

The Role of Phonological Deficits in Developmental Reading Problems

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Relationship between Phonological Processing Abilities and Reading Development

Many researchers who are interested in reading acquisition and reading disabilities have focused on the role of phonological processing. Some of them have hypothesized phonological deficit as a candidate for a cause of reading disabilities. There are three major research designs to test this hypothesis. One is the group comparison studies in which the characteristics of cognitive abilities and reading abilities are compared between children with and without reading problems. A second one is the longitudinal correlational studies whose focus is on finding the best predictors for future reading abilities. A third one is the experimental studies in which the effects of phonological skill training on reading performance are examined. In the following sections, studies of each research design are reviewed and their implications for the future studies and education are discussed.

Group Comparison Studies

Deficits in phonological processing abilities have been consistently reported in the group comparison studies between children with and without reading problems. Catts (1989) reviewed studies that dealt with the characteristics of phonological processing in children with reading problems. Children with reading problems have deficits in the processes of encoding phonological information in memory, retrieving words, and storing verbal information in the working memory. They also have problems in analyzing and synthesizing sound. One of the recent studies that indicated strong relationship between reading problems and phonological deficits was a meta-analytic study reported by Siegel (1993). She conducted meta-analysis with her past data that consisted of 1493 children including those with learning disabilities (LD). The results indicated that correlation among reading and phonological abilities were significantly higher than those between IQ and either of these abilities. Such phonological deficit among children with reading problems may be maintained after they grow up. Bruck (1993) also reported phonological deficit among adults with childhood diagnosis of dyslexia.

Because children with LD also have many perceptual and cognitive problems, we cannot interpret the deficit in phonological skills easily. It may be a cause of reading

disability, by-product of other dysfunction, or outcome of their learning experiences. Simple comparison between children with reading disabilities and those without disabilities can not provide evidence to explain the causal relationship, if any, between phonological processing abilities and reading problems. Longitudinal correlational studies and experimental studies are employed to examine the causes of reading problems.

Longitudinal Correlational Studies

Phonological processing ability at kindergarten age explains a considerable amount of variance of later reading performance, although tasks chosen as predictors varied across studies (Bradley & Bryant, 1983, 1985; Mann, 1984; Mann & Liberman, 1984; Lundberg, Olofsson, & Wall, 1980; Velluntino & Scanlon, 1987). Maclean, Bryant, and Bradley (1987) reported that this relationship was found even after the influence of IQ and social background were controlled. Tornéus (1984) conducted a longitudinal study with half of his subjects were diagnosed as dyslexia. Phonological processing abilities had a significant contribution to later reading skills. He also found the influence of both language and cognitive development on phonological ability. Cognitive ability also showed a direct influence on reading skills.

Although these studies have shown a consistent relationship between phonological abilities at the kindergarten level and early reading development, most of them lacks the ability to describe the causal relationship. Torgesen, Wagner, and Rashotte (1994) summarized three problems in the research design of these longitudinal studies. First, most studies did not include other plausible causal variables as predictors. They suggest that reading skills and general verbal ability might exert causal influences on later reading abilities. Second, to examine whether there is bi-directional causal relationship, both reading and phonological skills should be measured at all assessment points in the longitudinal study. Third, measurement error should be taken into consideration because reliabilities of measures are not perfect.

There are several longitudinal studies that satisfy some of their criteria. Perfetti, Beck, Bell, and Hughes (1987) collected phonological and reading skill data from first grade children at four different time points. Their samples came from 3 different schools and one of them had a curriculum in which coding instruction was emphasized. They found that the difference in the instruction method did not yield any difference in the development of reading and phonological skills and thus concluded that the relationships between those skills were reciprocal. It is reasonable to assume that reading experience facilitates the development of phonological skills. However, our interest is whether phonological deficits that children have before they receive reading instruction can be a cause of reading problems. Thus, subjects who have not received reading instruction

should be in the experiment. One of the problems of this design is that it is difficult to measure reading ability of children who have not received reading instruction, although we need both reading and phonological ability measures at all assessing points. Vellutino and Scanlon (1987) included kindergartners who might have reading problems in the future. They used a reading readiness test to measure the kindergartners' reading abilities. They found strong correlation between phonological skills in kindergartners and later reading skills even after controlling for intelligence and prior ability in word recognition. This study satisfies 2 of 3 criteria that were proposed by Torgesen et al. (1994), but the measurement error issue was not taken into consideration in their research design.

Torgesen et al. (1994) and Wagner, Torgesen, and Rashotte (1994) used latent variables (used multiple measures to assess each construct) to deal with measurement error, and used all measures at all assessing points. They found that only the phonological analysis ability among five of their subtypes of phonological abilities assessed at kindergarten had a significant causal influence on word-reading skills at first grade, when verbal abilities and reading skills at kindergarten are considered simultaneously. A similar pattern was found in the causal model with kindergarten and second grade results. However, the influence of phonological abilities at kindergarten on reading at the second grade was relatively weaker than that at the first grade. The analyses of causal influence of letter-name knowledge on the phonological skills also showed a significant effect, although this effect was moderate when it is compared with the effect of phonological skills on reading. Their results suggest that phonological abilities are important in early reading development. The effect of reading on phonological abilities is not as significant as the other direction.

In sum, longitudinal studies suggest that phonological abilities that children have before they receive reading instruction are one of the most important predictors of later reading development. The phonological abilities are influenced by reading instruction, but it seems that the effect of phonological skills on reading development is larger than that of reading experiences on phonological skills.

Experimental Studies

As summarized in previous sections, children with reading problems show poor phonological skills, and longitudinal correlational studies suggest that phonological skills at the kindergarten age level are good predictors for early reading development. Then, the next question is whether we can teach the phonological skills. If we can teach them, do the learned phonological skills facilitate reading development? There are some studies that were designed to answer these questions.

Contents, length, and style (individual or group) of training programs vary across

studies. Training sessions in most of the training study are 15 to 30 minutes a day, several days a week, and last for several weeks to 2 years. Training sessions include listening and repeating rhymes and alliterations, segmentation (or phonemic analysis), addition or deletion of sound in a word, blending (or phonemic synthesis), meta-level knowledge of phonemic awareness, letter name knowledge, and letter sound knowledge. In spite of the diversity of the programs, there are consistent results showing phonological skills can be improved by training (Ball, & Blachman, 1988, 1991; Bradley, 1988; Castle, Riach, & Nicholson, 1994; Cunningham, 1990; Fox, & Routh, 1984; Lundberg, Frost, & Peterson, 1988; Olofsson, & Lundberg, 1983, 1985, Torgesen, Morgan, & Davis, 1992; Trenéus, 1984; Velluntino, & Scanlon). One of the shortest training effect is presented by Treiman and Baron (1983). One brief phonemic analysis training enhanced children's use of spelling sound rule in the following reading task.

Phonological skill training is also promising to improve reading ability. Many studies have reported positive effects of phonological skill training on reading abilities (Ball, & Blachman, 1988, 1991; Bradley, & Bryant, 1983, 1985; Bradley, 1988; Castle, Riach, & Nicholson, 1994; Cunningham, 1990; Fox, & Routh, 1984; Lundberg, Frost, & Peterson, 1988; Torgesen, Morgan, & Davis, 1992). However, the effect of training on reading ability is not as clear as the effect on phonological skills.

Olofsson & Lundberg (1983) designed a study with three groups of kindergartners that received different levels of phonological training. Only the group trained the most showed significant improvement after the training, and children with poorer performance in the group received more benefit. Olofsson and Lundberg (1985) reported the follow up data of phonological skill, reading, and spelling one year after the training. Although children in the trained group showed better performance on a phonological skill (phoneme synthesis) task, no difference was found on the reading and spelling performance.

Tornéus (1984) reported similar results. Children with poor performance on phonological skill tasks showed more improvement on a spelling task after eight weeks of phonological skill training. Those results suggest possible benefits of phonological training for poor readers. However, the impact on reading performance was not seen. One possible reason for this lack of positive effect on reading is that the training of the letter name and sound was not included in the training program (Blackman, 1989). The knowledge of letter name and sound is important when children learn how to read printed or written words.

Bradley and Bryant (1985) assigned first graders with poor phonological skill performance into four groups. The first experimental group was trained in phonological skill only, and the second group was trained in both the phonological skill, and letter

name and sound information. Results indicated that the children received both the phonological awareness training and letter-sound training had significantly higher scores on reading and spelling than the two control groups and on spelling than the phonological awareness only group.

To examine the effect of letter name and sound instruction, Ball and Blachman (1988) conducted training study with phonological awareness, letter-sound combination group and letter-sound training only group. The result indicated that the combination group performed better on phonological awareness task and word reading task. This result suggests letter naming and sound training itself does not improve phonological awareness. Vellutino and Scanlon (1987) trained poor readers in phonological and alphabetic skills and found positive effects on word identification skill.

In sum, training in phonological skills may be beneficial for both normal and poor readers when combined with letter name and sound training. Recent longitudinal study also supports this idea. Wagner, Torgesen, and Rashotte (1994) reported that letter-name knowledge has a significant contribution to the development of phonological abilities.

Role of Phonological Processing in Normal and Abnormal Reading Development

The research findings presented here provide evidence to support a strong relationship between phonological processing abilities and reading problems. Can we say phonological deficit is the cause of reading problems? Before we make any conclusion, we need to consider the role of phonological processing in the larger context of reading development.

Spear-Swerling and Sternberg (1994) summarized the reading development into six stages: (a) visual cue word recognition, (b) phonetic cue word recognition, (c) controlled word recognition, (d) automatic word recognition, (e) strategic reading, and (f) highly proficient reading. Children in the first stage tend to rely on some salient visual cue, such as color or a distinctive logo, to recognize words. In the second stage, readers begin to use phonetic cues to recognize words, but their use of these cues is not complete. In the third stage, children have fully attained the word decoding skills and this process becomes automatic in the next stage. With developing metacognitive abilities, with reading experience, with an increasing knowledge base, and with automatic word recognition skills, children become more capable of acquiring strategies to increase reading comprehension. Highly developed comprehension abilities characterizes the final stage of reading development.

Although phonological skills do not take a significant role in the later stages, they are essential during the transition from the first to the second stage. Due to the nature of the English orthography, in which readers need to know the alphabetic principle (Lieberman, Shankweiler, & Liberian, 1989) to figure out the pronunciation of a word. If

a child in the first stage of the reading development has a severe phonological deficit, the child cannot move onto the subsequent stages. In this sense, phonological skills are one of the causes of reading problems. On the other hand, phonological skills are also influenced by the reading experiences. Once children start receiving reading instruction, knowledge of reading skill enhance phonological processing (Perfetti, Beck, Bell, & Hughes, 1987). Thus the relationship between phonological ability and reading ability is reciprocal or bi-directional.

In sum, although we cannot say the deficit in phonological processing ability is the single cause of reading problems, it seems reasonable to conclude that reading and phonological processing share some common processes. Since some phonological tasks can be used for very young children to whom we cannot apply any reading measure, such tasks are very useful tools to screen the reading problems of pre-reading level children.

Implications for the Future Research and Education

Based on the review of studies on children with reading problems, issues for future research and implications for education are discussed below.

Fundamental Issues : Definition and Classification

Although there is a consensus on the relationship between phonological deficits and reading problems, we do not have clear definition and classification system, which are the most fundamental issue for research. First of all, we need clear operational definitions of these disabilities. Although there are several conceptual definitions such as defined in the World Federation of Neurology (cited in, Escobar, Shaywitz, Fletcher, & Makuch, 1992), there is not one operational definition upon which everyone agrees. This is one reason that many studies involving with reading disability sometimes yield inconsistent results.

Another basic issue in reading problems research is the classification of reading problems. For research, heterogeneous group of children with dyslexia is a cause of inconsistent results. For education, a teaching strategy which is effective for one type of dyslexia may not work for another type. One possible classification may use the distinction between auditory and visual subtypes (Smith, 1994). Although the phonological aspect of reading has been emphasized in the research field of reading disability, visual deficits have also been reported among children with dyslexia (Lehmkuhl, Garzia, Turner, Hash, Baro, Garzia, Turner, & Baro, 1993; Livingstone, Rosen, Drislane, & Galaburda, 1991). Shaywitz, et al. (1991) proposed another classification system that is based on children's performance on an assessment battery. Their subtypes include phonology, phonology and short term memory, and general cognitive.

Implication for Instruction Methods

Although phonological skill training is promising for the reading development, we

cannot overlook the real reading activities. There is an on-going argument between educators with the phonics/skills-based orientation and the meaning/literature-based orientation. Blachman (1991) suggests that any single approach will not meet the needs of all children. Children may miss opportunity to learn how to make the connections between print and speech in literature-based approach. On the other hand, they can not have rewarding literacy experiences in the instruction that heavily relies on isolated skill instruction. We need to consider an approach that includes both real reading activities and skill instruction.

For the children with severe reading problems, choice of an appropriate instruction method is especially important. This can only be achieved with accurate diagnosis. Research findings suggest that the reading disabled group diagnosed by the discrepancy between an IQ score and a reading achievement score are not homogeneous. It is impossible to develop an effective remedial program for such heterogeneous group of children. Thus, we need comprehensive battery to assess various cognitive and neurological abilities for diagnosis.

Compensation for Disabilities

Many individuals with dyslexia learn to read well enough to attend colleges and become successful professionals (Pompian, & Thun, 1988). However, phonological deficits are found among adults with childhood diagnosis of dyslexia despite of their high educational attainment. The knowledge of how they compensate for their deficits would be beneficial for children with similar problems. Some neurophysiological studies reported that adults with childhood diagnosis of dyslexia showed more brain activities during linguistic or auditory tasks (Flowers, et al., 1991 ; Hagman, et al., 1992 ; Harter, Anllo-Vento, Wood, & Schroeder, 1988), which suggests more effort or alternative pathways can compensate for the deficits. Further research is necessary to investigate what kind of training program can facilitate the development of compensatory brain system. Because reading skills are important for academic success, development of the well-designed reading training program should be one of the most important goals in educational psychology.

Conclusion

There are several conclusions we can make with some certainty through the review of research in this area : (a) most of the children with Reading problems have deficits in phonological processing abilities, (b) adults with childhood diagnosis of reading disability also show deficits in phonological processing abilities, (c) phonological processing abilities at pre-reading level are the best predictor of word reading performance at early developmental stages of reading, (d) deficits in phonological processing can be one of the

causes of later reading problems, (e) phonological skill training is beneficial both for normal and poor readers. It is more effective when it is combined with letter name and sound training, (f) morphological and functional anomalies in the left hemisphere of the brain are possible causes of deficits in phonological processing and reading disabilities, and (g) we should keep in mind there are children with reading problems whose primary cognitive problem is not phonological processing.

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