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Developing and validating an abbreviated adult reading history questionnaire in the Finnish and Dutch contexts

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Background: The adult reading history questionnaire (ARHQ) is frequently used in research on adult dyslexia and family risk for dyslexia. However, this measure is lengthy (23 items), reducing its applicability in studies with extensive assessment batteries.
Methods: We identified the best-performing ARHQ items in a sample of 396 Finnish adults using exploratory factor analysis and item response theory. Consequently, we validated the brief questionnaire in independent Finnish and Dutch samples by comparing its performance with that of the complete questionnaire. We also evaluated how the scores on the questionnaires related to the scores on direct adult reading assessments in the Finnish samples. Finally, we tested how predictive parental questionnaires were of children's skills in the Dutch and one of the Finnish samples.
Results: Five items were selected to construct the short version of ARHQ. All of them relate to childhood/adolescent reading difficulties rather than current adult skills. The scores of the complete ARHQ significantly correlated with those of the abbreviated

version in all samples. Moreover, in one of the samples, direct reading assessment scores had a stronger correlation with the short ARHQ than with the full version. Additionally, across all three samples parental scores on the short ARHQ were at least as predictive of children's reading skills as the complete ARHQ.
Conclusions: The short ARHQ proved to be on a par with the complete version in its usefulness for identifying adults with dyslexia. Future research should investigate whether the five selected items can effectively serve as a brief screening measure for adults with dyslexia in languages other than Finnish and Dutch.

Keywords: adult literacy, assessment, dyslexia, adult reading history questionnaire

Highlights

What is already known about this topic

- The adult reading history questionnaire (ARHQ) is known for its high dyslexia identification accuracy in adult samples.
- Recently, an abbreviated version of the ARHQ has been developed in the US (Feng et al., 2022) appearing to be a good alternative to the full version.

What this paper adds

- This study developed and validated a short version of ARHQ using Finnish and Dutch samples; the present short version with five items is very similar to the one recently developed in the US, which suggests the generalisability of the previous findings across contexts.

Implications for theory, policy or practice

- The short ARHQ is a more convenient alternative to the complete version: when completed by parents, it is at least as predictive of children's reading skills as the full version and may thus be used to facilitate more targeted early interventions and/or support and more research with at-risk children.
- The short ARHQ mostly consists of childhood-related items, which makes it a useful measure for identifying adults who had early difficulties that resolved over time and can be used in future research focusing on factors predictive of resolving dyslexia.

Dyslexia is a neurodevelopmental disability characterised by persistent difficulties with reading fluency, accuracy and spelling that occur independently of sensory abilities or intelligence (Peterson & Pennington, 2012). Adult dyslexia is mainly identified with questionnaires and direct reading and cognitive assessments. Questionnaires, in particular, are of special interest to researchers because they are quicker and less expensive in identifying reading difficulties than direct assessments. Moreover, in cases of resolved adult dyslexia, questionnaires could be the only way to identify adults who had reading difficulties as children. Importantly, the offspring of these adults are genetically predisposed to early reading

difficulties, and for this reason, wide screenings of parents can facilitate the early identification of these children subsequently ensuring early targeted interventions.

The length of questionnaires is important. Too short questionnaires lack reliability whereas too long ones are inconvenient to administer and might be burdensome in clinical and practical settings, especially for poor readers. One of the most popular questionnaires to identify reading difficulties in adults is the adult reading history questionnaire (ARHQ). Lefly and Pennington (2000) developed and tested this self-report measure with two longitudinal samples; they demonstrated its excellent internal consistency (with Cronbach's alpha $>.90$) and its high dyslexia identification accuracy (the ARHQ's sensitivity and specificity are 81.8% and 77.5%, respectively, providing an overall correct identification rate of 79.0%). This measure includes 23 Likert-type items (rated from 0 to 4) that ask about childhood (early reading-related difficulties, school attainment and attitudes), current reading and spelling (adult habits, attitudes and self-concept) and short-term memory. The total ARHQ score is calculated as a sum of all items divided by 92 (the total number of all possible points), with higher scores corresponding to poorer reading skills.

Studies that followed Lefly and Pennington (2000) also consistently showed that higher scores on the ARHQ strongly correlated with adult reading difficulties (Deacon et al., 2012; Welcome & Meza, 2019). Therefore, the ARHQ has attracted international attention and has been adapted into several languages (Alves & Castro, 2005; Bjornsdottir et al., 2014; Krasowicz-Kupis et al., 2014). Although these studies confirmed the overall validity and reliability of the questionnaire, they also revealed that not all items significantly contributed to screening poor readers across countries, thus indicating clear differences in how the ARHQ items work across contexts (Bjornsdottir et al., 2014; Welcome & Meza, 2019).

A recent study in the US constructed an abbreviated version of the questionnaire using a machine learning approach (Feng et al., 2022) and found that six items sufficiently identify most adults with dyslexia (specificity = 81.5%; sensitivity = 72.4%). Five of the items they identified were about childhood difficulties (such as struggling to remember letter and/or colour names, poor early reading, reversing the order of letters and numbers, struggling to deal with one's own school workload), and one item was about current spelling. Importantly, parental scores on the authors' abbreviated version were more strongly predictive of children's skills in Grade 2 than their scores on the full ARHQ – the abbreviated ARHQ and the full ARHQ explained respectively 31.1% (R^2 = 29.5%) and 20.0% (R^2 = 18.2%) of the variance of the children's reading composite. However, Feng's et al. study employed a relatively small and well-educated sample of English-speaking adults (n = 97) and children (n = 51), raising concerns about the generalisability of the results. Therefore, replicating their study in contexts with other languages and using larger samples is important.

Our study aimed to develop and validate an ARHQ-brief in independent Finnish and Dutch samples. The writing systems of both these languages are transparent compared with English (Seymour et al., 2003) making our findings potentially generalisable to other contexts with consistent orthographies. Furthermore, our analytic strategy was different from that of Feng et al. (2022) and included item response theory (IRT).

Method

The researchers obtained ethical approvals for data collection from the ethical committees of the following institutions: the University of Jyväskylä, the Central Finland Hospital

District and the University of Amsterdam. All participants across our three samples provided informed and active consent prior to their participation in research.

Sample 1 was collected as part of the Interaction, Development and Learning study (VUOKKO) study, focusing on early skill development and learning environments (Lerkkanen & Salminen, 2015–2019; Salminen et al., 2021–2023). Families with young children, recruited via daycare centres, have been participating in this study since 2015. When the participating children were in Grade 1 (in Spring 2021), their parents were invited to answer the ARHQ (n = 396). Parents were between the ages of 26 and 67 (M = 39.99 years, SD = 5.37). Most of them were female (71%), monolingual Finns (93%), and well-educated (36% had a university degree and 35% completed a degree at a university of applied sciences). One participant had missing values on more than 25% of the ARHQ items and was excluded from analysis.

The parents were also invited for direct skill assessments (n = 201); three adult reading fluency tasks were included: text reading (Tunturilappi: Leinonen et al., 2001), word list reading and pseudoword list reading (Nevala et al., 2006). In all tasks, participants were asked to read aloud as accurately and as fast as possible. The time in seconds required for completing the task was then considered as the score. The total score of parental reading skills was the average of the three z-scores (Cronbach's alpha for the composite score = .87).

Children were in Grade 1 and aged between 7 and 8 years (M = 94.70 months, SD = 3.52), with 47% of them being female. Children's reading assessments included a nationally standardised word reading fluency task (ALLU/TL2A; Lindeman, 1998) and a sentence reading fluency task (TOSREC; Wagner et al., 2009). The former task included 80 items that were attempted within a 2-min limit. Each item offered a picture that needed to be matched with one out of four words. The latter task took 3 min and included 60 items, in each of which the participant was instructed to verify the truthfulness of a simple sentence. The total score of children skills was the average of the two fluency tasks' z-scores (Cronbach's alpha for the composite = .87) (for more details about the task, see Khanolainen et al., 2022).

Sample 2 was collected as part of the Jyväskylä Longitudinal Dyslexia study that recruited 200 families with newborn children (born between 1993 and 1996) and has followed them for almost 30 years. Half of the children were at family risk for dyslexia (had at least one parent and at least one other relative with dyslexia) and the other half was a matched control group of typically developing peers. In 2016–2018, when the participating children became young adults, they completed the ARHQ (n = 134, 22–23 years old, 52% were female, 100% were monolingual Finnish, 56% were at family risk for dyslexia, 56% of the risk group and 47% of the control group were female). Their educational levels were close to the average level in Finland. No participant had missing values on more than 25% of the ARHQ items. In addition, participants' reading skills were assessed (n = 134), and these direct adult assessments included exactly the same three reading fluency tasks used in Sample 1 (the composite score was the average of the three z-scores with Cronbach's alpha of .86). This sample included only adult data (child data were not collected because most of these young adult participants did not yet have children).

Sample 3 was collected as a part of a larger EEG study conducted at the University of Amsterdam between April 2021 and April 2022. The participants comprised 71 readers with dyslexia (38 girls) and 59 typically developing peers (29 girls). The average age of the dyslexic group was 9.82 years (SD = 0.96) and of the typically developing peers 9.22 years (SD = 1.29). Children with dyslexia were recruited via *Regionaal Instituut voor*

Dyslexie (RID), a nationwide clinical centre for dyslexia in the Netherlands. Children were referred to RID for diagnostic screening for dyslexia because of severe and persistent reading disabilities at school (i.e., below the 10th percentile on standard reading measures or below the 10th percentile on spelling in combination with a score below the 16th percentile on reading). Typically developing peers included acquaintances or siblings of the participants with dyslexia or were recruited via word of mouth. Both parents of the participating children were asked to answer the full ARHQ questionnaire. Of the 185 parents who answered the questionnaire, 5 had to be removed for missing more than 25% of the data, but the rest answered all items. Approximately half of these respondents were female (54%) and 57% of the sample was highly educated, which aligns with reported average education levels in 25- to 34-year-old adults in the Netherlands (Eurostat, 2023). Parents did not participate in any direct skill assessments; thus, their test scores as well as their exact ages were not available in this sample. Children's word reading skills were assessed with the Dutch one-minute test (Brus & Voeten, 1973). The test consisted of 116 Dutch words displayed on a sheet of paper with increasing difficulty. Children were instructed to read the words as accurately and quickly as possible within 1 min. Reading fluency was computed as the number of correctly read words, with a maximum score of 116.

Statistical Analysis

This study was preregistered on the Open Science Framework before data collection in Samples 1 and 3 and before any data inspection of all three samples (https://osf.io/e3c95). The analysis included five steps. First, the full ARHQ questionnaire's factor structure was explored in Sample 1 via exploratory factor analysis (EFA) using Mplus Version 8.10. We opted not to utilise confirmatory factor analysis in this study due to the absence of prior investigations into the factor structure of ARHQ within the Finnish context. EFA also aligned best with our primary objective at this stage, which was simply to identify items that did not fit any of the factors. We applied oblique rotation (GEOMIN) and maximum likelihood estimation with robust standard errors (MLR). This analysis in Mplus by default handles missing values using full information maximum likelihood. For the best fitting model, item loadings for each factor were inspected. Items that did not load to >0.4 on at least one of the factors were excluded (following Feng et al., 2022). Second, we employed IRT analysis on the retained items to determine the best-performing items. Items that were not efficiently discriminating based on a combination of discrimination parameters and item characteristic curves (ICCs) were eliminated. Third, correlations among the retained items were computed. Items that correlated $>.70$ with each other were eliminated to remove redundancy. We then validated the questionnaire by testing the associations between the scores on the brief and full versions of the ARHQ in all samples and tested the association between scores of the direct reading assessments in Samples 1 and 2 and those on the two ARHQ versions. Finally, we ran simple linear regressions with Samples 1 and 3 to compare how predictive the full and the short parental ARHQ scores were of children's reading skills.

Results

The data in all three samples followed an almost normal distribution. Appendix S1 presents the detailed descriptive statistics.

EFA

In Sample 1, we conducted EFA with all 23 ARHQ items. Mplus provided model solutions with one to eight factors whereas the models with nine or more factors did not converge. We selected the model with six factors based on the model comparison information derived from chi-square difference tests. The 6-factor model was significantly better than the 5-factor model, $\chi^2(18) = 193.292$, $p < .001$, but the 7-factor model was not significantly better than the 6-factor model, $\chi^2(17) = 20.730$, $p = .2386$. The 6-factor model (Table 1) also had the best fit (comparative fit index = 0.95, standardized root mean square residual = 0.03, root mean square error of approximation = 0.06, $\chi^2[130] = 299.65$, $p < .001$). Four items (1, 7, 12 and 19) did not load to >0.4 on at least one of the factors and were therefore excluded from further analysis. Thus, 19 items were further analysed.

Table 1. Exploratory factor analysis: factor loadings and communalities for GEOMIN rotated solution for 23 adult reading history questionnaire items.

	Factor loading						
Items	1	2	3	4	5	6	Communality
1	.121	.349*	.010	.035	.092	.041	**.572**
2†	**.981***	−.051	.051	−.031	.045	−.022	**.765**
3†	**.808***	.074	.014	.025	−.020	−.007	**.694**
4†	.341*	**.512***	−.089*	−.009	−.096	.017	**.623**
5†	.271	**.728***	.022	−.023	−.011	−.334*	**.669**
6†	**.583***	.070	.011	−.021	−.010	.268*	**.625**
7	.268	.359*	−.109*	.044	.106	.082	**.594**
8†	.213	**.406***	.010	.104*	.085	.117	**.535**
9†	−.057	.217*	**.527***	−.022	−.076	.077	**.589**
10†	.011	.012	**.902***	.047	.013	−.029	**.736**
11†	.118	−.007	−.225	−.071	−.002	**.503***	**.647**
12	−.143*	.185	.292*	.096	.009	.014	.352
13†	**.612***	.303*	−.035	.074*	.014	.023	**.755**
14†	−.006	.257*	.068	.025	.025	**.663***	**.517**
15†	−.023	**.639***	.065	−.052	.032	−.328*	**.667**
16†	.021	−.029	.003	.020	**.733***	.087	**.733**
17†	−.058	.005	−.037	−.016	**.948***	.001	**.821**
18†	.120	.143*	.055	.033	**.619***	−.071	**.668**
19	.001	.386*	−.021	−.008	.234*	.049	**.655**
20†	.106*	−.030	**.763***	−.005	.017	.024	**.685**
21†	−.027	−.080	.190*	**.415***	.076	.010	**.497**
22†	.025	−.010	.002	**.876***	−.033	−.014	**.813**
23†	−.003	.029	−.004	**.874***	−.002	.015	**.820**

Note. The items in this table are shortened for brevity.
†Items included in the next step of our analysis.
*Significant loadings at 5% level. Bolded communalities are above.40. Bolded loadings are above .40.

IRT

Because the questionnaire comprises items with multiple response options (polytomous items) ordered from 0 to 4, a graded response model using MLR was estimated using Mplus Version 8.10. The estimated model examined the associations between the latent trait measured (reading difficulties) and two types of item parameters – discrimination parameters (a) and threshold parameters (b1–b4) (Table 2). A higher discrimination parameter score indicates a higher response probability when there are changes in the latent trait. Items 2–6, 8, 13 and 15 had the highest discrimination parameter scores (>0.60), indicating their greater sensitivity to changes in the latent trait. In addition, ICCs were constructed for all items (Figure 1 and Appendix S2), and their examination suggested that Items 2 and 3 were the most efficient in discriminating along the continuum of reading skills. Based on the ICCs and discrimination parameters, 12 items were identified (9–11, 14–18 and 20–23) that failed to make clear discriminations and thus were dropped from the abbreviated questionnaire.

Table 2. Standardised item response theory parameters for adult reading history questionnaire items selected after exploratory factor analysis.

	Discrimination parameter			Threshold parameters							
Item	A	SE	A/SE	B1	SE	B2	SE	B3	SE	B4	SE
2†	.933	.017	55.249	0.264	.062	0.932	.074	1.302	.088	1.785	.127
3†	.932	.016	56.878	0.635	.066	0.680	.067	1.479	.102	1.892	.133
4†	.722	.046	15.595	0.348	.062	0.947	.075	1.404	.099	1.974	.146
5†	.819	.039	21.050	0.985	.078	1.717	.122	2.246	.186	2.519	.202
6†	.784	.035	22.477	−0.704	.069	−0.076	.060	1.131	.082	1.948	.142
8†	.705	.040	17.417	0.023	.059	0.763	.068	1.560	.105	2.094	.164
9	.289	.065	4.473	0.522	.062	1.346	.099	2.498	.266	3.233	.530
10	.248	.066	3.771	−0.915	.075	−0.215	.057	0.849	.073	2.502	.273
11	.422	.055	7.657	−1.010	.078	−0.203	.058	1.513	.111	2.253	.211
13†	.897	.020	44.630	0.107	.061	0.800	.070	1.434	.099	1.920	.133
14	.577	.042	13.629	−0.813	.070	0.046	.058	1.486	.104	2.726	.325
15	.716	.082	8.734	1.965	.147	2.415	.218	‡	‡	‡	‡
16	.390	.060	6.343	−0.732	.068	−0.117	.058	.647	.065	1.507	.111
17	.374	.060	6.205	−0.677	.066	0.064	.057	0.937	.075	1.670	.127
18	.511	.054	9.482	−0.678	.066	0.079	.058	0.884	.073	1.647	.120
20	.281	.066	4.538	−0.479	.061	0.028	.056	0.601	.064	1.460	.110
21	.154	.060	2.550	−1.343	.101	−0.664	.066	−0.017	.056	1.533	.118
22	.225	.061	3.682	−0.315	.059	0.036	.057	0.489	.061	1.053	.082
23	.253	.060	4.228	−0.748	.068	−0.192	.057	0.206	.057	0.923	.075

†Items included in the next step of our analysis.
‡These numbers are missing from the table because IRT treated Item 15 as a binary variable. This happened because 97.5% of the sample picked 'no' when replying to this item, and there was almost no variance.

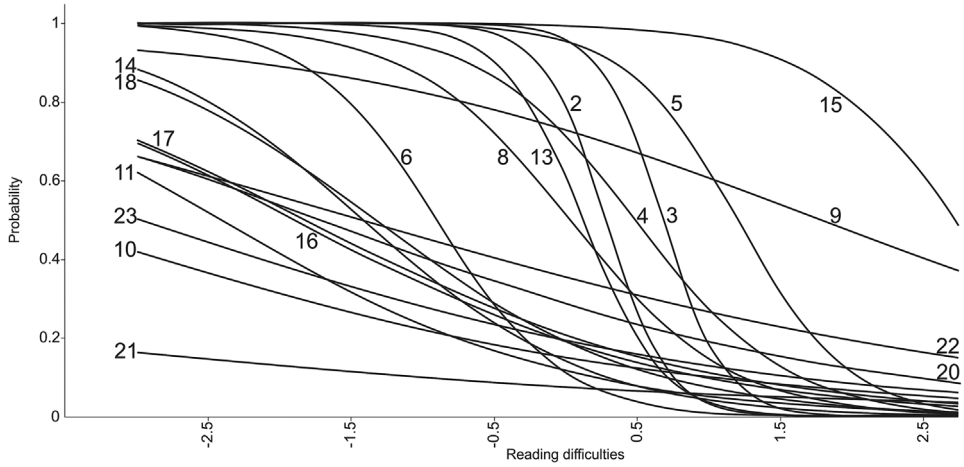

Figure 1. Item characteristic curves for the items included into the second step of analysis (item response theory).

Correlations

To eliminate redundancy, Pearson correlation coefficients were calculated (Appendix S1). Items 2 and 3 highly correlated (.81) and had very similar relations with the remaining items. Moreover, Item 13 highly correlated with Items 2 (.76) and 3 (.71). At the previous analysis step, Item 2 was slightly more discriminating than Items 3 and 13. Thus, we retained Item 2 and discarded Items 3 and 13. The English versions of all items included into the short version are presented in full below:

- How much difficulty did you have learning to read in elementary school?
- Did you ever reverse the order of letters or numbers when you were a child?
- Did you have difficulty learning letter and/or colour names when you were a child?
- How would you compare your reading skill to that of others in your elementary classes?
- Did you experience difficulties in high school or college English classes?

Validation

Five items (2, 4–6 and 8) were retained to construct the abbreviated questionnaire. To validate the results, we calculated the correlations between the scores of the brief and full versions. Correlations were high across the three samples (.80–.88) (Table 3). We then calculated the correlations between the reading assessment scores in the two Finnish samples (1 and 2) and the scores on the questionnaire's brief and full versions (Table 3). We then tested the difference between the correlations using Fisher's *r*-to-*z* transformation and an asymptotic *z*-test (Lee & Preacher, 2013). In Sample 2, the full and brief versions showed almost identical correlations with reading skills (.56 and .55, respectively) and the test of the difference confirmed that the two correlations were not statistically different (*z*-score = −0.28, $p = .776$). However, in Sample 1, reading scores more strongly correlated to the scores on the brief version (.56) than to those on the full version (.46). The test of the difference showed that the two correlations were indeed statistically different (z-score = 3.73, $p < .001$).

Table 3. Correlations between different measures of reading skills in the three samples.

Sample	ARHQ-23 (original version)	ARHQ-5 (short version)
Sample 1 – Finnish Sample 1 (N = 396)		
ARHQ-23	1	
ARHQ-5	0.80***	1
Direct assessment of adult skills	0.46***	0.56***
Sample 2 – Finnish Sample 2 (N = 134)		
ARHQ-23	1	
ARHQ-5	0.88***	1
Direct assessment of adult skills	0.56***	0.55***
Sample 3 – Dutch sample (adults did not participate in direct skill assessments)		
ARHQ-23	1	
ARHQ-5	0.87***	1

*$p < .05$.
**$p < .01$.
***$p < .001$.

Next, we calculated the questionnaires' internal consistency for all three samples. In Sample 1, Cronbach's alphas were .81 (brief) and .86 (full). In Sample 2, they were .84 (brief) and .89 (full), and in Sample 3, Cronbach's alphas were .87 (brief) and .90 (full).

Predicting children's Skills

Using Sample 1, two simple linear regressions were performed to predict children's reading skills in Grade 1 based on (1) the full parental ARHQ score and (2) the short parental ARHQ score. Significant regression equations were found for both regressions (for the full version: $F[1, 333] = 35.464$, $p < .000$, with R^2 of 9.6%; and for the short version: $F[1, 333] = 34.319$, $p < .000$, with R^2 of 9.3%). In Sample 3 we found similar results, that is, children's reading fluency was significantly predicted by both the full and short parental ARHQ scores (for the full version: $F[1,174] = 4.915$, $p = .028$, with R^2 of 2.7%; and for the short version: $F[1,174] = 10.150$, $p = .002$, with R^2 of 5.5%).

Discussion

The ARHQ is a popular but rather lengthy questionnaire and therefore is burdensome in clinical and research settings, especially for adults with poor reading skills. A recent study constructed an abbreviated version of the questionnaire in a US sample (Feng et al., 2022), but none have tried to replicate the results. Our study developed and validated an abbreviated version of the ARHQ in Finnish and Dutch samples using IRT (see Appendix S3 for all items in Finnish and Dutch).

Five items were selected to construct the short ARHQ. The scores of the full ARHQ highly correlated with those of the short version in all samples, suggesting little disagreement in using the short or full ARHQ when identifying adults' reading difficulties. These

findings support Welcome and Meza's (2019) argument that not all ARHQ items significantly contribute to the identification of adults with reading difficulties. The five items identified in this study are very similar to the six items identified by Feng et al. (2022). We aimed to replicate their study using a different analytic approach while addressing their main limitation (a relatively small convenience sample of 146 adults) and evaluating the generalisability of their results to contexts with orthographies more transparent than English. Note that our samples might not be perfectly representative of the Finnish and Dutch contexts either, but the three samples included 715 adults and demonstrated a high level of skill variability – both very low and very high skills were represented.

One of the main limitations of our study was that the full ARHQ was offered to all participants across three different samples, and the developed short version was not validated in a separate sample. Being exposed to the complete set of items might have affected the way participants interpreted the items and responded to them. New patterns of interpretation and response might arise when participants are presented with only the items from the short ARHQ. Therefore, future studies should test if our results can be replicated with the use of only the short ARHQ.

Overall, our results are in line with Feng et al.'s (2022) findings (four items were the same in both versions), indicating that indeed similar abbreviated ARHQ versions could be effectively used across contexts; this supports the generalisability of the results. Moreover, note that most questions in both their and our versions ask about childhood literacy development. Our version has an additional Item 6 (comparing the respondent's reading skills to that of peers during elementary school) whereas their version had additional Items 7 (struggling to complete work in school) and 14 (comparing current spelling skills). This latter item might be particularly important in opaque orthographies where inaccurate spelling is more common (Reis et al., 2020).

Considering that childhood-related items performed best both in our study and in Feng et al.'s (2022) study, retaining these items in future versions of reading questionnaires is important. Adding these items to direct reading assessments that measure current adult skills but overlook participants' reading history could also be beneficial. These childhood-related items are particularly useful for identifying adults with resolved reading difficulties, who constitute about half of those struggling with reading during early grades in Finland (Eloranta et al., 2019). Identifying such adult readers would facilitate the early identification of their children who are at risk for developing reading difficulties, allowing for preventive interventions (similar to the one organised by Zijlstra et al., 2021). This identification will also aid in conducting better research on the home literacy environment. Measuring true environmental effects is possible if genetic influences are controlled for (van Bergen et al., 2017), and the short ARHQ could be an easy addition to commonly used batteries, thus facilitating the parental skill control method.

Another important finding is that the scores of our short ARHQ were significantly correlated with participants' directly assessed skills. Interestingly, in Sample 1, adults' reading scores had a stronger association with the short ARHQ than with the full version. This could be attributable to some of the discarded items regarding printed media use that are outdated, owing to the increasing volume of digital resources, and therefore have limited predictability for current reading performance.

Furthermore, parental scores on the short ARHQ appeared to be more predictive of children's reading fluency in Sample 3 compared with the full version. At the same time, the two versions of ARHQ were equally predictive in Sample 1. These findings are partly in line with what was reported by Feng et al. (2022) – parental scores on their abbreviated

ARHQ were also more predictive of children's skills than the scores on the full version (even though Feng et al. (2022) reported larger R^2, the amount of variance explained in our study is similar to what was found in other family risk studies (Torppa et al., 2011; van Bergen et al., 2014). Moreover, these findings support our earlier argument about the importance of childhood-related items for identifying adults with resolved difficulties. Indeed, our short version consists of only childhood related questions, which highlights that parents' reading history rather than their adult reading skills are particularly important when screening for children at risk for early reading difficulties. This might be generalisable to other transparent orthographies but perhaps not to opaque orthographies (cf. Feng et al., 2022, who found spelling skills to be an important item). Items focusing on adult skills, attitudes and current reading habits fail to identify adults with resolved difficulties, but these items might be particularly useful for identifying those with late-emerging dyslexia. This hypothesis should be explored in future research.

Finally, it is worth noting that both short and long questionnaires explained a lower proportion of variance in children's skills within the Dutch sample. However, the reasons behind this disparity remain somewhat unclear. One possible contributing factor might be the differing levels of orthographic depth between the two contexts, with Finnish orthography generally being more transparent (Seymour et al., 2003). Additionally, the Finnish sample relied upon a slightly more comprehensive assessment of children's skills, which included two different measures. Finally, in the Dutch sample, the group of typically developing peers consisted of acquaintances or siblings of the children with dyslexia. This setup occasionally led to instances where the same parental self-reports were matched with both high- and low-scoring children.

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Conflicts of Interest

The authors have no conflict of interest to disclose.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request (Preregistration: https://doi.org/10.17605/OSF.IO/E3C95.

Appendices S1–S3: https://doi.org/10.17605/OSF.IO/9VK5C).

References

Alves, R. A., & Castro, S. L. (2005). Despistagem da dislexia em adultos através do questionário história de leitura [Screening of dyslexia in adults through the adult reading history questionnaire]. *IberPsicologia: Anales de la Revista de Psicologia General y Aplicada*, *10*(8), 9.

Bjornsdottir, G., Halldorsson, J. G., Steinberg, S., Hansdottir, I., Kristjansson, K., Stefansson, H., & Stefansson, K. (2014). The adult reading history questionnaire (ARHQ) in Icelandic: Psychometric properties and factor structure. *Journal of Learning Disabilities*, *47*(6), 532–542. https://doi.org/10.1177/0022219413478662

Brus, B. T., & Voeten, M. J. M. (1973). *Een minuut test: Verantwoording en handleiding [One minute decoding test, form A and B: Rationale and manual]*. Berkhout.

Deacon, S. H., Cook, K., & Parrila, R. (2012). Identifying high-functioning dyslexics: Is self-report of early reading problems enough? *Annals of Dyslexia*, *62*(2), 120–134. https://doi.org/10.1007/s11881-012-0068-2

Eloranta, A. K., Närhi, V. M., Ahonen, T. P., & Aro, T. I. (2019). Resolving reading disability – Childhood predictors and adult-age outcomes. *Dyslexia*, *25*(1), 20–37. https://doi.org/10.1002/dys.1605

Eurostat. (2023, April). Population by educational attainment level, sex and age (%). https://ec.europa.eu/eurostat/databrowser/bookmark/b9a5f8d9-9f5f-41d7-856c-8f5c675283d0?lang=en

Feng, L., Hancock, R., Watson, C., Bogley, R., Miller, Z. A., Gorno-Tempini, M. L., Briggs-Gowan, M. J., & Hoeft, F. (2022). Development of an abbreviated adult reading history questionnaire (ARHQ-brief) using a machine learning approach. *Journal of Learning Disabilities*, *55*(5), 427–442. https://doi.org/10.1177/00222194211047631

Khanolainen, D., Salminen, J., Eklund, K., Lerkkanen, M.-K., & Torppa, M. (2022). Intergenerational transmission of dyslexia: How do different identification methods of parental difficulties influence the conclusions regarding children's risk for dyslexia? *Reading Research Quarterly*, *58*(2), 220–239. https://doi.org/10.1002/rrq.482

Krasowicz-Kupis, G., Bogdanowicz, K. M., & Wiejak, K. (2014). Familial risk of dyslexia in polish first grade pupils based on the ARHQ-PL questionnaire. *Health Psychology Report*, *2*(4), 237–246. https://doi.org/10.5114/hpr.2014.46235

Lee, I. A., & Preacher, K. J. (2013, September). Calculation for the test of the difference between two dependent correlations with one variable in common [Computer software]. http://quantpsy.org

Lefly, D. L., & Pennington, B. F. (2000). Reliability and validity of the adult reading history questionnaire. *Journal of Learning Disabilities*, *33*(3), 286–296. https://doi.org/10.1177/002221940003300306

Leinonen, S., Müller, K., Leppänen, P. H., Aro, M., Ahonen, T., & Lyytinen, H. (2001). Heterogeneity in adult dyslexic readers: Relating processing skills to the speed and accuracy of oral text reading. *Reading and Writing*, *14*(3), 265–296. https://doi.org/10.1023/A:1011117620895

Lerkkanen, M.-K., & Salminen, J. (2015–2019). Interaction, development & learning (VUOKKO) – study. Early Childhood Education. Unpublished data. University of Jyväskylä, Finland.

Lindeman, J. (1998). *ALLU – Ala-asteen lukutesti [Reading test for primary school]*. University of Turku.

Nevala, J., Kairaluoma, L., Ahonen, T., Aro, M., & Holopainen, L. (2006). *Lukemis- ja kirjoittamistaitojen yksilötestistö nuorille ja aikuisille [Individual test material for assessing dyslexia in youth and in adult age] (standardization version)*. Niilo Mäki Instituutti.

Peterson, R. L., & Pennington, B. F. (2012). Developmental dyslexia. *The Lancet*, *379*(9830), 1997–2007. https://doi.org/10.1016/S0140-6736(12)60198-6

Reis, A., Araújo, S., Morais, I. S., & Faísca, L. (2020). Reading and reading-related skills in adults with dyslexia from different orthographic systems: A review and meta-analysis. *Annals of Dyslexia*, *70*(3), 339–368. https://doi.org/10.1007/s11881-020-00205-x

Salminen, J., Lerkkanen, M.-K., Koponen, T., & Torppa, M. (2021–2023). Interaction, development, and learning (VUOKKO) – study: Early school years (Grades 1–3). Research data. University of Jyväskylä. Finland.

Seymour, P. H., Aro, M., Erskine, J. M., & Collaboration with COST Action A8 Network. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, *94*(2), 143–174. https://doi.org/10.1348/000712603321661859

Torppa, M., Eklund, K., Van Bergen, E., & Lyytinen, H. (2011). Parental literacy predicts children's literacy: A longitudinal family-risk study. *Dyslexia*, *17*(4), 339–355. https://doi.org/10.1002/dys.437

van Bergen, E., De Jong, P. F., Maassen, B., & van der Leij, A. (2014). The effect of parents' literacy skills and children's preliteracy skills on the risk of dyslexia. *Journal of Abnormal Child Psychology*, *42*(7), 1187–1200. https://doi.org/10.1007/s10802-014-9858-9

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

Wagner, R. K., Torgesen, J. K., Rashotte, C. A., & Pearson, N. A. (2009). *TOSREC: Test of sentence reading efficiency and comprehension*. Pro-Ed.

Welcome, S. E., & Meza, R. A. (2019). Dimensions of the adult Reading history questionnaire and their relationships with reading ability. *Reading and Writing*, *32*(5), 1295–1317. https://doi.org/10.1007/s11145-018-9912-z

Zijlstra, H., Van Bergen, E., Regtvoort, A., De Jong, P. F., & Van Der Leij, A. (2021). Prevention of reading difficulties in children with and without familial risk: Short-and long-term effects of an early intervention. *Journal of Educational Psychology*, *113*(2), 248–267. https://doi.org/10.1037/edu0000489

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