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Toward an understanding of the development of time preferences: Evidence from field experiments☆

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ABSTRACT

Time preferences have been correlated with a range of life outcomes, yet little is known about their early development. We conduct a field experiment to elicit time preferences of over 1200 children ages 3–12, who make several intertemporal decisions. To shed light on how such primitives form, we explore various channels that might affect time preferences, from background characteristics to the causal impact of an early schooling program that we developed and operated. Our results suggest that time preferences evolve substantially during this period, with younger children displaying more impatience than older children. We also find a strong association with race: black children, relative to white or Hispanic children, are more impatient. Finally, assignment to different schooling opportunities is not significantly associated with child time preferences.

1. Introduction

The rate of time preference as elicited in the laboratory is strongly associated with a range of life outcomes, including health status, educational attainment, and labor market earnings (Golsteyn et al., 2014).[1] Among children and adolescents, higher rates of impatience have been linked to a greater number of disciplinary referrals at school, lower high school completion rates, and more money spent on alcohol and cigarettes (Castillo et al. 2011, 2015, forthcoming; Sutter et al., 2013). In addition, impatient children are more affected by incentives than their patient counterparts (Oswald and Backes-Gellner, 2014).[2] Therefore, how intertemporal preferences form at an early age, and how they interact with the environment, has direct policy implications.

This paper makes three overarching contributions to our understanding of the development of time preference. First, we design and implement a time preference elicitation task in which children ages 3–12 years old make a series of choices between receiving smaller amounts of candy at the end of the day or larger amounts of candy on the next day. There is a growing literature seeking to understand how economic preferences, such as time preferences, form at an early age. Yet the assessment of child preferences is still in its infancy, and there is no agreement about best methods. We simplify the elicitation tasks typically used with adults and adjust the incentives to make the measures developmentally appropriate and incentive-compatible for the children in our sample.

Our second contribution is exploring the correlates of time preferences. An advantage of this paper relative to prior work is that our dataset is very comprehensive. We have the expected data on child demographic background (age, gender, race) and household

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[1] In related work among adults, time preferences predict health, smoking, drinking and drug abuse behaviors (Bradford et al., 2017; Chabris et al., 2008; Harrison et al., 2010; Khwaja et al., 2006; Weller et al., 2008), demand for medical screening tests or vaccines (Picone et al., 2004; Chapman and Coups, 1999) and take up financial education programs (Meier and Sprenger, 2013).

[2] In a related paper, Courtemanche et al. (2015) find that impatient adults are more sensitive to food price changes and exhibit the largest weight gain when food prices fall.

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characteristics (parents' educational attainment, household income). We go beyond these basic variables to collect detailed data on child cognitive and executive function skills via a rigorous skills assessment. We also collect data on a sub-set of the children's parents, which allows us to evaluate whether child time preferences are associated with their parents' time preferences. This lends insights into the origins of time preferences.

We find that time preferences evolve significantly as children age, with younger children displaying more impatience than older children. This is in line with related work that finds a similar association with age (Bettinger and Slonim, 2007; Angerer et al., 2015; Deckers et al., forthcoming; Sutter et al., 2015). We also find a strong association with race: black children are significantly more impatient than white or Hispanic children, even while controlling for socio-economic status, cognitive skills and executive function skills. Only one other paper has been able to explore this race relationship, and it found a similar association for adolescents (Castillo et al., 2011). Studying the associations of time preferences with race is important since – given that time preferences predict academic outcomes – it may help us understand the origins of the academic achievement gap.

We do not observe a correlation between preferences of parents and their children. We might have expected such a correlation due to genetics or social learning. However, the results in the related literature on the inter-generational transfer of time preferences are also mixed. Kosse and Pfeiffer (2012, 2013) do find associations between time preferences of preschool children and their parents, while Bettinger and Slonim (2007) do not find an association with children ages 5–16 and their parents. Researchers also find some support for a link between future orientation of parents and young adult children (Webley and Nyhus, 2006; Brown and Van der Pol, 2015). Understanding the associations of time preferences of parents and children is important in light of the recent interest in investing in parents as a policy tool for human capital accumulation (Fryer Jr et al., 2015).

Our third contribution is to evaluate the causal influence of early childhood education on child time preferences. For this evaluation, we take advantage of the Chicago Heights Early Childhood Center (CHECC) study (Fryer Jr et al., 2015, 2018). Children in our study are participants in CHECC, which randomly assigned children and parents from Chicago Heights, Illinois and surrounding areas to 1) a free, high-quality preschool program, 2) a parenting program in which parents were taught how to implement components of the preschool curriculum at home, or 3) a control group that did not receive an intervention. We hypothesized that children randomized to CHECC preschool might become more patient since they were exposed to an environment and activities that promoted patience, such as a structured preschool day, turn-taking and modeling patience. The parenting program at CHECC also provided tools that parents could use to teach patience – such as a unit on self-regulation – hence, we hypothesized that children exposed to CHECC parent programs might also become more patient than children in the control group.

Our evaluation of CHECC joins a very small literature aimed at studying the causal impact of education programs on time preferences. Alan and Ertac (2014) found that random assignment to a program aimed at helping 3rd and 4th grade children imagine their future selves increased patience relative to children assigned to a control group. Lührmann et al. (2018) found that random assignment of adolescents to a financial education program increased time consistency relative to those assigned to a control group. Unlike these studies, our early childhood interventions do not focus specifically on time preferences and are broader in scope. We believe that it is important to learn whether "standard" early childhood programs, designed to impact cognitive abilities, also affect time preferences. Moreover, we explore time preference development in very early childhood, which is a critical period of non-cognitive skill development (Heckman, 2000). Our study also speaks to the literature that uses early childhood interventions to understand the impact on the academic achievement gap, such as High/Scope Perry Preschool and the Abecedarian project (Schweinhart, 1993; Campbell et al., 2002). The evaluation of High/Scope Perry and Abecedarian did not consider time preferences as we do, and the sample size of these programs was significantly smaller than ours.

In contrast to our hypotheses, we do not find a statistically significant impact of CHECC programs on time preferences. This is true both immediately after the intervention as well as a few years after the end of the intervention. By contrast, another paper evaluating CHECC found an impact of the preschool and parent programs on fairness and efficiency concerns (but not on selfishness) (Capellen et al., forthcoming). The fact that our early interventions, which were quite broad, did not lead to durable changes in time preferences suggests that such preferences may be difficult to change with education programs for 3–5 year olds. An important caveat is that we have substantial attrition in our analysis sample.

The population we study is also policy relevant. By virtue of being from CHECC, the households in our sample are of generally low SES. Understanding how time preferences form may be even more important among low SES children, since they are the ones most likely to exhibit impatience (Deckers et al., forthcoming) and may therefore benefit the most from policy interventions. Finally, our study includes a much broader age range than most other papers (for example, Castillo et al., 2011; Sutter et al., 2013 focus on adolescents, while Kosse and Pfeiffer, 2012, 2013 focus only on preschoolers).

In what follows, Section 2 discusses our time preference elicitation, summarizes our data and provides a discussion of the strengths and weaknesses of our measure. Section 3 discusses the correlates of time preferences, including age, race, and parent time preferences. Section 4 explains CHECC in more detail and provides the causal evidence. Section 5 concludes.

2. Time preference elicitation

2.1. Experimental design and procedures

The experiment was conducted in 4 waves: October 2010–April 2011 (2010–11 wave), July 2012 (2012 wave), October 2013 (2013 wave) and December 2017 (2017 wave). In the earlier waves of the experiment (2010–11, 2012 and 2013), families brought their children to the CHECC center outside of school time to participate. Participants did not know what the experiments were about when they signed up, and participation was voluntary. Participation took approximately 30 min and parents received approximately $25 for their participation. In the last wave (2017), we conducted the experiments during school and children were pulled from class to participate individually. The sessions differed in their implementation, as described below. Most children participated 1–2 times between 2010 and 2017.

The basic experimental design of the time preference elicitation task followed a multiple-price list format with 3–4 decisions (Coller and Williams, 1999). Eliciting time preferences in this way has been shown to be correlated with life outcomes of adolescents and adults (e.g., Castillo et al., 2011). Children made a series of decisions in which they were asked to choose between a smaller amount of rewards on the day of the experiment at the end of the day ("at the end of the day TODAY"), and a larger amount of rewards on the day after the experiment ("at the end of the day TOMORROW"). Only one of the decisions "counted" for payment, and this was randomly selected at the end of the experiment.[3] In the earlier sessions, rewards from the relevant

[3] For children ages 3–5, the random selection was done in the following way. Children were told that at the end of the session, one of their decisions would be selected at random as the 'decision that counts.' The 'decision that counts' was selected by having the child close his or her eyes and select one of X containers in the bin, each of which held the candy and time for the candy to be given to the child for one of the decisions. For children ages 6–12, the random selection was done via bingo cage at the front of the experiment room.

Table 1
Child experiment design.

Wave	Elicitation task (today v. tomorrow)	Incentives	Implementation
2010–11	4v5, 4v6, 4v7, 4v8	Candies	One-on-one or in a group
2012	3v3, 2v3, 1v3	Candies	One-on-one, outside of school
2013	2v3, 2v4, 2v5, 2v6	Candies	One-on-one, outside of school
2017	4v5, 4v6, 4v7, 4v8 (same as 2010–11)	Choice of candies/prizes	One-on-one, in-school

Note: This table reports the experimental design for the child experiments, broken down by wave.

decision for payment were placed in paper bags with the date of payment on them and were given to the child's parents with a note providing instructions for when to give the child the candies. We also verbally explained to parents when to give the rewards to the child.[4] In the 2017 wave that was conducted during school time, we gave bags of rewards to teachers to put in child backpacks on the dates that children selected. Table 1 summarizes the series of decisions in each experimental session.

For most children, the experiment was conducted one-on-one with a trained experimenter, and each decision was accompanied by physical containers holding the number of rewards that would be earned by the child for each alternative. The rewards were always candies in waves 2010–11, 2012 and 2013; and were the choice of different candies or prizes in 2017. Some of the older children (ages 6–12) in the 2010–11 wave participated in small groups whereby children circled pictures of candies on their record sheets in private while experimenters walked around to assist. The age overlap in procedures allows us to control for differences in implementation approach.

2.2. Data

Table 2 provides a summary of the observations in our dataset, by data collection wave. A total of 1265 individual children participated in our experiments, with 926 participating in only one wave, 307 participating in two waves and 32 participating in three waves. This gives us a total of 1636 observations, of which 1614 are not missing gender and race, spanning ages 3 through 12 (Mean = 6.93, S.D. = 2.81). In what follows, we restrict our sample to children who are not missing gender and race. About half the observations were girls. In line with the population of Chicago Heights, IL, our sample is highly diverse, with 35% black and 56% Hispanic observations. The households are relatively low income: 29% of observations come from a household with an annual income of $0–$15,000 and 28% come from a household with an annual income of $16,000–$35,000. About 17% of the observations have mothers who do not have a high school diploma, while 35% have a high school diploma or some college education and 23% have a college degree.

Fig. 1 provides a histogram of the proportion of patient decisions (giving up fewer rewards today to choose more rewards tomorrow) across all sessions. It is notable that a large proportion (28.97%) of children always select the earlier, smaller reward while a small proportion (12.04%) always select the later, larger reward.

We also find that a sizable fraction of the children exhibit non-monotonicities in their choices, preferring a larger, later number of rewards to a smaller, sooner number, and subsequently preferring an even smaller, sooner number of rewards to the aforementioned later, larger number. The overall proportion of children displaying such non-monotonicities is 40.63%. However, 68.87% of the 965 children who are not always impatient or always patient are non-monotonic. Despite the high frequency of non-monotonicities, as displayed in Fig. 2, we do observe that in the aggregate children are more likely to be patient when the cost of being impatient is high (i.e., when the 1-day interest rate between the earlier and later rewards is largest), a finding that is also observed in Lemmon and Moore (2007) for children aged 4–5.

2.3. Discussion

Our time preference elicitation methodology is similar to that used with adults in experimental economics, and is in line with related work in developmental psychology that uses children as young as age 2–3 to study future orientation (Schwarz et al., 1983; Lemmon and Moore, 2007; Garon et al., 2012). Our elicitation is similar to Sutter et al. (2015), who conduct time preference experiments with Kindergarteners and use 1 choice of 1 reward today versus 2 rewards the next day. Different from Sutter et al. (2015), we used a series of questions with varying interest rates rather than just one question. Our elicitation is also similar to one of the elicitations in Angerer et al. (2015), who include children ages 6–11 in their experiments and use a series of questions in which children choose between 2 tokens (which can be exchanged for candy or prizes) at the end of the experimental sessions versus 3, 4 or 5 tokens in 4 weeks. Our elicitation is also similar

Table 2
Summary of observations.

	Wave 2010–11	Wave 2012	Wave 2013	Wave 2017	Total
Child Age Range (in Years):	3–12	4–8	3–6	6–12	3–12
Child Age (in Years)	5.59	5.24	4.73	9.76	6.93
	(0.14)	(0.05)	(0.04)	(0.05)	(0.07)
Child Gender (Female = 1)	0.48	0.48	0.54	0.49	0.50
Child Race - Black	0.37	0.51	0.41	0.23	0.35
Child Race - Hispanic	0.49	0.37	0.49	0.72	0.56
Child Race - Other	0.01	0.01	0.01	0.00	0.01
Child Race - White	0.13	0.11	0.09	0.04	0.08
Household Income (0–15 k)	0.21	0.31	0.28	0.32	0.29
Household Income (16 k–35 k)	0.20	0.26	0.34	0.27	0.28
Household Income (36 k–60 k)	0.13	0.13	0.11	0.09	0.11
Household Income (60 k+)	0.06	0.08	0.10	0.02	0.06
Mother Edu (Less than High School)	0.12	0.11	0.15	0.23	0.17
Mother Edu (High School)	0.31	0.40	0.35	0.35	0.35
Mother Edu (College)	0.20	0.33	0.31	0.13	0.23
Cog Pre-Assess.	0.37	0.39	0.37	0.29	0.34
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Non-Cog Pre-Assess.	0.66	0.58	0.51	0.50	0.55
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Pretest Cog Missing	0.04	0.13	0.09	0.20	0.13
Pretest EF Missing	0.04	0.13	0.11	0.22	0.14
Cog Missing	0.30	0.43	0.55	0.01	0.28
EF Missing	0.30	0.43	0.55	0.03	0.29
Income Missing	0.40	0.22	0.18	0.30	0.27
Mother Educ Missing	0.38	0.16	0.18	0.28	0.25
Observations	248	286	447	633	1614

Note: This table reports sample averages. Standard errors of means are in parentheses. The number of observations is the number of subjects in each wave, regardless of if they participated in the previous wave. Demographic data is available for nearly all observations. Age is available for all observations. Gender is available for all but 7 observations (6 children), and race is available for all but 15 observations (15 children). The "other race" category refers to Asian/Pacific Islander (1 child), Native American (2 children) and multiracial (5 children). Socioeconomic status data is only available for children whose parents completed the voluntary questionnaire (873 children).

[4] The potential for parents to not follow through on the experimental timing, and the child's expectation thereof, presents a potential confound in our study. If parents are likely to give their children the candy as soon as possible, children should choose the most candy possible and, hence, appear quite patient in our study. This prediction is in contrast to aggregate behavior, which exhibits substantial impatience.

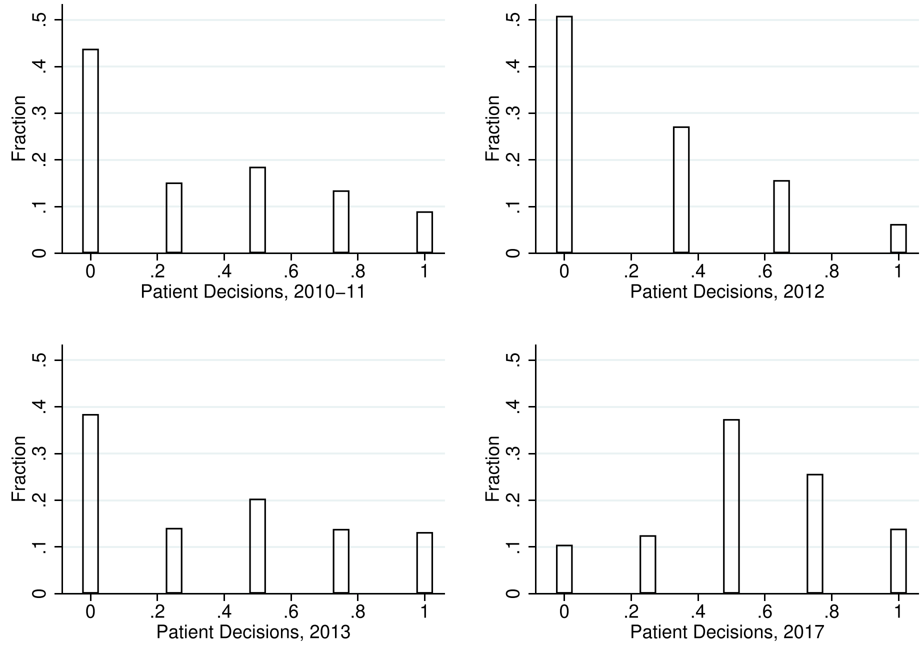

Fig. 1. Histogram of child decisions by wave. Note: This figure shows a histogram of the proportion of patient decisions, by wave. This proportion is defined as the number of delay decisions made over total decisions in the experimental task.

to Bettinger and Slonim (2007), who include children as young as 5 in their experiments, but the series of choices is delayed further in time – by 1–2 months rather than by 1 day as in our study. We believe that the shorter delay is more appropriate, since in developmental psychology, a 1-day delay is sometimes considered a "long" delay condition for this age group (Schwarz et al., 1983).

Since the high degree of non-monotonicities of the children will not allow us to calculate or estimate a conventionally meaningful discount rate, in our analysis we use two non-parametric measures of time preference. The first measure is the total number of patient decisions (standardized by session). The second measure is a binary variable indicating whether a child is always impatient or not. Despite the non-monotonicities, we believe the elicitation task is still useful since it allows us to categorize children with narrower bracketing than a single question measure.

A different method for eliciting the impatience level of young children is Mischel's "marshmallow" paradigm (Mischel et al., 1972; Mischel and Moore, 1973). In this experiment, preschool aged children are seated in front of a treat and are offered the option to either eat the treat, or to wait to receive double the amount. This paradigm is commonly used in the developmental psychology literature (e.g., Karniol et al., 2011) and was also used by Kosse and Pfeiffer (2012, 2013) to study intergenerational transfer of impatience from mothers to their preschool-aged children. Developmental psychologists use the "marshmallow" paradigm because unlike the "choice" paradigm, it puts children in a situation where they must overcome their frustration and inhibit their desire to eat the treat in front of them for a prolonged period of time (Shoda et al., 1990). In the "choice" paradigm, children view the reward only briefly before making their decision, and therefore are not in a prolonged situation where they must exercise inhibitory control. In our study, we used the "choice" paradigm as our primary measure because we believe that the "choice" paradigm, and not the "marshmallow" paradigm, is most similar to the time preference elicitations that economists are interested in with adults.

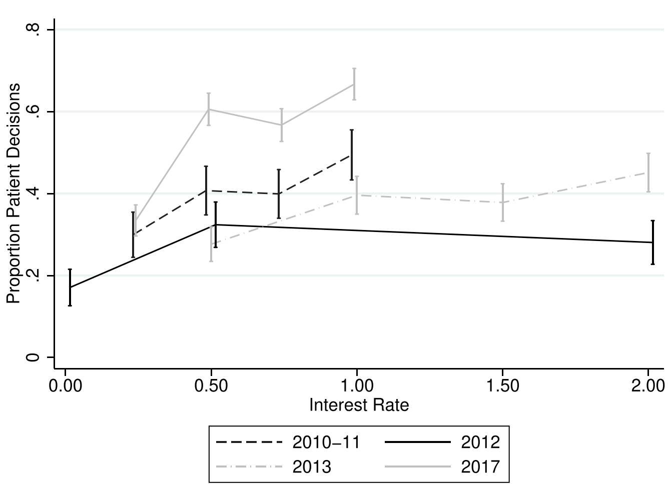

Fig. 2. Proportion child patient decisions by interest rate and wave. Note: This figure shows the proportion of child patient decisions by interest rate and wave. The error bars show confidence intervals around the estimates, jittered for visualization.

A sub-set of the younger children in our study also participated in the "marshmallow" paradigm at different points in time than the main experiment (880 observations with 799 children, mean age = 4.8 years, min = 3.2 years and max = 7.6 years). In different waves, we gave children either 5, 8 or 15 min wait time before the experimenter returned and doubled their treat. Castillo et al. (2019) use the time preferences data we report on here, the "marshmallow" paradigm and a number of other measures not reported here to study associations of skills at an early age and demonstrate that the "marshmallow" paradigm is not correlated with the "choice" paradigm. They also show that the time preferences measured at an early age using our paradigm are associated with disciplinary referrals several years later. In this paper, in the proceeding sections we use the "marshmallow" paradigm as an alternative measure of impatience to study the robustness of our findings.

A concern when evaluating time preferences with either children or adults is that they are confounded with risk preferences (Andreoni and Sprenger, 2012). Participants may choose an immediate reward rather than delaying the reward because they are risk averse and prefer a certain outcome. We address this in two ways. First, all of our sooner, smaller rewards have a front-end delay since children receive them "at the end of the day today." Second, we also elicit risk preferences

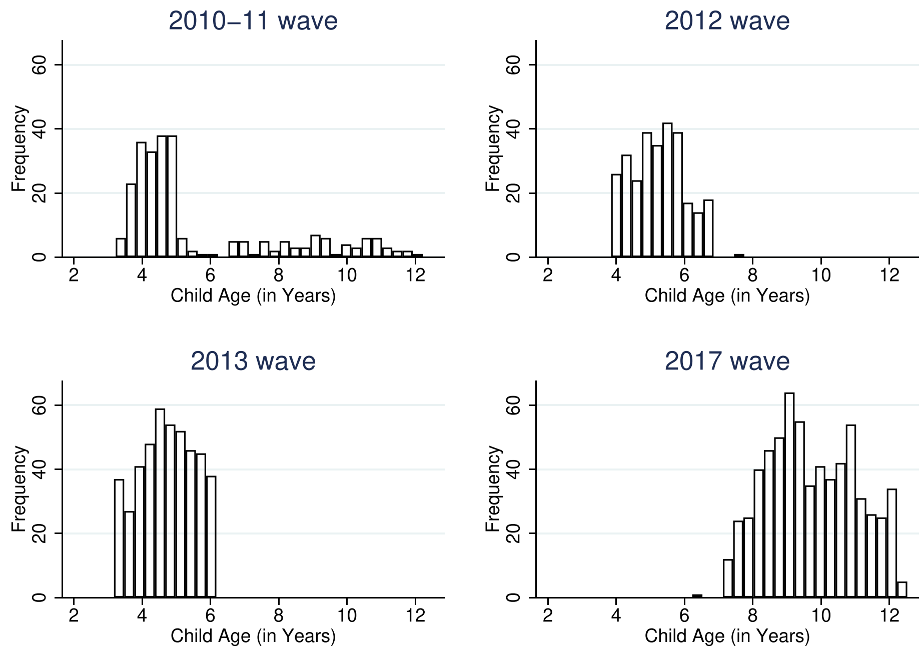

Fig. 3. Histogram of child ages by wave. Note: This figure shows a histogram of child age at the time of the experiment, by wave.

during the session, and we control for risk preferences in our analyses. The risk preference elicitation in the 2010–11 wave features the choice of a number of pencils from a jar, whereby one of the pencils has a red mark on the bottom. Children get to keep all the pencils, unless one of the pencils has a red mark. If any pencil has a red mark, children must return all the pencils. This elicitation is summarized in greater detail in Andreoni et al. (2019). The risk preference elicitation in the remaining waves features a multiple price list of choices between smaller, certain rewards and the different probabilities of winning larger rewards. This elicitation is summarized in greater detail in Castillo et al. (2019).

3. Correlates with time preferences

3.1. Age-related changes

Fig. 3 provides a histogram of the ages in our sample and Fig. 4 provides the trends of patient decisions and choice monotonicity with age. Using the proportion of patient decisions as our main measure, referred to as "Time Pref" in Panel A, we find a slight decline in patience from about 3 years old to 5 years old, and a larger increase in patience from 5 years old to 12 years old. Fig. 4, Panel B graphs the proportion of decisions that are "all now" or "all delayed." About 25% of decisions among 3 year olds are "all now," and this number increases to nearly 50% for 5-year-olds and drops to under 10% for children age 9 and up. Only about 10–20% of decisions at any age are "all delayed." Fig. 4, Panel B also displays the proportion of decisions that are monotonic, only for those decisions with at least one switch point. We see that for children who have at least one switch point, monotonicity increases from about 20% of observations among 3 year olds to about 30% of observations among 12 year olds.[5]

The standard errors of the proportion of patient choices in Fig. 4, Panel A are largest at the extremes of our age range. The standard errors are smaller in the center of the age distribution, where we see a clear positive relationship between age and patience that is statistically significant in regression analyses.

Interestingly, we see some indication that children become less patient from age 3 to 5. We attribute this to the possibility that some 3 year olds have not yet understood the concept of "tomorrow." These children might choose the preferred, larger reward and not anticipate that they will have to wait for it. An indication that 3 year olds might have difficulty with predicting the future is presented in Suddendorf and Busby (2005), who find that only 30% of 3 year olds and 65% of 4–5 year olds were able to correctly predict events that would happen tomorrow.

A confound with studying the evolution of time preferences with age is that other variables are also changing during this time. For instance, there are increases in cognitive abilities during this same time period. In our analysis, we can control for cognitive abilities, as measured by a score on a reading, writing and math assessment administered within a year of the experiments. We can also control for executive functions, as measured by an assessment of inhibitory control, working memory and attention shifting.[6] Finally, we can control for risk preferences, which may also change during this time period.

Table 3 provides regressions with proportion of patient decisions (standardized by session, referred to as "Time Pref") and immediate choices (binary, specifications (5)–(8)) as dependent variables, using all the observations and clustering at the individual level. In specifications (2) and (6), we add socio-economic characteristics (imputing 0

[5] A similar figure showing monotonicity that does include the "all now" or "all delayed" data results in a decrease in monotonicity with age. That is partly because many more young children prefer "all now" than older children.

[6] For participants below second grade, the cognitive abilities are measured by four subtests of the Woodcock-Johnson III and the Peabody Picture Vocabulary III test. The executive functions are measured using Blair and Willoughby's tests of working memory, attention shifting and inhibitory control. More details about each test are provided in Castillo et al. (2019), which goes into detail on each sub-test. For participants in third grade and above, cognitive abilities are taken from the NWEA MAP test administered by the state of Illinois each year, which is a personalized assessment that measures individual student growth using a cross-grade scale. Executive functions are taken from a separately administered assessment using the working memory and executive function and attention subtests of the NIH Toolbox.

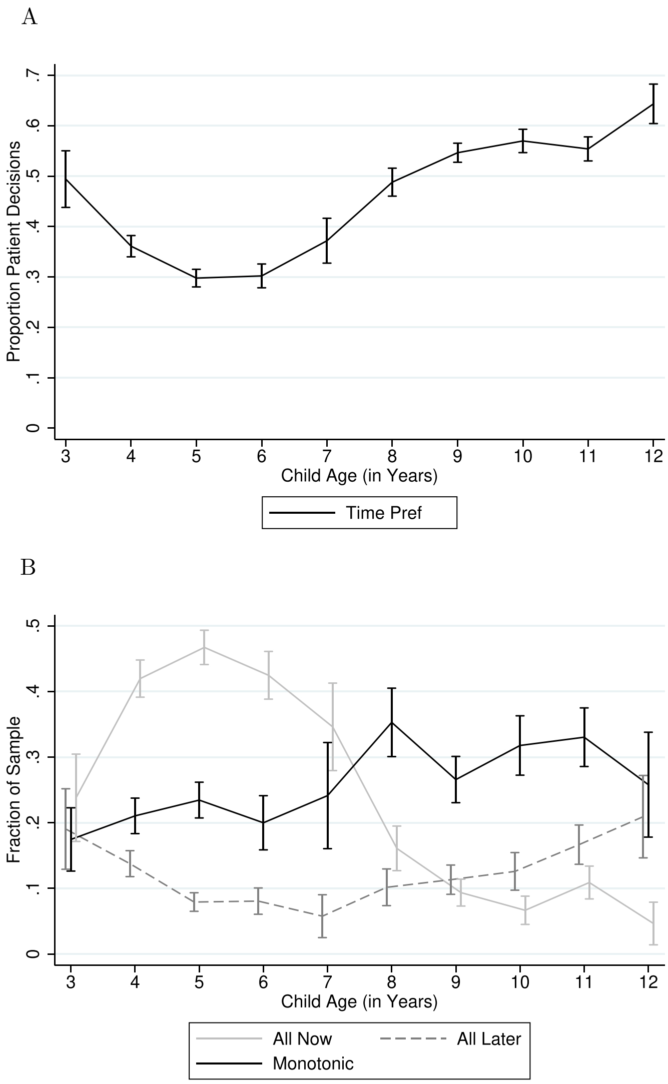

Fig. 4. Patient and monotonic decisions, by age *Panel A*. Note: This figure shows the time preferences and consistency of decisions of children by age. In Panel A, "Time Pref" refers to the average proportion of patient decisions in the experimntal task. In Panel B, "All now" referes to children who chose all immediate options in the experimental task. "All later" referes to children who chose all delayed options in the experimental task. "Monotonic" refers to the proportion of children who have at least one switch point and were monotonic in their decisions. The error bars show confidence intervals around the estimates, jittered for visualization.

for missing and including a missing dummy); in specifications (3) and (7), we add controls for cognitive ability and executive functions, and in specifications (4) and (8), we add the risk preference control. The coefficient on age (row 1) is positive (0.08) and statistically significant in specifications (1)–(2) and (4), and negative (between 0.02 and 0.03) and statistically significant in specifications (5)–(6) and (8), providing support for the age trend displayed in Fig. 3. Appendix Table A.1 includes an age squared variable and shows a minimum in the Time Pref variable between four and five years old, whereas the best fit for the All Now variable is monotonically negative in specifications 5, 6, and 8.

Studying the cross-sectional variation in time preferences is valuable because time preferences are predictive of later life outcomes. But studying the evolution of time preferences by age is itself interesting since children make decisions that affect their future selves (such as choice to complete homework, or show up to school). Understanding children's levels of patience by age is important to understand the evolution of choices that children make as they age. Further, many interventions are geared at this age range, and understanding the impact of these interventions on children may require understanding child time preferences. For example, the evolution of time preferences we see here may suggest that younger children would do better with immediate incentives while older children may accept delayed incentives as part of an intervention.

3.2. Correlates with race

We next consider associations between child demographic and socio-economic characteristics on child time preferences. In the regression tables, we include dummies for child race – white, child race – black and child race – other. The omitted category is Hispanic, because this is the largest category. We find that child race is statistically significantly related to their level of patience. Black children make a higher proportion of impatient decisions and are more likely to make all impatient decisions relative to Hispanic children (see all specifications in Table 3 – coefficient estimates are between −0.16 and − 0.24 in specifications 1–4, all of which are statistically significant). There are no consistent or significant differences between white and Hispanic children. In Appendix Table A.2, we also include an interaction term between race and age. The estimates suggest that the black-Hispanic difference attenuates with age. Our finding that black children are more impatient is in line with Castillo et al. (2011), who find that, among 13- to 14-year-old children, black children are more impatient than other children. Our sample includes children of ages 3–12, showing that this heterogeneity appears at even younger ages.

3.3. Correlates with parent time preferences

The parent experiment included 16 decisions from two multiple-price lists, where parents chose between amounts of $6 to $20 earlier versus $20 later. For the first 8 decisions, the earlier time was today, and the later time was 5 weeks from today; for the remaining 8 decisions, the earlier time was 5 weeks from today, and the later time was 10 weeks from today. Only one decision was randomly paid out.

The parent time preference experiments were carried out in two waves: once in July 2012, and again in February–October 2018. We have a total of 643 adult caregiver observations for the parent preference elicitation tasks (262 in 2012 and 381 in 2018). 501 caregivers participated only once and 71 participated two times. Using the original CHECC registration data, we identified 444 (77.62%) as the mother, 91 (15.91%) as the father, and 36 (6.29%) as another caregiver (usually this is the grandmother or relative who lives with the child). For parent time preferences, we simply calculate the proportion of patient decisions out of 16 (a histogram of these outcomes is available as Appendix Fig. A.1). We refer to this measure as "Parent Time Pref." In case of households that had multiple parents participating, we averaged the time preferences of both caregivers for the analysis. In case of caregivers who participated more than once, we average their 2012 and 2018 observations.

The raw correlation between child and parent time preferences is 0.04 and is statistically insignificant (p-value = 0.23). Table 4 presents regression results including the controls for parent time preferences. We do not find strong associations of parent time preferences with child time preferences. The coefficients on Parent Time Pref are small, insignificant and even change signs across specifications. Note that in Table 4, we continue to see the effects of age and race that we described in sub-sections 3.1 and 3.2. As a robustness check, Appendix Table A.3 replicates this regression using only mothers, finding qualitatively similar results (no effect of mother's time preferences, and continued effects of age and race as described in sub-sections 3.1 and 3.2).

Table 3
Predictors of child time preferences.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)
Time Pref.	Time Pref.	Time Pref.	Time Pref.	All Now	All Now	All Now	All Now	Time Pref.
Child Age (in Years)	0.08***	0.08***	0.09	0.08***	−0.03***	−0.02***	−0.04	−0.03***
	(0.02)	(0.02)	(0.07)	(0.02)	(0.01)	(0.01)	(0.03)	(0.01)
Child Gender (Female = 1)	0.05	0.05	0.10	0.08	−0.03	−0.03	−0.05	−0.03
	(0.05)	(0.05)	(0.07)	(0.05)	(0.02)	(0.02)	(0.03)	(0.02)
Child Race - White	−0.03	−0.01	0.04	−0.03	0.02	0.01	−0.00	0.02
	(0.10)	(0.11)	(0.16)	(0.11)	(0.04)	(0.04)	(0.07)	(0.04)
Child Race - Black	−0.16***	−0 17***	−0 24***	−0.18***	0.09***	0.08***	0.12***	0.09***
	(0.05)	(0.06)	(0.08)	(0.06)	(0.02)	(0.03)	(0.04)	(0.03)
Child Race - Other	−0.46	−0.46	−0.44	−0.43	0.26	0.27*	0.35*	0.27*
	(0.37)	(0.37)	(0.58)	(0.37)	(0.16)	(0.16)	(0.21)	(0.16)
Experimental Controls	✓	✓	✓	✓	✓	✓	✓	✓
SES Controls	×	✓	✓	✓	×	✓	✓	✓
Cognitive/EF Controls	×	×	✓	×	×	×	✓	×
Risk Controls	×	×	×	✓	×	×	×	✓
R^2	0.02	0.02	0.04	0.03	0.14	0.14	0.14	0.14
Test Black = White	0.21	0.12	0.08	0.17	0.12	0.10	0.10	0.13
N	1614	1614	820	1592	1614	1614	820	1592

Note: This table reports OLS coefficient estimates of predictors of child time preferences. All regressions control for age at test date, gender and race. Hispanic is the reference category for race. Columns 1–4 use number of times child chose "now" as the dependent variable (standardized by.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

While parent preferences do not predict child preferences holding race fixed, we find that the difference in child time preferences across race is mirrored among their parents. Appendix Table A.4 presents regressions of demographic characteristics of the child on *parents'* time preferences. We find that parents of black children are significantly more impatient than parents of Hispanic or white children. This is in line with the race result for children presented in sub-section 3.2, and suggests a persistence of measured time preferences into adulthood.

4. Impact of early childhood interventions

4.1. Experimental design

Our participants were recruited from the Chicago Heights Early Childhood Center (CHECC) program.[7] CHECC is a large-scale intervention study on the role of different early education programs on schooling outcomes of disadvantaged children conducted in 2010–2014 (Fryer et al., 2015, Fryer et al., 2018). Households who participated in CHECC originated from the surrounding area of Chicago Heights, Illinois. Chicago Heights is an ethnically diverse (41% African American, 34% Hispanic) and generally low-income area (29% of persons below poverty level, $18,121 per capita money income).[8] To support recruiting efforts, CHECC ran a local marketing campaign each year, which included direct mailings, automated phone calls to families with children enrolled in the district, and information booths at community events in and around the district. Program information was also distributed through district leadership staff in the school districts, and administrative assistants at schools were encouraged to collect and submit registration forms for CHECC.

The main goal of CHECC was to investigate the role of early childhood programs on educational attainment; therefore, households who signed up for the program were randomized each year (during four years 2010–2013) into one of several different treatment arms or to a control group.[9] A different set of treatments was tested in 2010 and 2011 and another set was tested in 2012 and 2013. The treatments are described below:

- Preschool-Literacy and Math (2010 and 2011): This was a free, full-day 9-month long preschool program that used the *Literacy Express* curriculum combined with a math component. The purpose of this curriculum was to teach academic skills like literacy and math.
- Preschool-Tools of the Mind (2010 and 2011): This was a free, full-day 9-month long preschool program that used *Tools of the Mind* curriculum. The purpose of this curriculum was to teach executive functioning skills.
- Parent Academy-Cash (2010 and 2011): This was a class that parents attended two times a month to learn how to teach to their children at home. Parents received $100 in cash for attending each class, and earned additional cash rewards for completing homework assignments and for their child's performance on tests.
- Parent Academy-College (2010 and 2011): This was a class that parents attended two times a month to learn how to teach to their children at home. Parents received $100 in cash for attending each class, and earned additional rewards for completing homework assignments and for their child's performance on tests. The additional rewards were deposited into an account they could access for their child's college (or other vocational, post-secondary) education.
- Preschool-CogX (2012 and 2013): This was a free, half-day preschool program with half-day of child-care, for 9 months. It also included a class that parents attended two times a month to learn how to scaffold their children's learning at home. Parents received $50 in cash for attending each class, but did not receive additional rewards. The curriculum used was *CogX*, which combines aspects of literacy, math, and executive functions and was developed by the PIs (Fryer Jr et al., 2018).
- Kinderprep (2012 and 2013): This was a free, half-day preschool program during the two months of summer prior to the start of Kindergarten. It also included a class that parents attended two times a

[7] CHECC was called the Griffin Early Childhood Center (GECC) between 2010 and 2012, and was renamed to CHECC in 2012.
[8] Data from the United States Census http://quickfacts.census.gov/qfd/states/17/1714026.html
[9] The CHECC randomization followed a blocked approach. In each randomization, matched groupings of children were created based on gender, race (white, Hispanic or black), and age (within ½ years). Then, each child in the grouping was randomly assigned to a treatment or control group. Children for whom matched groupings were not created were placed in the control group. In Fryer et al. (2018) only the matched pairs are used and the full sample is used as a robustness test, but in our analysis here we use the full sample.

Table 4
Predictors of child time preferences with parent controls.

	(1) Time Pref.	(2) Time Pref.	(3) Time Pref.	(4) Time Pref.	(5) All Now	(6) All Now	(7) All Now	(8) All Now
Child Age (in Years)	0.09***	0.08***	0.10	0.09***	−0.03***	−0.03***	−0.04	−0.04***
	(0.03)	(0.03)	(0.08)	(0.03)	(0.01)	(0.01)	(0.04)	(0.01)
Child Gender (Female = 1)	0.11*	0.11*	0.18**	0.13**	−0.04	−0.04	−0.07*	−0.04
	(0.06)	(0.06)	(0.09)	(0.06)	(0.03)	(0.03)	(0.04)	(0.03)
Child Race - White	−0.03	−0.01	−0.06	−0.03	0.06	0.06	0.11	0.06
	(0.14)	(0.14)	(0.22)	(0.14)	(0.06)	(0.06)	(0.09)	(0.06)
Child Race - Black	−0.21***	−0.21***	−0.27***	−0.21***	0.10***	0.10***	0.13***	0.10***
	(0.07)	(0.07)	(0.10)	(0.07)	(0.03)	(0.03)	(0.05)	(0.03)
Child Race - Other	−0.31	−0.30	−0.28	−0.28	0.21	0.21	0.33	0.21
	(0.51)	(0.54)	(0.92)	(0.53)	(0.21)	(0.22)	(0.34)	(0.21)
Parent Time Pref	0.02	0.02	−0.04	0.02	−0.01	−0.01	0.03	−0.01
	(0.03)	(0.03)	(0.04)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)
Experimental Controls	✓	✓	✓	✓	✓	✓	✓	✓
SES Controls	×	✓	✓	✓	×	✓	✓	✓
Cognitive/EF Controls	×	×	✓	×	×	×	✓	×
Risk Controls	×	×	×	✓	×	×	×	✓
R^2	0.03	0.03	0.06	0.04	0.17	0.18	0.19	0.18
Test Black = White	0.19	0.17	0.32	0.20	0.46	0.51	0.79	0.49
N	1051	1051	554	1037	1051	1051	554	1037

Note: This table reports OLS coefficient estimates of predictors of child time preferences. All regressions control for age at test date, gender, race and parent time preferences. Hispanic is the reference category for race. Columns 1–4 use number of times child chose "now" as the dependent variable (standardized by session). Columns 5–8 use an indicator for if the child chose all immediate options in the experimental task (all now) as the dependent variable. Experimental controls include wave year, year parent was measured, and a dummy for whether the parent preference is an average of two parent observations for the same child. Socioeconomic status (SES) controls include household income, mother's educational attainment, mother's age at child birth, child's birthweight and whether SES is missing. Columns 3–4 and 7–8 include controls for cognitive and non-cognitive index scores assessed within a year of the preference measures, as well as an indicator for whether the score is based on MAP/NIH Toolbox assessments or WJ/PPVT. Columns 4 and 8 include a control for child risk preference, evaluated concurrently with time preference. The row Test Black = White reports the *p*-value of a chi-squared test of the equality of the race coefficients. Standard errors are in parentheses. All regressions are clustered at the individual level.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

month to learn how to scaffold their children's learning at home. Parents received $50 in cash for attending each class, but did not receive additional rewards. The curriculum used was *CogX,* which combines aspects of literacy, math, and executive functions and was developed by the PIs (Fryer Jr et al., 2018).

- Control group (all years): Children randomized to the control group did not receive any educational programming from us. This group was referred to externally as the Family Group and families were invited to family parties several times a year to minimize attrition. They also received cash incentives to participate in assessments.

Fryer Jr et al. (2015) reports on the impact of the Parent Academy programs, while Fryer Jr et al. (2018) reports on the impact of Preschool-CogX and Kinderprep on cognitive skills and executive functions. The authors find that Parent Academy primarily improved executive functions, while Preschool-CogX and Kinderprep primarily improved cognitive skills. The impact on cognitive skills faded out several years after the end of the programs.

In this paper, to investigate the impact of early education programs on time preferences, we use data from the 2012, 2013 and 2017 data collection waves since these were conducted after most children had the chance to participate in CHECC education programs.[10] There are some caveats with the sample selection. In 2012 and 2013, we invited parents to participate in sessions by bringing children in during a non-school time, and we did not attempt to recruit the full sample. Only 28.9% (511 of 1767) of children who had participated in a CHECC program were part of the time preference data collection (23.3% - 274 of 1178 in 2012 - and 15.7% - 277 of 1767 in 2013). This includes 27.8% of the Parent group, 39.4% of the Preschool group and 21.8% of the Control group. 471 children participated once, and 40 participated twice.

We used a different strategy in the 2017 wave. Instead of relying on parents to bring in their children, in 2017, we collected data from all children who were attending one of the 9 schools in Chicago Heights Illinois School District 170. Data was collected during school. Therefore, by design, we do not have data on children who were attending other school districts during this time period (data is available for 26.9% or 588 of 2185 of children). This includes 32.7% of the Parent group, 25.6% of the Preschool group and 25.9% of the Control group. However, if we believe that children did not move in and out of district due to CHECC treatment assignment – which they would have had no reason to do – then this attrition should not affect the results of our experiment.

Fig. A.2 in the appendix provides a diagram that describes how children flow through the programs and the experimental waves. Table A.5 in the appendix provides summary statistics comparing participants in the 2012–2013 waves to non-participants from CHECC who would have been eligible, and participants in the 2017 wave who were in District 170 with non-participants from CHECC who were not in District 170. There are some similarities and some differences across participants and non-participants. In the 2012–13 waves, participants were similar to non-participants on race, pre-assessment scores and some categories of household income and mother's educational attainment. They differed somewhat on age and some categories of household income and mother's educational attainment. In the 2017 wave, participants were similar to non-participants on age and gender, but differed with respect to race and most categories of SES. These latter differences are expected because District 170 is located in an area with more Hispanic residents relative to areas where the rest of the sample resides, and the 2017 wave was limited to District 170 students.

It is important to delineate how this paper relates to other papers that have been published using the CHECC sample. Fryer et al. (2015)

[10] For this analysis, we consider as our denominator only children who had a chance to complete their participation in any CHECC treatment arm at the time of the experiment. This means that, for example, for the 2012 wave, we consider children who finished the program by 2012 but do not consider children who started the program in 2012. Similarly, for the 2013 wave, we consider children who finished the program by 2013 but do not consider children who started the program in 2013.

Table 5
Treatment effect regressions: 2012–2013 waves.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)
Time Pref	Time Pref	Time Pref	Time Pref	All Now	All Now	All Now	All Now	Time Pref
Preschool Dummy	0.04	0.05	0.08	0.04	−0.03	−0.04	−0.06	−0.03
	(0.09)	(0.09)	(0.11)	(0.09)	(0.05)	(0.05)	(0.05)	(0.05)
Parent Academy Dummy	−0.07	−0.03	−0.01	−0.05	0.03	0.02	−0.01	0.03
	(0.12)	(0.12)	(0.13)	(0.12)	(0.06)	(0.06)	(0.07)	(0.06)
Child Age (in Years)	0.02	0.03	0.09	0.03	−0.04	−0.05	−0.08	−0.05
	(0.13)	(0.13)	(0.15)	(0.13)	(0.07)	(0.07)	(0.08)	(0.07)
Child Gender (Female = 1)	0.10	0.12	0.13	0.13	−0.04	−0.05	−0.06	−0.05
	(0.08)	(0.08)	(0.09)	(0.08)	(0.04)	(0.04)	(0.05)	(0.04)
Child Race - White	0.07	0.07	0.09	0.05	0.06	0.06	0.10	0.07
	(0.15)	(0.16)	(0.18)	(0.16)	(0.07)	(0.07)	(0.08)	(0.07)
Child Race - Black	−0.21**	−0.23**	−0.25**	−0.25***	0.13***	0.13***	q	0.14***
	(0.09)	(0.09)	(0.10)	(0.09)	(0.05)	(0.05)	(0.05)	(0.05)
Child Race - Other	0.24	0.16	0.13	0.16	0.01	0.06	0.10	0.06
	(0.52)	(0.50)	(0.51)	(0.50)	(0.20)	(0.19)	(0.19)	(0.19)
Experimental Controls	✓	✓	✓	✓	✓	✓	✓	✓
SES Controls	×	✓	✓	✓	×	✓	✓	✓
Pretest Cognitive/EF Controls	×	×	✓	×	×	×	✓	×
Risk Controls	×	×	×	✓	×	×	×	✓
R^2	0.03	0.05	0.06	0.05	0.05	0.06	0.09	0.06
Test PK=PA	0.40	0.49	0.52	0.48	0.34	0.37	0.49	0.35
N	551	551	475	544	551	551	475	544

Note: This table reports OLS coefficient estimates of Preschool and Parent Academy treatment effects on child time preferences for the 2012–2013 wave samples. All regressions control for age at test date, gender, race, wave year, year of treatment, age at beginning of treatment and total years in the program. Hispanic is the reference category for race. Columns 1–4 use number of times child chose "now" as the dependent variable (standardized by session). Columns 5–8 use an indicator for if the child chose all immediate options in the experimental task (all now) as the dependent variable. Experimental controls include wave year. Socioeconomic status (SES) controls include household income, mother's educational attainment, mother's age at child birth, child's birthweight and whether SES is missing. Columns 3–4 and 7–8 include controls for cognitive and non-cognitive index scores assessed within a year of the preference measures, as well as an indicator for whether the score is based on MAP/NIH Toolbox assessments or WJ/PPVT. Columns 4 and 8 include a control for child risk preference, evaluated concurrently with time preference. The row Test PK=PA reports the p-value of a chi-squared test of the equality of the preschool treatment and parent academy treatment coefficients. Standard errors are in parentheses. All regressions are clustered at the individual level.
$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

and Fryer et al. (2018) report on the impact of the programs on cognitive abilities and executive functions. Andreoni et al. (2019) reports on the evolution of risk preferences of CHECC children and of adolescents who participated in a separate intervention program. Capellen et al. (forthcoming) reports on the impact of the CHECC programs on fairness preferences. Unlike Andreoni et al. (2019) and Capellen et al. (forthcoming), we consider the impact of the programs on time preferences. Castillo et al. (2019) considers the associations of risk

Table 6
Treatment effect regressions: 2017 Wave.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)
Time Pref	Time Pref	Time Pref	Time Pref	All Now	All Now	All Now	All Now	Time Pref
Preschool Dummy	0.02	0.02	0.03	0.03	−0.01	−0.00	−0.01	−0.00
	(0.10)	(0.10)	(0.11)	(0.09)	(0.03)	(0.03)	(0.03)	(0.03)
Parent Academy Dummy	−0.11	−0.08	−0.10	−0.07	−0.03	−0.04	−0.04	−0.04
	(0.12)	(0.12)	(0.14)	(0.12)	(0.03)	(0.03)	(0.04)	(0.03)
Child Age (in Years)	0.21*	0.19	0.10	0.18	−0.04	−0.03	0.01	−0.03
	(0.12)	(0.12)	(0.14)	(0.12)	(0.04)	(0.04)	(0.05)	(0.04)
Child Gender (Female = 1)	0.08	0.08	0.02	0.09	−0.01	−0.01	0.02	−0.01
	(0.08)	(0.08)	(0.09)	(0.08)	(0.03)	(0.03)	(0.03)	(0.02)
Child Race - White	−0.15	−0.20	−0.21	−0.20	0.03	0.05	0.05	0.05
	(0.22)	(0.22)	(0.24)	(0.23)	(0.07)	(0.07)	(0.07)	(0.07)
Child Race - Black	−0.03	−0.02	0.08	0.00	0.00	−0.01	−0.04	−0.02
	(0.10)	(0.10)	(0.12)	(0.10)	(0.03)	(0.03)	(0.04)	(0.03)
Child Race - Other	−0.97	−1.00	−0.93	−1.11	0.39	0.39	0.37	0.40
	(0.66)	(0.71)	(0.75)	(0.77)	(0.37)	(0.38)	(0.36)	(0.38)
Experimental Controls	✓	✓	✓	✓	✓	✓	✓	✓
SES Controls	×	✓	✓	✓	×	✓	✓	✓
Pretest Cognitive/EF Controls	×	×	✓	×	×	×	✓	×
Risk Controls	×	×	×	✓	×	×	×	✓
R^2	0.04	0.06	0.08	0.08	0.03	0.05	0.06	0.05
Test PK=PA	0.34	0.45	0.37	0.46	0.41	0.31	0.47	0.31
N	588	588	499	586	588	588	499	586

Note: This table reports OLS coefficient estimates of Preschool and Parent Academy treatment effects on child time preferences for the 2017 wave sample. All regressions control for age at test date, gender, race, wave year, year of treatment, age at beginning of treatment and total years in the program. Hispanic is the reference category for race. Columns 1–4 use number of times child chose "now" as the dependent variable (standardized). Columns 5–8 use an indicator for if the child chose all immediate options in the experimental task (all now) as the dependent variable. Experimental controls include wave year. Socioeconomic status (SES) controls include household income, mother's educational attainment, mother's age at child birth, child's birthweight and whether SES is missing. Columns 3–4 and 7–8 include controls for cognitive and non-cognitive index scores assessed within a year of the preference measures, as well as an indicator for whether the score is based on MAP/NIH Toolbox assessments or WJ/PPVT. Columns 4 and 8 include a control for child risk preference, evaluated concurrently with time preference. The row Test PK=PA reports the p-value of a chi-squared test of the equality of the preschool treatment and parent academy treatment coefficients. Standard errors are in parentheses. All regressions are clustered at the individual level.
$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

preferences, time preferences, social preferences, cognitive abilities and executive functions at an early age and evaluates the impact of these skills on disciplinary referrals several years later. They only use the time preferences (and other skills) collected at the beginning of the CHECC study, while in this paper, we use all of the time preference measures collected throughout the CHECC study to understand the evolution of time preferences across ages. Several related papers also use small sub-samples of CHECC students to understand parental cheating behavior (Houser et al., 2016), parental charitable giving (Ben-Ner et al., 2017; Samek and Sheremeta, 2017), child charitable giving behavior (List and Samak, 2013; List et al., 2017; Cowell et al., 2015; Cox et al., 2016), child competitiveness (Samak, 2013) and parent food choice (Sadoff and Samek, 2019). A paper has also been written about the test-retest reliability of executive function measures (Willoughby et al., 2017).

4.2. Treatment effects

Tables 5 and 6 show the impact of being randomly assigned to one of our interventions on time preferences. Table 5 uses the 2012 and 2013 waves of data (including only children who had been part of a CHECC treatment arm by these waves) and Table 6 uses the 2017 wave of data. The dummy variable "Preschool Dummy" refers to whether the child was randomized to any of the preschool programs (including the Kinderprep program), while the dummy variable "Parent Academy Dummy" refers to whether the child was randomized to any of the Parent Academies. In some specifications, we also control for SES and cognitive and executive function abilities at baseline (when children entered CHECC). Appendix Tables A.6 and A.7 perform the same analysis but disaggregating the Parent Academy and Preschool variables into each of the separate curricula treatment arms described in sub-section 4.1. Appendix Tables A.8 and A.9 perform the same analysis but using inverse probability weighing to adjust for observable differences by program participation.

We do not see a strong association with randomization to one of the programs on child time preferences (all coefficients small – on the order of 0.00 to 0.11 in absolute value – and insignificant with $p > 0.10$), suggesting that perhaps time preferences are difficult to influence through general education programs such as ours. For example, Specification (5) in Tables 5 and 6 provides treatment effects of the programs on the choice of "all now." We see that Preschool results in an insignificant 1–3% decrease in the probability of choosing "all now." We see that Parent Academy results in either an insignificant 3% increase (Table 5, 2012–2013 waves) or 3% decrease (Table 6, 2017 wave) in the probability of choosing of "all now". The standard errors on these coefficients are 0.06 and 0.03, respectively. By contrast, being black relative to Hispanic is associated with a 13% increase in the probability of choosing "all now" in Table 5. And, in the Capellen et al. (forthcoming) experiment that evaluated the impact of CHECC programs on fairness, being assigned to Parent Academy is associated with a 13% increase in the probability of choosing the efficient versus fair allocation of resources.

Note that race, but not age, continues to be associated with time preferences in Table 5. We speculate that age is not statistically significant in Table 5 because the 2012–2013 waves include only children ages 3–6 (a more narrow age range). We speculate that race is not statistically significant in Table 6 because the racial composition in the 2017 wave is predominately Hispanic since we collected data in one particular school district.

5. Additional analysis

5.1. Multiple hypothesis test correction

Tables 5–6 imply 5 different hypotheses are being tested, i.e., that time preferences evolve with age, and may differ when comparing boys and girls, black and white children, black and Hispanic children, and Hispanic and white children. It is thus important to adjust for the family-wise error rate (e.g., see List et al., forthcoming). Holm-Bonferroni p-value correction yields continued statistical significance for the comparisons of black and Hispanic children in Tables 3 and 4, as well as specifications (4)–(8) in Table 5. The association of age with time preferences remains statistically significant in specifications (1), (2), (4)–(6) and (8) in Table 3.[11]

5.2. Robustness test with marshmallow paradigm

We also investigate the robustness of our results using the wait time on the marshmallow test as the outcome variable. In Table A.10 in the Appendix, we report on regressions that use the total number of seconds waited as a dependent variable, setting all wait times to 5 min for children who waited longer in sessions where it was feasible. We find results that are noisy but qualitatively similar to the results that use the Time Pref variable as the outcome: an increase of one year in child age is associated with an increase in wait time of 3–6 seconds, and black children tend to wait less than both Hispanic and white children (these differences are only statistically significant in specification (5)). We also do not find effects of the Preschool and Parent Academy treatments.

6. Conclusion

Time preferences are associated with a range of life outcomes, including educational attainment, health, and financial capability. To shed light on the development of time preferences in children, we conducted experiments to evaluate correlations of child time preferences with age, race, and parent time preferences. We also investigated the impact of assignment to early childhood on time preferences.

We found that time preferences evolve significantly during ages 3–12, with younger children displaying more impatient preferences than older children. We also found a strong and significant association with race: black children, relative to white or Hispanic children, are significantly more impatient. Parent time preferences are not good predictors of child time preferences, but parents of black children are also more impatient than parents of white or Hispanic children. Interestingly, assignment to different schooling opportunities is not significantly associated with our measures of child time preferences. More work is needed to understand the emergence of these observed racial differences, which are present at an early age.

There are certain limitations within our data. First, it is unclear whether the ability to wait is increasing with age because time perceptions change with age (i.e., 1 day to a 3-year old feels "longer" than 1 day to a 12-year old) or whether the underlying time preference construct is changing. To disentangle these differences, future research should explore how changing the time delay affects willingness to wait by age. Future research should also explore the test-retest reliability of this measure.

Second, it is unclear whether parent preferences are uncorrelated with child preferences, whether the measures that we use are the most appropriate for observing this correlation, or whether the preferences of children are simply difficult to measure. Our results are in line with Bettinger and Slonim (2007) who also found no correlation between adolescent and parent time preferences, but are at odds with Kosse and Pfeiffer (2012, 2013). Notably, we found no association in parent and child time preference using two different measures of time preferences: the standard economic time preference elicitation task, and the delay of gratification paradigm. We also found no association

[11] The Bonferroni procedure involves dividing 0.05 by the number of tests (5) and then comparing each calculated p-value to the new p-value of 0.01. The Bonferroni-Holm procedure is sequential and compares the rank of each p-value to 0.05/(5-rank+1). Both procedures yield qualitatively similar results in our case.

when constraining our sample to mothers only, as Kosse and Pfeiffer (2012, 2013) do. An interesting extension would be to systematically use alternative tests of parent preferences, such as a qualitative question with parents, to see if differences in methodology can partly explain the mixed findings in this literature.

Third, because our experiment was not initially designed to disentangle the causal impact of schooling on child time preferences, we only see a sub-set of children in our data who were also part of the CHECC randomization. Hence, while we do not see statistically significant differences in time preferences by treatment assignment, this could be due to a small sample size or due to sample selection. For instance, suppose that random assignment to a CHECC treatment group does causally affect child time preferences, but there is differential attendance at the experimental sessions based on child level of impatience, such that parents of more impatient control group children are less likely to attend than parents of more impatient treatment group children. Such a story would undermine our ability to find treatment effects. To address this, we conducted a wave of data collection in 2017 that assessed children in school. This allowed us to reach all of the children within one participating district, independent of parental involvement. But this wave occurred several years after the intervention, when the potential effects of the intervention on time preferences could have faded out. We believe that future work should continue to use exogenous variation in early childhood environments to better understand the causal impact of such variation on time preference development.

Finally, another possibility is that early childhood education treatments are causally related to making mistakes in the decision task, which could result in non-monotonic decisions. However, when we re-run Specification (4) from Tables 5–6 with a 0/1 measure for monotonicty as the dependent variable, we do not observe statistically significant coefficients on CHECC treatment assignment. This is reported as Appendix Table A.11.

Taken together, our results suggest racial patterns of patience that emerge from a very young age and appear to persist. A deeper understanding of the determinants of these differences and the extent to which they can be influenced by interventions are important topics for future research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpubeco.2019.06.007.

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