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FEATURE

Discerning Shapes, Reading Words Like Faces: The Current Science of Literacy and its Implications for Low-Income Countries

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Abstract. *Despite much donor investment in low-income countries, student populations may fail to learn even the first steps of literacy. To some extent this may be due to teaching materials and methods that were developed for high-income students who get more experience with reading at home. State-of-the-art learning research offers alternatives. Basic reading involves "low-level" neurological functions, visual discrimination, detection of patterns, chunking, working memory mechanisms, and activation of a brain region that processes words as if they were faces. Texts can be understood only after a minimum reading speed has been attained. A prototype reading program was developed on the basis of the research to explicitly teach the low-level discrimination skills that better-off students may acquire on their own. Such a course may succeed in teaching basic decoding to nearly all but the learning disabled. In consistently spelled languages, this goal may be accomplished in about 100 days. It is hoped that its publication will stimulate debate and suggestions for improved implementation.*

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Ensuring the education of the poor, particularly in low-income countries, has been an important goal of the international donor community. United Nations agencies, affiliated organizations such as the World Bank, and bilateral agencies have devoted many resources in the last 20 years to improve access to good-quality education for low-income populations. In 1990, a worldwide initiative was instituted to ensure that by 2015 all children in the world should complete primary school. The Education for All (EFA) initiative has helped distribute US$2.2 billion in financial aid to more than 43 low-income countries.[1] The investments in buildings, materials, and salaries have made primary education accessible to over 19 million additional children between 2002 and 2008. But teaching basic skills to all or even most of the poor has been nearly impossible.

In high-income countries, all but the disabled learn to read. However in such countries reading materials are plentiful, instructional time is used for teaching, teachers are well educated, weaker students get help from teachers and parents; there is time to review, present material in different ways, and there is even time to have fun and explore meaning early on. By contrast, in low-income countries textbook procurement fails, instructional time is used poorly, while teachers are poorly trained and are often absent (Abadzi, 2007). Students may attend sporadically and forget letters from one time to the next. Parents are often illiterate and cannot help children at home to make up what they miss in school. Faced with a mass of illiterates, teachers may only work with the few better students and ignore the rest (Llambiri, 2004; Lockheed & Harris, 2005).

Not surprisingly, 80-90% of second and third graders in some countries cannot even read a single word and may know few if any letters (Research Triangle Institute (RTI) 2009, 2010). Many do not persist until they somehow learn. Every year hundreds of thousands drop out illiterate in the early grades while others even graduate illiterate from primary school. Therefore, along with those who never attend school, about 67 million children are growing up without learning how to read (UNICEF, 2011).

Time is of essence for the poor, since so many drop out of school early. In nearly all low-income countries, if students are to become literate, they must somehow learn fluent reading very quickly upon school entry and must do so using the scant opportunities available. If illiteracy is to drop, this must be achievable in all the languages and scripts used in low-income countries.

The international education community has persisted in helping low-income countries improve student performance. Thus, the Global Partnership for Education pledged on November 7, 2011 to halve the number of non-readers in 20

[1] Global partnership for Education data, www.globalpartnership.org and http://data.worldbank.org/news/education-key-to-achieving-MDGs

countries in 2012-2017. Similarly the United States Agency of International Development announced on November 18, 2011 a grand challenge, that is, the All Children Reading initiative. Other donors such as AusAid and the United Kingdom Department for International Development (DFID) are similarly committed to help children learn reading in the early grades.

To fulfill this agenda, there is a need to hone on the variables really crucial in developing reading fluency. What would be the easiest, most parsimonious means of teaching at least decoding skills to nearly all students? And would these suggested methods be applicable given teacher capacities and the systemic limitations of low-income countries?

To find answers, a search was made in domains of knowledge that are rarely linked to reading instruction. The story of reading acquisition in the age of cognitive neuroscience sounds quite different from commonly held views. Basic reading involves "low-level" neurological functions, reactions to letter combinations that must take place in milliseconds. It also involves visual discrimination, detection of patterns, chunking, working memory mechanisms, and activation of a brain region that processes words as if they were faces. Letters are chunked into syllables progressively; bigger chunks of letters are formed by mastering and combining smaller ones. Texts can be understood only after the visual signs have been interpreted and a minimum reading speed has been attained. These processes are necessary for all humans and hold for all languages and scripts (see for example Bolger, Perfetti, & Schneider, 2005; Culbertson & Legendre, 2010; Miestamo, Sinnemäki, & Karlsson, 2008).

Some of these neuropsychological functions may significantly limit what low-income schools offer the average student. Those who fail to learn the sound-letter combinations or small letter units cannot go on to texts of greater complexity. The higher grades deal with more complex visual patterns and require rapid identification. So even when promoted for social reasons to the next grade, students remain illiterate.

But why do these concepts frequently receive limited attention among reading specialists? A partial answer is that in higher-income countries these variables have brief and limited importance. Children grow up in a world rich with symbols and may learn to discriminate among letter shapes even without knowing their sounds. Many do so even before coming to school. They may thus be more likely to recognize larger psycholinguistic grains (see for example Ziegler & Goswami, 2005) fairly quickly. Furthermore, the processes are unconscious, and colleges of education rarely offer training in aspects of perceptual psychology. This may be why reading is commonly thought of as an activity involving meaning and comprehension rather than visual discrimination.

The brains of educated people have been "programmed" and perfected since early childhood to read automatically. Inevitably we tend to trust our own

perceptions. It is difficult, if not impossible, to understand the viewpoint of learners, who may see only jumbles of squiggles. Consequently, many well-meaning individuals and non-governmental organizations worldwide have tried to adapt activities effective in higher-income countries, usually in English. But unless an enormous amount of time and practice is also employed, frequently only the better-off or brightest among the poor can perform them.

Research also opens potential solutions. Efficient instruction to the very poor ought to focus on lower-level variables. In some respects this means that an introduction must be inserted into textbooks using the whole word or whole language approach, or a section that presents many letters in quick sequence. It is important to convince educators that students will be much more likely to understand texts if they read them fluently, and of course, if they understand the language. The encouraging message of the research is that in alphabetic and even in syllabic scripts basic decoding can be reliably taught even to less able students in about 100 days (see for example Schmoker, 2011).

Perceptual Learning and Memory: The Invisible Tunnels to the Literacy Fortress

Reading is a rapid interplay between visual perception and memory. Expert readers first recognize letter features, and within milliseconds they probe their memory for related words and for the prior knowledge needed to understand a text (Gabrieli, Christodoulou, O'Loughlin, & Eddy, 2010). But to enter this fortress of learning, children must first quickly crawl through two narrow tunnels that elude consciousness. These are visual perception and working memory.

Decoding Requires Perceptual Learning

Students must learn to detect and discriminate among not just multiple letters, but also their components. Even after we read billions of letters, we always recognize letters from features, which must be individually detected rigorously and independently (Pelli, Burns, Allison & Moore-Page, 2006). Recognition is greatly facilitated when features are few and when the letters are well spaced and in the center of the eye; complex letter shapes and combinations create a bottleneck in visual recognition, slowing reading significantly (Pelli et al., 2006). Practice results in rapid adaptation; some distinctions may only require a total of two hours of exposure (Hussain, Sekuler & Bennett, 2011). But early on, detection and discrimination are crucial. Dirty blackboards, calligraphy, and small, crowded print may delay perceptual learning, especially among students who get little outside exposure to these stimuli.

Education for All means teaching everyone a skill that was traditionally taught to a selected minority. Scripts have evolved over the centuries to fit the properties of the human visual system (Changizi & Shimojo, 2005; Changizi,

Zhang, Ye & Shimojo, 2004), so in principle, everyone can learn them. But the amount of needed time will differ. Overall, the amount of "ink" needed to write a letter or character is related to learning speed (Changizi & Shimojo, 2005). Some scripts have more letters than others, and some letters more features than others. For example, some Asian syllabic scripts are more visually complex than others, and, despite consistency, will require more practice than smaller alphabet sets, such as Latin, Cyrillic, Armenian, or Dhivehi. Voweled Arabic is a fairly transparent orthography, but unvoweled Arabic script requires predictions and dependence on vocabulary and syntax (for the Arabic, Urdu, Pashto, or Farsi languages).

Much research exists to show that learning the linkages between specific letters and sounds is faster than learning the links between letter groups and multiple sounds (e.g., McCutchen et al., 2002; McCutchen & Berninger, 1999; Moats & Foorman, 2003; Spear-Swerling & Brucker, 2004; Zorzi, 2005). Languages with spelling complexities (such as English, French, Portuguese, or Khmer) require deciphering multiple letters simultaneously; these large "psycholinguistic grains" also require more practice (Ziegler & Goswami, 2005). English, in particular, is an unusually difficult language for fundamental reading due to spelling irregularities (Share, 2008).

The research suggests that phonics rather than the whole word approach should teach beginning readers more efficiently (e.g., Wyse & Goswami, 2008). Students who get help at home get extra practice and can learn reading from methods that teach multiple letters quickly or focus on entire words. But the limited engagement time of poorer students suggests that synthetic phonics (which presents fewer letter features at a time) would be more efficient in low-income classrooms and for lower-scoring students (Wyse & Goswami, 2008).

Capacity Challenges of Working Memory and Their Resolution

When letters get through the visual bottleneck and are recognized, they meet another bottleneck, that of working memory. To understand, readers must hold a text in their minds long enough to recall relevant information about it, but they only have a few seconds; working memory may span only about 12 seconds (Atkinson & Schiffrin, 1968; Baddeley, 1999; Miller, 1956; Peterson & Peterson, 1959).[1] So a message must be deciphered quickly enough to fit within this short

[1] More recent working memory research points to different timeframes for various tasks and lower capacity limits (Cowan, 2005), but elementary fluency tests resemble the older protocols and still seem appropriate (e.g., Daneman & Carpenter, 1980). Very roughly, a minimum reading speed to understand a simple sentence of about seven words in about 12

timeframe. Until speed increases to suitable levels, students may be unable to make much sense of the text.

Initially readers recognize only one or two letters at a time, but experienced readers recognize about four letters simultaneously in about 250 milliseconds. To facilitate the process, the letters must be well spaced and clearly distinguishable from each other (Pelli et al., 2006).

Practice builds in the brain the white matter necessary to transmit messages quickly (Keller & Just, 2009).[1] Practice also helps chunk letters together and reduces reaction time (Miller, 1956). Longer and complex chains of skills can only be developed after smaller chains have been formed (Keele, 1973; Schmidt & Lee, 2005). Chunking has received limited research attention, perhaps because in higher-income countries students progress quickly from letters to words. Research with adults learning new scripts suggests that letters must be seen and decoded about 3000 times before reaction time to them levels off (Pelli et al., 2006). Low-income students tend to get less practice at school or at home, so they may read letters one by one and with hesitation.

Several weeks of practice activate the visual word form area in the left occipitotemporal part of the brain (Dehaene, Stanislas, & Cohen, 2010; McCandliss et al., 2003; Shaywitz, 2003;). All humans seem to use this area for automatic reading, including blind students reading Braille (Reich, Szwed, Cohen, & Amedi, 2011). The visual word form area specializes in the recognition of faces or shapes, and sufficient activation of that part in the brain permits fast and effortless detection of multiple letters at a time (Dehaene et al., 2010). This research finding helps explain some reading phenomena and predict the effectiveness of some teaching activities. For example, perceptual constancy is a feature of face or shape recognition (Ahissar & Hochstein, 1998). Readers may identify different writing styles and fonts easily when the visual word form area is activated, but possibly not before that stage. One implication is that reading instruction should mainly use standard letter shapes until automaticity is attained. However, many African textbooks teach calligraphic letters from the first page,

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seconds would be about 45 words per minute, but reading studies in multiple languages have shown that 50-60 words per minute are needed to respond at 80% correct to shallow questions of a simple text (e.g., RTI, 2010). Despite apparent differences, the languages of the world conform to the same human capacity constraints and can thus be compared in terms of words per minute (Seymour, Aro & Erskine., 2003). More research, however, is needed to decide how to count words across language families.

[1] A US study using diffusion tensor imaging showed that the brains of dyslexic 8-10 year olds receiving 100 hours of instruction improved in terms of white matter quality, and students' decoding skills improved as well (Keller & Just, 2009).

creating needless difficulties for students (See for example the Grade 1 primer of Cote d'Ivoire, Ministry of National Education, n.d.).

With practice, reading becomes effortless, and speed starts rising rapidly. Once experienced readers learn a word, sounding it out is no longer necessary. A visual dictionary gets created, and readers rely on it to recognize words (Glezer, Jiang, & Riesenhuber, 2011). Thus, people can read hundreds of words per minute without sounding them out.

Insights about working memory capacity lead to the conclusion that reading, as well as other basic skills, must be executed rapidly (Cooper & Sweller, 1987). Classroom time and practice must be dedicated early on to make the students capable of reading text or writing ideas effortlessly, without having to think much about the actual mechanics. Students who do not get sufficient practice may never acquire the speed needed for such performance levels.

Local Languages and the Advantages of Spelling Consistency

The two secret tunnels of working memory and visual perception keep a lot of students from progressing into the fortress of literacy and "reading to learn." These bottlenecks highlight the value of consistent orthographies than can be easily deciphered during instruction. Because students pronounce only the letters a word contains in a consistent language, they need to depend less on vocabulary knowledge or on predictions to decipher text, and they have less need of parents reading to them at home (Georgiou, Das & Hayward, 2008, 2009; Share, 2008). When students put letters and words in their working memory quickly enough and know the vocabulary, they typically understand (Share, 1999, 2008). Complex classroom activities are also needed less. Thus learning lists of frequent English sight words or activities to enhance listening comprehension may not be necessary for literacy in consistently spelled languages.

The fundamental reading instruction to help children "crack the code" may only need 3-4 months of consistent work in transparent orthographies (Aro & Wimmer, 2003; Ellis et al., 2004; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006; Seymour et al., 2003). By contrast, English has a 3-year learning timeframe. In consistently spelled languages, reading can be taught in four or five months even when scripts are visually complex. For example, Pratham, a non-governmental organization in India successfully taught syllabic scripts to illiterate fourth graders in 6 weeks by dedicating one hour per day for reading and one hour for math. At the end of 6 weeks, about 85% of the students had progressed from halting or no reading to fluency (Banerji, Chavan, & Rane, 2005). Similarly, the Intervida association of six community-run schools in Peru increased students' reading rate by 22% on average (11 words per minute) in 4 months once it was decided to focus on practice (World Bank, 2008). In Mali, a method emphasizing

practice was shown to triple the number of words children read in local languages compared to control classes studying in French (Alfari, 2009; Mitton, 2008).

Obviously, learning to read in a language known by a child offers many benefits, including faster identification of letters within known words (word superiority effect; e.g., Changizi et al., 2004; Changizi & Shimojo, 2005). A vast volume of research on language of instruction exists that documents the benefits of teaching children in a language they understand (e.g., Thomas & Collier, 1997). Automaticity in the same script transfers from one language to another; so for instance, reading fluency in an African language greatly facilitates fluency in English, French, or Portuguese (see also August, Carlo, Calderón, & Proctor, 2005 for Spanish; Ledesma & Morris, 2005 for Tagalog; Walter, 2010 for Kom).

Almost all the languages of Africa and Asia are spelled consistently, so in most countries, children could in principle learn to read in consistently spelled languages. However, it is often inconvenient to teach children in their own language. Multilingual societies present logistical complexities with respect to teacher assignments, textbooks, and linguistic decisions. In urban areas, it is also uncertain which language(s) to use in a school. And where the number of languages is large, only a few can be used for instruction. Complex political issues may arise with linguistic minorities. Also parents, mindful of status and employment possibilities, may demand instruction in local languages. Thus almost all African countries, as well as some East Asian countries, teach children to read in English, French, Portuguese, or Spanish. These languages, unfortunately, have complex spelling systems that require learning all larger psycholinguistic grains all at once. When children also lack language knowledge, the limited time of low-income schools ensures that only the most privileged learn to read.

It is possible, however, that the linguistic conflicts which created the need for a lingua franca may be less frequent than one might expect. In Africa, people commonly use two or three local languages with relatives and neighbors, and many of the languages are closely related (Prah & Brock-Utne, 2009). And students may be acquiring local languages in the playgrounds of multilingual schools. Young children need interaction to learn languages (Nation & Waring, 1997; Putnam, 1975), in contrast to a formal language that may only be spoken by a teacher who "broadcasts" to all. Thus, choosing to teach in a consistently spelled language taught at a time when children are still learning language may address the logistical difficulties of trying to teach in a larger number of languages.

One small study lends support to this hypothesis. Pulaar-speaking children in Cameroon scored higher in English and math after they had studied in a Kom language school than Pulaar speakers studying directly in English (Walter, 2010). Surely more research is needed on the children's command of local languages, and detailed local knowledge is also needed in the political contexts of various

countries. But it is possible that under certain circumstances, children could become literate more easily in a language similar to their own, one they know partially or one they can learn from interaction on the playground or in the market. Careful linguistic mapping in individual countries would be needed to use the optimal number of languages necessary to serve all students. Communication campaigns would be indispensable in explaining the rationale and expected benefits to the population.

Activities Conducive to Consolidation of Knowledge

Teaching Letters One by One

Recent research has not yet offered clear guidance on how quickly letters should be introduced, but perhaps at most one letter a day should be taught. Capitals would be separated from small letters in scripts where these exist. Reading practice should be extensive; not just a few sentences, as commonly happens. Students ought to read multiple times together, alone, and in small groups. Research shows that repeated reading reduces the effects of visual crowding (Huckauf & Nazir, 2007).

Writing for Memory Consolidation

Movements help consolidate the memory of associated information (Dijkstra, Kaschaka, & Zwaana, 2007); so extensive writing practice will help establish the automaticity and speed children will need later to express concepts on paper quickly, before they forget them. Paper in low-income countries is often scarce, but students can write on slates, the ground, or in the air or on the table with their finger. Also dictation of letters, syllables, words, ought to facilitate consolidation by creating procedural memory of how the shapes are formed.

Phonological Awareness

One pattern that students must understand early on is how to map letters onto sounds. Much research has linked phonological awareness to reading achievement; for consistently spelled languages, word segmentation is particularly useful (e.g, Durgunoglou & Oney 1999). Students ought to receive such exercises, which are oral, during the early stages of instruction. This skill is harder to teach to students and teachers than it seems (Stainthorp, 2003), so extra efforts may be needed to promote this practice extensively.

Pattern Detection for Faster Progress

The mind seeks patterns and learns them easily, and children are expert pattern detectors (Devlin, 2010). Instruction and practice in analogies and systematic patterns (such as *ka ki ku ke ko*) may facilitate chunking and eventual automaticity. Teachers of earlier eras found empirically that literacy was facilitated by the use of analogies in systematic vowel-consonant combinations. (For example, Greek textbooks of 1860 and 1863 contain such combinations in their first few pages; Koromilas, 1863). Thus students can learn letters quickly through synthetic phonics and by explicit instruction on the rules and change patterns related to various sounds and parts of speech.

For similar reasons, morphological awareness exercises have been found to be beneficial and could be introduced (Bowers, Kirby, & Deacon, 2010). In Spanish, for example, students would receive specific practice on prefixes like de- (de-mostrar, de-cifrar, de-cidir, vide) or suffixes like -ión. Common prefixes and suffixes would also use the most frequent letter combinations in a language. The technique has some similarities to the linguistic method, which analyzes languages to focus on the more common linguistic features (Trudell & Klaas, 2009). Much research has also linked phonological awareness to reading achievement, particularly word segmentation for consistently spelled languages (e.g., Durgunoglu & Oney, 1999).

Maintaining Student Attention to the Target Letters

Visitors in lower-grade classes often observe students repeating in chorus text written on the blackboard without actually reading. They may be looking away, or text may be undecipherable from the back seats. Their voices may assuage teachers, but many of the students may, in fact, still be illiterate.

In classes of students at risk of falling behind early, mere presentation of lessons and choral answers may be insufficient. ***Focusing on the right shapes and excluding others*** is a significant perceptual problem that seems to have escaped attention. Observers often notice that students repeat verbally, but it is unclear if they are looking at the characters being taught. Thus this issue may be widespread among young students, but it is not very amenable to assessment with educational instruments, so it has received little attention. Some research suggests that spatial attention, that is ability to focus on letters, is linked to reading performance (Franceschini et al., 2012). The study suggests that spatial attention is linked to executive control and may have developmental origins.

Techniques must be used to attract and maintain attention on the letter being taught. For example, a teacher may present the letter using as few words as possible to focus attention on the sound-shape linkage. Children may be asked to put their thumbs up if they understood and down if they did not. Drawing large letters without other shapes nearby, bringing the kids close to the blackboard on

critical moments, asking them to draw the shapes, asking them to point to the blackboard or to the textbook (if they have one) ought to help. Such techniques may increase opportunities for long-term potentiation, the neural level process which enables stimuli to be linked permanently in memory (e.g., Arai, Li, Hartley, & Feig, 2009).

The Importance of Systematic Attention and Feedback to Students

Classroom observations often show that few students are involved in instruction at any given time (e.g., Independent Evaluation Group [IEG], 2008; 2009a; 2009b; 2009c; Schuh, DeStefano, DeStefano, & Adelman, 2009). Teachers in low-income environments often stand by the blackboard, address students at large, call for volunteers, and interact mainly with the few who know the answers. Corrective feedback is crucial because the nervous system must determine whether or not an action is correct (Galvan et al., 2006; Salamone & Correa, 2002). The better students may gradually concentrate at the front, while weaker students may sit silently in the back. Children that fail to attract the teacher's attention may never learn to read (Llambiri, 2004; Lockheed & Harris, 2005). Focusing on the few best students was perhaps a reasonable teacher decision when materials were nonexistent and only few could learn from limited instruction. "*If the student cannot learn, we send him home*," said a senior teacher from Mali at a 2009 workshop. But to educate *all* students, teachers must somehow interact with the entire group.

Teachers in high-income countries are expected to give individual attention to students' learning needs. But this is nearly impossible in countries with a long tradition of selectively attending to the best. However, some experiences, notably from the Bangladeshi nongovernmental organization Gonoshahajjo Sangstha (n.d.) suggest that it may be possible to systematize the checking of all students' knowledge and offering of brief corrective feedback. The teacher could hear each child read three or four lines for a few seconds per day during a time others are practicing. Teachers could be taught to do this systematically row by row starting from the back. The three or four of the best students could also be identified and set to work with the weaker children at the same time.

Textbook Design for Practice and Rapid Attainment of Automaticity

To attain automaticity, students need many pages of legible text to practice. Students in the United States who score at the 98th percentile may read as many as 4.7 million words per year, or 67 minutes per day, while those scoring in the 10^{th} percentile may read only 51,000 words per year or 1 minute a day (Anderson,

Fielding, & Wilson, 1988). Each student ought to receive a book to take home for practice and homework.

Print exposure statistics are usually not available for low-income countries. However, the schools of low-income countries often face "print poverty." Procurement and distribution problems are often severe, so reading practice is often limited to texts written on the blackboard. Even when books are available, however, the average students may not be able to read due to a lack of language knowledge or literacy skills (Glewwe, Kremer, & Moulin, 2009).

Procurement problems aside, what should the Grade 1 reading books look like? Taking cues from high-income countries, many of them have large, colorful illustrations, just two or three lines of text per page, and a lot of blank space. Examples analyzed here are the French textbook of Cote d' Ivoire (Ministère de l'Education Nationale, 2006) and the Chichewa textbook of Malawi (Malawi Institute of Education, 2006). Both introduce whole words and whole sentences in the first lesson, with little emphasis on individual letters or syllables. Such books may be acceptable for middle-class children whose parents will buy supplements and will help them read, but in low-income countries these are the only reading materials available, and only the brightest may be able to decode them.

In Grade 1, the amount of practice also matters. The Chichewa textbook only has 55 pages of text, the introduction of multiple letters, and a total of about 500 words for practice. It is unknown how many words in a textbook are required to bring about automaticity even among the weaker students. But older European textbooks had more text than contemporary textbooks, and could offer some guidance. For example, the Greek Grade 1 readers of the early 1900s had about 5000 words in about 190 pages with large fonts (one example is Gianelli & Sakka, 1955). Each page explicitly introduced one letter (capitals separate from small letters when dissimilar) as well as common diphthongs. Letter introduction covered about 60 lessons, and then the second half of the book consisted of stories. Research on visual perception gives some guidelines on how Grade 1 textbooks could be formatted. To facilitate visual discrimination, critical size and critical spacing could be respected (Pelli et al., 2006; Zorzi et al. 2012). They could be printed with 24 point courier fonts, double-spaced with three spaces between each word; research also suggests that picture size can be minimized because children attain visual acuity early (Martelli et al., 2002). Research on colors in the early grades has been limited. Many people believe that children are attracted to them, but the advantage of colors in actual reading acquisition has not been studied. One study on color coding suggests that its use may not be efficient before age 12 (Madrid & Crognale, 2000). To minimize expenditures while using paper efficiently, books could be printed in black and white.

After basic automaticity is attained, students must increase fluency and vocabulary depth. Thus, reading books are needed in local languages that can be read for fun and information. These are rarely available in schools, but several

have been developed in various countries, from South Africa to Mali. Copyrights may be purchased, and textbooks may be adapted for expediency. An important part of a country's reading strategy would be to make reading books available for sale at accessible prices in local languages.

Using Observational Learning Paradigms for Teacher Training

Often, teachers in low-income countries are unsure how reading should be taught. The curricula of many countries mix reading with language arts and lack clear guidance on how to teach this skill. Thus teachers would have to be trained on a large scale for reading. But in low-income countries, preservice and inservice teacher training efforts have produced limited results and limited behavioral changes (e.g., UNESCO, 1998). Poor outcomes are partly due to brief training duration, limited prior education, lack of textbooks for student teachers, poor time use in training classrooms, and curricula that offer little actual guidance on how to teach.

Trainees may receive instructions to execute various procedures when they return to their class, but observations suggest that they may not do so. Perhaps the need to recall and carry out multiple tasks at the same time fills their working memory beyond capacity and result in "cognitive overload" (Feldon, 2007). Those teachers with more limited education and fewer automatized skills may be more vulnerable to this phenomenon. They must acquire automaticity in carrying out the requested procedures.

One little-explored mechanism is observational learning. People are biologically inclined to model the actions of similar people, so instructional behaviors may be more effectively taught through audiovisual role modeling and visualization (Dowrick, 2010). These methods have rarely been used in low-resource environments, and they are more complex to create than mere lectures. However, the cost of technology has dropped significantly in the past years. Camcorders are prevalent everywhere through cell phones, and editing software is available on every computer. Palm-top projectors running on batteries can be taken to areas that have no electricity. Initial trials with brief instructional video clips were conducted informally in Liberia and the Gambia in 2011. Informal feedback was very positive, and more detailed plans were underway to pilot this methodology in 2012.

Brief visually based training would cover the issues presented in the earlier sections of this article. Teachers would be shown how to interact with students in the back rows, how to listen to each child reading a few lines, how to deal with absent students systematically, how to write with large, clear letters on the blackboard. Teachers can also learn to fluidly carry out a consistent schedule of daily routines, which helps students anticipate the next activity (Stronge, 2009).

Audiovisual-based training could also be used for school principals and supervisors, who often fail to actually supervise. Establishing a few critical variables for supervising teachers and demonstrating them on video would help them detect patterns of more and less effective teaching and make this work more interesting.

Teachers are typically expected to develop their own lesson plans, but even when these are completed in low-income countries, they may rarely be carried out. To increase the probability that teachers will carry out the expected activities it may be advisable to plan centrally and prepare a series of "scripted" lessons. These have been a feature of Direct Instruction for decades in the Unites States and elsewhere (Adams & Engelmann, 1996). Teachers can read instructions to students rather than trying to invent them. Practicing with the students may also teach teachers content and methodology. It is useful to keep in mind, however, that teachers of limited education read slowly and need practice to read in local languages. Thus scripted lessons should be very short.

Measurement and Evaluation of Reading Performance

Quick and inexpensive testing may be the simplest means to monitor achievement. This would include a timed reading of letters and a simple 60-word passage along with five "shallow," fact-based comprehension questions (RTI, 2009, 2010). Words per minute and comprehension percentages would be important variables, but equally important would be to leave no child behind. The goal would be to have nearly all students at least decoding after the first 100 days of instruction and almost no *students reading at 0 words per minute.* Some allowance must be made for learning disabilities but their incidence in low-income countries is uncertain.

Literacy in 100 Days: A Pilot Program Based on Neurocognitive Research

The implications of the above research have been operationalized by the *Global Partnership for Education* in a basic parsimonious reading course. This program would be used with consistently spelled languages that children can understand and aimed at first graders or older children who have remained illiterate. The course would have a specific time in the curriculum and would not be mixed with language arts. The activities would be similar each day, and would thus create a specific routine for students and teachers to follow. Instructional features would be

- Synthetic phonics instruction with only one new letter taught per day at most; revisions every 5 days to deal with absent students;

- Writing and dictation to consolidate memory of movements;
- Techniques to direct student attention to the correct letter being taught and to maintain it;
- Word segmentation exercises and systematic instruction in patterns and analogies;
- Brief corrective feedback for all students (even for 30 seconds per day), partly through the better students;
- Affordably priced textbooks optimized for extensive reading practice; attention to letter size and spacing, given poor students' limited experience in letter discrimination;
- Brief scripted lessons for teachers;
- Teacher training at least partly through observational learning, visualization, and detailed planning for critical behavior sequences;
- Frequent and specific supervision, partly by school directors who would also be trained through audiovisually-based techniques;
- Division of the school year into two or three modules to help teachers maintain proximal goals and enhance the probability of continuing performance.
- Results monitored relatively through quick, inexpensive one-minute reading fluency tests.

The government of the Gambia showed interest in this method (see Education for All, 2011) and in 2011 committed resources to pilot it in five local languages and expand it if feasible. Two 35-minute classes were combined into a 60-minute period in Grade 1. The first module teaches all letters and diphthongs in 65 days, with capitals and small letters taught separately when dissimilar. This number of days was set to include reviews, take into account modest teacher absenteeism, and provide remediation for frequently absent students. Preliminary observations showed that in the early weeks one letter would best be taught every two or even three days, but the overall time necessary was well within the 100-day timeframe. Data were unavailable as this document went to press, but experiences have been very encouraging and suggest that this model can be generalized to entire countries.

A second module to sum up to 100 days would develop reading and writing speed, simple composition, text interpretation, and vocabulary. For multilingual countries, a subsequent module would be necessary to bridge students into the spelling of the official language if written in the same script (English, French, Portuguese, Khmer, Lao, etc.). Syllabic scripts (e.g., Amharic, Bengali) would still require one module for the essential letters, but those scripts using conjoint

consonants might need an extra module. If the courses are implemented as expected (and this is always uncertain), the weaker students would be able to barely decode by the end of the first module, while the better off students would be reading fluently. Variance among students is inevitable as are subsequent inequalities, but it is hoped that early systematic intervention will provide basic decoding for all.

Conclusions and Implications for Further Research

All methods teach some proportion of the students, but sometimes that proportion is small. The challenge has been to create a course pitched at lower-scoring students which might be effective at teaching nearly all levels. Most of the activities are not new, but they may not have been used all together in a single program.

The research on memory and on perceptual learning implies that some fundamental prerequisites must be satisfied before students enter the world of meaning, reading for fun, and "reading to learn." Students must first be able to distinguish letters, detect their salient features, associate specific shapes to sounds. They should learn individual letters and connections to sounds rather than entire words. Then they should decode letter groups fast enough to fit messages into working memory. And they must have in their cognitive networks the needed prior knowledge to understand the vocabulary, grammar, and context of the messages. In higher-income or higher-performance populations the perceptual and memory-related variables are learned fast, so they may be taken for granted, and knowledge about them may be limited. But for lower-performing students these variables must be taught explicitly. It is unwise to assume that students will somehow skip these essential reading stages and focus on meaning and interpretation.

Would the classroom activities bring about basic literacy for nearly all students if implemented approximately as planned? Would the package of activities work together in a program? Would most teachers be able to implement it without degrading it inordinately? Can systemic difficulties be overcome given that the supervisory chain is broken? The authors have experience in reading instruction and are very cognizant of the capacity limitations in low-income countries. This is why there is much emphasis on parsimony, that is carrying out the minimal number of activities that would teach basic literacy to nearly everyone. While watching programs unfold, monitoring the research for new insights and interventions continues.

Arguably, more research would be needed on each of the variables discussed and for their interactions, but it is not possible to wait for the normal academic research processes to unfold. Children are dropping out illiterate even as this document is being read. Governments must act quickly. The Global Partnership

for Education must give interested countries the best advice available at the moment to facilitate their work. In any case, some research implications can be applied with relatively little risk.

In some respects the neurocognitive research that has influenced this methodology marks the evolution of constructivism into the 21st century. Cognitive neuroscience shows that students indeed build their own cognitive networks on the basis of prior knowledge and environmental stimuli, and learning research clarifies how this is done. When skills involve time-bound and "low-level" processes, it would be ethically and socially responsible to teach them in the most efficient way possible. On the other hand, learning that involves higher-order processes should be challenging and exciting. Thus, the greatest gift poor first graders can receive is the activation of the visual word form area. This gift puts comprehension within the students' reach. The invisible underground tunnels become passable, and the child walks into the fortress of knowledge.

The Global Partnership for Education aims at providing children with access to learning. Broad understanding and partnerships are needed for the investments and also for agreement on principles. We are still in the initial stages of the road, but the mist is beginning to clear. The road may be convoluted, but a faraway light is visible.

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