Lyytinen, H. (2014). Children at risk of reading problems – from identification to prevention. *International Journal for Research in Learning Disabilities, 2*(1), 2-17.

William M. Cruickshank Memorial Lecture Delivered at the 2014 Conference of the International Academy for Research in Learning Disabilities

Children at Risk of Reading Problems – From Identification to Prevention

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A fundamental skill for growth and improvement in modern society is the ability to read – a skill still denied to many millions of children across the globe. A number of factors share the responsibility for this dilemma. In developing countries, most potential readers live under conditions where instruction is non-optimal or even unavailable (UNESCO, 2014). However, even in the developed world, some children still face serious problems in learning to read. In this latter context, the most severe bottlenecks result from biological factors that lead to dyslexia. In addition, a large proportion of cases of inadequate literacy result from apathy towards reading. The most important correlate of complete reading skill - which also includes comprehension of the subject matter - is the reading activity itself. After first acquiring the ability to decode written material as a necessary prerequisite, a learner can only achieve full literacy by further prolific reading. My emphasis here is to illustrate the early identification of children who will face such decoding problems and also how such difficulties can be surmounted.

The term 'dyslexia' is often used in the description of those children who, despite being in receipt of appropriate instruction, and in the absence of any apparent reason, continue to face severe difficulties in the acquisition of basic reading skill. Dyslexia compromises the positive school learning experiences of fewer than 10% of children during their early school years. As a consequence, however, such a negative start in the quality of their reading acquisition may subsequently result in many such children reading too little in terms of quantity in order to boost the chances of becoming 'compensated'. Nonetheless, approximately 20% of children who initially demonstrate severe difficulty in learning basic reading skills (decoding accuracy) during the first grades end up as typical readers (Leinonen et al. 2001). This is a promising prognosis, suggesting that individuals with dyslexia (which we now know has a genetic basis) can also overcome their difficulties – as will be described below – and sometimes, without recourse to exceptional means. In short, appending initial and appropriate special education support with persistent reading activity can result in 'compensation'. This compensatory scenario has been demonstrated in both transparent and non-transparent writing environments (see below for an explanation of writing transparency). The most typical scenario that differentiates 'compensated' from other learners who faced similar initial difficulties is that, irrespective of the underlying reason, compensated learners are motivated towards prolific reading and consequently attain full literacy. Our unpublished data reveal that the only discernable 'dyslexic' difference in adulthood can be found by measuring auditory memory, and this points saliently to the attenuation of the same core cognitive problem that we define below as characteristic of dyslexia. This finding fuels optimism that dyslexia, independent of its genetic background, can be overcome to such an extent that it does not compromise full literacy, although much more reading effort is required.

In the Jyväskylä Longitudinal study of Dyslexia (JLD) we followed 200 children from birth, half of whom had a familial background of reading problems. Prior to commencing the follow-up of the infants at risk due to their being born to parents with dyslexia, we interviewed a large number of parents who had acknowledged in a questionnaire at the maternity clinic (visited by all Finnish families prior to a birth) that they had had severe problems in learning to read. This defined the risk status of the expected infant. As an acknowledged fact, approximately 20% of the parents showed reading skill that was within normal limits. This transpired despite their having encountered such severe early problems that they repeated a school year (common in Finland at that time for children who did not learn to read during the first grade in line with the very large majority who become accurate readers within the first few months of schooling) and failed to become accurate readers during the early school years. Similar findings have been reported from an English reading environment (Lefly & Pennington, 1991).

The transparency of different writing systems (orthographies) affects the learning burden placed on children during their acquisition of basic reading skill (Seymour et al., 2003). The burden is low in fully transparent and high in non-transparent alphabetic orthographies. Examples of almost transparent orthographies include Finnish and Italian, where each letter represents its own phoneme (or sound) and, in turn, each phoneme is represented consistently by only one letter (or letter combination, grapheme). Thus, the learning burden to acquire basic decoding skill entails little more than to learn the sounds of < 30 letters/graphemes and to realize how to assemble these sounds in the order of letters. Mastery of these basic steps results in the learner's ability to sound out any pronounceable sequence of letters.

The situation is quite different in non-transparent writing such as in English, where none of its letters consistently represent the same sound, independent of the context of where, in the word, the letter occurs. Furthermore, the meaning of the word may also affect the sound of its written form, which means that the learner first has to know the spoken form of the word being read. Thus, the differences between various alphabetic orthographies are already substantial, before even considering those writing systems that are non-alphabetic. As previously mentioned, readers of transparent orthographies tend to learn basic reading skills during the first months of school, or even earlier. More than 1/3 of Finnish children are able to read before entering school at 7 years of age. However, children learning to read English require two more years of school instruction in order to reach the mean level of reading of 6- to 7-year-old Finnish children, even when they have not yet been influenced by formal teaching (Seymour et al., 2003). It is, however, prudent to acknowledge that UK children start school around age 5.

The difference between the learning burdens can be illustrated by counting the number of connections that the learner has to store before becoming a relatively accurate reader. In Finnish, this number approximates 30 while in English, it numbers more than a thousand. This is because English has, for example, a number of written words that defy sounding out before all the letters are seen (e.g. 'view'). In general, due to the aforementioned inconsistency, the size of the written unit that the English reader must learn in order to connect to the spoken language item is much larger than the letter. Larger units (typically >2 letters) can be connected to a spoken segment of English when learning the consistently-behaving connections (i.e., those which are true in all contexts of written English (Ziegler & Goswami, 2005).

This introductory issue should be considered when interpreting the summary of results that I focus on next. These results are based on the previously mentioned JLD follow-up study of Finnish children who have been assessed continuously from birth to puberty. Finnish children who face problems in learning basic reading skills have specific difficulties in a) learning the less than 30 connections between spoken and written units of Finnish and/or b) becoming fluent decoders of Finnish writing. These difficulties were observed in the JLD among learners who have no general cognitive problems (IQ >80).

Bottlenecks Compromising Reading among Learners with Dyslexia

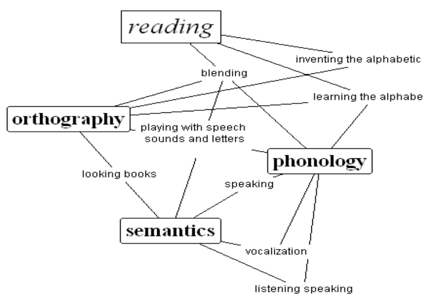
A typical child with dyslexia who is learning to read Finnish can be helped towards accuracy simply by sufficient drilling of the sounds of the letters and by motivating him/her to automatize the assembly of letter sequences through repeated practice. Such practice helps them to become fluent readers. In the learning of Finnish spelling, however, the most challenging initial difficulties tend to persevere, despite substantial training, in relation to mastery of the most difficult aspects of such connection building. In Finnish, such a bottleneck is the differentiation between short and long phonemes (i.e. 'phonemic duration' whereby a long phoneme is clearly marked by repeating the letter). A further bottleneck often concerns the automatization of reading. That is, to attain sufficient reading fluency/speed in order to still recall the beginning of a sentence when the end is reached and thus facilitate comprehension of long sentences.

The initial focus of learning to read transparent writing is to connect the sounds of single phonemes to the representative letter/grapheme. Therefore, any difficulty with the differentiation of such small speech units may manifest as a substantial bottleneck. This is, in fact, the case, as we have documented in the Jyväskylä Longitudinal study of Dyslexia (JLD; for a review of findings, see Lyytinen et al., 2008). The case is further supported by our findings of very early differences shown by newborns (at familial risk) in their responses to speech stimuli. Brain event-related potentials at age 3-5 days can predict reading acquisition (Guttorm, Alinäveri, Richardson & Lyytinen, 2011; Hämäläinen et al., 2013) and perception of phonemic length is, finally, the most concrete expression of compromised speech perception that can be observed from a very early age and further, at reading age. This has been shown by the JLD results wherein school age children's perception of the occurrence of long vs. short phonemes still predicts later reading acquisition after the effect of other known predictors has been controlled (Pennala et al., 2013). This finding uncovers a central specific factor within the domain of phonemic awareness that manifests as the most serious bottleneck to delay a learner's progression towards accurate spelling. It may be important to understand that, in a transparent orthography, 'phonemic awareness' per se is not dissimilar to letter sound knowledge. As such, it is achieved no later than the first exposure to initial reading instruction during the first few months of school, which is the first and most necessary step that the learner needs for acquisition of basic reading skill. In short, phonemic awareness is acquired reliably and relatively easily via appropriate instruction of the sounds of the letters in the context of transparent writing. Instruction that includes assembly – by introducing consonants after acquisition of the easy-to-store vowel sounds – together with vowels (i.e., in v-c or c-v syllables) facilitates easy learning of the basic steps of reading skill.

Such an early focusing of the child's attention towards important small units may, however, affect the emergence of later bottlenecks - fluency problems. In transparent orthographies, where only a few fail to become accurate readers, excessively slow reading is the most serious and common difficulty among children with dyslexia. Overly fixating the attention on such small units may therefore culminate in dysfluency. Consequently, the initial instruction must be organized in such a way that it can alert the teacher to any such potential danger and, as such, can be avoided by instigating the transition towards the reading of larger units as early as possible in transparent orthographies. This same process occurs naturally in non-transparent environments where reading cannot start successfully without the use of larger units from the outset.

Early Identification of Children in Order to Provide Preventive Practice

The Jyväskylä Longitudinal study of Dyslexia (JLD) has provided a detailed perspective on the obstacles faced by children with a genetic risk for dyslexia. In the JLD, the development of language from an early age was assessed in detail, starting with the earliest imaginable indications. These comprised the brain responses to speech sounds soon after birth. Next, there was a follow-up of the early indications of expressive and receptive speech, the development of morphological skills, phonological sensitivity, letter knowledge and then naming fluency. Figure 1 summarizes the significant predictors of compromised reading acquisition in second grade, by which time the vast majority of Finnish pupils are accurate readers. The most significant predictors are listed from birth to reading age. The table also shows those predictive measures on which the groups with and without familial risk differed significantly.



P = Predictors
D = Differences between groups

Age	Variable	
7 - yrs	Reading accuracy & speed	D
5 - yrs	Naming speed	P & D
4 - 6 yrs	Phonological manipulation	P & D
5 - 6 yrs	Letter knowledge	P & D
5 - yrs	Verbal memory	P & D
3 - 6 yrs	Phonological sensitivity	P & D
3 - 5 yrs	Inflectional skills	P & D
2 - 3 yrs	Articulation accuracy	P
2 yrs	Maximum sentence length	P & D
6 mth	Speech perception	P & D
Birth	ERP to speech sound	P & D

Figure 1. Early measures with significant predictive correlation (P) to reading acquisition or group difference (D) between children with and without familial risk for dyslexia (D). For more, see Reid et al., *Sage Handbook of Dyslexia*, 2008.

As previously mentioned, the first indications of the realization of risk can be observed at the age of a few days. The brains of infants with and without risk respond differently to syllabic stimuli (ba, da, ga) and this difference has a significant positive correlation with reading at second grade. The differential features of the waveform of the brain event related responses (ERP; between these groups) reveal correlations to indices that also reflect the earlier steps towards reading skill (Guttorm et al., 2005; Guttorm , Leppänen, Hämäläinen, Eklund, & Lyytinen, 2010; Lyytinen et al., 2005). The next observable difference, at age 6 months, reveals compromised speech perception of phonemic duration. Apparently, this is the most difficult-to-differentiate feature of spoken Finnish among children with reading problems, as mentioned above. The first indications were present in categorical perception performance of 6-month-olds (Richardson, Leppänen, Leiwo, & Lyytinen, 2003). Also, as early as 6 months of age, the ERP to change in the phonemic duration feature in the auditory stream revealed a differential response between the groups with and without dyslexia (Leppänen, Pihko, Eklund & Lyytinen, 1999; Leppänen et al., 2002) and also predicted letter knowledge and naming fluency (Leppänen et al., 2012).

Furthermore, those at-risk newborns who ended up facing reading difficulties at age 8 had atypical ERPs to sound frequency changes and showed, before reading age, compromised perceptual differentiation of phonemic duration (Leppänen et al., 2010).

The next important aspect of language development that deserves attention among children who are at familial risk for dyslexia is the delay in expressive language. Late talking was the earliest easy-to-observe indicator to cue the need for help along the developmental route towards acquisition of good reading skills. Children with familial risk and whose speech is delayed at 2 years of age have an elevated risk of facing difficulties in reading acquisition, as can be gleaned from Figure 2. If receptive language (comprehension of spoken messages) is similarly delayed, early support in language development is especially important. Otherwise, the risk of facing difficulties in the attainment of sufficient literacy to comprehend written material in line with the expected developmental milestones is quite high.

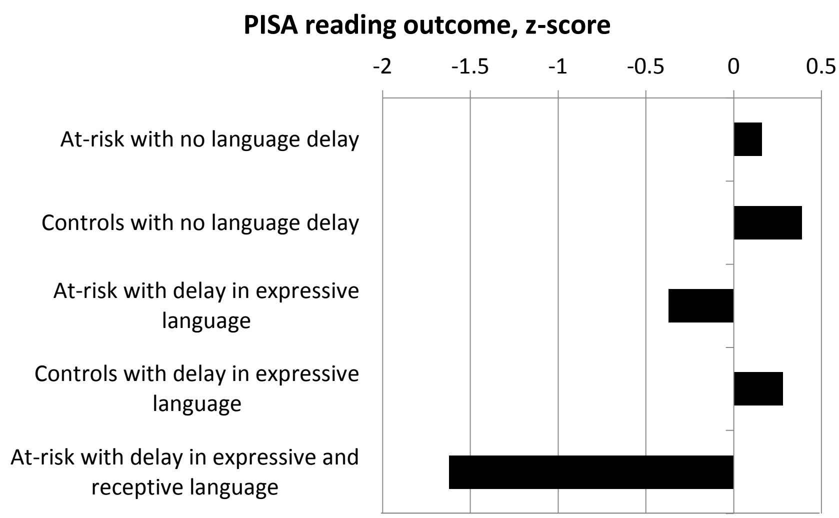


Figure 2. Pisa reading scores reflecting the degree of full literacy including reading comprehension from children who had delayed language development at 2.5 years of age.

The developmental routes that precede the acquisition of reading skill vary. The three most apparent routes, all of which are connected to somewhat compromised reading during school age, are illustrated in Figure 3, together with a typically developing group with no difficulties in reading acquisition. To illustrate this summary, the entire battery of language measures collected in the JLD were fed into the same latent profile analysis (via MPLUS) to highlight those children with sufficient familiarity to form a group sharing a relatively similar developmental route and also to uncover developmentally different groups.

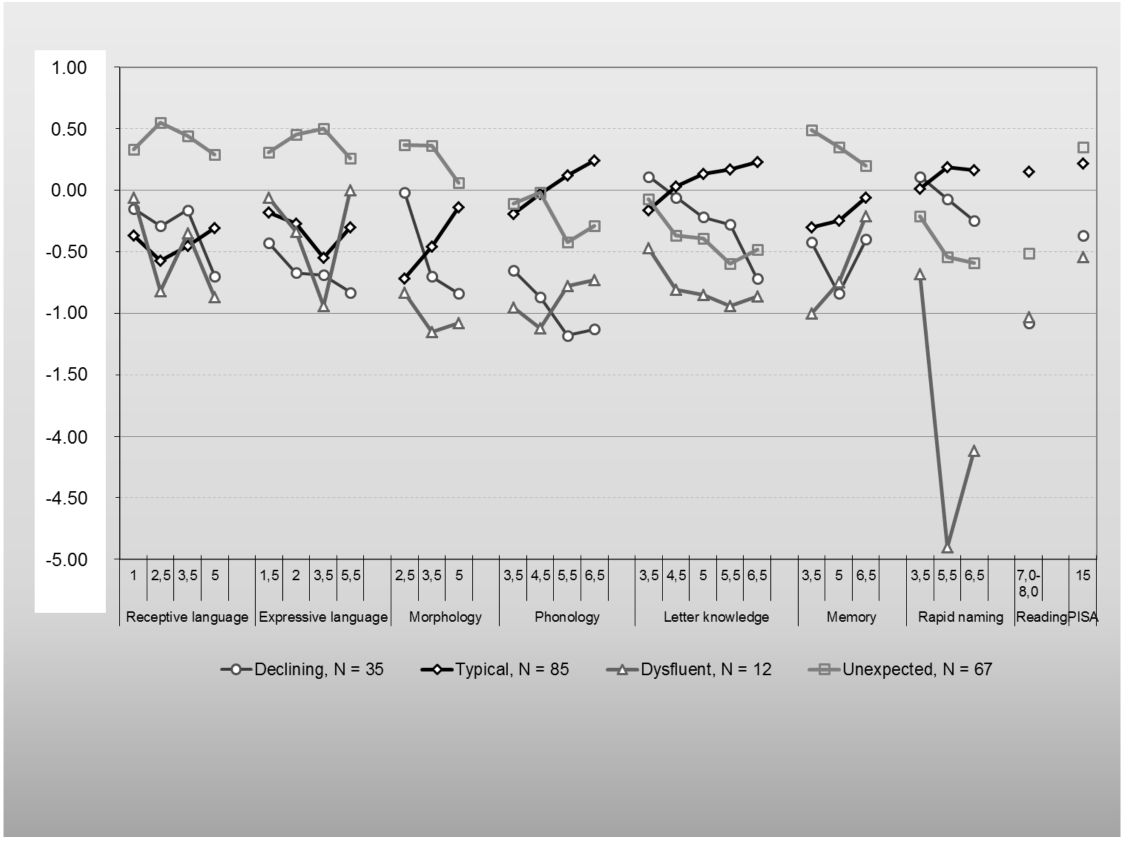


Figure 3. Average profiles of developmental language characteristics for different subgroups across ages 1 to 6.5 years, their average performance in reading and writing composite score during the second grade, and in PISA reading composite at 15 years of age. (Modified from Figure 1 in Lyytinen et al., *Merrill-Palmer Quarterly*, 2006).

The classic phonological difficulty can be observed therein as a relative decline of phonological development (among 35/199) during the critical pre-school years. The reading level of this group at the end of the second grade is one standard deviation below norm in comparison to other children.

A similarly compromised level of reading skill characterizes the second developmental route, which reveals somewhat delayed early language skills in nearly all measures, with special difficulties in the readiness to rapidly name familiar objects at five and half years of age (Dysfluent group, *n*=12). The most surprising group, which we call "Unexpected" (*n*=67), had atypically good early language development. This group's mean level of reading, however, reached a mean composite score of -.5 (resulting from low scores among a small portion of members of this subgroup) of reading only, during the second grade. The surprising end result consequently revealed by this group is, however, that its achievement in the PISA-assessment at age 15 reached a score +.5 above the mean of all the participating children – higher than those of the typically developing final group, as shown in Figure 3 (for more, see Lyytinen et al., 2006).

There is one very easy-to-assess measure that seems to be accurate in the identification of the children who will face problems in their reading acquisition. This is "letter knowledge." Almost in the order that the JLD-children were able to store letter names during the years before they entered school, they learned to read, as revealed by Figure 4. This figure illustrates the individual profiles of all children who faced problems in their reading acquisition in the JLD study. Almost all Finnish children are exposed to letters portrayed on the walls of the kindergarten (obligatory environment for Finnish children), although teachers are advised not to begin reading instruction before children enter school at age 7. This means that children have had the opportunity to become interested in letters and to learn the names. Ultimately, some do not learn the letters in line with the majority. As revealed by Figure 4, from amongst all of the most well-known early age predictors of reading acquisition shown in the profiles, those children whose reading development still continues to be atypical through the early grades are differentiated, without exception (with scores below the level of typical children), by their letter knowledge. No other measure is perfect in the same sense.

We always find that some children who are failing to learn to read in a typical way have a score above the mean on another early predictor included in the figure.

Letter knowledge – especially learning the letter sounds – plays a pivotal role in reading acquisition of transparent orthographies such as Finnish, German, Italian and Spanish. Thus, it is not surprising to find that if we measure letter knowledge and phonological awareness at different ages and model their relationship, we can find what is observed in Figure 5. In transparent orthographies, where letters have a consistent connection to reading, the necessary phonemic awareness is most efficiently supported by the visible letters that the children are interested in naming. Thus, they become motivated to store important cues associated with their sounds. This helps children to gain sufficient impetus from the sounds of the letters and thus prepares them to take the first step towards basic reading skill with efficiency. Those children who need help are therefore easy to identify by using only one simple assessment. Following on from this realisation that early identification can be achieved with such relative ease, naturally, the next step is to know how to help. Before going on to illustrate the interventions that can help, even when commenced only shortly before school entry, it is important first to consider the implications of the earlier-mentioned results associated with delay in receptive language and its predictive relation to reading comprehension.

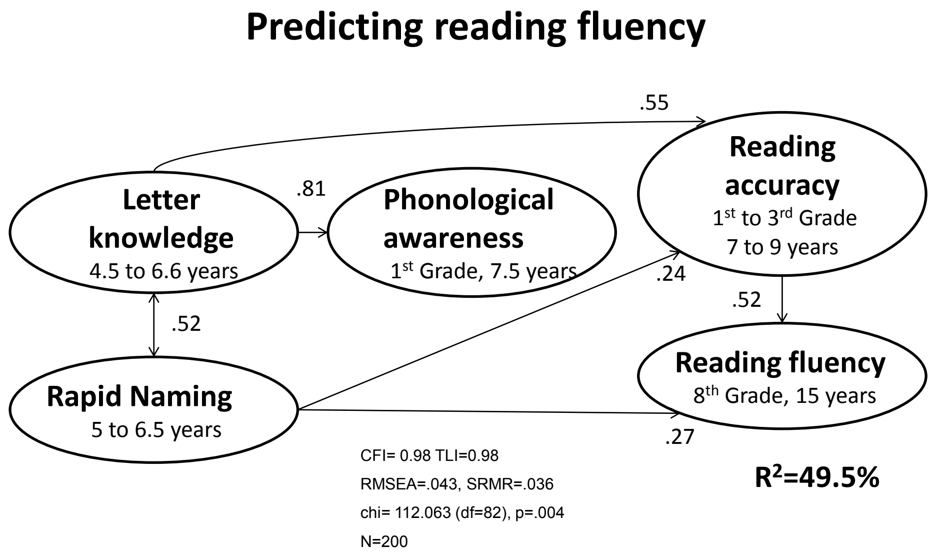


Figure 4. A model illustrating the order of influences of different variables of interest predicting reading acquisition in a transparent writing environment.

We now know (as illustrated earlier, see Figure 2) that from among the half of children with a familial background of reading problems who face difficulties in learning to read, those whose spoken language development is delayed need early help to support their vocabulary development. Receptive skills have to be strengthened from early on to help them become sufficiently prepared to approach full literacy following reading instruction.

Children with or without familial risk and without any substantial delay in the development of early language, which can be observed in their use of spoken language, can be helped to acquire basic reading skills by starting effective preventive training that focuses specifically on the learning of written language skills just before, or at least at the point of, school entry. At least this is the case if they can use a training regimen which is comparable to the 'Graphogame', a learning environment that we have developed for children with a risk factor associated with reading acquisition. Graphogame is used in such a way that those children for whom reading acquisition is predicted to be more difficult and consequently more time-consuming in comparison to the requirements of their peers, can start to use it before such a difference can be observed. If Graphogame is implemented no later than school entry and used in an optimal way, potential obvious disparities between the child in difficulty and his or her peers are unlikely to be noticeable throughout the process of reading skill acquisition. [1]

[1] Footnote 1. What follows informs how Figure 5 can be understood. It reveals an example from a situation where the /N/ sound (in the centre) has been repeatedly heard by the leaner in more than 100 trials when this

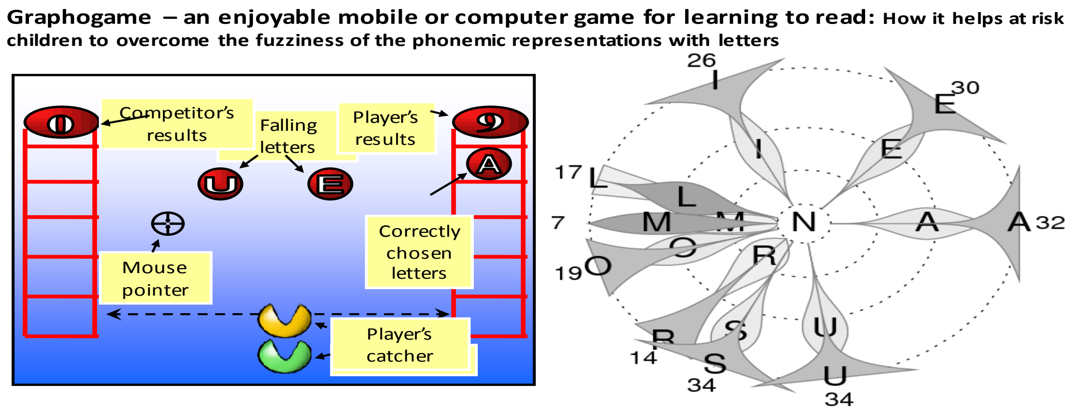


Figure 5. The classical Graphogame display (left, not available any more) illustrating the still applied principle of how GG works. The learner is choosing from the falling balls, the written item corresponding to the one s/he hears from headphones. The right side illustration informs how the "phonemic space" of the learner is becoming differentiated. For an explanation, see footnote 1.

Prevention of Reading Difficulties

We all know that there are different reasons why reading acquisition is not equally easy for all children. Nonetheless, one could argue that the same core content must be learned by all concerned. Ultimately, the initial 'diagnosis' of why a child faces difficulty in acquiring initial reading skills may have little effect on what the learner has to do in order to

picture was printed from the game log data. The numbers on the outside of the circular picture show how many times each of the letters on side of it which is an incorrect alternative has been presented. The distributions reveal that the learner has made errors and chosen R, M and L letters during the first repetitions of such trials, but was able to learn during the last fourth of the trials that none of those letters represents the /N/ sound. For this learner, learning that the /N/ sound is **not** represented by the letter M has been a real challenge, as shown by the distributions, which reveal that most of the choices during the first and second fourths of trials (respectively) have ended up with this mistake. The learner has failed to learn to identify the accurate correspondence of the /N/ sound during the whole session in all 7 trials where M has occurred as an alternative, which s/he has chosen repeatedly. On the other hand s/he has not chosen, for example, S to represent the /N/ sound any more during the last fourth of the trials (no misidentifications during the 9 last of the 34 trials with S as an alternative). For more details, see Lyytinen et al., 2009, *Scandinavian Journal of Psychology*, *50*, 668-675 and for documentation of the efficiency of the game in supporting learning among at risk children, see e.g., Saine et al., *Child Development* ,*82*(3),1013-1028.

actually learn basic reading skills. One has to acquire the connections between spoken and written language. This is relatively straightforward under two conditions.

The first condition is that the learners must master the spoken form of the language that is to be read. At least some kind of implicit phonological sensitivity associated with the speech sounds must be available before anyone can begin to connect sounds to letters. As we now know, this condition has not always been met. This has been the case in Africa where attempts have been made to instruct the reading of English to children who have never been exposed to spoken English. Also, in the developed world, many children are instructed to read a language that is not the most familiar language to the learner. Such situations compromise the opportunity to achieve the goal of reading before implicit awareness of the sounds of the intended-to-be-read language have been formulated in the mind of the learner.

The second condition that affects the establishment of connection-building between spoken and written language depends on the consistency of the connections. In transparent orthographies, consistency can be perfect (e.g. Finnish) or partly compromised (e.g. German, where the spelling direction is not fully consistent). If there are inconsistent connections, a way in which to help the learner avoid being confounded by inconsistencies must be found when organizing the instruction. This may be a challenge for English, where the appropriate segmentation of the speech that helps to isolate the relevant sound units that are always connected to the same written unit is a challenging computational problem. Instruction must begin with large units which behave consistently, independent of the context in which they occur, and then inform those contexts where the less consistently behaving connections are valid.

The instruction of initial reading skill can be organized simply and effectively in the aforementioned Graphogame (GG) learning environment. To illustrate its operations, see Figure 6 (left part). When training basic reading within a transparent orthography that is consistent at the letter-sound level, the computer display shows a variable number of falling balls, each containing a different single letter. Simultaneously, the learner hears the sound of one of the visible letters. The task is to choose the letter that represents the sound. Children quickly learn to choose the correct letter which represents the sound in each trial. This makes the connection-building very efficient because new sets of letters are presented all the time and the child receives sufficient repetition to store the connections. The GG program selects items for the subsequent trials by taking into account the knowledge demonstrated by the learner during the preceding trials and this dictates the new content. Thus, it is possible to ensure that the practice is very rewarding because, in most cases, the learner can make a successful choice (e.g. 80% of the time, which we have found to be the best proportion of 'easy' trials) and thus, motivation is sustained. This also guarantees sufficient repetition to ensure storage.

A very simple procedure is run in the initial stages with a content of sound-wise and visually easy-to-differentiate items whereby the number of falling alternative written units is few. Next, the number of alternatives from which the learner must choose is increased before the more difficult-to-differentiate phonemes/letters are included. This may culminate, if necessary, in drilling of minimal pairs to differentiate the phonemic space where their perception is not yet accurate and reliable. After the sounds of the single letters have been reliably learned, the unit size increases to 2 or more letters in each item. This motivates the learner to invent the principle of assembly, how the sounds merge together following the sequence of letters. Thus, syllables, words and even sentences can be used to take steps towards accurate decoding skills.

The present GG developments also include fluency training and we are moving now to support reading comprehension. Further information is available from the info.graphogame.com pages. The way in which related support services are organized for all Finnish children (due to public procurement from us by the Ministry of Education) can be seen at www.lukimat.fi (for an English description push the flag at the top right corner and see the further English description in the next page). Training in basic math skills is also provided within this service. The pages contain substantial information for teachers and parents concerning these basic scholastic skills, ways to learn them and ways to overcome related learning problems.

The provision of very detailed feedback makes such a preventive training environment invaluable to teachers and special education experts. An example is shown on the right side of Figure 5, where the illustration models a hypothetical reflection of the differentiation of phonemic space in the learner's mind. It illustrates an individual's learning status, which can be computed and drawn to represent a summary of a group. Any phase of the learning process can be selected in order to identify any as yet unopened bottlenecks, such as which sounds/letters are not sufficiently differentiated. This is revealed by distributions between the target sound in the center and the chosen letters printed at the ends of each distribution. If the distribution has its widest part in the most distant position, the wrong choice has ceased. In the case of severe dyslexia, the learner may require individual tailoring of the content and sequences introduced. Almost all children can reach the goal without further tailoring because of the automatic adaptation that is implemented to organize the steps in the learning process, beginning with easy and small items, moving towards the most demanding-to-differentiate items, and then to larger items by introducing the need to assemble sounds together. The adaptation procedure efficiently accommodates the bottlenecks, which are systematically opened by using the approximately 20% of difficult items to keep the child happy and motivated but by not repeating these too often.

Interested readers can learn more about the use of Graphogame via the published documentation on its efficiency. Saine, Lerkkanen, Ahonen, Tolvanen and Lyytinen (2011) illustrate how a special education teacher can achieve good results by implementing Graphogame as part of face-to-face teaching in small groups. When given the opportunity to play Graphogame as part of their remedial teaching, struggling children, irrespective of the severity or type of their initial risk factors, reached the level of the mainstream children before the end of the third grade. Very comparable results were observed for the elevation of reading fluency (Heikkilä, Aro, Närhi, Westerholm, & Ahonen, 2013; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010).

Today, the illustrated Graphogame is utilized in a research capacity in more than 30 countries, some of which are close to achieving a similar level of implementation to that in Finland where all children can receive help from Graphogame. At best, more than 20,000 children use Graphogame in a single school day. Such a large number of users from amongst Finland's 60,000 age cohort is understandable because the support is appropriate not only for Grade 1, but also for second graders, whose automatization of decoding skills can also benefit.

Conclusion

My experience has made me optimistic to the extent that we believe that, with optimal use, such an efficient training environment can help most, if not all, children who face difficulties in learning to read. Optimal use entails short (<15 min) sessions, repeated at least three times per day over several subsequent days until the goal of accurate reading skill has been reached. The later fluency training may be conducted with slightly longer sessions when children are older. Overly lengthy sessions increase the risk of boredom, which is why we do not recommend acceptance of long playing sessions. We are also trying to motivate parents not to introduce children to Graphogame too early because if it is not helping at the time that the child starts using it, it may not be of interest to her/him at the time that it can help. We know that the probability of achieving good gains from its use are substantially larger if started close to school entry when the brain of even delayed children is sufficiently mature. However, it must be added that this training is complementary to contact and support from a human teacher. Teachers' and parents' supportive advice and their genuine demonstrations of happiness gleaned from witnessing the child's training is important and should be directed as positive reinforcement towards the child. It is also necessary that, soon after the child has learned the basic reading skill which is trained in the GG-environment to a sufficiently fluent level, the learner is introduced to a lot of reading in order to achieve full literacy. For this purpose, exciting and sufficiently easy-to-begin-with reading material should be made readily available, as soon as the skill is sufficiently prepared. As mentioned at the beginning of this story, learners who become strongly motivated to read a great deal will overcome their problem and attain the status of those 'compensated' readers whose competence cannot be differentiated from that of other readers.

In the high income countries, Graphogame can help children with a risk of facing difficulty in learning to read and, most importantly, children who are resistant to the typical instruction available. This means a relatively low (<10) percentage. However, in Africa, the conditions to ensure sufficient instruction are often lacking, as shown in the most recent UNESCO summary (UNESCO, 2014). This is why the percentage of children who can benefit is very high. One principle in the declaration signed with our collaborators from universities such as Cambridge, Oxford, Harvard, Stanford, Yale and Zurich (see http://info.graphogame.com/wpuploads/2011/04/GraphoWORLDDeclaration110216.pdf) is that the efficiency of the Graphogame implemented in a given language/writing system/educational culture has to be empirically validated before starting any distribution of the support service.

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