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Content

Summer Activities and Vocabulary Development: Relationships Across Middle Childhood and Adolescence

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Abstract: This paper examines the relation between children's summer activities before fourth through sixth grade and their vocabulary knowledge in fifth grade and at age fifteen using the NICHD SECCYD dataset (N = 1,009). We used OLS regression and propensity score analyses to understand how children's summer reading, library visits, participation in enrichment classes, and unsupervised time predicts their vocabulary knowledge. Propensity score matching and OLS analyses show that time spent reading predicts vocabulary during the following two years, and high levels of time allocated to reading across three or more summers in middle childhood predicts vocabulary knowledge at age 15. OLS analyses suggest a relationship between library visits and vocabulary knowledge. There is no short-term relationship between enrichment classes and vocabulary knowledge, although our OLS analysis demonstrated that consistent enrollment in summer enrichment classes over three years predicted improved vocabulary. Unsupervised time predicted poor vocabulary in both the short and long-term.

Keywords: summer, out-of-school time, vocabulary, reading, unsupervised time

1 Introduction

Student vocabulary knowledge correlates strongly with reading comprehension measures across grade levels (Snow, Porche, Tabors, & Harris, 2007) and is a key component of skilled adolescent reading (Kamil, 2003; Snow & Biancarosa, 2003). Children learn new words rapidly throughout early childhood (Anglin, 1994) and the amount and quality of home language exposure predicts children's vocabulary knowledge (Hart & Risley, 1995; Pan, Rowe, Singer, & Snow, 2005). As children progress through elementary school they begin to learn more words from explicit instruction at school and text than from family or peer discourse. In the summer, families have more discretionary time to allot to preferred activities. The current paper explores the relationship between children's summer activity and vocabulary knowledge, in both the short and the long term (at age 15). We examine the time students (N = 1,009) spend reading, visiting the library, engaging in supervised enrichment

activities, and unsupervised with friends in relation to their vocabulary scores in fifth grade and at age fifteen using the NICHD SECCYD dataset.

Summer time. Summer is a time when many students, especially students from low-income homes, struggle to maintain learning trajectories established during the school year (Alexander, Entwisle, & Olson, 2001). Heyns (1978) found that sixth and seventh graders ($N = 2978$) learned vocabulary at a higher average rate during the school year than they did during the summer. She also found that out-of-school activities and differences in family socio-economic status accounted for differences in summer vocabulary learning, but not vocabulary learning during the school year (during which time all students were receiving instruction). Lawrence (2009) found that sixth-grade ($n = 87$) and seventh-grade ($n = 104$) students' vocabulary knowledge (measure on the Group Reading and Diagnostic Evaluation; Williams, 2000) decreased during the summer. In separate longitudinal analysis of an academic vocabulary intervention, middle-school children in both treatment ($n = 757$) and comparison groups ($n = 204$) showed marked decline in their knowledge of high-leverage academic words during summer months (Lawrence, Capotosto, Branum-Martin, White, & Snow, 2012). These findings mirror results in related literacy domains (Carver, 1994; Cooper, Nye, Charlton, Lindsay, & Greathouse, 1996; Entwisle, Alexander, & Olson, 1997; Kim, 2004; Kim & White, 2008). A multi-year study of student learning across early grades suggests learning differences during the summer are cumulative, and that these cumulative differences explain the reading achievement gap (Alexander, Entwisle, & Olson, 2001).

Understanding which activities are most likely to help students continue to learn during the summer months is difficult because students who struggle during the summer are also usually the least prepared at school entry and had the least support during the school year. Although many studies control for well-known predictors of children's vocabulary growth such as maternal education, family socio-economic status, home literacy environment and school year activity in OLS regressions, statistical controls do not necessarily guard against selection bias. If high-income families make up most or all of the subsample that engage in enrichment activities, for example, an OLS model might suggest a relationship between enrichment activities and student achievement that is driven by many factors related to family wealth rather than the enrichment classes *per se*. In this paper we use propensity score matching as a robustness check to guard against selection bias.

This study examines how reading, library use, enrichment activities, and unsupervised time predict vocabulary outcomes. We also test how cumulative summer persistence in each activity is related to vocabulary knowledge at age 15. Each of these activities is common during the summer, and have been explored as predictors of vocabulary growth.

Reading. Researchers have argued that reading increasingly drives student word learning as they get older (Nagy, Herman, & Anderson, 1985). Firstly, the density of new words that children meet in text increases as they expand their reading diet to include more expository texts in upper elementary and middle grades (Gardner, 2004). This means children are more likely to encounter new words in reading than in discussion at this age. Secondly, older children are better able to infer the meaning of new words encountered in text (Swanborn & de Glopper, 1999). Out-of-school

reading is correlated with vocabulary knowledge. Anderson, Wilson, and Fielding (1988) gathered self-reported daily activity logs from 155 fifth graders for 26 weeks and found reading books was associated with improvement on a vocabulary checklist measure even after controlling for second grade reading achievement. Lawrence (2009) found that students' self-report of time spent reading narrative and expository texts during the summer was related to improved vocabulary scores for better readers but not for less skilled ones. Heyns (1978) found that summer reading offset the summer setback of middle schoolers in her comprehensive analysis. Recognition tests are an alternative measure of reading amount and correlate with vocabulary knowledge (Cunningham & Stanovich, 1990; Cunningham & Stanovich, 1991). Cunningham and Stanovich (1991) found that reading and receptive vocabulary correlated moderately (r = .46, p <.05) in a sample of fourth-, fifth-, and sixth-grade students (N = 134). Allen, Cipeilewski and Stanovich (1992) used both activity preference questionnaires and title recognition tasks and found these measures correlated with fifth-grade students' (N = 63) vocabulary knowledge as measured by the Peabody Vocabulary Test and two checklist measures. For instance, students who reported reading more books did better than peers on the vocabulary checklist measures (r = .41, p <.05). In a study that recruited its participants (n = 1687) from ethnically diverse elementary schools, Kim (2004) found that summer readers improved more on the Stanford Achievement Test of reading than less-frequent readers. Kim and White (2008) randomized students to three intervention conditions and found that books plus instructional scaffolding resulted in improved literacy outcomes for students.

There are certainly individual differences in how well students learn new words from independent summer reading. Lawrence (2012) found that summer reading did not offset predicted vocabulary setback for sixth and seventh grade students (N = 278) in a longitudinal model controlling for grade level, baseline standardized scores, gender, and home-language status. Kim and Guryan's (2010) study of fourth-grade students (N = 370) included measures of vocabulary knowledge, and found that student participation in a summer reading program did not result in improved vocabulary or comprehension scores. In a randomized trial, Kim (2006) found that participating in a summer reading program, (which included reading instruction and texts provided to the student during summer months) resulted in improved reading, but was especially helpful for less-fluent readers and students with fewer books at home.

This study extends the literature about summer reading and vocabulary. For one, we explore both short- and long-term gains associated with summer reading. Additionally, we analyze the impact of summer activities over multiple summers to test whether the cumulative impact of activities is related to later vocabulary gains. Furthermore, we use propensity score matching to compare differences between groups of individuals who read different amount despite having the same statistical propensity to read (based on key characteristics).

Library visits. According to the American Library Association (2000), 94% of libraries surveyed throughout the US provide study space, 95% of libraries offer summer reading programs, and 89% of libraries offer story hours – each of which are provisions linked to academic achievement (Celano & Neumann, 2001). Kim

(2004) found that access to libraries during the summer predicted improved reading outcomes (controlling for baseline achievement) and there was an interaction between access and race such that Black students benefited even more than other students from summer access to texts. Our study adds to the sparse research on library patronship by examining the relationship between library visits and vocabulary, and especially how regular patronship over many summers relates to adolescent vocabulary knowledge.

Enrichment. Enrichment activities are of interest because they offer opportunities for aural vocabulary exposure and rich discussion. Enrichment activities, in this paper, refer to courses or programs that promote learning through recreational means. For example, woodworking courses and hands-on science programs constitute enrichment courses. In some respects, participation in these activities is similar to school attendance. For instance, these activities are likely to provide students with opportunities to talk and work with adults in contexts that facilitate use of specialized language in completing problem-solving tasks. Thus, while summer enrichment activities may not provide rich opportunities to encounter new words in text or learn from direct vocabulary instruction, they may provide opportunities for discussion and new experiences. Although there is a rich research literature related to discussion and reading outcomes in school contexts (Lawrence & Snow, 2010; Murphy, Wilkinson, Soter, Hennessey, & Alexander, 2009), much less is known about how child-adult discussion in summer or enrichment settings might support student word learning.

Unsupervised Time with Peers. Unsupervised time may provide opportunities for peer-to-peer discussion. During the school year, unsupervised time has been associated with mostly negative academic outcomes, however most research has been conducted on adolescent samples. Unsupervised time has been linked to behavioral and academic problems (e.g., Mahoney & Parente, 2009; Richardson , Radziszewska, Dent, & Flay, 1993). Unsupervised time is more problematic (i.e., it leads to delinquency) when peers are present (Osgood and Anderson, 2004; Osgood, Wilson, O'Malley, Bachman Johnston, 1996; Warr, 2005). The current paper extends the investigation into the relationship between unsupervised time with peers by adding to the small body of literature on the implications of unsupervised time in elementary school.

One of the few studies involving unsupervised time in elementary school aged children found that third grade children who spent time unsupervised actually earned higher grades and scored higher on standardized test scores than children attending low quality after-school programs (Vandell & Corasaniti, 1988). Also, there is evidence that peer-to-peer discussion facilitates vocabulary learning (Cekaite, Blum-Kulka, Grøver, & Teubal, 2014). The current study adds to the small body of literature investigating the link between unsupervised time with peers and vocabulary development.

The Present Study

The current study examines the link between time spent reading, visiting the library, taking enrichment classes, and being unsupervised during the summers before fourth through sixth grade and vocabulary knowledge. Vocabulary is measured by Woodcock Johnson Test Picture Vocabulary (PV) in 5th grade and at age 15. Because activity involvement and academic achievement are dynamically related over time (Posner & Vandell, 1999), stability and change of summer activity involvement is measured and accounted for here. The current study includes a longitudinal exploration of whether cumulative participation in each activity across summers is related to performance on delayed vocabulary scores and uses propensity score matching as a guard against selection bias. If child outcomes are determined by characteristics that differ between those who select to participate in given activities versus those who do not, propensity score matching ensures comparison between groups of students who do not statistically differ on key observable characteristics and acts as our robustness check. Our research questions are:

(1) Does participation in each of the above activities during summers before fourth and/or fifth grade predict PV tests scores in fifth grade?

Based on current knowledge, we hypothesize that reading, library use, and enrichment will predict higher vocabulary scores in fifth grade. Because of inconclusive findings surrounding unsupervised time with peers in elementary school and vocabulary, we do not have a prediction of whether unsupervised time with peers will predict lower or higher vocabulary scores.

(2) Does participation in particular types of activities during one, two, and/or three summers (compared to zero summers) before fourth through sixth grade summers predict PV test scores at age fifteen?

We hypothesize that more reading, library use, and enrichment will predict higher vocabulary scores at age fifteen. We do not have a prediction of whether unsupervised time with peers will predict lower or higher vocabulary scores. We do not have a prediction of whether unsupervised time with peers will predict lower or higher vocabulary scores.

(3) Do students who participate in an activity for several summers improve more than those how don't meet a participation thresh hold?

Because studies on cumulative activity involvement and vocabulary are lacking we do not have specific hypotheses for the number of summers associated with vocabulary outcomes.

2 Method

2.1 Participants

Participants in the NICHD Study of Early Child Care and Youth Development were recruited as newborns in 1991 from hospitals in or near Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia and Pittsburgh, PA; Charlottesville, VA; Seattle, WA; Hickory and Morganton, NC; and Madison, WI. Of the 8,986 mothers who gave birth during the sampling period, 5,416 (60%) met eligibility requirements and agreed to be contacted. From that pool, a conditionally random sample of 1,364 were included in the study pool which attempted to mirror the demographics of the overall eligible sample, including: 24% ethnic minority children; 11% mothers who had not completed high school; and 14% single family homes. Of these 1,364 children, 1,009 remained in the study until they were 15 years old. A detailed description of participant selection can be found in several publications (see NICHD ECCRN, 2005 for complete details) as well as on the National Institute of Child Health and Human Development (NICHD) Study of Childcare and Youth Development website (https://secc.rti.org).

A total of 992 children completed vocabulary tests in 5th grade, and data contributed by these children are used in the first set of analyses. For the second set of analyses (RQ2 and 3), we use data collected from 889 children who also completed vocabulary tests at age 15.

2.2 Measures

Summer Activity Participation. During the fourth, fifth, and sixth grade school years, mothers reported their children's previous summer's activity participation. Mothers indicted the frequency that their child "read a book, magazine or newspaper" and "visited a library". Response options for *reading* and *library use* ranged from "less than once per month" to "almost every day" on a six-point scale. Parents also reported how many weeks their child "attended an enrichment class (e.g. foreign language) or program for recreational learning activities such as woodworking, hands-on science projects, art, performing arts, etc." Lastly, parents were asked how much time their child spent "out with friends without an adult supervising." Response options for *enrichment* and *unsupervised time with peers* ranged from "none" to "8 weeks or more" along a six point scale. See Table 1 for a complete summary of category distributions.

Activity participation responses were collapsed into two categories: high and low activity levels. If past literature provided insight into the minimum level of each activity which lead to improved literacy, we used criteria from existing research. If there is no empirical base for choosing a threshold of activity participation, an attempt was made to create a roughly equal distribution between groups in our data by examining the frequency of responses.

Summer reading groups were created by identifying students who read a few times per week or more (i.e., the "high" group) and those who read one time per week or less (i.e., the "low" group). This cut was made because benefits of reading occur when children engage in independent reading more than once a week (Kane, 2004). Between 64% and 68% of students were categorized as "high" readers each summer.

Library patronage is understudied. It is not clear what threshold of library patronage is associated with improved vocabulary. We designated students who went to the library at least 2–3 times per month as frequent library patrons (in the "high" group). Between 32% and 41% of students were identified as active patrons each summer.

Current research suggests relatively low levels of unsupervised time experienced by children in the United States; even one unsupervised period a month could be considered a high level (Mahoney & Parente, 2009). The current study categorized students having experienced at least one period of unsupervised time a month as frequently unsupervised and those who had not as infrequently unsupervised. The group of "highly unsupervised" students was between 38% and 50% of the sample each summer using this criterion.

There is sparse empirical research on the impact of enrollment in summer enrichment courses. We wanted to split the distribution as evenly as possible, so we categorized "high" enrichment participation as equal to any level of enrichment course activity, and low participation as no participation. This cut off resulted in between 23% and 26% of students being grouped into the high enrichment category each summer.

In addition to considering what levels of activity participation are used to distinguish between high and low levels of participation at each level, our analyses investigate the relationship between participation levels across multiple summers and their vocabulary scores. Table 2 presents the percentage of students who participated at a high level of each activity for either zero, one, two, or three summers during the summers before fourth through sixth grade (under the heading *high levels of summer activity*).

Vocabulary Measure. The Woodcock-Johnson Psycho-educational battery Test of Achievement was used to measure children's Picture Vocabulary (PV) scores in fifth grade and at age fifteen. This vocabulary test measures verbal comprehension (i.e., naming pictured objects). This task asks children to identify one of four pictures that matches a word spoken by the examiner. Normative data for PV scores allows for standardization and comparison of scores across time (McGrew, Werder, & Woodcock, 1991; Woodcock, 1990). A person's standard vocabulary score will stay the same if their vocabulary increases at a standard rate across time. Table 2 demonstrates the mean scores of the study sample remains within a half of a standard deviation of the normed score across all waves; vocabulary growth in this sample is roughly similar to the norming sample.

Control variables. Because summer activity participation was not randomly assigned to children, the current study takes careful steps to control for confounding variables that may be related to both activity participation and vocabulary scores. The following three sections describe possible confounds which were controlled for

in Ordinary Least Squares (OLS) regression equations and used as matching variables in analyses using propensity score matching.

Vocabulary. Third grade vocabulary test scores were included in each analysis to control for vocabulary performance not long before the first summer of interest (the summer before fourth grade).

Child and Family Characteristics. Maternal education was reported by the child's mother when the child was one month old (Table 2). Average number of years of maternal education ($M = 14.23$) indicates that on average mothers completed a little over two years of school after 12th grade. Child gender was reported by the child's mother when the child was 24 months old; 48% of the sample is female. Ethnicity was coded as either white or non-white; 80% of the sample is white. The family income-to-needs ratio is based on the total family income divided by the poverty-level income for that family size based on federal guidelines. Scores between 0 and 1 indicate poverty, scores between 1.1 and 1.9 indicate near poverty, and scores greater than 1.9 indicate non-poor. The mean income to needs ratio of the sample is substantially above poverty level ($M = 4.5$). Finally, mothers reported the number of parents in the home when the child was in third grade. Eighty percent of the children in this sample lived in two parent homes.

School-year activities. The current study aims to measure how *summer* activity involvement relates to vocabulary knowledge independent of *school-year* participation. To clarify the influence of school-year and summer activities, third grade school-year activities that paralleled summer activities were controlled for. To control for the influence of school-year reading practices on test scores, the home literacy score during the school year was controlled for in analyses involving summer reading and library visits. The home literacy score was computed as the sum of points assigned to nine items related to the child's home literacy environment (Griffin & Morrison, 1997). The score was based on the mothers' answers to nine survey items related to the following: television watching; library card use; newspaper subscription score; adult magazine subscription; child magazine subscription; mother reads to self; adult reads to self; someone reads to child; and books owned by child. Each of the nine items was scored from 0 to 2 points, with 2 indicating a more positive literacy environment. Total scores range from 0–17. The home literacy score was used as a school-year control of library use.

We used the After School Time Use Child Interview, a modification of the time use interview used by Posner and Vandell (1994, 1999), to separate the influence of school-year and summer-time enrichment and unsupervised time. A guided recall format was used to obtain information about children's weekday afternoons during the third grade school year. For each fifteen minute interval from the end of the school day to 6:00pm, children were asked to report how they spent their time. The interview was completed with each child up to three times in third grade. To allow for comparisons across children, children's time use across twenty eight recorded activities were summed and then scaled to twelve intervals per interview to allow comparisons to be made across children. Values for academic enrichment ranged from 0 to 9 intervals per day. Values of unsupervised time range from 0 to 12 intervals per day.

School-year and summer activities (i.e., the independent variables of interest) are only modestly correlated with each other (Table 3).

2.3 Data Analysis

Analyses corresponding to the first research question (RQ1) illuminate relations between summer activity participation in fourth or fifth grade and fifth grade vocabulary scores. Analyses corresponding to the second (RQ2) and third (RQ3) research questions illuminate relations between participation across summers between fourth through sixth grade and vocabulary scores at age 15.

RQ1. Summer activity participation predicting vocabulary tests in grade five. The first set of analyses tested hypothesized associations between participation in specified activities during the summers before fourth and fifth grade and tests of vocabulary in fifth grade. These analyses were conducted in two steps. First, fifth-grade vocabulary tests scores of children who participated in each activity (i.e., reading, library visits, enrichment courses, and unsupervised time with peers) during fourth and/or fifth grade summers were compared with scores of students who did not participate in each summer activity. Because participants were not randomly assigned to activity participation, control variables included: third grade PV scores; gender; ethnicity; maternal education; single parent status; and family income to needs ratio. Additionally, independent school-year activity participation levels were also included as control variables (as described above).

As a robustness check against selection bias, propensity score matching was performed to match individuals who participated in each summer activity during the summers before fourth and fifth grade to those who did not participate in the activity but had a similar probability of participation. Using PSMATCH2 (Leuven & Sianesi, 2003) to perform 1-to-1 propensity score matching with replacement, propensity scores were developed to predict participation in each summer activity using control variables (i.e., third grade PV scores; gender; ethnicity; maternal education; single parent status; family income to needs ratio and participation in each activity during the school year). To determine whether each summer activity predicted tests of vocabulary, children who participated in each activity during each summer were compared to propensity-matched individuals not involved in the activity of interest during that summer.

RQ2. Cumulative summer activity participation predicting vocabulary scores at age fifteen. The second set of analyses tested the hypothesized associations between vocabulary scores at age fifteen between children who participated in each activity during either one, two, or three summers (during fourth through sixth grade) versus those who do not participate in the activity during any of these summers. Again, because participants were not randomly assigned to activity participation, a list of confounds were controlled for in this initial regression analysis (see list of control variables above). Propensity score matching was not performed in this case because the variables of interest (number of summers at high levels of activity) were not dichotomous.

RQ3. Threshold analysis of summer activity participation predicting vocabulary scores at age fifteen. The third set of analyses tested whether a minimum number of summers (i.e., a threshold) significantly related to test scores when comparing children who participated in activities above and below this threshold. The threshold of activity participation across summers was determined as the least number of summers associated with significantly different test scores for children in each activity compared to those who did not participate in the activity at all in the analyses for RQ2 above. This threshold was used to determine two groups of children for each activity (i.e., those who participated in the activity at or above the threshold versus those who did not).

As a robustness check, propensity score matching was performed to match individuals who participated in each summer activity at or above the threshold to those who did not but had a similar probability of activity participation up to the threshold. Using PSMATCH2 (Leuven & Sianesi, 2003) to perform 1-to-1 propensity score matching with replacement, propensity scores were developed predicting participation in each summer activity of interest using the control variables specified above as matching variables. To determine whether each "threshold" of summer activities predicted WJ-R tests of vocabulary test scores, children at or above the threshold were compared to propensity-matched individuals not involved in the activity of interest up to the threshold level.

3 Results

3.1 RQ1. Summer Activity Participation Predicting Vocabulary Scores in 5th Grade

Table 4 provides results from OLS and propensity score matching analysis.[1]

Reading. In both the OLS and propensity score matching (PSM) analyses, children in the high reading exposure groups during fourth or fifth grade summers scored significantly higher on vocabulary tests in fifth grade (OLS: $b = 3.04$, $p < .01$; $b = 2.68$, $p < .01$.; PSM: $b = 3.21$, $p < .05$; $b = 2.95$, $p < .001$).

Library visits. There was a positive significant relationship between library use during the summer of fourth grade and vocabulary in fifth grade in the OLS regression analyses ($b = 1.84$, $p < .05$; $b = 1.90$, $p < .05$.), but this relation was not evident in the propensity score analysis.

Enrichment. There were no significant differences on fifth grade vocabulary tests between children who attended summer enrichment classes during summers before fourth or fifth grade and those who did not.

1 Children participating in each summer activity were well matched to non-participants after propensity score matching. With few exceptions, bias in matching variables described above was reduced after propensity score matching between children involved in each summer activity versus those not involved in each activity. Comparisons after matching are described in the following section. Significance tests for an interaction between participation in each activity and maternal education were not found to be significant for any of the below analyses and were therefore omitted.

Unsupervised Time with Peers. Children who were unsupervised with peers during the summer before fifth grade displayed significantly lower vocabulary tests in fifth grade in both the OLS regressions (b = -1.87, $p < .05$) and the PSM analysis (b = -2.25, $p < .05$). There were no significant differences in the vocabulary tests of children in the high and low unsupervised groups during the fourth grade summer.

3.2 RQ2. Cumulative Summer Activity Participation Predicting Vocabulary Scores at Age Fifteen

Next, we describe associations between the number of summers that children participated in each activity between fourth through sixth grade summers and their vocabulary test scores at age 15. These results tell us about relationships between summer activities and vocabulary development for students in our sample, and help us establish a threshold for cross-summer activity levels we use in RQ3. Unstandardized coefficients and effects sizes (calculated by dividing the coefficient by the grand vocabulary standard deviation [SD = 14.8]) are reported on Table 5.

Reading. Vocabulary tests were estimated for children who had high reading participation for one, two, or three summers (versus zero summers) between fourth through sixth grade. Children who read regularly during at least three summers scored significantly higher on vocabulary tests at age 15 years (d = 0.41, $p > .001$) than children who did not regularly read at high levels between fourth through sixth grade.

Library visits. Children who regularly visited the library across all three summers scored higher on vocabulary test scores at age 15 than those who did not regularly visit the library during any summer (d = 0.22, $p < .01$).

Enrichment. Children who participated in enrichment courses for three summers demonstrated better vocabulary knowledge at age 15 (d = .49, $p < .01$) than those who did not attend enrichment courses regularly during any summer.

Unsupervised Time. Children who were unsupervised for two or three summers between fourth through sixth grade scored lower on vocabulary tests at age fifteen (d = -0.18, $p < .05$ and d = -.37, $p < .001$ respectively) than children who were not regularly unsupervised during any summer between fourth through sixth grade.

3.3 RQ3. Threshold Analysis of Cumulative Summer Activity Participation Predicting Vocabulary Scores at Age Fifteen

RQ3 results illuminate differences between individuals who participated in each activity above and below the threshold number of summers associated with significantly different test scores, as determined in response to RQ2. Unstandardized coefficients and effects sizes for both OLS and propensity score matching analysis are provided on Table 6.

Reading. In our last set of analysis (RQ2) we saw that students who reported high levels of reading for three summers had better age-15 vocabulary scores than students who did not read at high levels during any summer. Therefore, in this set

of analysis (RQ3) we compare students who reported reading at high levels during three summers with those who read at high levels for only two summers or less using OLS and propensity score matching. Both approaches indicate that those who read during at least three summers scored significantly higher on vocabulary tests at age 15 (OLS $d = .27$, $p < .001$; PSM $d = .28$, $p < .001$).

Library visits. Children who regularly visited the library across all three summers scored higher on vocabulary tests at age 15 than those who did not regularly visit the library during the summer. Accordingly, three summers was determined as the threshold for RQ3 analysis. However, although the parameter associated with 3 summers of high levels of library patronage was significant in the OLS analysis (OLS $d = .26$, $p < .001$), it was not in the propensity score matching model.

Enrichment. Three summers was used as the threshold for analyzing the relationship between enrichment attendance and vocabulary. OLS threshold analysis (OLS $d = .46$, $p < .001$) suggests the importance of consistent attendance in enrichment classes. However, after matching, no significant differences in age fifteen vocabulary scores were found between children who did or did not regularly attended enrichment courses for three summers.

Unsupervised Time. In both OLS and propensity score matching models, children who were unsupervised for two summers or more scored significantly lower on vocabulary tests (OLS $d = -0.25$, $p < .001$; PSM d = -0.19, $p < .01$) than children who experienced zero or one summer with an unsupervised period.

4 Discussion

Findings from this study fill gaps in the literature concerning relations between summertime activity involvement and vocabulary knowledge. Specifically, three issues were addressed: (1) whether participation in specific activities during the summers before fourth and fifth grade is related vocabulary test scores in fifth grade; (2) whether cumulative activity participation across summers between fourth and sixth grade predicts vocabulary test scores at age fifteen; and (3) whether there is a threshold number of summers in each activity associated with vocabulary test scores at age 15.

The most consistent finding is that reading is an important predictor of vocabulary knowledge in both the short and long term. Findings indicated that summer reading during fourth and/or fifth grade is positively associated with higher vocabulary scores whereas unsupervised summer time during fifth grade is related to lower PV scores. Three summers of reading between summers before fourth through sixth grade predict higher vocabulary scores at age 15. These findings are consistent with previous research showing that reading during the summer is associated with subsequent positive academic achievement (e.g., Kim, 2004). Current findings add to the literature by revealing that reading during the summer is not only associated with short term academic achievement in grade 5, but is associated with longer term academic achievement in later adolescence as well. Further, the current paper provides evidence that consistent reading across each summer between fourth through sixth is the activity threshold associated with higher vocabulary at age 15. If this finding

holds across future studies, careful attention should be paid to fostering reading opportunities for children across multiple summers.

The finding that unsupervised time with peers during the summer is associated with lower vocabulary scores adds to the literature on unsupervised time during elementary school and during the summers. Unsupervised time has previously been associated with misconduct and problem behaviors. The current findings suggest that at least two summers of unsupervised time are also related to lower vocabulary scores in later adolescence. The lack of research on the relation between unsupervised time during elementary grades and academic achievement may be explained by the fact that at least two summers of unsupervised time are required before significant differences in test scores appear.

The finding that library use and enrichment participation were only associated with significant findings before propensity score matching may suggest that selection differences were controlled through propensity score matching. The magnitude of the effect sizes yielded by summer enrichment activity participation is noteworthy. A review of out-of-school programs indicated that program effect sizes are strongly related to high levels of program implementation and consistency of implementation (Durlak & DuPre, 2008). Specifically, programs that were consistently implemented have yielded effect sizes as high as .50. Because the current study analyzed activity dichotomously, as either at or above previously determined "effective" levels of activity involvement (based on past literature) it makes sense that effect sizes would be similar to effect sizes for "high levels of implementation." The fact that these activities are not significant in the propensity score matching analyses suggest that these classes may be enrolled in by families with other advantages and so selection bias needs to be carefully considered when estimating the impact of these programs.

Limitations and Future Directions

While this study adds to the literature on summer and vocabulary development, several limitations should be noted. First, while the sample was ethnically and economically diverse, the NICHD dataset does not include language minority children because the initial sample was created from a pool of English speaking mothers. A nationally and linguistically representative sample is needed to make broader generalizations about findings.

A second limitation is that this study was not a randomly assigned experiment. However, use of controls and propensity score matching provided a strong test of quasi-experimental research. Importantly, school-year activities that closely matched summer activities of interest were included as control variables in the regular regression analyses and matching variables in the propensity score matching analyses. Inclusion of school-year activities allowed for a more precise measure of the association between activity involvements *during the summer* without confounding participation in the activity during the school year. Future studies can similarly benefit from inclusion of school-year activities as controls if the goal is to isolate effects of summer activities, independent of school year activity participation.

Future research should measure activity quality. This study did not take into account activity quality because this measure was not available. This is a limitation because quality of out-of-school time experiences has been shown to be significantly linked to outcomes (Pierce, Hamm, & Vandell, 1999; Posner & Vandell, 1994; Rosenthal & Vandell, 1996; Vandell et al., 2006). Similarly, the current study was limited by the inability to account for activity content. For example, the relation between library use and test scores may depend on the content of what children do while at the library. As with any activity, the content of the experience (e.g., whether a student completed research in the library or talked to friends) should be considered in studies of summer experiences. For example, the null findings associated with enrichment activities could be related the fact that enrichment activities in this study were measured as a hodgepodge of different sorts activities without knowledge of organization level or quality. Future studies would benefit from looking at whether specific enrichment activities are related to vocabulary scores. Future studies that use more specific measures of summer activities and specific learning processes within the activities would be informative.

Despite limitations, this study begins to fill gaps in the literature concerning the relation between summer experiences (during middle childhood in the summers between fourth through sixth grade) and measures of vocabulary up to age fifteen. The current study's findings that specific elementary summer experiences predict vocabulary at age fifteen provide impetus for further research into understanding potentially effective summer learning opportunities. This study indicates that studying activity involvement cumulatively across summers and over time is important to understanding relationships between activities and outcomes over time. Overall, current findings fit with past literature demonstrating that summer learning during elementary school explains academic achievement into high school (Alexander et al., 2001) and provide more information about what activities are related to a specific measure of vocabulary development.

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Table 1. Distribution of scores along the six point scales of activity involvement

	>1x/ month	≈ 1x/ month	2-3x/ month	≈ 1x/ week	few x/ week	≈ daily	N	Total % in "high" group
Reading								
Grade 4	2%	6%	9%	15%	*29%*	*39%*	957	68%
Grade 5	3%	7%	12%	14%	*28%*	*36%*	987	64%
Grade 6	4%	6%	11%	14%	*27%*	*38%*	949	65%
Library Visits								
Grade 4	37%	23%	*20%*	*16%*	*4%*	*1%*	951	41%
Grade 5	38%	25%	*16%*	*16%*	*4%*	*1%*	975	37%
Grade 6	43%	24%	*15%*	*13%*	*4%*	*1%*	944	32%
Unsupervised Time								
Grade 4	61%	*4%*	*5%*	*7%*	*13%*	*9%*	948	38%
Grade 5	56%	*7%*	*7%*	*8%*	*14%*	*9%*	982	45%
Grade 6	50%	*7%*	*8%*	*11%*	*14%*	*10%*	948	50%
	None	1 day–1 week	2–3 weeks	4 weeks	5–7 weeks	≥ 8 weeks	N	Total % in "high" group
Enrichment								
Grade 4	74%	*9%*	*8%*	*3%*	*3%*	*2%*	940	26%
Grade 5	74%	*10%*	*9%*	*3%*	*2%*	*2%*	969	26%
Grade 6	77%	*10%*	*7%*	*2%*	*3%*	*2%*	937	23%

Note: The frequencies for each activity align with the frequencies on the parent questionnaire soliciting amount of time their child spent in each activity during the previous summer. Parents were asked to circle a number (1-6) to indicate which category of time their child spent on each activity. For "reading," "library visits,' and "unsupervised time" category options range from "less than once a month" to "almost every day" as indicated in the top columns. For "enrichment" category options ranged from "none" to "8 weeks or more" as indicated by the column headers directly above "enrichment." The numbers in italics represent categories that are part of the "high" activity involvement group for certain analyses, whereas percentages that are not in italics represent activities part of the "low" activity involvement for the given activity.

Table 2. Demographic Characteristics of Children and Families

		N	%	Mean	SD	Range
Demographics						
Maternal education				14.23	2.51	7 to 21
Female children		1364	48%			
Ethnicity: white		1364	80%			
Family income/needs		985		4.5	3.88	.07 to 32
Two parent homes		1045	80%			0 to 1
Home Literacy Score		1016		10.31	3.57	1 to 17
Enrichment		1022		.45	.90	0 to 9
Unsupervised Time		1022		1.78	2.37	0 to 12
High levels of summer activity						
Reading	0 Summers	889	12%			
	1 Summer	889	20%			0 to 1
	2 Summers	889	20%			0 to 1
	3 Summers	889	49%			0 to 1
Library	0 Summers	889	20%			
	1 Summer	889	17%			0 to 1
	2 Summers	889	24%			0 to 1
	3 Summers	889	39%			0 to 1
Enrichment	0 Summers	889	51%			
	1 Summer	889	27%			0 to 1
	2 Summers	889	14%			0 to 1
	3 Summers	889	7%			0 to 1
Unsupervised	0 Summers	889	33%			
	1 Summer	889	25%			0 to 1
	2 Summers	889	20%			0 to 1
	3 Summers	889	22%			0 to 1
Vocabulary						
Grade 3		1014		105.47	14.8	34 to 152
Grade 5		992		103.1	14.8	29 to 155
Age 15		889		99.93	14.8	34 to158

Note: Maternal education is measured by years of schools starting in first grade. The mean of 14.23 represents completion of 2.23 years of school after 12th grade. For analysis purposes, ethnicity was collapsed into white versus all other ethnicities. A family income/needs ratio of 0–1 indicates poverty, 1.1–1.9 indicates near poverty, and greater than 1.9 indicates non-poor. Two parent homes is a measure of how many children live with two parents (instead of only one).

Table 3. Correlations between activity involvement during summer (left column) and school year (top row) activities

Summer	School-year		
Activity	Literacy Score	Enrichment	Unsupervised
Reading			
Grade 4	*.30***	.04	-.06
Grade 5	*.29***	.09**	-.05
Grade 6	*.31***	.11***	-.06
Library			
Grade 4	*.22***	.10**	-.08*
Grade 5	*.18***	.07*	-.04
Grade 6	*.14***	.03	-.06
Enrichment			
Grade 4	.17***	*.07**	.05
Grade 5	.14***	*.07**	-.04
Grade 6	.21***	*.09***	.01
Unsupervised			
Grade 4	-.16***	-.06	*.12****
Grade 5	-.21***	-.03	*.10***
Grade 6	-.15***	-.12**	*.12****

Note: The numbers in *italics* represent matched school and summer year variables.

*p < .05; ** p < .01; *** p < .001

Table 4. Regression Coefficients (and Standard Errors) of Summer Activity Involvement and Vocabulary Scores in Grade 5 for OLS and Propensity-Score Matching Analysis

	OLS Regressions	Propensity Score Matching
Reading		
Grade 4	3.04** (.96)	3.21* (.79)
Grade 5	2.68** (.92)	2.95*** (.82)
Library		
Grade 4	1.84* (.90)	-.71 (1.15)
Grade 5	1.90* (.90)	.87 (1.24)
Enrichment		
Grade 4	1.26 (1.02)	.37 (1.51)
Grade 5	1.78 (.99)	2.10 (1.49)
Unsupervised		
Grade 4	-1.32 (.93)	-.12 (1.12)
Grade 5	-1.87* (93)	-2.25* (1.05)

Note. Study members were categorized as involved in each activity at least once per week or not. Controls variables include: 3rd grade vocabulary score; sex; mother's education; family income to needs ratio; whether or not the family is a singly family household; child's race; data collection site; involvement in specific activity during school year. The same variables used as controls were used as matching variables in the propensity score matching analysis.

*p < .05.; ** p < .01; *** p < .001

Table 5. OLS Regression Coefficients (and Standard Errors) of Summer Activity Involvement during One, Two, or Three Summers compared to Zero Summers (During 4th–6th Grade)

	Vocabulary Scores	
	OLS Coefficient	Effect Size
Reading		
1 summer	.80 (1.74)	0.05
2 summers	2.85 (1.75)	0.19
3 summers ◊	6.02*** (1.51)	0.41
Library		
1 summer	-.48 (1.19)	-0.03
2 summers	-.26 (1.33)	-0.02
3 summers ◊	3.31* (1.36)	0.22
Enrichment		
1 summer	.78 (1.15)	0.05
2 summers	1.01 (1.39)	0.07
3 summers ◊	7.26** (1.86)	0.49
Unsupervised		
1 summer	-1.80 (1.25)	-0.12
2 summers ◊	-2.66* (1.37)	-0.18
3 summers	-5.44*** (1.35)	-0.37

Note. Controls variables include: either 3rd grade vocabulary score; sex; mother's education; family income to needs ratio; whether or not the family is a singly family household; child's race; data collection site; involvement in specific activity during school year. The same variables used as controls were used as matching variables in the propensity score matching.

◊ indicates the "threshold" or least number of summers associated with either significantly higher or lower test scores than children who did not participate in the activity during any summer measured.

*p < .05.; ** p < .01; *** p < .001

Table 6. OLS and Propensity Score Matching Analysis of Activity Thresholds Predicting Vocabulary Scores at Age 15

	OLS Coefficients	Effect Size	Propensity Score Matching	Effect Size
High Reading	3.93***	0.27	4.07***	0.28
(3 summers vs. 0, 1, 2 summers)	(1.14)		(1.29)	
High Library Patronage	3.92**	0.26	2.97	0.20
(3 summers vs. 0, 1, 2 summers)	(1.38)		(2.07)	
Attending enrichment	6.76***	0.46	4.98	0.34
(3 summers vs. 0, 1, 2 summers)	(1.78)		(3.35)	
Unsupervised time	-3.67***	-0.25	-2.75**	-0.19
(3 & 4 summers vs. 0, 1 & 3 summers)	(.98)		(1.09)	

Note. Controls variables include: either 3rd grade vocabulary score; sex; mother's education; family income to needs ratio; whether or not the family is a singly family household; child's race; data collection site; involvement in specific activity during school year. The same variables used as controls were used as matching variables in the propensity score matching.

*p < .05.; ** p < .01; *** p < .001