

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

by

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

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University of Nebraska, 2007

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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.

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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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PREVIEW

## TABLE OF CONTENTS

Chapter I—Introduction.....	1
Consequences of Poor Spelling .....	2
Poor Spelling Affects Writing Achievement .....	2
Poor Spelling Affects Reading Achievement .....	3
Models of Spelling.....	4
Ellis' Strategy Model .....	5
Ward's Strategy Model .....	7
Implications for Assessment .....	9
Current Variables of Spelling .....	12
Purpose of the Study .....	14
Research Questions .....	15
Hypotheses .....	16
Research Hypotheses .....	16
Null Hypotheses .....	17
Definition of Terms.....	17
Pseudowords .....	18
Speech Sound Production .....	19
Speech Sound Perception.....	20
Chapter II—Literature Review .....	22
Evidence of Two Routes in Spelling .....	22
Developmental Nature of Dual Routes .....	22
Evidence of Dual Systems .....	23
Typical Spellers .....	24

Poor Spellers .....	28
Evidence of Components of Dual Route Model .....	32
Semantic System .....	32
Environmental Influences .....	33
Syntactical Awareness .....	35
Orthographic Output Lexicon .....	36
Morphological Awareness .....	37
Word Frequency .....	40
Neighborhood Density .....	42
Phonotactic Probability .....	43
Inconclusive Evidence .....	44
Phonological Output Lexicon .....	45
Speech Sound Production .....	46
Speech Sound Perception .....	54
Speech Perception-Speech Production Relationship .....	55
Phonological Awareness .....	66
Phoneme Level .....	72
Phoneme-Grapheme Converter .....	75
Graphemic Output Buffer .....	76
Cognition .....	77
Memory .....	78
Evidence of a Graphemic Output Buffer .....	80
Allographic Level .....	81
Graphomotor Level .....	81
Types of Spelling Errors .....	83
Summary of Literature Review .....	85
Statement of the Problem .....	85



	iii
Chapter III—Pilot Investigations.....	89
Pilot 1: Spelling of Pseudowords.....	89
Participants.....	89
Settings.....	89
Stimuli.....	89
Pseudowords .....	89
Development of Stimuli.....	89
Recording Pseudoword Stimuli .....	95
Picture Stimuli .....	98
Procedures.....	98
Pilot 2: IA-SAILS with Adults .....	
Participants.....	100
Setting .....	100
Stimuli.....	100
Introducing Noise and Reverberation .....	101
Rationale .....	101
Procedures for introducing SNR and RT .....	104
Altering Instructions .....	106
Rationale .....	106
Adaptations to Instructions .....	107
Changes to Administration of SAILS .....	107
Procedures.....	107
Pilot 3: IA-SAILS with Children .....	110
Participants.....	110
Setting .....	110

Stimuli.....	110
Recording Responses within SAILS Software.....	110
Maintaining Appropriate SNR.....	111
Procedures.....	112
Familiarization Practice Block.....	112
Administration of Assessment Modules.....	113
Practice with Assessment Module.....	113
Assessment Modules.....	113
Chapter IV—Methodology.....	116
Participants.....	116
Measures.....	117
Setting.....	119
Categorizing Participants.....	119
Stimuli.....	124
Speech Sound Production Stimuli.....	124
Recording Speech Sound Production Stimuli.....	124
Other Stimuli.....	125
Procedures.....	125
Assessing Speech Sound Production Accuracy.....	126
Assessing Speech Sound Perception.....	126
Assessing Pseudoword Spelling.....	127
Accuracy in Hearing the Stimuli.....	127
Data Analysis.....	128
Treatment of Data.....	128
Variables Used.....	129

Question 1 .....	129
Question 2 .....	130
Question 3 .....	132
Question 4 .....	133
Interjudge Reliability .....	133
Chapter V—Results .....	136
Data Cleaning and Outlier Analysis .....	136
Analyses.....	138
Descriptive Statistics.....	138
Question 1 .....	138
Question 2 .....	139
Within-condition Visual Analyses.....	140
General Linear Model Univariate Analyses .....	154
Linear Discriminate Function Analyses.....	158
Question 3 .....	171
Within-condition Visual Analyses.....	172
Mann-Whitney U Tests.....	172
Number of Spelling Errors for /Phoneme/.....	174
Linear Discriminant Functions (ldfs).....	175
Question 4 .....	183
Spearman Rho Correlations .....	183
One Way ANOVAs .....	184
Chapter VI—Discussion .....	185
Questions 1.....	186

Social Validity .....	187
Speech Sound Perception of Older Children .....	191
Differences of Specific Phonemes .....	193
Implications for Spelling Instruction .....	198
Question 2 .....	200
Empirical Support for Theoretical Models .....	201
Possible Explanation for Variations in Spelling Skills .....	204
Speech Sound Perception of Specific Phonemes .....	212
Implications for Spelling Assessment and Intervention .....	214
Question 3 .....	218
Empirical Support for Theoretical Models .....	219
Phonological Spelling Related to Specific Phoneme Production Errors .....	224
Implications for Assessment and Treatment of Children with Spelling Difficulty .....	228
Question 4 .....	230
Summary .....	232
Limitations .....	236
Future Study .....	238
References .....	240
Appendices .....	278

## LIST OF TABLES

Table 1	Levels of Difficulty for SAILS.....	103
Table 2	Pilot Phase 1 Final SNR and Reverberation .....	109
Table 3	Pilot Phase 2 Final SNR and Reverberation .....	115
Table 4	Means, Standard Deviations, and Ranges for Descriptive Characteristics of Typical and SSD Group.....	123
Table 5	Means, Standard Deviations, and Ranges for Descriptive Characteristics of Control Group.....	124
Table 6	List of Participants with Outlier Scores and Their Frequency.....	137
Table 7	Paired Samples T-Tests for Dependent Variables .....	138
Table 8	Paired Samples T-Tests for Speech Sound Perception Between Typical and SSD Children .....	139
Table 9	Summary of Fit of Data Between Speech Sound Perception and Spelling Errors for Typical Children .....	153
Table 10	Summary of Fit of Data Between Speech Sound Perception and Spelling Errors for SSD Children .....	154
Table 11	Results from ANCOVA Predicting Mean Number Spelling Errors by Group .....	157
Table 12	ANCOVA with /phoneme/dev and /phoneme/dev <sup>2</sup> Variables Predicting Mean Number Spelling Errors.....	159
Table 13	ANCOVA with /phoneme/dev and /phoneme/dev <sup>2</sup> Variables Predicting Number Spelling Errors for /Phoneme/.....	161
Table 14	Limited Model Ldf Predicting Type of Speller from Mean Speech Perception with All Children.....	163
Table 15	Limited Model Ldf Predicting Type of Speller from Mean Speech Perception with Typical Children.....	164
Table 16	Limited Model Ldf Predicting Type of Speller from Mean Speech Perception with SSD Children .....	165
Table 17	Full Model Ldf with Mean Speech Perception Predicting Type of Speller with All Children.....	167

Table 18	Full Model Ldf with Mean Speech Perception Predicting Type of Speller with Typical Children.....	169
Table 19	Full Model Ldf with Mean Speech Perception Predicting Type of Speller with SSD Children .....	171
Table 20	Limited Model Ldf Predicting Type of Speller from PCC-R with All Children .....	176
Table 21	Limited Model Ldf Predicting Type of Speller from PCC-R with Typical Children .....	177
Table 22	Limited Model Ldf Predicting Type of Speller from PCC-R with SSD Children .....	178
Table 23	Full Model Ldf with PCC-R Predicting Type of Speller with All Children .....	180
Table 24	Full Model Ldf with PCC-R Predicting Type of Speller with Typical Children .....	181
Table 25	Full Model Ldf with PCC-R Predicting Type of Speller with SSD Children .....	182

## LIST OF FIGURES

Figure 1	Ellis' (1993) Model of Spelling .....	6
Figure 2	Ward's (2003) Dual Route Model of Spelling.....	8
Figure 3	SAILS Module of "Sheet" .....	63
Figure 4	Settings of Room, Signal, and Microphone Parameters for Echo Chamber.....	105
Figure 5	Decision Flowchart Developing SAILS Stimuli with 90% Accuracy .....	108
Figure 6	Comparison of Linear Regression Lines for Speech Perception between Typical and SSD Children.....	141
Figure 7	Comparison of Quadratic Regression Lines for Speech Perception between Typical and SSD Children.....	141
Figure 8	Typical and SSD Children's Speech Perception /f/ Scatterplots and Regression Lines for Mean for Mean Number Spelling Errors and Number Spelling Errors for /f/ .....	143
Figure 9	Typical and SSD Children's Speech Perception /tʃ/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /tʃ/ .....	145
Figure 10	Typical and SSD Children's Speech Perception /l/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /l/ .....	146
Figure 11	Typical and SSD Children's Speech Perception /r/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /r/ .....	148
Figure 12	Typical and SSD Children's Speech Perception /s/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /s/.....	149
Figure 13	Typical and SSD Children's Speech Perception /ʃ/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /ʃ/ .....	151

Figure 14	Typical and SSD Children's Speech Perception /θ/ Scatterplots with Regression Lines for Mean Number Spelling Errors and Number Spelling Errors for /θ/ .....	152
Figure 15	Comparison of Linear Regression Lines for PCC-R between Typical and SSD Children .....	173

PREVIEW



## LIST OF APPENDICES

Appendix A	Rationale for Criteria Selecting Pseudowords for Pseudoword Spelling Test.....	278
Appendix B	Seven Pseudoword Spelling Lists and Distributions ..... Example of Picture of Space Alien List of Multisyllabic Words and Pseudowords	282
Appendix C	Answer Sheet for Spelling Pseudowords..... Instructions for Spelling Practice Pseudowords Instructions for 84 Item Pseudoword Spelling Task Revised Instructions for 84 Item Pseudoword Spelling Task	292
Appendix D	Calculation of Reverberation Time (RT).....	297
Appendix E	IA-SAILS Instructions: Pilot 2 ..... IA-SAILS Answer Sheet: Pilot 2	299
Appendix F	IA-SAILS Instructions for <i>Cat</i> Practice Module ..... IA-SAILS Instructions Practice Modules IA-SAILS Instructions Assessment Modules	302
Appendix G	Developmental Questionnaire for Parents .....	306
Appendix H	Instructions for Repetition of Multisyllabic Words and Pseudowords .....	308
Appendix I	Guidelines for Assignment of Phonological Spelling Errors.....	310

## **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 (Baillet, 2004; Juel, 1988; Stanovich, Siegel, & Gottardo, 1997; Uhry & Clark, 2005) or speech-language disorders (Bishop & Adams, 1990; Leitaio & 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 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).

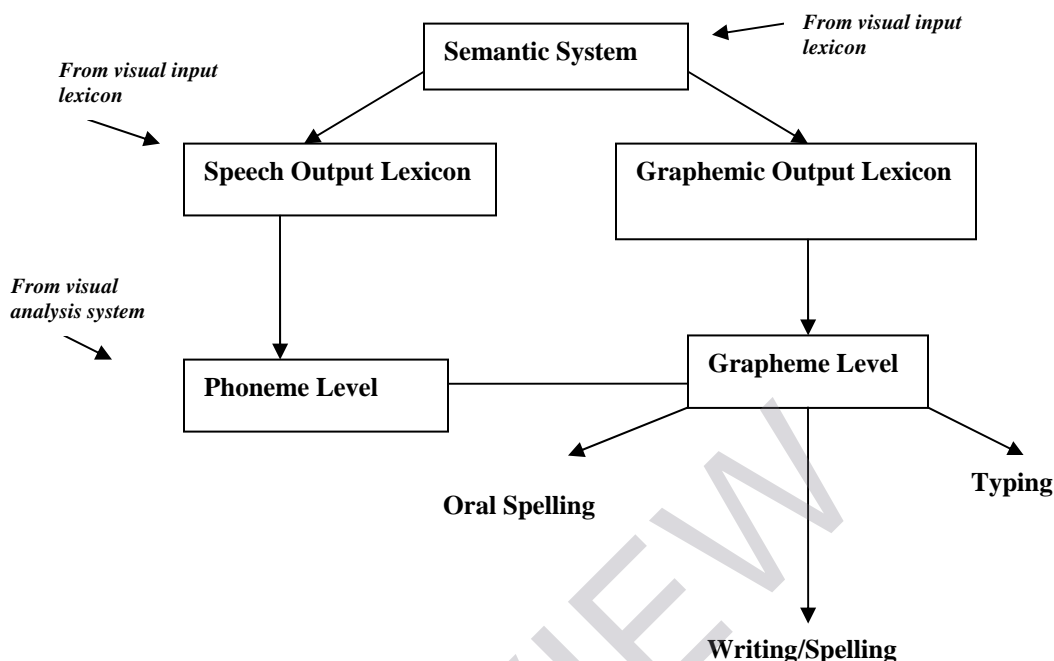


Figure 1. Ellis' (1993) model of spelling.

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