

## B. SPECIFIC AIMS

We propose to investigate links between various skills and capacities in middle childhood (age 7-10) and both positive (completed schooling, earnings, good health) and negative (criminality) outcomes in adulthood (age 25-50). We hypothesize that early school success and the absence of anti-social behavior help to launch children on positive school trajectories that lead ultimately to more successful labor market careers, better adult health and avoiding costly involvement with the criminal justice system. In the case of adult health, we hypothesize that early skills and the absence of anti-social behavior improve health by reducing teen health risk behaviors.

Our investigation will be a comparative one, involving population-based data from six datasets drawn from four countries: the Swedish Study of Individual Development and Adaptation (IDA), the Finnish Jyväskylä Longitudinal Study of Personality and Social Development (JYLS), the British Cohort Study (1970 birth cohort; BCS) and the British National Child Development Survey (1958 birth cohort; NCDS), the U.S. Baltimore Beginning School Study (BSS), and the U.S. National Longitudinal Survey of Youth, Child Sample (NLSY). All of these datasets share four crucial properties: i) representative samples of children drawn from national or large community populations; ii) measurement of achievement and behavioral skills between ages 7 and 10 and between age 13 and 16; iii) measurement of completed schooling, adult earnings, work hours, crime and health, after the children had reached adulthood (between the ages of 25 and 50); and iv) prior family (e.g., parental education, family structure) and often child (e.g., IQ, early temperament, birth weight) controls to help ensure that the estimated effects of middle-childhood skills are not simply the product of unmeasurable family circumstances and correlated individual characteristics. One of our datasets includes siblings, which enable us to eliminate biases from persistent unmeasured family condition by estimating family fixed effects models.

The key aims of our research are as follows:

**Aim 1:** Describe cross-country differences in age 7-10 and age 13-16 skills and behaviors and age 25-50 outcomes by various measures of parental socioeconomic status.

**Aim 2:** Estimate regression-adjusted associations between middle-childhood skills and adult labor market, crime and health outcomes for each of our samples and identify social-class differences in these associations. We hypothesize mostly within-domain (e.g., early anti-social behavior and adult criminality) linkages and expect that child/adult associations will be weaker in Nordic than in Anglo-American countries.

**Aim 3:** Assess the extent to which adolescent skills and behaviors mediate the effects of middle childhood skills and behaviors in predicting adult outcomes. Here we expect mostly within-domain mediation.

**Aim 4:** In the case of middle-childhood skills and adult health, estimate to what extent teen health risk behaviors account for the links. In this case, we expect that early cognitive and achievement skills will reduce the changes of adolescent health risk behaviors and thereby matter the most for adult health.

By assessing the adult correlates of childhood and adolescent skills and behaviors, our project complements the other three in the program project by showing which skills and behaviors and which childhood periods (middle childhood and adolescence) targeted by the various human capital-related interventions we evaluate matter most for adult well-being. Specifically, our middle-childhood math and reading achievement and anti-social behavior are outcomes in Projects I and III. Project II's outcomes – adolescent health risk behaviors – are key mediators in our analyses of links between middle childhood skills and adult health. Moreover, our SES-based moderational analyses complement those undertaken in Projects I-III in conjunction with their searches for SES-based child/policy fit impact heterogeneity.

Our efforts build on the research infrastructure provided by the Center for the Analysis of Pathways from Childhood to Adulthood (<http://rcgd.isr.umich.edu/capca/about/index.htm>). CAPCA includes more than two dozen researchers from the U.S. and Europe. Since several of us have already collaborated successfully on a widely cited study of early skills and school achievement published in *Developmental Psychology* (Duncan et al., 2007) and on a chapter in a forthcoming Russell Sage volume (Duncan et al., forthcoming), the feasibility of our ambitious project is not in question.

## C. RESEARCH STRATEGY

### C.1 Significance

Why should we care about the long-run correlates of skills and behaviors developed by middle childhood?

First, this issue is directly related to fundamental questions regarding the nature and malleability of human development. Uniformly high correlations across socioeconomic strata and country may reflect “canalization” (Waddington, 1942; Gottlieb, 1991), the process by which phenotypes are led to the same fate regardless of environmental experiences. Results from our earlier collaborative work (Duncan et al., 2007) clearly supported this view when examining associations between kindergarten entry and primary school achievement. The current study would extend the time at which outcomes are measured from middle childhood to adulthood and expand the outcome domains from achievement to crime and health.

Second, finding that skill and behavior linkages to adult outcomes arise more in middle childhood than in adolescence has clear implications for when the outcomes of early interventions should properly be measured. If, for example, adult earnings have strong associations with age-16 but not age-8 test scores, then tracking achievement impacts of preschool interventions only through middle childhood will tell us little about their likely long-run impacts.

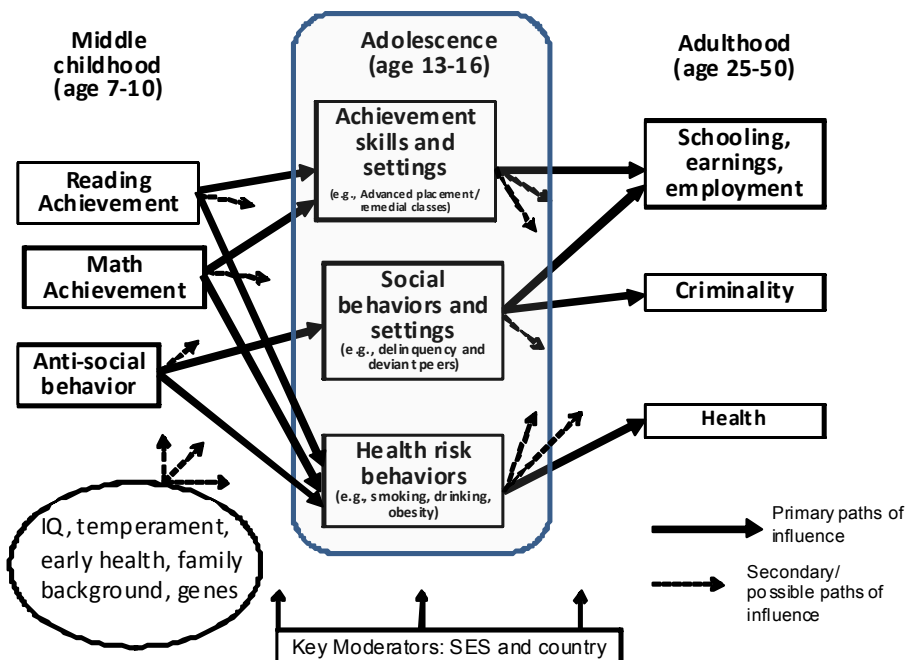
Third, ours would be the first multiple dataset and transnational comparative examination of links between several key skills and behaviors in middle childhood and a host of important adult outcomes. Past work has tended to concentrate within single domains (e.g., early and later anti-social behavior) which risks falsely attributing a given measure the explanatory power of correlated skills and behaviors. And key findings from studies using single datasets sometimes fail to replicate when tested with other, comparable data. Our work would help promote a needed culture of replication in developmental studies.

A fourth reason why our proposed research is so important is that childhood skill/adult outcome linkages have implications for the timing and SES-based moderation of human capital intervention policies such as those investigated in Projects I-III. Specifically, it will provide valuable perspective on the possible adult consequences of: i) heterogeneous treatment impacts of high-quality preschool programs (Project I); improving health risk behavioral outcomes in adolescence (Project II); and improving student achievement through vouchers and high-stakes testing (Project III). SES moderation discovered in our studies will inform the policy implications of SES-based moderation in program impacts discovered in these other projects. Moreover, the child/adult associations will inform the within-person rank assumptions made in Project III.

Fifth, consistent cross-country SES differentials in the links between middle-childhood skills and adult outcomes would be indicative of the immutability of the powerful role played by SES. Particularly impressive would be similar SES-based results across our Nordic, British and U.S. datasets. With very different preschool, primary school and family support systems, overt class consciousness, and ethnic heterogeneity, the countries covered by our datasets provide diverse settings in which SES-based gradients might develop.

*C.1.a Conceptual Framework*

*C.1.a.1 Model.* The conceptual model of the skills/outcome pathways we propose to investigate begins with our achievement and anti-social behaviors, all of which are measured in middle childhood – between ages 7 and 10 in our six datasets (left-hand side of diagram). On the far right are the various domains of adult outcomes (measured between ages 25 and 50): attainment, consisting of years of completed schooling, earnings and employment; criminality; and health. The adolescent mediators depicted in the middle panel of the figure will be featured in some but not all of our proposed analyses.



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Middle-childhood skills and behaviors are themselves a product of genetic endowments

affecting early cognition, temperament and health, plus the positive and negative early environmental experiences associated with socioeconomic status and parental actions and choices. To the extent possible, we will control for these background factors in our estimates of the association between middle-childhood skills and adult outcomes. As control strategies we will both draw from the extensive sets of family and child background measures available in some of our datasets as well as estimate siblings fixed effects model in the case of the NLSY dataset. Sibling-based models eliminate biases owing to characteristics that are common to all siblings in the same family. But since they fail to control for unmeasured characteristics that are specific to individual children, we will be mindful of possible sources of lingering bias when interpreting our results.

In keeping with the prior literature, we expect considerable life-course continuity within domains (e.g., McCall et al., 1973, for cognition; Moffitt, 1993, for anti-social behavior; and Kuh and Ben-Shlomo, 2004, for health). Continuities can arise from genetic causes (Bouchard & McGue, 1990); from the productivity of self-investments leading to “skills begetting skills” (Cunha et al., 2005); from skills and behaviors developed by middle childhood leading to the selection of certain environments (e.g., advanced placement classes for high achieving adolescents); and from deviant peer groups (in the case of anti-social teens) that reinforce specific skills and behaviors (Magnusson, 1998).

As indicated by the dashed lines, cross-domain influences are possible as well. Success in sustaining most careers requires a combination of cognitive and pro-social skills.<sup>1</sup> Physical health in adulthood benefits from knowledge of current best-practice medical regimens and an ability to implement them. Since most of the existing life course literature focuses on cross-time within-domain connections (e.g., trajectories of anti-social behavior), our proposed investigation of these cross-domain effects would be one of our innovative contributions. Our hypotheses here are as follows:

**Hypothesis 1:** Within-domain linkages (e.g., achievement to completed schooling; anti-social behavior to adult crime) will be stronger than between-domain linkages. Multi-faceted adult outcomes (i.e., labor market success, health) will be a product of both earlier achievement and anti-social behavior.

*C.1.a.2 SES interactions.* The parameters of our model could well vary by children’s socioeconomic backgrounds. Expectations of *higher* skill payoffs for *lower*-SES children come from the labor economics literature’s consensus finding that the labor-market payoffs to increased schooling are generally higher for low relative to higher levels of skill (i.e., as measured by completed education) (Card, 1999; Currie and Thomas, 1999; Cawley et al. 2001). Relative to lower SES parents, higher SES parents are better able to afford tutors and other enriched learning experiences, specialized health services, legal support and the like in response to their perceptions of and experiences with their children’s skills. This could produce two types of effects. If these services are enlisted in remedial responses to perceptions of and experiences with below-average age 7-10 skills (and not controlled for in our empirical models), then low skills for higher-SES children will not be as damaging for future life chances as low skills for lower-SES children. But if higher SES parents are better able than lower SES parents to nurture and complement the exceptional talents of their children, then the payoffs to high skills levels will be greater for higher than lower SES parents. The issue of SES moderation has important links to Project I, which investigates SES moderation in early-childhood programs effects.

**Hypothesis 2:** On balance, we expect to observe stronger associations between early skills/behavior and adult outcomes for lower- as opposed to higher-SES children.

*C.1.a.3 Cross-country differences in achievement and SES gradients.* Comparisons of models of child skills and adult outcomes across countries raise important questions about cross-national differences in whether countries offer fair opportunities for their citizens. As Bratberg, Nilsen, and Vaage (2007) discuss, poor children may grow up to be poor adults because of inherited preferences for market work, inherited differences in market ability, or constraints on their ability to secure and invest in opportunities, such as for education and skill development (see also Roemer 2004). Many regard it as unfair that a child’s future prospects depend on his or her parents’ capabilities in these domains (Swift 2005).

The Nordic welfare states have attempted in many ways to “level the playing field” with respect to the circumstances that are beyond children’s control, including parental earnings. This has been especially true for publicly subsidized center-based child care, as well as for higher education, which is publicly financed with few

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<sup>1</sup> A cluster of attention and executive function skills likely matter for these outcomes as well. Most of our datasets do not measure these kinds of skills very well. To help reduce bias, our analysis will control to the extent possible for these kinds of skills, but they are not featured skills in our analyses.

or no tuition fees. On the other hand, Nordic schools often employ more tracking in the early grades. By and large, however, Nordic countries as opposed to the U.S. and Britain have sought to reduce the importance of family background in securing opportunities typically associated with successful human capital development.

**Hypothesis 3: Associations between early skills/behavior and adult outcomes will be stronger in Nordic countries than in the U.S. or Great Britain.**

#### *C.1.b Adult Achievement Outcomes*

We include key labor market outcomes such as adult earnings and unemployment under the heading of “achievement” but expect their determinants to be a mixture of both academic and behavioral skills developed in childhood and adolescence. Constrained by the nature of the available data, most work in this area has concentrated on cognitive skills measured during the teenage years. Thus, for example, Murnane et al. (1995) show links between the mathematics tests scores of two cohorts of high school seniors and their wages at age 24 while Neal and Johnson (1996) find strong associations between a cognitive/achievement test and earnings measured a decade later. Secondary school measurement of pre-adult skills also characterizes attempts to relate labor market outcomes to combinations of cognitive and so-called “noncognitive” skills. Heckman et al. (2006) show the remarkable power of a scale combining adolescent self-esteem and sense of personal effectiveness for explaining later earnings in NLSY data.

Despite the value of these adolescent-based skill studies, they beg a vital question: To what extent is the apparent predictive power of adolescent skills and behaviors a mere reflection of fundamental skills determined much earlier in life? If skill trajectories are relatively rigid products of genetic factors, child self-selection into classroom behavior, study habits and peer-group interactions, or school structures such as tracking, then adolescent interventions are too late to produce lasting improvement.

A handful of studies have attempted to assess the importance of middle-childhood skills using data from the National Child Development Survey (NCDS – one of the datasets in our proposed studies), which has followed a cohort of British children born in 1958 through midlife (more on these data below). Currie and Thomas (1999) use these data to relate scores on reading and math tests administered at age 7 to wages and employment at age 33. Even in the presence of extensive family background controls, their models show 10%-20% earnings differentials when comparing both males and females in the top and bottom quartiles of the two test score distributions. Although they find no evidence of SES interactions for wages, they do find that higher test scores provide more of a boost to the employment chances of a low than a high SES child. An important omission in the Currie and Thomas (1999) analysis are controls for other domains of child functioning at age 7.

Carneiro et al. (2007) also use the British NCDS, but include data on a wide variety of achievement and behavioral measures assessed when the sample children were 11 years old and an extensive list of adult outcomes, including completed schooling and teen motherhood as well as age-42 criminality and mental and physical health. In many ways, then, their examination is similar in nature and scope to the one that we propose to conduct using six rather than just one dataset, which is important in light of the fact that the economic and social policy conditions under which the 1958 birth cohort established their careers differs greatly from those conditions for later cohorts and across countries (Buchholz et al., 2009).

**Hypothesis 4: Positive adult labor market outcomes will be predicted (positively) by achievement and (negatively) by anti-social behavior in middle childhood.**

#### *C.1.c Adult Crime and Aggression Outcomes*

The continuity of aggressive and antisocial behavior is considered to be “one of the few ‘knowns’ in aggression and criminology research” (Juon et al., 2006, p. 194). Several ongoing prospective studies (e.g., Farrington, 2000; Huesmann et al., 2002; Huizinga & Jakob-Chien, 1998; Pulkkinen et al. (2009), Loeber et al., 1999; Tremblay et al., 1999), while only beginning to report extensive data on middle and late adulthood behavior, confirm continuities from childhood aggression to late adolescent delinquency and early adulthood criminality. Adolescent anti-social behavior is a clear predictor of later crime. That this relationship holds even from middle childhood to middle age is supported by consensual findings (Farrington & Pulkkinen, 2009). Moffit (1993) proposed that anti-social behavior from early childhood through adolescence could be characterized by two patterns: life-course persistent and adolescence-limited. Empirical studies have produced conflicting evidence on the number and nature of distinct trajectories (Nagin & Tremblay, 2005; Piquero, 2008), and have often identified groups that exhibit behavior problems early but not later in childhood (Odgers et al., 2008).

Less clear is whether *pre*-adolescent anti-social behavior is also linked to later crime. Leschied and

colleagues (2008) conducted a meta-analysis of associations between externalizing concerns in middle childhood and later crime and found an average effect size of .31. Among studies too recent to be included in the meta-analysis, Fergusson et al. (2005) found that after controlling for measures of attention and IQ, higher levels of conduct problems at ages 7-9 were associated with more crime at ages 21-25.

Achievement is another early childhood domain that might have lasting links with later criminal activity. Numerous studies have demonstrated an association between low achievement early in a child's school career and conduct problems in adolescence (e.g., Maguin & Loeber, 1996), with much of the research debating whether anti-social or more general behavior problems precede or follow early reading difficulties (Vanderstaay, 2006). School difficulties in adolescence relate to relative increases in delinquency and drug use across late adolescence and early adulthood (Bachman et al., 2008). Far fewer studies have followed participants from childhood into early adulthood to examine associations between early achievement difficulties and criminal outcomes.

Our proposed study takes a broad look at the middle-childhood precursors to criminal involvement in adulthood. The policy issue that motivates us is whether one can predict and perhaps remediate against later crime on the basis of behavior problems and achievement skills in the early elementary-school grades. Prior literature and our own preliminary work (see section C.3.f) leads us to expect that early anti-social behaviors will be more predictive than will achievement problems, and that the early persistence of anti-social behavior throughout childhood and adolescence will be the dimension that matters the most.

**Hypothesis 5: Adult crime will associate most strongly with middle childhood anti-social behavior and, especially, persistent anti-social behavior across middle childhood.**

#### *C.1.d The Role of Adolescence*

Central to theories of developmental psychology and social policy is the role of adolescence in the life course. In the context of our focus on links between middle childhood skills and behaviors and adult attainments, our interest is in to what extent adolescent skills and behaviors mediate middle childhood effects, within and across constructs. The studies included in this application are very well suited to address these questions.

Continuity of adaptation takes center stage in many developmental theories (Cicchetti & Rogosch, 2002; Schulenberg & Zarrett, 2006). That is, difficulties in childhood lead to difficulties in adolescence which in turn lead to difficulties in adulthood; likewise, doing well sets the stage for continuing to do well. Similarly, the idea that early skills matter the most is the foundation of social policies such as enriched preschool experiences (Knudsen et al., 2006). In these conceptualizations, adolescence is logically assumed to largely mediate childhood effects on adulthood outcomes, and thus contribute little to the prediction of adulthood functioning.

But more recent developmental theories emphasize dynamic person-context interactions and multi-directional change (e.g., Cairns, 2000; Lerner, 2006; Sampson & Laub, 2005; Stouthamer-Loeber et al., 2004) across childhood and adolescence. Moreover, empirical evidence concerning the internal and contextual changes of adolescence argues for the power and unique contributions of adolescent experiences and characteristics. For example, with adolescence comes an increase in the quantity and power of social contexts (Steinberg, 2008), a decrease in parental (and other adult) supervision, and an increase in personal agency (Shanahan, 2000). In this view, the experiences of adolescence can alter ongoing trajectories, for better or worse, effectively negating or reversing the influence of childhood functioning (Schulenberg et al., 2003). To the extent that this is true, adding adolescence into the prediction of adulthood functioning appreciably increases the predictive power, and social policies aimed entirely at early or middle childhood are, at best, incomplete.

During adolescence, there tends to be a convergence of various problem behaviors such that difficulties in one domain (such as school difficulties) correspond to difficulties in other domains (such as spending time with deviant peers, depressive affect, substance use) (Jessor, 1987, 1991). To conceptualize long-term connections across the life course, and more specifically to portray how cross-construct influences play out developmentally, the cascade model has gained prominence recently (e.g., Dodge et al., 2009). Cascading effects, where earlier difficulties in one domain (e.g., school performance) contribute to subsequent difficulties in another domain (e.g., substance use), have become central to understanding how psychopathology accumulates across the life course (e.g., Dodge et al., 2008; Masten et al., 2005). For instance, Dodge and colleagues (2008) demonstrate that an adverse economic and social context in childhood can have cascading effects on adolescent violence through a sequence of diminished academic achievement, disengagement from

school, reduced parental attachment and monitoring, and engagement with delinquent peers. In the proposed projects, we will use both within-construct mediational models and cross-construct cascade models to examine the interplay of childhood and adolescent effects on adulthood outcomes.

Within a structural equation modeling framework, common when examining mediating and cascading effects, we will consider two overarching questions: a) whether the effects of childhood constructs are fully or partially mediated by similar adolescent constructs in the prediction of adulthood outcomes; and b) consistent with a cascading model, the extent to which cross-construct effects occur from childhood to adolescence. Mediation models constitute reasonable starting points for these analyses, and we will consider necessary modifications to such models to show additional longitudinal mechanisms (e.g., adolescent effects independent of childhood effects). In addition, an important descriptive question here will be the extent to which adolescent constructs add to the amount of variance accounted for by childhood constructs in adulthood outcomes. With data from six longitudinal studies drawn from four countries, all of which provide at least some parallel measures of development in middle childhood, adolescence and adulthood, we are in an ideal position to assess the role of adolescent functioning.

**Hypothesis 6:** Adolescent skills and behaviors will mediate the bulk of the effects of middle-childhood skills on adult attainment and behavioral outcomes, through both within-domain continuity and cross-domain cascade effects.

The nature of SES and country moderation is difficult to predict. Higher SES families will likely be more successful at enhancing their children's achievement advantages, which strengthens the mediational role of adolescent skills. But they may also reduce academic deficits in adolescence and the negative legal and academic consequences of anti-social behavior, both of which weaken mediation for high SES children. Active (i.e., Nordic) social policies may better compensate for achievement and behavioral deficits that children bring into adolescence. On the other hand, Nordic schools often employ more tracking in the early grades.

#### *C.1.e Health Outcomes*

Behaviors that directly increase or decrease risk of disease have long been recognized as primary drivers of variation in individual as well as population health, and health-related behaviors are major contributors to social and economic gradients in morbidity and mortality in the U.S. and other industrial nations (Gerrard, Gibbons, Benthin, & Hessling, 1996; Lynch, Kaplan, & Salonen, 1997). Health behaviors therefore represent important pathways linking socio-economic environments and socio-economic disparities in health outcomes, but the more proximate determinants of engaging in health behaviors are poorly understood. In this study we have the opportunity to investigate whether middle childhood skills and behaviors are significant predictors of adolescent health risk behavior, with implications for adult outcomes such as general health, body mass, cardiovascular health and depression.

We will test two pathways linking middle childhood skills, health behaviors, and adult health. In the first pathway, the effects of middle childhood skills on adult health are mediated by adult socioeconomic attainments. It is well-established that health risk behaviors such as smoking, consumption of foods of poor nutritional quality, and low levels of physical activity are all more likely among individuals of lower socioeconomic status (SES) (Hanson & Chen, 2007; Jeffery, French, Forster, & Spry, 1991; Marmot et al., 1991). Therefore, early achievement skills may matter to adult health if they improve adult career prospects and boost earnings and income (Grossman, 1972; Fuchs, 2004). Higher incomes can be used to purchase better medical care and food, higher-quality homes and safer neighborhoods. This indirect pathway can be summarized as middle childhood skills→adult SES→adult health.

Alternatively, a more direct, life course development process may be in play, summarized as childhood skills→adolescent health behaviors→adult health. In this pathway, childhood skills predict health behaviors in adolescence, which have lasting consequences for health in adulthood. A line of research on delinquency in adolescence indicates that lower self-regulation skills and more anti-social behavior in middle childhood lead to increased adolescent health risk behaviors such as smoking, drug use, unprotected sexual activity, selling drugs, weapon use, and attempted suicide. Many of these behaviors can have short- as well as long-term effects on adult health, particularly if the behaviors are perpetuated. These are the kinds of mechanisms Repetti et al. (2002) write about in their "risky families" hypothesis; they help provide an integration of early insults and stressors which may underlie both poor early skill development and poor adult health. While most research on adolescent risk behavior focuses on delinquency and other conspicuously dangerous activities, our focus here is on more mundane, everyday behaviors related to body mass, physical activity, smoking, drinking and drug use



that accumulate over time to shape risk for the chronic diseases that represent principal threats to public health in the US. While controlling for the former in our analyses, we concentrate on the latter because of their importance for population health and nearly universal availability in our six datasets.

Fortunately, all of our six studies collect data from their subjects between ages 13 and 16 that include measures of various health risk and health promoting behaviors. As described in our analysis section, we are able to use these data to test the mediational models implied by the literature reviewed above.

Understanding the determinants of health behaviors in adolescence is important because the pathophysiological origins of cardiovascular disease and diabetes can be traced to lifestyle factors in childhood and adolescence (Freedman et al. 2007; McGill et al., 2002). Furthermore, the transition through adolescence is marked by increased autonomy and the assumption of greater responsibility for decisions regarding diet, exercise, and other health-related behaviors. While adolescents tend to take health for granted, they have a growing ability to reflect on their own behavior, and to weigh the long term consequences of their actions (Millstein, 1993; Weithorn & Campbell, 1982). From a life course health development perspective, adolescence therefore represents a sensitive period during which habits may form that help shape trajectories of disease risk later in life (Halfon & Hochstein, 2002). Are middle childhood skills and behaviors significant, independent predictors of health-promoting behaviors in adolescence? We regard the answer to this question as a highly innovative contribution of this study.

**Hypothesis 7: Higher achievement skills and less anti-social behavior in middle childhood will lead individuals to: i) adopt healthier lifestyles in adolescence and ii) enjoy higher SES as adults. Both sets of mediators will improve adult health and account for a portion of the early skills/adult health associations.**

## C.2 Innovation

Virtually all of our existing knowledge regarding linkages between pre-adult and adult skills, behaviors and attainments suffer from one or more of the following problems: i) pre-adult skills and behaviors are measured no earlier than adolescence, which provides little guidance regarding the optimal foci of preschool and elementary school human capital interventions; ii) analyses are confined to within-domain associations (e.g., early anti-social behavior and adult crime), which risks attributing to early anti-social behavior what might really be caused by, for example, low school achievement; iii) analyses are restricted to a single dataset, which fails to establish the robustness of results to variation in study design, cohort and country-specific social welfare policies; and iv) analyses often fail to address issues of bias arising from omitted family characteristics.

Our proposed examination of links between several key skills and behaviors in middle childhood and a host of important adult outcomes addresses all of these limitations. It draws its skill and behavior measures from middle childhood (age 7-10) while at the same time includes adolescent measures as mediators. All of its models of the effects of a given skill or behavior control for concurrent skills and behaviors. Its collective data spans four countries, cohorts born in the 1950s, 1960s, 1970s and 1980s, and both Nordic and Anglo-American social welfare regimes. And, in one case, sibling data support the estimation of family fixed-effects models in which all of the variation used to estimate the models is drawn from siblings growing up in the same family.

## C.3 Approach

### C.3.a Datasets

**C.3.a.1 Samples.** We use six datasets, all of which are drawn from either national populations or diverse communities: i) the **U.S. Beginning School Study** selected 12 first graders per classroom at random from 1<sup>st</sup> grade classroom in Baltimore public schools in 1982. Sample sizes and response rates (using the 1<sup>st</sup> wave n as a base) are as follows: 1<sup>st</sup> grade: 838 (97%), Age 7/8: 545-667 (65-80%), Age 9/10: 410-589 (49-70%), Age 14/15: 412-668 (49-80%) and Age 27/28: 660 (79%). ii) the **U.S. National Longitudinal Survey of Youth** drew a national sample of 14-21 year old men and women in 1979. The children born to the sampled women comprise our analysis sample, and are observed biennially since 1986, with the most recent data available from 2008. Sample sizes depend on the ages of the children at observation. For example, about 4,025 children are observed at ages 19 or 20 and 1,830 were observed at ages 25-26. Some 2,703 of children observed at age 21-22 will have siblings observed at the same age. Response rates in the original 1979 interviewing wave were 82% of households approached for screening. Among children observed at age 7 or 8 at an early enough point to have been at least 23 by the 2008 interviews, some 68% were successfully interviewed at age 23 or 24. iii) the **Finnish Jyväskylä Study** selected all students in second grade classrooms in Jyväskylä, Finland in 1968. Sample sizes and response rates are: Age 8: 369 (100%), Age 14: 356 (96%), Age 27: 321 (87%), Age 36: 311 (85%), Age 42: 285 (79%), Age 50: 271 (76%). iv) the **Swedish IDA study** selected all third grade students

in Örebro, Sweden in 1965. Sample sizes and response rates are 3<sup>rd</sup> grade (age 10): 958 (93%), Age 13: 90%, Age 15: 87%, Age 16: 83% , Age 43 for females (84%); Age 48 for males (75%). v) the **British NCDS** selected all British births in one March, 1958 week. Sample sizes and response rates are: Birth: 17,416 (98%), Age 7: 15,425 (89%), Age 16: 14,647 (84%), Age 33: 11,407 (65%), Age 42: 11,419 (66%), Age 46: 9,531 (55%), Age 50: Release late 2009. vi) the **British BCS** sample all British births in one April, 1970 week. Sample sizes and response rates are: Birth: 17,287 (97%), Age 10: 14,350 (83%), Age 16: 11,206 (65%), Age 30: 10,833 (63%), Age 34: 9,316 (54%).

The BSS sample is based on the population of students in Baltimore public schools at a time (1982) when Baltimore was more racially diverse; 45% of the first graders in the sample are white. The city of Jyväskylä is located in central Finland, some 170 miles north of Helsinki. Its population was around 75,000 when the study began. It has been the site of many cutting-edge educational initiatives. The Swedish IDA sample is drawn from students in Örebro, which is located in central Sweden, roughly equidistant from Stockholm, Gothenburg and Oslo. Its 2005 population was 98,237, making it the seventh largest city in Sweden. Although NLSY is based on a national sample (of 14-21 year olds in 1979), the children of the sampled females who are observed between birth and at least age 25 were all born to relatively young women and there are no births to women who immigrated after 1979.

Begun in a halcyon era of public and school cooperation with survey researchers, all but the NLSY achieved initial wave response rates in excess of 95%, although response rates in subsequent waves are lower and raise concerns of potential nonresponse bias. We intend to address nonresponse concerns in two ways – i) multiple imputation and ii) by developing a set of study-specific nonresponse-adjusted weights, where the weights are the inverse of response-rate probabilities predicted from a probit model regressing response status on a host of baseline family and child demographic characteristics. In the case of NLSY, the released data already include weights that incorporate nonresponse adjustments. Reliable results should be robust to these alternative treatments of missing data adjustment.

*C.3.a.2 Outcome measures.* As to adult outcome measures available in each of the six datasets: all six provide quite comparable measures of years of completed schooling and annual earnings.<sup>2</sup> All provide measures of arrests or criminal convictions. Adult health information varies somewhat across studies, with all studies including a self report of general health, five of six providing a measure of BMI, and three of the four European datasets providing biomarker data. Details for crime outcomes are as follows: the BSS measures number of arrests and age of first arrest; number of convictions and age of first conviction; ever and length of incarceration at age 28/29. The NLSY measures number and charges of convictions and ever spent time in a youth or adult corrections facility. The JYLS measures from registers (age 15-42) and self-report (age 15-50) seriousness and number of criminal acts and convictions. The Swedish IDA measures from registers the number of convictions between ages 21 and 35. The British NCDS gathers an interview report of number of arrests and convictions at age 42. The British BCS gathers this same information at age 30.

As to health outcomes, the BSS measures BMI, general health, health limitations; depression inventory; drug use in recent past at age 28/29. The NLSY measures type and duration of health limiting conditions, recent hospitalizations, body mass and a CES depression scale. The JYLS measures self-reported health, health behavior, general health, and psychosomatic symptoms, data from medical examination (e.g., BMI, blood pressure) (ages 42 and 50), various biomedical parameters from blood at ages 42 and 50. The Swedish IDA measures from self-reported health, standard health variables from a health examination by physician, various biomedical parameters from blood, all at ages 43 and 48. The British NCDS gathers BMI, general health, health behaviors (ages 33, 42, 46, 50), waist & hip measurements, sleep, blood pressure, fibrinogen, C-reactive protein, mental health (age 45). The British BCS gathers BMI, general health, health behaviors (ages 30, 34, 38), waist and hip measurements, diet and exercise, mental health.

*C.3.a.3 Age 7-10 skill and behavior measures.* Five of the six studies provide both math and reading measures. Specifically, the BSS gathers California Achievement Test (CAT) math and reading scores from school records; the NLSY tests for achievement skills with the Peabody Individual Achievement Tests (PIAT)

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<sup>2</sup> For our descriptive work, outcomes measured in currency (e.g., earnings) will be converted to 2010 U.S. dollars using within-country inflation rates and 2010 Purchasing Power Parities. Earnings models will be estimated using the natural logarithm of earnings as the dependent variable. This not only provides for a more normally distributed dependent variable but also avoids noncomparability problems stemming from different currency and rates of inflation.



Reading Recognition (test-retest reliability=.89) and Math (test-retest reliability=.74) tests; the IDA provides school-administered scores on mathematics and reading tests as well as math and reading grades. The NCDS provides measures math with the Southgate test and reading with the Problem Arithmetic Test. The BSC measures math with the Edinburgh Reading Test ( $\alpha$ =.96) and reading with the University of Bristol Math Test; ( $\alpha$ =.93). Math and reading tests are not available in the JYLS; however, teacher-rated information about school achievement is available.

As to anti-social behavior, the BSS gathers teacher reports of an index with sample items “fights too much, teases, picks on, or bullies other children”; “has a strong temper; loses it easily” “cheats, tells lies, is deceitful” -- 3 items,  $\alpha$ =.85; the NLSY has a parent report of a 6-item antisocial scale (e.g, cheats, bullies, lies;  $\alpha$ =.67) ; the JYLS has teacher-rated aggression, e.g., does the pupil hurt another child when angry, e.g. by hitting; 8 items,  $\alpha$  = .91. The IDA provides a teacher report of aggressiveness. The NCDS provides parent reports of, e.g., irritable, quick to fly off handle, has temper tantrums, fights other children ( $\alpha$ =.63). The BCS gathers teacher reports of child being irritable, quick to fly off the handle, quarrels or bullies other children, destroys others' belongings ( $\alpha$ =.91).

*C.3.a.4 Age 13-16 skill and behavior measures.* Five of the six studies provide both math and reading measures. As with the age 7-10 skill measures, the BSS gathers California Achievement Test (CAT) math and reading scores from school records; the NLSY administers PIAT reading and math tests until children reach age 15; the IDA provides school-administered scores on standardized mathematics and reading tests as well as math and reading grades. The standardized achievement tests were constructed by the Swedish national board of education and they did not compute reliabilities (Chonbach’s  $\alpha$  is not appropriate since the achievement tests are composite tests). However, the correlations with school grades in Swedish and Mathematics were high (.73-.83). The NCDS provides measures of reading and math with tests specially constructed by the National Foundation for Educational Research I England and Wales. The BSC measures reading with the Edinburgh Reading Test ( $\alpha$ =.96) and math with the University of Bristol Math Test; ( $\alpha$ =.93). Math and reading tests are not available in the JYLS; however, teacher-rated information about school achievement as well as record-based GPA are available.

As to anti-social behavior, the BSS gathers the same teacher reports as age 7-10 of an index with sample items “fights too much, teases, picks on, or bullies other children”; “has a strong temper; loses it easily” “cheats, tells lies, is deceitful”-- 3 items,  $\alpha$ =.78; the NLSY has a parent report antisocial scale measured until children reach age 15; the JYLS has responses to a single teacher-rated question regarding aggression-- "attacks without reason, teases others, says naughty things". IDA provides a teacher report of aggressiveness. Although no reliability estimates are available aggression shows substantial correlations over 3-6 years with measures of antisocial behavior. The NCDS provides teacher reports of, e.g., destroys/damages own and others' property, bullies other children; is often disobedient (five items,  $\alpha$ =.63). The BSC gathers teacher reports of child being irritable, quick to fly off the handle, quarrels or bullies other children, destroys others' belongings ( $\alpha$ =.91).

*C.3.a.5 Age 13-16 health risk behaviors.* All of our six datasets measure adolescent health risk behaviors between ages 13 and 16. All six provide measures of problem drinking, height and weight. All but the Swedish IDA provide measures of smoking, while the Swedish IDA, British BCS and NLSY provide measures of various kinds of drug use. In terms of positive health behaviors, the BSS has reports of sports and band participation and the two British cohort studies gather self reports of various kinds of physical activities.

*C.3.a.6 Parent and child background controls.* Three of our datasets begin their interviews shortly after (BCS, NCDS) or years before (NLSY) birth and thus provide abundant measures of pre-middle childhood child and family characteristics and conditions. The other three begin between first and third grade. All have measures of child age, gender, family size and structure as well as SES components (parental education, occupation) and age of mother at the time of the child’s birth. The former three provide measures of birth weight and maternal employment and mental health. The NLSY measures also include child’s early temperament and receptive vocabulary; mothers’ cognitive ability, teen problem behavior, receipt of prenatal care; and family income and score on the HOME environmental assessment. The BCS provides extensive measures of the child’s cognitive skills and behavior at age 42 months, as well as frequency of reading to child. The NCDS collected measures of the maternal grandfather’s occupation and social class, mother’s employment during pregnancy, child gestational age, and extensive measures for obstetric complications.

### C.3.b Aim 1 Descriptive Analyses

Our work will begin by addressing *Aim 1: Describe cross-country differences in age 7-10 skills and behaviors and age 25-50 outcomes by various measures of parental socioeconomic status*. Our first task is to maximize the comparability of the measures available in these cross-country datasets. Parent education, occupation and family structure are the most comparable measures of SES across our datasets. All six of the datasets provide measures of parental schooling, which will be converted into equivalent years of schooling using ISCED codes. All of the datasets include a parental occupation-based measure of social class that differentiates blue- from white-collar jobs, and most distinguish lower- and upper-level white-collar occupations. And all provide measures of single- vs. two parent family structure. One of the datasets (the NLSY) provides annual measures of family income. Since it is the most comparable across the datasets, the average years of parental education will be our primary SES measure, but we will also develop an occupation-based measure approximating the upper white/lower white/blue collar division.

Similarly, cross-dataset differences in the definitions and distributions of age 7-10 and ages 13-16 skills and behaviors and adult outcomes will be scrutinized with a view to maximizing comparability. Since most of our analyses of age 7-10 skills and behaviors will use whole-sample-based standardized measures, we will want to examine to what extent sample distributions differ on comparable items. Our collective work this past year on the role of childhood skills and behaviors in the intergenerational transmission of educational attainment (see section C.3.f) convinces us that we can achieve a satisfactory level of comparability across our six datasets.

### C.3.c Aim 2 Analysis

Once we are satisfied that we understand the nature and distributions of the measures in our datasets, we will turn to **Aim 2: Estimate regression-adjusted associations between middle-childhood skills and adult labor market, crime and health outcomes for each of our samples and identify social-class differences in these associations**. In these and most of the other models in our research plan, the isolation of causal effects rests on the admittedly tenuous ability of measured control variables to account for the important sources of omitted-variable bias. All of the studies provide measures of family background, while most provide parallel parental measures of the children's adult outcomes, and several include prior (to ages 7-10) measures of cognitive skills, temperament and behavior problem. Notably, we have added the NLSY, which provides observations on siblings. This will enable us to eliminate bias from unmeasured persistent family characteristics through the estimating of sibling fixed-effects models. And finally, although not an explicit focus of our analysis, we will control for concurrent attention skills and internalizing behavior problems, both of which are measured with varying degrees of reliability in our datasets (Duncan et al., forthcoming).

**C.3.c.1 Completed schooling and labor market outcomes.** Dependent variables in these analyses will include years of completed schooling, dichotomous indicators of completion of meaningful schooling levels (e.g., university graduation); and annual earnings (available in all studies). In the case of dichotomous outcomes, we will be mindful of the difficulty interpreting skill/SES interactions from nonlinear logistic or probit models and rely on the marginal (probability change) effects (the "margins" [formerly "mfx"] procedure in Stata) evaluated at the mean of all independent variables in the analysis.

Based on the extensive evidence of life-course continuity within skill and behavior domains, our general expectation is that early academic skills will be the strongest predictors of these achievement-related outcomes. This is especially likely in Britain, with its early tracking, than in the U.S., with its second- and third-chance education system. We will also examine interactions between middle-childhood skills and parental SES. Here our hypotheses are of higher skill payoffs for lower-SES children are well supported in the labor economics literature for the reasons spell out in section C.1.a.3. Finally, we will contrast patterns between the Nordic countries and the U.S. and U.K., where we expect stronger skill/outcome association in the former than in the latter countries.

**C.3.c.2 Crime outcomes.** As described in section C.3.a.2, all of our datasets include measures of arrests and/or incarceration, which we will use to develop measures of serious adult criminality (e.g., incarceration, whether multiple arrests for something other than traffic violations (adjusted for age); arrests per year after age 25). By and large, we expect lower rates of persistent adult crime than crime around ages 19-21, although we expect to find a similar pattern of middle childhood correlates (i.e., with measures of anti-social behavior and aggression being the most predictive). It may be the case that since adult criminality reflects a combination of a propensity toward anti-social behavior and a lack of labor-market prospects, achievement in middle childhood by itself or perhaps in combination with early signs of anti-social behavior might also have some predictive

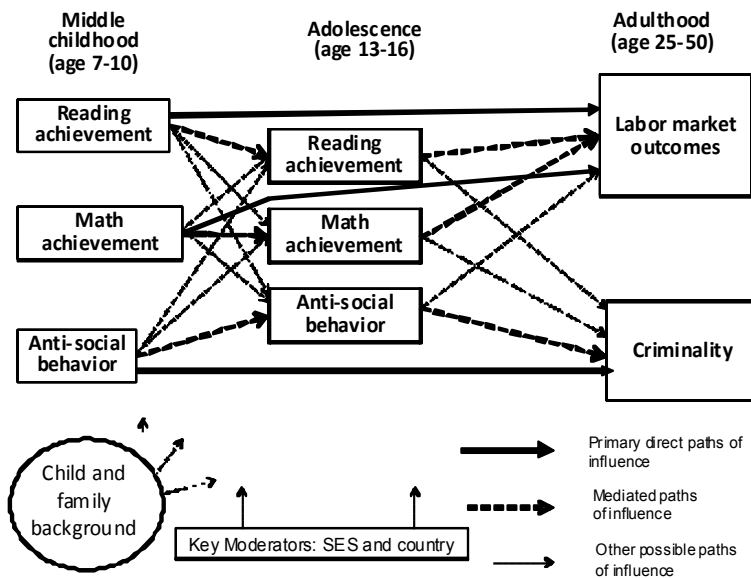
power. Two of our datasets (the BSS and NLSY) provide repeated measures of aggression/anti-social behavior between ages 7 and 10. We expect that, as in our earlier BSS/NLSY work (see section C.3.f), persistent measures of anti-social behavior will predict more strongly to adult criminality than single-year measures.

**C.3.c.3 Health outcomes.** As described in section C.3.a.2, all of our datasets include an array of adult health measures. Regressions relating these outcomes to middle-childhood skills and behaviors are expected to show that both achievement skills and anti-social behaviors have, at best, modest predictive power in accounting for differences in adult health. Our mediational analyses of health outcomes are described in section C.3.e.

**C.3.d Aim 3 Adolescence Analyses**

Our third aim is to assess the extent to which adolescent skills and behaviors mediate the effects of middle childhood skills and behaviors in predicting adult attainment and behavioral outcomes. Our Aim 2 models provide estimates of background-variable-adjusted but unmediated links between middle childhood skills and behaviors and adult outcomes. Aim 3 calls for the estimation of mediated models to show both within-domain continuity and cross-domain cascading effects.

**C.3.d.1 Model.** A schematic representation of our mediational model is provided in the diagram below. Adult achievement (indicated here by labor market success) and behavior problems (indicated by criminality) are measured in all six of our datasets at least once during the age interval 25-50. At the left side of our diagram are our middle-childhood skill and behavior domains. In the middle are the corresponding domains measured during the adolescent years (between ages 13 and 16).



For the most part, we expect within-domain mediation. So, for example, the bulk of the total effect of age 7-10 reading achievement on, say, labor market earnings will be accounted for by adolescent reading achievement. And, despite evidence of adolescent-limited anti-social behavior (Moffitt & Caspi, 2001), we expect that most of the links between age 7-10 problem behavior and adult criminality to be mediated by adolescent anti-social behavior. Cross-domain (cascade) paths of influence are likely, as with higher achievement helping to deter criminality. Our omnipresent set of family and child background controls measures are shown in the lower left-hand corner.

**C.3.d.2 Analysis.** We will use structural equation models (SEM) to estimate the mediated model represented in the above diagram. Our general strategy will be to compare nested models, starting with within-construct mediational models and then build in cross-construct cascading effects based on previous research and conceptual considerations (e.g., that early antisocial behavior contributes to later academic difficulties – e.g., Tremblay et al., 1995) as well as indications of model stress. We will follow standard procedures for model construction and testing, attending to complexities involved with using panel data, including both categorical and continuous constructs (e.g., Little et al., 2009). Given the likely intercorrelations among the adolescent constructs, building on Jessor’s problem behavior theory mentioned above, we will include correlations among the residual variances of the adolescent factors (not shown in the figure above). We will also test multiple-group models to examine sociodemographic moderation and determine the extent to which model parameters are equivalent across important subgroups (e.g., SES, country). SEM-based sibling fixed effects models will be estimated using the models proposed by Teachman et al. (2001). In the case of SES-based moderation, sibling models cannot identify SES components such as parent education that are common to all siblings, but could identify child-specific SES-related moderation in, e.g., whether the child’s mother was a teenager at the time of birth. Building on the accepted mediational/cascading models, we will also consider the “value added” in regard to proportion of variance accounted for in the adulthood outcomes with the adolescent constructs, as well as alternative models

concerning adolescent effects that do not mediate child effects, but instead add independently to the prediction of adulthood functioning.

**C.3.e Aim 4 Health Analyses**

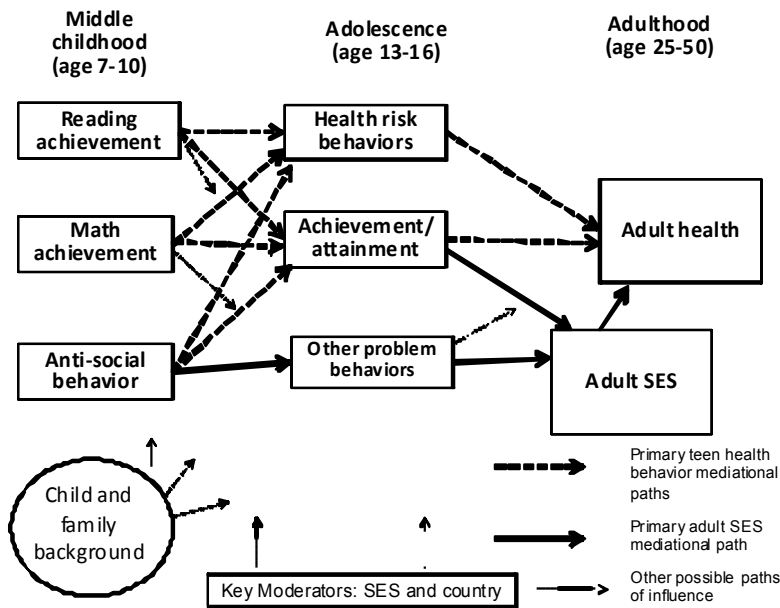
Our fourth aim is as follows: *In the case of middle-childhood skills and adult health, estimate to what extent teen health risk behaviors and adult SES account for the links.* The sparse literature linking childhood skills and behaviors provides few strong hypotheses to guide our work. One set that we will investigate is a cognitive one, in which achievement skills lead an individual to be aware of and act on the latest health information in adolescence. A second focuses on the continuity in anti-social behavior between middle childhood and adolescence. To the extent that anti-social behavior is correlated with high-risk adolescent health behavior, which in turn is associated with poorer adult health, we would expect an effect of early anti-social behavior on adult health operating through teen health risk behaviors. Alternatively, we also hypothesize that middle childhood skills will affect adult health through adult SES.

**C.3.e.1 General health.** Our mediated model is depicted below (direct effect paths from age 7-10 skills and behaviors to adult health and SES are part of the model but are omitted to clarify the mediational paths). Principal paths of mediation for early reading and math achievement involve health risk behaviors and adolescent achievement/attainment (shown with dotted lines). Most of the mediation involving early anti-social behavior is expected to run through health risk behaviors. The model also shows that other problem behaviors at age 13-16 will be included in the mediated model to avoid attributing to health risk behaviors what should really be attributed to other problem behaviors. A second mediational pathway we will test involves adult SES and is depicted with solid lines in the figure. Here, early achievement skills improve adult SES by both boosting achievement and reducing problem behaviors in adolescence. Early anti-social behaviors will boost adult SES primarily by reducing teen problem behaviors.

**C.3.e.2 Body mass.** All but one of our datasets provide measures of height and weight in middle-childhood, adolescence and adulthood, which provides some interesting opportunities to explore the roles of early skills

and behaviors in the development of obesity (Parsons et al., 1999). After a comparative look at patterns of birth weight and BMI in middle childhood, adolescence and adulthood, we will focus on the role of middle childhood skills. Our main models to do this will be regressions of adult body mass on our collection of middle childhood skills and behaviors, controlling for the given child's BMI history prior to and including middle childhood.<sup>3</sup> We expect that, holding constant BMI history, children with higher achievement skills in middle childhood will have lower adult body mass than children with lower achievement.

We will also run mediational models in which adolescent body mass is used to account for the middle childhood skill/adult body mass relationship. Given the continuities in skills and behaviors, we



expect a considerable amount of mediation.

**C.3.f Preliminary Studies**

**C.3.f.1 CAPCA.** Seven of the key personnel in our proposal are members of the Center for the Analysis of Pathways from Childhood to Adulthood (CAPCA). This NSF-funded Developmental Sciences Center is housed at the University of Michigan and has brought together investigators from 20 multi-disciplinary national and international longitudinal projects to work collaboratively on analyses aimed at answering some of the key

<sup>3</sup> Although we will follow convention in treating overweight (BMI>25) and obesity (BMI>30) as discrete outcomes, we will also use quantile regression approaches.

questions about how children's environments affect their development. CAPCA is funded for a total of ten years, the last of which roughly coincides with the middle of the third year of our proposed project period. With all of the key investigators associated with our six datasets members of CAPCA, we will take full advantage of the meeting and other services offered by CAPCA during our first three project years.

*C.3.f.2 Prior work on achievement, attainment and behavior outcomes.* As part of their CAPCA activities, several of the collaborators on the current proposal used six longitudinal datasets (two of which – the 1970 BCS and NLSY – are the same as the six proposed for use here) for a widely-cited comparative analysis of the role of behavior and academic skills acquired by the point of kindergarten entry in the development of children's later classroom achievement and test performance (Duncan et al., 2007). In follow-on CAPCA work, Magnuson et al. (2009a and b) used the BSS and NLSY to study links between middle-childhood skills and behaviors and both high school dropout and arrests or incarceration at ages 20/21. In the case of high school dropout, Magnuson et al. found age 7 or 8 math and reading achievement and anti-social behavior were at best modestly predictive of high school completion. Magnuson et al. (2009a) found persistent anti-social behavior across elementary school nearly doubled the risk of boys' later arrest or incarceration.

*C.3.f.3 Prior work on childhood skills and the intergenerational correlation in education.* Duncan et al. (forthcoming)<sup>4</sup> is the result of a collaboration from all but one (Magnuson) of the proposed investigators on this project using data from five of our six datasets (all but the NLSY) to estimate cross-country differences in the extent to which child skills and behaviors account for intergenerational correlations in the completed schooling of parents and their grown children. Regressions of completed schooling on a standardized measure of a given skill or behavior measure showed that middle-childhood math and reading scores to be significant predictors of eventual completed schooling in all but one of the datasets. Aggression/anti-social behavior measures were significant in four of the six datasets, but there was little consistency within country or region in the estimated effects. Across all of the data, childhood and adolescent skills and behaviors accounted for between one-third and one-half of the intergenerational correlations in the completed schooling of parents and children. Looking across countries, Finland conformed more closely than Sweden did to the Nordic ideal of promoting equality of opportunity.

### *C.3.g Interdependence with the Core and Other Subprojects*

The proposed work in this subproject complements the Core through its involvement of prominent senior developmental (Bergman), health (McDade) and adolescent (Schulenberg) researchers. The personnel on this subproject will meet twice each year in the first three years, once in conjunction with CAPCA and the other in Irvine at the time of the annual advisory board meeting, where they can help provide input to the Program Project as a whole. In the final two years of the project, we will continue with the annual Irvine meeting but substitute conference calls for a second physical meeting.

In substantive terms, the current subproject now focuses on the adult consequences of the middle childhood skills and behaviors that are treated as outcomes in two of the other three subprojects (Projects I and III). This subproject's focus on teen health risk behaviors complements Project II's focus on how these behaviors are affected by school curricular changes. SES moderation discovered in our studies will inform the policy implications of SES-based moderation in program impacts discovered in these other projects. Moreover, the child/adult associations will inform the within-person rank assumptions made in Project III.

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<sup>4</sup> [http://www.gse.uci.edu/person/duncan\\_g/docs/CRITA\\_paper\\_070410.pdf](http://www.gse.uci.edu/person/duncan_g/docs/CRITA_paper_070410.pdf)

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## **E. PROTECTION OF HUMAN SUBJECTS**

Our project involves the use of six population-based developmental datasets: the Swedish Study of Individual Development and Adaptation (IDA), the Finnish Jyväskylä Longitudinal Study of Personality and Social Development, the British Cohort Study-1970 birth cohort and the British National Child Development Survey-1958 birth cohort, the U.S. Baltimore Beginning School Study, and the U.S. National Longitudinal Survey of Youth.

Four of the datasets (the Beginning School Study, NLSY and the two British cohort studies) are public use and do not contain identifying information. Our use of these datasets will not be human subjects research.

Public use datasets are not available for the Finnish Jyväskylä Longitudinal Study and the Swedish IDA. Our work with these data will be human subjects research. We will analyze existing data only; no new data will be collected for this project, nor will we analyze data that will not already have been collected.

### **E.1 Protection of Human Subjects in the Jyväskylä Longitudinal Study of Personality and Social Development**

#### *E.1.a Risks to Human Subjects*

*E.1.a.1 Human subjects involvement, characteristics, and design.* In the Jyväskylä Longitudinal Study of Personality and Social Development (JYLS), the development of the same individuals has been followed from early school age to middle age. Its main focus is on understanding developmental continuity and interaction in the following areas: 1) socioemotional behavior, personality, and well-being, 2) education and work career, 3) family of origin and one’s own family, 4) health behavior and health, and 5) social adjustment and delinquency.

The JYLS involves six *main* waves of data collected over a 40-year span on 369 children who were living in the town of Jyväskylä, Finland in 1968. Twelve randomly selected complete second-grade school classes ( $N = 369$ ; 196 boys, 173 girls) were included into the study sample. Ninety-five percent of the participants were born in 1959 (the rest either in 1958 or 1960). Consequently, the participants were about 8 years old when the study began. Main follow-up assessments were conducted in 1974 ( $n = 356$ , 189 boys, 167 girls) when the subjects were approximately 14 years of age; in 1986 ( $n = 321$ ; 166 males, 155 females) at age 27; in 1995 ( $n = 311$ ; 161 males, 150 females) at age 36; in 2001 ( $n = 285$ ; 151 males, 134 females) at age 42; and most recently in 2009 when the subjects were approximately 50 years of age ( $n = 271$ ; 144 males, 127 females).

All of the original participants were white children, reflecting the ethnic distribution of the population of second graders in the town of Jyväskylä in 1968. The participants’ family socioeconomic background represented well that of the time in general. All the participants were from normal school classes, excluding students with special educational needs. In adulthood, the participants have represented well the Finnish age-cohort group born in 1959 in, for example, marital status, number of children, and employment when the figures provided by the Statistics Finland were used as the criteria.

The JYLS is housed at the University of Jyväskylä, Finland, a collaborating site in this project. The data analyses that comprise human subjects research will be conducted there by Dr. Katja Kokko, Ms. Anna-Liisa Lyyra, and possibly some other members of the JYLA research team. The JYLS data have also been archived

anonymously in the Finnish Social Science Data Archive.

*E.1.a.2 Sources of materials.* In the first wave of data collection in 1968, teacher ratings were obtained and the original subjects provided data via classroom-based peer nominations. In 1974, teacher ratings and interviews were obtained and the subjects also provided peer nomination data. A sub-sample of the subjects and their parents were also interviewed. During the 1986, 1995, 2001, and 2009 data collection periods, subjects completed a mailed questionnaire and were interviewed in person. In the context of the interviews, the subjects were presented with self-report inventories. In 2001 and 2009, medical examinations with laboratory tests were conducted. Archival data also have been collected throughout the years. (For further information, please see <https://www.jyu.fi/ytk/laitokset/psykologia/en/research/jyls>) The University of Jyväskylä collaborators are the only members of the research team who will have access to identifiable private information. No new data will be collected in the proposed project.

*E.1.a.3 Potential risks.* The only risk associated with the analyses of existing data described in this proposal involves the potential for a breach of confidentiality.

#### *E.1.b Adequacy of Protection Against Risks*

*E.1.b.1 Recruitment and informed consent.* The proposed analyses of existing data do not involve contact with research subjects and we therefore will have no role in recruitment and consent. Previously, informed consent was obtained for all data collections of the JYLS from the participants in the mailed questionnaire, and separately for the psychological interview, medical examination and laboratory tests. Additionally, the Ministry of Health and Social Welfare and the Ministry of Justice have given permission to use register data about health and criminality, respectively. The study has been approved by the Ethical Committee of the Central Finland Health District.

*E.1.b.2 Protections against risk.* Confidentiality of the data is protected by the use of numerical identification numbers for subjects. The dataset does not contain names or other direct identifiers. The master list connecting names to ID numbers and contact information files are stored separately from the data and accessible only to the Director (Prof. Lea Pulkkinen) and Co-Directors (Drs. Katja Kokko and Marja-Liisa Kinnunen) of the JYLS.

#### *E.1.c Potential Benefits of the Proposed Research to Human Subjects and Others*

There are no immediate benefits of the proposed analyses of existing data to the research subjects.

#### *E.1.d Importance of the Knowledge to be Gained*

The Finnish Jyväskylä Longitudinal Study of Personality and Social Development is part of this application's four-country look at the links between childhood and adolescent skills and behaviors on the one hand and career success, criminality and adult health on the other. Its longitudinal data, combined with a life-span approach, will provide solid knowledge about childhood factors that promote good adult adjustment and protect against bad outcomes. Benefits from the research include implications for the timing of child and youth policies such as educational tracking and behavioral interventions as well as for when the outcomes of early interventions should properly be measured.

## **E.2 Protection of Human Subjects in the Swedish Study of Individual Development and Adaptation**

### *E.2.a Risks to Human Subjects*

*E.2.a.1 Human subjects involvement, characteristics, and design.* The general purpose of the Swedish Study of Individual Development and Adaptation (IDA) is to study individual development as a process in which adaptation is a central concept. It is a multidisciplinary approach and the focus is on forms of individual development in a representative sample. We are interested in factors leading to a good or bad adaptation with regard to work and family, social adjustment including social relations, subjective well-being, and selected aspects of physical and mental health. We are also interested in how adaptation in different areas emerges together in the same individual through development and the influence on that process of multiple determinants.

The IDA began in 1965 with three complete school-grade cohorts of children from the Swedish town of Örebro, aged about 10, 13, and 15, respectively. The youngest group, called the *main* group, has been followed to adult age ( $N = 958$ ; 477 boys, 481 girls). Data collection with the main group occurred in Grade 3 (1965; age 10); Grades 6, 7-9, and 10-12; early adulthood; at ages 43, 47, and 49 with the females; and at age 48 with the males. Register data were collected covering the age period up to about age 30. This concerns official records

about criminality, alcohol abuse and mental health problems. All of the participants are white, reflecting the population in Örebro in 1965.

The IDA is housed at Stockholm University, Sweden, a collaborating site in this project. The data analyses that comprise human subjects research will be conducted by Molly Metzger under the supervision of Dr. Lars Bergman.

*E.2.a.2 Sources of materials.* Data collection in 1965 when the subjects were in Grade 3 involved questionnaires completed by children, teachers, parents, and peers, and school records data. Questionnaire data were collected at all waves. Additional data sources included medical and health examinations in Grade 6 for the full sample and at age 43 for the females; Register data about criminality, alcohol abuse, and mental health problems through age 30; personal interviews at age 43 for the females and at age 48 for the males; and administration of psychological tests to the females at age 43 and the males at age 48.

The Stockholm University collaborator, Lars Bergman, is the only member of the research team who will have access to identifiable private information. No new data will be collected in the proposed project.

*E.2.a.3 Potential risks.* The only risk associated with the analyses of existing data described in this proposal involves the potential for a breach of confidentiality.

#### *E.2.b Adequacy of Protection Against Risks*

*E.2.b.1 Recruitment and informed consent.* The proposed analyses of existing data do not involve contact with research subjects and we therefore will have no role in recruitment and consent. Previously, informed consent was obtained for all IDA data collections.

*E.2.b.2 Protections against risk.* The IDA database contains sensitive information about individuals that needs strong protection against risks for misuse. The database and confidentiality measures have been approved by the Swedish Data Inspection Board, by the ethics committee at the Swedish Council for Research in the Humanities and Social Sciences, and by the ethics committee at the Örebro County Regional Hospital. Participation in the project is voluntary and all participants have been informed of that and that they have the right to withdraw from the project at any time.

The only identification of subjects is by a code number with the key locked in a safe to which only two persons have access. No information is ever published that allows for the identification of an individual. Currently, about 15 projects are active using IDA data and only completely anonymized data are disseminated to researchers outside the core project in Stockholm.

#### *E.2.c Potential Benefits of the Proposed Research to Human Subjects and Others*

There are no immediate benefits of the proposed analyses of existing data to the IDA research subjects.

#### *E.2.d Importance of the Knowledge to be Gained*

The IDA longitudinal study of individual development and adaptation is part of this application's four-country look at the links between childhood and adolescent skills and behaviors on the one hand and career success, criminality and adult health on the other. Its longitudinal data, combined with a life-span approach, will provide solid knowledge about childhood factors that promote good adult adjustment and protect against bad outcomes. Benefits from the research include implications for the timing of child and youth policies such as educational tracking and behavioral interventions as well as for when the outcomes of early interventions should properly be measured.

The special contribution of the Swedish subproject in relation to the aims of the proposed project is mainly in the following three areas:

(1) The high quality of the initial IDA sample and a favourable Swedish survey climate has led to that follow-up data from childhood to adult age have a low attrition rate. Access to register data without any drop out also means that drop out bias can be estimated and perhaps corrected. In the USA, sample attrition tends to be a more serious problem and the whole project is strengthened by that some sub projects, especially the Swedish and Finnish ones, can analyze fairly representative samples.

(2) The Swedish educational system is quite different from the American one and Sweden's social structure and parameters are also different. This means, for instance, that communality of results between Sweden and the USA increases the generalizability of the findings.

(3) In Sweden there are ongoing discussions about how to improve the educational system, both with regard to the degree of emphasis that should be given to core school subjects like Swedish and Mathematics and with regard to methods for improving school class climate and educationally relevant behaviors. It is in

this context crucial to learn more about the long-term implications of early achievement and behaviors. Here the proposed project promises to make an important contribution.

### **E.3 Inclusion of Women and Minorities**

All six of the datasets used in our proposed studies are drawn from population-based sample and include approximately equal numbers of males and females. Although initially aged 7-10, the sample children in all of the studies are followed into adulthood, which provides full representation of the women that the female children have become.

The British, Swedish and Finnish populations have very small numbers of minorities in their population. As a result, there are virtually no minorities in these studies. For the two U.S. datasets, one is drawn from a national sample and the other from heavily minority Baltimore public schools, which provides substantial numbers of African-American sample members.

### **E.4 Targeted/Planned Enrollment Tables**

Targeted/planned enrollment tables for the six datasets are appended to this research plan.

### **E.5 Inclusion of Children**

Children, initially ages 7-10, are the focal subjects of all six studies and are therefore fully included in all of the datasets.

### **F. VERTEBRATE ANIMALS**

Not applicable

### **G. SELECT AGENT RESEARCH**

Not applicable

### **H. INVESTIGATORS**

**Greg Duncan**, Distinguished Professor at the University of California, Irvine is the PI of this subproject. His general biography is presented in his biosketch and the Introductory Overview sections of this program project application. Of special relevance for this subproject is Duncan's experience working with a number of interdisciplinary research networks on topics related to child development and prior CAPCA-based work on school readiness and later achievement" as well as the book chapter "The Role of Child Skills and Behaviors in the Intergenerational Transmission of Inequality: A Cross-National Study" (Duncan et al., forthcoming). Duncan will assume overall responsibility for the substantive and management goals of the project. As director of the overall program project, Duncan is ideally suited to ensure that this project's connections to the other projects are maximized. He will also direct Aim 1 descriptive analyses, and co-direct analyses associated with Aims 2, 3 and 4.

**Lars Bergman** is Professor, Head of the Laboratory for Developmental Science, and Head of the research program Individual Development and Adaptation at the University of Stockholm. He directs the Individual Development and Adaptation (IDA), which is perhaps the largest longitudinal program within psychology in the Nordic countries. Bergman's research includes the study of the adaptation process in a life-span perspective as well as theoretical and methodological research relating to the longitudinal approach. Bergman will direct of all of the IDA analyses in the project and will be a principal advisor for Aim 2 and Aim 4's conceptual models of the linkages between middle-childhood, adolescence and adulthood.

**Kathryn Duckworth** is a Post-Doctoral Research Fellow in the Department of Quantitative Social Science at the Institute of Education, University of London. In 2005, Kathryn was based at the University of Michigan working as Visiting Scholar in CAPCA, Institute of Social Research and remains a Research Associate of this group. Her research interests include the intergenerational transmission of education in the family and its effects on achievement and adult success, children's school readiness, progress and attainment during school, as well as the role of self-regulation in learning and the amenability of low attainment to policy leverage. She has written numerous reports for various UK Government departments including the Department for Education and Skills (now DCSF), the Treasury, and the No. 10 Strategy Unit. Duckworth will be in charge of all of the BCS analyses in the project and a principal advisor for Aim 2's analyses of linkages between middle-childhood skills and behaviors and adult attainment outcomes.

**Katja Kokko** is Academy Research Fellow, Department of Psychology, University of Jyväskylä, Finland. Her research interests include risk and protective factors in life-span psychological and social development, continuity of socio-emotional behavior over time, the structure and formation of adaptive individual functioning, and the timing of life events. She is co-PI of the Finnish Jyväskylä Longitudinal Study of

Personality and Social Development. Kokko's analyses based on JYLS data have identified, for example, early risk and protective factors for subsequent psychological (e.g., well-being, identity) and social functioning (e.g., long-term unemployment, career stability), patterns of continuity (of, e.g., aggression) across time, various components of well-being, and the role of timing of life events on individuals' functioning. The analysis of the JYLS dataset through CAPCA has produced several publications on the child, adolescent, and young adulthood predictors of mid-adulthood aggression (see her bio-sketch). Kokko will be in charge of all of the JYLS analyses in the project and a principal advisor for Aim 2's analyses of linkages between middle-childhood skills and behaviors and adult attainment and crime outcomes.

**Katherine Magnuson** is an Associate Professor of Social Work, and Associate Director of the Institute for Poverty Research, University of Wisconsin-Madison. Dr. Magnuson studies the wellbeing and development of economically disadvantaged children and their families, with a particular focus on academic achievement. Magnuson has expertise in the rigorous analysis of large longitudinal datasets. Specifically, she has worked extensively with the National Longitudinal Study of Youth 1979 Maternal and Child Study (NLSY79) and the Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K). Her analysis of these datasets has resulted in numerous publications, including several CAPCA-based collaborations. Most recently she has been working on projects that use these data to examine the progression of early skill and socio-economic disparities throughout childhood. The combination of her substantive knowledge about developmental processes and her research expertise with the NLSY79 make her an extremely valuable collaborator for this project. Magnuson will be in charge of all of the NLSY analyses in the project and a principal advisor for Aim 2's analyses of linkages between middle-childhood skills and behaviors and adult attainment and crime outcomes.

**Thomas McDade** is an Associate Professor of Anthropology, Director of the Laboratory for Human Biology Research and Associate Director of Cells to Society: The Center on Social Disparities and Health at Northwestern University. He also received a Presidential Early Career Award for Scientists and Engineers (PECASE), and has contributed to two National Academy of Sciences panels on collecting and utilizing biological indicators in survey-based research. His research focuses on the impact of social, economic, and cultural transitions on child/adolescent health in lowland Bolivia, the long term effects of undernutrition and infectious disease in infancy on health in adulthood in the Philippines, and the impact of social stressors on mental and physical health in the US. He applies an ecological, life course framework to understand the factors that shape trajectories of health, and in recent work he has shown that prenatal and early postnatal environments are important determinants of immune function and inflammation in adolescence and young adulthood. McDade will co-direct, with Duncan, the Aim 4 analyses of the extent to which teen health risk behaviors account for the link between early skills and adult health.

**Candice Odgers** is an Assistant Professor of Psychology and a William T. Grant Foundation Scholar. Odgers is trained as a developmental and quantitative psychologist, but has also received training in psychiatric genetics and criminology. Her research focuses on the developmental course of externalizing (i.e., disruptive) disorders, with an emphasis on physical-health outcomes and early initiation of substance use. To answer questions related to how children and adolescents navigate important developmental transitions, Odgers applies longitudinal models designed to facilitate causal inference and identify mechanisms of change. Her research optimizes the fit between advances in longitudinal modeling and developmental theory. During the past 36 months, Odgers has been the Co-PI on two large grants from the Canadian Institutes of Health Research and has been awarded 3 multi-year grants from the National Institutes of Aging, the William T. Grant Foundation, and the National Institute of Child Health and Development. For the current study, Odgers will co-direct, with Duncan and Schulenberg, Aim 2's analyses of crime outcomes and will be a principal advisor for Aim 3's analyses of the extent to which adolescent skills and behaviors mediate the explanatory power of middle childhood skills and behaviors in predicting adult outcomes.

**John Schulenberg** is a Professor in the Department of Psychology and Research Professor at the Institute for Social Research, the University of Michigan. He has published widely on several topics concerning psychosocial development across adolescence and into early adulthood, focusing on how developmental transitions and tasks relate to health risks and adjustment difficulties over time. His current research is on the etiology of substance use and psychopathology, focusing on continuity, discontinuity, and co-morbidity across adolescence and adulthood. Schulenberg is Co-PI of the NIDA-funded national Monitoring the Future study, which will be analyzed in Project II. Several recent efforts have been aimed at the understanding of long-term linkages across the life span (see his bio-sketch). Schulenberg will co-direct, with Duncan and Odgers, Aim 3's analyses of the extent to which adolescent skills and behaviors mediate the explanatory power of middle

childhood skills and behaviors in predicting adult outcomes.

**Sharon Simonton** is a Research Investigator at the Institute for Social Research, University of Michigan. Simonton is a social epidemiologist and her research interests include socioeconomic and racial/ethnic health disparities, life course and contextual determinants of health and health inequalities, and social, economic, and structural determinants of population health. Of special relevance for this project, she has extensive experience with advanced statistical methods and working with large complex sample survey datasets and presented a conference paper using data from the NCDS examining relationships between socioeconomic adversity and academic achievement during middle childhood. Simonton will be in charge of all of the NCDS analyses in the project and a primary advisor for Aim 3's analyses of the extent to which adolescent skills and behaviors mediate the explanatory power of middle childhood skills and behaviors in predicting adult outcomes.

## **I. CONSORTIUM/CONTRACTUAL ARRANGEMENTS**

Subcontracts will be implemented with Co-Investigators Duckworth, Kokko, Magnuson, and Simonton, and with Advisor Karl Alexander for his assistance with the Beginning Schools Study dataset. We will implement consultant agreements with Bergman, McDade, and Schulenberg, and with Molly Metzger to conduct analyses of the Individual Development and Adaptation dataset.

Seven of the key personnel in our proposal (Bergman, Duckworth, Duncan, Kokko, Magnuson, Schulenberg and Simonton) are members of the Center for the Analysis of Pathways from Childhood to Adulthood (CAPCA). This NSF-funded Developmental Sciences Center is housed at the University of Michigan and has brought together investigators from 20 multi-disciplinary national and international longitudinal projects to work collaboratively on analyses aimed at answering some of the key questions about how children's environments affect their development. Formed in 2002, CAPCA has provided an infrastructure for group meetings and methods training. CAPCA is funded for a total of ten years, the last of which roughly coincides with the third year of our proposed project period. After six consecutive years of CAPCA-related group interactions, group members know one another and each others' datasets fairly well.

CAPCA provides several very helpful infrastructure elements: i) it funds travel and per diem expenses for one or two face-to-face meetings each year; ii) it provides training in advanced statistical techniques and advice to graduate student research assistants; and (iii) it offers research assistance for tasks such as multiple imputation for research groups requiring that assistance.

Thus, for the first three of the five years of the project, the key personnel will meet once or twice a year to review progress on our analyses and plan next steps. Odgers and McDade will join these meetings by phone. We intend to supplement these meetings with one additional meeting each year, to be held in Irvine, which will provide the group a chance for yet more planning as well as interacting with the Irvine-based members of the network.

## **J. LETTERS OF SUPPORT**

Letters of collaboration from the subcontracting investigators, and letters of support from the consultants, are appended to this research plan.

## **K. RESOURCE SHARING PLAN**

Four of the datasets involved in this project are or will soon be available to the general research community: the Baltimore Beginning School Study, the National Longitudinal Survey of Youth, the National Child Development Survey and the British Cohort Study. Existing data will be analyzed; no new data will be collected.

The datasets from the Swedish Study of Individual Development and Adaptation and the Finnish Jyväskylä Longitudinal Study of Personality and Social Development have been compiled in accordance with strict country-specific data protection laws. Release of these data to outside researchers is impossible.