RELATIONSHIPS AMONG SPEECH SOUND PERCEPTION, SPEECH SOUND PRODUCTION, AND PHONOLOGICAL SPELLING IN SECOND GRADE CHILDREN

by

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This study examined the relationships among speech sound perception, speech sound production, and phonological spelling relative to seven phonemes in 15 pairs of 2nd grade children. Each pair consisted of one typically developing child and one child with speech sound disorder who presented at least one fricative, affricate, and/or liquid error. The pairs were matched for gender, nonverbal reasoning, and level of parent education.

Speech sound perception was assessed with a modification of the Speech Assessment and Interactive Learning System, a computer program which assesses speech identification of phonemes. White noise and reverberation were introduced into the stimuli so listening conditions would resemble those in typical classrooms.

Children's speech sound production skill was determined by Percent of Consonants Correct-Revised while repeating multisyllabic words and pseudowords. Phonological spelling was assessed by comparing the phonological skeleton of 84 one syllable pseudowords to the child's orthographic representation. Pseudowords were

controlled for morpheme length, orthographic legality, vowel distribution, grapheme length, number of phonemes, position of phoneme, number of target singletons and clusters, frequency of nontarget consonants, and number of phonological neighbors.

Results revealed significant differences in speech sound perception between typical and SSD children. Speech sound perception of typical children showed a small but significant relationship to phonological spelling, whereas children with SSD demonstrated a moderate relationship. The type of relationship between speech sound perception and phonological spelling could not be determined for typical children, but appeared quadratic for children with SSD. Speech sound repetition accuracy of typical children had a modest linear relationship to phonological spelling, whereas children with SSD demonstrated a small linear relationship. There was no significant relationship between speech sound perception and speech sound repetition accuracy for children with SSD.

These results provide partial support for the Dual Route Model of Spelling and the Motor Theory of Speech Perception. In addition, these findings imply that spelling errors in 2nd grade children may result, in part, from poor speech sound perception and/or poor speech sound production.

Acknowledgements

As this project unfolded, I spent some time reflecting on how I would acknowledge the guidance, support, and expertise provided by my committee members: Drs. John Bernthal, Tom Carrell, Guy Trainin, and Kathy Wilson. I realized that whatever public words expressed would be, quite simply, inadequate. I can only hope that the simple words expressed here offer some insight into my appreciation for the expert instruction and kind counsel afforded me.

Dr. Kathy Wilson provided extensive instruction in children's spelling development, showing me in the process how important it is to teach with high expectations tempered with support and guidance. Substantial statistical expertise was lent to this investigation by Dr. Guy Trainin, whose warm and patient manner demonstrated that excellent teaching and superior research includes a belief and passion for student learning. Dr. Tom Carrell's superb knowledge of speech perception and instrumentation was invaluable to this investigation. I am grateful for his incalculable contributions in problem-solving methodological issues, and for teaching me in the process that a memorable scholar-researcher demonstrates perseverance, geniality, and true commitment to one's students.

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requires forthrightness of expression, genuine concern for others, and high standards of scholarship. I am endebted to him, and to all my committee members, for their support.

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CHAPTER I

INTRODUCTION

A literate society is a national priority in the United States. As noted by Green, McCutchen, Schwiebert, Quinlan, Eva-Wood, and Juelis (2003), "teaching children to read and write is one of the primary goals of instruction in U.S. elementary school classrooms" (p. 752). Among the skills comprising literacy, spelling is considered essential (Rankin, Bruning, Timme, & Katkanant, 1993), more valued than all other writing conventions (Turbill, 2000), and a notable characteristic of education (Robinson, 2005). Learning to spell strengthens and reflects reading and writing skills (Ehri, 2000; Ehri & Snowling, 2004; Moats, 2005), illustrating spelling's importance as a literacy skill. In a national survey of 355 teachers, most teachers (98%) spent a specific time each week on spelling instruction (Fresch, 2003) which suggests that teachers believe spelling instruction is a necessary component of the curriculum.

Despite spelling's perceived importance and the availability of instructional programs, many children have difficulty learning to spell (Frith, 1980; Moats, 2005), especially children with dyslexia (Bailet, 2004; Juel, 1988; Stanovich, Siegel, & Gottardo, 1997; Uhry & Clark, 2005) or speech-language disorders (Bishop & Adams, 1990; Leitao & Fletcher, 2004; Lewis, Freebairn, & Taylor, 2002; Nathan, Stackhouse, Goulandris, & Snowling, 2004).

Recent longitudinal evidence raises concerns whether poor spelling may be becoming more widespread (Mehta, Foorman, Branum-Martin, & Taylor, 2005). A factor analysis of the literacy achievement of group of 1342 elementary children in 127 high

poverty schools revealed that although reading scores were maintained between 1998 and 2002, children's spelling competency dropped significantly and consistently during this time period.

Not only do many children have difficulty with spelling, but poor spelling (and its associated consequences) often continue into adulthood and remain a life-long problem, despite intervention programs (American Speech Language Association, 2007; Bailet, 2004; Caravolas, Hulme, & Snowling, 2001; DeKemel, 2003). As a result, career opportunities and advancement for individuals with spelling disorders may be limited (Wasowicz, Masterson, & Apel, 2003).

Consequences of Poor Spelling

Poor Spelling Affects Writing Achievement

Poor spelling adversely affects children's writing achievement. Writing composing for poor spellers may be difficult because the writer's working memory is burdened (Berninger, Vaughan, Abbott, Brooks, Abbott, Rogan, et al., 1998; Invernizzi & Hayes, 2004), reducing the automaticity of spelling and making writing all the more difficult (Graham, 1999; Wasowicz et al., 2003). When writing is constrained, children may not adequately demonstrate written content knowledge and receive poorer grades as a result (Hughes & Searle, 1997). In addition, the perceived quality of written work appears to be influenced by the presence of spelling errors (Marshall & Powers, 1969). When children are poor spellers and have little confidence in their writing, teachers are likely to be unaware of children's elaborate and individual ideas (Bailet, 2004).

Poor Spelling Affects Reading Achievement

A second consequence of poor spelling is that it may negatively affect children's reading skills. Because learning to spell and read inform each other and are highly correlated (r = .5 to r = .86) (deJong & Share, 2007; Ehri, 2000; Graham, 2000; Leppanen, Niemi, Aunola, & Nurmi, 2007), poor spellers are often poor readers (Kamhi & Hinton, 2000). Both spelling and reading draw from a child's knowledge of word phonological segmentation and sound-symbol relationships (Ehri, 2000; Gillon, 2004; Gough & Walsh, 1991; Moats, 2005; Treiman, 1998; Vellutino, Tunmer, Jaccard, & Chen, 2007). Spelling in kindergarten has been has been associated with 1st grade reading achievement (Mann, 1993); orthographic knowledge was found to be a unique contributor to word reading in 2nd grade students "at risk" for poor reading fluency and accuracy (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003).

The negative consequences of poor spelling on reading are further explicated by studies of the effect of direct spelling instruction on children's reading. Kindergarteners and/or 1st graders given explicit spelling and segmentation training performed better in reading decoding than their peers who did not receive spelling instruction (Ball & Blachman, 1991b; O'Connor & Jenkins, 1995). Explicit spelling instruction for "at risk" children had a positive transfer effect to word-attack skills (Berninger, Vaughan et al., 1998; Graham, Harris, & Chorzempa, 2002). Instruction in graphosyllabic instruction to below average readers in grade 6 through grade 10 resulted in significant improvement in their ability to decode whole words correctly (Bhattacharya & Ehri, 2004). Spelling instruction which focused on rime patterns and analogies was found to result in

significant improvements in word reading (Greaney, Tunmer, & Chapman, 1997). Thus, there is experimental evidence that improving spelling leads to better reading skills.

Models of Spelling

Several models of spelling have been proposed. These models can be broken into two types – stage (or phase) versus strategy models (Treiman, 1998).

Stage models are characterized by qualitatively distinct stages. Because children rely on different information at different times, a stage model of spelling predicts that children will consistently spell a word the same way at any given stage, but will demonstrate qualitatively different spellings of a word as the child moves to a new stage.

Strategy based models (also known as repertoire models) suggest that children use multiple sources of information (phonologic, orthographic, semantic, and morphological knowledge) continuously as they develop their spelling ability. The degree to which these linguistic sources of information are utilized varies with the child's developmental ability and across time. As an example, even kindergarten and 1st grade children use morphological and orthographic knowledge in spelling although such knowledge is more common in older children (Treiman, Cassar, & Zukowski, 1994). Because children continuously use varying sources of linguistic knowledge during spelling development, strategy models predict that different children of the same developmental spelling ability will not demonstrate similar spellings of a given word, nor can consistent spelling "stages" be identified across time.

Ellis' Strategy Model

Information processing theory and the dual route memory system hold that information is encoded, stored, and retrieved based, in part, on the type of information to be processed (Atkinson & Shiffrin, 1968; Baddeley, 1986; Miller, Galanter, & Pribram, 1960). Based upon the substantial body of research in this field, many researchers believe that children spell using a strategy or repertoire based model of spelling known as the Dual Route system or dual route access (Apel, Masterson, & Niessen, 2004; Bates, Castles, Luciano, Wright, Coltheart, & Martin, 2007; Bruck, 1988; Cipolotti & Warrington, 1996; Ellis, 1993; Jorm & Schoknecht, 1981; Lennox & Siegel, 1996; Treiman, Freyd, & Baron, 1983; Vellutino et al., 2007; Ward, 2003; Waters, Bruck, & Seidenberg, 1985). In the Dual Route Model of Spelling, the phonological system is tapped for words not yet automatic, unfamiliar, or for spelling pseudowords. The visual system is tapped to recall the spelling of "sight" words as well as regular decodable words which are so familiar that they are spelled automatically. Therefore, young children use phonological decoding to spell words until/unless repeated exposure and experience with a word allows for its direct recall via visual orthographic memory (Cataldo & Ellis, 1988). Ellis (1993) proposed a version of the Dual-Route Model of Spelling. This version is shown below (Figure 1).

The phonological system consists of the semantic system, speech output lexicon, phoneme level, and grapheme level. The semantic system contains everything known about a word. What is known comes from visual input lexicon (words seen and read).

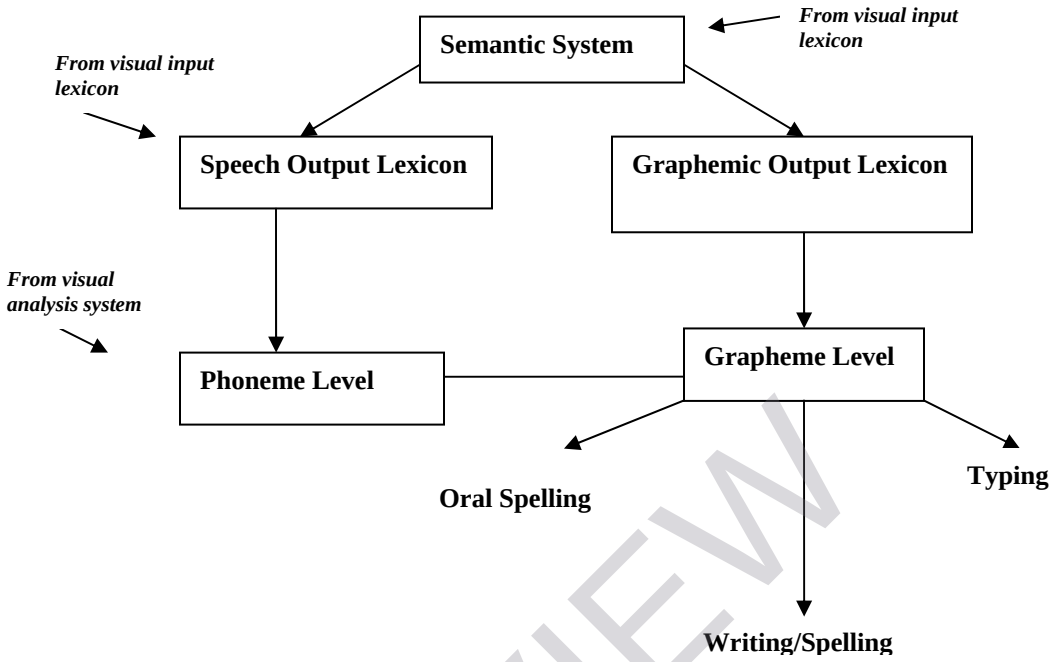

Figure 1. Ellis' (1993) model of spelling.

Information about the pronunciation of a word is contained in the speech output lexicon which receives information about the pronunciation of a word from the visual input lexicon in the form of letter-sound correspondences. The phoneme level is where the coordinated articulatory movement sequence needed to produce a word is held in short term storage. The phoneme level is needed because multiphonemic words (like "mountainous" or "hippopotamus") contain a long string of phonemes which can not be articulated at once and so are held in storage as the word is produced.

The grapheme level is the short term storage for a word's spelling where the sequence of graphemes for the latter part of a word is held in storage while the first part of the word is being written. Ellis notes that since the spelling of a word does not depend upon whether a letter is uppercase or lowercase, the term "grapheme" level is a better

linguistic choice for the name of this level than "letter" level. Furthermore, because grapheme refers to the letters or groups of letters which represent speech sounds (phonemes), it explains that more than one letter may be assigned to a single speech sound (e.g., TH for /θ/ or /ð/).

The visual system consists of the semantic system, graphemic output lexicon, and grapheme level. The graphemic output lexicon contains all the words which have been memorized. This lexicon receives information from two sources, the semantic system and the speech output lexicon which suggests that spelling a familiar word is a result of both knowing its meaning and knowing its sound-form.

Ward's Strategy Model

Ellis' model has some drawbacks. It does not account for the known graphomotor component of spelling (Berninger, Abbott, Abbott, Graham, & Richards, 2002; Cunningham & Stanovich, 1990) nor the allographic variations of spelling where the different written forms of letters are recognized as acceptable (such as *Fine and fine*). To account for these phenomena, Ward (2003) adapted Ellis' (1993) Dual Route Model (Figure 2).

In this revised model, there are a few changes to the names of lexicons but they function in a similar way. The speech output lexicon is referenced as the phonological output lexicon to more accurately reflect that the pronunciation of a word comes from consideration of the distinctive features (phonemic characteristics) of a word and not "speech." The graphemic output lexicon is now called the orthographic output lexicon to