

## E-Risk Study Concept Paper template

<b>Provisional Paper Title:</b> Parent-child resemblance in reading ability predicts children’s school performance
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<b>Please indicate if you will require an E-Risk independent reproducibility check:</b> <input type="checkbox"/>

Please describe your proposal in 2-3 pages with sufficient detail for helpful review.

### **Background & objective of the study:**

Person–environment fit (P–E fit) refers to the degree to which individuals’ characteristics are aligned with their environment. An example for the application of the P–E fit model is ‘personalized education’, which focuses on tailoring instruction to the learners’ characteristics (Bernacki et al., 2021) because optimizing the fit between instruction and learner is thought to benefit learning engagement and outcomes (von Stumm & Wertz, 2021).

Of particular interest for developmental psychologists is the P–E fit of children to the environments that they are reared in (Chess & Thomas, 1999). One specific aspect of this rearing environment is the home literacy environment reflecting the surroundings and conditions in which a child is exposed to language and literacy-related activities (Hamilton et al., 2016). A positive home literacy environment is crucial for fostering early literacy skills as well as later success in school-based reading and language development, which in turn directly relates to students’ educational achievement throughout their school career (Savolainen et al., 2008). Whether children experience rearing environments that provide a good fit for their personal characteristics and abilities may in part depend on how closely they resemble their parents in learning-related traits, such as cognitive ability and reading skills.

Here, we propose to leverage a **within-family design** by using longitudinal data from mothers and their twin children in E-Risk to investigate the **role of mother-child differences in reading ability for children’s subsequent school performance**. Specifically, we will tackle three research questions regarding the resemblance of mothers and children in their reading ability, including (1) whether children who resemble their mothers more closely in reading ability perform better in school, (2) if this effect persists after controlling for mothers’ and children’s reading ability and family SES, and (3) whether the direction of child-mother differences in reading ability matters for children’s school performance.

This study will be a **replication** of analyses that we have previously conducted using data on general cognitive ability from mothers and children who participated in the German TwinLife study (preregistration available on the OSF: <https://osf.io/p9vtk/>). We report our findings from

these analyses below. In the following, we provide more background information to our study's objective.

The umbrella term home literacy environment encompasses aspects such as, access to books, joint reading experiences, parent-child communication, as well as literacy-related attitudes and resources which children experience and that are associated with their language and reading skills development (Sénéchal & LeFevre, 2002). While a variety of factors shape the home literacy environment, parents' own reading ability is likely a particular important predictor. First, reading ability in itself and in association with intelligence and academic motivation, predicts crucial life outcomes, including socioeconomic markers such as the attained educational level and occupational status (Johnson et al., 2010; Ritchie & Bates, 2013). The family's socioeconomic background links to children's development, including their reading skills, since it forms the backdrop of financial, cultural, and social resources available in the context of children's upbringing (Hemmerechts et al., 2017). Second, the level of parents' reading skills and their reading interest also contribute to their parenting in terms of interaction behaviours, their reading attitudes and the activities they choose to engage in with their children. Parent-child interactions such as shared storybook reading or teaching reading skills to pre-school children by practising the alphabet and providing the name and sound of letters, predicts children's reading development, their interest, and joy in reading (Niklas et al., 2016; van Bergen et al., 2017). These initial skills shape children's own attitudes and reading self-concept over time, which likely affects how often they practice reading, thus giving rise to a bidirectional relationship of reading ability and reading enjoyment over time (cf. Malanchini et al., 2017). Through these processes, individual differences in children's reading activities emerge over development, which results in variation in reading ability as well as in children's school performance.

Apart from being exposed to more or less stimulating environments created by parents, children actively select and evoke learning experiences based on their abilities and skills from their environments; these learning experiences reciprocally influence their development, for example in the cognitive domain (cf. transactional process; Tucker-Drob et al., 2013). With regard to reading development, previous findings showed that children's reading skills are related to the frequency of home reading and that parents are likely to adjust these activities depending on the child's abilities (Silinskas et al., 2012). Effective learning experiences involve systematic interactions between person and environment that occur on a regular basis over extended periods of time (i.e., proximal processes; Bronfenbrenner & Morris, 2006). We hypothesise that the benefits of proximal processes for children's reading skills increase if parents and children resemble each other closely in the traits that pave the way to skill acquisition, in particular reading ability. In other words, parent scaffolding for reading development will be more effective if parents and children within a family resemble each other in their (age-adjusted) reading ability, and that the effect of parent-child resemblance on learning will be significant after adjusting for parents' and children's levels of reading. We propose that the learning opportunities that parents afford will be more available, accessible, and usable for their children, if parent-child differences in reading skills are small. By contrast, children may miss out on effective learning experiences if their parents' reading ability differs too greatly from their own, with alienation and discomfort in both parents and children as possible consequences.

Beyond the degree of resemblance, the direction of the parent-child difference in reading may also affect children's learning outcomes. Children, whose reading ability is lower than their parents', may struggle to utilise the learning opportunities that their parents afford. Yet, it is also possible that parents with high reading ability recognise their children's different learning needs and adapt the reading opportunities that they provide accordingly, for example by hiring after-school tutors or enrolling their children in dyslexia interventions to help them overcome any disadvantages. By comparison, children, whose reading ability exceeds that of their parents, may not find their home literacy environment sufficiently stimulating, which could have negative effects on their further reading development and learning. That said, children, who have better reading skills than their parents, may proactively seek reading opportunities elsewhere that offer them appropriate scaffolding for their development. To the best of our knowledge, no previous study has empirically tested these ideas; thus, our hypotheses are speculative and not derived from previous findings on the effects of parent-child resemblance in reading ability on children's educational achievement.

In the same vein, we conducted preliminary analyses to investigate the effect of mother-child resemblance in IQ on children's school performance. We used IQ data from a sample of twins (aged on average 11 years) and their mothers (N = 1,043 families), drawn from the German TwinLife study, and predicted children's achievement both cross-sectionally and two years later (i.e., at age 13 years, on average). While children's as well as mothers' IQ scores were significantly predictive of school achievement, the degree of mother-child resemblance (i.e., absolute difference IQ mother - IQ twin1/2) was not associated with school grades (cross-sectional:  $b = -0.05$ , 95% CI: -0.10, 0.01; longitudinal:  $b = -0.03$ , CI: -0.10, 0.04). While one would expect to see a similar effect pattern for IQ resemblance as we propose above for mothers' and children's reading ability, the measure of general cognitive ability is likely too coarse and abstract to have a direct and substantial effect on perhaps very specific activities and interactions in the everyday family life that would be relevant to children's long-term differences in educational performance. Thus, by focussing on reading ability specifically we expect to be able to observe the hypothesised mechanisms more closely.

### **Significance of the study (for theory, research methods or clinical practice):**

Here, we propose that studying how parents tailor family environments to their children's characteristics and needs can provide insights into personalized learning that are also applicable to classroom contexts. Within-family designs are particularly suited to test hypotheses about personalized learning, because they are likely better statistically powered due to larger sample sizes. That is, it is more feasible to collect data on person-environment fit in learning situations for a large sample of parent-child dyads/trios compared to collecting similar data for a large number of classrooms across schools (i.e., consisting of teachers and numerous children).

Educators, researchers, and policymakers are concerned with the question of how learning environments can be designed to best meet the needs of children who differ in their abilities, skills, and interests. In this study, we will provide insights about the role of the optimal 'match' between learner and environment, indicated by the mother-child resemblance in reading ability, for children's school performance. Our findings will enable inferring the extent to which the person-

environment fit affects children's learning ability and school performance and thus, contribute to our understanding of personalising education. This knowledge is crucial for designing and implementing evidence-based interventions that aim to provide all children with equally fair education opportunities.

### **Data analysis methods:**

We will capitalise on data from British family trios (i.e., mothers and their twin children), drawn from E-Risk. Measures will include mothers' reading ability when the twins were aged 5 years (assessed with the WRAT-3), the twins' reading ability at age 7 (measured using the sight word efficiency and phonemic decoding efficiency subtests of the TOWRE), and the twins' school performance in English and maths rated by their teachers at age 10 years. As control variables, we will include a composite of the family's social class as well as children's reading ability at age 10 (sight word efficiency subtest only).

In the following, we state our research questions and briefly describe our planned analysis approach to answer these questions.

As preliminary analyses, we will conduct bivariate correlations for twins' reading ability and their school performance at the ages 7 and 10 years as well as with mothers' reading ability and the family's social class.

### **Do children who resemble their mothers more in reading ability perform better in school?**

To address this question, we will fit a series of linear regression models. Regression error terms will be clustered at the family level to account for the correlation of error terms within families. Model 1 will specify the absolute difference between mothers and their twins in reading ability as predictor of children's school performance. Model 2 will include two variables that are likely to confound the association between mothers' and children's absolute difference in reading and children's school performance, including children's and mothers' level of reading and the family's SES. Note that the relative difference between mothers and children in their reading ability as a measure of parent-child resemblance cannot be entered in a regression model, because the variance of relative difference score is the same as the variance of the two main effects of mothers' and children's reading ability. Model 3 will use the co-twin design, in which within-twin-pair differences in school performance are predicted from their within-twin-pair differences in parent-child resemblance in reading ability after controlling for their within-twin-pair differences in reading ability (i.e., predictor (twin1 abs mother-child resemblance - twin 2 abs mother-child resemblance) + control (twin1 reading ability - twin2 reading ability) --> outcome (twin1 school perf - twin2 school perf). The co-twin design offers a stringent test of whether associations between mother-child resemblance in reading ability and school performance are due to unmeasured variation in objective family home characteristics or due to genetic factors that are shared between siblings within the same family (i.e., confounding).

### **Does the direction of child-mother differences in reading ability matter for children's school performance?**

To test if the effect of child-mother resemblance on children's school performance depends on if children have better reading ability than their mothers, compared to having weaker reading ability, we will add the direction of the child-mother difference as an additional predictor to our

regression models 1 to 3. We will create a three-level categorical variable (i.e., 0 = no difference between mother and child, 1 = mother has higher reading ability; 2 = mother has lower reading ability), which will be transformed into two dummy-coded variables before inclusion into the regression analyses (no difference between mother and child will serve as the reference category).

Model 1a will predict school performance from the absolute child-mother difference in reading, the dummy-coded direction of this difference, and their interactions. Model 2a will add the confounders mothers' and children's reading ability and the family's SES, to test if findings are robust. Finding that the influence of child-parents' resemblance in reading ability on learning is greater for children, who have lower reading ability than their mothers, would suggest that the person-environment fit for these children negatively affects their learning. Conversely, finding that the influence of child-parents' resemblance in reading ability on learning is weaker for children, who have lower reading ability than their mothers, would suggest that mothers effectively personalise their children's learning environments. Because we consider our analyses here exploratory, we make no specific predictions about the effect of the direction of the degree of the child-mother resemblance in reading ability on learning.

**Variables needed and at which ages:**

Phenotypic data:

Age 5:

Variable name	Description
familyid	Family ID
atwinid	Twin1 ID
btwinid	Twin2 ID
rorderp5	Random order
sampsex	Sex
TAGEE/Y5	Twins age
zygosity	Zygosity
hiedm5	Highest educational qualification mother
SESW	Continuous social Class Composite
ERDTM5	Mother's total reading score from WRAT-3
STEDRTM5	Standard Reading Score (Mother)
STEDRTGM5	Standard Reading Score (Mother) - grouped

Age 7:

Variable name	Description
TAGEE/Y7	Twins age
ETRWM7	Raw Reading Scores - Real Words - Elder Twin (SWE)
YTRWM7	Raw Reading Scores - Real Words - Younger Twin (SWE)
STRWEM7	Standard Reading Scores - Real Words - Elder Twin (SWE)
STRWYM7	Standard Reading Scores - Real Words - Younger Twin (SWE)
STRWGEM7	Grouped Standard Reading Scores - Real Words - Elder Twin (SWE)
STRWGYM7	Grouped Standard Reading Scores - Real Words - Younger Twin (SWE)
ETNWM7	Raw Reading Scores - Nonsense Words - Elder Twin (PDE)
YTNWM7	Raw Reading Scores - Nonsense Words - Younger Twin (PDE)
STNWM7	Standard Reading Scores - Nonsense Words - Elder Twin (PDE)
STNWYM7	Standard Reading Scores - Nonsense Words - Younger Twin (PDE)
STNWGEM7	Grouped Standard Reading Scores - Nonsense Words - Elder Twin (PDE)
STNWGYM7	Grouped Standard Reading Scores - Nonsense Words - Younger Twin (PDE)
TRFPEE7	English - School performance - Elder

TRFPEY7	English - School performance - Younger
TRFPME7	Maths - School performance - Elder
TRFPMY7	Maths - School performance - Younger

Age: 10

Variable name	Description
TAGEE/Y10	Twins Age
ETRWM10	Raw Reading Scores - Real Words - Elder Twin (SWE)
YTRWM10	Raw Reading Scores - Real Words - Younger Twin (SWE)
STRWEM10	Standard Reading Scores - Real Words - Elder Twin (SWE)
STRWYM10	Standard Reading Scores - Real Words - Younger Twin (SWE)
STRWGEM10	Grouped Standard Reading Scores - Real Words - Elder Twin (SWE)
STRWGYM10	Grouped Standard Reading Scores - Real Words - Younger Twin (SWE)
TRFP EE10	English - School performance - Elder
TRFPEY10	English - School performance - Younger
TRFPME10	Maths - School performance - Elder
TRFPMY10	Maths - School performance - Younger

**References cited:**

Bernacki, M. L., Greene, M. J., & Lobczowski, N. G. (2021). A Systematic Review of Research on

Personalized Learning: Personalized by Whom, to What, How, and for What Purpose(s)?

*Educational Psychology Review*, 33(4), 1675–1715. <https://doi.org/10.1007/s10648-021-09615-8>

Bronfenbrenner, U., & Morris, P. A. (2006). The Bioecological Model of Human Development. In

*Handbook of child psychology: Theoretical models of human development, Vol. 1, 6th ed* (pp. 793–828). John Wiley & Sons Inc.

Chess, S., & Thomas, A. (1999). *Goodness of Fit: Clinical Applications, From Infancy through Adult Life*.

Routledge. <https://doi.org/10.4324/9780203727607>

Hamilton, L. G., Hayiou-Thomas, M. E., Hulme, C., & Snowling, M. J. (2016). The Home Literacy

Environment as a Predictor of the Early Literacy Development of Children at Family-Risk of Dyslexia. *Scientific Studies of Reading*, 20(5), 401–419.

<https://doi.org/10.1080/10888438.2016.1213266>

- Hemmerechts, K., Agirdag, O., & Kavadias, D. (2017). The relationship between parental literacy involvement, socio-economic status and reading literacy. *Educational Review*, 69(1), 85–101.  
<https://doi.org/10.1080/00131911.2016.1164667>
- Johnson, C. J., Beitchman, J. H., & Brownlie, E. B. (2010). Twenty-Year Follow-Up of Children With and Without Speech-Language Impairments: Family, Educational, Occupational, and Quality of Life Outcomes. *American Journal of Speech-Language Pathology*, 19(1), 51–65.  
[https://doi.org/10.1044/1058-0360\(2009/08-0083\)](https://doi.org/10.1044/1058-0360(2009/08-0083))
- Malanchini, M., Wang, Z., Voronin, I., Schenker, V. J., Plomin, R., Petrill, S. A., & Kovas, Y. (2017). Reading self-perceived ability, enjoyment and achievement: A genetically informative study of their reciprocal links over time. *Developmental Psychology*, 53(4), 698–712.  
<https://doi.org/10.1037/dev0000209>
- Niklas, F., Cohrssen, C., & Tayler, C. (2016). Parents supporting learning: A non-intensive intervention supporting literacy and numeracy in the home learning environment. *International Journal of Early Years Education*, 24(2), 121–142. <https://doi.org/10.1080/09669760.2016.1155147>
- Ritchie, S. J., & Bates, T. C. (2013). Enduring Links From Childhood Mathematics and Reading Achievement to Adult Socioeconomic Status. *Psychological Science*, 24(7), 1301–1308.  
<https://doi.org/10.1177/0956797612466268>
- Savolainen, H., Ahonen, T., Aro, M., Tolvanen, A., & Holopainen, L. (2008). Reading comprehension, word reading and spelling as predictors of school achievement and choice of secondary education. *Learning and Instruction*, 18(2), 201–210. <https://doi.org/10.1016/j.learninstruc.2007.09.017>
- Sénéchal, M., & LeFevre, J. (2002). Parental Involvement in the Development of Children's Reading Skill: A Five-Year Longitudinal Study. *Child Development*, 73(2), 445–460. <https://doi.org/10.1111/1467-8624.00417>
- Silinskas, G., Lerkkanen, M.-K., Tolvanen, A., Niemi, P., Poikkeus, A.-M., & Nurmi, J.-E. (2012). The frequency of parents' reading-related activities at home and children's reading skills during kindergarten and Grade 1. *Journal of Applied Developmental Psychology*, 33(6), 302–310.  
<https://doi.org/10.1016/j.appdev.2012.07.004>



- Tucker-Drob, E. M., Briley, D. A., & Harden, K. P. (2013). Genetic and Environmental Influences on Cognition Across Development and Context. *Current Directions in Psychological Science*, 22(5), 349–355. <https://doi.org/10.1177/0963721413485087>
- van Bergen, E., van Zuijen, T., Bishop, D., & De Jong, P. F. (2017). Why Are Home Literacy Environment and Children’s Reading Skills Associated? What Parental Skills Reveal. *Reading Research Quarterly*, 52(2), 147–160. <https://doi.org/10.1002/rrq.160>
- von Stumm, S., & Wertz, J. (2021). Who’s learning? Using within-family studies to understand personalized learning. *Npj Science of Learning*, 6(1), Article 1. <https://doi.org/10.1038/s41539-020-00082-4>

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