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Preschoolers' Delay of Gratification Predicts Their Body Mass 30 Years Later

Dr. Tanya R. Schlam, PhD, Dr. Nicole L. Wilson, PhD, Dr. Yuichi Shoda, PhD, Dr. Walter Mischel, PhD, and Dr. Ozlem Ayduk, PhD

Center for Tobacco Research and Intervention and Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI (Dr. Schlam); Department of Psychology, University of Washington, Seattle (Drs. Wilson and Shoda); Department of Psychology, Columbia University, New York City (Dr. Mischel); Department of Psychology, University of California, Berkeley (Dr. Ayduk)

Abstract

Objective—To assess whether preschoolers' performance on a delay of gratification task would predict their body mass index (BMI) 30 years later.

Study design—In the late 1960s/early 1970s, 4-year-olds from a university-affiliated preschool completed the classic delay of gratification task. As part of a longitudinal study, a subset ($N = 164$, 57% women) completed a follow-up approximately 30 years later and self-reported their height and weight. Data were analyzed using hierarchical regression.

Results—Performance on the delay of gratification task accounted for a significant portion of variance in BMI (4%, $p < .01$), over and above the variance accounted for by sex alone (13%). Each additional minute a preschooler delayed gratification predicted a .2 point reduction in BMI in adulthood.

Conclusions—Delaying gratification longer at 4 years of age was associated with having a lower BMI three decades later. The study is, however, correlational, and it is therefore not possible to make causal inferences regarding the relation between delay duration and BMI. Identifying children with greater difficulty delaying gratification could help detect children at risk of becoming overweight or obese. Interventions that improve self-control in young children have been developed and might reduce children's risk of becoming overweight while having positive effects on other outcomes important to society.

Keywords

overweight; obesity; self-regulation; self-control; cognitive control

Over the last 30 years, the prevalence of overweight and obesity has risen substantially, and we now face a global obesity epidemic.¹ Contributing factors include people adopting more sedentary lifestyles and consuming more calories than in the past (due in part to the ready

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Corresponding Author and Reprint Request Author: Ozlem Ayduk, Department of Psychology, University of California, Berkeley, 3411 Tolman Hall, Berkeley, CA 94720. Phone: 510 642-5619. Fax: 510 642-5293. ayduk@berkeley.edu.

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availability of supersized portions of cheap, easily consumed, calorically-dense foods and sweetened beverages).¹ Within this obesogenic environment, protective factors—including high self-control and ability to delay gratification—may help some people to resist overeating and maintain a healthy weight.

The ability to delay gratification develops as children mature and learn to forgo less valued, short-term pleasures in favor of pursuing valued long-term goals. Ability to delay gratification depends on executive function (ie, cognitive control)—the cognitive functions underlying effective attention deployment, self-monitoring, and planning. The preschool delay of gratification task assesses preschoolers' self-control by asking them to choose between a small immediate reward (eg, one marshmallow) or waiting for an unspecified time to earn a somewhat more desirable reward (eg, two marshmallows). A longitudinal study of children attending the Stanford University Bing Nursery School found that delaying gratification for a longer time as a preschooler was associated with important outcomes (eg, adolescent academic strength, social competence, planfulness, and ability to handle stress).² In some children, it was also associated with higher Scholastic Aptitude Test (SAT) scores and less illegal drug use in adulthood.^{3,4}

Recent research in other samples has found that children's self-control is associated longitudinally with their weight.^{5–10} Results from a longitudinal study following children into adolescence found that children scoring low versus high on self-control tasks at ages 3 and 5 years had higher body mass indices (BMIs) and greater increases in BMI through age 12 years.⁶ A study of 1000 New Zealanders found that levels of self-control in childhood (ages 3–11 years) predicted health outcomes at age 32, including having at least three of six metabolic risk factors (eg, being overweight).¹⁰

The current study uses a longer (30-year) lag between measurement of self-control and BMI to test the a priori hypothesis that delaying gratification for a greater number of seconds in early childhood is associated with having a lower BMI in middle adulthood.

Methods

Between 1968 and 1974, 653 4-year-olds (52% female) attending the Bing Nursery School completed at least one version of the delay of gratification task. This cohort has been followed longitudinally.^{11,12} As part of a recent follow-up (approved by the Columbia University Institutional Review Board), we sent participants two mailings asking them to report their height and weight. The first follow-up, which also included demographic questions, was mailed in December 2002/January 2003 to all participants for whom we had a valid address ($N=306$), and the second follow-up (approximately 17 months later) was mailed in May 2004. (We sent two mailings in an effort to obtain data from as many in the original sample as possible.) All participants gave written informed consent for the follow-up. The current study includes the 164 participants (57% women) who completed the delay task at age 4 and reported their height and weight approximately 30 years later at the first follow-up ($N=146$; 58% women) and/or at the second follow-up ($N=97$; 60% women). Seventy nine participants (62% women) responded to both follow-ups. One woman's BMI data from the first follow-up and two women's BMI data from the second follow-up were not included in the analyses because they had recently been pregnant and their weight may not have reflected their typical non-pregnant weight.

At the first follow-up, participants' mean age was 39.0 ($SD=2.0$; range: 34.0–42.9 years). The majority were married or engaged (72%), had one or more children (63%), and had a college degree or higher (44.5% had obtained a bachelor's degree, 28.8% had a master's degree, and 21.2% had a JD, MD, or PhD as their highest level of education).

In the delay of gratification task, the child was seated at a table with a bell in an experimental room. The experimenter then asked the child if he or she would prefer a smaller or larger reward. The reward offered varied depending on study condition; almost all of the conditions used food rewards (eg, one vs. two cookies, marshmallows, or pretzels), but some conditions used pennies. (To the best of our knowledge, all participants in the current follow-up were offered food rewards in the task.) The experimenter explained that if the child could wait until the experimenter returned, then he or she could have the larger reward. Alternatively, the child could ring the bell on the table to bring the experimenter back immediately, but then the child would have to settle for the smaller reward. The experimenter then exited the room, and delay duration was measured in seconds up to 15 or 20 minutes (at which point the experimenter returned) or until the child rang the bell, got out of the seat, or ate the reward. Delay times greater than 15 minutes were recoded as 15 minutes to permit combining data across different versions of the delay task.

Most children completed more than one version of the task. Therefore, to eliminate practice effects, only performance on the first task was analyzed, as has been done in prior research.^{2,4} The delay task was used in a series of experimental studies examining the effects on delay times of reward visibility (eg, rewards visible versus covered by a tray) and of strategies for waiting (eg, focusing on the shape versus the taste of the rewards). Because delay times from these different experimental conditions were not comparable and because the experimental condition for the first task varied, we followed the procedure used by Shoda et al and centered the delay times by subtracting from the participant's delay time the mean delay time of children from the same experimental condition.³

We calculated participants' BMI (weight [kg]/height [m]²) from their self-reported height and weight at each follow-up and created a composite BMI measure by calculating the mean of their two BMI scores. If a participant reported his or her BMI at only one follow-up, this number was used. (We created a composite measure because (a) the two BMI scores were highly correlated, $r = .97$, (b) delay did not predict change in BMI in the 17 months between the follow-ups, and (c) the composite gave us the largest and most reliable sample.)

Results

Descriptive statistics of participants' BMI scores are in Table I. A hierarchical regression was performed to examine the hypothesis that the number of seconds preschoolers delayed gratification would account for a significant amount of variance in BMI 30 years later, over and above that accounted for by sex. For this purpose, sex was entered at step one of the regression (male = 0 and female = 1), and the duration of delay was entered at step two. Increments in variance accounted for, the overall R^2 , and standardized regression coefficients (β s) for the final model are presented in Table II. Sex accounted for a significant portion of variance (13%) in the composite measure of BMI (ie, women tended to report a lower BMI than men). In addition, the duration of delay accounted for a significant portion of variance (4%) in the composite measure of BMI over and above the variance accounted for by sex such that the longer a child was able to delay gratification at age 4 years, the lower his or her self-reported BMI tended to be approximately 30 years later. Specifically, each additional minute a child delayed gratification predicted a .2 point reduction in BMI in adulthood.

When we instead used as the criterion variable BMI scores from the first follow-up ($n = 146$), duration of delay accounted for a significant portion of variance in BMI (4%, $p = .009$), over and above the variance accounted for by sex alone (16%). Using only BMI scores from the second follow-up, with a smaller sample of $n = 97$, the effect was in the expected direction, but the amount of variance in BMI delay accounted for (3%), over and above the

variance accounted for by sex alone (14%), was significant only at the $p < .10$ level (two-tailed; the β for delay with sex in the model was $-.16$, $p = .099$.)

Discussion

This study found, as hypothesized, that delaying gratification longer at age 4 was associated with having a lower BMI approximately 30 years later. Although the effect was not particularly large, finding an effect three decades later is noteworthy. Additionally, given the severity and intractability of the obesity epidemic, accounting for any of the variance in BMI may have practical implications. The magnitude of the effect in the current study is consistent with the finding of Duckworth et al that self-control assessed in fifth grade (a composite measure that included performance on two delay tasks) accounted for 4% of the variance in BMI in eighth grade over and above the variance accounted for by demographic variables.⁵ The present results are also consistent with studies that have found a relationship between duration of delay in early childhood and BMI status in early adolescence,^{6,7} and consistent with the longitudinal study of 1000 New Zealanders that found an association between childhood self-control and having multiple metabolic risk factors (such as being overweight) as an adult.¹⁰

Excess weight results when people consume more calories than they expend. Given the wide availability of appealing, calorically dense foods, maintaining a healthy weight long term may require resisting the more immediate impulse to overeat. One explanation for the current findings may be that those who more successfully delayed gratification at age 4 may also be more successful at regulating their caloric intake throughout their lives.

Indeed, successfully delaying gratification has been shown to be related to the use of attentional strategies that should also be helpful for regulating caloric intake. These strategies include not looking at the rewards, distracting oneself, and reminding oneself why one is waiting (ie, motivationally “cool” processing). Delaying gratification is also related to the inhibition of such strategies as smelling the reward and thinking about how good the reward would taste (ie, motivationally “hot” or tempting processing).^{12,13} In general, performance on the delay of gratification task is considered to reflect cognitive control (ie, executive function), which enables people to suppress attention and inhibit responses to irrelevant information in the service of a desired goal.^{14,15} Thus cognitive control should help people maintain a healthy weight by, for example, enabling successful implementation of strategies to regulate caloric intake. Identifying children who exhibit greater difficulty with cognitive control in general and with delaying gratification in particular could help detect children at risk of becoming overweight or obese.

Difficulty with cognitive control is a potentially modifiable risk factor. Interventions that improve cognitive control in young children have been developed^{16,17} and theoretically could reduce children’s risk of becoming overweight. (Interventions designed specifically to help preschool children and obese children better self-regulate their caloric intake have also been developed and have shown somewhat promising effects.)^{18–20} Interventions that improve children’s cognitive control/self-control could be quite cost-effective because these interventions could have positive effects on many outcomes important to society, including adult BMI, general health, financial stability, and likelihood of being convicted of a crime (all outcomes associated with childhood self-control).¹⁰ Such interventions might only lead to a modestly lower adult BMI—a decrease that might not be particularly clinically meaningful for a single individual but that, on a population level, could be quite meaningful from a public health perspective. Indeed, even at the individual level, preventing a modest amount of excess weight gain may be clinically meaningful given that for people who are obese losing just 5% of their body weight can have significant health benefits.²¹

Some important study limitations should be mentioned. First, this study relied on self-reported height and weight, and people tend to underestimate their weight somewhat, with heavier people underestimating their weight to a greater extent than do lighter people.²² Self-reported height and weight tend to be fairly accurate, however;^{23–25} one study ($N=4808$) found participants only somewhat underestimated their actual measured BMI (women by a mean of 0.72 BMI units and men by a mean of 0.96 BMI units).²² In the current study, BMI scores from the two follow-ups were highly correlated ($r=.97$) even though participants would likely not remember the height and weight they reported 17 months earlier. The reliability of the two BMI scores further reinforces that we would not expect to see different results had BMI been calculated from measurements rather than from self-report.

A second limitation is that this study is correlational, and it is therefore not possible to make causal inferences regarding the relation between delay scores and BMI. A third limitation is that the study's sample was primarily white and not representative of the population of the United States. The sample also had relatively high socio-economic status (which is presumably associated with stronger executive function and therefore lower BMI), and only 24.4% of participants were overweight but not obese, and 9.1% were obese. By contrast, in 2007–2008, among U.S. adults, 34.2% were overweight but not obese and 33.8% were obese.²⁶ A fourth limitation is that we were not able to control for obesity risk factors such as maternal and childhood BMI. It seems likely, however, that most participants were normal weight when they completed the preschool delay task given the time period (late 1960s and early 1970s) and given that only approximately a third of the sample was overweight or obese by their mid-30s. Finally, this study used a single measure of executive function. Future longitudinal studies should use multiple objective measures of executive function and also assess possible mediators (e.g., childhood and adolescent diet and physical activity) and moderators (e.g., maternal BMI, parental social class, intelligence) of the relationship between executive function and adult BMI.

Obesity prevention efforts have begun to focus on changing food environments and societal norms that encourage a sedentary lifestyle.¹ Instituting changes to the obesogenic environment should be the primary prevention focus, but it may also be fruitful to implement interventions to enhance young children's ability to self-regulate and delay gratification.

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List of abbreviations

BMI Body mass index

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Table 1

Descriptive statistics for participants' body mass indices (BMI) and frequencies within BMI categories

	First Follow-Up <i>n</i> = 146	Second Follow-Up <i>n</i> = 97	Composite <i>N</i> = 164
BMI, <i>M</i> (<i>SD</i>)	23.9 (3.8)	24.2 (4.8)	24.3 (4.4)
Median BMI	23.6	23.1	23.7
BMI range	17.2 – 35.7	17.2 – 46.0	17.2 – 46.0
Underweight (BMI < 18.5)	7 (4.8%)	5 (5.2%)	8 (4.9%)
Normal weight (18.5 ≤ BMI < 25)	93 (63.7%)	57 (58.8%)	101 (61.6%)
Overweight but not obese (25 ≤ BMI < 30)	33 (22.6%)	29 (29.9%)	40 (24.4%)
Obese (BMI ≥ 30)	13 (8.9%)	6 (6.2%)	15 (9.1%)

Table 2

Hierarchical Regression Analyses Controlling for Sex Predicting Body Mass Index (BMI) Approximately 30 Years Later From the Number of Seconds Preschoolers Delayed Gratification

	ΔR^2	β
Step 1	.13 **	
Sex		-.36 **
Step 2	.04 *	
Delay Duration		-.19 *
Total R^2	.17 **	

Note. $N = 164$. Sex was coded male = 0 and female = 1.

* $p < .01$.

** $p < .001$.