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ABSTRACT

The effect of group size, staff-child ratio, training, and other characteristics of child care on child development is estimated using data from the National Longitudinal Survey of Youth. In contrast to most previous research, the sample is large and nationally representative, the data contain good measures of the home environment, and there are repeated measures of child development. Child care characteristics have little association with child development on average. Associations are found for some groups of children, but they are as likely to be of the "wrong" sign as they are to be of the sign predicted by developmental psychologists.

I. Introduction

The majority of young children in the United States spend a large amount of time in the care of adults other than their parents. It is therefore important to ask how the characteristics of the child care experienced by children affect their development. The interactions young children have with adults and other children are among the most important external determinants of their social, emotional, and cognitive development. And there is little doubt that the development of young chil-

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dren influences their subsequent outcomes as adults. A child who spends 40 hours per week in child care is exposed to the influence of the child care provider for close to half his or her waking hours, and it is natural to expect the child's development to be affected by this influence.

The effect of child care on child development has been an important research question in the developmental psychology literature for about two decades. This research started with the issue of whether nonmaternal child care harms the emotional development of infants, but has evolved in the last decade or so to asking how the quality of child care affects child development. The quality of child care is defined in this literature by the nature of the interactions between the provider and children, and the nature of the environment, curriculum, and materials to which children are exposed in the child care arrangement. A child care arrangement is deemed to be of high quality if the interactions, environment, and so forth are rated relatively high on scales of "developmental appropriateness." For example, teachers can be rated by observers on how sensitive they are to children, whether they encourage children to be engaged in activities, use positive guidance techniques, and encourage independence (Love, Schochet, and Meckstroth 1996). Child care arrangements can also be rated on health and safety practices and the developmental appropriateness of the materials, play equipment, and curriculum. It is almost tautological that child care quality measured in this manner will have a positive effect on child development, since quality is *defined* by provider behavior and environments that have been determined through research and practice to foster child development. Indeed, there is a considerable amount of evidence that child care quality is positively associated with child development (Love, Schochet, and Meckstroth 1996).

A more controversial issue is how to "produce" high quality child care. Many developmental psychologists claim that caring for children in relatively small groups with a high ratio of adults to children and with providers who have been trained in early childhood education is the key to providing child care of high quality. This is an important assertion because the quality of child care as described above is costly to measure, requiring trained specialists to spend up to a day observing and rating each provider. This makes it impractical to use quality as the basis for regulating and subsidizing child care. Characteristics such as group size, staff-child ratio, and provider training are more easily observed and measured and therefore serve as the basis for regulation of child care providers by state governments and eligibility for federal and state subsidies. However, the evidence in the developmental psychology literature linking the characteristics, or "inputs" to the quality of care is not strong. Elsewhere, I review this evidence in detail and report on a sensitivity analysis in which I found that evidence of the type produced in this literature is not robust to changes in functional form and to allowing for unobserved heterogeneity among providers (Blau 1997). The evidence shows that there are large differences across providers in the United States in the quality of care, but these differences are only weakly related to differences in the inputs once the influence of unobserved heterogeneity is accounted for. These results are quite similar to findings that easily measured school resources often have weak effects on student achievement (Hanushek 1996). Knowing that high quality child care is good for children is of little use for policy if we do not know how to produce high quality child care.

In this paper I analyze the relationship between child care inputs and child devel-

opment outcomes. This approach provides direct evidence on whether easily observed and regulatable attributes of child care arrangements have an impact on children. If they do, then the absence of a strong association between the inputs and the quality of child care is less worrisome, since the ultimate concern is child development, not child care quality. The inputs might, for example, affect children through mechanisms other than the quality of child care. On the other hand, if there is little impact of the inputs on child development then the lack of a strong relationship between the inputs and child care quality is of more concern and it would be important to rethink government child care policies that are based on the inputs.

There are many studies in the developmental psychology literature that examine the relationship between child care inputs and child development outcomes. I review this literature in Section II, and find that much of it is uninformative. Only one study presents persuasive evidence of a positive link, and it is not clear how robust the results of this study are. In Section III, I discuss issues involved in modeling and estimating the effect of child care inputs on child development and present the model and estimation strategy. Section IV describes the data, which are from the National Longitudinal Survey of Youth (NLSY). These data have a number of important strengths for analyzing child development, and while they have been widely used for this purpose there have been few efforts to estimate the effects of child care inputs on child development with the NLSY. The data have some drawbacks for this purpose, but I argue that it is nevertheless possible to derive useful information from the NLSY on the child care inputs. The empirical results are presented in Section V. They indicate that on average group size, staff-child ratio, and provider training have little association with child development outcomes. For some groups of children and some types of child care, associations do exist, but they are as likely to be of the opposite sign as predicted by the literature as they are to be of the "right" sign. Many of the associations that do exist are not robust to controls for unobserved heterogeneity that causes spurious correlation between the child care inputs and child outcomes. Section VI concludes by discussing the implications of the results for government child care policy.

II. Previous Literature

Recent reviews of the literature by Love, Schochet, and Meckstroth (1996), Doherty-Derkowski (1995), Dunn (1993a), Lamb (in press), and Hayes, Palmer, and Zaslow (1990) identify about 30 studies of the effects of child care inputs on child development or child behavior. Only about one-third of these studies provide interpretable results.[1] Around half of the latter group find that either smaller groups, more staff per group, or better trained teachers have positive and statistically

1. Some studies group child care arrangements into clusters based on the values of several of the inputs and analyze the association between clusters and child outcomes (for example Broberg et al., 1997; Field, 1980; Howes and Rubenstein, 1985; Howes and Olenick, 1986; Kontos, 1991; Peterson and Peterson, 1986; Vandell and Powers, 1983; Studer, 1992). This approach does not provide estimates of the impact of varying each input separately. Others do not present coefficient estimates or in some cases even the signs of the estimated effects of the inputs (for example Howes et al., 1998; Phillips, McCartney, and Scarr, 1987; Smith and Connolly, 1986; Howes and Rubenstein, 1981; Kontos and Fiene, 1987).

significant effects on child development and behavior. The others find either no statistically significant effects of any of the inputs or statistically significant effects of the "wrong" sign. Many of these studies present simple correlations between inputs and child outcomes without controls for other variables, including other inputs. Most of these studies suffer from small sample size, nonrandomly selected convenience samples, few or no measures of family and child characteristics, no measure of child development prior to exposure to the child care arrangement being studied, and no control for self-selection of children into child care arrangements. The problem of self-selection is likely to be especially important in this context. Parents who provide a home environment that fosters positive child outcomes would plausibly select child care arrangements that do so as well. In the absence of measures of the home environment it is easy to imagine that spurious correlation between the child care inputs and child outcomes could exist. Most of the studies include only a few measures of the home environment, such as the mother's education and family income, and do not consider the possibility of selection on unobserved aspects of the home. In view of this and the other problems mentioned above it is hard to know how much credence to give to the results of these studies.[2]

One of the studies was better designed than the others, and its results may be more credible. The National Day Care Study (NDCS; Ruopp et al., 1979) closely monitored a sample of 64 day care centers and approximately 1,600 of the children they served for a period of about nine months. The children were given baseline developmental assessments and were assessed again at the end of the nine month period during which classroom activities and inputs were monitored. The study design included two experiments in which some children were randomly assigned to classrooms with different staff-child ratios and teachers with different levels of training. The results indicated that preschool age children (ages three to five) in classrooms with smaller groups and teachers with training in early childhood education made greater gains on tests of language receptivity and general knowledge and showed more cooperative behavior than other children. Staff-child ratio was not associated with child development for preschoolers, but was for toddlers (ages one to two). Doubling group size from 12 to 24 was estimated to reduce the proportion of time spent by children in cooperative and reflective/innovative activities by about one percentage point each; and to reduce Fall-to-Spring gains on the Peabody Picture Vocabulary Test by 1.7 points, a 23 percent effect. These results have been widely cited, and the NDCS report is a model of clarity and thorough discussion. Nevertheless, this study does have some of the problems cited above. The centers were not randomly selected, but rather were chosen to be representative of centers that serve predominantly low-income children in urban settings. The analysis included more than the usual one or two measures of the home environment, but did not deal with the self-selection problem and in most analyses did not include all three inputs in the same model. The analysis of child development was conducted using centers rather than children as the unit of analysis, and the sensitivity of the results to unob-

2. The studies on which the statements in the text are based include Burchinal et al. (1996), Clarke-Stewart and Gruber (1984), Dunn (1993b), Holloway and Reichart-Erickson (1988), Howes et al. (1988), Kontos, Hsu, and Dunn (1994), McCartney (1984), Parcel and Menaghan (1990), Ruopp et al. (1979), and Smith et al. (1988). Most of these studies examined multiple child outcomes. The studies that found statistically significant effects of the inputs usually found such effects for a minority of the outcomes examined.

served center characteristics was not examined. The NDCS report is noteworthy for discussing these issues carefully:

> "If an unmanipulated center characteristic, such as group size, proved to be associated with several quality measures (as in fact it did), that association might be due to a causal relationship between group size and quality, but it might also be due to unmeasured center characteristics that were associated with both group size and the particular quality measures in question" (Ruopp et al. p. 79)

However, the sensitivity of the results to unobserved heterogeneity has not been assessed.[3]

Several studies have used the NLSY to analyze the determinants of child development. These data have large samples of children, and good measures of child development and home inputs (repeated in some cases). Some studies have included in their specifications variables related to child care and/or maternal employment. However, most have used measures of the mode of child care (for example, day care center, family day care home, etc.), the age at which the child entered nonmaternal care, or just maternal employment indicators.[4] Parcel and Menaghan (1990) and Studer (1992) are the only studies using the NLSY that included child care inputs. Parcel and Menaghan report that the staff-child ratio had a negative but statistically insignificant effect in a model of the Peabody Picture Vocabulary Test (PPVT) score in an analysis of the 1986 cross-section. Studer combined group size and staff into an "index of quality," which had a positive but statistically insignificant effect on PPVT in a sample of 95 children from the 1986 wave.[5]

3. Two other studies with potentially useful sample designs include the Florida Child Care Quality Improvement Study (Howes et al. 1998) and the Study of Early Child Care (NICHD, 1996). In 1992 the legal minimum staff-child ratio for day care centers in Florida was raised from 1:6 to 1:4 for age zero, 1:8 to 1:6 for age one, and 1:12 to 1:11 for age two. The new regulations also increased the amount of training that new staff members are required to complete within one year of hiring from 20 to 30 hours. To evaluate the effects of the regulatory changes, a sample of 150 day care centers in four Florida counties was drawn before the new regulations went into effect. Three classrooms in each center were observed and two randomly selected children in each classroom were given developmental assessments. The centers were revisited two years later and the same process repeated. However, the children assessed in the second visit were *not* the same children who had been assessed at the first visit, so it is not possible to determine if the observed gains in development were caused by the regulations or by changes in the clientele. The NICHD study has followed a sample of 1,300 children from birth through age six, closely monitoring their home and child care environments and their development. Results on the effects of child care characteristics on child outcomes are not yet available.

4. Baydar and Brooks-Gunn (1991); Blau and Grossberg (1992); Desai, Chase-Lansdale and Michael (1989); Korenman, Miller, and Sjastaad (1995); Mott (1991).

5. Evaluations of Head Start and other preschool intervention programs could in principle provide very useful information on the effects of the inputs. However, virtually all evaluations of such programs compare outcomes for a group of children subjected to the "treatment" to a control or comparison group not treated, but do not estimate the impact of the specific features of the program such as group size and teacher training. See Currie and Thomas (1995) for a recent evaluation of Head Start, and Barnett (1992) and Campbell and Ramey (1994) for evaluations of the Perry Preschool Project and the Carolina Abecedarian Project, two well-known early intervention programs. Bryant et al. (1994) analyze the effect of a summary indicator of Head Start classroom quality on child outcomes but do not study the effects of attributes such as group size and teacher training.

III. Models and Methods

The goal of the analysis is to estimate a "production function" for child outcomes such as scores on tests of ability, achievement, and behavior. A commonly used value-added specification for a child-outcome production function is (see for example Blau, Guilkey, and Popkin 1996; and Hanushek 1992)

$$(1)\quad Y_{ij,t+1} = \alpha_1 H_{ijt} + \alpha_2 Q_{ijt} + \alpha_3 X_{ijt} + \alpha_4 Y_{ijt} + \alpha_5 S_{ijt} + \mu_j + \delta_{ij} + \varepsilon_{ijt}$$

where Y is an outcome for the ith child in the jth family at time $t + 1$, H represents the quantity and quality of home inputs, Q is a vector of the quantity and quality of child care inputs, X is family and child characteristics, S represents the quantity and quality of school inputs, μ is a family effect, δ is a child effect, and ε is a transitory (serially uncorrelated) effect. The model is dynamic, allowing the period t outcome to influence the period $t + 1$ outcome, and the inputs operate with a lag: development takes time. Child outcomes and home inputs are measured every other year in the NLSY, so the length of a period is two years in the empirical analysis. If the researcher does not observe μ_j, δ_{ij}, and ε_{ijt} but parents do, and if parents choose some of the inputs based on these unobserved variables, then estimates that do not account for unobserved heterogeneity will be biased. Even if parents do not choose the inputs, Y_{ijt} will be correlated with μ_j and δ_{ij}.

By substituting lagged versions of Equation 1 repeatedly for Y_{ijt} a "whole-history" version of the production function can be derived:

$$(2)\quad Y_{ij,t+1} = \sum_{k=0}^{t} \beta_{1k} H_{ijk} + \sum_{k=0}^{\max\{t,5\}} \beta_{2k} Q_{ijk} + \sum_{k=0}^{t} \beta_{3k} X_{ijk} + \sum_{k=6}^{t} \beta_{4k} S_{ijk} + \beta_5 \mu_j + \beta_6 \delta_{ij} + \sum_{k=0}^{t} \beta_{7k} \varepsilon_{ijk}$$

where the βs are functions of the αs, the child care inputs have direct effects only during the preschool years, the school inputs only during school-age years, and define $\sum_{k=6}^{t} = 0$ if $t < 6$. This specification avoids the problem of correlation between the lagged outcome and the error components, but requires the entire history of a child's inputs.

In order to characterize the models that can actually be estimated it is necessary to describe the availability of child care and child development data in the NLSY. A large amount of information on child care has been collected in the NLSY, but at irregular intervals. Table 1 shows the child care items collected from 1979 through 1992. Retrospective histories of the child care arrangements used for every child during the first three years of life were collected in 1986, 1988, and 1992. These histories provide the mode of each arrangement and in some cases the number of months of care and the child's age at entry. From 1982 through 1986 and again in 1988 information on various aspects of child care arrangements used during the four weeks prior to the survey date was collected. In some years this information was collected only if the mother was employed, in school, or in a training program. In

Table 1
Child Care, Home Inputs, and Child Development Data in the NLSY, 1979–92

Survey Year	Retrospective Child Care History for Every Child by Age, Ages 0–2	Child Care Used During the Four Weeks Prior to the Survey			Child Development and Home Inputs
		Mode, Hours, Paid Cash	Amount Paid	Group Size, Staff, Specialized Training	
1979–81					
1982		If Mother is Employed, In School, or in Training (EST); youngest and next youngest child; primary arrangement only			
1983		EST; youngest child; Primary and Secondary Arrangements (PSA)			
1984					
1985		EST; youngest child from 1984 (youngest child in 1985 if no children in 1984); PSA			
1986	Number of Arrangements and mode (NAM)	Every child (total amount paid only)			Home: all BPI: 4+ PIAT: 5+ PPVT: 3+

1987					
1988	NAM; Number of months per arrangement (MPA) and total	Every child (total amount paid only)			Home: all BPI: 4+ PIAT: 5+ PPVT: 3+; repeat if 10–11
1989					
1990					Home: all BPI: 4+ PIAT: 5+ PPVT: 4+; repeat if 10–11
1991					
1992	NAM; MPA; age of child at entry				Home: all BPI: 4+ PIAT: 5+ PPVT: 3+

some years information was collected only for the youngest child or the two youngest children, while in other years data for all children were collected. In all six of these years the items include the mode and hours of care, and whether any cash payment was made. In four of the years, additional information on the amount paid was collected. And in three of the years, the number of children cared for in the same group, the number of adult care providers per group of children, and whether the main provider had received any training in early childhood education and development were ascertained. These are the child care inputs that are the main focus of the analysis. The last column of Table 1 shows that the children of the NLSY have been assessed every other year beginning in 1986, with some measures repeated at each assessment and others given less often (details on the measures are provided in the next section).

The fact that the child care inputs of interest were measured in only three of the survey years and that child development was measured in four survey years limits the sample that can be used in the analysis, and precludes use of estimation methods that fully account for unobserved heterogeneity. In particular, it is impossible to use a child-fixed-effects (within-child) estimator to control for endogeneity caused by δ_{ij} in Equations 1 and 2. Estimation of Equation 1 by Ordinary Least Squares (OLS) requires two observations per child as a result of the presence of the lagged dependent variable as a regressor. A child fixed effects estimator involves first-differencing Equation 1, and therefore requires three observations per child on the outcome and two observations on the lagged inputs. But as a result of the sequence in which the input and development data were collected, this combination of data is not available for any child. Furthermore, data on school inputs are not available in the NLSY.[6] As a result of these two considerations, the only version of Equation 1 that can be estimated with the NLSY omits school inputs, and is estimated by OLS. The estimates are therefore potentially biased as a result of unobserved heterogeneity (correlation between the regressors and δ_{ij} and μ_j). On the other hand, the availability of good measures of the home environment and family background (described below) reduces the potential for omitted variable bias if home inputs are correlated with child care inputs. As noted previously, this has been a potentially serious problem in most previous studies of the effects of the inputs on child development.

An alternative statistical approach to dealing with the possible endogeneity of many of the regressors in Equation 1 is Instrumental Variables (IV). As described below, there are many potentially endogenous home and child care inputs in H_{ijt} and Q_{ijt}, so this method requires the availability of many instruments that are good predictors of the inputs, have no direct impact on the child outcomes, and are uncorrelated with the disturbance in the production function. Many of the potential candidates for instruments are already included in the model in X_{ijt}, the vector of child and family characteristics. For example, in the empirical analysis X_{ijt} includes variables characterizing the mother's childhood environment such as her mother's education and presence in the home. Other possible instruments such as state child care regula-

6. A survey of schools attended by the children of the NLSY was conducted in 1994–95. This survey collected much useful information, but it covers a period after the end of the sample period used in this study.

tions have been shown to have effects in the child care market that are quite fragile with respect to changes in specification such as inclusion of state fixed effects (Blau 1993). Thus IV estimation is not feasible in this case.

Data limitations also preclude estimation of Equation 2. Instead, I estimate two special cases of Equation 2. The first is:

$$(3)\quad Y_{ij,t+1} = \beta_1 H_{ijt} + \beta_2\left(\sum_{k=0}^{2} Q_{ijk}/3\right) + \beta_3 X_{itk} + \left\{\sum_{k=6}^{t} \beta_{4k} S_{ijk} + \beta_5 \mu_j + \beta_6 \delta_{ij} + \sum_{k=0}^{t} \beta_{7k} \varepsilon_{ijk}\right\}$$

This specification includes only one lag of the home inputs (H) and family and child characteristics (X) and includes child care inputs averaged over the first three years of life (or as many of the first three years for which the inputs are available). Averaging is necessary because there are very few children for whom child care inputs were measured in each of the first three years of life. School inputs are not included; the composite error term is in braces. If the child care and home inputs are highly correlated over time as a child ages, then this specification will be an adequate approximation to Equation 2. For children who remain in the same mode of care in two successive years, the correlation between group size in the two years is .54, between staff-child ratio in the two years is .58, and between training in the two years is .78. And the two-year-apart correlations in the two summary measures of the home environment described below are .53 and .72. These are high enough correlations to suggest that this specification will provide useful results. This model is estimated by Ordinary Least Squares (OLS) and by the method of Mother Fixed Effects (MFE). The latter method exploits the fact that there are a large number of families in the NLSY with more than one child. The MFE method averages the terms in Equation 3 over all the observations for a given family and subtracts the average from Equation 3. This eliminates any observed and unobserved variables that do not vary within a family, and therefore eliminates any bias caused by correlation between the regressors and μ_j, the mother fixed effect. For example, families with above-average unobserved preferences for or ability to produce good child developmental outcomes may tend to place their children in child care arrangements with better inputs. In this case μ_j would be correlated with Q_{ijk} and the MFE estimates would be free from bias resulting from this correlation whereas the OLS estimates would be biased.

The other special case of Equation 2 is

$$(4)\quad Y_{ij,t+1} = \beta_1 H_{ijt} + \beta_{2a}\left(\sum_{k=0}^{2} Q_{ijk}/3\right) + \beta_{2b}\left(\sum_{k=3}^{5} Q_{ijk}/3\right) + \beta_3 X_{itk} + \left\{\sum_{k=6}^{t} \beta_{4k} S_{ijk} + \beta_5 \mu_j + \beta_6 \delta_{ij} + \sum_{k=0}^{t} \beta_{7k}\, \varepsilon_{ijk}\right\}$$

This model adds to Equation 3 child care inputs averaged over all of the second three years of life for which the inputs were measured. The sample of children for whom inputs were measured in at least one of the first three years and at least one of the second three years of life is fairly small, and includes few siblings, so mother fixed-effect estimates are not possible in this case.[7] Comparison of estimates of Equation 3 by OLS and MFE will provide a partial check for the influence of fixed family-level unobserved heterogeneity, but the potential bias caused by fixed or transitory child-level heterogeneity and transitory family heterogeneity cannot be controlled in this study. The inclusion of extensive measures of family background and home inputs will mitigate this potential bias.

IV. Data

The NLSY has surveyed since 1979 a sample of individuals who were aged 14 to 21 in 1979. The original sample of 12,652 included a random sample and oversamples of Blacks, Hispanics, low-income Whites, and military enlistees. The low-income White and military oversamples were eventually dropped from the survey. Every other year beginning in 1986 all children of female sample members have been given a battery of developmental assessments and the mothers have been asked a series of questions about the home environment and child behavior. I use data from 1979 through 1992 on the mothers and from 1986 through 1992 on the children, including all children who were ever assessed. All descriptive statistics and estimates are weighted by the mother's original 1979 sample weight.

A disadvantage of the child care data is that the inputs are reported by the mother rather than being recorded by trained observers who visit the child care arrangement, as in most studies in the developmental psychology literature.[8] A major advantage of the NLSY data on child care inputs is that they are available for a large random sample of children. Below, I evaluate the potential impact of measurement error in the child care inputs.

Table 2 provides descriptive statistics on the child care variables used in the analysis, by age of the child. On average, 44 percent of children aged zero through two years (infant-toddlers) were in a nonparental child care arrangement, and the percent-

7. The mother fixed-effect method could in principle be used to estimate Equation 1 as well, but in practice the number of cases in which there are multiple children in a family with the necessary data is too small to obtain reliable estimates. Currie and Thomas (1995) estimate MFE models of child development using the NLSY, but do not examine the effects of child care.

8. One study checked reports of the child care inputs by the mother against direct observations of the child care arrangement for a sample of family day care homes (Kontos et al., 1995). The study reports correlations, but no direct measures of the rate of agreement. The correlations between the mother report and direct observations were .76 for group size, .54 for the number of adults, and .28 for training. Another study checked parent reports of inputs against reports from a telephone interview with the provider for a sample of centers and family day care homes (Hofferth, West, and Henke 1994). This study reported t-tests for differences in means. For family day care homes the p-values from these tests were .77 for group size, .63 for child-staff-ratio, and .23 for training, suggesting that on average parent reports are close to provider reports. For centers the p-values were .000, .000, and .707, respectively, suggesting that parents who use centers are less well-informed about the inputs.

age increases with age. This variable is from the retrospective histories that cover all children. On average, 71 percent of children aged three through five (preschoolers) are in nonparental child care, but data for these ages are from the "last four weeks" questions, which are available only for certain years and in some cases only if the mother is employed, in school, or in training. In the analysis that follows, all of the child care variables are set equal to zero at a given age if nonparental child care was not used by the child at that age. Thus the child care variables can be interpreted as being interacted with the nonparental child care dummy. However, the descriptive statistics on the other child care variables in Table 2 exclude cases in which nonparental child care was not used (as well as cases in which nonparental child care was used but measures of the inputs are unavailable; these cases are also excluded from the regression samples). Table 2 shows that average group size rises with age and peaks at 9.2 at age four, while the staff-child ratio falls with age to a mean of 0.40 at age four. A dichotomous indicator of whether the provider had "received any education or training specifically related to children such as early childhood education, special education, or childhood psychology," referred to hereafter as "training," also peaks at age four at a mean of 0.61.

Table 2 also shows the age patterns of the other child care variables. Hours per week and months per year of child care are included in the regression models to capture the effects of the amount of time spent in child care. The mode of care, whether paid care is used, the amount paid, and the number of child care arrangements per child are included to measure aspects of quality that are not captured by the inputs. For example, better-paid providers may be more attentive and responsive to children. If the better-paid providers also are more likely to be trained or provide care in small groups, then omitting the amount paid would yield biased estimates of the effects of the inputs. The average number of arrangements does not vary much with age. The mode variables are measured as the proportion of the year that the child was in the indicated mode of care. Use of centers increases with age during the infant-toddler years and declines during the preschool years. Family day care declines after age one while relative care remains popular throughout the infant-toddler and preschool years.

The age patterns of the inputs are strongly influenced by differences across modes in typical values of the inputs and changes in the typical mode used as a child ages. The lower panel of Table 2 shows that GS is more than twice as large in centers than in other modes, and SCR is correspondingly smaller. Training is also far more common in centers than in family day care. These differences make it important to control for the mode of care. In the analysis that follows I also investigate whether the effects of the inputs differ by mode.

Home inputs are measured in the NLSY by about 30 age-specific questions concerning toys, books, records, musical instruments, newspapers, and magazines in the home; how often the child is read to, taken on outings, watches television, sees his father, is spanked, eats meals with both parents, is included in conversation while the mother is doing housework; whether the parents help the child learn the alphabet and numbers; the parents' response to child misbehavior; and a variety of other items, including interviewer observations of mother-child interactions and the physical environment. The raw responses were converted to dichotomous scores and summed

Table 2
Descriptive Statistics on Child Care by Age and Mode

	Age 0	Age 1	Age 2	Average, Age 0–2 (Infant-Toddler)	Age 3	Age 4	Age 5	Average, Age 3–5 (Preschool)
Used any nonparental care	0.37	0.46	0.50	0.44	0.70	0.72	0.77	0.71
Number of arrangements	1.3	1.3	1.2	0.9				
	(0.5)	(0.6)	(0.5)	(0.5)				
Center	0.04	0.12	0.17	0.11	0.30	0.24	0.15	0.25
Family day care home (FDCH)	0.13	0.18	0.14	0.15	0.07	0.05	0.03	0.04
Relative	0.12	0.17	0.21	0.17	0.46	0.42	0.47	0.46
Babysitter	0.02	0.02	0.03	0.03	0.02	0.03	0.04	0.03
Hours per week	34.8	34.7	32.0	31.9	30.8	31.4	27.5	29.6
	(13.5)	(14.6)	(13.6)	(13.7)	(15.5)	(13.6)	(14.6)	(14.6)
Months/year of nonparental care	9.0	10.1	10.0	9.7				
	(3.3)	(3.4)	(3.3)	(3.2)				
Paid cash	0.27	0.47	0.46	0.61	0.47	0.69	0.46	0.60
Dollars per hour	1.42	1.26	1.45	1.36	1.38	1.85	1.63	1.70
	(0.91)	(1.00)	(1.41)	(1.18)	(0.79)	(1.74)	(2.10)	(1.67)

Group size	2.5	4.2	5.3	4.2	5.3	9.2	5.9	7.1
	(2.5)	(5.5)	(5.6)	(4.6)	(5.9)	(11.4)	(6.7)	(9.2)
Staff-child ratio	0.70	0.53	0.45	0.51	0.49	0.40	0.47	0.44
	(0.33)	(0.34)	(0.30)	(0.30)	(0.33)	(0.31)	(0.32)	(0.31)
Training	.05	.20	.25	.20	.36	.61	.38	.29
	Center		FDCH		Relative		Babysitter	
	Infant-Toddler	Preschool	Infant-Toddler	Preschool	Infant-Toddler	Preschool	Infant-Toddler	Preschool
Group size	9.0	9.3	3.9	2.8	2.8	4.2	2.4	1.2
	(7.9)	(7.1)	(2.3)	(2.6)	(2.7)	(6.1)	(1.3)	(0.8)
Staff-child ratio	0.33	0.23	0.46	0.64	0.66	0.59	0.62	0.97
	(0.21)	(0.12)	(0.25)	(0.19)	(0.31)	(0.32)	(0.24)	(0.12)
Training	0.66	0.58	0.24	0.07	0.07	0.11		

Notes: Figures are means and (in parentheses) standard deviations. The sample for all variables other than "Used nonparental child care" includes only those cases that used nonparental child care and for which valid data on the indicated variable were available. The infant-toddler averages include all cases with at least one year of data, even if data are missing for the other two years. The infant-toddler average can therefore lie outside the range of the means for each age. The same method was used for the preschool averages. The number of arrangements is the response to the question "Not counting yourself, how many different child care arrangements did you use for the child during his or her first (second, third) year of life that lasted for one month or more?" The mode variables (center, family day care, relative, babysitter) are measured as the proportion of the year during which the child was in the indicated mode. Information on training was not collected for babysitters.

into two aggregates: a cognitive stimulation index and an emotional support index.[9] These indexes provide good measures of home inputs to include in the analysis, making it unlikely that the child care variables are picking up the effects of omitted home inputs.

The measures of child development used as dependent variables are the Behavior Problems Index (BPI), scores on the Peabody Individual Achievement Tests (PIAT) in mathematics and reading recognition, and the Peabody Picture Vocabulary Test (PPVT) score. The BPI is derived from a series of questions to the mother about the child's behavior.[10] The 28 individual items were dichotomized, summed, and normed against a national sample by age. The resulting index is scaled to have a mean of 100 and a standard deviation of 15 in the national population. A higher score represents worse behavior. This assessment was collected for children aged four and over and was repeated in each year, so multiple observations are available for many children. The PIAT and PPVT are standard and widely used tests of achievement and ability, respectively. Both were normed against national populations and scaled in the same way as the BPI. The PIAT was given to children aged five and over and was repeated if a child was age-eligible in more than one of the years in which assessments were given. The PPVT was given to children aged three and older (four in 1990) and in 1988 and 1990 was repeated only for 10–11 year-old children, while in 1992 it was repeated for all age-eligible children. Thus multiple observations are available on these items for some children. Descriptive statistics on the home inputs and the child outcomes are given in Appendix Table A1.

In addition to the child care and home inputs I also include a number of variables characterizing the mother's background, the demographic structure of the child's household, the mother's employment history, prenatal and infant health inputs, and child characteristics. These variables include the mother's score on the Armed Forces Qualification Test (AFQT),[11] the mother's education, race, household structure as a child, education of her parents, and related background measures; the presence in the child's household of other children and family members by age group; the mother's marital status and the education of her spouse if she is married; the month of pregnancy in which prenatal medical care was first obtained; the child's age sex, birth weight, birth order, well-care medical visits in the first year of life, whether and how much the mother smoked cigarettes and drank alcohol during pregnancy, and her age at the birth of the child; the fraction of the mother's pregnancy and the child's infant-toddler and preschool years during which the mother was employed, and whether she was employed full time; and whether the child was ever enrolled in Head Start or preschool. Descriptive statistics on these variables are given in the Appendix. As noted above, the child development assessments are given beginning

9. I repeated most of the analysis using the individual items and found that the estimated effects of child care were very similar to those obtained when using the aggregated home items.

10. These include questions about mood, affect, attention span, obedience, cruelty to others, impulsiveness, depression, ability to get along with other children, stubbornness, irritability, etc.

11. The AFQT, which is considered to be a measure of intelligence, was administered in 1980, when sample members were 15 to 22 years old. In order to remove age effects from the AFQT I regressed it on age dummies and use the regression residual as an explanatory variable in the regressions reported below.

at ages four or five, and in some cases are repeated every two years. Hence the average age of the children at the date of assessment is eight years. Thus there is a fairly long lag between the age at which the child care inputs were measured (zero to two and three to five) and the age at which developmental outcomes were assessed. In some of the results presented below I allow the effects of the child care inputs to vary with the age of the child at the time of the developmental assessment.

V. Results

Panel A of Table 3 presents simple correlations between the three main child care characteristics of interest, measured during the infant-toddler years, and the developmental outcomes. Group Size (GS) is uncorrelated with the outcomes, as is Staff-Child Ratio (SCR) for the most part. Training is positively and significantly correlated with all four outcomes (recall that a higher BPI score indicates more behavioral problems, so a negative correlation indicates that training is associated with fewer behavioral problems). Panel B presents OLS results from regression Equation 3 in which the child care characteristics are included along with indicators of the mode of care, but all other regressors are excluded.[12] Controlling for mode of care is important because the average levels of the characteristics are quite different across the modes. Training is positively and significantly related to the PIAT-Math and PPVT scores; GS and SCR have no impacts that are significantly different from zero. Adding additional regressors in Panel C reduces the magnitude of the training effects. In this specification, GS and SCR are both positively related to the PIAT-Reading score. Adding the additional child care variables in Panel D yields results similar to those in Panel C. This first pass through the data suggests that infant-toddler child care characteristics are in most cases not strongly associated with child outcomes.

Table 4 presents coefficient estimates on all of the child care variables from the Panel D model of Table 3, estimated by OLS. Coefficient estimates on the other variables in these models are given in Appendix Table A1. The lower panel of Table 4 presents the results of F-tests of various hypotheses about the effects of the child care variables. The first test result indicates that the hypothesis that the child care coefficients are jointly equal to zero is rejected at the 10 percent level for three of the four outcomes. However, the individual child care coefficient estimates are all statistically insignificant in the BPI, PIAT-Math, and PPVT regressions. As noted above, GS and SCR both have positive and statistically significant effects on the reading score. Note that the GS effect is of the "wrong" sign. To illustrate the magnitude of these effects consider a group of ten children cared for by one provider. Adding a second adult leaves GS unchanged and increases the SCR by 0.1 (from 0.1 to 0.2). Splitting the group in half and providing a teacher for each of the two

12. The standard error estimates in this and all subsequent tables have been calculated to account for nonindependence due to the presence of multiple observations on some children.

Table 3
Ordinary Least Squares Estimates of the Effects of Infant-Toddler Child Care Characteristics in Alternative Specifications

	BPI	PIAT-Math	PIAT-Reading	PPVT
		A. Simple Correlations		
Group size	−0.015	0.02	−0.006	−0.048
Staff-child ratio	0.023	0.019	0.073*	0.037
Training	−0.035*	0.068***	0.036*	0.052***
		B. Regressions including inputs and mode of care only		
Group size	0.02	−0.084	−0.003	−0.17
	(0.10)	(0.080)	(0.08)	(0.15)
Staff-child ratio	0.02	1.4	2.6	2.7
	(1.8)	(1.8)	(1.7)	(2.2)
Training	1.5	3.3**	1.9	4.1*
	(1.7)	(1.6)	(2.1)	(2.3)
		C. Regressions including inputs, mode, and other regressors; excludes additional child care variables		
Group size	0.11	0.06	0.39***	0.07
	(0.15)	(0.11)	(0.10)	(0.26)
Staff-child ratio	0.29	2.7	4.6***	2.9
	(2.5)	(1.8)	(1.9)	(2.2)
Training	2.2	1.9	−0.61	1.5
	(1.9)	(1.6)	(1.8)	(2.2)
		D. Regressions including inputs and all other regressors		
Group size	0.08	0.06	0.37***	0.05
	(0.16)	(0.11)	(0.10)	(0.27)
Staff-child ratio	−0.0006	3.0	5.0***	2.7
	(2.5)	(1.9)	(1.9)	(2.2)
Training	2.2	1.92	−0.56	1.5
	(1.9)	(1.56)	(1.7)	(2.2)

Notes: The mode variables indicate the proportion of the child's first three years of life spent in each mode of care. The other regressors in Panels C and D are listed in the Appendix. The omitted "additional child care variables" in Panel C are listed in Table 4.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

Table 4
Ordinary Least Squares Estimates of the Effects of Infant-Toddler Child Care

	BPI	PIAT-Math	PIAT-Reading	PPVT
Group size	0.08	0.06	0.37***	0.05
	(0.16)	(0.11)	(0.10)	(0.27)
Staff-child ratio	−0.00	3.05	5.00***	2.72
	(2.53)	(1.87)	(1.88)	(2.21)
Training	2.25	1.92	−0.56	1.47
	(1.86)	(1.56)	(1.74)	(2.19)
Nonparental care	2.37	−4.83	−6.99**	−3.24
	(3.72)	(3.37)	(3.29)	(4.04)
Number of arrangements	−0.20	1.37	0.28	−1.70
	(1.74)	(1.61)	(1.53)	(1.60)
Center	−1.85	0.22	−2.16	1.28
	(3.46)	(3.07)	(3.28)	(3.44)
Family day care home	1.01	−2.09	−1.15	−4.64
	(3.15)	(2.54)	(2.73)	(3.07)
Relative	2.55	0.79	4.22	2.68
	(2.90)	(2.36)	(2.57)	(3.24)
Paid cash	−1.43	0.68	1.63	1.50
	(1.94)	(1.51)	(1.64)	(1.84)
Hours per week	0.03	−0.02	−0.01	0.00
	(0.05)	(0.04)	(0.04)	(0.05)
Months per year	−0.31*	−0.08	−0.14	0.14
	(0.18)	(0.14)	(0.17)	(0.17)
Dollars per hour	−0.23	0.17	−0.61	0.01
	(0.61)	(0.53)	(0.64)	(0.54)
$\bar{R}^2$	.137	.229	.225	.374
P-values from Specification Tests (degrees of freedom)				
1. All child care effects = 0 (12)	0.094*	0.217	0.000***	0.086*
2. Mode* input effects = 0 (8)	0.113	0.998	0.483	0.037**
3. Age group* input effects = 0 (6)	0.063*	0.219	0.250	0.371
4. Race* input effects = 0 (6)	0.300	0.950	0.190	0.007***
5. Poverty* input effects = 0 (6)	0.017**	0.472	0.834	0.168
6. Additional age*child care effects = 0 (18)	0.235	0.432	0.675	0.563
7. Additional race*child care effects = 0 (18)	0.775	0.101	0.168	0.630
8. Additional poverty*child care effects = 0 (18)	0.598	0.001***	0.035***	0.882
n	4,031	3,515	3,464	2,504

Note: See the Appendix for the effects of the other variables included in the regressions. Standard errors, corrected for multiple observations per child, are in parentheses. The null hypothesis for the first specification test is that all the coefficients in the upper panel of the table equal zero. The null hypothesis for the tests in Rows 2–5 is the specification in the upper panel. The null hypothesis for the test in Row 6 (7, 8) is the specification in Row 3 (4, 5).

* Statistically significant at the 10 percent level

** Statistically significant at the 5 percent level

*** Statistically significant at the 1 percent level.

smaller groups causes group size to fall by five and SCR to rise by 0.1. Based on the results in Table 4 the estimated impacts of these two hypothetical experiments are as follows:

	ΔBPI	ΔPIAT-M	ΔPIAT-R	ΔPPVT
Add a second adult; ΔGS = 0; ΔSCR = 0.1	−.00	.31	.50*	.27
Split the group in half; ΔGS = −5; ΔSCR = 0.1	−.40	.00	−1.35*	.02

Adding a second care giver is predicted to increase the reading score by 0.50 (3.5 percent of a standard deviation of the reading score) and to have smaller and statistically insignificant effects on the other outcomes. Reducing GS from ten to five while also raising SCR by 0.1 is predicted to reduce the Reading score by 1.35. These are relatively small effects in view of the large changes in GS and SCR considered in these experiments, and in the latter case the net impact is negative rather than positive.[13] The elasticity of PIAT-Reading with respect to GS is .015 and with respect to SCR is .024, evaluated at the means of the data, confirming the small magnitude of the effects of the child care inputs.[14]

It is well-known that classical measurement error in a regressor causes the coefficient estimate on the regressor to be biased toward zero. In the absence of information about the magnitude of the measurement error variance or appropriate instrumental variables, it is not possible to correct the estimates for this bias. But it is possible to gauge the potential magnitude of the bias under some assumptions. For example, if GS is the only regressor measured with error, if GS is uncorrelated with the other regressors, and the measurement error is classical (uncorrelated with other variables and homoscedastic) then the bias in the OLS estimate is easily computed for any specified value of the proportion of the total variance in GS accounted for by measurement error. Thus under these assumptions if half the variance in GS is the result

13. GS and SCR are negatively correlated since GS is the denominator of the SCR. The correlation is −0.46 in centers, −0.55 in family day care homes, −0.61 in care by relatives, and −0.79 in care by a babysitter. It is possible that these two variables are too closely related to allow distinct effects of each to be identified. I reestimated the models excluding SCR and found results for GS very similar to those reported in Table 4. Another potentially important specification issue is whether the effects of the child care characteristics depend on the duration of the child's exposure to the arrangement. To examine this issue, I added interactions terms between the inputs and months per year and hours per week of care. Most of the coefficient estimates on the interactions were statistically insignificant. The few that were significantly different from zero were as likely to be of the "wrong" sign (namely, effects that were weaker the longer the duration of exposure) as the right sign.

14. The elasticity is the percent change in one variable caused by a one percent change in another variable. The mean value of PIAT-Read is 103.8 and the mean value of GS is 4.2. A one percent change in GS is .042; when multiplied by the coefficient of .37 from Table 4, this yields a change of .01554 in PIAT-Reading, which is .015 percent of the mean PIAT-Reading score.

of measurement error, then the bias is equal to the OLS coefficient estimate. In this case an estimate of the effect of GS that is free of measurement error bias is obtained simply by doubling the coefficient estimates in Table 4. This admittedly crude approach to the measurement error issue suggests that the main finding from Table 4, that the child care inputs have small impacts on child development, would be robust to accounting for measurement error.

Before proceeding further, it is worth asking whether any variables included in the model help explain child development. The results presented above suggest little impact of child care characteristics, but if other variables had little impact as well then the absence of child care effects would not be so surprising. For example, if child development is mainly genetically determined, then one would expect that home inputs would also have little impact. In fact, results presented in the Appendix show that the home inputs and a number of other variables have substantial impacts on child development. The estimated elasticities of the child development outcomes with respect to the cognitive and emotional stimulation home environment measures are in the .08−.15 range and are all significantly different from zero. These are three to five times larger than any of the child care elasticities reported above. Other variables with relatively large effects on child development include the child's sex and race, family religion, the mother's AFQT score, the child's birth weight, and the presence of the mother's spouse and children aged six to eleven. Thus child development is associated with home inputs and some of the other measurable factors. It is also worth noting that the effects of variables such as the child's age, race, and sex, and the mother's education are generally similar to the effects found in other studies for which such effects are reported.[15]

The main message of Table 4 is that there seems to be little association on average between child care inputs experienced during the first three years of life and subsequent child development, controlling for family background and the home environment. However, the results in Table 4 are averages over all children and could mask differences in effects for different groups of children. In order to examine this issue I estimated several models with interactions between the child care variables and mode of care, age, race/ethnicity, and long-run poverty status. In 22 out of 28 cases the hypothesis that the interaction effects are jointly zero cannot be rejected at the 10 percent level (see the lower panel of Table 4). This suggests that there is relatively little variation in the effects of child care across groups of children. Three of the six rejections are for poverty interactions, so selected results from a specification with poverty-child-care interactions are presented in Table 5. The GS effects again are often of the "wrong" sign, while the effect of SCR is more often of the expected sign. Based on the results in Table 5, the effects of the same two hypothetical experiments described above are as follows:

15. Few studies report the effects of these variables. In some cases this is due to the fact that the sample used is, for example, all Black or all of the same age. In other cases, such variables were not included in the analysis. The results for child age, race, and so forth are quite similar to those reported in other studies using the NLSY, not surprisingly (Korenman et al, 1995; Caughy et al., 1994; Parcel and Menaghan, 1990). Duncan et al. (1994) report results for a sample of low-birth weight children and find that boys and Blacks have lower age-five IQ and children with a more highly educated mother have higher IQ.

	ΔBPI	ΔPIAT-M	ΔPIAT-R	ΔPPVT
Add a second adult; ΔGS = 0; ΔSCR = 0.1				
Very poor	−.08	−.34	.08	−.50
Somewhat poor	.25	−.00	.47	.09
Not poor	−.11	.62*	.59*	.54*
Split the group in half; ΔGS = −5; ΔSCR = 0.1				
Very poor	1.62	−1.04	−2.52*	−2.40
Somewhat poor	−2.50*	.65	−1.13*	1.09
Not poor	1.54	−2.03*	−1.01	−2.26*

Adding a second adult has beneficial effects on the PIATS and PPVT for children in families that are not poor, with effects of 0.54 to 0.62(3–5 percent of a standard deviation of the dependent variable). Long-run poverty status can be interpreted as a proxy for the level of purchased inputs to the production of child quality. This result suggests that complementary home inputs may be required for the child care inputs to produce benefits for children, and that such inputs are more likely to be present in the homes of children who are not poor.[16] Splitting the group in half has harmful effects on the PIAT and PPVT scores of all three groups, and a statistically significant beneficial effect on the BPI score of moderately poor children. The implied elasticities of the outcomes with respect to GS and SCR are all less than or equal to 0.03 in absolute value. Use of a trained provider would *increase* the BPI score of not-poor children by 4.8, a fairly large effect of the "wrong" sign. Thus the results in Table 5 do not contradict the basic finding that the effects of child care inputs on child development seem to be small.

As discussed above, the OLS estimates presented so far are potentially subject to bias due to the omission of unobserved variables correlated with the included regressors. Therefore, Table 6 presents Mother Fixed Effects (MFE) estimates of Equation 3 that can be compared directly to the OLS estimates of this equation in Table 4. The MFE estimates are free of bias caused by permanent family-specific unobserved heterogeneity, but could still be biased if there is child-specific unobserved heterogeneity or time-varying family-specific unobserved heterogeneity. The child care variables in the MFE estimates are jointly statistically insignificant except in the PIAT-

16. I examined this issue further by interacting the two summary home-input measures (cognitive and emotional stimulation) with the child care inputs. For each dependent variable there was at least one statistically significant interaction, but there was little evidence that child care inputs are substantially more productive when the home inputs are larger. The positive effect of training on PIAT-Math and PPVT is 1.8–2.5 points larger if the home inputs are one standard deviation above the mean compared to one standard deviation below the mean. Other estimates were either negligible or of the wrong sign. I also estimated models with polynomial terms in GS and SCR. Higher order terms were never statistically significant.

Table 5
OLS Estimates of the Effects of Infant-Toddler Child Care by Poverty Status

	Very Poor	Somewhat Poor	Not Poor
		BPI	
Group size	−0.34 (0.26)	0.55 (0.15)***	−0.33 (0.31)
Staff-child ratio	−0.83 (4.15)	2.46 (3.02)	−1.13 (3.51)
Training	4.70 (4.54)	−2.34 (3.06)	4.83 (2.45)**
$\bar{R}^2$ (n)		.139 (4,031)	
		PIAT-Math	
Group size	0.14 (0.17)	−0.13 (0.12)	0.53 (0.25)**
Staff-child ratio	−3.39 (4.12)	−0.04 (3.21)	6.17 (2.42)**
Training	−0.96 (4.34)	−1.65 (3.14)	1.50 (1.93)
$\bar{R}^2$ (n)		.234 (3,515)	
		PIAT-Reading	
Group size	0.52 (0.22)**	0.32 (0.15)**	0.32 (0.25)
Staff-child ratio	0.77 (5.33)	4.66 (3.84)	5.86 (2.31)**
Training	3.65 (4.22)	−0.20 (2.83)	−0.92 (2.34)
$\bar{R}^2$ (n)		.227 (3,464)	
		PPVT	
Group size	0.38 (0.27)	−0.20 (0.27)	0.56 (0.31)*
Staff-child ratio	−4.97 (6.24)	0.93 (3.67)	5.43 (2.76)**
Training	4.25 (4.12)	3.09 (3.47)	−0.40 (2.57)
$\bar{R}^2$ (n)		.373 (2,504)	

Note: Very poor means that the household was in poverty during more than half the years from 1979–92. Somewhat poor indicates that the household was in poverty between 10 percent and 50 percent of the years from 1979–92. Not poor indicates that the household was in poverty during fewer than 10 percent of the years from 1979–92. The models also include all of the other child care variables listed in Table 4, along with interactions between these variables and poverty status, as well as the additional variables listed in the Appendix. The other coefficient estimates from these models are available on request from the author.

Math equation (see Row 1 of the lower panel of Table 6), and all of the coefficient estimates on the inputs are statistically insignificant in all four equations. These estimates imply negligible and/or wrong-signed effects of the inputs on child development, thus providing no evidence to contradict the implications of the OLS estimates.

The lower panel of Table 6 shows the results of specification tests for interactions between the child care variables and mode of care, age, race/ethnicity, and poverty in the MFE models. There are many cases in which the test results suggest that the inputs have different effects on different groups of children. When disaggregated by mode of care several input coefficient estimates are statistically significant but half are of the "wrong" sign (these results are available from the author). When disaggregated by the child's age at the time of the assessment, there is evidence that there

Table 6
Effects of Infant-Toddler Child Care with Mother Fixed Effects

	BPI	PIAT-Math	PIAT-Reading	PPVT
Group size	0.10	0.30	0.30	0.13
	(0.22)	(0.27)	(0.31)	(0.35)
Staff-child ratio	1.65	−1.72	−0.18	3.85
	(2.01)	(2.62)	(3.20)	(2.88)
Training	−1.67	−1.69	−1.97	−2.48
	(1.75)	(2.18)	(2.53)	(2.40)
Nonparental care	2.10	−1.46	0.85	−1.75
	(3.42)	(3.79)	(4.25)	(4.25)
Number of arrangements	−1.51	−2.94*	−3.45*	0.72
	(1.47)	(1.70)	(1.82)	(2.51)
Center	18.80**	−4.07	−10.38	−2.26
	(9.22)	(7.63)	(10.09)	(10.05)
Family day care home	2.61	1.31	3.59	−5.78
	(3.28)	(3.15)	(3.86)	(4.06)
Relative	0.19	1.56	3.84	−4.65
	(1.88)	(2.32)	(2.62)	(3.06)
Paid cash	−0.74	−1.32	−0.58	2.63
	(1.35)	(1.81)	(2.04)	(2.35)
Hours per week	−0.01	0.15***	0.05	−0.00
	(0.04)	(0.05)	(0.06)	(0.06)
Months per year	−0.35	−0.12	0.02	−0.35
	(0.24)	(0.42)	(0.37)	(0.31)
Dollars per hour	0.28	2.58***	−0.50	−0.87
	(0.69)	(0.84)	(0.90)	(0.98)
$\bar{R}^2$ (n)	0.03	0.03	0.03	0.10
	(2,646)	(2,255)	(2,220)	(1,273)
P-values from Specification Tests (degrees of freedom)				
1. All child care effects = 0 (12)	0.491	0.008***	0.494	.713
2. Mode * input effects = 0 (8)	0.036**	0.021**	0.013**	.635
3. Age group * input effects = 0 (6)	0.019**	0.036**	0.083*	.143
4. Race * input effects = 0 (6)	0.074*	0.007***	0.006***	.198
5. Poverty * input effects = 0 (6)	0.052	0.010**	0.002***	.115
6. Additional age * child care effects = 0 (18)	0.013**	0.356	0.647	.681
7. Additional race * child care effects = 0 (18)	0.053*	0.003***	0.713	.809
8. Additional poverty * child care effects = 0 (18)	0.169	0.999	0.166	.415

are small beneficial effects of the SCR and training experienced at ages 0–2 on children who were aged three through nine when the outcome tests were administered, but little evidence of beneficial effects at later ages (these results are also available from the author). This suggests that the effects of child care may fade over time. However, the fact that measures of school inputs are unavailable means that the child care variables for school-age children may pick up the effects of any school inputs that affect child development and are correlated with the child care inputs, complicating inferences about fade-out.

Table 7 presents OLS estimates of equation (4) with child care variables for both the infant-toddler and preschool years. The hypothesis that the coefficients on the preschool child care variables are all zero, conditional on the inclusion of the infant-toddler child care variables, is rejected at about the ten percent level for each outcome (see Row 2 of the lower panel of the table). Note that the samples are much smaller in these regressions because child care data for preschoolers were not collected every year. As in the results presented above, the infant-toddler child care variables in these models have coefficient estimates that are often of the "wrong" sign. For example, the two cases in which the infant-toddler training coefficients are statistically significant indicate that using a trained provider increases behavior problems and reduces reading achievement by about four points each. The only statistically significant coefficient on GS experienced as an infant or toddler implies that bigger groups improve reading achievement. However, the results for the preschool-age child care variables are more consistent with expectations. GS has statistically significant coefficients of the "right" sign in all four models. The following figures illustrate the effects of adding a second teacher and splitting the group in half, starting from a group of ten children with one adult:

	ΔBPI	ΔPIAT-M	ΔPIAT-R	ΔPPVT
Add a second adult $\Rightarrow \Delta GS = 0$; $\Delta SCR = 0.1$				
Infant-toddler	−.10	−.11	.28	−.08
Preschool	.72*	.18	−.06	.11
Split the group in half $\Rightarrow \Delta GS = -5$; $\Delta SCR = 0.1$				
Infant-toddler	−.50	−.40	−2.12*	−.38
Preschool	−.13*	1.22*	1.19*	2.11*

Adding a second adult has negligible effects on all outcomes at all ages except for increasing BPI by .72, an effect of the "wrong" sign. Splitting an infant-toddler group in half is estimated to reduce PIAT-Reading by about two points, another effect of the "wrong" sign. Splitting a group of preschoolers in half causes a small reduction in the BPI score, increases the PIAT scores by about one point, and raises the PPVT score by two points, effects that are all of the "right" sign. The elasticity of the outcomes with respect to the preschool GS and SCR is less than or equal to .03 in absolute value in every case. The results in Table 7 also indicate that training

Table 7
OLS Estimates of the Effects of Infant-Toddler and Preschool Child Care

	BPI		PIAT-Math		PIAT-Reading		PPVT	
	Infant-Toddler	Preschool	Infant-Toddler	Preschool	Infant-Toddler	Preschool	Infant-Toddler	Preschool
Group size	0.08	0.17*	0.06	−0.21**	0.48***	−0.25**	0.06	−0.40***
	(0.15)	(0.10)	(0.17)	(0.10)	(0.17)	(0.11)	(0.20)	(0.15)
Staff-child ratio	−0.96	7.16**	−1.15	1.75	2.81	−0.56	−0.78	1.06
	(2.64)	(2.81)	(2.78)	(2.45)	(3.37)	(3.58)	(3.56)	(3.18)
Training	4.35**	0.52	2.41	0.83	−4.37*	3.43	−2.01	4.28
	(2.21)	(2.36)	(2.14)	(2.12)	(2.59)	(2.43)	(2.61)	(2.99)
Nonparental care	−10.27*	−5.90*	−2.26	2.07	−2.99	−3.38	1.75	2.96
	(5.47)	(3.27)	(4.72)	(3.18)	(5.03)	(3.86)	(5.62)	(3.38)
Number of arrangements	−0.43	—	0.59	—	−0.27	—	0.58	—
	(1.63)		(1.45)		(1.99)		(1.58)	
Center	5.04	2.40	2.39	−0.48	−1.96	1.12	3.61	2.74
	(5.44)	(2.40)	(5.39)	(2.80)	(5.44)	(3.04)	(4.63)	(2.65)
Family day care home	6.75*	−0.11	−1.93	−9.96**	−3.73	−3.07	−3.78	−3.94
	(3.71)	(3.95)	(3.70)	(4.87)	(3.66)	(4.15)	(3.55)	(6.37)
Relative	10.86***	−0.84	5.03	−2.32	4.88	2.42	4.82	−1.43
	(3.47)	(2.19)	(3.59)	(2.34)	(3.85)	(2.68)	(4.87)	(2.28)
Paid cash	−5.06**	2.23	1.45	−1.97	2.39	−0.44	7.42***	−0.89
	(2.45)	(2.15)	(2.19)	(2.01)	(2.31)	(2.27)	(2.68)	(2.45)

Hours per week	0.11	−0.05	0.03	−0.02	−0.01	0.01	−0.12	0.01
	(0.07)	(0.06)	(0.06)	(0.05)	(0.07)	(0.06)	(0.08)	(0.07)
Months per year	0.03	—	−0.07	—	−0.24	—	−0.03	—
	(0.29)		(0.24)		(0.27)		(0.25)	
Dollars per hour	0.55	−0.21	−0.46	0.44	0.92	0.27		0.60
	(1.13)	(0.79)	(0.95)	(0.48)	(1.02)	(0.40)	3.09***	(0.63)
							(1.09)	
$\bar{R}^2$ (n)	.185 (1.287)		.198 (1,192)		.253 (1,176)		.366 (769)	
	P-values from Specification Tests (degrees of freedom)							
1. All child care effects = 0 (22)	0.000***		0.146		0.016**		.024**	
2. Preschool child care effects = 0 (10)	0.091*		0.026**		0.104		.050**	
3. Mode * input effects = 0 (8)	0.823		0.000***		0.280		.552	
4. Age group * input effects = 0 (6)	0.165		0.014**		0.027**		.007***	
5. Race * input effects = 0 (6)	0.043**		0.000***		0.315		.208	
6. Poverty * input effects = 0 (6)	0.125		0.027**		0.352		.345	
7. Additional age * child care effects = 0 (18)	0.271		0.732		0.009***		.450	
8. Additional race * child care effects = 0 (18)	0.612		0.052*		0.506		.006***	
9. Additional poverty * child care effects = 0 (18)	0.006***		0.042**		0.005***		.014**	

Note: Number of arrangements and months per year were not measured for the preschool ages.

for preschool child care providers increases PIAT-Reading and PPVT by three to four points, but the estimates are imprecise.[17]

Table 8 presents OLS estimates of Equation 1 for BPI and the PIAT scores with the lagged value of the dependent variable included as a regressor. There were too few cases with PPVT scores in adjacent assessment years to obtain estimates for this outcome. The child care variables are jointly statistically significant only for PIAT-Reading (see the lower panel of the table). In the BPI model GS has a positive statistically significant coefficient of 0.21, indicating that a reduction in GS of five children would reduce BPI by about one point. SCR has a negative statistically significant effect on PIAT-Reading; an increase of 0.1 is estimated to reduce the score by 0.58. These estimates are consistent with the other specifications presented above in showing that most of the input effects are small and statistically insignificant, and often of the "wrong" sign.[18]

VI. Conclusions

The estimates presented in this paper suggest that the child care inputs experienced during the first three years of life have little impact on the child outcomes studied here. The magnitudes of the effects are generally small, often insignificantly different from zero, and are as likely to be of the "wrong" sign as the "right" sign. This conclusion holds when mother fixed effects are controlled and when the effects are allowed to vary by mode, age, race/ethnicity, and poverty. It also holds when a value-added specification is used in which the child outcomes are regressed on child care inputs during the previous two years along with the lagged outcome. In contrast, a smaller group size experienced during the second three years of life has positive effects on child outcomes. These effects are significantly different from zero but fairly small. However,it has not been possible to assess the robustness

17. The lower panel of Table 7 shows the results of specification tests for interactions between the child care variables and mode, age, race/ethnicity, and poverty. The results show one case in which there are jointly significant interactions between mode and the inputs, and several cases of significant interactions with age and race/ethnicity. There are many statistically significant coefficient estimates on the inputs interacted with the age at which the child was assessed, and the majority are of the "wrong" sign. Six out of the seven significant training coefficients indicate that trained providers harm development. Two of the three statistically significant GS coefficients for infants and toddlers imply that bigger groups are beneficial, but all of the statistically significant GS coefficients for preschoolers imply that bigger groups have harmful effects, consistent with the results from Table 7 without age interactions. SCR generally has the "wrong" sign in the BPI equations. A higher SCR for infant-toddlers reduces PIAT-Reading and PPVT measured at age ten and over, while a higher SCR for preschoolers raises these scores. These results are available on request from the author.

18. The lower panel of Table 8 shows the results of specification tests for interactions between the child care variables and mode, age, race/ethnicity, and poverty. Only two sets of interactions are statistically significant, both for mode interacted with the inputs. Training in family day care homes has a large beneficial effect on BPI(−11). GS and SCR in family day care have large negative effects on the PIAT scores. Consider a group of four children cared for by one provider in a family day care home. Adding a second care giver raises the SCR from 0.25 to 0.50, and is predicted to reduce the math score by 11.0 and the reading score by 19.0. Splitting the group in half is predicted to *raise* the math score by 22.2 (16.6*2–43.7*0.25) and the reading score by 36.7 (27.9*2–76.3*0.25). Both sets of effects seem implausibly large. These results are available on request.

Table 8
OLS Estimates of the Effects of Child Care During the Previous Two Years

	BPI	PIAT-Math	PIAT-Reading
Group Size	0.21**	−0.13	−0.13
	(0.11)	(0.12)	(0.12)
Staff-Child Ratio	−1.09	−1.70	−5.83*
	(1.99)	(3.10)	(3.06)
Training	−1.81	1.87	−2.68
	(1.59)	(2.23)	(2.35)
Nonparental care	0.41	3.74	5.19
	(2.70)	(3.14)	(3.20)
Number of arrangements	−0.07	5.32***	4.36*
	(1.18)	(1.82)	(2.28)
Center	−2.51	−1.60	0.31
	(2.97)	(3.71)	(3.73)
Family day care home	0.66	−4.00	−8.73
	(3.52)	(5.61)	(5.76)
Relative	−0.85	−1.62	−2.14
	(2.36)	(2.62)	(2.41)
Paid cash	−0.19	0.79	−1.66
	(1.51)	(2.51)	(2.24)
Hours per week	−0.04	−0.12	−0.06
	(0.04)	(0.06)	(0.06)
Months per year	0.31	−0.32	−0.28
	(0.17)	(0.26)	(0.32)
Dollars per hour	−0.65	−0.32	−0.14
	(0.53)	(0.85)	(0.80)
Lagged dependent variable	.057***	.471***	.521***
	(.003)	(.058)	(.052)
$\bar{R}^2$ (n)	0.43	0.37	0.41
	(1,075)	(621)	(603)
P-values from Specification Tests (degrees of freedom)			
1. All child care effects = 0 (12)	0.177	0.357	0.018**
2. Mode * input effects = 0 (8)	0.231	0.016**	0.002***
3. Age group * input effects = 0 (6)	0.356	0.609	0.651
4. Race * input effects = 0 (6)	0.753	0.820	0.407
5. Poverty * input effects = 0 (6)	0.555	0.848	0.449
6. Additional age * child care effects = (18)	0.753	0.457	0.458
7. Additional race * child care effects = 0 (18)	0.931	0.931	0.181
8. Additional poverty * child care effects = 0 (18)	0.706	0.882	0.126

of the effects of inputs experienced during the preschool years to controls for unobserved heterogeneity.

The consistently beneficial effects of small groups at the preschool ages and the more inconsistent effects of staff-child ratio and specialized training that I found were also found in the National Day Care Study, which is the best known and most reliable existing study. Based on extensive observations in the day care centers they studied, the NDCS suggested an explanation for the finding that group size matters while staff-child ratio does not: assistant teachers do not actually do very much.

The most important difference between this paper and previous papers on the same subject is the nature of the data. The large, nationally representative, longitudinal sample of children provided by the NLSY together with the availability of a rich set of home input and family background measures makes the NLSY a very useful data set for analyzing child development outcomes. There are many child care variables available in the NLSY, but they are measured at irregular intervals and, in the case of the key inputs, potentially with greater error than in studies based on direct observation of child care arrangements. As noted previously, allowing for the possibility of a substantial amount of measurement error would not change the results enough to alter the basic message of the paper. But the potential inadequacies of the child care data in the NLSY do require that some caution be exercised in drawing conclusions from the results presented here. Two conclusions seem warranted. First, the nature of the data and the methods used to analyze them may strongly affect the results obtained when analyzing the effects of child care inputs. Child care researchers may want to reexamine their sampling and data analysis methods in view of this finding. Second, the possibility that easily observed child care inputs may not provide the hoped-for benefits to children suggests that regulations and subsidies should not be assumed to be the "solutions" to the problem of pervasive low-quality child care in the U.S. Regulations and subsidies may be beneficial for other reasons, but the findings of this study suggest that improvements in child development may not be one of the benefits.

Appendix 1

Additional Descriptive Statistics and Results

Table A1
Descriptive Statistics and Effects of Other Variables From the Models of Table 4

Variable	Mean (standard deviation)	BPI	PIAT-Math	PIAT-Reading	PPVT
Mean (standard deviation) of the dependent variable		106.6	100.1	103.8	93.6
		(15.1)	(13.1)	(14.2)	(19.0)
Boy	0.50	1.63**	0.14	−2.41***	−0.56
	(0.50)	(0.71)	(0.59)	(0.68)	(0.77)
Hispanic	0.08	−1.10	−3.47***	−0.59	−6.32***
	(0.26)	(1.24)	(1.11)	(1.16)	(1.52)
Black	0.19	−3.40***	−1.68*	0.45	−9.10***
	(0.39)	(1.02)	(0.90)	(1.13)	(1.26)
Child age (months)	97.6	0.10	0.06	−0.07	0.13*
	(35.7)	(0.06)	(0.05)	(0.07)	(0.07)
Year = 90	0.35	−2.48***	0.54	−1.20	−0.47
	(0.48)	(0.77)	(0.76)	(0.80)	(1.18)
Year = 92	0.37	1.21	1.73	3.41	2.05
	(0.48)	(3.78)	(2.18)	(3.00)	(2.82)
Mother born in LDC	0.02	−0.25	−0.38	2.06	−4.34
	(0.15)	(1.65)	(2.06)	(2.14)	(2.83)
Grandmother worked when mother was 14	0.48	1.09	−0.73	−0.41	−1.02
	(0.50)	(0.73)	(0.58)	(.67)	(0.78)
Grandfather worked when mother was 14	0.82	−1.15	−0.57	−1.05	−0.14
	(0.39)	(0.83)	(0.70)	(0.89)	(1.11)

Table A1 (*continued*)

Variable	Mean (standard deviation)	BPI	PIAT-Math	PIAT-Reading	PPVT
Mother's education	11.9	0.27	−0.01	−0.20	0.02
	(2.1)	(0.23)	(0.20)	(0.22)	(0.26)
Grandmother's education	10.0	−0.14	0.12	0.17	0.38***
	(3.7)	(0.11)	(0.08)	(0.09)	(0.12)
Fraction of mother's preschool years her mother was present	0.98	−1.11	−2.60	1.29	−3.92
	(0.12)	(3.28)	(2.48)	(2.69)	(4.35)
Fraction of mother's primary school years her mother was present	0.95	−6.74**	1.08	1.22	4.71
	(0.19)	(2.97)	(2.12)	(2.89)	(3.48)
Fraction of mother's high school years her mother was present	0.91	4.62**	0.95	1.01	−4.52*
	(0.25)	(1.93)	(1.65)	(2.12)	(2.69)
Fraction of mother's preschool years her father was present	0.96	−4.19	2.84	6.28*	−0.54
	(0.15)	(3.72)	(2.92)	(3.30)	(3.29)
Fraction of mother's primary school years her father was present	0.89	−1.35	−4.29**	−5.27**	1.69
	(0.30)	(2.76)	(2.14)	(2.54)	(2.82)
Fraction of mother's high school years her father was present	0.83	−2.25	1.90	3.43*	−1.68
	(0.36)	(1.73)	(1.56)	(1.81)	(2.05)
Fraction of the mother's life lived in present location as of 1979	0.60	−0.32	−1.18	1.71*	−0.27
	(0.40)	(0.99)	(0.79)	(0.95)	(1.04)
Catholic	0.29	−2.20**	2.17***	1.59*	2.19**
	(0.46)	(0.93)	(0.74)	(0.88)	(0.95)
Mother's age at birth of the child	21.9	0.79	0.40	−0.80	0.95
	(3.3)	(0.73)	(0.62)	(0.73)	(0.87)
Mother's residual AFQT score	1.1	−0.05**	0.13***	0.21***	0.19***
	(21.1)	(0.02)	(0.02)	(0.03)	(0.03)

Month of pregnancy in which mother first received prenatal care	2.6	0.27	0.16	0.09	0.58**
	(1.5)	(0.21)	(0.18)	(0.24)	(.23)
Mother consumed moderate amount of alcohol during pregnancy	0.08	1.57	−1.93**	−0.42	−2.42
	(0.27)	(1.44)	(0.96)	(1.18)	(1.49)
Mother consumed a lot of alcohol during pregnancy	0.01	0.83	4.79**	6.13***	5.41
	(0.10)	(2.36)	(2.22)	(2.23)	(4.76)
Mother smoked while pregnant, <1 pack per day	0.26	0.93	0.75	0.69	2.51**
	(0.44)	(0.89)	(0.72)	(0.85)	(1.01)
Mother smoked while pregnant, ≥1 pack per day	0.12	1.37	−1.19	−1.89	0.74
	(0.32)	(1.30)	(0.91)	(1.27)	(1.32)
Birthweight (ounces)	117.1	−0.03	0.06***	0.06***	0.03*
	(20.1)	(0.02)	(0.01)	(0.02)	(0.02)
Birth order	1.7	−0.66	0.33	−0.03	−2.26***
	(0.9)	(0.59)	(0.55)	(0.70)	(0.63)
Breastfed	0.46	1.65**	0.14	−0.95	1.58
	(0.50)	(0.80)	(0.69)	(0.78)	(0.96)
Child received well-care visit in first quarter	0.90	−2.04	0.54	−1.11	0.28
	(0.30)	(1.30)	(0.94)	(1.10)	(1.31)
Child received well-care visit in second quarter	0.67	0.47	0.18	1.52	−0.19
	(0.47)	(0.95)	(0.79)	(0.92)	(1.00)
Child received well-care visit in third quarter	0.34	−0.24	−1.36*	0.28	−0.67
	(0.47)	(0.86)	(0.74)	(0.88)	(0.99)
Child received well-care visit in fourth quarter	0.32	0.52	−0.06	−0.98	−0.31
	(0.46)	(0.88)	(0.80)	(0.91)	(1.05)
Mother is widowed, divorced, or separated	0.16	0.71	−0.70	0.37	1.73
	(0.37)	(1.16)	(0.94)	(1.14)	(1.34)
Mother is married	0.71	1.12	1.67	3.09	−0.92
	(0.45)	(2.45)	(1.98)	(2.59)	(3.34)
Mother's age	28.0	−1.11	−0.12	1.16	−0.36
	(2.8)	(0.73)	(0.63)	(0.72)	(0.88)

Table A1 (*continued*)

Variable	Mean (standard deviation)	BPI	PIAT-Math	PIAT-Reading	PPVT
Spouse is present	0.71	1.04	−7.62***	−6.46*	−0.77
	(0.45)	(3.51)	(2.86)	(3.47)	(4.36)
Spouse's education	12.6	−0.26	0.43**	0.25	0.27
	(6.1)	(0.21)	(0.17)	(0.20)	(0.22)
Female relatives	0.07	0.10	0.27	0.05	−0.71
	(0.25)	(1.52)	(0.96)	(1.17)	(1.31)
Male relatives	0.04	−0.61	−0.39	−1.69	−3.09
	(0.19)	(1.83)	(1.36)	(2.03)	(2.16)
Children 0–2	0.53	−0.47	−0.46	0.02	−0.93
	(0.65)	(0.52)	(0.50)	(0.48)	(0.66)
Children 3–5	0.76	−0.44	−0.68*	−0.91*	−0.88
	(0.68)	(0.48)	(0.39)	(0.47)	(0.61)
Children 6–11	0.89	0.55	−0.98**	−1.42***	−1.67***
	(0.96)	(0.45)	(0.45)	(0.54)	(0.61)
Children 12–17	0.18	−0.16	−1.30**	−0.34	−1.20
	(0.50)	(0.66)	(0.57)	(0.63)	(0.77)
Other adults	1.12	0.93	−0.26	−0.48	0.21
	(0.42)	(0.63)	(0.57)	(0.65)	(0.77)

Cognitive stimulation score	99.7	−0.14***	0.08***	0.07***	0.09***
	(15.2)	(0.02)	(0.01)	(0.02)	(0.03)
Emotional support score	99.7	−0.10***	0.10***	0.08***	0.14***
	(15.0)	(0.02)	(0.02)	(0.02)	(0.03)
Child attended head start	0.16	2.26**	−0.09	−1.56*	−0.93
	(0.36)	(0.95)	(0.82)	(0.88)	(1.62)
Head start missing	0.37	0.78	−0.85	1.41*	−0.87
	(0.48)	(0.71)	(0.74)	(0.82)	(0.80)
Child attended preschool	0.92	−0.50	−0.18	−4.57*	2.01
	(0.27)	(1.74)	(2.28)	(2.39)	(1.67)
Preschool missing	0.64	2.66	1.74	1.43	3.70
	(0.48)	(3.99)	(2.98)	(3.69)	(2.99)
Fraction of pregnancy during which mother worked	0.34	−2.47*	0.59	−0.41	−0.93
	(0.39)	(1.49)	(1.23)	(1.39)	(1.58)
Fraction of first three years of child's life during which mother worked	0.26	0.52	1.52	0.06	1.46
	(0.34)	(1.84)	(1.47)	(1.73)	(1.76)
Full-time work during pregnancy	0.39	2.32**	−0.20	1.57	−0.19
	(0.48)	(1.10)	(0.86)	(1.05)	(1.27)
Full-time work during child's first three years	0.29	−0.20	−0.10	−0.24	−0.61
	(0.39)	(1.32)	(1.05)	(1.23)	(1.35)
Intercept		146.04***	64.20***	70.47***	44.54***
		(8.08)	(6.96)	(8.70)	(9.63)

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