Childhood Instability Predicts Educational Attainment*

Andrew Caplin
New York University

Nora C. Harhen
New York University

Catherine A. Hartley
New York University

Ida Maria Hartmann†
University of Copenhagen

Søren Leth-Petersen
University of Copenhagen

Johan Sæverud
University of Copenhagen

October 1, 2026

Abstract

Educational attainment is a major determinant of health, wealth, and relationship quality, making it key for human flourishing. A diverse set of major childhood disruptions are known to predict poorer academic performance. Here we propose that childhood unpredictability constitutes a latent dimension of early-life environments underpinning these effects, suggesting everyday instability, in addition to major disruptions, should determine educational success. To test this hypothesis, we link population-wide Danish administrative records with a validated survey measure to quantify individuals' life disruptions, both major and minor. Among 2,793 respondents, greater unpredictability is associated with lower grade point averages and reduced high school completion, even after accounting for parental socioeconomic status and observed major life disruptions. Our finding that childhood unpredictability alters educational success, suggests a pathway through which disadvantage may be transmitted across generations and highlights everyday unpredictability as a potential target for interventions aimed at improving social mobility.

*The work presented in this paper benefited from financial support from the Center for Economic Behavior and Inequality (CEBI), a center of excellence at the University of Copenhagen, financed by grant DNRF134 from the Danish National Research Foundation.

†Corresponding Author: imh@econ.ku.dk

Introduction

Education is a major predictor of later-life well-being. Individuals with more education earn higher incomes, have better physical and mental health, and report closer social relationships[1–3]. Given this broad range of benefits, understanding what enables an individual to succeed in primary and secondary school and motivates them to pursue higher education is critical to promoting flourishing across the population. An extensive literature has established that major adverse childhood experiences, such as poverty, parental divorce, and parental death, are associated with worse educational outcomes[4–7]. However, we still lack a comprehensive understanding of the factors that drive children's educational attainment. One possibility is that the experiences identified thus far matter because they share a common latent variable. Identifying this variable could reveal an even broader class of childhood experiences relevant for shaping educational outcomes and clarify how and why these experiences produce their effects.

We propose childhood predictability as one candidate latent variable underlying the experiences already known to shape educational outcomes. Unpredictability can arise from major disparate events, such as parental divorce or death, as well as from subtler disruptions to daily life. These include irregular morning and bedtime routines, high levels of household commotion, inconsistent rules or discipline, frequent changes in residence or schools, fluctuations in parental mood, and instability in food or financial circumstances. Causal evidence for the importance of predictability during childhood comes from rodent models, in which unpredictable maternal behavior alters the maturation of brain systems that govern motivated behavior, emotion regulation, and memory[8–14]. Human studies have found similar associations[15–19]. Beyond what has been observed empirically, normative models further predict that unpredictability should reduce goal-directed, proactive behavior[20–24], abilities foundational to educational success[25]. When the longer-term consequences of actions are difficult to anticipate, the effort associated with goal-directed behavior may be less worthwhile[26]. Together, these findings suggest a mechanism by which early-life unpredictability

could shape educational outcomes.

Here, we test whether childhood experiences of unpredictability, both major and ordinary, are associated with poorer academic outcomes. We use a unique dataset from a large cohort of young adults in Denmark that combines population-wide administrative records with the Questionnaire of Childhood Unpredictability (QUIC)[27], a 38-item retrospective measure of social, emotional, and physical unpredictability during childhood. The administrative records provide objective measures of major life disruptions, including parental divorce and unemployment; academic outcomes, including ninth-grade GPA and high school completion; and key covariates, including parental education and household income. The QUIC complements these records by capturing aspects of childhood unpredictability that administrative data largely miss, including the stability of daily routines and the reliability and emotional stability of caregivers. By bringing together these measures, we can estimate the distinct associations of major destabilizing events and everyday unpredictability to educational outcomes, assessing whether accounting for both helps narrow the predictive gap.

Research Transparency Statement

Conflicts of interest: All authors declare they have no conflicts of interest. **Funding:** This research benefited from financial support from the Center for Economic Behavior and Inequality (CEBI), a center of excellence at the University of Copenhagen, financed by grant DNRF134 from the Danish National Research Foundation. The funders did not have any role in study design, implementation, analysis, reporting or interpretation. The funders did not have any role in study design, implementation, analysis, reporting or interpretation. **Artificial intelligence:** No artificial intelligence assisted technologies were used in this research or the creation of this article. **Ethics:** This research received ethics approval from Statistics Denmark. **Preregistration:** No aspects of this study were preregistered. **Materials:** All study materials are provided in the Supplementary Material. **Data:** Access to the primary data is restricted. The micro data set used in the paper combines survey data with

administrative data from government registers, merged by Statistics Denmark using social security numbers. The data use is subject to the European Union's General Data Protection Regulation (GDPR) per Danish regulations. The data are physically stored on computers at Statistics Denmark and, due to security considerations, the data may not be transferred to computers outside Statistics Denmark. In general, researchers interested in obtaining access to micro data at Statistics Denmark are required to submit a written application to gain approval from Statistics Denmark. Applications can be submitted by researchers who are affiliated with Danish institutions accepted by Statistics Denmark, or by researchers outside of Denmark who collaborate with researchers affiliated with these institutions. The procedure is described by Statistics Denmark at www.dst.dk/en/TilSalg/Forskningsservice. **Analysis scripts:** Analysis scripts will be shared in a public GitHub repository.

Methods

Participants

We invited a random sample of 19,390 individuals born in 2004 and recorded in the Danish population registry to participate in an online survey. The registry contains a unique personal identifier (CPR number) for all individuals born in Denmark or residing at an address in Denmark. Using these identifiers, we distributed survey invitations through an official email (E-boks) that all residents in Denmark have. Of those invited, 2,793 fully completed the survey. Invitations were sent in May 2025, and the survey remained open for three weeks. During this time, we sent one reminder two weeks after the initial invitation. To encourage participation, respondents were informed that upon completing the full questionnaire, they would be automatically entered into a prize draw for ten gift cards worth DKK 1,000[1] each and one gift card worth DKK 10,000.

Respondents differed modestly from the full population in terms of academic performance

[1] 1,000 DKK 150 USD.

and parental socioeconomic status, tending to fare better (cf. Table S3). However, these differences were small, and the sample remained broadly representative of the population. On average, respondents had a GPA of 8.33, with a slightly higher median of 8.5 (Figure S5). The majority, of respondents (75 pct.) have a GPA of 7 or higher.

Danish Administrative Records

Upon completion of the survey, we linked respondents' survey responses to the Danish administrative registries using their personal identifiers. The administrative records include standard demographic information, such as age, gender and household composition. The latter allows us to identify parents and siblings. The data further include annual information about education, income and wealth. All the administrative data are longitudinal by nature and are currently available up to and including 2022.

Academic Performance

The Danish administrative data contains records of all grades received by Danish students. Danish students first receive their grades in 8th grade and complete their first final examinations at the end of 9th grade, marking the end of lower secondary education. After lower secondary school, students may enter either general upper secondary education, which primarily prepares them for higher education, or vocational upper secondary education, which primarily prepares them for a specific trade or industry. We measure academic achievement using 9th-grade grades because 9th grade is the final year in which all Danish students remain in compulsory schooling and are evaluated on a common grading scale. Students receive teacher-assessed grades reflecting general proficiency in each subject, as well as examination grades in a subset of subjects. All students are required to sit for exams in Danish, English, Mathematics, and Science and complete two additional examinations selected by lottery. We calculate each student's GPA using all available teacher-assessed and examination grades. Grades are assigned on the Danish seven-point scale: –3, 00, 02, 4, 7, 10, and 12. The first

two grades, –3 and 00, are failing grades; the remaining five are passing grades.[2]

Mental Health

In addition to academic outcomes, we considered respondents' mental health for two reasons. First, mental health is a strong predictor of educational outcomes[28] and may therefore account for variation in academic achievement. Second, prior work has linked early-life unpredictability to self-reported symptoms of anxiety and depression[19,27]. Our data allow us to test whether these associations extend to clinically recognized anxiety and depression in a considerably larger sample.

The administrative data contain comprehensive health records, which we use to determine whether a respondent has ever received a clinical diagnosis of anxiety or depression or had a hospital visit for which anxiety or depression was recorded as the primary reason. Our measures therefore capture the presence of clinically recognized anxiety or depression, rather than symptom severity.

Self-report Measures

The Questionnaire of Unpredictability in Childhood

We measured self-reported childhood unpredictability using the Questionnaire of Unpredictability in Childhood (QUIC), designed by[27]. The QUIC includes 38 questions, designed to capture experiences of social, emotional, and physical unpredictability prior to age 18, with some questions focusing on events occurring before age 12. Items cover five different domains; Parental Involvement (9 items), Parental Predictability (12 items), Parental Environment (7 items), Physical Environment (7 items), and Safety and Security (3 items). Respondents agree or disagree to each item, after which an aggregate score is calculated.

[2]More information can be found at the Danish Agency for Higher Education and Science's website: https://ufsn.dk/english/education/the-danish-education-system/grading-system/

QUIC scores range from 0 to 38, with higher scores indicating more unpredictability.

Mental health measures

To gain a more graded measure of mental health symptoms than what can be obtained from the administrative records, we measured mental health using self-report measures as well using two widely validated instruments. Anxiety symptom severity was measured using the Generalized Anxiety Disorder scale (GAD-7). Respondents completed a battery of seven questions (listed in table S1). Each item is scored from 0 to 3, corresponding to the response categories "not at all," "several days," "more than half the days," and "nearly every day." Summing across items yields a total GAD-7 score ranging from 0 to 21, which can be categorized as follows: 0–4 = minimal anxiety, 5–9 = mild anxiety, 10–14 = moderate anxiety, and 15–21 = severe anxiety.

Depression symptom severity was measured using the Patient Health Questionnaire (PHQ-9), a screening tool for depressive symptoms (listed in table S2). We excluded one item on suicidal thoughts because we administered the instrument online, and thus lacked a means to rapidly intervene had an individual endorsed suicidal ideation or intent. Responses were scored analogously to the GAD-7, with values 0–3 assigned to the four response categories. The total score thus ranges from 0 to 24 across the eight items, and is categorized as 1–4 = minimal depression, 5–9 = mild depression, 10–14 = moderate depression, 15–19 = moderately severe depression, and 20–24 = severe depression.

Cognitive Abilities

Approximately half of the respondents had previously participated in the January 2024 wave of the Copenhagen Life Panel (CLP) [29]. The CLP is an online survey administered annually in Denmark to a random selection of individuals aged 20–70 from the Danish population registry. In 2024, the CLP elicited several measures of cognitive ability among younger participants. Using unique personal identifiers, we link the QUIC survey responses to these

cognitive scores for the subset of respondents (1,098 respondents) who participated in both surveys.

The CLP measured three dimensions of cognitive ability: cognitive reflection, abstract reasoning and probabilistic reasoning. Cognitive reflection was measured using six items modeled after the Cognitive Reflection Test (CRT). These questions are designed to trigger an immediate but incorrect intuitive response, with correct answers requiring suppression of intuition and more deliberate reasoning. Probabilistic reasoning and statistical numeracy were measured through a set of four problems requiring the application of probability rules, conditional reasoning, and Bayesian updating. Unlike the CRT items, these tasks do not rely on misleading intuitions but instead test whether respondents can apply statistical principles correctly. Abstract reasoning was measured using five Raven's Progressive Matrices, a widely used test of fluid intelligence. Respondents are shown a visual pattern with a missing piece and asked to identify the correct option to complete it. This task captures fluid reasoning, abstract problem-solving, and working memory, and is independent of language and formal education. While Raven's Progressive Matrices test consists of 60 items, we included only five that have been shown to predict the total Raven's score with high accuracy [30]. Together, these tasks capture complementary dimensions of cognitive ability. The cognitive reflection items assess individuals' tendency to engage in deliberate reasoning rather than relying on intuitive responses. Raven's Progressive Matrices provide a benchmark measure of fluid intelligence and abstract problem-solving. The probabilistic reasoning tasks evaluate the ability to apply statistical principles and reason under uncertainty. Linking these measures with the QUIC allows us to examine whether childhood unpredictability predict academic performance above and beyond what can be explained by cognitive abilities.

Statistical Analyses

Childhood Unpredictability and Academic Performance

To examine whether experiences and perceived unpredictability in childhood predict academic performance, we consider different educational outcomes (9th grade GPA and high school completion). For each of these, we estimate equation 1,

$$Y_i = \beta_0 + \beta_1 QUIC_i + \beta_2 \mathbf{X}_i + \beta_3 \mathbf{Z}_i + \varepsilon_i \tag{1}$$

where $QUIC_i$ is individual i's QUIC score, standardized to have mean 0 and standard deviation 1. $\mathbf{X}_i$ is a vector of socioeconomic controls, parental gross income and parental education. Finally, $\mathbf{Z}_i$ is a vector of childhood experiences that may increase potential exposure to unpredictability, taken from the administrative data, including parental split, parents' number of partners, parental death, number of residential addresses, number of schools, parental unemployment and parental mental health issues.

Controlling for Cognitive Abilities

As described in Section S1.1.3, cognitive ability measures are available for a subset of respondents. In this appendix, we examine whether the predictive relationship between childhood unpredictability and educational outcomes is robust to controlling for these measures. Specifically, we estimate a modified version of equation 1, in which we augment the baseline specification with a vector of cognitive ability measures, CA_i,

$$Y_i = \delta_0 + \delta_1 QUIC_i + \delta_2 \mathbf{X}_i + \delta_3 \mathbf{Z}_i + \delta_4 \mathbf{CA}_i + \varepsilon_i \tag{2}$$

Childhood Unpredictability and Mental Health

To examine whether the relationships shown in S9 when controlling for socioeconomic status and parental mental health, we estimate the following relationship:

$$MH_i = \beta_0 + \beta_1 QUIC_i + \beta_2 \mathbf{X}_i + \varepsilon_i \tag{3}$$

in which MH_i is individual i's mental health outcome of interest, $QUIC_i$ is the individual's QUIC score and $\mathbf{X}_i$ is a vector of controls, including the individual's gender, their parents' average gross income during the individual's childhood, their parents' education measured in years and their parents' mental health, measured by the same binary indicators for anxiety and depression as described in Section S1.2.

Results

Validation of self-reports

With this dataset, we first sought to validate self-reported experiences of childhood unpredictability. By linking QUIC survey responses to Danish administrative data, we test whether participants' retrospective reports align with objective records of their life events. Because the QUIC relies on recall, such reports could be vulnerable to memory or reporting biases. Nevertheless, we find strong concordance between self-reports and administrative data. Records show clear differences between participants who endorsed having specific destabilizing experiences and those who did not. For example, participants who reported frequent school changes attended more schools, those who reported moving more often lived at a greater number of unique residential addresses, and those who reported that a parent had many romantic partners had parents who cohabited with a greater number of unique adults (Fig. 1, B). While changes in school, address, and parental partners are likely to be salient to children, we also observe concordance for experiences that may be less evident. For instance, participants who

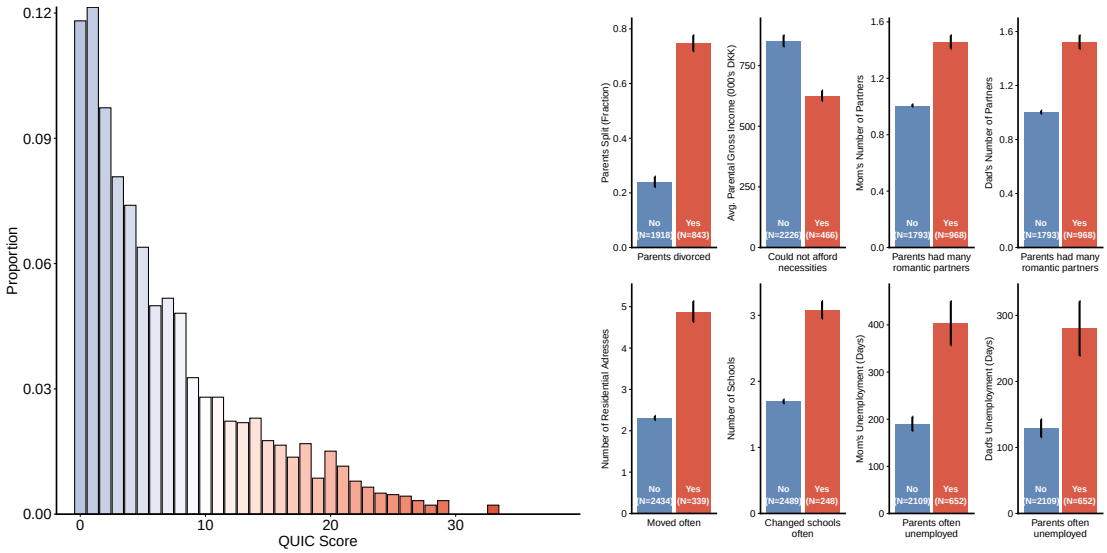


Figure 1: **Validation of self-reported childhood unpredictability.** A. Distribution of QUIC scores across respondents, showing substantial variation in reported childhood unpredictability. Bar colors indicate QUIC score, ranging from blue at lower scores to red at higher scores. B. Administrative records are compared with participants' responses on the QUIC. Red bars indicate the mean number of documented events or outcomes among respondents who endorsed a given QUIC item, with error bars indicating 95 % confidence intervals; blue bars indicate the mean among those who did not. All QUIC items refer to experiences occurring before age 18. Consistent with a high degree of reporting accuracy, endorsement of QUIC items was associated with a higher frequency of corresponding administrative events, with the exception of reverse-coded items for which the pattern reversed.

reported that their parents experienced a period of involuntary unemployment had parents who were, on average, unemployed for nearly one year longer than parents of participants who did not. Together, these patterns provide evidence that respondents reliably recalled and reported key aspects of their childhood.

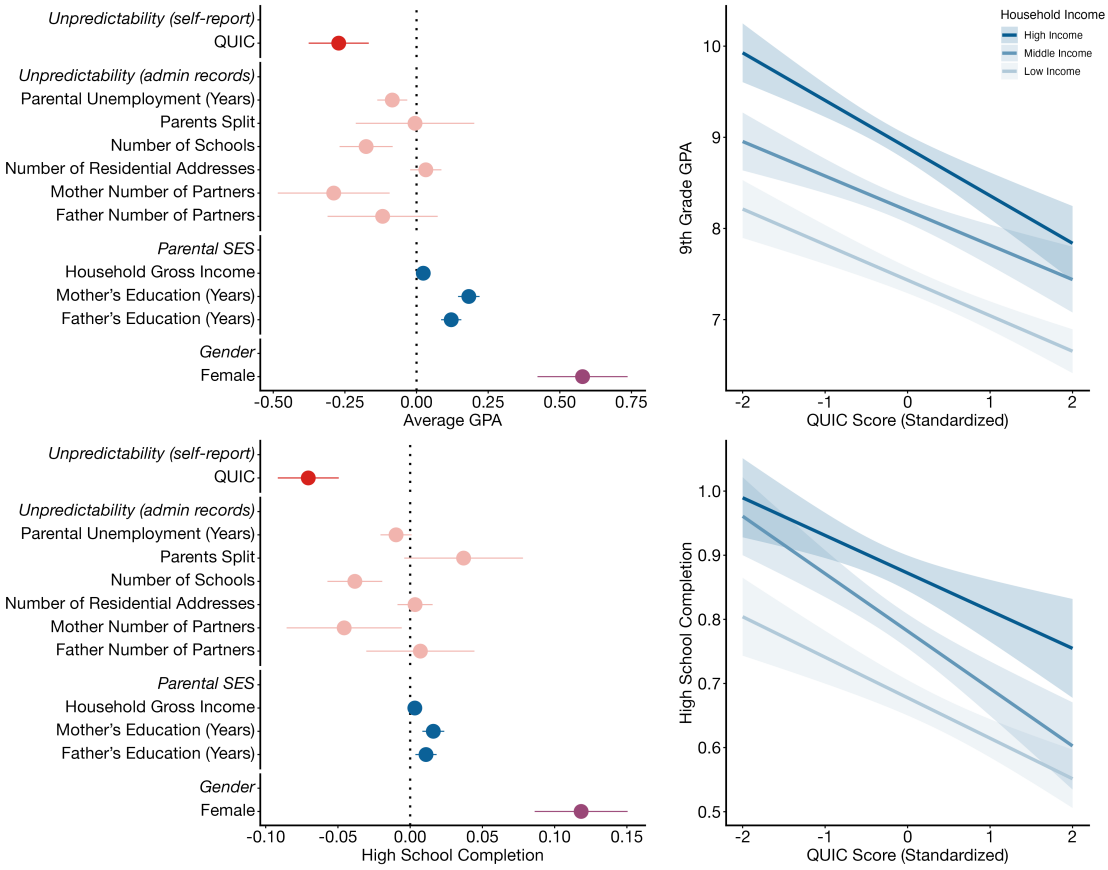


Figure 2: **Childhood unpredictability predicts educational outcomes.** Estimates from regression models relating ninth-grade grade point average and high school completion to standardized QUIC scores. Models include traditional indicators of parental socioeconomic status (income and education) and objective administrative measures indexing likely exposure to unpredictability, including parental separation, parental death, number of parental romantic partners., measured over ages 0–18. Estimates are also presented in table S6. We standardized QUIC scores to have mean 0 and standard deviation 1. Greater childhood unpredictability is associated with lower academic performance and reduced high school completion, even after accounting for these factors.

Unpredictability predicts educational attainment

We next examined whether childhood unpredictability predicted academic performance after controlling for parental socioeconomic status (i.e., income and education) and major disrup-

tive childhood events. As expected, parental income and education were strong predictors of academic outcomes, as were a subset of objectively measured events. But even with this comprehensive set of controls, QUIC persisted in predicting both ninth-grade grade point average (GPA) and high school completion (Fig. 2). The magnitude of these effects was substantial: a one-SD increase in QUIC score was associated with a 0.3-point reduction in GPA and a 7%-point lower probability of high school completion. For comparison, a 1.2 SD decrease in average annual household income would produce a comparable effect. Demonstrating the robustness of these effects, they persisted across a wide range of model specifications and after controlling for cognitive ability and parental mental health (see supplemental materials). This suggests that childhood unpredictability captures a distinct and consequential aspect of early-life environments that standard measures of disadvantage or major life disruptions neglect.

Discussion

Our findings demonstrate that both major life changes and everyday disruptions negatively impact educational attainment. These results align with those from epidemiology and psychiatry, where chronic daily stressors predict mental and physical health outcomes as strongly as major life traumas[31,32] with some even proposing that these acute traumas exert their long-term effects *through* their disruptions to everyday routines[33]. Likewise, in our data, administrative records capture major events that signal potential exposure to unpredictability, whereas QUIC scores summarize individuals' day-to-day experiences of unpredictability across childhood. Although related, these measures need not align. For example, two children may both experience parental divorce but the effects of these events on daily routines and close relationships may greatly differ. Administrative records would predict similar outcomes for these children. By measuring everyday disruptions, the QUIC provides a more complete account of childhood unpredictability, helping to explain disparities in academic achievement that remain unexplained by traditional socioeconomic indicators or administrative records

alone.

Our findings suggest that childhood predictability is a critical determinant of educational outcomes. While QUIC represents a summary measure of childhood instability, experienced instability could, in principle, be documented in many other types of data. Smartphones and wearable devices offer opportunities for continuous, objective measurement of individuals' locations and interactions with others over extended durations of time[34–36]. Such data could reveal the presence–or absence–of stable routines, including regularly visited locations at particular times of day and in a certain order, as well as exposure to novel contexts and people. These technologies could provide unprecedented resolution for measuring fluctuations and stability in daily life during critical developmental periods.

Our results contribute to a growing cross-disciplinary literature demonstrating that individual differences in decision making reflect differences in personal history. Past personal exposure to financial shocks or high unemployment rates reduces financial risk taking and overall consumption[37–39]. Variation in childhood environments predicts differences in exploration, risk taking, and time preferences in experimental tasks designed to index specific cognitive mechanisms[40–42]. Here, we extend this literature by demonstrating that early-life experience also predicts educational attainment.

Our findings suggest a potential pathway through which disadvantage may be transmitted across generations. Animal models in neuroscience provide causal evidence that low-resource environments increase caregiver instability[8]. Theoretical accounts from developmental psychology and evolutionary biology propose that such environmental instability disrupts the development of skills[20–24,43] including motivation, perseverance, and planning that have long been emphasized as essential for long-term educational and career success[44,45]. Consistent with this, we find that early-life unpredictability predicts less academic achievement, even in Denmark, a country that invests heavily in equalizing educational opportunity. Because academic performance strongly shapes later income and employment stability[44–46], childhood instability may reduce the prospects for upward social mobility.

Our results indicate that promoting childhood stability may be a powerful lever for improving long-term economic outcomes. The success of early childhood interventions such as Head Start, the Perry School Project, and the Abecedarian Project may stem in part from their capacity to reduce early-life unpredictability. These programs offer reliable childcare, structured school routines, and consistent access to food; Head Start programs additionally provide caregivers with resources to obtain stable employment, housing, and medical care. Future interventions could build on these projects' approach by not only increasing parents' access to work but also the stability of their work schedules[47], enabling them to develop structured routines at home. More generally, helping families establish consistent daily routines, traditions, and rituals may be a promising and low-cost avenue for intervention[48]. Given the magnitude of the associations we observe between early-life unpredictability and educational attainment, even modest reductions in instability could disrupt the intergenerational transmission of inequality.

References

[1] Zajacova, A. & Lawrence, E. M. The relationship between education and health: Reducing disparities through a contextual approach. *Annu. Rev. Public Health* **39**, 273–289 (2018).

[2] Hout, M. Social and economic returns to college education in the united states. *Annu. Rev. Sociol.* **38**, 379–400 (2012).

[3] Kondirolli, F. & Sunder, N. Mental health effects of education. *Health Econ.* **31 Suppl 2**, 22–39 (2022).

[4] Astone, N. M. & Mclanahan, S. S. Family Structure, Parental Practices and High School Completion. *American Sociological Review* **56**, 309–320 (1991).

[5] Corak, M. Death and Divorce: The Long-Term Consequences of Parental Loss on Adolescents. *Journal of Labor Economics* **19**, 682–715 (2001).

[6] McLanahan, S., Tach, L. & Schneider, D. The Causal Effects of Father Absence. *Annual Review of Sociology* **39**, 399–427 (2013).

[7] Rege, M., Telle, K. & Votruba, M. Parental Job Loss and Children's School Performance. *Review of Economic Studies* **78**, 1462–1489 (2011).

[8] Baram, T. Z. *et al.* Fragmentation and unpredictability of early-life experience in mental disorders. *Am. J. Psychiatry* **169**, 907–915 (2012).

[9] Ivy, A. S., Brunson, K. L., Sandman, C. & Baram, T. Z. Dysfunctional Nurturing Behavior in Rat Dams with Limited Access to Nesting Material: A Clinically Relevant Model for Early-Life Stress. *Neuroscience* **154**, 1132–1142 (2008).

[10] Rice, C. J., Sandman, C. A., Lenjavi, M. R. & Baram, T. Z. A Novel Mouse Model for Acute and Long-Lasting Consequences of Early Life Stress. *Endocrinology* **149**, 4892–4900 (2008).

[11] Bolton, J. L. *et al.* Early-life adversity facilitates acquisition of cocaine self-administration and induces persistent anhedonia. *Neurobiol Stress* **8**, 57–67 (2018).

[12] Bolton, J. L. *et al.* Anhedonia following early-life adversity involves aberrant interaction of reward and anxiety circuits and is reversed by partial silencing of amygdala corticotropin-releasing hormone gene. *Biol. Psychiatry* **83**, 137–147 (2018).

[13] Molet, J. *et al.* Fragmentation and High Entropy of Neonatal Experience Predict Adolescent Emotional Outcome. *Translational Psychiatry* **6** (2016).

[14] Johnson, F. K. *et al.* Amygdala hyper-connectivity in a mouse model of unpredictable early life stress. *Transl. Psychiatry* **8**, 49 (2018).

[15] Davis, E. P. *et al.* Exposure to Unpredictable Maternal Sensory Signals Influences Cognitive Development Across Species. *Proceedings of the National Academy of Sciences of the United States of America* **114**, 10390–10395 (2017).

[16] Davis, E. P. *et al.* Early Life Exposure to Unpredictable Parental Sensory Signals Shapes Cognitive Development across Three Species. *Frontiers in Behavioral Neuroscience* **16**, 1–10 (2022).

[17] Granger, S. J. *et al.* Aberrant maturation of the uncinate fasciculus follows exposure to unpredictable patterns of maternal signals. *J. Neurosci.* **41**, 1242–1250 (2021).

[18] Noroña-Zhou, A. N. *et al.* Unpredictable maternal behavior is associated with a blunted infant cortisol response. *Dev. Psychobiol.* **62**, 882–888 (2020).

[19] Spadoni, A. D. *et al.* Contribution of Early-Life Unpredictability to Neuropsychiatric Symptom Patterns in Adulthood. *Depress Anxiety* **39**, 706–717 (2022). URL `doi:10.1002/da.23277`.

[20] Frankenhuis, W. E., Panchanathan, K. & Nettle, D. Cognition in harsh and unpredictable environments. *Current Opinion in Psychology* **7**, 76–80 (2016).

[21] Moscarello, J. M. & Hartley, C. A. Agency and the Calibration of Motivated Behavior. *Trends in Cognitive Sciences* **21**, 725–735 (2017).

[22] Huys, Q. J. & Dayan, P. A Bayesian Formulation of Behavioral Control. *Cognition* **113**, 314–328 (2009).

[23] Munakata, Y., Placido, D. & Zhuang, W. What's Next? Advances and Challenges in Understanding How Environmental Predictability Shapes the Development of Cognitive Control. *Current Directions in Psychological Science* **32**, 431–438 (2023).

[24] Kool, W., Gershman, S. J. & Cushman, F. A. Cost-Benefit Arbitration Between Multiple Reinforcement-Learning Systems. *Psychological Science* **28**, 1321–1333 (2017).

[25] Heckman, J. J. Skill Formation and the Economics of Investing in Disadvantaged Children. *Science* **312**, 1900–1902 (2006).

[26] Lei, J., Olieslagers, J., Arfaei, N., Lin, D. & Ma, W. J. Human planning in stochastic environments. *PsyArXiv* (2025).

[27] Glynn, L. M. *et al.* Measuring Novel Antecedents of Mental Illness: The Questionnaire of Unpredictability in Childhood. *Neuropsychopharmacology* **44**, 876–882 (2019).

[28] Currie, J. & Stabile, M. Mental health in childhood and human capital. In Gruber, J. (ed.) *The Problems of Disadvantaged Youth*, 115–148 (University of Chicago Press, Chicago, 2009).

[29] Caplin, A., Gregory, V., Lee, E., Leth-Petersen, S. & Saeverud, J. Subjective Earnings Risk. *NBER Working Paper* **31019** (2024).

[30] Bilker, W. B. *et al.* Development of Abbreviated Nine-Item Forms of the Raven's Standard Progressive Matrices Test. *Assessment* **19**, 354–369 (2012).

[31] Kanner, A. D., Coyne, J. C., Schaefer, C. & Lazarus, R. S. Comparison of two modes of stress measurement: daily hassles and uplifts versus major life events. *J. Behav. Med.* **4**, 1–39 (1981).

[32] DeLongis, A., Coyne, J. C., Dakof, G., Folkman, S. & Lazarus, R. S. Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychol.* **1**, 119–136 (1982).

[33] Odgers, C. L. & Jaffee, S. R. Routine versus catastrophic influences on the developing child. *Annu. Rev. Public Health* **34**, 29–48 (2013).

[34] Harari, G. M. & Gosling, S. D. Understanding behaviours in context using mobile sensing. *Nat. Rev. Psychol.* **2**, 767–779 (2023).

[35] Onnela, J.-P. Opportunities and challenges in the collection and analysis of digital phenotyping data. *Neuropsychopharmacology* **46**, 45–54 (2021).

[36] Laurenceau, J.-P., DiGiovanni, A. M. & Bolger, N. Intensive longitudinal methods: Toward a psychological science of daily life. *Annu. Rev. Psychol.* **77**, 513–541 (2026).

[37] Malmendier, U. & Nagel, S. Depression Babies: Do Macroeconomic Experiences Affect Risk Taking? *Quarterly Journal of Economics* **126**, 373–416 (2011).

[38] Malmendier, U. & Nagel, S. Learning from inflation experiences. *Q. J. Econ.* **131**, 53–87 (2016).

[39] Malmendier, U. & Shen, L. S. Scarred Consumption. *American Economic Journal: Macroeconomics* **16**, 322–355 (2024).

[40] Xu, Y., Harms, M. B., Green, C. S., Wilson, R. C. & Pollak, S. D. Childhood unpredictability and the development of exploration. *Proc. Natl. Acad. Sci. U. S. A.* **120**, e2303869120 (2023).

[41] Amir, D., Jordan, M. R. & Rand, D. G. An uncertainty management perspective on long-run impacts of adversity: The influence of childhood socioeconomic status on risk, time, and social preferences. *J. Exp. Soc. Psychol.* **79**, 217–226 (2018).

[42] Lloyd, A., McKay, R. T. & Furl, N. Individuals with adverse childhood experiences explore less and underweight reward feedback. *Proc. Natl. Acad. Sci. U. S. A.* **119** (2022).

[43] Pepper, G. V. & Nettle, D. The behavioural constellation of deprivation: Causes and consequences. *Behav. Brain Sci.* **40**, e314 (2017).

[44] Heckman, J. J. & Mosso, S. The Economics of Human Development and Social Mobility. *Annual Review of Economics* **6**, 689–733 (2014).

[45] Currie, J. & Almond, D. Human capital development before age five. In *Handbook of Labor Economics*, vol. 4 of *Handbook of Labour Economics*, 1315–1486 (Elsevier, 2011).

[46] Chetty, R. *et al.* How Does your Kindergarten Classroom Affect your Earnings? Evidence from Project STAR. *Quarterly Journal of Economics* **126**, 1593–1660 (2011).

[47] Glynn, L. M., Liu, S. R., Lucas, C. T. & Davis, E. P. Leveraging the science of early life predictability to inform policies promoting child health. *Dev. Cogn. Neurosci.* **69**, 101437 (2024).

[48] Fiese, B. H. *et al.* A review of 50 years of research on naturally occurring family routines and rituals: cause for celebration? *J. Fam. Psychol.* **16**, 381–390 (2002).

Supplementary Material

for

Childhood Instability Predicts Educational Attainment

S1 Measures

S1.1 Survey

We invited a random selection of individuals who are recorded in the Danish population registry and born in 2004 to participate in an online survey. The Danish population registry contain a personal identifier (CPR-number) for all individuals who are born or who have an address in Denmark. Using this CPR-number, we sent out invitations to the survey through an official email (E-boks) that all residents in Denmark have. We invited 19,390 individuals to participate, and received 2,793 full responses. Invitations were sent out in May 2025 and the survey was open for three weeks. During this time, we sent out one reminder, two weeks after the first invitation. To encourage participation, the survey included a lottery-based incentive. Respondents were informed that, upon completing the full questionnaire, they would be automatically entered into a prize draw for ten gift cards worth DKK 1,000[3] each and one gift card worth DKK 10,000. As participants were not informed of the total number of invitees, they did not know their precise probability of winning the lottery.

S1.1.1 The Questionnaire of Unpredictability in Childhood

We measured self-reported childhood unpredictability using the Questionnaire of Unpredictability in Childhood (QUIC), designed by[27]. The QUIC includes 38 questions, designed to capture experiences of social, emotional, and physical unpredictability prior to age 18, with some questions focusing on events that are more likely to occur before age 12. Items cover five different domains; Parental Involvement (9 items), Parental Predictability (12 items), Parental Environment (7 items), Physical Environment (7 items), and Safety and Security (3 items). Respondents have to agree or disagree to each item, after which an aggregate score in calculated. QUIC scores range from 0 to 38, with higher scores indicating more unpredictability.

[3] 1000 DKK $\simeq$ 150 USD.

The following text were given as introduction to the QUIC:

This set of questions asks about your childhood experiences. When we say parents, we mean whoever in your life fills that role for you (e.g. biological parents, step parents, grandparents, foster parents). This could be one person, or this could be multiple people.

Following the text, respondents where introduced to the 38 items listed below, to which they were asked to either agree or disagree.

1. Parental monitoring and involvement
1.. Prior to age 12: I had a set morning routine on school days (i.e., I usually did the same thing each day to get ready). (R)
2. Prior to age 12: My parents kept track of what I ate (e.g., made sure that I didn't skip meals or tried to make sure I ate healthy food). (R)
3. Prior to age 12: My family ate a meal together most days. (R)
4. Prior to age 12: My parents tried to make sure I got a good night's sleep (e.g., I had a regular bedtime, my parents checked to make sure I went to sleep). (R)
5. Prior to age 12: I had a bedtime routine (e.g., my parents tucked me in, my parents read me a book, I took a bath). (R)
6. Prior to age 12: In my afterschool or free time hours at least one of my parents knew what I was doing. (R)
7. Prior to age 12: At least one of my parents regularly checked that I did my homework. (R)
8. Prior to age 18: At least one of my parents regularly kept track of my school progress. (R)
9. Prior to age 18: At least one parent made time each day to see how I was doing. (R)

2. Parental predictability
1. Prior to age 12: My parents were often late to pick me up (e.g. from school, aftercare or sports)
2. Prior to age 12: I usually knew when my parents were going to be home. (R)
3. Prior to age 18: At least one of my parents had punishments that were unpredictable
4. Prior to age 18: I often wondered whether or not one of my parents would come home at the end of the day
5. Prior to age 18: My family planned activities to do together. (R)
6. Prior to age 18: At least one of my parents would plan something for the family, but then not follow through with the plan.
7. Prior to age 18: My family had holiday traditions that we did every year (e.g., cooking a special food at a particular time of year/decorate the house the same way). (R)
8. Prior to age 18: At least one of my parents was disorganized.
9. Prior to age 18: At least one of my parents was unpredictable.
10. Prior to age 18: For at least one of my parents, when they were upset I did not know how they would act.
11. Prior to age 18: One of my parents could go from calm to furious in an instant.
12. Prior to age 18: One of my parents could go from calm to stressed or nervous in an instant.

3. Parental environment

1. Prior to age 18: There was a long period of time when I didn't see one of my parents (e.g. military deployment, jail time, custody arrangements).

2. Prior to age 18: I experienced changes in my custody arrangement.

3. Prior to age 18: At least one of my parents changed jobs frequently

4. Prior to age 18: There were times when one of my parents was unemployed and couldn't find a job even though he/she wanted one.

5. Prior to age 18: My parents had a stable relationship with each other. (R)

6. Prior to age 18: My parents got divorced.

7. Prior to age 18: At least one of my parents had many romantic partners.

4. Physical environment

1. Prior to age 18: There were often people coming and going in my house that I did not expect to be there.

2. Prior to age 18: I moved frequently.

3. Prior to age 18: I changed schools frequently.

4. Prior to age 18: I changed schools mid-year.

5. Prior to age 18: I lived in a clean house. (R)

6. Prior to age 18: I lived in a cluttered house (e.g., piles of stuff everywhere).

7. Prior to age 18: In my house things I needed were often misplaced so that I could not find them.

5. Safety and security

1. Prior to age 18: There was a period of time when I often worried that I was not going to have enough food to eat.

2. Prior to age 18: There was a period of time when I often worried that my family would not have enough money to pay for necessities like clothing or bills.

3. Prior to age 18: There was a period of time when I did not feel safe in my home.

S1.1.2 Measures of Mental Health

We measured mental health in our survey, using two widely validated instruments. Anxiety symptom severity was measured using the Generalized Anxiety Disorder scale (GAD-7). Respondents complete a battery of seven questions (listed in table S1). Each item is scored from 0 to 3, corresponding to the response categories "not at all," "several days," "more than half the days," and "nearly every day." Summing across items yields a total GAD-7 score ranging from 0 to 21, which can be categorized as follows: 0–4 = minimal anxiety, 5–9 = mild anxiety, 10–14 = moderate anxiety, and 15–21 = severe anxiety.

Depression symptom severity was measured using the Patient Health Questionnaire (PHQ-8), a screening tool for depressive symptoms (listed in table S2). The PHQ-8 is based on the PHQ-9 but excludes one item on suicidal thoughts for ethical reasons. Responses are scored analogously to the GAD-7, with values 0–3 assigned to the four response categories. The total score thus ranges from 0 to 24 across the eight items, and is categorized as 1–4 = minimal depression, 5–9 = mild depression, 10–14 = moderate depression, 15–19 = moderately severe depression, and 20–24 = severe depression.

Figure S1 shows the distribution of the GAD-7 scores and the PHQ-8 scores. While the majority of the respondents have minimal or mild anxiety according to their GAD-7 scores, a small fraction would be classified as having moderate or severe anxiety. We see a similar pattern with the PHQ-8 scores and depression.

Table S1: **Anxiety (GAD7):** Over the last two weeks, how often have you been bothered by the following problems?

	Not at all	Several Days	More than half the days	Nearly every day
1. Feeling nervous, anxious, or on edge				
2. Not being able to stop or control worrying				
3. Worrying too much about different things				
4. Trouble relaxing				
5. Being so restless that it is hard to sit still				
6. Becoming easily annoyed or irritable				
7. Feeling afraid, as if something awful might happen				

If you checked any problems, how difficult have they made it for you to do your work, take care of things at home, or get along with other people?

☐ Not difficult at all

☐ Somewhat difficult

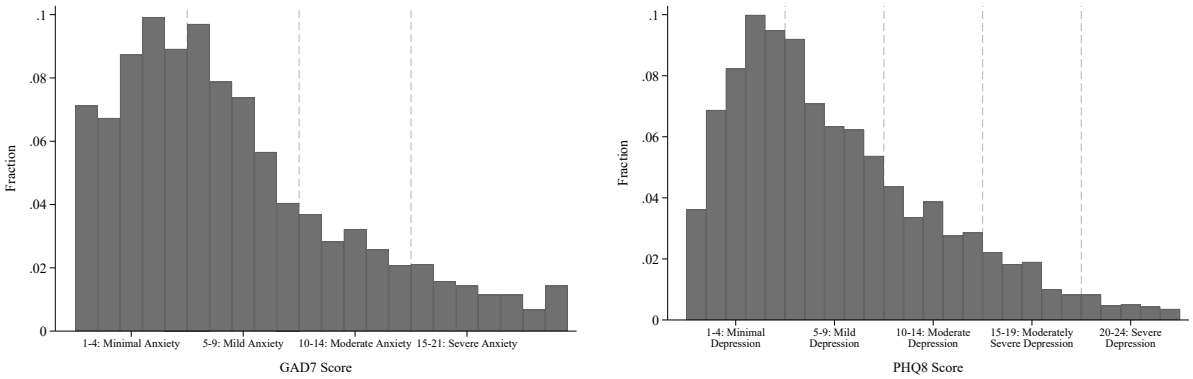
☐ Very difficult

☐ Extremely difficult

Table S2: **Depression (PHQ8):** Over the last two weeks, how often have you been bothered by the following problems?

	Not at all	Several Days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things				
2. Feeling down, depressed or hopeless				
3. Trouble falling or staying asleep or sleeping too much				
4. Feeling tired or having little energy				
5. Poor appetite or overeating				
6. Feeling bad about yourself - or that your are a failure or have let yourself or your family down				
7. Trouble concentrating on things, such as reading the newspaper or watching television				
8. Moving or speaking so slowly that other people could have noticed. Or the opposite - being so figety or restless that you have been moving around a lot more than usual				

Figure S1: Distribution of Mental Health Measures



(a) Anxiety symptom severity (GAD-7 scores) (b) Depression symptom severity (PHQ-8)

S1.1.3 Cognitive Abilities

Approximately half of the respondents had previously participated in the January 2024 wave of the Copenhagen Life Panel (CLP)[29]. The CLP is an online survey administered annually in Denmark to a random selection of individuals aged 20–70 from the Danish population registry. In 2024, the CLP elicited several measures of cognitive ability among younger participants. Using unique personal identifiers, we link the QUIC survey responses to these cognitive scores for the subset of respondents (1,098 respondents) who participated in both surveys. The CLP measured three dimensions of cognitive ability: cognitive reflection, abstract reasoning and probabilistic reasoning.

Cognitive reflection was measured using six items modeled after the Cognitive Reflection Test (CRT). These questions are designed to trigger an immediate but incorrect intuitive response, with correct answers requiring suppression of intuition and more deliberate reasoning:

- A bat and a ball are 1.10$. And the bat is 1$ more than the ball. How much is the ball?

- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

- In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake?

- Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in a class?

- If Neil can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take them to drink one barrel of water together?

- Anne bought a cow for $600. She sold it for $700. She bought it again for $800. She sold it again for $900 Dollars. How much did Anne earn?

Probabilistic reasoning and statistical numeracy were measured through a set of four problems requiring the application of probability rules, conditional reasoning, and Bayesian updating. Unlike the CRT items, these tasks do not rely on misleading intuitions but instead test whether respondents can apply statistical principles correctly:

- Out of 1,000 people in a small town, 500 are members of a choir. Of the 500 choir members, 100 are men. Of the 500 residents who are not in the choir, 300 are men. What is the probability that a randomly selected man is a member of the choir?

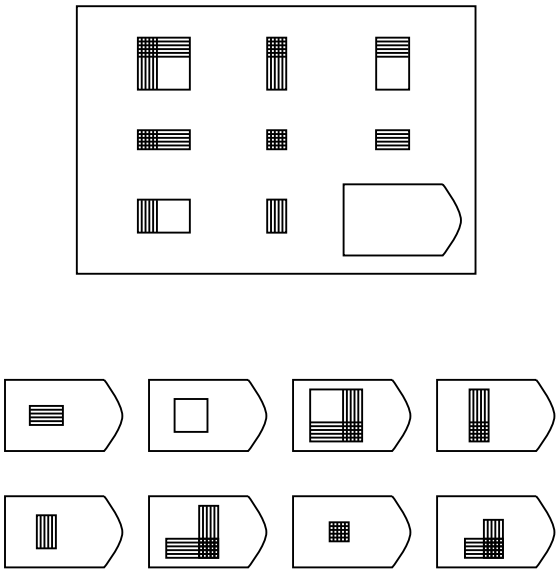
- Imagine rolling a 6-sided die 70 times. The die is biased, so the probability of rolling a 6 is twice as high as the probability of rolling any of the other numbers. On average, how many times will the die show the number 6 out of these 70 rolls?

- Imagine rolling a 5-sided die 50 times. On average, out of these 50 rolls, how many times would this five-sided die show an odd number (1, 3, or 5)?

- In a forest, 20 pct. of the mushrooms are red, 50 pct. are brown, and 30 pct. are white. A red mushroom is poisonous with a probability of 20 pct. A mushroom that is not red is poisonous with a probability of 5 pct. What is the probability that a poisonous mushroom in the forest is red?

Abstract reasoning was measured using five Raven's Progressive Matrices, a widely used test of fluid intelligence. Respondents are shown a visual pattern with a missing piece and asked to identify the correct option to complete it. This task captures fluid reasoning, abstract problem-solving, and working memory, and is independent of language and formal education. While Raven's Progressive Matrices test consists of 60 items, we included only five that have been shown to predict the total Raven's score with high accuracy [30], as exemplified by figure S2.

Figure S2: Example of Raven Matrix

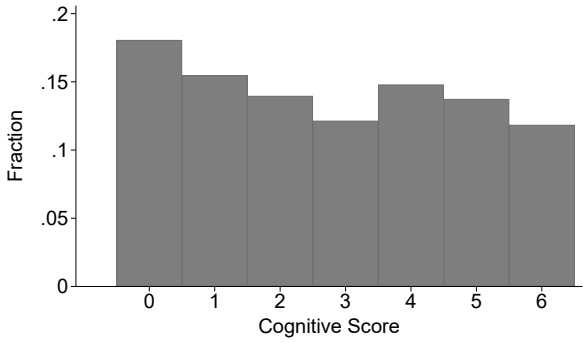


Together, these tasks capture complementary dimensions of cognitive ability. The cognitive reflection items assess individuals' tendency to engage in deliberate reasoning rather than relying on intuitive responses. Raven's Progressive Matrices provide a benchmark measure

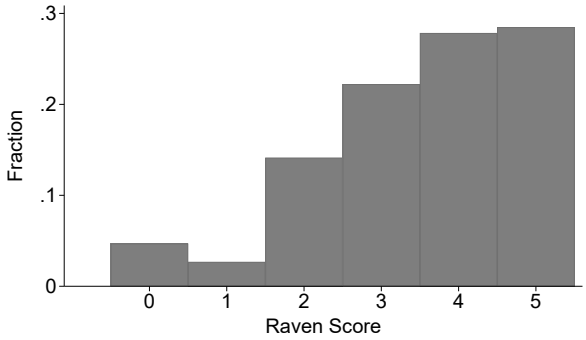
of fluid intelligence and abstract problem-solving. The probabilistic reasoning tasks evaluate the ability to apply statistical principles and reason under uncertainty. Linking these measures with the QUIC allows us to examine whether childhood unpredictability predict academic performance above and beyond what can be explained by cognitive abilities.

Figure S3 presents the distribution of cognitive ability scores as measured in the 2024 CLP survey. Across all three measures, respondents' answers span the full scoring range, indicating broad variation in performance. For cognitive reflection, the distribution is slightly skewed toward lower scores, although the difference in mass between the lowest and highest scores is modest. Performance on Raven's Progressive Matrices is comparatively higher, with the majority of respondents correctly solving three or more items. By contrast, performance on the probabilistic reasoning tasks is weaker on average, with 71 pct. of respondents answering at most two of the questions correctly. While these measures index distinct dimensions of cognitive ability, they were all highly correlated with one another (Fig. S4)

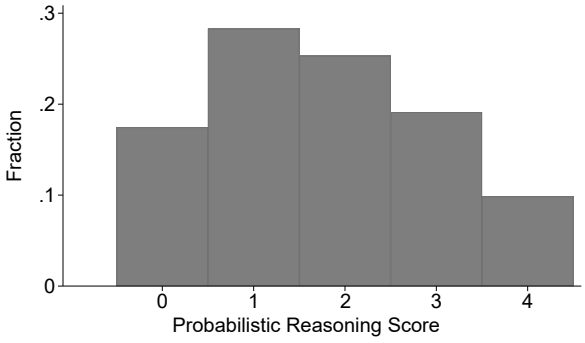
Figure S3: Distribution of Cognitive Ability Scores



(a) Distribution of Cognitive Reflection Scores

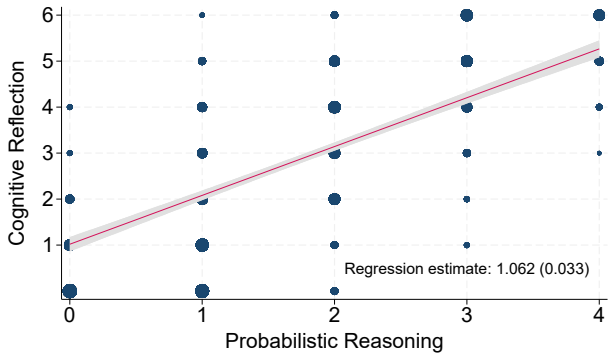


(b) Distribution of Raven Scores

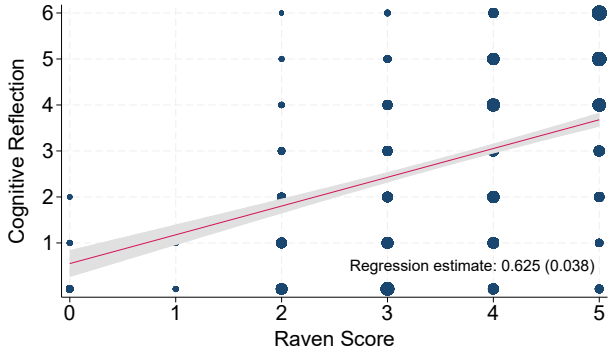


(c) Distribution of Probabilistic Reasoning

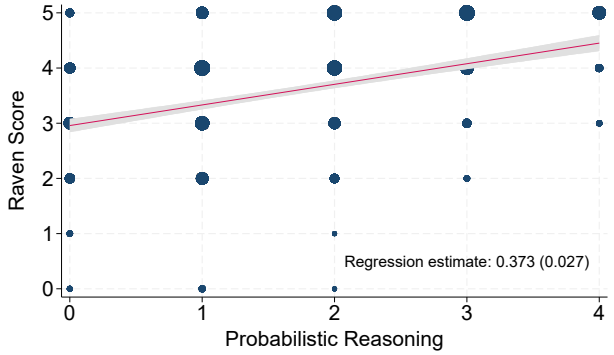
Figure S4: Correlations between Cognitive Ability Measures



(a) Cognitive Reflection and Prob. Reasoning



(b) Cognitive Reflection and Raven Score



(c) Raven Score and Probabilistic Reasoning

The figures show the correlations between our three cognitive ability measures. The size of the scatters indicate the number of observations in each cognitive ability score and the red line depicts the best linear fit for each cognitive ability pair.

S1.2 Danish Administrative Records

Upon completion of the survey, we linked all survey responses with the Danish administrative registries using the personal identifiers. The administrative records include standard demographic information, such as age, gender and household composition. The latter allows us to identify parents and siblings. The data further include information about education, income and wealth, all collected at the annual frequency. All the administrative data are longitudinal by nature and are currently available up to and including 2022.

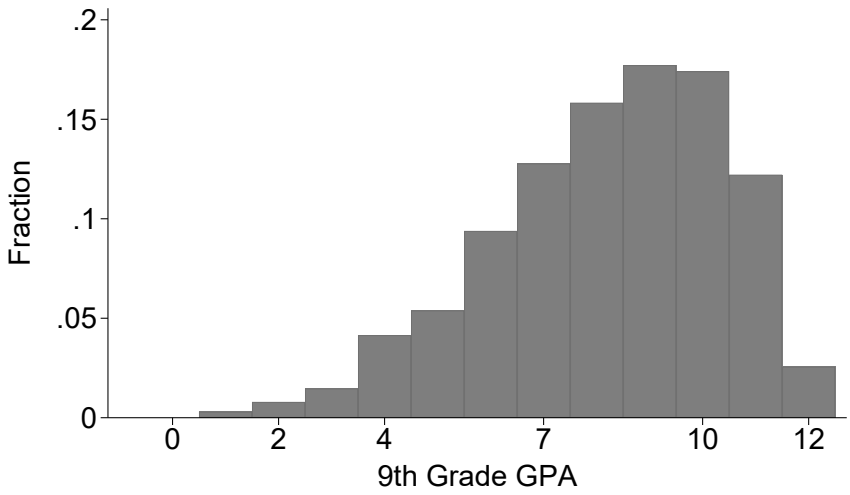
S1.2.1 Academic Performance

The Danish administrative data contains information about all grades that the Danish students receive. In Denmark, students receive their first grades in 8th grade. At the end of 9th grade, they take their first final exams, which marks the end of their lower secondary education. Following lower secondary education, students can choose to enter general upper secondary school, which primarily prepare students for higher education, or vocational upper secondary school, which primarily prepare students for a career in a specific trade or industry. We construct our measure of academic achievement using 9th grade grades, as 9th grade is the final year in which all Danish students are enrolled in compulsory schooling and receive standardized grades. Each student receives both a teacher-assessed grade for general proficiency in every subject and examination grades in a subset of subjects. All students are required to sit for exams in Danish, English, Mathematics, and Science, and additionally take two exams selected by lottery. We calculate each student's GPA based on all available grades combining both general teacher-assessed proficiency and examination grades. The Danish grading system is a seven-point scale, consisting of the grades: –3, 00, 02, 4, 7, 10, and 12. The first two (–3 and 00) are failing grades, while the remaining five represent passing performance[4].

[4]More information can be found at the Danish Agency for Higher Education and Science's website: https://ufsn.dk/english/education/the-danish-education-system/grading-system/.

Figure S5 shows the distribution of GPA. The respondents on average have a GPA of 8.33, with a slightly higher median of 8.5. The majority, of respondents (75 pct.) have a GPA of 7 or higher.

Figure S5: Distribution of GPA



Distribution of GPA for all survey respondents. GPA is calculated as an average of all available grades in 9th grade, combining both general teacher-assessed proficiency and examination grades.

S1.2.2 Mental Health

In addition to academic records, the administrative data include comprehensive health records, which we use to construct measures of mental health. We focus on the presence of mental health conditions rather than their intensity or severity. Specifically, we define binary indicators for anxiety and depression based on diagnoses and hospital contacts recorded in the national health registers. An individual is classified as having anxiety if they have received a clinical diagnosis of an anxiety disorder or if anxiety is recorded as the primary reason for a hospital visit. Analogously, an individual is classified as having depression if they have received a clinical diagnosis of depression or if depression is listed as the primary reason for a hospital visit. These measures capture the incidence of clinically recognized mental health

574 conditions observed in administrative data.

S2 Ethics Approval

UNIVERSITY OF COPENHAGEN
DEPARTMENT OF ECONOMICS

Søren Leth-Petersen
Department of Economics

23. APRIL 2025

ØSTER FARIMAGSGADE 5, BUILDING 26
DK-1353 COPENHAGEN

ethics@econ.ku.dk

"Expectations"

Dear Søren Leth-Petersen,

The Research Ethics Committee at the Department of Economics at University of Copenhagen has assessed your project "Expectations". Based on the information you have provided in your application for ethical approval, the Committee has concurred that the project activities are in accordance with the relevant International and Danish ethical guidelines and regulations.

The Committee bases its assessments on appropriate University, National and International guidelines, codices and legislations, including The Danish Code of Conduct for Research Integrity, which is based on among others The Singapore Statement on Research Integrity (developed at the 2nd World Conference on Research Integrity in 2010), The Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations (developed at the 3rd World Conference on Research Integrity in 2013) and the European Code of Conduct for Research Integrity (developed by the European Science Foundation and all European Academies in 2011).

Note that you as a researcher are yourself responsible to comply with all privacy and Data protection regulations of the University of Copenhagen as well as all other types of regulations and legislations relevant to your project activities in Denmark and abroad."

The Committee hereby approves your project.

On behalf of the Committee

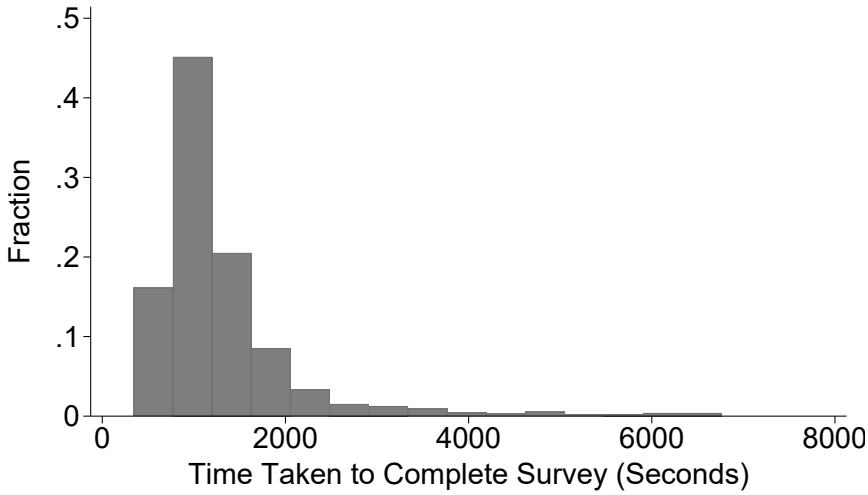
Torben Heien Nielsen, Chairman, The Research Ethics Committee at Department of Economics, University of Copenhagen

S3 Supplementary Results

S3.1 Summary Statistics

We invited 19,390 individuals to participate in the survey. 3563 individuals participated, with 2812 filling out the survey in full. On average, participants who filled out the survey in full spent 23 minutes. Figure S6 shows the distribution of time spent on the survey. In our analyses, we drop 19 respondents, who spent less than 5 minutes in total, leaving us with 2793 full responses.

Figure S6: Distribution of Time Taken



Because we know the identity of all individuals who were invited to the survey, but did not participate, we are able to identify them in the administrative registries.To examine selection into the survey, we compare key characteristics of the survey respondents to non-respondents. These are presented in Table S3. Parental characteristics, including earnings and unemployment, are averages over the years 2004-2022, i.e., the period in which the child was between 0 and 18 years old.

Respondents are slightly more likely to be female than the non-respondents (60% vs. 45%) and have higher academic performance (9th grade GPA of 8.19 compared to 6.93). Respon-

dents also have slightly fewer siblings, older mothers, and parents with higher earnings and lower unemployment. While these patterns suggest modest selection into the survey, particularly along dimensions correlated with socioeconomic advantage and academic performance, the differences are modest.

Table S3: Observable Characteristics for Respondents and Non-Respondents

	Respondents	Non-Respondents	Difference	P-value
Females	0.60	0.45	0.15	0.00
Age	18.00	18.00	0.00	-
9th Grade GPA	8.19	6.93	1.26	0.00
Number of Siblings	1.72	1.87	-0.14	0.00
Parents Divorced	0.13	0.12	0.00	0.54
Mom Age	30.99	30.38	0.62	0.00
Dad Age	33.49	33.20	0.29	0.01
Mom Avg. Annual Earnings (DKK)	269,603.83	239,825.37	29,778.46	0.00
Dad Avg. Annual Earnings (DKK)	415,902.32	369,890.30	46,012.02	0.00
Mom Unemployment (Days)	240.58	294.89	-54.31	0.00
Dad Unemployment (Days)	164.68	218.55	-53.87	0.00
Anxiety Diagnosis	0.05	0.03	0.02	0.00
Depression Diagnosis	0.03	0.02	0.01	0.00
Mom Anxiety Diagnosis	0.08	0.10	-0.02	0.00
Dad Anxiety Diagnosis	0.05	0.07	-0.02	0.00
Mom Depression Diagnosis	0.05	0.06	-0.02	0.00
Dad Depression Diagnosis	0.03	0.04	-0.01	0.02
Observations	2,793	16,597		

Based on 2022 data. P-values are based on t-tests of equality of means between respondents and non-respondents. Mom and dad avg. earnings are averages for the years 2004-2022. Mom and dad unemployment is total number of days being unemployed during the years 2004-2022. Anxiety diagnosis and depression diagnosis are indicators of the individual having received the diagnosis or been hospitalized sometime in the years 2004-2022.

S3.2 QUIC Reporting Accuracy

The linkage between survey responses and Danish administrative data provides a unique opportunity to validate the accuracy of self-reported experiences of childhood unpredictability. As a first step, we benchmark the survey against objective registry information on basic demographics, confirming that respondents' self-reported age and gender align closely with their official records. All respondents report their correct age. Further, 98 pct. of the respondents report that their gender is the same as their administratively recorded gender. The remaining 2 pct. either report that they do not wish to disclose their gender, or that they are non-binary, something which is not registered in the administrative records.

S3.2.1 QUIC Items and Administrative Records

In addition to the means presented in figure 1 in the main text, we also consider the distribution of administratively recorded outcomes that match the QUIC items. Figure S8 shows the distribution of the number of parental partners. While figure 1 showed significant, but small, differences in the average number of parental partners for respondents who responded, respectively, yes and no to question 3.6, figure S8 shows us that these differences mask a great deal of heterogeneity. Among respondents who reported that their parents did not have many romantic partners, 98 pct. of both mothers and fathers had only one registered partner during the respondent's childhood. By contrast, parents of respondents who reported many romantic partners were substantially more likely to have two or more registered partners.

In figure S8 we also show the distribution of number of recorded residential addresses during childhood for respondents who reported that they moved frequently prior to age 18 (red bars) and respondents who reported that they did not move frequently (grey bars), respectively. The two distributions exhibit clear differences. Respondents who reported not moving frequently had, on average, 2.3 residential addresses, with a right-skewed distribution concentrated at three or fewer addresses during childhood. By contrast, those who reported moving frequently had an average of 4.9 residential addresses, and their distribution places

considerably more weight on higher values; notably, 60.3 pct. of this group had more than three residential addresses before age 18. In figure S8, we show the distribution of number of recorded schools that the respondents were enrolled at prior to age 18 for respondents who reported that they changed schools frequently prior to age 18 (red bars) and respondents who reported that they did not change schools frequently prior to age 18 (grey bars), respectively. Similar to the patterns seen in figure S8, we see that the distribution is right skewed for respondents who reported that they did not change schools frequently, while the majority (70.6 pct.) of respondents who reported that they did change schools frequently were enrolled in three or more schools.

Because the survey questions ask about the frequency of moves or school changes rather than a specific number, some overlap between the two groups is to be expected. Nevertheless, the distinct separation of the distributions in both figures demonstrates a strong correspondence between retrospective reports and administrative records, providing compelling validation of the survey measures of physical environment.

Figure S7: QUIC Responses Align with Administrative Records

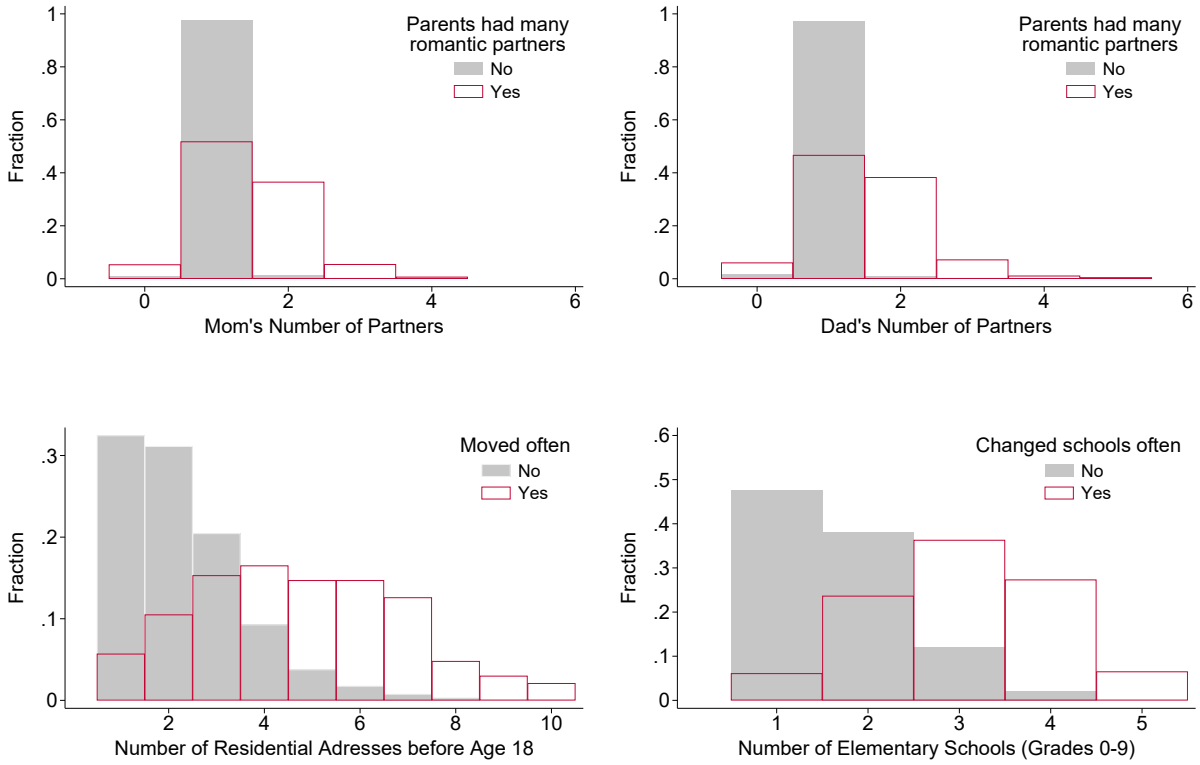


Figure S8: Distribution of outcomes from the administrative records are compared with participants' responses on the QUIC. Red bars indicate the distribution of documented events or outcomes among respondents who endorsed a given QUIC item; grey bars indicate the distribution of documented events or outcomes among respondents who did not. All QUIC items refer to experiences occurring before age 18. Consistent with a high degree of reporting accuracy, endorsement of QUIC items was associated with a higher frequency of corresponding administrative events.

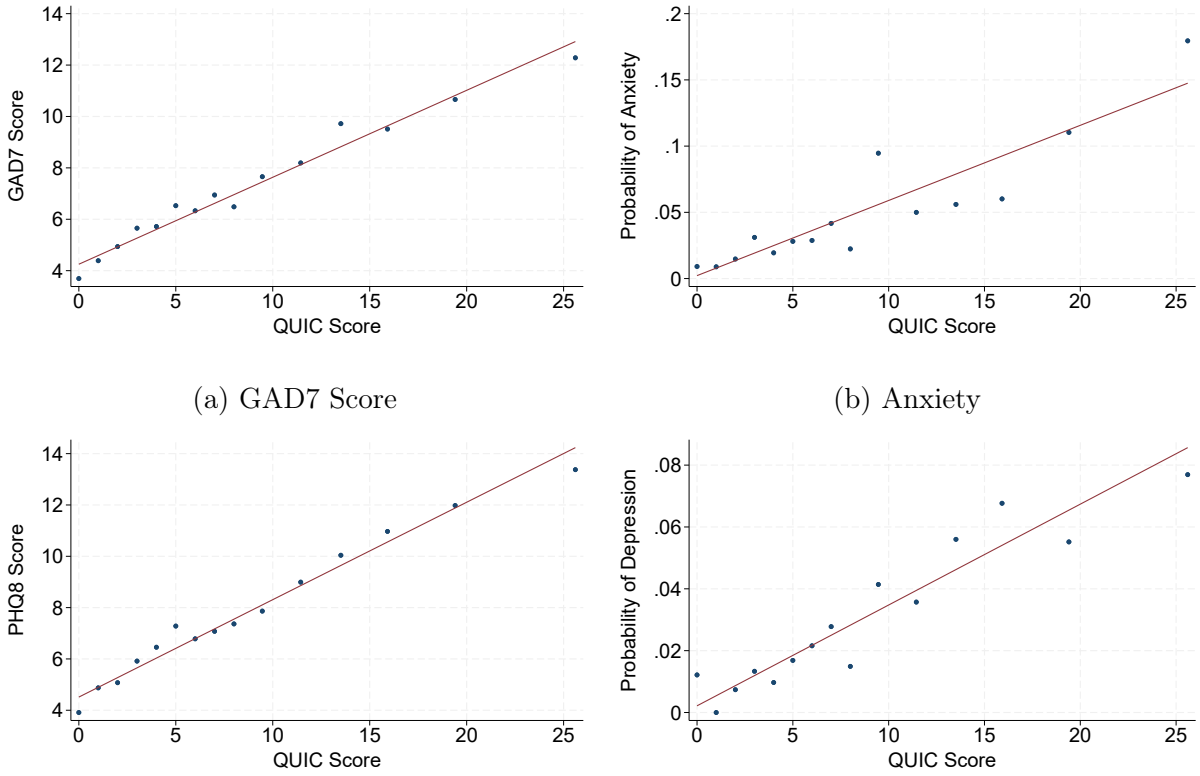
S3.2.2 QUIC and Mental Health

To further validate the QUIC measure, we examined its association with mental health outcomes. Prior research has documented a link between childhood unpredictability, as measured by the QUIC, and self-reported symptoms of anxiety and depression [19,27]. Replicating these findings in our sample, we correlated QUIC scores with both self-reported measures of anxiety (GAD-7 score) and depression (PHQ-8 score), as well as registry obtained diagnoses of anxiety and depression. Figure S9 displays binned scatterplots for each of these. In all cases, we observe a clear positive relationship: higher levels of childhood unpredictability are associated with greater symptoms of anxiety and depression in late adolescence, both when considering self-reported symptoms of anxiety(Fig. S9a)and depression (Fig. S9c) and when considering third-party reported diagnoses of anxiety (Fig. S9b) and depression (Fig. S9d). These results are consistent with prior evidence and provide additional validation of the QUIC in a large, population-based sample.

To examine whether the relationships shown in S9 when controlling for socioeconomic status and parental mental health, we estimate the following relationship:

$$MH_i = \beta_0 + \beta_1 QUIC_i + \beta_2 \mathbf{X}_i + \varepsilon_i \tag{4}$$

in which MH_i is individual i's mental health outcome of interest, $QUIC_i$ is the individual's QUIC score and $\mathbf{X}_i$ is a vector of controls, including the individual's gender, their parents' average gross income during the individual's childhood, their parents' education measured in years and their parents' mental health, measured by the same binary indicators for anxiety and depression as described in Section S1.2.



(a) GAD7 Score

(b) Anxiety

(c) PHQ8

(d) Depression

Figure S9: The relationship between QUIC scores and mental health outcomes are illustrated using binned scatterplots. Graphs (a) and (c) show self-reported mental health scores and graphs (b) and (d) show registry obtained diagnoses of anxiety and depression. The Relationship between QUIC and Mental Health Outcomes Aligns with Previous Findings, as all graphs depicts a clear positive relationship: higher levels of childhood unpredictability are associated with greater symptoms of anxiety and depression in late adolescence. Corresponding regression estimates are presented in table S4.

Table S4 presents regression estimates with anxiety as the outcome. Columns (1)–(3) use self-reported anxiety symptoms measured by the GAD-7 scale, while columns (4)–(6) use a registry-based indicator for an anxiety diagnosis. Across both outcome measures, we find a positive and statistically significant association between childhood unpredictability, as measured by the QUIC, and anxiety. This relationship remains stable across specifications and persists when controlling for parental income, parental education, and parental mental health. These results indicate that higher levels of perceived unpredictability during childhood are associated with an increased risk of anxiety in late adolescence, independent of observed family background characteristics.

Table S5 reports analogous results for depression. Columns (1)–(3) use self-reported depressive symptoms measured by the PHQ-8 scale, while columns (4)–(6) rely on registry-based diagnoses of depression. As with anxiety, we observe a positive and statistically significant association between childhood unpredictability and depression across both measurement approaches and across all specifications. The magnitude and significance of the estimates are robust to the inclusion of controls for parental income, education, and parental mental health. Together, these findings show that higher levels of perceived childhood unpredictability are consistently associated with an elevated risk of depression.

Table S4: QUIC Predicts both Survey Measured Anxiety and Registry Measured Anxiety

	(1) GAD7	(2) GAD7	(3) GAD7	(4) Anxiety	(5) Anxiety	(6) Anxiety
QUIC	2.160***	2.036***	2.038***	0.0352***	0.0326***	0.0309***
	(0.103)	(0.105)	(0.108)	(0.00579)	(0.00576)	(0.00572)
Constant	6.449***	5.942***	5.883***	0.0405***	0.0540*	0.0442
	(0.0901)	(0.644)	(0.648)	(0.00394)	(0.0278)	(0.0283)
Observations	2,515	2,515	2,515	2,515	2,515	2,515
R-squared	0.180	0.227	0.227	0.031	0.036	0.040
Gender		X	X		X	X
Parental Income		X	X		X	X
Parental Education		X	X		X	X
Parental Mental Health			X			X

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. The QUIC score has been standardized to have mean 0 and std. deviation 1. GAD7 scores elicited in the survey. Anxiety is an indicator equal to one, if the individual has an anxiety diagnosis registered in the administrative data.

Table S5: QUIC Predicts both Survey Measured Depression and Registry Measured Depression

	(1)	(2)	(3)	(4)	(5)	(6)
	PHQ8	PHQ8	PHQ8	Depression	Depression	Depression
QUIC	2.439***	2.302***	2.309***	0.0230***	0.0219***	0.0213***
	(0.100)	(0.102)	(0.105)	(0.0047)	(0.0047)	(0.0047)
Constant	7.000***	7.385***	7.410***	0.0252***	0.0331	0.0322
	(0.0898)	(0.637)	(0.651)	(0.00316)	(0.0221)	(0.0226)
Observations	2,515	2,515	2,515	2,515	2,515	2,515
R-squared	0.220	0.257	0.258	0.021	0.025	0.027
Gender		X	X		X	X
Parental Income		X	X		X	X
Parental Education		X	X		X	X
Parental Mental Health			X			X

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. The QUIC score has been standardized to have mean 0 and std. deviation 1. PHQ8 scores elicited in the survey. Depression is an indicator equal to one, if the individual has an depression diagnosis registered in the administrative data.

S3.3 Main Results

S3.3.1 Childhood Unpredictability and Academic Performance

To examine whether experiences and perceived unpredictability in childhood predict academic performance, we consider different educational outcomes. For each of these, we estimate equation 1 (repeated here),

$$Y_i = \beta_0 + \beta_1 QUIC_i + \beta_2 \mathbf{X}_i + \beta_3 \mathbf{Z}_i + \varepsilon_i$$

where $QUIC_i$ is individual i's QUIC score, standardized to have mean 0 and standard deviation 1. $\mathbf{X}_i$ is a vector of socioeconomic controls, parental gross income and parental education. Finally, $\mathbf{Z}_i$ is a vector of childhood experiences taken from the administrative data, including parental split, parents' number of partners, parental death, number of residential addresses, number of schools, parental unemployment and parental mental health issues.

We first consider 9th grade GPA as the outcome. Table S6 shows the estimated relationship between childhood experiences and perceived unpredictability and 9th grade GPA. Across specifications, QUIC is a strong and robust predictor of GPA.

Column (1) presents a baseline specification of the relationship between GPA and QUIC. The QUIC coefficient is –0.58, indicating that a one standard deviation increase in perceived unpredictability is associated with a reduction in GPA of just over half a grade point. In column (2), we control for socioeconomic status controls. Although these variables strongly and positively predict GPA, the QUIC coefficient remains large and statistically significant at –0.38.

Column (3) introduces a vector of administrative records of childhood disruptions, including parental relationships, residential mobility, school changes, parental unemployment, and family deaths. These objective indicators of instability are, in several cases, significantly associated with GPA. However, the coefficient on QUIC remains sizable at –0.36, suggesting that perceived unpredictability captures information beyond what is contained in individual

administrative measures of childhood instability.

In column (4), socioeconomic controls are reintroduced alongside the full set of objective instability measures. The coefficient on QUIC attenuates somewhat but remains large and statistically significant at –0.26, even as parental income and parental education continue to strongly predict higher GPA. Finally, column (5) adds controls for parental mental health. The QUIC coefficient is virtually unchanged at –0.26, indicating that perceived unpredictability predicts academic performance over and above socioeconomic background, detailed administrative indicators of childhood instability, and parental mental health.

Overall, the results in Table S6 show that perceived unpredictability is a strong and robust predictor of academic performance. Both the perceived unpredictability and objective records of childhood experiences are negatively associated with GPA, but the QUIC measure remains particularly stable across increasingly demanding specifications, suggesting that children's perceived unpredictability captures dimensions of early-life environments that are not fully reflected in the objective records.

Table S7 presents analogous results for high school completion. As in the GPA analysis, QUIC is a strong and robust predictor of educational attainment. In the baseline specification shown in column (1), higher levels of perceived unpredictability are associated with a significantly lower probability of completing high school. A one standard deviation increase in the QUIC is associated with a reduction in the probability of completing high school of approximately 9.6 percentage points.

In column (2), we add parental socioeconomic status controls. These variables are positively and significantly associated with high school completion, yet the coefficient on the QUIC remains large and statistically significant at –0.076. Column (3) introduces a vector of objectively measured childhood disruptions, including parental relationship transitions, residential mobility, school changes, parental unemployment, and family deaths. Several of these objective indicators, particularly school changes, maternal partnership instability, and parental unemployment, are negatively associated with high school completion. Nevertheless,

the coefficient on the QUIC remains largely unchanged.

Column (4) combines socioeconomic controls with the full set of objective instability measures. While the magnitude of the QUIC coefficient attenuates modestly, it remains highly statistically significant at –0.070. Finally, column (5) adds controls for parental mental health. The association between perceived unpredictability and high school completion remains stable at –0.067, indicating that perceived unpredictability predicts educational attainment over and above socioeconomic background, detailed administrative indicators of childhood instability, and parental mental health.

As in the GPA analysis, the coefficient on the QUIC remains stable in both magnitude and statistical significance across specifications. This pattern suggests that perceived unpredictability captures dimensions of childhood environments relevant for educational attainment that are not fully summarized by objectively recorded childhood experiences alone.

Across educational outcomes, perceived childhood unpredictability emerges as a strong and robust predictor of academic performance. Higher levels of perceived unpredictability, as measured by the QUIC, are associated with lower grade point averages and a reduced likelihood of completing high school. These associations are large in magnitude, statistically significant, and persist across a wide range of specifications.

The predictive power of the QUIC remains after controlling for traditional socioeconomic background, including parental income and education, as well as for a comprehensive set of objectively measured childhood disruptions. While several individual indicators of instability are negatively associated with educational outcomes when examined in isolation, their explanatory power diminishes when modeled jointly. In contrast, the association between perceived unpredictability and educational outcomes remains stable. One interpretation is that perceived unpredictability integrates information across multiple domains of childhood experience, including aspects of instability that are difficult or impossible to observe in administrative data.

Taken together, these findings suggest that reports of perceived unpredictability provide a

summary of complex childhood environments and life-course dynamics. The QUIC captures how predictable or unstable childhood life felt based on their everyday experiences that administrative records rarely capture. The persistence of its association with educational outcomes highlights the value of self-report surveys as a complement to objective records when studying the long-run consequences of childhood environments.

Table S6: QUIC Predicts GPA Above SES and Objective Stability Measures

	(1) GPA	(2) GPA	(3) GPA	(4) GPA	(5) GPA
QUIC	-0.582***	-0.375***	-0.359***	-0.264***	-0.261***
	(0.0454)	(0.0452)	(0.0555)	(0.0538)	(0.0538)
Parental Gross Inc. (100 000 DKK)		0.0698***		0.0624***	0.0604***
		(0.0125)		(0.0127)	(0.0126)
Mother's Education (Years)		0.180***		0.170***	0.168***
		(0.0196)		(0.0194)	(0.0195)
Father's Education (Years)		0.117***		0.108***	0.108***
		(0.0183)		(0.0183)	(0.0184)
Parents Split			0.0311	-0.00970	-0.00511
			(0.114)	(0.108)	(0.109)
Mother # of Partners			-0.345***	-0.287***	-0.282***
			(0.102)	(0.1000)	(0.0994)
Father # of Partners			-0.124	-0.115	-0.119
			(0.110)	(0.0985)	(0.0964)
Mom Dead			-0.181	-0.134	-0.146
			(0.373)	(0.336)	(0.339)
Dad Dead			-0.0623	0.181	0.193
			(0.411)	(0.386)	(0.389)
# of Residential Addresses			-0.00269	0.0307	0.0340
			(0.0292)	(0.0278)	(0.0279)
# of Schools			-0.204***	-0.176***	-0.174***
			(0.0492)	(0.0473)	(0.0473)
Parental Unemployment (Months)			-0.016***	-0.006***	-0.006***
			(0.00222)	(0.00224)	(0.00225)
Constant	7.876***	3.216***	9.014***	4.323***	4.388***
	(0.0676)	(0.300)	(0.167)	(0.346)	(0.350)
Observations	2,515	2,515	2,515	2,515	2,515
R-squared	0.080	0.190	0.119	0.204	0.205
Gender	X	X	X	X	X
Parental Mental Health					X

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. QUIC has been standardized to have mean 0 and standard deviation 1. Parental SES and objective instability outcomes all measured in the years 2004-2022, i.e., the years when the child was 0-18 years old. Parents split, mom died and dad died are indicators. Parental mental health all indicators equal to one if a parent has been diagnosed with depression or anxiety in the years 2004-2022.

Table S7: QUIC Predicts High School Completion Above SES and Objective Stability Measures

	(1)	(2)	(3)	(4)	(5)
	High School	High School	High School	High School	High School
QUIC	-0.0963***	-0.0762***	-0.0784***	-0.0697***	-0.0672***
	(0.00890)	(0.00912)	(0.0109)	(0.0108)	(0.0108)
Parental Gross Inc. (100 000 DKK)		0.00922***		0.00822***	0.00776***
		(0.00246)		(0.00246)	(0.00247)
Mother's Education (Years)		0.0159***		0.0145***	0.0134***
		(0.00391)		(0.00392)	(0.00392)
Father's Education (Years)		0.0102***		0.00934**	0.00946**
		(0.00385)		(0.00385)	(0.00385)
Parents Split			0.0408*	0.0371*	0.0380*
			(0.0220)	(0.0219)	(0.0219)
Mother # of Partners			-0.0517**	-0.0450**	-0.0453**
			(0.0207)	(0.0205)	(0.0207)
Father # of Partners			0.00588	0.00643	0.00732
			(0.0198)	(0.0193)	(0.0191)
Mom Dead			0.000383	0.00863	0.00780
			(0.0721)	(0.0736)	(0.0744)
Dad Dead			-0.0317	-0.00438	-0.00162
			(0.0672)	(0.0673)	(0.0673)
# of Residential Addresses			0.000471	0.00321	0.00397
			(0.00625)	(0.00619)	(0.00616)
# of Schools			-0.0409***	-0.0381***	-0.0374***
			(0.00978)	(0.00969)	(0.00971)
Parental Unemployment (Months)			-0.00161***	-0.000674	-0.000668
			(0.000444)	(0.000463)	(0.000467)
Constant	0.710***	0.275***	0.842***	0.414***	0.433***
	(0.0140)	(0.0613)	(0.0327)	(0.0722)	(0.0724)
Observations	2,586	2,586	2,586	2,586	2,586
R-squared	0.066	0.094	0.084	0.105	0.108
Gender	X	X	X	X	X
Parental Mental Health					X

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. High School is an indicator equal to one if the respondent reported that they had completed high school by the time of the survey. QUIC has been standardized to have mean 0 and standard deviation 1. Parental SES and objective instability measures are observed in the years 2004–2022 (ages 0–18). Parents split, mom died, and dad died are indicator variables. Parental mental health indicators equal one if a parent has been diagnosed with depression or anxiety during 2004–2022.

S3.3.2 The Predictive Power of QUIC is Robust to Controlling for Cognitive Abilities

As described in Section S1.1.3, cognitive ability measures are available for a subset of respondents. In this appendix, we examine whether the predictive relationship between childhood unpredictability and educational outcomes is robust to controlling for these measures. Specifically, we estimate a modified version of equation 1, in which we augment the baseline specification with a vector of cognitive ability measures, CA_i (equation 2 in the main text, repeated here),

$$Y_i = \delta_0 + \delta_1 QUIC_i + \delta_2 \mathbf{X}_i + \delta_3 \mathbf{Z}_i + \delta_4 \mathbf{CA}_i + \varepsilon_i$$

The results are reported in Tables S8 and S9. Column (1) reproduce the specifications presented in Section S3.3.1. Column (2) re-estimates the baseline specification from column (1) using the restricted sample of respondents for whom cognitive ability measures are available, allowing us to assess the sensitivity of the estimates to sample selection. Column (3) then adds the cognitive ability controls.

Comparing columns (1) and (2), we find that restricting the sample does not materially alter the estimated association between the QUIC and either GPA or high school completion. The magnitude of the QUIC coefficient remains similar across outcomes, indicating that the main results are not driven by differential selection into the cognitive ability subsample.

In column (3), all cognitive ability measures are positively associated with academic outcomes, as expected. Importantly, however, the coefficient on the QUIC remains statistically significant and economically meaningful for both GPA and high school completion. This indicates that the relationship between perceived childhood unpredictability and educational outcomes is not accounted for by differences in measured cognitive ability.

Table S8: QUIC Predicts GPA Above SES and Objective Stability Measures

	(1)	(2)	(3)
	GPA	GPA	GPA
QUIC	-0.261***	-0.401***	-0.367***
	(0.0538)	(0.0837)	(0.0704)
Parental Gross Inc. (100 000 DKK)	0.0604***	0.0980***	0.0721***
	(0.0126)	(0.0194)	(0.0176)
Mother's Education (Years)	0.168***	0.122***	0.0843***
	(0.0195)	(0.0291)	(0.0266)
Father's Education (Years)	0.108***	0.130***	0.0945***
	(0.0184)	(0.0278)	(0.0247)
Parents Split	-0.00511	-0.0314	-0.0498
	(0.109)	(0.157)	(0.139)
Mother # of Partners	-0.282***	-0.304*	-0.197
	(0.0994)	(0.164)	(0.151)
Father # of Partners	-0.119	-0.103	-0.0649
	(0.0964)	(0.138)	(0.125)
Mom Dead	-0.146	0.0292	0.168
	(0.339)	(0.382)	(0.307)
Dad Dead	0.193	0.817*	0.699**
	(0.389)	(0.455)	(0.347)
# of Residential Addresses	0.0340	0.0262	0.0352
	(0.0279)	(0.0411)	(0.0376)
# of Schools	-0.174***	-0.0628	-0.0465
	(0.0473)	(0.0714)	(0.0639)
Parental Unemployment (Months)	-0.00592***	-0.00119	-0.00189
	(0.00225)	(0.00314)	(0.00290)
Cognitive Reflection			0.442***
			(0.0670)
Probabilistic Reasoning			0.388***
			(0.0649)
Raven Score			0.316***
			(0.0557)
Constant	4.388***	4.558***	5.177***
	(0.350)	(0.534)	(0.486)
Observations	2,515	1,098	1,098
R-squared	0.205	0.232	0.400
Gender	X	X	X
Parental Mental Health	X	X	X

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. QUIC has been standardized to have mean 0 and standard deviation 1. Parental SES and objective instability outcomes are measured during ages 0–18. Parents split, mom died, and dad died are indicator variables. Parental mental health indicators equal one if a parent has been diagnosed with depression or anxiety.

Table S9: QUIC Predicts High School Completion Above SES and Objective Stability Measures

	(1)	(2)	(3)
	High School	High School	High School
QUIC	-0.0672***	-0.0604***	-0.0561***
	(0.0108)	(0.0165)	(0.0161)
Female	0.118***	0.0745***	0.119***
	(0.0164)	(0.0241)	(0.0251)
Parental Gross Inc. (100 000 DKK)	0.00776***	0.0140***	0.0119***
	(0.00247)	(0.00351)	(0.00347)
Mother's Education (Years)	0.0134***	0.00689	0.00340
	(0.00392)	(0.00590)	(0.00583)
Father's Education (Years)	0.00946**	0.0120**	0.00919*
	(0.00385)	(0.00566)	(0.00553)
Parents Split	0.0380*	0.0140	0.0103
	(0.0219)	(0.0338)	(0.0334)
Mother # of Partners	-0.0453**	-0.0490	-0.0396
	(0.0207)	(0.0356)	(0.0353)
Father # of Partners	0.00732	0.0179	0.0219
	(0.0191)	(0.0287)	(0.0290)
Mom Dead	0.00780	0.100	0.113
	(0.0744)	(0.0805)	(0.0885)
Dad Dead	-0.00162	0.0471	0.0372
	(0.0673)	(0.0916)	(0.0885)
# of Residential Addresses	0.00397	0.00563	0.00592
	(0.00616)	(0.00933)	(0.00911)
# of Schools	-0.0374***	-0.0324**	-0.0299**
	(0.00971)	(0.0146)	(0.0143)
Parental Unemployment (Months)	-0.000668	-4.82e-05	-0.000110
	(0.000467)	(0.000729)	(0.000721)
Cognitive Reflection			0.0380**
			(0.0156)
Probabilistic Reasoning			0.0320**
			(0.0148)
Raven Score			0.0262*
			(0.0138)
Constant	0.433***	0.461***	0.514***
	(0.0724)	(0.109)	(0.105)
Observations	2,586	1,127	1,127
R-squared	0.108	0.105	0.138
Gender	X	X	X
Parental Mental Health	X	X	X

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. QUIC has been standardized to have mean 0 and standard deviation 1. Parental SES and objective instability measures are observed during ages 0–18. Parents split, mom died, and dad died are indicator variables. Parental mental health indicators equal one if a parent has been diagnosed with depression or anxiety.