Accepted 2024: *International Journal of Disability, Development and Education*

Developmental Trajectories of Reading Ability in Adolescents with Intellectual Disabilities

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Abstract

Individuals with ID often struggle with decoding and reading comprehension, and some studies indicate that these students do not progress beyond the early stages of decoding development. The aim of this study was to investigate the developmental trajectories of reading abilities in relation to mental age in a sample of 136 adolescents with mild, non-specific ID. Decoding and reading comprehension, together with their predictors of phonological awareness, RAN, phonological working memory, and vocabulary, were fitted against mental age. The results showed that, after 105 months, there was an unexpected plateau in the development of decoding, phonological awareness, rapid automatized namning (RAN), and phonological working memory in this sample, while reading comprehension and vocabulary continued to show growth in relation to mental age. The implications of these different trajectories are discussed in relation to developmental models of disability, and possible reasons for the plateau in decoding are suggested.

Keywords: decoding, reading comprehension, development, intellectual disability, mental age

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Introduction

It is well known that individuals with intellectual disability (ID) exhibit difficulties with reading, and that these difficulties apply to both decoding and reading comprehension abilities (Afacan & Wilkerson, 2022; Lemons et al., 2013; Ratz & Lenhard, 2013; Wei, Blackorby, & Schiller, 2011). Our study aimed to investigate concurrent developmental trajectories of decoding and reading comprehension in a sample of adolescents with mild, non-specific ID. These two abilities were chosen because they are often thought of as the goals of reading instruction, and are the most common ways of operationalising reading ability. Studies focussing on the developmental trajectories of these abilities in adolescents with ID in comparison to typical development at the same mental age are sparse, and better understanding of this could inform future research on reading instruction and interventions for individuals with ID. There are a number of investigations of reading that focus on students with ID who have known aetiologies, such as Down Syndrome (DS, Boudreau, 2002) and Williams syndrome (WS, Menghini et al., 2021), or samples with mixed aetiologies (Channell et al., 2013). Because less is known about individuals with mild, non-specific ID, i.e. mild ID of unknown aetiology, and because this group constitutes a large proportion of the population with ID (Lichtenstein et al., 2022), it was decided to investigate the developmental trajectories in these individuals.

In relation to decoding, a study by Ratz and Lenhard (2013) showed that many students with ID, regardless of aetiology, failed to progress beyond the early stages of decoding development. In a group of individuals aged 11-15 years (n = 631), 29.8% still read at the alphabetic stage. Reading at this stage is characterized by decoding a word letter by letter, as the decoding process is not yet automatized. For the individuals aged 16-21 (*n* = 417), the corresponding figure was 18.6%. The authors concluded that decoding ability develops during primary and up to the end of secondary school but with little progress after that. A study by Lemons et al. (2013) found that over 50% of individuals with ID in Grade 11 had word reading abilities corresponding to the benchmark for Grade 1. These figures indicate that a substantial proportion of individuals with ID do not develop an automatized decoding ability with increasing chronological age.

In relation to the development of reading comprehension abilities, Wei et al. (2011) used a longitudinal data set to model reading growth curves for students with different disabilities aged between 7-17 years. The models showed that the growth rate for all disability groups decreased over time in a similar manner, but the students with ID had the lowest starting and end point of development. Afacan and Wilkerson (2022) investigated the reading performance of students with ID in Grade 5 and 8 on statewide assessments of reading comprehension. They found that the majority of students only reached the minimal reading proficiency level on the general reading assessment. Among students that took an alternate reading assessment (e.g. administered one-to-one, not timed, and with various accommodations), approximately a third reached the proficient level. However, the percentage of students that reached the advanced level was small for both types of assessment.

It is clear from these studies that individuals with ID are delayed relative to chronological age, both in decoding abilities and reading comprehension abilities. In the current study, we argue that an important issue is to investigate developmental trajectories in individuals with ID. Further, we argue that looking at these trajectories in relation to mental age rather than chronological age has the potential to be the best approach, since it is not expected that individuals with ID should develop in accordance with their chronological age (Burack et al., 2021). Hence, the aim of this study was to explore the developmental trajectories of decoding and reading comprehension abilities in relation to mental age in a group of adolescents with mild, non-specific ID.

Development of Decoding Abilities in Relation to Mental Age

As outlined earlier, the level of decoding ability in individuals with ID has not been found to correspond to their chronological age (e.g. Lemons et al., 2013; Ratz & Lenhard, 2013). Previous research about the relation of decoding ability and mental age (MA) have produced inconsistent results from various groups with ID such as those with known aetiologies (often DS or WS) or mixed aetiologies. For example, there are two studies reporting that participants with WS perform on par with, or better than, their peers matched on MA (Menghini et al., 2004; Pezzino et al., 2021); some research on participants with mixed aetiology ID indicates poorer performance (Channell et al., 2013); and yet other research shows that participants with DS perform better than their MA matched peers (Boudreau, 2002). These differences could reflect that the aetiology of the ID differs between these studies (i.e., DS, WS or mixed aetiologies), but they could also depend on the measure of decoding that was used. In the study by Menghini et al. (2004), a group of individuals with WS (n = 16) was compared to a group of typically developing children (n = 16) matched on MA. Here, the groups did not differ on accuracy measures of word recognition, but they did differ significantly on accuracy measures of phonological decoding, i.e., non-word reading. In contrast, Pezzino et al. (2021) found that a group with WS (n = 29) performed better than the MA matched group (n = 192) on both word recognition and phonological decoding. In addition, a study investigating reading abilities in a group with DS (n = 20) found that the group with DS performed better than the MA matched control group (n = 20) on a measure of word recognition, while there were no group differences on a measure of phonological decoding (Boudreau, 2002). A narrative review concluded that children with ID with genetic aetiologies mostly performed better compared to MA matched groups on measures of word recognition, but performed on par with the MA matched group on measures of phonological decoding (Blasi et al., 2018). In summary, the evidence concerning the relationship between MA and decoding in individuals with ID is inconclusive, and there is a lack of studies examining decoding ability in relation to MA in individuals with non-specific ID.

Development of Reading Comprehension Abilities in Relation to MA

The limited findings about the development of reading comprehension in relation to MA in individuals with ID are also inconsistent and differ according to aetiology (e.g., WS, DS or mixed aetiology). Individuals with WS were found to perform more poorly on a reading comprehension task in comparison to MA matched typically developing children (Menghini et al., 2004). In contrast, a study on individuals with DS showed that the DS group performed on par with the MA matched control group on a test of passage comprehension (Boudreau, 2002). These different patterns could be explained by syndrome specific differences, or the level of reading comprehension ability that was required to solve the tasks. For example, in a study by Wingerden et al. (2014), a group of individuals with mixed aetiology ID were compared to a group of younger typically developing children on measures of higher- and lower-level reading comprehension. The lower-level comprehension task included the use of explicit text cues, while the higher-level comprehension task assessed the participant's ability to make inferences and to extract the main topic of the story. The results showed that there were no group differences on lower level-reading comprehension, while there was a significant group difference on higher-level reading comprehension. As was the case for decoding, there is a lack of studies focussing on reading comprehension in relation to MA in individuals with non-specific ID.

Present study

The previous studies that we have reviewed focused on whether decoding and reading comprehension abilities in individuals with ID are better, worse or similar to MA matched groups of typical individuals. As such, they can elucidate whether developmental approaches (e.g., Burack et al., 2021) are suitable to account for decoding and reading comprehension development in samples of young people with ID, i.e., are decoding and reading comprehension abilities commensurate with mental age? However, these studies do not tell us about the general rate or pace of development in relation to MA because they consider mean scores between groups. In addition, there is a lack of studies focussing on non-specific ID, an issue addressed by the current study. Additional information can be captured using a developmental trajectories approach because this allows us to see whether development proceeds (in relation to MA) at an improving rate that is broadly linear, or whether there are plateaus at certain points. Further, the developmental trajectories approach provides a richer vocabulary in describing developmental delay, leading to a better understanding of the underlying mechanisms (Thomas et al., 2009).

Figure 1 shows the growth trajectories of decoding and reading comprehension in relation to reading age in a Swedish sample of typically developing children, similar curves would be expected if the decoding and reading comprehension of individuals with ID followed a delayed path. These trajectories were based on the normative data from the decoding test LäSt (Elwér et al., 2016) used in the current study. The normative data comes from Swedish speaking children with a chronological age between 7 and 13 years. According to these normative data, there should be a continuous development of both decoding and reading comprehension abilities up to the reading age of 13 years in Swedish speaking children. Reading age is expected to coincide with chronological age in a typical reader, in the same manner as MA is expected to coincide with chronological age in a typically developing individual.

[Figure 1 around here]

In the present study, developmental trajectories for decoding and reading comprehension were investigated in relation to MA in a sample of 136 Swedish adolescents with mild, non-specific ID using a cross-sectional design. Two earlier studies with the same sample have described the predictors of decoding and reading comprehension, respectively (Nilsson et al., 2021a, 2021b). The study focussing on decoding showed that this ability was predicted by phonological awareness and rapid automatized naming (RAN, Nilsson et al., 2021a) and it was evident that phonological awareness exhibited the strongest predictive relationship to decoding. For typically developing adolescent readers in a transparent orthography such as Swedish, the opposite is often true; this appears to be because during adolescence phonological awareness becomes a weaker predictor of decoding, while RAN persists as a predictor (Furnes & Samuelsson, 2010; Landerl & Wimmer, 2008). Together these two sets of findings imply that adolescents with ID have not shifted decoding strategies and progressed into an orthographic stage, and that they have a delayed profile of decoding. The other previous study, of reading comprehension in adolescents with ID, showed that comprehension was best predicted by decoding, vocabulary, and phonological executive-loaded working memory (ELWM, Nilsson et al., 2021b), indicating a delayed pattern of development since the same predictors are often found in younger typically developing children. Given the results of these previous studies, the variables of interest in the current study were decoding and reading comprehension, but also their respective predictors. The present study used an exploratory approach in answering the following research question: What are the developmental trajectories of decoding and reading comprehension together with their predictors in relation to mental age in adolescents with mild, non-specific ID?

Methods

The data used in this study was collected in a larger project on reading abilities in adolescents with ID.

Ethical approval

This study received ethical approval from the regional Research Ethics Committee in Linköping, Sweden.

Participants

For inclusion in this study the following were required: 1) age 12-19 years; 2) a level of decoding ability that could be measured with the tests used in this study (i.e., >0 words correct); 3) normal or corrected to normal vision and hearing; 4) Swedish speaking home environment since birth; and 5) mild non-specific ID. The decision to focus on adolescents with mild ID was connected to the second inclusion criterion. It is reasonable to assume that the milder the ID, the higher the chance of these adolescents decoding at a measurable level. A total of 136 participants were included. The mean chronological age was 189.61 months (*SD* = 25.87 months), the mean estimated IQ of the participants was 59.43 (*SD* = 9.72), and the mean mental age was 112.88 months (*SD* = 25.26 months). More information is provided in Table 1. IQ was estimated using two sub-tests from the WISC-V (Wechsler, 2014). Fifteen of the participants were estimated to have an IQ above 70, however, all participants were enrolled in special education classes during data collection, which in Sweden means that they have been tested and diagnosed as having ID by a clinical psychologist. Participants were recruited via schools, and both written and oral consent was obtained. For participants under the age of 15 years, written consent was obtained from caregivers and oral consent was obtained from the participant. For participants over the age of 15, additionally, written consent was obtained from the participants.

[Table 1 around here]

Assessment

All participants were assessed in their school environment. The assessments took approximately 4 hours in total; the assessment sessions were divided into shorter parts to fit in with the school schedule. Sessions were completed on different days and breaks were allowed when necessary to avoid fatigue. A wide range of tests was administered, but only the measures of interest for the current study are described below.

Decoding. Decoding was measured using the LäSt test (Elwér et al., 2016) where both word recognition and phonological decoding are assessed. The test consists of two forms covering both types of decoding. One form had a time constraint, meaning that the participants were instructed to read separate lists of words and non-words as quickly as possible in 45 seconds. The other form was used to measure decoding ability without a time constraint and the participants were instructed to read the whole list of words and non-words as accurately as possible. Testing with this form was stopped following 10 consecutive errors. The raw scores were calculated from the total number of correct words that were read on each form.

Reading comprehension. Reading comprehension was measured using the LäSt test (Elwér et al., 2016). The test consists of 17 passages of increasing length and complexity, and the level of comprehension is measured via multiple-choice questions following each passage.

The first three passages were mandatory and after finishing these, testing was stopped if the participant answered less than two questions correctly. The raw score was the total number of correct answers.

Phonological awareness. Phonological awareness was measured using three different tests. Two of them were subtests from the Comprehensive Test of Phonological Processing (CTOPP) (Wagner et al., 1999). In the Blending Words subtest participants are required to blend sounds together to say a word (e.g. What word do these sounds make /s/-/un/: sun). In the Elision subtest the participants are required to repeat a word after the examiner and then say the word again but with the requirement to leave out a particular sound for each item (e.g. Say firetruck. Now say firetruck without saying truck: fire). Both these tests consist of 20 items and testing stops following three consecutive errors. The third test is called 46-items (Olson et al., 1994), and here the participants are required to repeat non-words presented orally by the examiner and then to say the word again but leaving certain sounds out (e.g., Say prot. Now say prot without the /r/ sound: pot). There are 46 items and testing stops following five consecutive errors. For each test in this section the raw scores are the total number of correct answers. All measures of phonological awareness were combined (sum of z-transformed measures) to give one variable that was used in the analysis.

Rapid automatized naming (RAN). Participants are shown a series of objects, colours, or symbols (letters or digits), and they are asked to sequentially name these items as quickly as they can (Wagner et al., 1999). Participants were given two different RAN tests; they were asked to name as quickly as possible six different letters and six different colours, in total the participants named 72 items in each of the two tests. The items in the tests were presented randomly. For each test, the time taken to name all the items was recorded and this was the raw score. Measures from both letters and colours were combined (sum of z-transformed measures) to give one variable that was used in the analysis. Because a lower score indicates better performance, RAN usually displays a negative relationship with other variables. For reporting and visual interpretation purposes, this variable was inverted.

Vocabulary. Receptive vocabulary was measured using the Swedish version of the Peabody Picture Vocabulary Test, Third Edition (PPVT-III) (Dunn & Dunn, 1997). The participants were asked to match an orally presented stimulus word to one of four drawings. The test is arranged in blocks of 12 items and has a total of 204 items. The blocks are arranged in order of increasing difficulty and testing is stopped following eight or more errors within one block. According to the manual, the level of difficulty of the initial testing should be related to the participant's age. In this study, we started from the first block with all participants as it can be difficult to ascertain where to start graded tests in individuals with ID. The Swedish translation of the test has changed the order of the blocks to take account of the difficulty of the items, which also supports the decision to start with the easiest block. The raw score was the total number of correct answers.

Phonological executive-loaded working memory (ELWM). Phonological ELWM was measured using listening span. This test requires participants to listen to a sentence spoken by the examiner, state whether it is true or false, and then retain the last word of that sentence while subsequent sentences are presented and processed. This test was in the format of a span test which had three trials per list length, and the participants were allowed to continue to the next span level if two out of three trials were correct (both items and serial order). Item sequences started with one or two items but became longer until the stopping rule was fulfilled. The raw score was the total number of trials correct.

Mental age (MA). MA was calculated using full-scale IQ and chronological age (MA = CA x IQ/100). Full-scale IQ was estimated with the Block design and Vocabulary subtests from Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) (Wechsler, 2014). These subtests were chosen due to their high reliability and a high correlation with the full-scale IQ (Silverstein, 1983). In the Block design subtest the participants were asked to arrange several blocks according to a given pattern. Testing was stopped following two consecutive errors. In the Vocabulary subtest the participants were asked to name pictures and describe the meaning of words. Testing was stopped following three consecutive errors. Testing and scoring were done according to the manual.

Approach to data analysis

We used R (Version 4.3.1; R Core Team, 2017) and the R-packages *citr* (Version 0.3.2; Aust, 2016), *dplyr* (Version 1.1.3; Wickham et al., 2021), *forcats* (Version 1.0.0; Wickham, 2022a), *GGally* (Version 2.1.2; Schloerke et al., 2021), *ggplot2* (Version 3.4.3; Wickham, 2016), *ggpubr* (Version 0.6.0; Kassambara, 2020), *janitor* (Version 2.2.0; Firke, 2021), *lubridate* (Version 1.9.3; Grolemund & Wickham, 2011), *mice* (Version 3.16.0; van Buuren & Groothuis-Oudshoorn, 2011), *papaja* (Version 0.1.2; Aust & Barth, 2020), *psych* (Version 2.3.9; Revelle, 2021), *purrr* (Version 1.0.2; Henry & Wickham, 2020), *readr* (Version 2.1.4; Wickham et al., 2022), *readxl* (Version 1.4.3; Wickham & Bryan, 2019), *stringr* (Version 1.5.0; Wickham, 2022b), *tibble* (Version 3.2.1; Müller & Wickham, 2022), *tidyr* (Version 1.3.0; Wickham & Girlich, 2022), *tidyverse* (Version 2.0.0; Wickham et al., 2019), and *tinylabels* (Version 0.2.4; Barth, 2022) for all our analyses. Raw scores were used in the analyses rather than standardized scores as the latter do not provide an indication of developmental progress (see Messer et al., 2023). The main decoding variable was calculated with a principal component analysis (PCA) on two measures of word recognition and two measures of phonological decoding. The PCA favoured a one component solution with high loadings for all decoding measures (range 0.88 to 0.93) that explained 81.90 % of the variance. For two assessments, composite measures were calculated by combining scores (RAN - 2 measures; phonological awareness - 3 measures). The sum of the z-transformed measures gave two composite variables used in the analysis. The intra-correlations between the measures ranged between 0.50 and 0.84. All variables were z-transformed to facilitate comparison between variables. Decoding, phonological awareness, RAN, reading comprehension, phonological ELWM, and vocabulary were each fitted against MA using a local polynomial regression (method = "loess"). A visual inspection revealed a flattening regression line around an MA of 105 months for the following variables: decoding, phonological awareness, RAN and phonological ELWM (see Figure 2). Therefore, the sample was divided into two age groups; MA <= 105 months (n = 57) and MA > 105 months (n = 79). The variables were fitted again, but this time using linear regressions for each age group (see Figure 3).

[Figure 2 around here]

Results

Descriptive data for all variables can be seen in Table 1. Figure 3 shows the plotted data after dividing the sample into two age groups (MA ≤ 105 months and MA > 105 months). For the group MA ≤ 105 months, a positive and significant relationship with MA was observed for all variables: decoding (r = 0.34, p = .010, R^2 = 0.11), phonological awareness (r = 0.31, p = .018, R^2 = 0.10), RAN (r = 0.42, p = .001, R^2 = 0.17), reading comprehension (r = 0.31, p = .020, R^2 = 0.09), phonological ELWM (r = 0.35, p = .007, R^2 = 0.12), and vocabulary (r = 0.28, p = .038, R^2

= 0.08). For the group MA > 105 months, a positive and significant relationship with MA was observed for reading comprehension (r = 0.28, p = .011, R^2 = 0.08) and vocabulary (r = 0.30, p = .008, R^2 = 0.09) only. There were no significant relationships with MA for decoding, phonological awareness, RAN, and phonological ELWM. These non-significant relationships were further investigated to establish the reason behind the flat regression line; a zero trajectory (meaning that development has stopped progressing) or no systematic relationship (when the distribution of performance scores is random, Thomas et al., 2009). The data were transformed by a 45° counter-clockwise rotation, and the analyses were repeated on the rotated data (see Figure 4). A zero trajectory would, after rotation, produce a significant relationship, while the case of no systematic relationship would produce a similar degree of fit before and after rotation (Thomas et al., 2009). The rotation yielded significant relationships for all four variables; decoding (r = 0.43, p = < .001, R^2 = 0.19), phonological awareness (r = 0.42, p = < .001, R^2 = 0.18), RAN (r = 0.33, p = .003, R^2 = 0.11), and phonological ELWM (r = 0.41, p = < .001, R^2 = 0.17) indicating that these were zero trajectories.

[Figure 3 around here]

[Figure 4 around here]

Discussion

Previous research concerned with the development of decoding and reading comprehension abilities in those with ID has usually focused on whether their abilities are better, worse or similar to MA matched groups of typical individuals (Boudreau, 2002; Channell et al., 2013; Menghini et al., 2004; Pezzino et al., 2021; Wingerden et al., 2014). However, the developmental trajectories approach has also been described as a potent method of looking at developmental delay (Thomas et al., 2009). The current study was designed to provide the first description, in adolescents with mild ID, of the developmental trajectories for decoding and reading comprehension and their respective predictors in relation to MA. Our study used a cross-sectional design with 136 individuals who had non-specific ID. The results showed three important features. First, up to 105 months, reading and its predictor abilities in individuals with ID appeared to be related to their growth in MA. Specifically, this relationship with growth in MA involved decoding and its predictors of phonological awareness and RAN as well as reading comprehension and its predictors of vocabulary and ELWM. Second, after the age of 105 months, the abilities of reading comprehension and vocabulary continued to show growth related to MA. Third, after the age of 105 months, there was no growth related to MA for decoding together with its two main predictors of phonological awareness and RAN, or for phonological ELWM, which had been identified as a predictor of reading comprehension. In other words, after 105 months, there was an unexpected plateau in the development of these variables in relation to MA.

What explanations can be put forward for this pattern of development, and, why did some abilities not continue to improve with increases in MA? Some of these developmental trajectories resemble those of typical readers. In typical readers, as chronological age increases, decoding and reading comprehension abilities increase. This increase is shown in relation to reading age in Figure 1, where the normative data from the decoding test LäSt (Elwér et al., 2016) were used. According to these data, decoding and reading comprehension are expected to exhibit significant and continuing growth up to a reading age of at least 13 years in a typical reader. Furthermore, for typical readers, reading age and MA should be highly related. In other words, for typical readers decoding ability and reading comprehension ability should increase with MA. Consequently, if the individuals with ID were following a delayed developmental path (Burack et al., 2021), growth in reading related abilities would be expected as MA increases. This was the pattern observed for all variables before an MA of 105 months, and for reading comprehension and vocabulary after an MA of 105 months. Thus, in these two cases, individuals with ID appeared to be following a developmental trajectory that had some correspondence to that in typically developing children. However, after an MA of 105 months (i.e., 8:9 years), for our ID sample, as MA increased there was no growth in the abilities of decoding, phonological awareness, RAN or phonological ELWM, suggesting that in these cases a different developmental path was being followed. It should be noted that, according to the developmental delay model (Zigler, 1967), individuals that follow a delayed pattern of development differ from typical development not only with respect to rate of development, but also with respect to the endpoint of development. Hence, the plateau in these abilities is not necessarily to be regarded as a qualitatively different pattern. Both cognitive and environmental explanations can be put forward to account for this pattern of development.

One possible explanation for this could relate to the diagnosis of ID. Having an ID will, by definition, affect the development of academic abilities, even though a mild ID means that some degree of academic success can be achieved (American Psychiatric Association, 2013). Therefore, it could be that difficulties in cognitive functioning associated with ID limit further development in decoding beyond a certain point. Furthermore, as phonological awareness, RAN, and phonological ELWM also failed to progress after an MA of 105 months, and as all these abilities involve some element of phonological processing, this could be a cause of the plateau in decoding development (but see Vander Stappen & Van Reybroeck, 2018).

The reasons for these different trajectories could be driven by educational factors. In the Swedish school system, individuals with ID follow a different curriculum compared to general compulsory school (Skolverket, 2022b), and students with ID could either be enrolled in an inclusive setting, where they are part of a general education classroom, or be enrolled in a special school. The adolescent participants in the present study were all enrolled in special schools where in Grades 1-6, the curriculum stresses reading instruction with a focus on phonics instruction (i.e., the systematic teaching of letter-sound correspondence). However, this focus shifts for Grades 7-9, and reading instruction instead targets the development of reading strategies, such as reading between the lines. This change in teaching could provide an explanation of the plateau in decoding because phonics instruction is no longer emphasized, while reading comprehension continues to develop. Studies focussing on reading instruction for students with ID emphasise that instruction needs to be delivered for a longer period of time, compared to typically developing individuals, to be beneficial for students with ID (Allor et al., 2014; Sermier Dessemontet et al., 2021; Sermier Dessemontet et al., 2019). Therefore, our findings suggest that Swedish students with ID in special schools might benefit from reading instruction continuing to focus on phonics for a longer period of time, especially since it is known that individuals with ID develop at a slower rate than typically developing individuals. There could also be a potential explanation in relation to how reading instruction is delivered. An observational study from Switzerland revealed a substantial research-to-practice gap in the observed classrooms in special education. Phonics instruction was used in the majority of classrooms, but the instruction was delivered in a systematic manner in only half of the classrooms (Sermier Dessemontet et al., 2022). In Sweden, phonics instruction is stressed in the curriculum, but only just above 20% of the teachers in special education classrooms for students with ID have the appropriate credentials to teach these students (Skolverket, 2022a). This could potentially affect the implementation of evidence-based practices, such as systematic teaching of phonics.

Related to this issue, earlier research has found that being fully included in a general education classroom predicts more progress in reading skills compared to being enrolled in a special school (Sermier Dessemontet et al., 2012; Sermier Dessemontet & Chambrier, 2015; Turner et al., 2008). This was also found to be true for language and memory abilities (Laws et al., 2000). Importantly, some of these studies originate from Switzerland (Sermier Dessemontet et al., 2012; Sermier Dessemontet & Chambrier, 2015) where the special schools do not have an imposed curriculum. For the studies that were carried out in the UK (Laws et al., 2000; Turner et al., 2008) there is more uncertainty about the teaching of phonics. This means that it could be difficult to translate these findings to a Swedish setting, where the students follow the same curriculum regardless of the form of schooling. However, the differences between special schools and the inclusive setting might also be attributed to other environmental variables, such as the impact of being surrounded by students that do or do not exhibit the same cognitive difficulties.

Limitations

The sample in this study was recruited only from special schools in Sweden, making a comparison between special schools and inclusive settings impossible. To further understand the reasons behind the different developmental paths for decoding and reading comprehension, future research needs to include a range of environmental variables such as type of school placement and the amount of time spent on phonics instruction.

Conclusion

The development of decoding and reading comprehension in adolescents with mild, non-specific ID appears to follow two different developmental trajectories. There was evidence for continued development (in relation to MA) for reading comprehension and a similar trajectory to that of students with typical development. In contrast, for decoding there was a plateau in development occurring at an MA of 105 months, so the trajectory was different to that seen in typically developing students. The reasons behind this plateau in decoding are still uncertain. It might be that having an ID hinders further development in decoding, although reading instruction practices could also be relevant as in many education systems the focus on the development of decoding abilities ends after the early school years. For individuals with ID, a continuing focus on developing decoding abilities using phonics instruction after elementary and secondary school might prove beneficial. More research needs to be directed towards investigating and understanding the development of reading abilities in individuals with ID, to develop appropriate interventions and school curricula.

Acknowledgement

The authors would like to thank the students and their parents for taking part in this research project. We would also like to thank the teachers for all their help and for making the data collection possible. Further, we would like to thank the research assistants Malin Dillner and Marie Annell for their hard work with collecting the data.

Funding details

This work was supported by the Swedish Research Council under Grant 2016-04217.

Disclosure statement

The authors report there are no competing interests to declare.

Data availability statement

Raw data with guidance notes, and analysis script are available at: https://doi.org/10.17605/OSF.IO/Q7MTC

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Table 1

Descriptive Statistics of Participant Characteristics and Task Performances (Raw Scores) of Adolescents With Intellectual Disability (n = 136)

Test	*M*	*SD*	Min	Max	Skewness	Kurtosis
Chronological age (months)	189.61	25.87	146.00	239.00	0.26	-1.02
Mental age (months)	112.88	25.26	63.32	190.28	0.62	0.31
IQ	59.43	9.72	40.00	88.50	0.30	-0.08
Word recognition timed	45.10	17.76	4.00	94.00	0.03	-0.55
Word recognition untimed	76.48	18.87	13.00	99.00	-1.02	0.32
Phonological decoding timed	23.28	11.75	2.00	55.00	0.32	-0.71
Phonological decoding untimed	36.18	16.38	2.00	61.00	-0.40	-1.02
Reading comprehension	18.04	12.54	2.00	56.00	0.81	0.10
Blending	15.71	3.66	2.00	20.00	-0.94	0.47
Elision	9.91	5.90	0.00	19.00	0.12	-1.47
46-items	18.26	14.93	0.00	43.00	0.26	-1.48
RAN colors	68.16	22.38	33.00	184.00	1.40	4.15
RAN letters	44.29	16.33	22.00	117.00	1.50	2.91
Phonological ELWM	4.88	2.01	0.00	10.00	0.15	-0.40
Vocabulary	131.15	27.35	33.00	179.00	-0.69	0.39

Figure 1

Growth Trajectories for Decoding and Reading Comprehension in Relation to Reading Age in Swedish Students With Typical Reading Development Aged Between 7 and 13 Years

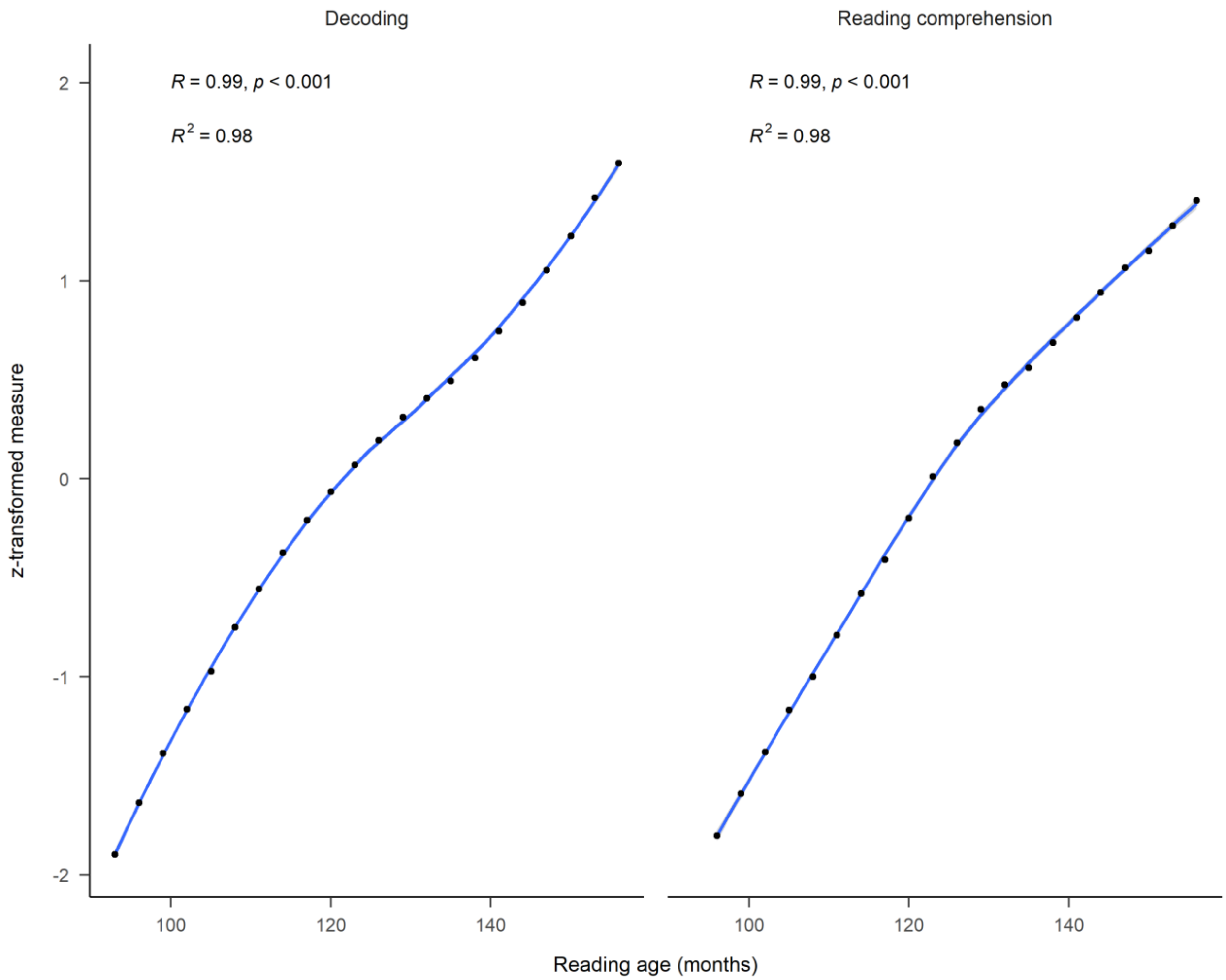

Figure 2

Visualization of All Variables Fitted Against Mental Age Using Method = 'loess'. R^2 and r Together With Significance Values are Presented for Each Plot. At an MA of 105 Months (Indicated by the Red Line), There is a Clear Deceleration of Growth for Decoding, Phonological Awareness, RAN, and Phonological ELWM

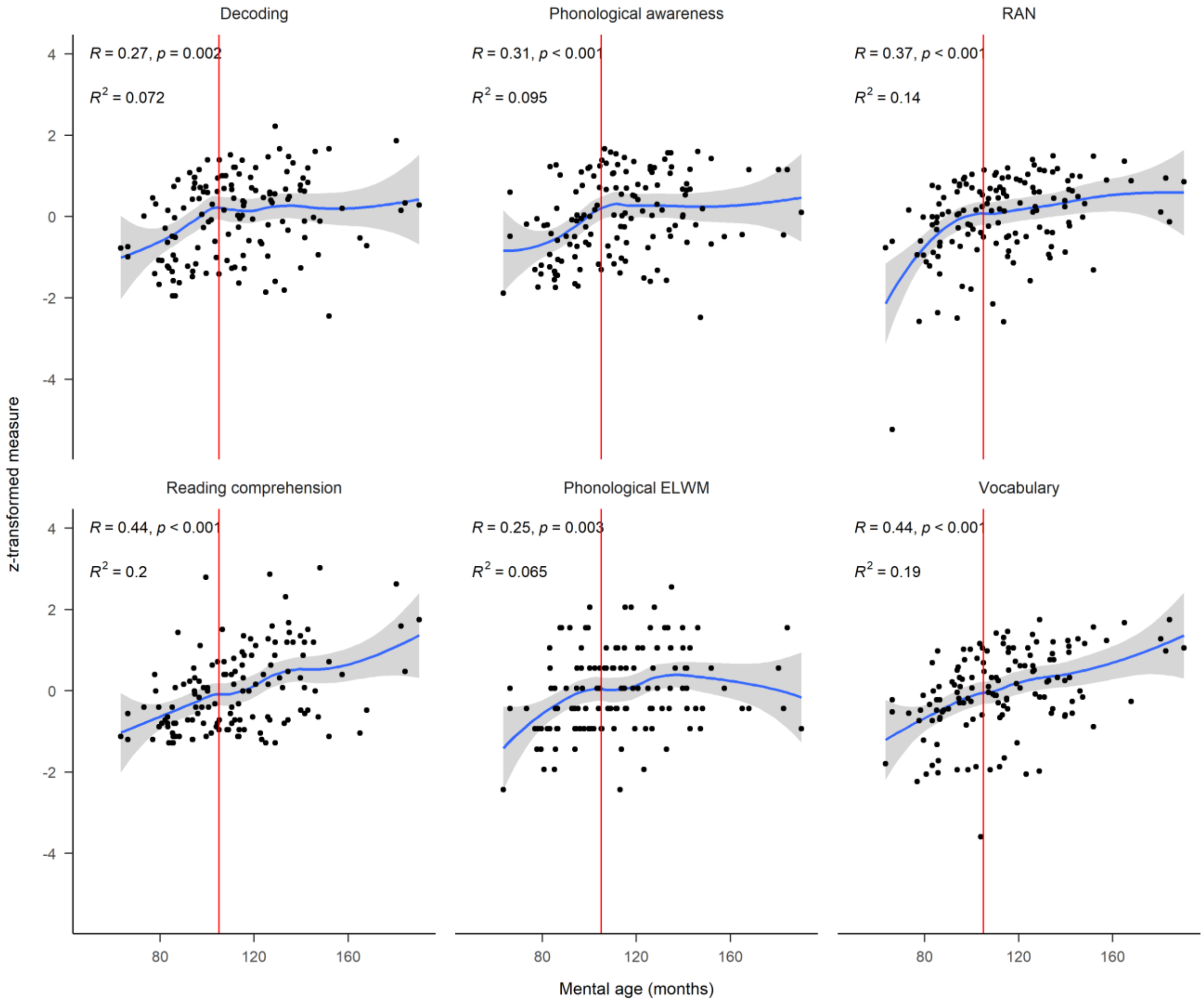

Figure 3

Visualization of All Variables Fitted Against Mental Age Using Method = 'lm', With the Sample Divided Into Age Groups. R^2 and r Together With Significance Values are Presented for Each Plot

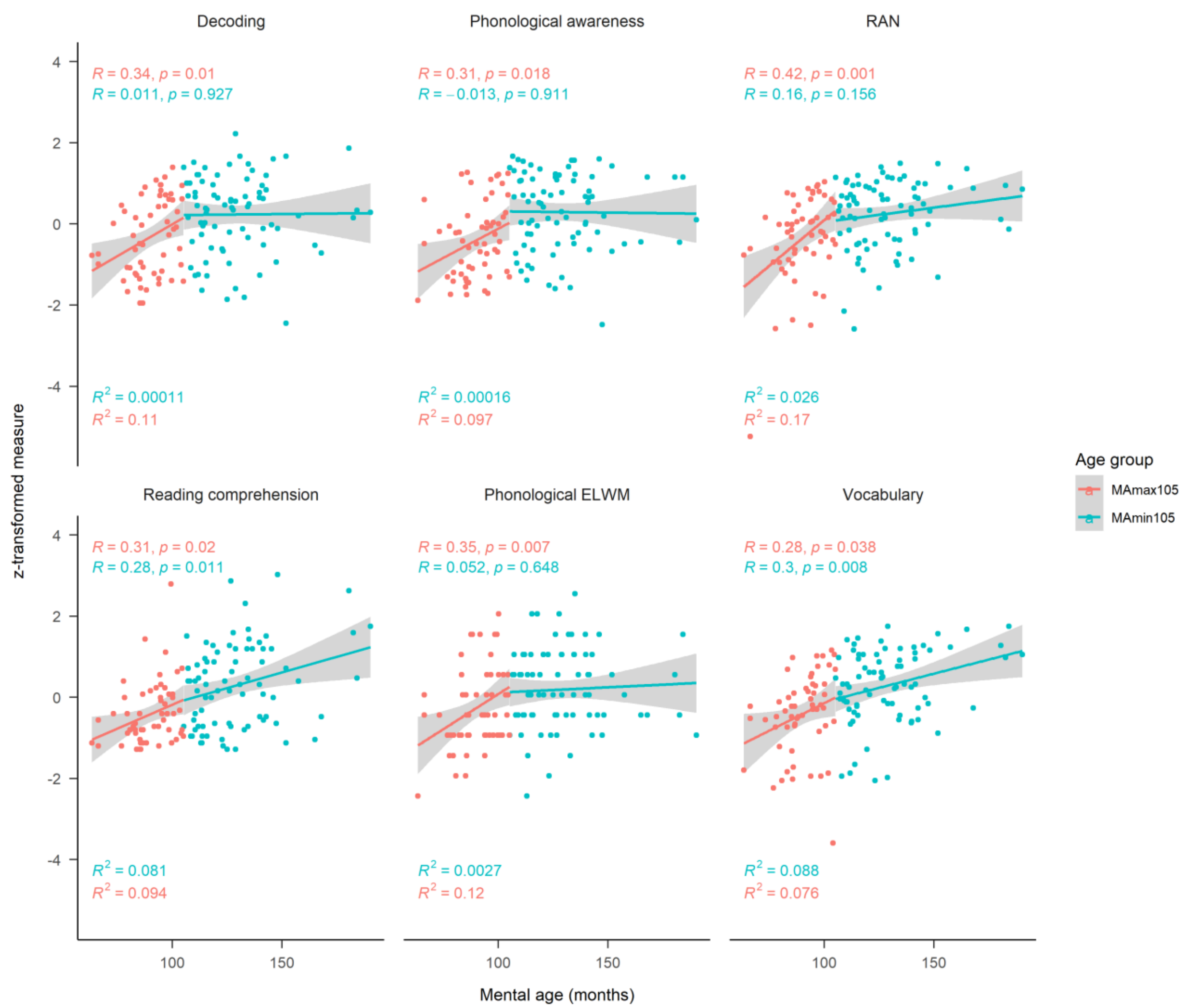

Figure 4

Visualization of Rotated Data for Decoding, Phonological Awareness, RAN, and Phonological ELWM. R^2 and r Together With Significance Values are Presented for Each Plot