribution of incentives to behavior change. For example, the Food Dudes program combines incentives with default servings of FV and video role-modeling. The program yields increases in fruit (+27-245%) and vegetable (+23-197%) consumption in preschool (Horne et al., 2011) and elementary-school settings (Horne et al., 2004, 2009; Lowe et al., 2004; Morrill et al., 2016; Wengreen et al., 2013). The exception to these findings is Upton et al. (2013), who took a naturalistic approach to implementation of the Food Dudes program. Specifically, they provided the program to the schools but did not take steps to ensure that all components of the program were properly implemented. In this case, they reported no positive effect of the program on FV consumption.

In a laboratory study, Cooke et al. (2011a) isolated the effects of incentives in a 12-session program targeting consumption of a non-preferred vegetable. Tangible incentives (stickers) and social praise produced large, and statistically comparable increases in vegetable consumption. Following up on the Cooke et al. findings, Morrill et al. (2016) found that social praise produced comparable increases in FV consumption only in the short term. At 6-month follow-up, only those whose FV consumption was tangibly incentivized continued to consume more FV. The substance-abuse literature offers one possible explanation for this finding. When incentives are used to encourage drug abstinence, better long-term outcomes are observed among those who sustain abstinence for a longer continuous duration during the incentive phase (Higgins et al., 1999). Similarly, tangible incentives may be necessary to sustain FV consumption over a continuous duration sufficiently long to shift the behavior from conscious control to habit (Lally et al., 2010).

Because long-duration incentive-based interventions often evaluate FV consumption long after incentives are withdrawn, we can return to concerns about the overjustification effect. Cooke et al. (2011b) reviewed the available research and found evidence for the overjustification effect only when consumption of *palatable* foods was incentivized; importantly, the effect was confined to food-liking, not consumption. The same review revealed that incentives arranged for consuming *less palatable* foods (like vegetables) produced no decrement in any measure of intrinsic motivation.

In the ten relevant studies published after the Cooke et al. (2011b) review (Belot et al., 2016; Cooke et al., 2011a; Hoffman et al., 2011; Horne et al., 2011; Just & Price, 2013b; List &

Samek, 2015; Loewenstein et al., 2016; Morrill et al., 2016; Remington et al., 2012; Upton et al., 2013), all but one reported that incentives increased FV consumption during the intervention and in no way reduced intrinsic motivation to consume these foods after incentives were removed. The exception (Upton et al., 2013) failed to produce an incentive effect on FV consumption, and the post-incentive decline in consumption was observed in both the incentive and control schools; thus, it would be inappropriate to refer to the post-incentive decline as an overjustification effect. In those nine studies that showed a positive effect of incentives on FV consumption, six reported that the significant increases in FV consumption were still evident months after the incentives had been terminated (Cooke et al., 2011a; Horne et al., 2011; List & Samek, 2015; Loewenstein et al., 2016; Morrill et al., 2016; Remington et al., 2012). In sum, there is no published evidence that incentivizing FV consumption in schools will crowd out children's intrinsic motivation to consume these foods. To the contrary, the modal effect of incentives is the opposite.

The primary obstacle to adoption and long-term implementation of any school-based intervention is cost (Appleton et al., 2016). Schools' primary mission is education and their budgets leave little room to purchase tangible incentives that might be used to promote the repeated tasting and daily consumption of FV. An additional expense of incentive systems is the labor required to administer them. This typically involves verifying if each child has eaten their serving of FV and providing the incentive only when they did. Verification is important because incentives can induce cheating (Just & Price, 2013b). In our experience, the prevalence of cheating appears proportional to the amount of the reward. A large reward is likely to induce a host of cheats, including dropping vegetables on the floor, stuffing them into a pocket, or holding them in the mouth just long enough for an adult to be fooled into giving them a reward. Providing an incentive for these behaviors will undermine the intervention.

There are also the labor costs associated with transporting incentives to the schools and classrooms, and having teachers pass them out. These labor costs are serious impediments to the adoption of an incentive-based intervention. Much of the incentive-based research reviewed above is grant-funded, and so many of these materials and labor costs are not paid by schools. If they were, there seems little chance that schools would adopt these programs.

Low-Cost Game-Based Incentives

If the materials and labor costs of existing incentive programs are a barrier to their widespread adoption in schools, then reducing these costs should be a direction for future research and innovation. One such direction is to arrange no-cost virtual incentives that will establish patterns of healthy eating in children. A challenge is in giving virtual rewards enough value to influence real-world behavior. One context in which virtual incentives can strongly influence human actions is in videogames. These games might have a rich narrative and immersive environment in which the player will expend considerable efforts to acquire virtual rewards such as in-game currency which may be used to purchase items that aid in winning the game (Reeves & Read, 2009).

Some attempts have been made to create videogames designed to positively influence healthy eating. Many of these efforts has taken an education approach (e.g., Lew et al., 2017), where others have more comprehensively incorporated goal-setting, feedback, and self-efficacy building (e.g., Thompson et al., 2015). Two significant hurdles must be overcome if this gaming approach is to be successful. First, if the games are played on a computer, smartphone, or gaming platform, they will need to effectively compete against the large array of concurrently available highly entertaining games that include no healthy behavior messaging. Simply put, health-promoting games will need to be engaging. Second, the games must include a means of objectively measuring FV consumption. At present, serious games targeting healthy eating have relied heavily on self-reported outcomes (e.g., Baranowski et al., 2003) and this may inadvertently encourage cheating (Thompson, 2017).

Our research group has begun to address some of these challenges to the widespread use of low-cost game-based incentives to increase FV consumption in elementary schools. Jones et al. (2014a) developed a rudimentary episode-based adventure game. Within the narrative, heroic characters fought the forces of evil and enlisted the aid of the school – if they met a daily FV consumption goal, the heroes continued to make progress toward the object of the game: capturing a band of villains. When consumption goals were met, teachers would read the next episode; when the school fell short of their goal, they were encouraged to try again tomorrow. This rudimentary low-cost, no-tech game increased objectively measured fruit and vegetable consumption by 66% and 44%, respectively over a 13-day period (Jones et al., 2014a). Relative to our previous work using tangible incentives (Morrill et al., 2016; Wengreen et al., 2013), the game was far less expensive (no materials costs), did not induce cheating, and produced comparable increases in FV consumption.

The game was refined in a follow-up study conducted in a second school (Jones et al., 2014b). The revised game was designed using five rudimentary game-design principles (see Reeves & Read, 2009; Schell, 2015). First, and consistent with the prior version, there was a clear object of the game – locate and capture the villains. Second, the narrative was expanded and enriched to improve its entertainment value. A good vs. evil narrative formed the core archetype, and episodes included periodic surprises, humor, and cliff-hanger endings designed to better motivate meeting the daily FV-consumption goals. Third, children playing the game were occasionally given autonomy to choose the direction of the narrative. Fourth, the game included a virtual economy – when children exceeded their daily FV consumption goal, they earned virtual currency that could be exchanged for goods and services within the game (e.g., repairing the ship or purchasing a tool). Finally, the daily goal was set to a level that only slightly exceeded recent median levels of FV consumption. Because the incentives were judged to be small in benefit, their acquisition price was low. By gradually increasing the goal as the school succeeded in meeting it, the difficulty of the game matched the skills of the player. This redesigned version of the game increased fruit and vegetable consumption by 39% and 33%, respectively (Jones et al., 2014b).[3]

A third iteration of the game was designed to further reduce its operating costs. Where previous, the game asked teachers to read the episodes to children, Joyner et al. (2017) presented them in comic-book format in large-display format on a cafeteria wall. This change relieved teachers of a duty and served as a prompt, reminding children to meet their healthy-eating goal in the location in which this behavior was to occur. Only vegetable consumption was targeted for improvement and plate-waste measures were used, as above. In two participating elementary schools, the game nearly doubled vegetable consumption (fruit consumption was unchanged).

A shortcoming of these three game-based studies is their short duration (usually less than one month) and the lack of follow-up evaluations of FV consumption after the game has been won. Future research should expand game duration to evaluate if this approach can produce the long-lasting increases in FV consumption that are associated with tangible reward programs (e.g., Morrill et al., 2016). A barrier to this research is the substantial cost of expanding the game narrative when presented in comic-book format (e.g., the cost of an artist to render the panels).

Concise Policy Recommendations

This chapter has reviewed intervention research conducted in elementary school cafeterias that has objectively measured changes in FV consumption. The latter standard provides the most rigorous evidence for the efficacy of an intervention. Programs that have not provided such evidence cannot be recommended to policy makers. With the exception of

[3] The smaller percentage increase relative to Jones et al. (2014a) are due to higher baseline levels of FV consumption. The latter may be due to the increased variety of FV offerings (Adams et al., 2005) and chef-quality offerings (Cohen et al., 2015) available at the school throughout the study.

incentives, there are, at present, only small numbers of mostly short-duration studies available in any of the intervention categories summarize above. Thus, the recommendations below should be viewed as tentative, pending replications in future research.

As noted above, the widespread adoption of healthy-eating interventions in schools will be facilitated by low- (or no-) cost programs that are easy to implement. Several such programs may be initiated by food-service personnel without involvement of the school's faculty. The available evidence suggests that slicing fruits before serving them to children will increase their consumption. Serving them directly to the child's plate (instead of serving wrapped portions) reduces the handling-cost of accessing these foods. Large increases in vegetable consumption can be achieved by either serving these foods to children while they wait in the cafeteria line, or by serving fruit after the main course, as desert. Making a wider variety of vegetables available to children each day increases the probability they will find one they will eat. Two final simple policy changes include scheduling lunch after recess and giving children at least 25 minutes to eat their lunch.

Should more involved interventions prove necessary, increasing the benefits of eating FV is in order. This can be accomplished by improving the taste of these foods and/or incentivizing their daily consumption. Cohen et al. (2015) reported large increases in vegetable consumption when the taste of these foods was improved, but the effects were not observed for several months after the new menus were introduced. Children may have been afraid to try these new food, and may have done so only when they saw their peers try them and report that they tasted good. If so, the uptake of these new foods could be expedited if tasting them were briefly incentivized. If a no-cost game could be employed to motivate children to repeatedly try these better tasting vegetable offerings, the children may discover several foods that they like to eat, facilitating the acquisition of healthy eating habits at school and home, and maintained well after the game has been won.

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