No food for thought: moderating effects of delay discounting and future time perspective on the relation between income and food insecurity[1–4]

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Abstract

Background: Low income is related to food insecurity, and research has suggested that a scarcity of resources associated with low income can shift attention to the present, thereby discounting the future.

Objective: We tested whether attending to the present and discounting the future may moderate the influence of income on food insecurity.

Design: Delay discounting and measures of future time perspective (Zimbardo Time Perspective Inventory, Consideration of Future Consequences Scale, time period of financial planning, and subjective probability of living to age 75 y) were studied as moderators of the relation between income and food insecurity in a diverse sample of 975 adults, 31.8% of whom experienced some degree of food insecurity.

Results: Income, financial planning, subjective probability of living to age 75 y, and delay discounting predicted food insecurity as well as individuals who were high in food insecurity. Three-way interactions showed that delay discounting interacted with financial planning and income to predict food insecurity ($P = 0.003$). At lower levels of income, food insecurity was lowest for subjects who had good financial planning skills and did not discount the future, whereas having good financial skills and discounting the future had minimal influence on food insecurity. The same 3-way interaction was observed when high food insecurity was predicted ($P = 0.008$).

Conclusion: Because of the role of scarce resources on narrowing attention and reducing prospective thinking, research should address whether modifying future orientation may reduce food insecurity even in the face of diminishing financial resources. This trial was registered at clinicaltrials.gov as NCT02099812.   *Am J Clin Nutr* 2014;100:884–90.

INTRODUCTION

Income is a reliable predictor of food insecurity (1). Across a variety of ethnic and cultural groups, individuals with low income are more likely to experience food insecurity (2) or the inability to have enough food for all members of the household (3). Paradoxically, low income is related to obesity, with the relation strongest for women, which may be attributable in part to their choice of cheap, high–energy-dense foods (4–6). In addition, the reinforcing value of food may be increased by a lack of resources and hunger such that, when food is available, it is consumed beyond what is needed for homeostasis (7). Consistent with the effect of low income on food insecurity and obe-sity, food insecurity in low-income people is related to obesity (2, 8).

The lack of resources compounded by the daily challenge for adequate and nutritious food may shift people's attention to current demands, perhaps making them very resourceful for solving current problems but less interested in planning, or able to plan, for the future. A scarcity of resources has been shown by cognitive science research to be associated with focusing attention on immediate concerns, which influences decision making and contributes in part to the perceived inability to set long-term goals and make changes that would improve resources and reduce food insecurity (9–11). A major concern for low-income persons is a lack of monetary resources. However, increasing monetary resources alone is not sufficient to modify some important consequences of low income and food insecurity, such as obesity (12). Experimental data have suggested that providing monetary vouchers may increase obesity because people have more money to apply to unhealthy food choices (13). Increased resources for someone who is used to focusing on immediate goals and reducing hunger may be insufficient to shift decision making to a more–future-oriented time perspective that may foster a healthier lifestyle.

The narrowing of attention to immediate goals over extended time periods for someone with limited financial resources may result in a lack of future time perspective and a focus on immediate gratification rather than the ability to delay gratification to achieve long-term goals. The purpose of this study was to examine whether the ability to delay gratification and future time perspective are related to food insecurity and test if these

variables interact with income to predict food insecurity. Delay discounting is an operational measure of the extent to which people choose small, immediate rewards as opposed to larger, delayed rewards (14). Conceptually related measures of future orientation include measures of future time perspective (15), consideration of future consequences (16), the time period of financial planning (17), and the subjective probability of living to an old age (17).

SUBJECTS AND METHODS

Participants

Participants were 975 adults who completed all questions on Amazon Mechanical Turk (mTurk; Amazon.com Inc) from 10 December 2012 to 1 June 2013. mTurk is a crowdsourcing Internet marketplace on which investigators can post tasks, and interested participants can complete the task for monetary payment. mTurk has been used previously as a means to examine delay discounting in the obese (18). Exclusionary criteria were violating criteria for valid delay-discounting values on the delay-discounting task (19), being a student, or receiving money from Virginia Tech through employment or for any other reason including study participation in the previous year. Students were excluded because their income may not have been representative of family income. Eligible participants were compensated from $2.50 to $5.00 for their participation.

Procedures

An Internet-based questionnaire was administered via mTurk. A description of the questionnaire was posted on this service, and interested individuals completed a short series of demographic questions to determine eligibility. Participants who met eligibility criteria continued on to the main survey. On completion of the survey, $0.05 was automatically added to the participant's account. Within approximately one business day, each participant's answers were reviewed. Participants who spent ≥20 min taking the survey (pilot work with this survey determined <20 min was unreasonably fast responding) and who met delay-discounting consistency criteria outlined by Johnson and Bickel (19) modified for this survey, received an additional $4.95 payment deposited into their account. Eleven people completed the survey in <20 min, 27 people did not meet delay-discounting criteria, and 2 people were excluded for both of these criteria. Participants who did not meet these criteria but finished the survey received an additional $2.45. Two hundred seventeen people started but did not complete the survey and were not compensated; however, 18 participants were compensated $5.00 because they did not finish because of technical errors out of their control. The protocol was approved by the Virginia Tech Institutional Review Board.

Measures

Demographics

A demographics questionnaire was used to assess age, sex, race, height and weight, household income, educational attainment, household composition (ie, number of children and adults), current cigarette smoking and alcohol consumption, employ-

ment, and marital status. Income and education were reported categorically and were converted to continuous variables for analysis by using midpoints of categories. Race was categorized as a minority or nonminority on the basis of whether the participant reported being white, and this dichotomous variable was used in all analyses.

Food security

Household food insecurity during the past 12 mo was assessed via the Six-Item Food Security Scale, which was adapted from the 18-item US Household Food Security Survey Module (20). Food security refers to having enough food for all active, healthy members of the household (3). Total food insecurity scores 0–1 were interpreted as high or marginal food security, 2–4 as low food security, and 5–6 as very low food security. The short form of the household food-security scale has been validated in a large nationally representative sample of families from the Current Population Survey, and the short form classified 97.7% of families correctly (21), which made it an ideal scale to be used in large batteries of questionnaires or surveys.

Delay discounting

The delay-discounting task measures the degree to which people discount a hypothetical monetary reward. Participants were asked to select whether they would prefer a smaller, immediate reward compared with a larger, delayed reward. The value of the immediate reward was adjusted across trials by using a decreasing-adjustment algorithm, whereas the delayed value remained constant at $1000. This procedure determined the point at which participants were indifferent to the difference between the smaller, immediate reward and the larger, delayed reward at 7 time delays (1 d, 1 wk, 1 mo, 6 mo, 1 y, 5 y, and 25 y). These indifference points were fitted to the equation

$$V = A \div (1 + kD) \qquad (1)$$

where V is the indifference point, A is the amount of the delayed reward ($1000), D is the delay to the larger reward, and k is a free variable that represents the participant's discount rate (14). A normal distribution was approximated by using a $\log_e$ (ln) transformation of k values. Larger $\ln(k)$ values indicate the value of the delayed reward was discounted to a greater degree. On the basis of inclusion criteria outlined by Johnson and Bickel (19), data were excluded if the 25-y indifference point was not at least $100 less than the 1-d indifference point. In addition, starting with the 1-d indifference point, data were excluded if <2 indifference points were <$200 greater than the previous.

Future orientation measures

Zimbardo Time Perspective Inventory

The Zimbardo Time Perspective Inventory measures a psychological orientation toward a future time perspective as well as the orientation toward other time perspectives, including past-negative, past-positive, present-hedonistic, and present-fatalistic perspectives. For the purposes of this study that focused on future orientation, only the future time-perspective scale was used (15). Future orientation was assessed on a 5-point Likert-type scale, where higher average scores reflected a greater future orientation.

Consideration of Future Consequences

The Consideration of Future Consequences Scale is a measure of temporal orientation regarding the perception of the immediate and future consequences of present behavior (16) on a 5-point Likert-type scale. Higher average scores indicated greater consideration of future consequences.

Financial planning and longevity

The time period of financial planning was assessed by the question, "In planning your, or your family's, saving and spending, which of the following time periods is more important to you and your partner, if you have one?" Answer choices ranged from not planning, day to day, next few weeks, new few months, next year, next few years, next 5–10 y, and planning for >10 y. Responses from these categories were converted to continuous variables for analysis by using midpoints of categories (17). The subjective probability of living to age 75 y was measured by asking "What do you think are the chances you will live to be 75 or more (where 0 means there is no chance you will live to 75 or more, and 100 means you will definitely live to 75 or more)?" (17). Higher values on either question indicated greater future orientation.

Analytic plan

The primary goal of these analyses was to assess whether delay discounting and psychological measures of future time orientation predicted food insecurity and whether delay discounting and measures of a future time orientation moderated the influence of income on food insecurity. First, separate zero-influenced negative binomial regression models were used to assess predictors of food insecurity, with income as the variable that predicted inflated zeros. In addition, logistic regression models assessed whether those variables predicted very high food-insecurity (≥5) scores. Two-way interactions assessed whether delay discounting or other measures of future time orientation moderated the effect of income on food insecurity, and 3-way interactions assessed the moderation of income and delay discounting by measures of future orientation. Moderation analyses controlled for BMI, smoking or alcohol-drinking status, age, sex, minority status, and household size. Zero-inflated negative binomial regression models were used because data involved counts, and a large number of participants recorded zero food insecurity (572 or 975 subjects). Each moderation analysis was also run to predict very high food insecurity by using logistic regression. Interactions for the negative binomial analyses were graphed by dividing income into 3 levels [<\$30,000 (*n* = 286; ≥\$30,000 and <\$60,000 (*n* = 374); and ≥\$60,000 (*n* = 315)], and the other variables were graphed by using the median split. The probability of having high food insecurity was based on the regression model by using regression coefficients for mean (±1 SD) for future orientation variables and income. Data analyses were conducted in SYSTAT 11 (22) and STATA 12 (23) software.

RESULTS

Participant characteristics and the prediction of food insecurity or very high levels of food insecurity are shown in **Table 1**. Numerous variables were negatively related ($P < 0.05$) to food

insecurity or very high food insecurity, including income, financial planning, subjective probability of living to age 75 y, education, and smoking and positively to delay discounting. Some variables were related ($P < 0.05$) to high levels of food insecurity but not food insecurity as a count variable, including sex, BMI, consideration of future consequences, and future time perspective (Zimbardo Time Perspective Inventory).

Zero-order correlations showed significant relations in all of the future-orientation measures and between delay discounting and all future-orientation measures (P values <0.001). Correlations ranged from 0.12 (future time perspective and probability of living to age 75 y) to 0.64 for the relation between consideration of future consequences and future time perspective. Two of the relations met criteria for at least a moderate effect size ($r > 0.30$), the relations between consideration of future consequences and financial planning ($r = 0.38$, $P < 0.001$) and future time perspective ($r = 0.64$, $P < 0.001$).

Zero-inflated negative binomial regression analysis showed income interacted with delay discounting and financial planning to predict food insecurity ($P = 0.003$; **Figure 1**, top graphs). Analyses that were based on income levels showed a significant 2-way interaction between financial planning and delay discounting only for subjects in the lower-income group ($P = 0.016$), whereas subjects in the middle- ($P = 0.14$) and higher- ($P = 0.45$) income groups did not show this interaction. The importance of income to food insecurity is clearly shown in Figure 1 (top graphs) because food-insecurity levels were reduced as income increased. The interaction for lower-income groups was attributable to a differential effect of delay discounting on food insecurity that was based on financial planning. There was a relation between being low in financial planning and high food insecurity, but if financial planning was higher, and people did not discount the future, levels of food insecurity were close to those in middle- or even higher-income groups.

The logistic regression that predicted high food insecurity showed the identical 3-way interaction of income × financial planning × delay discounting ($P = 0.008$). As shown in the Figure 1 (bottom graphs), the same pattern emerged as for food-insecurity count data. The probability of having high food insecurity was >0.40 for low-income, low financial planners or low-income, high financial planners who discounted the future. However, lower-income, high financial planners who did not discount the future had a probability of high food insecurity of 0.12, less than the probability of high food insecurity for middle-income, low financial planners who discounted the future (0.16). This value is also close to the probability of high food insecurity for other middle-income groups, which ranged from 0.05 to 0.09. The probability of being high in food insecurity was very low for the higher-income group, no matter the level of financial planning or delay discounting (probabilities ranged from 0.01 to 0.04).

DISCUSSION

The relation between income and food insecurity was consistent with previous research (2); individuals with lower incomes have greater food insecurity than do individuals those with higher incomes. Factors beyond income associated with food insecurity include processes that may change decision

TABLE 1
Descriptive characteristics of the sample and relation to food insecurity and very high levels of food insecurity[1]

	Mean ± SD	n (%)	Z_{NegBn}	P	z_{log}	P
Food-security questionnaire	1.4 ± 2.1		—	—	—	—
High or marginal food security (0–1)		665 (68.2)				
Low food security (2–4)		155 (15.9)				
Very low food security (5–6)		155 (15.9)				
Sex	—		1.59	0.112	2.12	0.034
M		498 (51.1)				
F		477 (48.9)				
Marital status	—		0.34	0.734	1.76	0.08
Single, divorced, widow, or widower		459 (47.1)				
Married or living with significant other		516 (52.9)				
Race	—		0.28	0.777	0.20	0.85
White		798 (81.8)				
Black		54 (5.5)				
Hispanic		29 (3.0)				
Asian		57 (5.8)				
Other race/multiple races		37 (3.8)				
Highest level of education completed	15.1 ± 2.0		−2.85	0.004	−4.81	<0.001
Less than HS/GED		8 (0.8)				
HS diploma/GED		130 (13.3)				
Some college		334 (34.3)				
Bachelor degree		394 (40.4)				
Advanced degree		109 (11.2)				
Income range	52,458 ± 42,744		−5.18	<0.001	−8.46	<0.001
<$30,000		286 (29.3)				
$30,000–$59,999		374 (38.4)				
≥$60,000		315 (32.3)				
Financial planning (y)	2.3 ± 3.2		−3.31	0.001	−4.68	<0.001
No plan		23 (2.4)				
Day to day		74 (7.6)				
Next few weeks		185 (19.0)				
Next few months		238 (24.4)				
Next year		119 (12.2)				
Next few years		153 (15.7)				
Next 5–10 y		104 (10.7)				
>10 y		79 (8.1)				
Smoke	—	289 (29.6)	−2.23	0.026	−3.99	<0.001
Drink alcohol	—	599 (61.4)	−0.28	0.778	0.04	0.97
Age (y)	34.2 ± 10.7	—	0.63	0.526	−1.76	0.078
BMI (kg/m²)	28.2 ± 7.7	—	1.87	0.062	3.31	<0.001
Household size	2.6 ± 1.4	—	−1.72	0.086	−0.32	0.75
Subjective probability of living to age 75 y	70.7 ± 25.9	—	−3.07	0.002	−5.09	<0.001
Consideration of Future Consequences Scale	3.6 ± 0.7	—	−1.29	0.198	−3.51	<0.001
Zimbardo Time Perspective Inventory	3.8 ± 0.5	—	−0.97	0.333	−2.27	0.023
Delay discounting [ln(k)]	−6.0 ± 1.8	—	3.16	0.002	4.83	<0.001

[1] GED, General Educational Development; HS, high school; z_{log}, z value for logistic regression models; Z_{NegBn}, z value from zero-inflated negative binomial regression models.

making when resources are scarce (9, 10), such as delay discounting and different measures of a future orientation. The 3-way interaction showed that the highest food insecurity was for lower-income families with low levels of financial planning or high levels of financial planning who discounted the future. Food insecurity was lowest for lower-income persons with higher financial planning who did not discount the future. This interaction was also evident when the probability of experiencing high food insecurity was the dependent variable. Being in the lower income group was associated with >40% of persons likely to be high in food insecurity, except if they had longer financial planning and did not discount the future, which was associated with 12% of these lower-income families having high food insecurity.

Having a future orientation represents important psychological processes that are related to food insecurity. The allocation of more attention to immediate challenges associated with day-to-day needs and forfeiting opportunities for future planning is logical for people with scarce or limited resources (11). The results further suggested that the tendency to delay gratification (ie, responding for larger delayed goals in preference over small immediate rewards) is associated with food security. This finding highlights the importance of delaying gratification as an essential skill for individuals with low income. Of course, someone with a reduced income and limited access to food who has the opportunity to eat may bias his or her decisions toward the immediate goal of eating and removing hunger rather than the
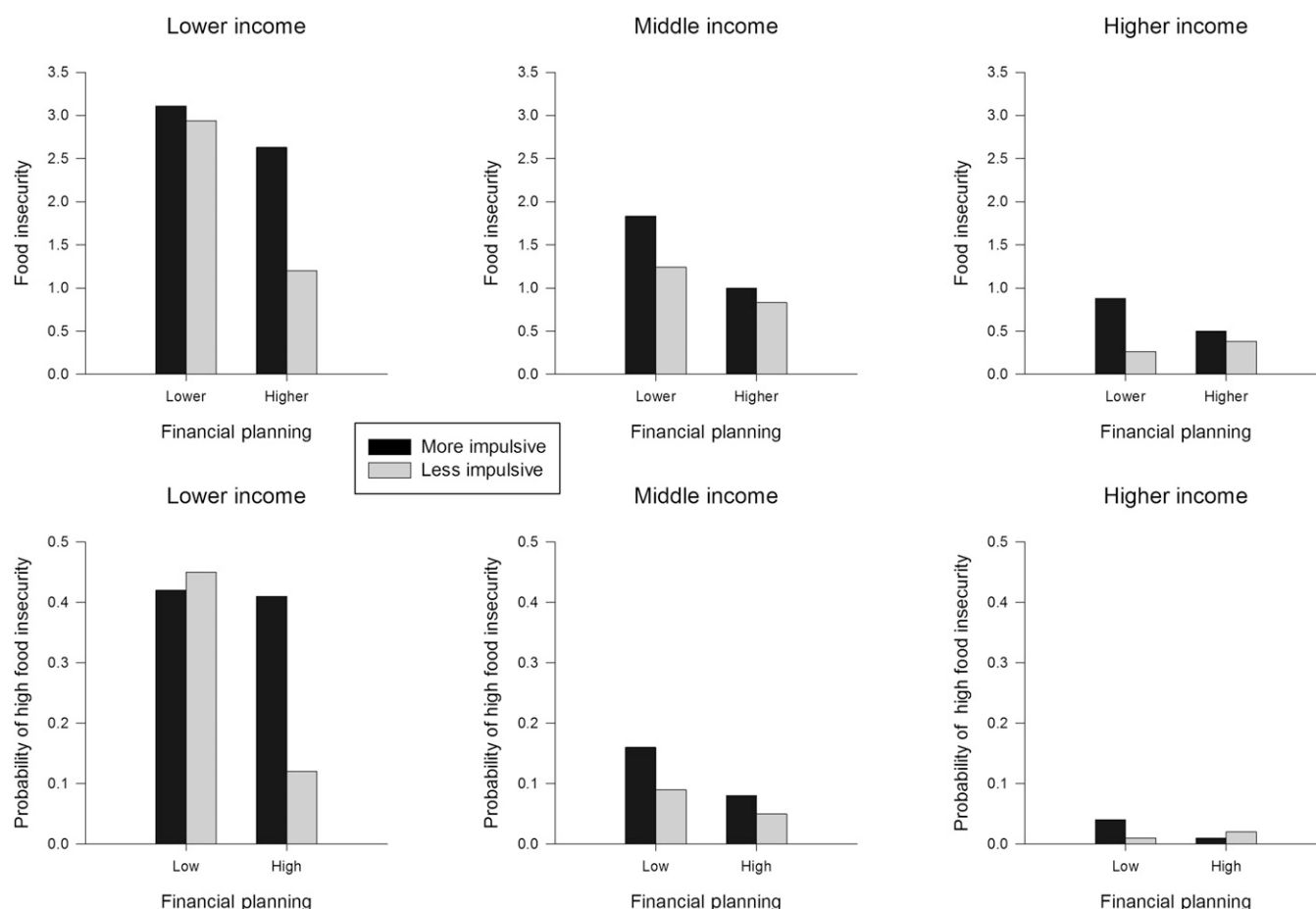
FIGURE 1. Predicting food insecurity (top graphs) and the proportion of very high food insecurity [≥5 on a 6-item food-security questionnaire (bottom graphs)] by interactions of income × financial planning × delay discounting (impulsivity). The 3-way interaction was significant for zero-inflated negative binomial regression predicting food insecurity counts ($P = 0.003$) and logistic regression predicting high food insecurity ($P = 0.008$). The interaction of financial planning by delay discounting on food-insecurity counts was observed for lower-income participants ($P = 0.016$) because subjects with high financial planning who did not discount the future (less impulsivity) had less food insecurity and a lower probability of having high food insecurity.

longer-term goal of developing a pool of resources to prevent scarcity and future problems. Hunger and food deprivation are strong motivators of behavior (24, 25), and the longer food is deprived, and the hungrier people become, the more motivated they may be to eat whatever is available and what they can afford, even if it is of lower nutritional quality.

An important limitation of this and any cross-sectional study is an understanding of the direction of influence. In the case of food insecurity and future orientation, both directions were possible (ie, individuals without an orientation toward planning for the future or delaying gratification of immediate rewards may develop food insecurity, or alternatively, a history of food insecurity and dealing with immediate challenges of having enough food may render an individual to be immediate as opposed to future oriented). Of course, these processes may also function reciprocally to influence each other, such that the effect of one on the other reveals a cycle of interdependence. Evidence of this cycle has come from research that showed that reducing perceived resources from normal subjects without financial constraints resulted in an attention to immediate goals and decision making that favored more-impulsive decision making (9). Measures of future orientation were not independent because there were significant relations in all future-orientation measures

and particularly strong relations between the consideration of future consequences and financial planning or a future time perspective. The 2 variables that moderated the influence of income on food insecurity (ie, delay discounting and financial planning) were related ($r = -0.25$), which may have suggested an underlying construct for a component of future orientation.

Because of these limitations, results underscored the importance of a future orientation in terms of financial planning and the ability to delay gratification for individuals with limited financial resources. Previous research has shown that training in financial planning can result in reduced drug use and less discounting of future rewards (26), and financial planning is an obvious tool that could benefit individuals with a low income to reduce food insecurity and eat more nutrient-rich foods. However, the intent to engage in long-range financial planning without the ability to delay immediate gratification may not be enough to reduce food insecurity. Training in impulse control may provide wide-ranging benefits for low-income persons to reduce food insecurity as well as enhance their financial portfolio. In addition, a focus on immediate challenges can be shifted to long-range goals by training in episodic future thinking, which teaches people to consider the future as they are making decisions about a small, current reward compared with a larger, delayed reward (27, 28).

Working-memory training may also be used to reduce the tendency to choose small, immediate rewards over larger, delayed rewards (29, 30) by acting at overlapping neural systems.

Because hunger is such a strong driver of the motivation to eat and can derail even the best of intentions to engage in future planning (11), there may be value in improving the nutrition of low-income people as they learn to value future goals as well as handle immediate challenges. Research has suggested that the volume of food consumed is the main driver of hunger, not caloric intake, and people will become full faster on very-low-energy-dense foods, particularly those with a high water content (31–34). However, many low-income people tend to choose cheap, very-high-energy-dense foods that are associated with obesity and poor health (4–6). Better choices would be low-energy-dense foods that are high volume and nutritious, which would lead to reduced hunger that may facilitate decision making. Katz et al (35) have argued that low-income people can eat healthy if they choose their foods wisely from low-energy-dense, high-nutrient-dense foods.

Although these results strongly support the role of a future orientation as essential to better adapt to low income and a scarcity of resources, the results have to be considered in relation to the sample collected by using the MTurk crowdsourcing Internet marketplace. Research has suggested that samples studied by using MTurk are more diverse than other Internet samples, and data are as reliable as those collected by using more traditional methods of data collection (36). The large number of low-income participants and subjects who scored high on food insecurity suggested a more-diverse sample than that often obtained for community samples.

In conclusion, these results confirm the known relation between low income and high food insecurity and suggest that psychological processes play an important role in moderating this relation. Research on scarcity has suggested that shifts in allocation of attention and decision making that occur when resources are scarce are a function of the context of having scarce resources, not a characteristic of the poor or people who have limited resources (9–11). Big shifts in problem solving and impulsivity are observed for people with extensive resources if they are placed in a context of scarcity or for people studied during periods of scarcity or replete with resources (9–11). Research is needed to test whether training to improve a delay of gratification, perhaps in combination with financial planning, can help reverse effects of low income on food insecurity. A complete intervention program should also consider the role of proper nutrition and nutritional counseling on maximizing the effects of programs training better skills in delaying gratification. A prescription of more resources, better nutrition, and learning to delay gratification may be important for future attempts to intervene with and prevent food insecurity.

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