

**How Does Early Childhood Care and Education Affect Cognitive Development? An International Review of the Effects of Early Interventions for Children from Different Social Backgrounds**

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## ABSTRACT

A number of authors have investigated the impact of early childhood education and care programs on the development of children. Often they have focused on the effects on children from socio-economically disadvantaged families. To assess the effects of various preschool programs on cognitive development, recent key studies were reviewed. In addition, the extent to which these programs could establish equal educational opportunities for children from different social backgrounds was evaluated. Program start, intensity, and duration were considered. The findings indicate that the vast majority of recent early education and care programs had considerable positive short-term effects and somewhat smaller long-term effects on cognitive development and that in relative terms children from socioeconomically disadvantaged families made as much or slightly more progress than their more advantaged peers. Despite this, early childhood education and care cannot compensate completely for developmental deficits due to unfavorable learning conditions in disadvantaged milieus. Implications for research and policy are discussed.

Children from disadvantaged families often experience particular difficulties at school. They enter school with fewer academic skills than their more advantaged peers, and they often lag behind in their cognitive development during the later school years (Stipek & Ryan, 1997). During the 1960s, these difficulties were attributed to adverse learning conditions in families that do not provide their children with what is required for successful development in the early years. In 1965, U.S. president Lyndon B. Johnson therefore implemented Head Start, the most widespread compensatory education programs for disadvantaged preschool children. Since then, numerous early education and care programs have been launched in many countries and researchers have begun to investigate the effects of these programs on the development of children.

Most of the 30 member countries of the OECD--an international organization committed to democratic government and the market economy--became concerned about early care and education after the Program for International Student Assessment (PISA, 2001, 2004, 2007) had highlighted the close relationship between school attainment and student social background for a number of countries. Up to now, the educational systems have not been able to compensate for social inequalities (e.g., Schütz & Wössmann, 2005; Wössmann, 2004). Many experts have therefore heralded preschool programs as a promising means of establishing equal educational opportunities for children from different social backgrounds. Early interventions have been assumed to reduce school readiness gaps among children from families with low educational aspirations and/or low socio-economic status. Recently, the United Nations have also considered preschool programs as a potential means of fostering school readiness. Within the scope of the six Education for All goals adopted at the World Education Forum in Dakar in 2000, the expansion and improvement of comprehensive early childhood care and education--especially for the most vulnerable and disadvantaged children--was declared to be the first of six goals of education for all (UNESCO, 2008). The priority given to early child support and development was justified by the claim that setting strong foundations for learning begins in the earliest years of life (UNESCO, 2007).

Hence there appears to be consensus that the early years are particularly important for the development of basic skills which will help children cope with everyday requirements later on. However, few reviews have been carried out of studies of the effectiveness of early

interventions in different countries and with different pedagogical approaches. The present paper therefore reviews recently published key studies from Europe, North America, and Asia in order to explore the extent to which preschool programs affect the development of children across national borders. Most earlier reviews of preschool programs have focused on studies in the U.S. (Anderson et al., 2003; Barnett, 1995; Currie, 2001; Karoly et al., 1998; Karoly, Kilburn, & Cannon, 2005; Yoshikawa, 1995). By drawing on major studies from different countries, the present analysis goes beyond previous reviews insofar as it attempts to detect a pattern of effects which is not bound to a particular country, cultural context, or curriculum. Moreover, in contrast to narrative literature reviews (e.g., Ramey & Ramey, 1998; Rossbach, Kluczniok, & Kuger, 2008), it provides important details about the statistical results of the studies included. Since the effects of early interventions are manifold, an exhaustive overview cannot be given. Instead, the paper focuses on cognitive development. Cognitive development is only one of several indicators of a successful development. Others include social skills, motivation to achieve, self-esteem, health status, and attitude towards school. However, the early cognitive effects of participation in a preschool program carry over to school competence and educational attainment, thereby influencing longer-term social development (Reynolds, Mann, Miedel, & Smokowski, 1997). This makes analysis of cognitive development particularly interesting.

### **RESEARCH OBJECTIVES**

The present review explores the cognitive development of children who attended an early care and education program comparing target children's progress with children who may have participated in all kinds of alternative programs or have not been cared for in a formal preschool setting at all. Along with the general effects on the child's cognitive development, the paper analyzes whether early interventions help to overcome social inequality, and if so, whether these interventions can ensure equal educational opportunities for children from different social backgrounds. Hence two major questions are considered: (1) what are the effects of early childhood care and education programs on the cognitive development of children? And (2) can such programs help to overcome inequalities among children from different social backgrounds?

To simplify matters, the terms early (childhood) education and care and preschool education are used interchangeably in this review. Both terms are intended to refer to center-based early intervention programs that foster the cognitive and socio-emotional development of children between about two years and the official school entrance age. In most instances, these programs address children between three and six years of age. As opposed to parental care or informal care by relatives, nannies, or babysitters, early childhood education and care (as it is defined here) is carried out in institutions such as day care centers, nursery schools, pre-kindergartens, and kindergartens. Many of the early education and care programs have been designed specifically to increase the school readiness of children from socio-economically disadvantaged families. It is therefore crucial to ask to what extent these programs can reduce disadvantage by providing socio-economically deprived children with a better start at school. This is particularly important since it is well known that low socio-economic status can have a detrimental influence on the development of children (Barnett & Belfield, 2006).

## **EFFECTS OF SOCIO-ECONOMIC STATUS ON THE DEVELOPMENT OF CHILDREN**

Socio-economic status refers to the relative position an individual, a family or a group holds within a societal hierarchy according to its access to or power over valued goods such as wealth or social recognition and privileges (McLoyd, 1998). Under these terms, the members of a society can be classified into different social strata according to the status values they have acquired. Typically, parental occupation and education, family income, power, and prestige are important components of these values, and members of the different strata are also faced with different living conditions (e.g., Hurrelmann, 2000; Mueller & Parcel, 1981). Children of families with a low socio-economic status are frequently at risk of not successfully developing the skills they need to achieve at school (Duncan, Brooks-Gunn, & Klebanov, 1994; McLoyd, 1998). Since their skills are less developed in their early years (Moser, Stamm, & Hollenweger, 2005; Roberts, Bornstein, Slater, & Barrett, 1999; Taylor, Dearing, & McCartney, 2004), the school readiness gap for these children is greater than for children from families with a higher socio-economic status (Barnett, Brown, & Shore, 2004; Paxson & Schady, 2007; Schady, 2006). Considerable discrepancies in academic competencies persist during the subsequent school years (Evans & Rosenbaum, 2008; Korenman, Miller, & Sjaastad, 1995; Magnuson, Meyers, Ruhm, & Waldfogel, 2004; Moser, Bayer, & Berweger, 2008; Osborn & Milbank, 1987; Sammons et al., 2008; Schneider & Stefanek, 2004).

As children from socio-economically disadvantaged backgrounds are prone to more unfavorable development, they are more likely to repeat grades, to develop special education needs in the course of their later school years, or to withdraw from school before completing their program (Goodman & Sianesi, 2005; Niles, Reynolds, & Roe-Sepowitz, 2008; Reynolds et al., 2007). This applies where low socio-economic status brings an impoverishment of the child's world so that the child lacks the basic social and cognitive stimulation required for optimum development. For this reason, researchers have examined informal education and school preparation at home, for example parents' teaching strategies when playing and their manner of conversing with their children. Their analyses have revealed differences between families that are associated with socio-economic status and identified these as a key cause of early differences between children in cognitive and language development, intelligence, and school achievement (Hoff, 2006; Hoff & Tian, 2005). Thus low socio-economic status can be associated with poorer informal learning at home, resulting in children being less well prepared for formal schooling (Leseman, 2002).

## **EARLY EDUCATION AND CARE AND EQUALITY OF OPPORTUNITY**

The aforementioned findings show that children from different social backgrounds have unequal skill levels when they enter school. The vast majority of early education and care programs strive to counteract such inequalities. By fostering the development in the early years, they aim to ensure that all children--regardless of their social background--have the prerequisites for a successful start at school (e.g., Siraj-Blatchford, 2004). If all children attain these prerequisites, they can be assumed to have comparable educational opportunities at the start of their school track. Hence early interventions attempt to enhance those abilities which are the basis for beneficial development. By enriching the learning environments of children at risk of less successful development, they aim to compensate for the unfavorable learning

conditions children face in families that provide less opportunity for informal learning. Equality of opportunity exists where everyone is accorded the same chance to develop his or her capacities and to be acknowledged for personal accomplishments irrespective of characteristics such as gender, religion, political stance, color of the skin, or social background, that is, characteristics which are not related to their personal performance (Hradil, 2001). Equality of opportunity, however, is not given in practice. In view of such social inequalities, it is imperative to ask whether early interventions help to overcome differences between children from different social backgrounds.

### **RELATED ANALYSES AND MAIN FOCUS OF THE PRESENT ANALYSIS**

Many specific questions have been analyzed in early childhood research. The following overview about research into the acquisition of skills and educational development of children may give insight into some of the most prominent research questions. So far, these questions have concerned the influence of time spent in preschool (e.g., Walston & West, 2004) and the differential effectiveness of different types of preschool provision (e.g., Schweinhart & Weikart, 1997). A number of authors have compared full-day with half-day kindergarten (e.g., Cryan, Sheehan, Wiechel, & Bandy-Hedden, 1992; Plucker et al., 2004; Votruba-Drzal, Li-Grining, & Maldonado-Carreño, 2008; Zvoch, Reynolds, & Parker, 2008). Others have analyzed the effects of preschool quality (e.g., Early et al., 2007; Fried, 2002; Fthenakis & Textor, 1998; Howes et al., 2008; Tietze, 1998; Vandell, Henderson, & Wilson, 1988), quality management (Spiess & Tietze, 2002), various program or process features (e.g., Guimarães & McSherry, 2002; Marcon, 1992; Montie, Xiang, & Schweinhart, 2006), the role of schools in sustaining the effects of early childhood education and care (e.g., Entwisle, 1995; Magnuson, Ruhm, & Waldfogel, 2007), the effects of parent support programs (Goodson, Layzer, St. Pierre, Bernstein, & Lopez, 2000), and the effects of state-funded preschool (Gilliam & Zigler, 2001). Still others have examined early training of cognitive competencies (e.g., Krajewski, Renner, Nieding, & Schneider, 2008; Pauen & Pahnke, 2008), the contribution of parent and peer support to children's early school adjustment (Bennett, Weigel, & Martin, 2002; Taylor & Machida, 1994), the role of the teacher-child relationship quality on preschoolers' academic readiness for kindergarten (Palermo, Hanish, Martin, Fabes, & Reiser, 2007), and comprehensive case management interventions (St. Pierre, Layzer, Goodson, & Bernstein, 1997). Finally, numerous researchers have focused on the return on financial investments in early education and care (e.g., Anger, Plünnecke, & Tröger, 2007; Bock-Famulla, 2002; Fritschi & Oesch, 2008; Fritschi, Strub, & Stutz, 2007; Heckman, 2006; Mackenzie Oth, 2002; Müller Kucera & Bauer, 2000; Pfeiffer & Reuss, 2008; Rauschenbach & Schilling, 2007; Spiess et al., 2002). The main focus of the present paper, however, is the overall influence of early education and care on the cognitive development of children and the extent to which early interventions can reduce social disparities among children. In addition, some of the questions addressed in other studies--such as the effects of age at entry, intensity, duration, and pedagogical focus of a program--will also be studied. However, although it would be interesting to relate differences in these variables explicitly to cognitive outcomes, this is not done here because well-grounded conclusions in these terms would require studies that have specifically focused on these questions. Instead, the review attempts to discover general and compensatory effects of program participation on several cognitive outcome measures.

## SYSTEMATIC REVIEW

In order to gain an overview of the relevant research, recent studies were analyzed using focussed categorizing of empirical findings. Systematic reviews and evidence-based conclusions are increasingly important for policy decision making. In education systems with rising demand and limited resources, methodical assessment of educational technologies is important for those who make resource allocation decisions. Moreover, reviews provide researchers with useful syntheses of the primary research literature guiding them to the principal contributions of the field and familiarizing them with the state of the art of a particular area of research. Reviews are an appropriate means to summarize the evidence of a given field, in particular when the data required for meta-analysis are not available exhaustively. Like meta-analyses, reviews can deal with certain heterogeneity of studies by paying attention to the methodological (and statistical) rigor of these studies. Reviews can organize and qualify conclusions by the type and quality of the studies. Hence good reviews weigh results by considering the elaborateness of the statistical approaches and by critically reflecting the scientific value of the studies included. Reviews range from highly qualitative methods which rely on subjective considerations about the research procedure and results to rather quantitative methods which include various statistical data from the literature. The present review attempts to draw on both a qualitative approach and inclusion of statistical results. Reviewing the literature is a scientific inquiry that needs a clear conceptual framework to preclude bias. This framework is specified hereafter.

### *Conceptual Approach and Criteria of Including Studies*

The framework for the review consisted of three major steps: First, relevant studies were identified in computerized databases (like ERIC, PsycInfo, and PubMed), in various online research portals (e.g., ec.europa.eu/research/; forschungsportal.net; researchportal.ch), and in books; furthermore, non-refereed publications such as major research reports from educational authorities and research institutes were searched on the internet. Secondly, since any literature review will inevitably be selective, eligibility criteria were defined which studies had to meet to be included for further analysis. These criteria concerned the type of program analyzed and the study reports:

- (1) The intervention must have begun during a child's preschool years, that is, before compulsory schooling.
- (2) The intervention was center-based and focused on the promotion of child well-being, that is, it was a promotion or prevention program.
- (3) The goal of this direct, child-focused approach was to enhance child development and learning by attending to the needs of children.
- (4) Center-based approaches involved several kinds of institutions offering early years provision such as preschools, childcare centers, crèches, playgroups, day-care nurseries, and nursery schools which served as alternative physical and social environments for care, development, and education.
- (5) Information was provided about characteristics of the type of service.
- (6) Studies were published after 1990; the only exception concerned the Child Health and Education study by Osborn and Milbank published in 1987 and included here because of its particular importance for early education and care research in the United Kingdom.
- (7) Studies had well-defined average- to large-scale samples with at least 300 study participants.
- (8) Research was reported in journal articles or research reports and documented an evaluation of an early childhood education and care program.
- (9) The report provided information from a primary study, and was not a literature review.
- (10)

Research methods, statistical analyses, and findings were sufficiently detailed to provide a basis for judgment about the robustness of the conclusions, that is, the research procedures and characteristics of the sample were specified in detail so that the validity of the results could be evaluated. (11) Outcome measures were indicators of the construct of children's cognitive development. (12) The evidence assessed linkages between participation in a program and cognitive outcomes. (13) A control (or comparison) group was given that either received no preschool education or had been assigned to another kind of program so that the effectiveness of different interventions could be compared. The present review does not aim to duplicate existing reviews like the ones by Anderson et al. (2003), Barnett (1995), Boocock (1995), and Currie (2001) and therefore largely omits the studies included in these thoroughly conducted previous reviews.

The third stage in the review was to summarize the evidence of effectiveness. Information was collected about outcomes of pre-specified interest concerning cognitive development measures rather than about all outcomes measured in a study. To this end, a data collection form was designed and used as a bridge between what was reported in the studies and what is reported here. It was linked directly to the review question and structured like tables 1 to 4 in this paper. However, statistical data from the original studies were recorded in more detail. For this review, four tables of evidence were defined in which various categories of information were included (see tables 1, 2, 3, 4). These tables are related and can be considered as one overall table with four parts. For studies that met the inclusion criteria, information was recorded about project period, age of the children at entry to the program, duration of program attendance, last follow-up of the study (for the time being), size of the original and the follow-up samples, cognitive achievement test outcomes and/or educational attainment, special education rates, grade retention rates, graduation rates, and number of years of school attendance whenever information about these indicators was provided in the publications. Furthermore, the capacity of projects to compensate for socio-economic disadvantage was specified by comparing developmental gains of children from more privileged families with gains of children from more disadvantaged families. When interventions targeted children from disadvantaged backgrounds exclusively, cognitive effects were assessed but no conclusion could be drawn about the compensation for socio-economic disadvantage in the strict sense. In addition, a selection of the major measuring instruments was reported in table 3 together with the publications included in the review. Finally, table 4 reports on the statistical methods and effect sizes and evaluates the quality of the study designs.

The table of evidence was designed to allow conclusions about the two questions of interest, firstly the general effects of early interventions on cognitive development and secondly the capacity of interventions to overcome social inequalities among children from different social backgrounds. In order to answer these questions, the most pertinent results from the individual studies were extracted and structured in tables 2, 3, and 4 to make them directly comparable. Further information on methods for conducting systematic reviews is given by Briss et al. (2000).

### *Experimental versus Quasi-Experimental Studies*

The most accurate estimates of the impact of early education and care programs can be derived from random-assignment, controlled experimental studies. These contrast children

who experience a particular form of preschool with children who do not experience any comparable program but are otherwise equivalent with regard to relevant background characteristics, thus ensuring that differences in development are attributable principally to the particular experiences in the program. However, randomized trials are generally conducted with small samples and at one single site only. For this reason, the majority of studies evaluating the effectiveness of preschool adopt a quasi-experimental design and investigate the impact of naturally occurring variations in different types of interventions. Similarly, birth cohort studies and large-scale representative surveys providing data on a wide range of information typically retrospectively compare children who have experienced some form of early intervention with children without this experience, while trying to control for other important background characteristics that could influence development.

The clearest evidence of the longer-term efficacy of preschool interventions, reaching into adolescence and young adulthood, comes from small-scale high-quality model programs such as High/Scope Perry Preschool (Schweinhart et al., 2005). These programs primarily enroll socio-economically disadvantaged children who are manifestly behind in their development compared to more privileged children. In addition, these programs generally use highly trained teachers and have low child-to-staff ratios in contrast to large-scale public programs. Hence they are designed to highlight the positive effects of early education and care. In fact it is well known that these model interventions have beneficial effects on the development of children (Barnett, 1995). However, while these programs illustrate how interventions could work, the present paper aims to explore how they do work. For this purpose, it is reasonable to examine the findings of quasi-experimental studies which analyze larger-scale programs. By mirroring more typical (real-world) experiences of children, these findings are more generalizable to other programs and children. As their external validity is superior to that of model program outcomes, they are analyzed in depth in this paper. Other authors have already reviewed studies of the effectiveness of preschool interventions (e.g., Barnett, 1995, 2008; Currie, 2001; Karoly et al., 1998; Rossbach et al., 2008). However, as Reynolds et al. (1997) observe, the majority of the empirical evidence comes from model programs. Unlike evaluations of model programs, the present review provides a synopsis of different average- to large-scale sample studies including curriculum comparison and birth cohort studies from different countries. The results of the Delaware Early Childhood Longitudinal Study (Gamel-McCormick & Amsden, 2002) included here were based on a sub-sample that was relevant to the present review. Hence we must avoid any assumption that the findings are nationally representative.

In sum, this review analyzes the effectiveness of early education and care interventions by drawing on quasi-experimental studies without random assignment of participants to an intervention or a control group. The Head Start Impact Study (U.S. Department of Health and Human Services, 2005) is the only one that used an experimental research strategy. Some of the studies used norm-referenced, age-standardized outcome measures to compare the achievement of children in early intervention programs with nationally representative norms. These measures were used for the evaluation of six projects, notably the North Carolina More at Four Pre-kindergarten Program (Peisner-Feinberg & Schaaf, 2008), the Head Start Family and Child Experiences Survey (FACES, 2006), the Universal Pre-kindergarten in Oklahoma (Gormley, Gayer, Phillips, & Dawson, 2005; Gormley, Phillips, & Gayer, 2008), the Georgia Early Childhood Study (Henry et al., 2003,

Table 1

*Project features*

| <b>Project</b>  | <b>Project period</b> | <b>Age at entry</b> | <b>Mean duration of attendance</b> | <b>Age at last follow-up</b> |
|---|-----------------------|---------------------|------------------------------------|------------------------------|
| <b>Europe</b>   |                       |                     |                                    |                              |
| Effective Provision of Pre-School Education (EPPE, EPPE 3-11), U.K. | 1997-2003             | 3 years             | variable                           | 7 years                      |
|   | 2003-2008             |                     |                                    | 11 years                     |
| Early Years Transition and Special Education Needs (EYTSEN), U.K.   | 1997-2003             | 3 years             | variable                           | 7 years                      |
| Effective Pre-School Provision in Northern Ireland (EPPNI), NI      | 1998-2005             | 3-4 years           | variable                           | 8 years                      |
| Socio-Economic Panel (SOEP), DE                                     | 1984 - ongoing        | variable            | a) 1 year, b) 2 years              | a) 14 years, b) 12-14 years  |
| Dutch Cohort Study of Primary Education (PRIMA), NL                 | 1996-2000             | 4 years             | 60-240 days                        | 10 years                     |
| Dutch Public Preschool Study (DPPS), NL                             | Not indicated         | 4-5 years           | 2.5 years                          | 6-7 years                    |
| School Success of Immigrant Children (CH), CH                       | 1998 - ongoing        | variable            | variable                           | 7 years                      |
| Panel 1997, FR  | 1997 - ongoing        | variable            | variable                           | 9 years                      |
| <b>USA</b>  |                       |                     |                                    |                              |
| Chicago Longitudinal Study - Child-Parent Center (CLS)              | 1985 - ongoing        | 3 years             | 2 years                            | 24 years                     |
| Early Childhood Longitudinal Study - Kindergarten Class (ECLS-K)    | 1998 - ongoing        | 5 years             | 1 year                             | 11 years                     |
| North Carolina More at Four Pre-kindergarten Program (Carolina)     | 2001 - ongoing        | 4 years             | 2 years                            | 6 years                      |
| Head Start Family and Child Experiences Survey (FACES)              | 1997-2010             | 3-4 years           | 1 year                             | a) 4 years, b) 5-6 years     |
| Head Start Impact Study (H.S. Impact)                               | 2002-2009             | 3-4 years           | 1 year                             | 4-5 years                    |
| Albuquerque Child Development Centers, ACDC (Albuquerque)           | 1999-2006             | 3-5 years           | 1-2 years                          | 13-17 years                  |
| Arkansas Better Chance Pre-kindergarten Program (ABC)               | 2005-2010             | 5 years             | 1 year                             | 7 years                      |
| Universal Pre-kindergarten - The example of Oklahoma (Oklahoma)     | 2003, 2006            | 4 years             | 1 year                             | 5 years                      |
| Georgia Early Childhood Study (Georgia)                             | 2001-2004             | 4 years             | 1 year                             | 7 years                      |
| Delaware Early Childhood Longitudinal Study (Delaware)              | 1997-2002             | 4 years             | 1 year                             | 8 years                      |
| Miami School Readiness Project (Miami)                              | 2002-2007             | 4 years             | 1 year                             | 5 years                      |
| <b>Asia</b>   |                       |                     |                                    |                              |
| Early Childhood Development in rural Vietnam (Vietnam)              | 1999-2003             | 4 years             | 2 years                            | 6-8 years                    |
| <b>Birth cohort studies in Great Britain and Canada</b>             |                       |                     |                                    |                              |
| National Child Development Study (NCDS), GB                         | 1958 - ongoing        | variable            | variable                           | 46 years                     |
| British Cohort Study (BCS), GB                                      | 1970 - ongoing        | variable            | variable                           | 34 years                     |
| National Longitudinal Survey of Children and Youth (NLSCY), CA      | 1994-2009             | 4 years             | 1-2 years                          | 14-25 years                  |

Table 2  
*Study samples and outcomes*

| Project     | Samples  | Cognitive achievement test outcomes and/or educational attainment  | Special education rates  |
|-------------|--|--|--|
| EPPE        | 2004: T = 2,857 C = 314 (a)<br>2008: T = 2,701 C = 276 (b)   | a) At age 7: ▪ T > C: in pre-reading, language, and early number concepts<br>b) At age 11: ▪ T > C: in English and math  | c) At risk of special needs:<br>▪ at age 6: T = 21%, C = 51%<br>▪ at age 7: T ≈ 25%, C = 42%               |
| EYTSEN      | 2003: T = 2,857 C = 314 (c)  |  |  |
| EPPNI       | 2003: T = 683 C = 151  | At age 8: ▪ T (nursery class/school) > C: in numeracy and literacy<br>▪ T (reception groups, private nurseries) ≈ C: in numeracy and literacy  |  |
| SOEP        | 2003: T = 266 C = 50 (a)<br>2007: T = 1,272 C = 60 (b)   | a) At age 14 at schools with extended requirements: ▪ T (64.4%) > C (41.4%)<br>b) At age 12 to 14 at the highest secondary school track: ▪ T > C   |  |
| PRIMA       | 1996: T = 10,097 C = 1,509<br>2000: N = 3,596  | At age 10: ▪ T ≈ C: in math and language   |  |
| DPPS        | t1: N = 333<br>t2: N = 312   | At age 6-7: ▪ significant verbal and fluid intelligence gains relative to age-norms  | Referrals during investigation:<br>▪ until age 6-7: 2.24%  |
| CH          | 1998: T = 98 C = 216   | At age 7: ▪ T > C: in cognitive capabilities and language  |  |
| PANEL1997   | 1997: N = 9,260<br>2001: N = 8,661   |  |  |
| CLS         | 1985: T = 989 C = 550<br>2004: T = 902 C = 487   | a) At age 23: ▪ College attendance: T (29.4%) ≈ C (27.4%)<br>▪ 4-year college attendance: T (14.7%) > C (10.0%)<br>▪ Highest grade completed: T (11.73) > C (11.44)  | c) At age 18:<br>▪ T (14.4%) < C (24.6%)   |
| ECLS-K      | 2004: T = 10,680 C = 2,124 (a)<br>2006: N = 11,468 (b)   | a) At age 7: ▪ T (center-based care) > C (parental care): in reading and math<br>▪ T (Head Start) < C (parental care): in reading and math   | b) Until age 9:<br>▪ T (Head Start) = 1.14%<br>▪ T (Non-Head Start) = 0.49%<br>▪ C (parental care) = 0.91% |
| Carolina    | 2003-2005: N = 514 (cohort 1)<br>2005-2007: N = 478 (cohort 2)   | At age 6: ▪ T > national norms: in language, literacy, math, general knowledge   |  |
| FACES       | 1997: N ≈ 3,200 (cohort 1)<br>2000: N ≈ 2,800 (cohort 2)<br>2003: N ≈ 2,400 (cohort 3)<br>Control group: - | a) Percentage of gap between 4-year-old children and national norms closed between fall and spring of Head Start year in cohorts 1, 2, and 3:<br>▪ In early reading: cohort 1: -11%, cohort 2: 7%, cohort 3: 10%*<br>▪ In vocabulary: cohort 1: 28%*, cohort 2: 27%*, cohort 3: 22%*<br>b) At age 5-6: ▪ Significant positive effects on vocabulary, early math, and writing |  |
| H.S. Impact | 2002: T = 2,783 C = 1,884  | At age 4 or 5: ▪ T > C: in pre-reading, pre-writing, vocabulary, literacy<br>▪ T ≈ C: in oral comprehension, phonological awareness, early math  |  |

|             |  |            |  |   |
|-------------|--|------------|--|---|
| Albuquerque | 2000: N = 3,943<br>2006: N = not specified   |            | Among the best two-thirds of students in reading in 2006:<br>▪ ACDC: 60.5%<br>▪ Free lunch program: 48.7%<br>▪ Reduced price: 63.5%<br>▪ No support program: 80.3%   | Not learning disabled in 2006:<br>▪ ACDC: 93.4% ▪ Free lunch: 91.4% ▪ Reduced price: 93.2%<br>▪ No support: 94.7% |
| ABC         | 2005: T = 530 C = 218<br>2007: T = 451 C = 190                                     |            | At age 7: ▪ T > C: in calculation and letter-word-identification<br>▪ T ≈ C: in receptive vocabulary, applied math problems, math fluency, word attack   |   |
| Oklahoma    | 2003: T = 1,461 C = 1,567<br>2006: T = 1,264 C = 1,492                             | (a)<br>(b) | a) ▪ T > C: in letter-word-identification, spelling, math applied problems<br>b) ▪ T > C: in letter-word-identification, spelling, math applied problems   |   |
| Georgia     | 2001: T = 630 C = 225<br>2004: T = 466 C = 204                                     |            | Mean scores of 1) Pre-K, 2) Head Start, and 3) private program attendees at age 4 versus age 7, and 4) scores of control group at age 7 (x = 100, SD = 15). All cognitive gains over time were statistically significant:<br>▪ Letter/word recognition: 1) 103 vs. 112 2) 95 vs. 103 3) 109 vs. 116 4) 114<br>▪ Language: 1) 93 vs. 99 2) 83 vs. 90 3) 98 vs. 104 4) 103<br>▪ Applied problems: 1) 97 vs. 110 2) 90 vs. 102 3) 101 vs. 114 4) 114<br>▪ School grades in 1 <sup>st</sup> , 2 <sup>nd</sup> , and 3 <sup>rd</sup> grade satisfactory: T (83.0%) > C (71.0%)<br>▪ Meeting reading standard at age 8: T (69.1%) > C (48.7%)<br>▪ Meeting math standard at age 8: T (61.9%) > C (45.8%) |   |
| Delaware    | 2002: T = 42 C = 109   |            | Cognitive and language skills in national percentile ranking in pre-kindergarten:<br>▪ at entry: 32 <sup>nd</sup> - 43 <sup>rd</sup> percentile < ▪ at end of program: 47 <sup>th</sup> - 52 <sup>nd</sup> percentile  |   |
| Miami       | 2003, 2004: N = 3,838  |            | At age 6-8: ▪ T > C: in cognitive test scores  |   |
| Vietnam     | 2004: T = 141 C = 170  |            | At age 16: a) ▪ T (pre-compulsory) > C: in math and reading<br>b) ▪ T (preschool) ≈ C: in math and reading   | At age 7:<br>a) ▪ T (pre-compulsory) < C<br>b) ▪ T (preschool) ≈ C  |
| NCDS        | 1974: T = 6,605 C = 4,343<br>1974: T = 9,266 C = 1,684                             | (a)<br>(b) |  |   |
| BCS         | 1980: T = 5,029 C = 3,380<br>1980: N = 3,568 (for math)<br>N = 3,227 (for reading) | (a)<br>(b) | At age 10: a) ▪ T > C: in British Ability Scale and Picture Language Test score, reading, math, and communication<br>b) ▪ T (preschool) ≈ C: in math; ▪ T (preschool) < C: in reading  |   |
| NLSCY       | 1996/1997: N = 8,600   |            | At age 6 or 7: Outcomes of children 1) in ECEC programs, 2) cared for by a person other than the mother, 3) cared for in the family environment by a parent at age 2 and 3 years:<br>▪ Very good math skills: 1) 34% 2) 18% 3) 25%<br>▪ Very good reading skills: 1) 27% 2) 25% 3) 16%<br>▪ Overall achievement: 1) 26% 2) 25% 3) 21%  |   |

*Note.* ACDC stands for Albuquerque Child Development Centers, Reduced Price stands for Reduced Price Lunch Support Programs, ECEC stands for early childhood education and care. Further information about programs and outcome measures is given in the text. <, >, and \* indicate statistically significant results at the p < 0.05 level at least.

Table 3

*Study outcomes, selected measuring instruments, selected publications*

| Project   | Grade retention; Graduation from school; School years  | Compensation for socio-economic disadvantage | Selected measuring instruments  | Selected publications   |
|-----------|--|--|---|---|
| EPPE      |  | Partially                                    | British Ability Scales; Reading and math tests  | a) EPPE (2004)<br>b) EPPE (2008a)<br>c) EYTSEN (2003)                               |
| EYTSEN    |  |  |   |   |
| EPPNI     |  | Partially                                    | British Ability Scales;   | EPPNI (2004)  |
| SOEP      |  | Yes  | Official reports  | a) Spiess et al. (2003)<br>b) Landvoigt et al. (2007)                               |
| PRIMA     |  | Not analyzed                                 | Student profiles; Concepts test; Ordering test  | Driessen (2004)   |
| DPSS      |  | Yes<br>(targeted intervention)               | Revised Amsterdam Child Intelligence Test RAKIT   | van Tuijl & Leseman (2007)  |
| CH        |  | Not analyzed                                 | Teacher reports   | Lanfranchi (2002)   |
| PANEL1997 | Grade retention until age 9: Children who entered kindergarten:<br>▪ at age 2: 9.2% < ▪ at age 3: 12.3% < ▪ at age 4 or older: 23.4%   | Partially                                    | Tests about general and specific cognitive abilities                                    | Caille (2001)   |
| CLS       | c) Grade retention by age 15:<br>▪ T (23.0%) < C (38.4%)<br>c) School dropout by age 20:<br>▪ T (46.7%) < C (55%)<br>a) High school completion by 23:<br>▪ T (71.4%) > C (63.7%) | Yes<br>(targeted intervention)               | School records;<br>Family and participant surveys; Administrative records               | a) Reynolds et al. (2007)<br>b) Reynolds et al. (2002)<br>c) Reynolds et al. (2001) |
| ECLS-K    | a) Grade retention until first grade:<br>▪ T (center-based care) < C<br>▪ T (Head Start) ≈ C   | a) Yes<br>b) Partially                       | Academic Rating Scale   | a) Magnuson et al. (2004)<br>b) Rumberger et al. (2006)                             |
| Carolina  |  | Yes  | Peabody Picture Vocabulary Test-III; Woodcock Johnson-III Tests of Achievement          | Peisner-Feinberg & Schaaf (2008)  |
| FACES     |  | Yes<br>(targeted intervention)               | Peabody Picture Vocabulary Test-III; McCarthy Draw-A-Design task; Woodcock-Johnson Test | a) Zill et al. (2006)<br>b) FACES (2006)  |

|             |   |  |                                |  |  |
|-------------|---|--|--------------------------------|--|--|
| H.S. Impact |   |  | Yes<br>(targeted intervention) | As in FACES  | U.S. Department of Health and Human Services (2005)      |
| Albuquerque | Not retained until 2006:<br>▪ ACDC: 73.0%<br>▪ Free lunch: 67.0%<br>▪ Reduced price: 75.3%<br>▪ No support: 75.5% | High school graduation on time:<br>▪ ACDC: 31.0%<br>▪ Free lunch: 23.0%<br>▪ Reduced price: 38.0%<br>▪ No support: 43.0% | Partially                      | Kindergarten Development Progress Report; School records   | Boyle (2007)<br>Boyle & Roberts (2003)                   |
| ABC         |   |  | Not analyzed                   | Peabody Picture Vocabulary Test; Woodcock Johnson Tests  | Hustedt et al. (2008)                                    |
| Oklahoma    |   |  | Partially                      | Woodcock-Johnson Tests of Achievement  | a) Gormley et al. (2005)<br>b) Gormley et al. (2008)     |
| Georgia     | Retention of pre-K children:<br>▪ in kindergarten: 5.3%<br>▪ in first school year: 9.8%                           |  | Partially                      | Oral and written language scale; Woodcock Johnson-III Tests; Comprehensive Test of Phonological Processing | Henry et al. (2003, 2004)                                |
| Delaware    | Grade retention until age 8:<br>▪ T = 6.67%, C = 16.5%  |  | Not analyzed                   | Delaware State Testing Program   | Gamel-McCormick & Amsden (2002)                          |
| Miami       |   |  | Yes<br>(targeted intervention) | Learning Accomplishment Profile-Diagnostic   | Winsler et al. (2008)                                    |
| Vietnam     |   |  | Not analyzed                   | Raven's Progressive Matrices Test  | Watanabe et al. (2005)                                   |
| NCDS        | Level 2 qualification by age 33:<br>a) ▪ T (pre-compulsory) > C<br>b) ▪ T (preschool) ≈ C                         | Higher education by age 33:<br>a) ▪ T (pre-compulsory) ≈ C<br>b) ▪ T (preschool) ≈ C                                     | Yes                            | Different tests for math and reading/language development and an overall measure                           | a), b) Goodman & Sianesi (2005)                          |
| BCS         |   |  | Yes                            | English Picture Vocabulary Test; British Ability Scales; Picture Language Test                             | a) Osborn & Milbank (1987)<br>b) Feinstein et al. (1999) |
| NLSCY       |   |  | Partially                      | Peabody Picture Vocabulary Test-Revised  | Lipps & Yiptong-Avila (1999)                             |

*Note.* Level 2 qualifications are usually obtained at age 15-16 years. Further information about programs and outcomes is given in the text.

Table 4

*Statistical methods, effect sizes, and quality of the studies*

| <b>Project</b> | <b>Statistical methods</b>   | <b>Effect sizes</b>   | <b>Quality of design</b> |
|----------------|--|---|--------------------------|
| EPPE           | (3) a) Multilevel analyses<br>b) Multilevel analyses   | a) ▪ Pre-reading: 0.28; ▪ language: 0.46; ▪ early number concepts: 0.47<br>b) ▪ English: 0.22; ▪ math: 0.26   | a) Good<br>b) Good       |
| EYTSN          | (3) Multilevel analyses  | –   | Good                     |
| EPPNI          | (3) Multilevel analyses  | ▪ Pre-reading: 0.38<br>▪ Early number concepts: 0.47  | Good                     |
| SOEP           | (3) a) Binary probit models<br>b) Binary probit models   | a) –<br>b) –  | a) Fair<br>b) Good       |
| PRIMA          | (3) ANOVA; Nominal-metric correlation  | ▪ Math: 0.04; ▪ language: 0.03  | Fair                     |
| DPPS           | (3) Means; ANOVA; Multiple regression analyses   | ▪ IQ on RAKIT: 0.58<br>▪ Verbal intelligence: 0.36<br>▪ Fluid intelligence: 0.44  | Good                     |
| CH             | (2) T-tests  | –   | Limited                  |
| PANEL1997      | (3) Logistic regressions   | –   | Fair                     |
| CLS            | (3) a) Probit, linear, and negative binomial regressions<br>(3) b) and c) Probit and negative binomial regressions | a) –<br>b) –<br>c) –  | a), b), c) Good          |
| ECLS-K         | (3) a) Ordinary least squares regressions<br>(3) b) Hierarchical linear models                                     | a) ▪ Mean cognitive outcomes: $\approx 0.15$<br>b) ▪ Reading: in Head Start: -0.12, in Non-Head Start: 0.10<br>▪ Literacy: in Head Start: –, in Non-Head Start: 0.25<br>▪ Math: in Head Start: -0.23, in Non-Head Start: 0.13<br>▪ Science: in Head Start: -0.27, in Non-Head Start: 0.06 | a) Good<br>b) Good       |
| Carolina       | (3) T-tests; PROC mixed models; Longitudinal growth models   | –   | Good                     |
| FACES          | (2) a) Percentages<br>(2) b) T-tests   | a) –<br>b) ▪ Vocabulary: 0.26; ▪ letter-word-identification: 0.05;<br>▪ early writing: 0.13; ▪ early math: 0.08; ▪ book knowledge: 0.67;<br>▪ color naming: 0.60  | a) Limited<br>b) Fair    |

|             |   |  |                    |
|-------------|---|--|--------------------|
| H.S. Impact | (3) Means; Ordinary least squares models; Logistic regressions        | Range of effect sizes for various measures:<br>▪ in pre-reading: 0.19 - 0.24; ▪ in pre-writing: n.s. - 0.16;<br>▪ in vocabulary: n.s. - 0.12; ▪ in oral comprehension: n.s.; ▪ in early math: n.s. | Good               |
| Albuquerque | (3) Percentages; Logistic regressions                                 | –  | Fair               |
| ABC         | (3) Regression-discontinuity analysis                                 | –  | Good               |
| Oklahoma    | (3) Regression-discontinuity analysis                                 | ▪ Letter-word-identification: a) 0.79, b) 0.985<br>▪ Spelling: a) 0.64, b) 0.743<br>▪ Applied problems: a) 0.38, b) 0.355  | a) Good<br>b) Good |
| Georgia     | (1) Means; (3) Hierarchical linear models                             | –  | Fair               |
| Delaware    | (2) Percentages; T-tests  | –  | Limited            |
| Miami       | (3) Repeated measures MANOVA; ANCOVA                                  | ▪ Cognitive skills: 0.33 - 0.55<br>▪ Language skills: 0.52 - 0.55  | Good               |
| Vietnam     | (3) Means, PROC GLM (least-squares means for different interventions) | –  | Good               |
| NCDS        | (3) a), b) Ordinary least squares regressions                         | –  | Fair               |
| BCS         | (3) a) Multiple regressions<br>b) Instrumental variables estimates    | a) –<br>b) –   | a) Fair<br>b) Fair |
| NLSY        | (3) Percentages; Ordered response logistic regressions                | –  | Fair               |

*Note.* Further information on the classification of the statistical methods is given in the text. A dash (–) indicates that effect sizes were not indicated. Other research questions in the same studies might have been treated with other statistical methods; this table only displays the statistical analyses adopted to deal with the effects of early childhood education and care on cognitive development.

2004), the Dutch Public Preschool Study (van Tuijl & Leseman, 2007), and the Miami School Readiness (Winsler et al., 2008) projects. The outcome measures of all the other studies included here differ depending on the method applied. The analytic framework used in the present review reports the findings of empirical studies which conform to the eligibility criteria even if the methodological approaches differ. The selection of studies was based on their common overall research objective. Thus the studies were equivalent in respect of their research questions but varied as regards their statistical methods. The techniques applied include *t*-tests,  $\chi^2$ -square tests, analyses of variance, regression (discontinuity) analyses, and instrumental variable estimates. An important issue in reviews concerns publication bias towards statistically significant results. This leads to an overestimation of positive results and poses a special challenge for interpretation. For this reason, the present review may have overrepresented positive findings so that some uncertainty may remain as to the effectiveness of early education and care programs. However, where nonsignificant findings were reported in the studies, they were included in the present review.

### ***Program Characteristics and Research Designs***

Table 1 provides an overview of the projects included in the review. It indicates project names and periods, mean age of children at entry to the programs, mean duration of attendance, and mean age of participants at the last follow-up. It includes studies about eight European, one Asian, and eleven North American projects as well as three birth cohort studies from Great Britain and Canada. The characteristics of the early education and care programs analyzed and the research designs adopted in these studies are specified in the next section. The pedagogical concepts of the programs are outlined as defined at the time of inquiry; ongoing projects do not necessarily continue to operate according to the same principles. It should be noted that the programs reviewed were all center-based and child-focused. Their common overall goal was to serve children by helping them to acquire social and cognitive skills. However, given the number of programs reviewed, they differed in some points: some included special kinds of supports, and three of them included parent involvement, notably the Chicago Longitudinal Study Child-Parent Centers (Reynolds, Temple, Robertson, & Mann, 2001, 2002; Reynolds et al., 2007), Head Start (FACES, 2006; U.S. Department of Health and Human Services, 2005; Zill, Sorongon, Kim, & Clark, 2006), and the Early Childhood Development Study undertaken in rural Vietnam (Watanabe, Flores, Fujiwara, & Huong Tran, 2005) (see below). In the according studies, differences in cognitive outcomes between program participants and comparison groups must not be attributed exclusively to the influence of the programs carried out in the centers but may be affected by parenting strategies which can work as multipliers of center-based effects. In the United States, parent involvement figures prominently in early childhood programming, and state and national agency regulations in this respect are more demanding than in most other countries (OECD, 2006). Hence they should not be left out completely in a review about the effects of center-based early education and care. However, program breadth appears to have an influence on child outcomes: Programs that adopt a multifaceted approach and provide more wide-ranging services including health and social services, transportation, neurodevelopmental therapies as needed, parent services and training, and a strong

educational program for the children, usually produce larger developmental gains (Ramey & Ramey, 1998). Their results will therefore need to be weighed in the conclusions.

### ***Programs Studied in Europe***

Several programs were studied in *Europe*: The early education and care services analyzed in the projects in the *United Kingdom*--the Effective Provision of Preschool Education (EPPE, 2004), the Effective Preschool and Primary Education (EPPE, 2008a, 2008b), the Early Years Transition and Special Education (EYTSEN, 2003), and the Effective Preschool Provision in Northern Ireland (EPPNI, 2004)--varied according to the institution offering the early years provision. These four projects explored nursery classes, playgroups, private day nurseries, local authority day care nurseries, nursery schools, and centers that combined education and care (so called integrated centers). Centers were selected randomly within each type of provision in each of six English local authorities in five regions and in Northern Ireland. The sample covered provision in urban, suburban, and rural areas, and a range of ethnic diversity and social disadvantage. The respective care and education programs differed with regard to the timing, duration, intensity, quality, and main pedagogical focus. Methodologically, these projects compared the development of children who had attended a preschool institution with home children who had not been cared for in a formal preschool setting. Individual preschool centers varied in terms of their effectiveness in promoting intellectual progress. Hence the results reported in this review reflect the average overall developmental benefits of the above programs.

In *Germany*, the preschool provision analyzed in the Socio-Economic Panel (SOEP) was equally varied. The SOEP is an ongoing survey of private households providing information on all household members, consisting of Germans, foreigners, and recent immigrants. It is a wide-ranging representative study with annual follow-ups (DIW Berlin, n.d.). As they do today, the public kindergartens analyzed in the SOEP primarily targeted four- and five-year-olds. The kindergartens were designed to promote both the social and the cognitive development of children and they were mostly available on a half-day basis. In West Germany, where the studies were conducted, only about 20% of all kindergarten slots offered full-day care in 2001, for instance. For this, working parents usually need additional care arrangements which consist mainly of private provisions (neighbors, grandparents etc.), although by law, the German kindergarten is supposed to support parents' labor market participation and help parents meet their family life responsibilities, and it is seen as the first stage of the education system. Kindergarten is generally provided by the community or non-profit organizations. It is intended to prepare children for school even though it is not compulsory. Providers of kindergartens receive high public subsidies and kindergartens are supposed to be available for every child. In Germany, family day care for children between four and five years plays a minor role and is rather used for toddlers (Spiess, Büchel, & Wagner, 2003). The main research question concerned the effect of kindergarten attendance on the probability of later attending a school with extended academic requirements, the so called "Gymnasium," or restricted requirements, "Realschule" and "Hauptschule" (Landvoigt, Muehler, & Pfeiffer, 2007; Spiess et al., 2003). In the *Netherlands*, a variety of early education and care programs was researched in the Dutch Cohort Study of Primary Education PRIMA (Driessen, 2004). The common aim of these different programs was to stimulate the socio-emotional and the cognitive development of children. Various institutions targeted

different age groups between birth and eight years. Most of the programs were available on a part-day basis: Day-care centers provide child care for children between birth and four years of age. They are generally open every work day and usually funded and administered by local authorities or private organizations. However, based on their income, parents have to contribute to the cost of day-care centers. Preschools or preschool playgroups target children between two and four years and are available two to three half-days a week. They are financed by municipalities which usually charge a fee to parents. Early childhood education and care programs, finally, are special services typically aimed at children from disadvantaged backgrounds and usually conducted in preschools or elementary schools. The programs are intended for children up to eight years of age. Three-quarters of all programs are at least partly financed by municipal authorities, and one-quarter by the ministry of welfare. The Dutch Public Preschool Study (DPPS) drew on public preschools which are integrated in the primary school system, forming the first two grades of primary school (van Tuijl & Leseman, 2007). Their curriculum is predominantly developmental: Most preschools work with mixed-age groups; most time is spent in free-play activities and work lessons with children in small groups. Whole group activities are regularly provided as start, break, or closing activities during the day and include book reading, play, talking, and singing. In the second year of preschool, these activities are complemented by literacy and math activities (exploring letters and words, counting, measuring etc.). The vast majority of preschools adopt an eclectic, practical pedagogical approach.

In *Switzerland*, Lanfranchi (2002) analyzed the effects of participation in day nurseries, playgroups, and kindergartens on the school success of immigrant children from Italian, Turkish, Portuguese, and Albanian families. Playgroups and day nurseries (for three- to four-year-olds) provided mainly custodial care and were attended on a rather irregular basis whereas kindergartens (for five- and six-year-olds) primarily fostered the socio-emotional development of children and were available on a regular basis as a half-day program. In these services, the promotion of pre-academic abilities was not stipulated explicitly but approved implicitly. In Switzerland, only kindergartens are subsidized entirely by public authority.

In *France*, the Panel 1997 explored the influence of age at entry to the kindergarten on the grade retention rates of children up to the second grade of primary school (Caille, 2001). The French kindergarten, the “*école maternelle*,” is available to all children from three to six years and it has an explicit educational mission although not all of the institutions analyzed in the Panel 1997 necessarily focused on the promotion of pre-academic skills (some primarily emphasized the promotion of social development instead). The French kindergarten is fully funded and organized by the State as it is part of the national education system. Furthermore, it is attended by almost 100% of three-to-five-year-olds (OECD, 2006).

### ***Programs Studied in the U.S. and Elsewhere***

The eleven *North American* projects represent a number of different early care and education institutions and pedagogical approaches. The research strategies in these projects are specified hereafter. Details about the early intervention programs and their characteristics are given in a subsequent section.

***Research strategies.*** The Chicago Longitudinal Study (CLS) is an ongoing quasi-experimental investigation of low-income children (the vast majority of whom are African-American) comparing children who have completed preschool and kindergarten in Child-

Parent Centers with children who participate in alternative full-day kindergarten programs available to low-income families (Reynolds et al., 2001, 2002; Reynolds et al., 2007). The Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K) contrasts different types of early education and care in the year before kindergarten in nationally representative surveys, notably center-based day care including pre-kindergarten programs, preschools, nursery schools, Head Start, and other non-parental center-based care (Magnuson et al., 2004; Rumberger & Tran, 2006). Children who attended these programs were compared with children who had experienced parental care but no preschool care. This type of comparison was also carried out in three other studies in the U.S., those based on the Albuquerque Child Development Centers (ACDC), the Arkansas Better Chance Pre-kindergarten Program (ABC), and the Delaware Early Childhood Longitudinal projects: In the Albuquerque study (Boyle, 2007; Boyle & Roberts, 2003), a comparison was made between children who had attended ACDC programs (these children were from families with household incomes of less than 175% of the national poverty line) with similar children who had attended federal free lunch programs (families with incomes below 135%), reduced price lunch support programs (incomes between 136% and 185%), and no support programs (incomes above 185% of the national poverty line). Similarly, children from at-risk, low-income families in ABC pre-kindergarten programs were contrasted with comparable children without pre-kindergarten experience (Hustedt, Barnett, & Jung, 2008). Finally, the Delaware study also assessed the effectiveness of interventions modelled after the federal Head Start program for children living in poverty (Gamel-McCormick & Amsden, 2002).

Unlike these analyses, the evaluation of five other projects drew on age-standardized norm-referenced measures, namely the North Carolina More at Four Pre-kindergarten project, the Head Start Family and Child Experiences Survey FACES, Oklahoma's Universal Pre-Kindergarten project in Tulsa, the Georgia Early Childhood Study, and the Miami School Readiness Project: The North Carolina project was an evaluation of a pre-kindergarten program for at risk children from families with an income of up to 75% of the average income or up to 300% above the national poverty line where longitudinal growth models were used to estimate whether the achievement gains of the children included exceeded national norms (Peisner-Feinberg & Schaaf, 2008). FACES is a research initiative of Head Start providing nationally representative longitudinal data on the outcomes of children served as compared to national norms (FACES, 2006; Zill et al., 2006). In the same way, Oklahoma's Universal Pre-K project assessed the effectiveness of typical pre-kindergartens (Gormley et al., 2005; Gormley et al., 2008) and the Georgia study investigated the effectiveness of pre-kindergarten, Head Start, and private preschool or childcare centers as described below (Henry et al., 2003, 2004). The research goal of the Miami project was to assess the extent to which ethnically diverse (i.e. mainly Hispanic/Latino, Black/African-American, and White non-Hispanic/Caucasian) children from low-income households who are at significant risk in the areas of language and cognition made school readiness gains in their pre-kindergarten year in terms of relative standing compared to national norms (Winsler et al., 2008). The Head Start Impact Study, finally, used an experimental methodology and assigned newly entering Head Start applicants randomly to either a treatment group that had access to Head Start services or a comparison group that could receive any other non-Head Start services chosen by their parents (U.S. Department of Health and Human Services, 2005).

***Pedagogical concepts.*** The following section summarizes the pedagogical concepts adopted in the different early education and care programs listed above, hence it relates to the North American studies cited above. The Child-Parent Centers investigated in the Chicago Longitudinal Study provide educational and family-support services for children between three and seven years. The intervention emphasizes the acquisition of basic cognitive skills through relatively structured but diverse learning experiences that include teacher-directed whole-class instruction, small-group work, and individualized activities. Major elements of the intervention include furthering educational attainment, parenting education, home visits, and health and nutrition services. Parents are expected to participate in the program for up to half a day per week. The program is run on a half-day basis whereas the subsequent kindergarten program is provided on a part-day or full-day basis during the school year.

The early childhood education and care programs analyzed in the other studies include a wide range of part-day and full-day programs that have an education and/or social welfare focus. Across the country, private family day care and center-based early education and care constitute 90% of provision for children between birth and three years. The most usual forms of provision for these children are private, giving way gradually to publicly-funded pre-kindergarten and kindergarten provision by school districts which are typically made available to four- and five-year-old children (OECD, 2006). Overall, three broad types of provision exist: the purchase of service systems which is composed of private centers and family day care homes, the public school system which is under the responsibility of each State and generally offers free, half-day kindergarten for five-year-olds and mostly preschool in addition, that is, publicly funded pre-kindergarten programs for three- and four-year-olds, and Head Start, that is, comprehensive child development programs that have the overall goal of increasing school readiness of children from low-income families and children with disabilities or developmental delays from birth to five, enrolling primarily three- and four-year-olds.

In state programs, program content and pedagogical approach are generally left open for each center to decide, and therefore many eclectic practices exist. Nevertheless, some more detailed information can be given: The U.S. *pre-kindergarten* is typically a part-day educational program situated within public schools. Some additional services are usually offered, including meals, but few programs provide a full array of comprehensive services. Almost all pre-kindergarten initiatives target children deemed in need of education due to the economic disadvantage of their families or other recognized risk factors. Accordingly, public schools with high ratios of children from disadvantaged families are more likely to have pre-kindergarten programs than other schools. The ABC pre-kindergarten, for instance, provided early care and education services for children from at-risk, low-income families. While the majority of the ABC participants were served in public schools, programs also operated in other locations such as educational cooperatives, Head Start facilities, and private child care services. *Universal pre-kindergarten* programs, on the other hand, are non-targeted services that do not require children to meet specific eligibility criteria. Oklahoma's universal pre-kindergarten programs, for instance, offer part- or full-day early education to any child who has turned four, and classes are held at local public schools. *Head Start* is a federally funded early education program that uses a comprehensive approach to service delivery, including nutrition programs and health check-ups, social services, such as assistance by lawyers, and parent involvement. The majority of Head Start programs operate part-day and part-year, but

some also provide full-day education and care to support parents in the labor market. Traditional *preschools and nursery schools* mainly provide early education for three- and four-year-olds. They are usually available part-day and part-week, serving sometimes for longer hours for families with working parents. Unlike preschools, center-based day care programs are typically open up to ten hours a day and five days a week and the facilities may accept children of all ages (see also Magnuson, Meyers, Ruhm, & Waldfogel, 2004).

One of the projects included in the review was carried out in *Asia* (Watanabe et al., 2005). The early childhood development intervention in rural Vietnam was conceptualized as a program that built on a nutrition intervention and strengthened existing center-based preschools. It added material and trained teachers in child-focused teaching methods. And it supported parental behavior with monthly training sessions for parents on different topics relating to child care and development. The intervention included the establishment of a small local library for parents and also promoted play corners in the homes of the participating families. It targeted children aged four to five years who had previously been exposed to a nutrition intervention. This early intervention project was evaluated through a comparison of children who had received a nutrition program from birth to three years with children who had received the same nutrition program together with an additional early childhood development program at four and five years of age.

As can be expected in large-scale surveys, the types of early education and care provision examined in the *birth cohort studies* included in this review varied widely. A range of preschool and pre-compulsory education centers were analyzed in Great-Britain in the National Child Development Study NCDS (Goodman & Sianesi, 2005) and in the British Cohort Study BCS (Feinstein, Robertson, & Symons, 1999; Osborn & Milbank, 1987), as well as in Canada in the National Longitudinal Survey of Children and Youth NLSCY (Lipps & Yiptong-Avila, 1999). As a result, these cohort studies reflect a broad overall picture of the effectiveness of various early education and care programs. The NCDS is a continuing, multi-disciplinary longitudinal study which takes as its subjects all the people born in Great Britain in one particular week in March 1958. It analyzes the effects of pre-compulsory education (any form of formal education before the compulsory school entry at age five, including premature school entry) and pre-school education (attendance of a crèche or playgroup, independently of premature school entry) as opposed to informal care. That applies to the BCS as well. The BCS is a continuing, multi-disciplinary longitudinal study which takes as its subjects all the people living in Great Britain who were born in one week in April 1970. Finally, the NLSCY is a long-term study that follows the development of Canadian children from birth to early adulthood. In 1994, it included children between birth and eleven years as well as their parents and it follows these children until the age of 14 to 25 years in 2008 and 2009 (the current data collection began in September 2008).

## EMPIRICAL EVIDENCE

Table 1 provides general information on the selected studies. For age at entry, there was variability among the different programs. Typically, children were between three and five years of age when they participated in early education and care programs. The mean duration of attendance varied between less than one year and more than three years with a majority of children attending a program for one to two years. Most of the research projects reached at

least into the primary school years. Some projects also followed the participants well into adulthood, that is, up to 46 years. Table 2 documents the size of the original and the follow-up samples, cognitive achievement test outcomes, educational attainment, and special education rates. Treatment groups are indicated by an upper case *T*, comparison groups are indicated by an upper case *C*. An upper case *N* refers to the overall number of participants in a study; this is reported when no information about the number of participants in treatment and comparison groups was found in the studies. Most of the samples were deemed to be large, the largest being the original sample of the British Cohort Study which comprised more than 12,000 participants, 72% of whom attended some form of preschool provision (Feinstein et al., 1999). However, a large sample size does not guarantee that a survey is nationally representative. In fact, only five studies--based on the SOEP, the Panel 1997, the ECLS-K, the FACES, and the Head Start Impact projects--used nationally representative samples.

Additionally, many studies were plagued by problems of attrition. Loss of participants over time is particularly serious when there is selective drop-out of a specific subgroup of participants. In this case, attrition is a severe threat to both the internal and the external validity of a study, and it can invalidate the outcomes so that they lose their generalizability to the larger population. In some studies, a relatively high proportion of participants were retained until the last follow-up survey reported here. Nevertheless, all of the outcomes were partially flawed as a result of sample attrition. The lowest attrition rate was measured in the Chicago Longitudinal Study: when the participants were 24 years old, 90.3% of the original sample still had valid data on educational attainment. The PRIMA study, on the other hand, appears to have suffered substantially from a loss of participants since over time there was selective drop-out of children who had scored lower on language and mathematics at the beginning of the study.

Another difference between the European and the North American studies concerns the early childhood services. According to a recent league table established by UNICEF (2008), most of the European countries from which studies were selected for this review currently meet more quality standards than the services in the United States. While the services in the United States only meet the standards of 'subsidized and regulated child care services for 25% of children under three years of age,' '50% of staff in accredited early education services having tertiary education qualification,' and 'a minimum staff-to-children ratio of 1:15 given in preschool education,' many European countries such as Germany, Netherlands, the UK, and France (excluding Switzerland) additionally meet standards such as 'subsidized and accredited early education services for 80% of four-year-olds,' '80% of all child care staff trained,' and '50% of staff in accredited early education services having tertiary education qualification' as well. When interpreting the results of the studies in this review, this should be kept in mind.

Almost all the studies measured academic performance with standardized academic achievement tests. A list of the most important tests is given in table 3. In some surveys, official reports were consulted and school records were interpreted to provide a measure of cognitive development. The academic achievement tests in the qualifying studies generally measured basic or advanced cognitive abilities with a special focus on language and mathematics development as assessed through reading, vocabulary, writing, and math scales. Compared with IQ tests, these scales primarily assessed academic accomplishment and the acquisition of what is taught in early education and care programs or schools. Along with

cognitive achievement test scores and special education rates, a range of other indicators for cognitive development have been used in early childhood research. The most common ones are grade retention and school graduation rates or years of school attendance. These indicators are illustrated in table 3 wherever they were included in the studies.

Finally, study design characteristics were evaluated. Three categories of quality were defined (good, fair, limited) and studies were classified along this dimension by taking account of four criteria: (1) Methodological quality was assessed by determining whether a study used retrospective reconstruction of data on early intervention use with post-test measures only or a sophisticated longitudinal design with pre- and post-test data. This distinction is important as lack of pre-test measures increases selection bias threats if children are not assigned randomly to treatment and control groups. However, lack of pre-test data can be acceptable if random assignment is given or if a regression discontinuity design is used where incoming younger cohorts serve as control groups for incoming older cohorts (see Cook, Shadish, & Wong, 2008, for an analysis which contrasts estimates from a randomized experiment with those from a regression discontinuity analysis providing evidence for comparable findings). (2) Specific investigations of effects of clearly defined early interventions were distinguished from general-purpose panel studies with data about early intervention use. (3) The extent of attrition was determined wherever applicable. And (4) sample size as well as representativeness of the study for a larger population were assessed. In the following, the effects of early education and care programs on children's cognitive development are discussed.

### *Evidence of the Effectiveness of the Programs*

Table 2 summarizes the key findings of the studies. Scepticism towards the comparison of children's learning progress in different programs is comprehensible because these programs do not necessarily pursue identical objectives and the children served in different institutions possibly differ according to their social backgrounds. All of the longitudinal studies included in the review provided pre-test data. However, the few cross-sectional studies (based on the CH, Delaware, and SOEP projects) and the birth cohort studies reviewed used a retrospective, two-group, post-test-only design. The differences in outcomes between children who did or did not attend preschool can therefore not be attributed unambiguously to the influence of preschool. It should be noted, for instance, that the factors affecting attendance are not known in these studies. Moreover, predictive validity of early academic test scores may differ across assessments as a function of test type, construct being assessed, length of prediction, and administration procedures (Kim & Suen, 2003). For this reason, the results must be treated with caution. Direct comparison of North American and European interventions, for instance, is problematic since children in the American programs typically suffered from greater economic disadvantage than the children in Europe (McLoyd, 1998). In most instances, early education and care programs in Europe are open to all children and are attended by children from both disadvantaged and more favored families whereas programs in the U.S. are frequently open primarily for the socio-economically disadvantaged. In many instances, particular preschool projects were evaluated by more than one study. In these cases, the authors usually drew on different data collections.

In tables 1, 2, 3, and 4, lower case letters--(a), (b), and (c)--indicate from which publication the information is taken in cases where more than one publication was analyzed.

The authors of the publications are listed in the last column of table 3. The sample sizes of these studies also differ. Where authors have carried out multiple follow-up examinations of a particular project, the findings are not reported exhaustively. The focus here is on the results of the latest investigation. Two major types of studies are included in this review. One type comprises studies that compared children in treatment groups with children without any treatment or “home children” in comparison groups. The other type comprises studies that compare different programs or curricula and measure academic achievement in comparison to national norms. The results reported in tables 2 and 3 are arranged as follows: Directly interpretable parameters such as age-standardized mean scores and percentages are reported as a common measure of different studies. Their statistical significance--at the  $p < 0.05$  level at least--is indicated by the symbols  $<$ ,  $>$ , or  $*$ , whereas statistical nonsignificance is indicated by the symbol  $\approx$ , whenever information about statistical (non-)significance was given in the original studies. The results of statistics such as  $t$ -tests,  $\chi^2$ -square tests, regression analyses, analyses of variance, or multilevel analyses, in contrast, are indicated merely by the two symbols  $<$  and  $>$  where they are statistically significant, and are denoted by the symbol  $\approx$  where they are not statistically significant.

The results of the 32 studies (concerning 23 projects) analyzed in this review are outlined and summarized below. They are based on studies that used different statistical methods. The included studies were therefore categorized according to their methodological rigor in studies that used (1) only descriptive measures like mean scores and percentages, (2) bivariate measures such as  $\chi^2$ -tests and simple correlations, or (3) multivariate measures such as binary probit models, (multiple) regression analyses, multilevel analyses, (multivariate) analyses of (co-)variance, or instrumental variables estimates (see table 4). Of the 32 studies, 27 (or 84.4%) used multivariate measures, four (12.5%) used bivariate measures, and one (3.1%) used descriptive measures exclusively. These methodological differences have to be considered when it comes to drawing conclusions based on the results reviewed. Furthermore, effect sizes are listed in table 4. Effect sizes are estimates of the magnitude of the relationship or difference between two or more variables and help to determine the size of an observed relationship. In the present review, no clear differences can be identified between effect sizes in studies that were published in peer-review journals and studies that were published in research reports or books. Out of 14 studies published in peer-review journals, six reported effect sizes whereas eight did not. Likewise, among the 18 studies published in reports and books, six recorded effect sizes whereas 12 did not. Effect sizes reported in peer-review journals do not appear to be higher than those reported in research reports. Apart from the impact of preschool experiences on cognitive development, the impact on the development of children from families with varying socio-economic status is discussed. Across the majority of studies, the results are comparatively consistent and constitute evidence that early childhood care and education can improve the cognitive development of children:

### ***Cognitive Achievement Outcomes***

With regard to *cognitive achievement outcomes*, the associations between preschool attendance and cognitive outcomes or educational attainment were mostly positive in 22 out of 32 studies (see table 2; the following conclusions are based on the results of the studies reported in this table; table 2 also indicates statistical significance of results). The sample sizes of these 22 studies ranged from  $N = 311$  in the Vietnam study to  $N = 4,667$  in the Head

Start Impact study. In one study (on the PRIMA project), no effects of preschool attendance were identified. In another eight studies (concerning five projects), mixed results were found, notably in the ECLS-K, Albuquerque, ABC, NCDS, and BCS70 studies. In the Panel 1997, an earlier beginning was found to be particularly beneficial for cognitive development even after a variety of variables had been controlled, namely sex, position among brothers and sisters, nationality, birth trimester, socio-professional category and educational diploma of parents, employment of the mother, family size and structure (single parent vs. couple), care experience before enrollment to the “*école maternelle*,” and several factors pertaining to characteristics of the institutions. As regards the presentation of the results, table 2 is self-explanatory for the most part. It indicates (1) the age at which the children were examined, (2) whether the treatment groups outperformed the comparison groups, (3) the domain in which achievement was measured, and (4) the institution for which the results are valid.

The findings of the studies about FACES and those about the Georgia study and the NLSCY require additional comment: The results of the study about FACES indicate the proportion of the gap between four-year-old program attendees and national norms which was closed between fall and spring of the Head Start year in three separate cohorts with regard to early reading competencies and vocabulary. With the exception of the early reading skills in cohort 1, the gaps in all the cohorts were closed considerably (i.e. up to 28%). A comparison between children’s test outcomes and national norms was also made in the Georgia study. Its results are indicated as age-standardized mean scores of children when they entered (1) pre-kindergarten, (2) Head Start, and (3) private programs at the age of four years and these results were compared to the outcomes at seven years of age, that is, two years after the end of the program. When the results at age seven exceeded those at age four relative to national norms, the programs were considered to benefit the children.

As shown in table 2, program attendees made sizeable gains in terms of relative standing compared to national norms. Another important finding of the Georgia study was that Head Start children's achievement test scores were consistently below those of pre-K, no preschool program, and--especially--private program children. Although this suggests that program features have a marked influence on the learning progress of children, this difference can be attributed more plausibly to differences in home learning environment or socio-economic status. These might have been worse for Head Start children since they faced more risk factors than their counterparts in the other programs. Moreover, the majority of children enrolled in Head Start were African-American, while the majority of children in private programs were White (Henry et al., 2004). Hence Head Start children could not catch up with their more favored peers (see also Henry et al., 2003). The NLSCY compared achievement outcomes of children (1) who attended early childhood education and care programs, with outcomes of children (2) who were cared for by a person other than the mother at two and three years of age, and with outcomes of children (3) who were cared for in the family environment by a parent at two and three years. This survey ascertained that children in early education and care had slightly better cognitive outcomes than their counterparts who were cared for by a person other than the mother, and they performed significantly better than children who were exclusively cared for in the family.

### ***Special Education***

With regard to *special education* rates, two out of six studies (concerning the EYTSSEN and the CLS projects) reduced the proportion of children who later needed special education or were at risk of special education needs. Two other studies (concerning the ECLS-K and the NCDS projects) found mixed results depending on the programs children attended. In the Albuquerque and in the Dutch Preschool studies, it was not possible to draw conclusions about the effectiveness of the preschool programs in preventing special education needs, as there was no control group without preschool experience (see tables 2 and 3).

### ***Grade Retention***

The third major category of outcomes examined in several studies was *grade retention*. As shown in table 3, in the studies on the CLS and the Delaware projects, the number of children who were retained in grade was smaller for children who attended preschools than for those who did not attend preschool. The ECLS-K studies provided mixed results depending on the program types, and three other studies unfortunately could not secure a control group of matched children who did not attend preschool, notably the studies on the Panel 1997, the Albuquerque, and the Georgia projects.

### ***School Graduation***

Finally, the *school graduation rates* and/or the *years of school attendance* were interpreted as an additional indicator of cognitive development. Four studies (concerning two projects, notably the NCDS and the CLS) allowed for a clear conclusion about the effectiveness of preschool in terms of fostering school graduation: In the NCDS project, no clear advantage of early education and care for the attainment of higher education degrees was found. However, the studies about the CLS project showed a clear advantage for preschool children as opposed to children without preschool attendance (see table 3).

Although this review suggests that preschool benefits children in most of the cognitive domains examined in the different studies, it also indicates that the extent to which preschool is capable of reducing grade retention and special education rates is more difficult to determine. The number of studies that have investigated retention and special education rates is too small to allow any clear conclusion. Cognitive achievement and scholastic success, however, are undoubtedly affected positively in the vast majority of cases.

### ***Evidence of Compensatory Effects***

A more detailed analysis can now provide evidence of whether the effects vary with the population served, that is, whether some groups of children derive a greater advantage from the programs than others. Socio-economic status variables are taken into account in order to answer the second research question of this review: Can preschool programs help to overcome inequalities among children from different social backgrounds? Theoretically, three patterns of results may emerge in studies of the differential effectiveness of early education and care programs: (a) children from families with a low socio-economic status gain more than their more advantaged peers, (b) these children gain less, or (c) children from families with a low socio-economic status and families with a high socio-economic status both benefit from early interventions. Two of these three patterns were identified here. Table 3 shows that of 26 studies that took account of families' socio-economic status, seven documented a

particular benefit for disadvantaged children whereas ten documented a benefit for both disadvantaged and privileged children, that is, the programs did not all compensate for social disadvantage (see below). Only one study (concerning the EPPNI project) revealed that in some domains disadvantaged children made fewer improvements than their more privileged counterparts. Five projects specifically targeted socio-economically disadvantaged children. According to the eight studies on these five projects, they all benefited the attendees, thus it can be assumed that they have a compensatory effect. However, since they only addressed one particular group of children, a compensatory effect cannot be unambiguously attributed. In table 3, this is indicated in brackets (“targeted intervention”). In the following, the key findings of the studies are briefly summarized so that the dimensions used to indicate socio-economic status can be identified.

### ***Projects Benefiting Mainly Disadvantaged Children***

Four projects benefited mainly the disadvantaged children: the SOEP, the NCDS, the BCS, and the North Carolina project. The respective studies illustrate that socio-economic disadvantage was compensated for by attendance of the interventions. In table 3, these projects were reported as having had a compensatory effect. Using information from the German SOEP, Spiess et al. (2003) found no significant correlation between kindergarten attendance of German children and their later school placement, but they identified a significant positive correlation for children from immigrant families of Italian, Greek, Turkish, Spanish, and formerly Yugoslavian origin. These children were found to perform on average more poorly at school (Alba, Handl, & Müller, 1994). Children from immigrant families attended schools with restricted academic requirements (“Hauptschule”) as opposed to schools with greater academic requirements (“Realschule,” “Gymnasium”) less often when they had attended kindergarten. In the NCDS, children from disadvantaged backgrounds did not gain more in absolute terms from pre-compulsory or preschool education than those from privileged backgrounds. If anything, taking into account that they tended to start from a lower base of attainment, their improvements were found to exceed those of their more advantaged peers in relative terms (see also Feinstein et al., 1999, for further details). In the BCS, socially disadvantaged children gained slightly more from their preschool experience than more advantaged children. The North Carolina project also benefited the disadvantaged children to a particular extent. In the according study by Peisner-Feinberg and Schaaf (2008), children were categorized in different risk groups based on poverty level, special needs, English proficiency, and chronic health condition. Although initially children in high-risk groups scored lower than other children in language, literacy, math, and general knowledge tests, and entered pre-K at a deficit, they gained at a similar or even greater rate, and for some measures (e.g., letter knowledge, color knowledge) they even caught up with lower risk groups in kindergarten.

### ***Projects Benefiting Privileged and Disadvantaged Children***

As opposed to the projects that mainly benefited disadvantaged children, the projects mentioned hereafter yielded benefits for both advantaged and disadvantaged children: there appears to be no consistent advantage from preschool accruing to lower social class children as compared to their more advantaged peers. These are examples of projects that did not effectively compensate for social inequalities but brought about general cognitive progress for

all the children involved to about the same extent. In table 3, these projects are reported as having compensated “partially” for socio-economic disadvantage.

This form of partial compensatory effect was observed in the following projects: In the EPPE project, the level of parental qualification, family socio-economic status, and the early years home learning environment were among the strongest predictors of academic attainment and progress, and there was only little evidence of differential effects of preschool according to the social status of the parents, although children with low early years home learning environment showed a benefit from attending a preschool as opposed to attending no preschool particularly if the preschool provision was of high quality and highly effective (EPPE, 2008a). The EPPNI (2004), on the other hand, had mixed results. As opposed to children with parents of a high socio-economic status (where parents were non-manual professionals), children from lower socio-economic status groups generally made less progress in numeracy and children from unemployed parents made less progress in literacy over the first four years of primary school. According to the Panel 1997, the French kindergarten did not effectively compensate for social disparities (Caille, 2001). In Albuquerque, the cognitive progress of children was associated with the economic status of the children’s families. The most disadvantaged children were eligible to attend the free lunch programs and the most privileged children attended no support programs, while ACDC programs and reduced price lunch programs fell in between. As expected, on average, children who attended free lunch programs ranked below children from the other programs. They were followed by children from ACDC programs and reduced price lunch support programs (Boyle, 2007; Boyle & Roberts, 2003). In the Georgia study, children from wealthier families started with better cognitive skills, and their school readiness at the end of the program remained higher than the school readiness of children from poorer families; hence disadvantaged children could not catch up with privileged children during the intervention (Henry et al., 2003, 2004). Oklahoma’s universal pre-kindergarten was shown to benefit children from diverse income brackets equally in absolute terms (Gormley et al., 2005; Gormley et al., 2008). And while important links between school readiness and several aspects of the home environment were identified in the NLSCY, no consistent effects of social disadvantage on learning progress were found (Lipps & Yiptong-Avila, 1999).

### ***Projects That Did Not Assess Differential Effects***

In the remaining projects, the differential effects of preschool on subgroups of disadvantaged and privileged children were either not analyzed in the studies (PRIMA, ABC, Vietnam project) or the intervention was specifically targeted at socio-economically disadvantaged children so that a comparison with privileged children was not feasible (DPPS, Miami, CLS, FACES, H. S. Impact projects), or the sample size was not large enough to allow reliable separate conclusions on the development of different subgroups (Delaware study). It has to be noted, however, that all of the targeted interventions had, for the most part, positive effects on disadvantaged children. Theoretically, comparing treatment children in targeted programs with an age norm corresponds to comparing disadvantaged children at risk with, on average, typically developing children, so that gains point to compensatory effects. Or the following could be argued at least: provided that privileged children are not fostered in other programs at the same time, targeted interventions can compensate for socio-economic disadvantage. In the studies on the Miami, CLS, FACES, DPPS, and Head Start Impact

projects, the differential influence of socio-economic status on the development was not investigated because all children were socio-economically disadvantaged. Although the ECLS-K did not measure socio-economic status, it investigated the influence of language backgrounds. Small effects of language background on special education and grade retention rates were identified. The language achievement of children from language minority backgrounds was lower than the achievement of children from families where English was the dominant language (Rumberger & Tran, 2006). Finally, although designed to investigate the development of disadvantaged children only, the evaluation of the study on the Miami School Readiness Project suggests that early care and education can help to overcome social differences if it specifically addresses economically disadvantaged children. Norm-referenced achievement test scores showed that poor children made significant gains in cognitive and language skills, so that by the end of the year, they were performing on average at or around the national average although they had started from well below the average (Winsler et al., 2008).

### *Age at Entry, Intensity, Duration, and Quality of Programs*

A number of additional aspects should be highlighted here, including age at entry and the intensity, duration, and quality of early education programs. Studies such as EPPE, PRIMA, CLS, Head Start Impact, and the Panel 1997 took into account the effects of age at entry and the duration of program attendance. Although other studies ascertained that an earlier beginning and a longer duration afford greater benefits to the participants (Bos et al., 2007; Gull & Burton, 1992; Ramey & Ramey, 1998), the present review is not conclusive. Longer preschool interventions do not necessarily result in better cognitive competencies (EPPE, 2008a; Driessen, 2004) although an early age at entry is associated with a more positive educational development in some instances (e.g., Caille, 2001; U.S. Department of Health and Human Services, 2005). However, the CLS provides evidence that an extended program can exceed a restricted program in terms of effectiveness. Children who received school-age services in first to third grades--in addition to preschool and kindergarten--up to nine years of age showed higher levels of cognitive achievement until 23 years of age (Reynolds et al., 2001).

The effects of intensity were analyzed in some studies. However, the empirical evidence in this review is too scarce for conclusions about the ideal intensity. While some other studies have established that more intensive interventions produce larger positive effects (Ramey & Ramey, 1998), results from a study based on the SOEP did not support this finding (Landvoigt et al., 2007), and the NICHD Study of Early Child Care (Belsky, 2006) highlighted that lots of time spent in any form of care--irrespective of its quality--can be related to problematic social development in subsequent years (although the effects on cognitive outcome measures were shown to be positive), which corroborated a finding of Vandell and Corasaniti (1990). For this reason, it seems reasonable to conclude that the quality of the programs including the early home learning environments (Foster, Lambert, Abbott-Shim, McCarty, & Franze, 2005) and family literacy environments (Christian, Morrison, & Bryant, 1998; Payne, Whitehurst, & Angell, 1994) also rank among the very important factors for a beneficial cognitive development (ECCE, 1999; Hodgen, 2007; Peisner-Feinberg et al., 2001). Hence whether or not children will be successful at school depends to a large extent on the overall quality of their experiences in early childhood.

According to the results of the EPPE (2008a), for instance, the early home learning environment is one of the most powerful predictors of cognitive attainment. In this project, the home environment measure was based on the frequency of parent-child interactions such as teaching the child the alphabet, playing with letters and numbers, visiting libraries, reading to the child, and teaching the child songs or nursery rhymes. Accordingly, these interactions can be regarded as essentials in the promotion of cognitive development. It should be noted, however, that the influence of a family compared to early center-based education may also reflect the potential effect of genetic differences, that is, genotype-based correlations between the childrearing environment parents provide and the cognitive achievement of their offspring. Furthermore, as highlighted above, exclusively family-based early education can be unfavorable in particular for children from families that do not provide their children with the opportunities for informal learning at home (e.g., Leseman, 2002). In sum, the present review suggests that high-quality early childhood experiences may play a more pivotal role for favorable cognitive development than age at entry, intensity, and duration of any intervention program.

## CONCLUSION

The present paper reports on the effects of early childhood education and care on cognitive development and the extent to which preschool programs can establish equality of educational opportunity for children from different social backgrounds. As outlined, early education and care programs typically aim to enhance those intellectual and social abilities of children which are the basis for their subsequent development. They aim to provide children with a favorable start at school and to prevent adverse developments such as school failure, grade retention, or special education needs. Since early development of basic competencies is assumed to have the potential to affect children's longer-term attainment, early education and care interventions attempt to foster these competencies by providing an environment that stimulates beneficial development. Moreover, the programs usually strive to establish equality of educational opportunity for children from different social backgrounds because children growing up in environments with little cognitive stimulation do not have the same chance to develop their abilities as children from more privileged families. Apart from the general effects of early education and care on cognitive development, this paper has analyzed the extent to which early interventions diminish social inequalities due to differences in socio-economic status. The favorable effects of model interventions being well-established and uncontested among early childhood analysts, this review has focused on studies based on larger-scale projects that reflect how early childhood education and care can work in a real-world setting.

### *General Effects*

Drawing overall conclusions on the basis of a set of different studies is risky. Yet any review attempts to aggregate results of somewhat heterogeneous studies into some concluding statements. This is done in the following; the conclusions need to be read as an interpretation of the evidence: The majority of studies find that preschool experience gives children a more favorable start at school and there is evidence of persistent effects during the subsequent school years. In many instances, short-term effects exceed longer-term effects on cognitive development. Overall, these findings seem to be independent of study design quality as they

applied to a variety of studies with heterogeneous methodological characteristics and quality. Hence we cannot assume any clear relation between the quality of studies and the cognitive outcomes of children. The results reviewed range from no effects on some or all cognitive outcome measures in a few studies to more sizable effects on several measures in, again, a few studies. However, many studies identified moderate effects in various domains. One can therefore conclude that preschool can endow children with a number of capacities that help them to master challenges at school more easily.

Early learning opportunities appear to enhance children's capacity to learn which might improve their later elementary school performance. By providing social and cognitive experiences, preschool programs supplement the home environments of children. They create a familiarity with (pre-) school institutions and procedures which might facilitate the formal schooling later on. The evidence in support of positive effects on special education and grade retention rates is less conclusive than might be expected. And the lack of information on these outcomes in many studies makes any general conclusions unwarranted. The evidence of positive effects on cognitive development, as measured by academic achievement tests, educational attainment, or years of school attendance can be ascertained with less ambiguity. The majority of the programs yielded positive effects. These findings corroborate the results of other studies which have established that preschool programs usually have significant positive short-term and moderate longer-term effects on the cognitive development of children (Anderson et al., 2003; Barnett, 1995, 2008; Currie, 2001; Nelson, Westhues, & MacLeod, 2003; Reynolds et al., 1997), and they contradict the assumption that the programs generally do not yield practically relevant benefits (Dollase, 2007). According to Magnuson et al. (2007), the advantages bestowed by early education and care will diminish by the second or third grade of formal schooling as children who did not attend any program start to catch up. The authors therefore conclude that formal schooling experiences are crucially important for the extent to which the effects persist. However, the few longer-term studies analyzed in this review indicate that positive effects can be maintained in some instances through adolescence and even into adulthood regardless of later experiences in school. No clear advantage of programs with parent support and parent involvement as opposed to those without these components was identified.

### *Compensatory Effects*

Along with the general effects of early education and care, this review has analyzed the potential of preschool programs to compensate for social inequalities. A number of studies show that the main beneficiaries of preschool interventions are children whose families are at lower levels of socio-economic status. However, other studies do not consistently report larger gains for these children. Instead, these studies illustrate that most children can benefit in equal measure regardless of their social backgrounds. In either case, research has demonstrated the value of providing preschool interventions for both socio-economically disadvantaged and more privileged children. The present overview of studies suggests that the developmental progress of disadvantaged and more privileged children in preschool programs either proceeds in equal measure in absolute terms or offers larger gains in relative terms to disadvantaged children. This implies that children's cognitive development can be fostered by the programs. In addition, since children from disadvantaged families usually start off with less developed skills, they lag behind in their development when compared to more privileged

children. The interventions obviously cannot make up completely for the developmental delay they started with. Hence this review is only partly in line with those studies that have identified the most striking benefits for disadvantaged children (e.g., Barnett, 1995; Büchel, Spiess, & Wagner, 1997; Dhuey, 2007; Peisner-Feinberg et al., 2001).

### ***Policy and Research Recommendations***

In addition to these effects of preschool programs, some important policy questions can be reviewed and research recommendations can be given on the basis of the present survey. In general, practical policy-related conclusions are to be drawn by policy makers rather than by scientists because policy inference is usually shaped not only by empirical evidence, but also by specific social values and economic conditions (e.g., Belsky, 2001). However, policy makers need to know whether particular types of programs are more productive than others according to the findings of current research. In this regard, some implications can be derived from the current review.

Interventions that have produced relatively distinct effects have adopted a broad, versatile approach by providing parent services and requiring parent involvement along with the center-based provision. Moreover, the quality of the early home learning environment has been shown to be an important predictor of subsequent cognitive attainment along with the center-based intervention. Strategies which support or encourage intense parental engagement in home learning activities could therefore enhance the benefits of center-based preschool attendance. Furthermore, it seems that the findings considered here do not allow conceiving of early education and care of children--especially of children from socio-economically disadvantaged families that provide only poor learning conditions--as a purely private matter. In countries where attitudes towards early childhood and family policy have traditionally been underpinned by an ideology that places a high value on individual responsibility and by a philosophy of limiting government interventions in matters related to family (see for instance, Allen, 1988, for an analysis concerning the U.S.), policy makers should consider encouraging tax policies that allow families to make use of preschool arrangements which might otherwise remain inaccessible to them for economic reasons. Besides, preschool policies should strive to foster the establishment of equal educational opportunities. In many cases, early interventions have been implemented especially for socio-economically disadvantaged children; in other cases, both disadvantaged and privileged children have been targeted in early childhood programs. However, in any case, the development of children at risk due to adverse learning environments needs to be supported to a particular extent and most carefully in early intervention programs because it is only by improving these children's competencies that equality of educational opportunity can be established for children at the start of their life.

In early childhood education and care research, many studies have focused on the influence of preschool programs on child development and educational success up to now. However, research often has not attempted to disentangle potentially distinctive effects of diverse aspects of preschool experience. For this reason, the effects of quality of institutions and pedagogical curricula as well as the effects of age at entry, duration, and intensity of attendance should be taken into account jointly in further studies. By this means, conclusions from research would not remain limited exclusively to the effects of particular features of preschool, and the extent to which different aspects of early care and education are related to children's skill development or educational outcomes could be determined. This would

necessitate thoroughly conducted large-scale--preferably longitudinal--studies with pre-test measures that are held constant when program effects are tested. However, paying attention more carefully to the specific effects of different early childhood education and care variables is worthwhile only if the sample of a study is reliable until the end of the study phase. Loss of participants over time, for instance, is unavoidable in social science research. However, selective drop-out of participants minimizes confidence in the quality and in the results of a study and it questions its validity. Hence if early childhood research ultimately aims to improve the lives of children, it can do so solely if it is carried out appropriately and in accordance with the latest and--above all--highest standards of scientific research.

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