Financial Constraints on Student Learning: An Analysis of How Financial Stress Influences Cognitive Function in Children

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December 28, 2019

Abstract

This paper uses a randomized control trial to estimate the effects of intra-monthly shifts in household financial stability on the cognitive performance of young children enrolled in California public schools. Primary caregivers are administered surveys, and children of low-income US households are randomly administered a cognitive assessment before or after their primary caregiver's payday. I find no significant differences in relative stress levels or material need of participating households, nor do I find before-after differences in the cognitive performance of participants.

* I would like to thank my thesis advisor Frederico Finan for his infallible guidance and support. I also thank Crystal Chang, Edward Miguel, Madeline Duhon, Arlen Guarin Galeano and Luis Molina for their insights and suggestions. All errors are my own. Contact information: smatecna@berkeley.edu.

1. Introduction

The ways in which persistent financial stress impact mental health have been well documented and studied (Chen et al., 2010; Fernald and Gunnar, 2009; Evans and English, 2002; Lupien et al., 2001). However, there is conflicting evidence on the effects of temporary shifts in financial security on mental performance. Less documented still, and increasingly of interest to economists and policy makers, are the ways in which this mental preoccupation can affect those around us, and whether or not the scarcity surrounding shifts in household liquidity are enough to impact the cognitive potential of young children. Given the heightened awareness of the implications for investment in early childhood outcomes, and the disproportionate number of children living below the poverty line in California, it is increasingly necessary to evaluate and draw attention to the influence of financial stress on students' ability to unlock their full cognitive potential.

This paper uses the natural variation in financial resources surrounding payday to conduct a quasi-experimental field study. My sample consists of parents and preschool aged children currently enrolled in the Oakland, West Contra Costa, and Berkeley Unified School Districts. I examine stress and material need - as it relates particularly to food security - as the purported channels through which payday could be moving. Previous scholars have documented the relationship of poverty and anxiety levels (Chen et al., 2010; Fernald and Gunnar, 2009; Evans and English, 2002; Lupien et al., 2001), and that of caloric intake and payday (e.g., Stephens 2003, 2006; Huffman and Barenstein 2005; Shapiro 2005; Mastrobuoni and Weinberg 2009). I use the shifts in financial resources at payday to empirically examine whether payday has a *causal* effect on the cognitive performance of young children.

To exploit this shift in household liquidity at payday, we administer surveys to primary caregivers to determine each families' pay cycle for the given month. Once each family was grouped with the other participants that shared this payday, half of the paydays for each given payday were assigned to either the *before-payday* group, in which their children would be assessed before or on their corresponding payday, or the *after-payday* group, in which their children would be tested shortly after their parents' corresponding payday. The assessment we administered is designed to measure cognitive function in children from 3 to 6 years old. Once we had administered the cognitive assessments to the children, the primary caregiver received a follow up survey. Our goal was to investigate whether the before-payday group would perform differently on the cognitive assessments from the after-payday group, and whether or not these differences could be traced back to differences in stress levels or material need between the two groups.

The rest of the paper is organized as follows. Section 2 describes the experimental design used to estimate the shift in household financial situation, and the assessment used to measure cognitive performance. Section 3 discusses the empirical strategy used, and Section 4 discusses the results. Finally, Section 5 presents the conclusions and implications of this paper.

2. Experimental Design

2.1 Experimental Survey Instruments

The first part of my data collection was done by administering surveys to primary caregivers.[1] These surveys were administered to participants almost entirely (99.98 percent) in person at the school sites. The experiment was conducted in a series of three trials over April, June, and

[1] Survey data was collected with the online survey platform Qualtrics®

August of 2019. There were two surveys: the baseline survey, administered once, and the follow up survey, administered each time the child was given a cognitive assessment. Both surveys were available in both Spanish and English.

A. Baseline Survey

The baseline survey was given once, prior to the start of each trial. The baseline survey began with basic demographic questions related to age, race, languages spoken at home, extracurricular involvement of the child, and number of children in the household. [2] The remainder of the baseline survey was used to collect data on the dates and amounts of all payments that the participant (and their spouse) expected to receive during a reference period: April 12, 2019 to April 30, 2019 for trial one, June 1, 2019 to June 7, 2019 for trial two, and the entirety of August 2019 for trial three. Trial one (April, 2019) was done in public elementary schools and Child Development Centers in Oakland Unified School District. Trial two (June, 2019) was done in a public elementary school in West Contra Costa County. [3] Trial three (August 2019) was done in YMCA Head Start school locations in Berkeley and Emeryville. [4] The study was conducted over multiple months to control for the possibility of confounding factors during any one particular month. See Appendix A for screenshots of the baseline survey.

[2] Participants were asked whether or not their child had been diagnosed with a developmental delay. Because greater response variability is commonly observed in children with Attention Deficit/Hyperactivity Disorder (ADHD), children whose parents reported a diagnosis of developmental delay were excluded from my analysis to test the utility of assessing cognitive fluctuations beyond clinical populations (Isbell et al., 2018; Fair et al., 2012; Kofler et al., 2013).

[3] The number of days used in trial two was limited as schools in WCCUSD let out for summer recess on June 7, 2019.

[4] Children from birth to age five from families with low income (according to the Federal Poverty Guidelines) are eligible for Head Start and Early Head Start services. Children in foster care, homeless children, and children from families receiving public assistance (Temporary Assistance for Needy Families or Supplemental Security Income) are eligible regardless of income. Head Start programs may enroll up to 10 percent of children from families that have incomes above the Poverty Guidelines, and an additional 35 percent of children from families whose incomes are above the Poverty Guidelines, but below 130 percent of the poverty line, if the program can ensure that certain conditions have been met.

The study was restricted to subjects who provided complete information about the number and dates of payments.[5]

B. Follow Up Survey

The follow up survey was administered to the primary caregiver within a few days of their child completing the cognitive assessment. A few of the questions are modified from the baseline survey in Carvalho et al (2016), whose design I borrow from heavily. The follow up survey was used to identify channels through which the payday effects of scarcity could be moving, and identified participants (i) who had been unable to meet their expenses (e.g., could not pay bills) and (ii) who were forced to reduce their food consumption due to a lack of money.[6] The follow up survey also asked participants to rate their own stress levels, and to estimate the number of hours they had spent with the child in the preceding days. See Appendix A for screenshots of the follow up survey.

2.2 Randomization and Treatment Compliance

After completing the baseline survey, participants' children were then randomly assigned to the before-payday group or the after-payday group using a stratified sampling procedure.[7] Table 1 presents the descriptive statistics for the 94 respondents with complete information. The randomization was successful in making assignment to the before-payday group orthogonal to observable baseline characteristics, with only the indicator for Native Hawaiian or Pacific

[5] Carvalho et al (2016) used a similar design. In addition to dropping participants with incomplete information, they drop participants first who reported that they expected five or more payments (from all sources). In their second trial, they drop participants who expected to receive payments in three or more different dates during the reference period. The rationale behind dropping participants with more frequent paydays is that their more regular income should make it easier for them to smooth consumption. I conduct a similar analysis with Model (6). See Section 4 for further discussion.

[6] Economists have long studied the relationship between poverty and malnutrition (Leibenstein, 1957; Bliss and Stern, 1978; Stiglitz, 1976; Dasgupta and Ray, 1986). Schofield (2014) tests this relationship with a randomized trial which examines the impact of additional calories on measures of cognitive function among cycle-rickshaw drivers in India, and found that the increase in calories led to a 12-percentage point increase in performance on the tasks.

[7] Participants were stratified based on gender, and whether or not they self-identified as Hispanic or Latino.

Islander significantly different at the 95 percent confidence interval. Note that there are 135 observations obtained from these 94 individuals, as many participants reported multiple paydays in a given month.[8]

The mean age of the children in my sample was approximately 4 years, and the age ranges from 3 to 7 years. Within the treatment group of children, about 58 percent of them were female, and 42 percent of them were male. In the control group, about 61 percent of them were female, and 39 percent of them were male. In both the treatment and the control group, about 62 percent of children were Hispanic or Latino. The average monthly income for participants in the treatment group with 3 children living in the house was approximately $2,190, and the corresponding monthly income for the control group was approximately $2,093.[9] As a reference, the Federal Poverty Guidelines for 2019 sets the monthly income level at $2,146 for a family of four, a figure that very likely underestimates the true financial need of families living in California or, particularly, the Bay Area (Bohn et al. 2013). [10] It is relevant to note that while there was no screening or income requirement to participate in this study, I successfully targeted areas where families were at or very near the poverty line.

Note that while it was possible for us to control when we interacted with participants while they were at school sites, absenteeism and school holidays inevitably comprised our compliance rates. The study design also allowed us to manipulate when the follow-up survey was made available to a participant, but we could not control when the participant agreed to take the survey. Thus, it often occurred that by the time the parent was willing to take the follow up

[8] Efforts were made to use every payday that participants reported for the randomizations.
[9] To make the comparison, I consider a participant who reported 3 children in the house as a family of four. Note that this is likely an overestimate of the total per family member, as participants were only asked to report other children in the household and not the total number of people.
[10] Mani et al. 2013 find effects of scarcity on the cognitive function of shoppers at a New Jersey mall, all of whom had an annual household income of at least $20,000.

survey, for example, a few days had passed since their child had been assessed, and consequently since the payday in question. Thus, we expected there to be imperfect compliance in both the survey completion rates, and in the days that we were able to test students. In practice, we had an 83 percent compliance rate. Details and implications of this imperfect compliance is discussed in Section 3.

Table 1: Baseline Characteristics

	(1) Control mean/sd	(2) Treatment mean/sd	(3) Difference mean/sd
School	5.836	7.230	-1.394
	(4.286)	(4.362)	(0.748)
School District	1.541	1.608	-0.067
	(0.886)	(0.919)	(0.156)
{Parent Fluent in English}	0.541	0.514	0.027
	(0.502)	(0.503)	(0.087)
{Extracurricular Programs}	0.328	0.284	0.044
	(0.473)	(0.454)	(0.080)
Child's 1st language	2.557	2.095	0.463
	(2.546)	(1.910)	(0.384)
{Bilingual}	0.623	0.554	0.069
	(0.489)	(0.500)	(0.086)
2nd Language	1.033	0.892	0.141
	(2.097)	(2.149)	(0.368)
3rd Language	0.459	0.243	0.216
	(2.248)	(1.577)	(0.330)
{Female}	0.607	0.581	0.025
	(0.493)	(0.497)	(0.086)
Age	4.180	4.068	0.113
	(0.764)	(0.998)	(0.156)
Other Children in House	1.508	1.405	0.103
	(0.829)	(0.890)	(0.149)
{Hispanic/Latino}	0.623	0.622	0.001
	(0.489)	(0.488)	(0.084)
{African American}	0.213	0.297	-0.084
	(0.413)	(0.460)	(0.076)
{Asian}	0.082	0.081	0.001
	(0.277)	(0.275)	(0.048)
{Native Hawaiian or Pacific Islander}	0.066	0.000	0.066*
	(0.250)	(0.000)	(0.029)
{American Indian or Alaska Native}	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
{White}	0.131	0.081	0.050
	(0.340)	(0.275)	(0.053)
{Middle Eastern}	0.016	0.014	0.003
	(0.128)	(0.116)	(0.021)
{Wages and Salary}	0.803	0.716	0.087
	(0.401)	(0.454)	(0.074)
{Self-Employed}	0.213	0.284	-0.071
	(0.413)	(0.454)	(0.075)
{Receiving TANF}	0.098	0.135	-0.037
	(0.300)	(0.344)	(0.056)
{Receiving Social Security}	0.066	0.068	-0.002
	(0.250)	(0.253)	(0.043)
{Receiving Public Assistance}	0.098	0.135	-0.037
	(0.300)	(0.344)	(0.056)
{Unemployed}	0.016	0.014	0.003
	(0.128)	(0.116)	(0.021)
Total Monthly Income	2026.689	2049.986	-23.298
	(1721.345)	(1896.685)	(314.688)
Number of Paydays/Month	2.623	2.905	-0.282
	(1.083)	(1.491)	(0.229)
Observations	61	74	135

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The indicator "Public Assistance" equals 1 if the respondent marked that they were receiving Unemployment Compensation, Social Security, or Temporary Assistance for Needy Families (TANF). Indicator variables are in curly brackets.

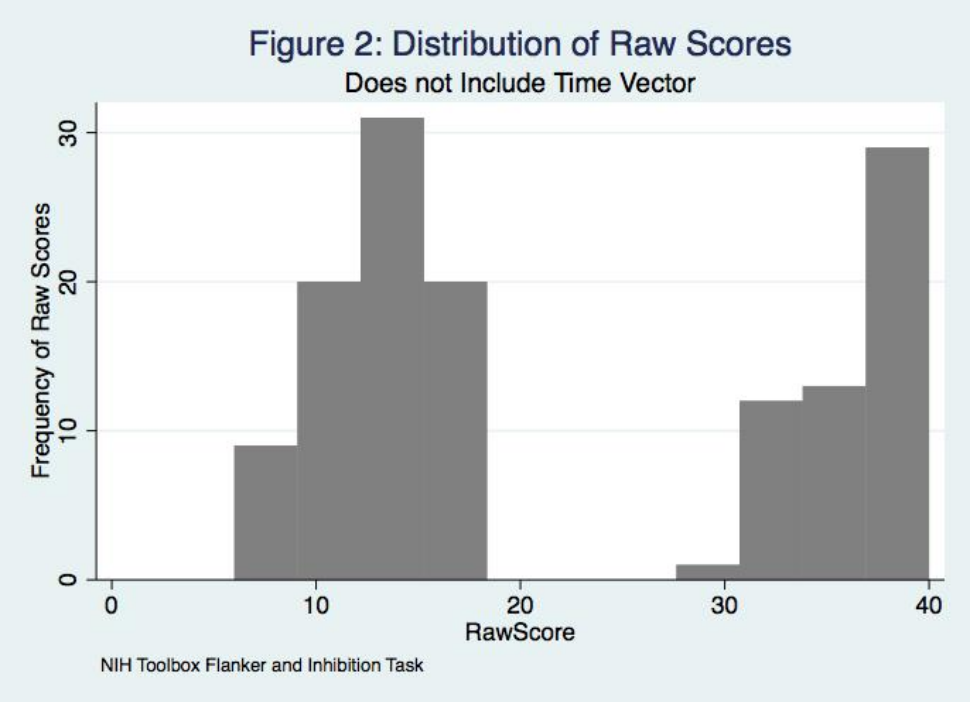
2.3 Cognitive Assessments

Of all of the tasks that the brain is responsible for, the set of functional areas known as cognitive functions are of particular interest to economists for their role in decision making. These functional areas can be broadly classified into four sub-components: *Attention*, *Inhibitory Control*, *Memory*, and *Higher-Order Cognitive Functions* (Dean et al., 2017). This paper focuses specifically on the effects of the intra-monthly shifts in household liquidity on attention. Attention is known as the ability to focus on particular pieces of information to allow for new incoming stimuli. A key feature of attention is that it is limited, and important for academic achievement in children (Broadbent, 1958; De Greeff et al., 2018; Dean et al., 2017). Attention is the most suitable outcome for this design in that it is more likely to vary with changes in the child's recent environment, and less likely to be a cumulative measure of knowledge, such as language or intelligence (Gershon 2013).

Once the participants were randomly assigned to either treatment (pre-payday) or control (post-payday) groups, the participants' child was given a short cognitive assessment. If the child agreed to participate, they were led to a designated area in their classroom. Efforts were made to ensure that the child was close enough to the teacher to minimize stress and confusion, and also somewhat secluded from the other classmates so as to minimize distractions. The child was then given the tablet and instructed in completing the task. The assessment was given one-on-one; after one child finished, they were led back to their classroom activity and the next selected student was approached. Importantly, once a child had been tested the first time, efforts were made to ensure that every future exam they were given was administered within a one-hour

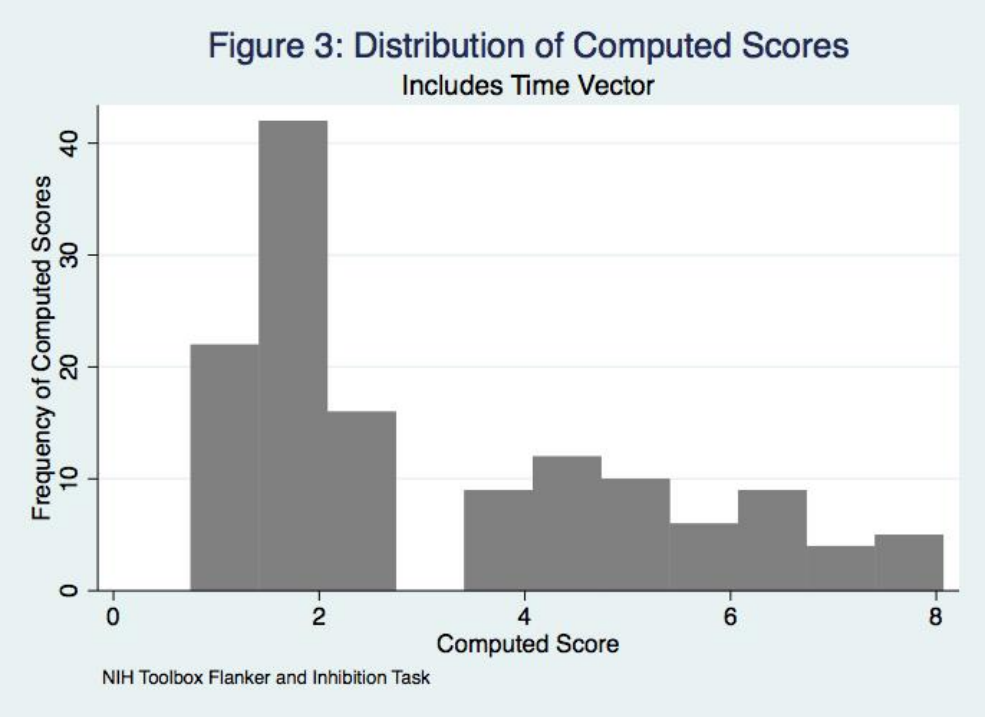
window of the initial time, and that consistency in the testing schedule of each child was maintained.[11]

I employ a modified version of the Flanker Inhibitory Control and Attention Test through the National Institute of Health (NIH) Toolbox Early Childhood Cognition Battery. The test requires the participant to focus on a given stimulus while inhibiting attention to stimuli flanking it. Sometimes the middle stimulus is pointing in the same direction as the "flankers" (congruent) and sometimes in the opposite direction (incongruent) (Gershon 2013).[12] Similar studies in children's early cognition have found this to be an apt measure of attention in that young children do not yet establish and adjust to patterns, and so must assess and evaluate each picture as it comes up (Isbell et al., 2018; Perlman et al., 2015). The test takes approximately 3 minutes to administer to each child. The overall distribution of scores for my sample is presented below.



[11] For example, if a child was initially tested right before they ate lunch, we ensured that the next time they were tested was also just before lunch.

[12] For ages 3-7, if a participant scores ≥ 90% on the first portion (with no more than one congruent and one incongruent trial incorrect), 20 additional trials are presented.



The distribution of scores is predictably bimodal, as only students who scored at least a 90 percent on the first portion (out of 20 points) moved on to the second portion, where there were another 20 points possible. Note that there is a gap in the raw scores between 18 – 29, which then translates to a gap in the computed scores around 3. This gap is likely due to the relative consistency of the task from level one to level two of the assessment. If the child scored with over 90 percent accuracy on the first portion, it is likely that they would score with high accuracy on the second portion as well. This would explain the gap in scores just above 20, and the median score of 37 for children that progressed to the second portion of the exam.[13]

The overall mean computed score for my sample was 3.1732 (out of 10). For females in my sample, the average was 3.2075, and the mean computed score for just males was 2.045. The mean score for children for who identify as Hispanic or Latino was 2.0912, and the mean score

[13] Note that this may also be a result of few observations.

for students who identify as African American was 3.0895. These outcomes are consistent with the literature on gender and racial achievement gaps, which have been shown to begin at birth and have implications for academic outcomes through 8th grade (Heckman, 2011; SF Reardon, 2013).

A. Scoring and Interpretation

Scoring is based on a combination of accuracy and reaction time, where each of these "vectors" ranges in value between 0 and 5. The computed score, combining each vector score, ranges in value from 0-10. For any given individual, accuracy is considered first. If accuracy levels for the participant are less than or equal to 80 percent, the final "total" computed score is equal to the accuracy score. If accuracy levels for the participant reach more than 80 percent, the reaction time score and accuracy score are combined. The accuracy score varies from 0 to 5 points. For every correct behavioral response, a participant receives a value of 0.125 (5 points divided by 40 trials) added to their Flanker score:

Flanker Accuracy Score = 0.125 * Number of Correct Responses

My analysis considers the computed scores, as this includes the reaction time vector.

a. Reaction Time Vector

The task-specific reaction time scores are generated using individuals' raw, incongruent median reaction time score from the Flanker assessment. Median reaction time values are computed using only correct trials with reaction times greater than or equal to 100 milliseconds and reaction times no larger than 3 Standard Deviations away from the individual's mean. To correct for the positively skewed distributions usually associated with reaction time, a log (Base 10) transformation is applied to each participant's median reaction time score from the Flanker,

creating a more normal distribution of scores.[14] This computed score ranges from 0-10, and in the case of subsequent assessments, provides a way of gauging raw improvement or decline from Time 1 to Time 2. A change in the participant's score from Time 1 to Time 2 represents absolute change in the level of performance for that individual, a useful metric given that many of the participants were assessed multiple times.

3. Model and Empirical Strategy

3.1 Identifying Channels Through Which Payday Affects Cognition

One of the hypothesized channels through which the primary caregivers' payday might be impacting cognitive performance of the child is by affecting stress levels of the primary caregiver. There are well known correlations between socioeconomic status and anxiety (Chen et al., 2010; Fernald and Gunnar, 2009; Evans and English, 2002; Lupien et al., 2001), and with the stress hormone cortisone (Cohen et al., 2006; Li et al., 2007; Saridjana et al., 2010). I attempt to test the relevance of this channel by having primary caregivers self-report their stress-levels.

Similarly, as the primary caregiver approaches payday there may be insufficient funds for food, and so the child may miss meals. Malnutrition and hunger have been negatively associated with mental function (Fonseca-Azevedo and Herculano-Houzel, 2012; Gailliot et al., 2007; Danziger et al., 2011; Baumeister and Vohs, 2007; US Army Institute of Environmental Medicine, 1987). I test the relevance of this channel with the question: "*In the past two days, did your child miss breakfast, lunch, or dinner because there was not enough food in the house?*"

[14] The formula for rescaling is: Reaction Time Score = 5 – (5*[logRT – log(500)/log(3000) – log(500)]). For more details on scoring the NIH Toolbox Inhibition and Flanker Task, see the online scoring and interpretation guide.

Finally, as the primary caregiver approaches payday, they may be working more hours or looking for work and so will spend less time overall and lower quality time with the child. Less time engaging with the parent(s) will decrease the amount of critical interactions with the parent(s), which has been found to negatively impact academic success in the long run (Suskind 2015). I test the relevance of this channel with the question: "*Over the past two days, about how many hours have you spent with your child while they were awake?"* I present the models for these OLS estimates below.

Model 1:

$$\text{No.Stress}_i = \alpha + \beta_1 \text{Assigned.Treat}_t + \beta_2 \text{Pay.Day}_i + \epsilon_{it} \quad (1)$$

No.Stress$_i$ is an indicator equal to 1 if individual *i* selected "*I feel no stress related to my financial situation*" on the follow up survey. *ß*$_1$ is an indicator equal to 1 if individual *i* was assigned to the treatment group, and *ß*$_2$ is an index of the paydays according to which each individual *i* was randomized. This model compares the individuals that selected "*I feel no stress related to my financial situation*" to those that selected "*I feel lots of stress related to my financial situation*".

Model 2:

$$\text{High.Stress}_i = \alpha + \beta_1 \text{Assigned.Treat}_t + \beta_2 \text{Pay.Day}_i + \epsilon_{it} \quad (2)$$

High.Stress$_i$ is an indicator equal to 1 if individual *i* selected "*I feel lots of stress related to my financial situation*" on the follow up survey. *ß*$_1$ and *ß*$_2$ are the same as above. This model

compares the individuals that selected "*I feel lots of stress related to my financial situation*" to those that selected "*I feel no stress related to my financial situation*".

Model 3:

$$\text{Missed.Meals}_i = \alpha + \beta_1 \text{Assigned.Treat}_t + \beta_2 \text{Pay.Day}_i + \epsilon_{it} \quad (3)$$

Missed.Meals$_i$ is an indicator equal to 1 if individual *i* responded to the question "*In the past two days, did your child miss breakfast, lunch, or dinner because there was not enough food in the house?*" with either "*Yes, this happened once*" or "*Yes, this happened a few times*." This model may be of particular interest to policy makers, as eliminating child hunger in schools is likely the most tangible goal related to the channels I identify here.

Model 4:

$$\text{Lots.Hours}_i = \alpha + \beta_1 \text{Assigned.Treat}_t + \beta_2 \text{Pay.Day}_i + \epsilon_{it} \quad (4)$$

Lots.Hours$_i$ is an indicator equal to 1 if individual *i* responded to the question "*Over the past two days, about how many hours have you spent with your child while they were awake?"* with "*15 or more"* where possible responses varied from 0 – 15 hours.

3.2 Effect of Payday on Assessment Scores

I estimate the effects of treatment on the computed scores of the participants using a standard OLS model. I regress the indicator that the child was assessed with the before-payday group on

their score, clustering at the individual level to control for progressive improvement over subsequent assessments, and indexing by the payday with which they were randomized.

Model 1:

$$\text{Cognitive.Score}_i = \alpha + \beta_1 \text{Assigned.Treat}_t + \beta_2 \text{Month}_i + \beta_3 \text{Tested.Afternoon}_i + \beta_4 \text{Pay.Day}_i + \epsilon_{it} \quad (1)$$

Cognitive.Score$_i$ refers to the computed Flanker score of the child (see Section 2.3. A for details on scoring). $ß_1$ is an indicator equal to 1 if individual *i* was assigned to the treatment group, $ß_2$ is a control for which month the child was tested in (which trial they were a part of), and $ß_3$ is an indicator equal to 1 if the child was tested after 12 pm Pacific Standard Time. $ß_4$ is the same as above. This model provides a baseline for measuring the difference in performance between the before-payday and after-payday groups.

Model 2:

$$\text{Cognitive.Score}_i = \alpha + \beta_1 \text{T}_t + \beta_2(\text{T} * \text{P}) + \beta_3 \text{P}_i t + \beta_4 \text{M}_i + \beta_5 \text{A}_i + \beta_6 \text{Pay.Day}_i + \epsilon_i t \quad (2)$$

I measure heterogeneity in treatment effects by interacting the indicator for treatment, T$_t$, with different characteristics gathered from the baseline survey. Here P$_{it}$ is an indicator equal to 1 if individual *i* was receiving public assistance at time *t*. The rest of the controls remain the same.

Model 3:

$$\text{Cognitive.Score}_i = \alpha + \beta_1 \text{T}_t + \beta_2(\text{T} * \text{A'}) + \beta_3 \text{A'}_i + \beta_4 \text{M}_i + \beta_5 \text{A}_i + \beta_6 \text{Pay.Day}_i + \epsilon_i t \quad (3)$$

In this model I include an interaction between the indicator for treatment, T_t, with the indicator A'_i equal to 1 if individual *i* identifies as African American.

Model 4:

$$\text{Cognitive.Score}_i = \alpha + \beta_1 \text{T}_t + \beta_2(\text{T} * \text{H}) + \beta_3 \text{H}_i + \beta_4 \text{M}_i + \beta_5 \text{A}_i + \beta_6 \text{Pay.Day}_i + \epsilon_i t \quad (4)$$

This model includes an interaction between the indicator for treatment, T_t, with the indicator H_i equal to 1 if individual *i* identifies as Hispanic or Latino.

Model 5:

$$\text{Cognitive.Score}_i = \alpha + \beta_1 \text{T}_t + \beta_2(\text{T} * \text{F}) + \beta_3 \text{F}_i + \beta_4 \text{M}_i + \beta_5 \text{A}_i + \beta_6 \text{Pay.Day}_i + \epsilon_i t \quad (5)$$

Here I include an interaction between the indicator for treatment, T_t, with the indicator F_i equal to 1 if individual *i* identifies as female.

Model 6 considers the initial Model (1) when restricting the sample to those individuals who indicated that they expected to have at most 1 or 2 paydays during the trial month. The rationale for dropping participants with more frequent paydays is that that their more regular income should make it easier for them to smooth consumption.[15]

Model 7 considers the initial Model (1) while restricting the sample to individuals who we would expect to experience higher levels of financial strain before payday, as indicated by their responses to questions on the baseline survey.

[15] The average number of paydays in a given month for my sample was 2.78, with a minimum of 1 and a maximum of 10.

4. Results

4.1 Differences in Before-Payday and After-Payday Groups

This section shows that the study design did not generate substantial differences in the levels of stress or food security between the before-payday and after-payday groups, nor did it create significant differences in the time the primary caregiver spent with the child. I examine whether the design generated differences in cognitive functioning, and find a persistent null effect. While these differences are not statistically significant, the positive coefficient is economically meaningful when we consider compliance rates and absenteeism.

A. Effect of Payday on Channels

Table 2 presents OLS regressions, where a measure of financial stress—either self-reported stress levels, missing meals due to lack of food, or total amount of hours spent with the child—is regressed on an indicator variable for being randomly assigned to the before-payday group and a constant. The coefficient on the constant gives the mean for the after-payday group.

The results in Table 2 indicate that there were no significant differences between the before-payday group and the after-payday group in terms of relative stress levels, the average number of meals that the child missed, or the number of hours that the primary caregiver was able to spend with the child in the preceding two days. In addition to identifying these specific channels, the questions included in the follow up survey could be interpreted as proxies for the subjective perception of scarcity. Mullainathan and Shafir (2013) posit that these feelings of scarcity, i.e., the feeling of "having less than you feel you need," explain how poverty can create a mental preoccupation and impede cognitive function. Table 2 shows that for three of these measures, the results have the opposite sign from what we would expect, i.e. the before-payday group reports better subjective states of well-being than the after-payday group. The only

measure of scarcity that would seem to increase with being assigned to the before-payday group is the indicator for High Stress, which has a positive coefficient. However, we cannot reject that these effects are statistically different from zero.

These findings are inconsistent with Carvalho et al. (2016), who find the statistically significant result that median grocery expenditures were 11 percent lower before payday than after payday. Note that while previous work has also documented that caloric intake decreases over the pay cycle (e.g., Mastrobuoni and Weinberg 2009; Shapiro 2005), these studies employ extensive food diaries to track caloric intake accurately. The data collected here from the follow up survey was limited to self-reporting, which may be inaccurate due to loss of recall or stigmas associated with such sensitive topics (Dean et al., 2017, Lauderdale et al., 2008). Despite the statistical insignificance, these results are nonetheless intriguing.

Table 2: Effect of Treatment on Stress, Nutrition, and Interaction

	(1) {No Stress}	(2) {High Stress}	(3) {Missed Meals}	(4) {Lots Hours}
{Assigned Treatment} (Before Payday)	0.294	0.120	-0.0543	0.0326
	(1.41)	(0.53)	(-0.41)	(0.19)
Constant	-0.294	0.440	0.0272	0.484
	(-1.41)	(0.78)	(0.38)	(1.00)
Observations	32	36	46	46

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: On (1) dependent variable is an indicator equal to 1 if respondent selects "*I feel no stress related to my financial situation*." On (2) dependent variable is an indicator for respondent selecting "*I feel lots of stress related to my financial situation.*" On (3) dependent variable is an indicator equal to 1 if respondent answered "*In the past two days, did your child miss breakfast, lunch, or dinner because there was not enough food in the house?*" with either "*Yes, this happened once*" or "*Yes, this happened a few times*." On (4) dependent variable is an indicator equal to 1 if respondent answered "*Over the past two days, about how many hours have you spent with your child while they were awake?"* with "*15 or more."* Indicator variables are in curly brackets.

B. Effect of Payday on Assessment Scores

If the financial strain that families experience before payday does impede cognitive function, then the before-after difference in scores should be negative (i.e., the before-payday group should have on average lower scores than the after-payday group). Further, we would expect the before-after difference in scores to be more negative for those with fewer paydays in a given month, due to the lower likelihood of consumption smoothing, and for those more financially strained subgroups (Carvalho et al., 2016). Table 3 shows that even among those with fewer paydays (6) and the strained subgroups (7), there is no evidence that scarcity before payday impedes the children's cognitive performance. This is somewhat surprising, given that Mani et al. (2013) did find effects of financial stress on cognitive function for a US population making more than $20,000 per year.

More variation is present in the interaction models, though none of them are statistically significant. Interpreting these estimates, in model (2), the added effect of being on public assistance in the before-payday group led to a 0.9 standard deviation decrease in average score on the assessment. Similarly, in model (3) the added effect of being African American in the before-payday group led to a 0.49 standard deviation decrease in average performance. Similarly, the added effect of being female in the before-payday group negatively affected test scores, as did being tested in the afternoon (across all models). In general, there is no indication that the before-after difference in performance is more negative for the subgroups than for the overall sample.

One explanation for the positive direction of our estimates is imperfect compliance. Though being assigned to treatment did significantly increase the probability of being tested before-payday, with a compliance rate of 83 percent, 100 percent of non-compliant individuals

were those assigned to the before-payday group. In fact, out of the 12 instances of non-compliance, 10 out of these was due to student absences precisely on their primary caregivers' payday.[16] This biases our estimates in the positive direction, in that those participants who were likely experiencing the greatest scarcity were unable to attend school, and thus those students that *were* able to be tested before or on their primary caregivers' payday may have parents who place a higher value on education and school attendance, or were in some other sense pre-disposed to perform better than their absent peers. The children that were likely experiencing the bulk of this mental preoccupation were absent, and so were not able to be tested with the before-payday group. As such, our estimates likely do not capture the impact for those students that were most affected.

Another explanation for these null effects is the frequent paydays that characterize our sample. Carvalho et al. (2016) restrict a portion of their analysis specifically to individuals who expect to have no more than one payday in a given month, before comparing their estimates to those of Mani et al. (2013). They find that that in order for their estimates to coincide, the before-after difference in economic circumstances around payday would have to be between 2.69 – 9 times larger.[17] As expected, the degree to which the financial resources vary determine the magnitude of the effect. Given that the mean number of paydays per month for my sample was 2.78, with a range of 1 – 10, it is unlikely that the financial resources vary enough to generate this level of scarcity. Students were assessed within a two to three-day window surrounding their primary caregivers' payday, implying that if the primary caregiver was expecting to have upwards of three or four paydays in a given month, their child being assigned to the before-

[16] The other two were due to school closures.
[17] Mani et al. (2013) conducted a pilot with 188 farmers in the districts of Thanjavur, Thiruvarur, Perambalur, and Pudokattai in Tamil Nadu, and find that on the cognitive task Raven's Progressive Matrices, the farmers scored an average of 5.45 items correct post-harvest but only 4.35 items correct pre-harvest ($P < 0.001$, $n = 460$ participants).

payday group may already be experiencing post-payday effects from the previous payday. If we attempted to restrict the testing window to just one day before or after payday, we ran higher risk of the student being absent, as previously discussed. Documenting the frequency of this pay schedule allows us to gain a deeper understanding of the labor supply curve for this population, and also suggests the utility of more frequent paydays to lessen this cognitive strain and improve outcomes. Indeed, a pilot done in Chicago replaced American workers' lump sum EITC refunds with periodic payments made over time, and found that with more frequent payments participants had an increased sense of financial security, decreased borrowing, and were more able to afford child care and education or training (Belisle & Marzahl, 2015).[18]

[18] Findings from the Chicago pilot cited in this paper are from Dylan Belisle and David Marzahl, "Restructuring the EITC: A Credit for the Modern Worker" (Chicago: Center for Economic Progress, 2015); Ruby Mendenhall et al., "Chicago Earned Income Tax Credit Periodic Payment Pilot Final Evaluation" (Urbana-Champaign: University of Illinois, 2015); and the author's analysis of project data on behalf of CEP.

Table 3: Treatment on Cognitive Performance

	(1)	(2)	(3)	(4)	(5)	(6) 1 or 2 Paydays	(7) Strained Subgroups
{Assigned Treatment} (Before Payday)	0.292	0.407	0.391	-0.0928	0.630	0.314	0.653
	(1.26)	(1.60)	(1.39)	(-0.28)	(1.89)	(1.16)	(1.88)
Month of Assessment	0.150	0.110	0.0173	0.0474	0.0755	0.428	0.644
	(0.48)	(0.35)	(0.05)	(0.14)	(0.24)	(1.18)	(1.94)
{Tested in the Afternoon}	-0.435	-0.508	-0.458	-0.498	-0.459	0.0651	-0.452
	(-1.29)	(-1.48)	(-1.36)	(-1.51)	(-1.38)	(0.16)	(-1.03)
Treatment * Receiving Public Assistance		-0.900					
		(-1.94)					
{Receiving Public Assistance}		-0.0607					
		(-0.27)					
Treatment * African American			-0.487				
			(-0.87)				
{African American}			0.592				
			(1.35)				
Treatment * Hispanic/Latino				0.608			
				(1.28)			
{Hispanic/Latino}				-0.560			
				(-1.61)			
Treatment * Female					-0.537		
					(-1.11)		
{Female}					0.619		
					(1.60)		
Constant	0.205	0.306	0.286	0.787	-0.0262	-0.0847	-0.326
	(0.33)	(0.49)	(0.47)	(1.05)	(-0.05)	(-0.10)	(-0.39)
Observations	135	135	135	135	135	77	71

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports results from OLS regressions of the dependent variable as the computed Flanker assessment score. Scores are standardized with mean zero. In (1) the dependent variable is regressed on an indicator variable for the before-payday group and a constant. In (2) an interaction between the indicator treatment variable and the indicator variable for whether or not the respondents' family is receiving public assistance is added.[19] (3) presents an interaction between treatment and whether or not the participant identifies as African American. (4) presents an interaction between treatment and whether not the participant identifies as Hispanic or Latino. (5) adds an interaction term for whether or not the participant is female. In (6) I restrict the analysis to participants who reported expecting only 1 or 2 paydays for the given month, and in (7) I restrict it to individuals who marked "*Totally Agree*" with questions on the baseline survey identifying particularly strained subgroups.[20] Response times in the Flanker task was measured in milliseconds. Standard errors are clustered at the individual level. Indicator variables are in curly brackets.

[19] The indicator "Public Assistance" equals 1 if the respondent marked that they were receiving Unemployment Compensation, Social Security, or Temporary Assistance for Needy Families (TANF).

[20] These questions asked participants to agree or disagree with the statements: "*After I pay my monthly expenses, there is no money left over*"; "*After I get paid, the money is spent quickly"*; *"Money starts to run out before the next payment comes and our family needs to cut the size of meals, skip meals, or eat more low-cost foods to cut expenses"*

5. Conclusion and Implications

Many scholars have attempted to deduce how material scarcity can translate into mental preoccupations that inhibit individuals' ability to access their full cognitive potential. I use a randomized control experiment conducted in public school programs in the Bay Area to assess whether or not this material scarcity can work through primary caregivers in impeding the cognitive performance of their young child, a salient topic for those interested in investment in early childhood education. While my results are not statistically significant, the persistence of racial achievement gaps in participants' scores and strong correlations between household pay cycles and school attendance rates point toward alarming nuances that need to be explored further, particularly in populations with less frequent paydays. In addition, the information suggesting food insecurity at any time of the month should elicit deep concern from local governments and school administrators.

The questions on the surveys intended to identify particularly strained sub-groups of my sample may be better suited to gauge subject's individual perceptions of their financial situation, as opposed to detecting accurately the material need of the household. More rigorous data collection, not limited to self-reporting, would add tremendous power to this study design in eliminating the need to predict whether financial circumstances of the household were in fact changing sharply at payday, and whether primary caregivers presented honestly the information used to control for heterogeneity in treatment effects.

My results do not support the hypothesis that financial strain associated strictly with payday increases stress levels or food insecurity of the household, nor do I find significant

before-after differences in the children's ability to pay attention. These null effects persist even across the small portion of my sample with at most two paydays in a given month, and for more financially strained subgroups. In congruence with Carvalho et al. (2016), I find that short-term variation in household liquidity does not causally determine cognitive performance. My findings suggest that more research needs to be done with young children to understand the effect of household pay cycles on cognitive performance. Further research should particularly investigate whether these findings generalize to households with different patterns of resource variation, for example, those with more permanent shocks or less frequent income streams.

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Appendix A: Survey Instruments

Baseline Survey:

Welcome! The purpose of this research project is to explore what factors influence a child's learning. This is a research project being conducted by Simone Matecna, at the University of California Berkeley.

This survey should take you about **7-10** minutes. You **do not** have to answer any questions you do not want to - simply move on to the next screen.

CONFIDENTIALITY
The results of this study will be used for scholarly purposes, and may be shared with the school district administration and representatives. No identifying information such as your name, email address or IP address will be kept for the purposes of our study.

If you have any questions about the research study, please contact Simone Matecna at smatecna@berkeley.edu.

These questions will ask some general information about your child.

Please answer these survey questions based on the **ONE** child participating in this class.

Does your child participate in any after school programs? Please check all that apply:

- Yes - Daycare
- Yes - School or club related program
- Yes - Extracurricular Sport or Physical Activity
- No my child does not participate in any after school programs
- Other, please describe:

Has your child ever been diagnosed with any developmental delays (e.g. Down Syndrome, Autism
Spectrum Disorder, ADHD, etc.)?

- Yes
- No

Child's primary language:

- Arabic
- English
- Vietnamese
- Mam
- Punjabi
- Español
- Portugese
- Cantonese
- Other, please describe:

Is your child bilingual?

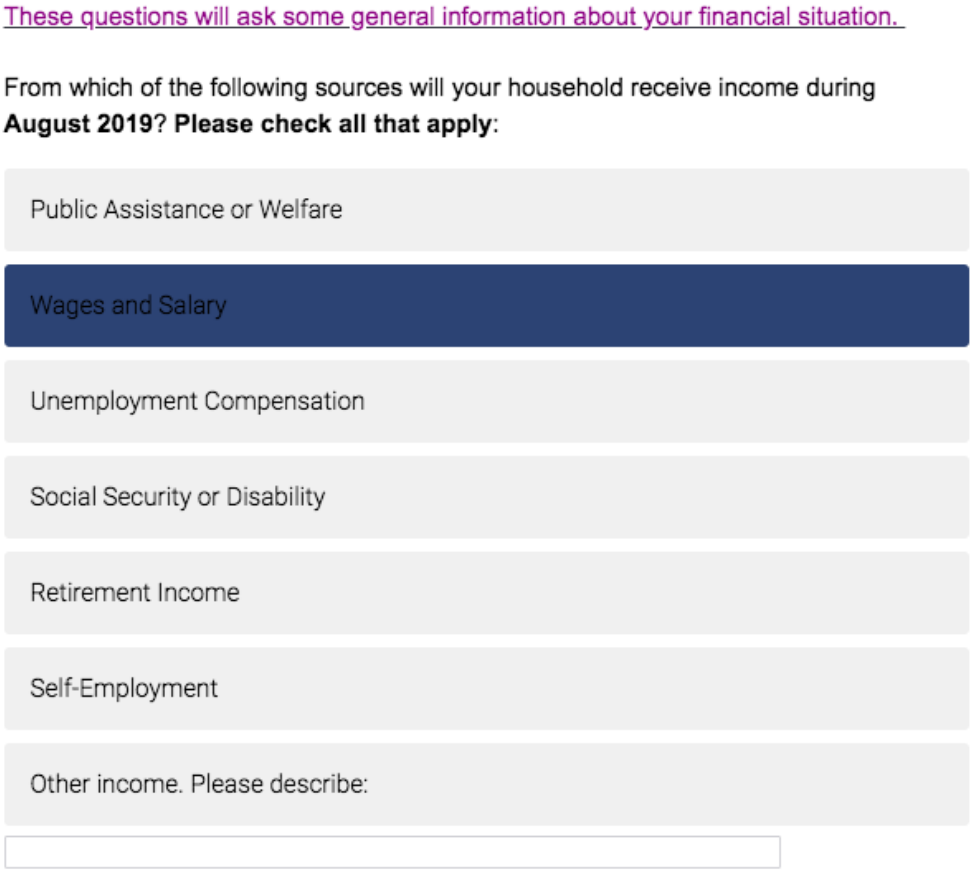
- Yes, they also speak:
- No

Participating child's gender:

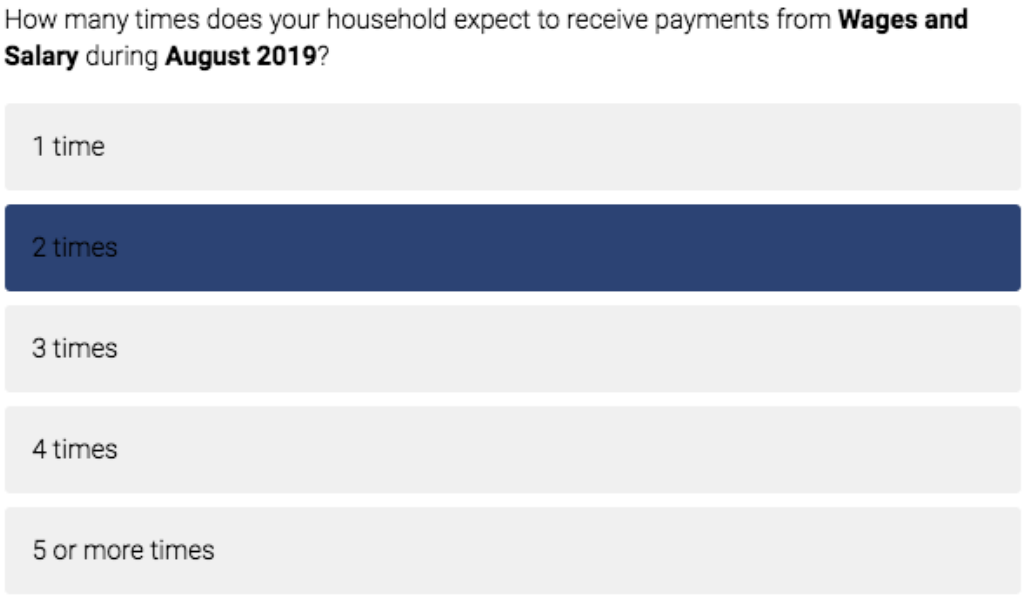
- Female
- Other/ Non-binary
- Male

Ethnicity of the participating child - Please check all that apply:

- Hispanic or Latino
- American Indian or Alaska Native
- White
- Black or African American
- Asian
- Native Hawaiian or Pacific Islander
- Decline to State
- Other ethnicity, please describe:



Note that while it says August here, this would've been **April June** or **August** depending on the trial.



Please enter **the date** in **August 2019** when your household expects to receive the **FIRST** payment from **Wages and Salary.**
(example: 8/12/19)

Please enter **the date** in **August 2019** when your household expects to receive the **SECOND** payment from **Wages and Salary.**

How strongly do you agree or disagree with the statement "**After I pay my monthly expenses, there is no money left over**"?

- Totally agree
- Agree
- Not sure
- Disagree

How strongly do you agree or disagree with the statement "**After I get paid, the money is spent quickly**"?

- Totally agree
- Agree
- Not sure
- Disagree
- Totally disagree

How strongly do you agree with the statement: "**Money starts to run out before the next payment comes and our family needs to cut the size of meals, skip meals, or eat more low cost foods to cut expenses**"?

- Totally agree
- Agree
- Not sure
- Disagree
- Totally disagree

Follow Up Survey:

Berkeley
UNIVERSITY OF CALIFORNIA

Welcome! The purpose of this research project is to explore what factors influence a child's learning. This is a research project being conducted by Simone Matecna, at the University of California Berkeley.

This survey should take you about **5-10** minutes. You **do not** have to answer any questions you do not want to - simply move on to the next screen.

CONFIDENTIALITY
The results of this study will be used for scholarly purposes, and may be shared with the school district administration and representatives. No identifying information such as your name, email address or IP address will be kept for the purposes of our study.

If you have any questions about the research study, please contact Simone Matecna at smatecna@berkeley.edu.

About how many hours of TV has your child watched in the **last 2 days**?

- 1-3
- 3-6
- more than 6
- not sure

Over the past **two days**, have any of the following happened to you because of a shortage of money? **Please check all that apply.**

- Pawned or sold something
- Sought financial help from friends or family
- Sought assistance from community organizations
- Could not pay electricity, gas or telephone bills on time
- Unable to heat or cool home
- Could not pay for car registration or insurance on time
- Took out a loan
- Went without meals
- None of the above

Suppose you had only **one week** to raise $2,000 for an emergency. Which of the following best describes how hard it would be for you to get the money?

- I could raise the money easily
- I could raise the money with some effort
- I could raise the money with a lot of effort
- I don't think I could raise the money

Please select which of the following is most accurate:

- I feel no stress related to my financial situation
- I feel some stress related to my financial situation
- I feel lots of stress related to my financial situation

Please answer these survey questions based on the **ONE** child participating in this class.

In the past **two days**, did your child miss **breakfast**, **lunch,** or **dinner** because there was not enough food in the house?

- No, this did not happen
- Yes, this happened **once**
- Yes, this happened **a few times**
- Not sure

Over the past **two days**, about how many hours have you spent with your child while they were awake? Please make your best guess.

- 1-3
- 3-6
- 6-9
- 9-12
- 12-15
- 15 or more