Holding on to Listening: Applying Current Research to Emergent Literacy: A Meta-Synthesis

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This meta-synthesis investigates connections between listening and emergent literacy. Recent articles in the fields of educational research and educational neuroscience are reviewed and summarized. Seven themes emerged from this analysis of 48 articles, included in this meta-synthesis. These emergent themes, or theme clusters, include: (a) the development, or lack of development of a left hemisphere "reading network"; (b) links between sensory and literacy skills; (c) correlations between language and musical abilities; (d) environmental factors impacting language and literacy; (e) vocabulary acquisition; (f) aural and oral strategies, or strategies involving listening and speaking; and (g) computer aided instruction.

1. Introduction

1.1. Background

"Reading never just happened," (Wolf, 2007, p. 25). Reading is a complex task. Unlike the ability to speak it must be explicitly taught. Cognitive Scientist Steven Pinker, as quoted by Maryanne Wolf states, "Children are wired for sound, but print is an optional accessory that must be painstakingly bolted on", (Wolf, 2007, p. 19). Neuroimaging allows us to look into the brain, mapping brain activity, patterns and changes. Non-invasive methods for measuring brain activity are available even for research on infants because they need only to listen. (Kuhl & Rivera-Gaxiola, 2008) This ability to see how brain changes take place in response to sounds, words, and language has contributed a wealth of new knowledge for researchers and educators to draw on in the design and implementation of interventions for struggling readers.

Insight into the brain's language system has, in some instances come through individuals who have suffered injury to the brain. Maryanne Wolf tells of a bilingual Chinese businessman who suffered a stroke and lost the ability to read Chinese, his first language, yet retained his ability to read English. (Wolf, 2007, p. 61) This scenario reflects the fact that reading Chinese involves both hemispheres of the brain, whereas reading English is a typically left hemisphere function. Babies from bilingual homes have provided researchers insight regarding the effects of experience vs. maturation. Barbara Conboy, and Debra L. Mills, in a study of infants in bi-lingual homes observed, that as vocabulary increased in the dominant language, specialization in the left hemisphere for that language also increased, while the non-dominant language continued to activate the brain in a more generalized pattern. This indicates that it is experience

in the dominant language rather than maturation that drives left hemisphere specialization, (Conboy, & Mills, 2006). "Non-invasive techniques that examine language processing in infants and young children include electroencephalography (EEG), event-related potentials (ERPs), magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), and near-infrared spectroscopy (NIRS)", (Kuhl & Rivera-Gaxiola, 2008, p. 513). Through fMRI and ERPs, Helen Neville, of the University of Oregon, studies the connections between speaking, listening and understanding. Her studies include identifying adequacies and deficiencies in the language systems of children who are language impaired, (Neville & Mills, 1997).

In "The Child's Brain: A Syllable From Sound", a documentary produced by David Grubin, Helen Neville states "Language depends on so many different systems and structures in the brain that a problem within any one of those systems could lead to a final common problem which is a language impairment" (Grubin, 2001, 8:40). The beginning reader's brain functions differently than that of a more skilled reader, (Perfetti & Bolger, 2004). In children, 13 to 17 months of age, when presented with known words, brain activity is recorded broadly over anterior and posterior regions of both left and right hemispheres. However, by 20 months of age, in similar tests, brain activity is predominantly limited to temporal and parietal regions of the left hemisphere, (Mills, et al., 1997). In proficient adult readers, left hemisphere regions composing a "reading network", include the posterior dorsal region, involved in phonological processing, the posterior ventral region, for visual word formation, and the anterior region, which supports articulatory recoding, (Yamada et al., 2011). This, however, is not the case for some readers. Variations on typical patterns of brain activation have been observed in readers with dyslexia (Vlachos, et al., 2013; Yamada, et al., 2011) Rather than accessing a reading network, we are

able to see through neural imaging that individuals with dyslexia develop alternative pathways for reading tasks, (Kovelman, et al., 2011).

For many years researchers have suggested a connection between language young children hear and the development of early literacy skills. Mass, as cited in Wan (2000), states that concepts of literacy can be promoted through listening to stories read aloud as well as hearing meaningful conversations. Referencing studies by Chomsky, Durkin, Teale and Wells; Casbergue and Harris, (1996), state, "being read to is unquestionably the best preparation for learning to read independently", (p. 48). For children with undiagnosed ear infections, inconsistencies in the language they hear can have a detrimental impact on subsequent language and literacy development, (Wolf, 2007, p. 104-105). Connecting these thoughts about the language young children hear to current research on brain development, which alludes to a "critical period," during which the infant brain is selecting and strengthening most frequently used neural pathways, highlights the importance of applying available research, (Kuhl, & Rivera-Gaxiola, 2008; Neville & Mills, 1997). Skills, which are encountered and mastered first in oral language such as phonological awareness, semantic and syntactic knowledge, even morphological concepts, such as the use of the plural "s" are supported by listening to conversations, and by being spoken, and read to. "The more children are spoken to the more they will understand oral language. The more children are read to, the more they will understand all the language around them, and the more developed their vocabulary becomes." (Wolf, 2007, p. 84) The young child is acquiring "hundreds upon hundreds of words, thousands of concepts, and tens of thousands of auditory and visual perceptions," (Wolf, 2007, p. 19). Infants and toddlers

with family members who speak to them, read to them, and who frequently engage in dialog with one another provide a perfect environment to develop pre-reading skills.

For the hearing world, the language we hear precedes the language we read and write. Brain research reveals that neural structures for spoken language are the most active brain structures for beginning readers, and that beginning readers recode from print to sound, (Goswami, 2008). The idea of sound before symbol is also found in music education. The Kodály concept directs teachers to introduce concepts moving from what is easiest for a child, listening to music, singing, and moving, to more difficult concepts, reading and writing music, (Lucas, & Gromko, 2007). "Language is most comparable to music because both are organized temporally, and we perceive music and spoken language aurally," (Hansen & Milligan, 2012, p. 78). As readers mature they develop efficiency and the ability to grasp word meanings without the need to recode print to sound, (Goswami, 2008). However, many readers continue to hold onto auditory supports, such as reading aloud to one's self. Some may describe this as a preferred modality, but perhaps some readers find comprehension of audible text more accessible than reading silently. "Adaptive teachers," a term used by Lynn Corno, (2008, p. 165), are able to recognize this difference and seek to provide necessary supports.

Though current research does not design curriculum, it can inform the philosophies of those who do, and provide explanations and recommendations for strategies which may increase student success, (Zadina, 2015). Universal Design for Learning, an educational philosophy, characterized by practices, which promote access to all learners, finds its inspiration in architectural designs, which increase accessibility to physical spaces for all users. Core

components of UDL are the reduction of learning barriers through utilization of multiple means of content representation, and student engagement and expression, (Meo, 2008). It is my goal to look to current research for insight, which may generate strategies, which promote success for struggling readers and those who teach them.

1.2. Author's beliefs and experiences

My first hints of the vast differences in how people experience language came as a young adult while giving driving directions to a friend. She wanted the names of the streets, just give her the names, I needed not confuse her with distinct, and well known landmarks, which in my opinion could only help, especially since I was not really certain about all of the street names. This experience began to clarify for me that the information she needed to understand, was not at all the information, which I needed.

I have always recognized that I had difficulties reading quickly, especially when the topics were technical in nature. However, a heavy emphasis on lecture and visual forms of information throughout high school, and a focus on the visual arts in college kept me from being challenged, keeping me from realizing that I experienced reading in a very different way than some of my peers. My previous academic successes gave me no reason to wonder if we all experienced text in the same way. Some people just read faster than others.

As I began my Master's coursework I discovered I could obtain digital copies of the required texts. It was simply convenient for me to choose the digital versions of texts, books and articles whenever they were available. As the pressure to move through lengthy reading

assignments mounted I found I could use the accessibility features on my computer and iPad to listen to my texts. When I listened to texts I no longer had trouble staying awake. I did not find a need to read and re-read the same pages and paragraphs attempting to extract the meanings. It was my secret strategy. Sometimes I wouldn't even look at the text! I still did not understand that my experiences of text were different than others. I did not know that everyone does not need to "hear" the words in their heads as they read them in order to comprehend text.

My second eye opener on the drastic difference in peoples' experience of text came as I noticed my husband's ability to read tirelessly for hours, with significant speed, in silence. He was reading his phone, so I had to double check, if it was actually a movie that had him so entranced. It was all text. I remember thinking "I would be asleep." I questioned him about his reading experiences and his answers opened the door for me to grasp how different we are when it comes to reading.

My interest and passion about recognizing, and differentiating instruction to support, learning differences, has been intensified by two experiences. As a student completing the last requirements of a Master's level degree I am seeing myself in a new light. A door to achieving higher academic degrees has opened for me. This has been a great realization. But, as a mother, the impact of recognizing and understanding my daughter's learning differences has been even more impacting. I have watched my daughter go from being identified by her pre-school teacher, a program director, with years of experience in early childhood and a legacy of training those under her, as a gifted and intelligent child, to being grouped with the lowest readers in her class by second and third grade. In this setting her self-confidence suffered. Throughout her third grade year she endured her reading group, chagrined that she had to leave the classroom for extra

help. She forfeited enrichment activities, given to the large group, while finding the pace of her pull out reading group to be too slow. The last unit of her third grade year, which occurred after the standardized testing, involved corporate, large group reading of Charlotte's Web. During this unit she was recognized as "the most improved reader." I was happy for her, but felt the true improvement had been in the methods. During her fourth grade year I introduced my daughter to audible books. Through audible books my daughter has developed a love for reading. She prefers audible texts, but she has also made great strides as a fluent reader of print as well.

Like my daughter I have experienced feelings of inadequacy as a reader. These feelings, in my case, have reflected the allowances I make for myself, listening to, rather than "actually reading" my texts. I certainly don't have the freedom to tell my colleagues at the next in-service day, "Excuse me, I don't mean to interrupt your silent flights through this article, but I will need to read out loud to really get it, I apologize." How do you admit, as an educator, that you need modifications with reading? Even this description, "modifications" reveals an accepted bias; that it is helpful to clarify meanings by reading aloud, but the goal is to be able to comprehend text silently. In my coursework, to my delight, I have found acceptance and encouragement whenever I acknowledge my need to hear what I read. How freeing it would be to find this type of acceptance standard and to reach a place where learning differences would be recognized as individual strengths. The words, "needs modifications" could be replaced with "prefers audible text" or "uses speaking to construct comprehension."

With this meta-synthesis, I hope to investigate the following research questions:

1. What does research show regarding how learning to read takes place in the

brain?

2. What does research show regarding the impact of listening on literacy?

3. What implications do these findings hold for educators?

1.3. The purpose of this meta-synthesis

This meta-synthesis, which focused on brain research related to the impact of hearing and listening on early literacy, had multiple purposes. One purpose was to review journal articles related to brain research into early literacy, specifically what insight does the current brain research provide reading teachers. A second purpose was to review what is known about the relationship between hearing or listening to language and learning to read. A third purpose was to explore the ways this knowledge is being utilized in the classroom in the teaching of reading. A fourth purpose was to classify each article by publication type, to identify the research design, participants, and data sources of each research study, and to summarize the findings of each study. My final purpose in conducting this meta-synthesis was to identify significant themes in these articles, and to connect those themes to my own classroom experience in teaching struggling readers in a multi-level elementary classroom.

2. Methods

2.1. Selection criteria

The 48 journal articles included in this meta-synthesis met the following selection criteria.

1. The articles explored issues related to brain research on language and literacy acquisition.

2. The articles explored issues related to the role of hearing and listening in

language and literacy acquisition.

3. The articles were published in peer-reviewed journals related to the field of education.

4. The articles were published between 1995 and 2017.

2.2. Search Procedures

Database searches and ancestral searches were conducted to locate articles for this meta-synthesis.

2.2.1. Database searches

In September of 2016 through February of 2017, I conducted systematic searches of Education Resources Information Center (ERIC Ebscohost) and OneSearch, a digital library catalog search tool which enables access to millions of scholarly electronic resources. I used the following search term combinations to conduct Boolean searches of each database:

1. (“text based instruction”) AND (“read aloud”) AND (“audible text” or “audiobooks”).

2. (“brain research”) AND (“alternative modalities” or “learning styles”) AND (“early literacy”).

3. (“learning styles”) AND (“reading comprehension”) AND (“listening comprehension”) AND (“brain research” or strategy) AND (“multisensory” or “UDL”) NOT (“deaf” or “blind”).

4. (“learning modalities” or “learning styles”) AND (“brain research”) AND (“reading”) AND (“listening”) AND (“language” or “English”) AND (“literacy”) NOT (“deaf”

or “blind”) NOT (“ELL” or “EFL” or “L2”).

5. (“listening”) AND (“assisted reading”) AND (“audiobook”) AND (“read aloud”) AND (“literacy”) AND (“reading”) NOT (“deaf” or “blind”).

6. (“assisted reading”) AND (“literacy”) AND (“reading comprehension”) AND (“brain research”) AND (“conversation” or “listening”) AND (“hearing”) NOT (“deaf” or “blind”) NOT (“ELL” or “EFL” or “L2”).

7. (“assisted reading”) AND (“listening comprehension”) AND (“early literacy”)

8. (“brain research”) AND (“literacy”) AND (“reading comprehension”) AND (“music”) AND (“aural”).

These database searches yielded a total of 31 articles (Aaron, Joshi, Gooden, & Bentum, 2008; Beck, & McKeown, 2001; Biemiller, 2003; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Casbergue, & Harris, 1996; Ciampa, 2012; Corno, 2008; Crowe, 2005; Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Fuchs, & Fuchs, 2005; Goswami, 2008; Hansen, & Milligan, 2012; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Hudson, Lane, & Pullen, 2005; Indrisano, & Chall, 1995; Lewandowski, Begeny, & Rogers, 2006; Meo, 2008; Morra, & Tracey, 2006; Roy-Charland, Saint-Aubin, & Evans, 2007; Rushton, Juola-Rushton, & Larkin, 2009; Ruston, & Larkin, 2001; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Slavin, Lake, Davis, & Madden, 2011; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Stevens, 2006; Van Keer, 2004; Vlachos, Andreou, & Delliou, 2013; Wanzek, 2014; Wood, Pillinger, & Jackson, 2010; Zadina, 2015).

2.2.2. Books and a documentary which led to resources

Two highly cited books, from the field of educational neuroscience, were also used as resources; The Secret Life of the Brain, by Richard Restak, (2001), and Maryanne Wolf's Proust and the Squid, (2007). "The Child's Brain: Syllable from Sound," which aired on January 22, 2002, from the TV mini-series, "The Secret Life of the Brain," written, directed, and produced by David Grubin, was cited from, and used to gather names of neuroscientists, whose research was pertinent to this study. The neuroscientists whose names were searched are (Patricia Kuhl; Debra L. Mills; Helen J. Neville; and Maryanne Wolf). Seven articles were selected from the searches conducted using these neuroscientists' names (Conboy, & Mills, 2006; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Kuhl, & Rivera-Gaxiola, 2008; Mills, Coffey-Corina, & Neville, 1997; Neville, & Mills, 1997; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011)

2.2.3. Ancestral searches

An ancestral search involves reviewing the reference lists of previously published works to locate literature relevant to one's topic of interest, (Welch, Brownell, & Sheridan, 1999). I conducted ancestral searches using the reference lists of the previously retrieved articles. These ancestral searches yielded 10 additional articles that met the selection criteria (Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Blomert, 2011; Carlisle, & Felbinger, 1991; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Jordan, Snow, & Porche, 2000; Karemaker,

Pitchford, & O'Malley, 2010; Lucas, & Gromko, 2007; Perfetti, & Bolger, 2004; Spörer, Brunstein, Kieschke, 2009; Wan, 2000). Carlisle, & Felbinger, 1991, fell outside of the time parameters, 1995 to 2016.

2.3. Coding procedures

I used a coding form to categorize the information presented in each of the 48 journal articles. This coding form was based on: (a) publication type; (b) research design; (c) participants; (d) data sources; and (e) findings of the studies.

2.3.1. Publication types

Each journal article was evaluated and classified according to publication type (e.g., research study, theoretical work, descriptive work, opinion piece/position paper, guide, review of the literature). Research studies use a formal research design to gather and/or analyze quantitative and/or qualitative data. Theoretical works use existing literature to analyze, expand, or further define a specific philosophical and/or theoretical assumption. Descriptive works describe phenomena and experiences, but do not disclose particular methods for attaining data. Opinion pieces/position papers explain, justify, or recommend a particular course of action based on the author's opinions and/or beliefs. Guides give instructions or advice explaining how practitioners might implement a particular agenda. Reviews of the literature critically analyze the published literature on a topic through summary, classification, and comparison.

2.3.2. Research design

Each empirical study was further classified by research design (i.e., quantitative, qualitative, mixed methods research). Quantitative research utilizes numbers to convey

information. Instead of numbers, qualitative research uses language to explore issues and phenomenon. My searches led me to a qualitative case study, which uses the qualitative, language based research methods with a single participant. Mixed methods research involves the use of both quantitative and qualitative methods to present information within a single study.

2.3.3. Participants, data sources and findings

I identified the participants in each study (e.g., children 13 to 20 months, second grade students and their parents, teachers). I also identified the data sources used in each study (e.g., neurological measures, observations, surveys). Lastly, I summarized the findings of each study (Table 2).

2.4. Data analysis

I used a modified version of the Stevick-Colaizzi-Keen method previously employed by Duke (2011) and Duke and Ward (2009) to analyze the 48 articles included in this meta-synthesis. Significant statements were first identified within each article. For the purpose of this meta-synthesis, significant statements were identified as statements that addressed issues related to: (a) contributions from neuroscience to knowledge about localization and specialization of language functions in the brain; (b) contributions from neuroscience regarding processing speed and its impact on language and literacy; (c) contributions from neuroscience to knowledge about dyslexia; (d) phonological awareness, musical skills, vocabulary, fluency, and their impact on emergent literacy; (e) environmental factors impacting literacy; (f) educational factors and resources impacting literacy; (g) implications of the research on educational practices. I then generated a list of non-repetitive, verbatim significant statements with paraphrased formulated meanings. These paraphrased formulated

meanings represented my interpretation of each significant statement. Lastly, the formulated meanings from all 48 articles were grouped into theme clusters, represented as emergent themes. These emergent themes represented the fundamental elements of the entire body of literature.

3. Results

3.1. Publication Type

I located 48 articles that met my selection criteria. The publication type of each article is located in Table 1. Twenty-nine of the 48 articles (60%) included in this meta synthesis were research studies (Aaron, Joshi, Gooden, & Bentum, 2008; Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Carlisle, & Felbinger, 1991; Ciampa, 2012; Conboy, & Mills, 2006; Crowe, 2005; Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Mills, Coffey-Corina, & Neville, 1997; Morra, & Tracey, 2006; Roy-Charland, Saint-Aubin, & Evans, 2007; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Spörer, Brunstein, Kieschke, 2009; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Van Keer, 2004; Vlachos, Andreou, & Delliou, 2013; Wanzek, 2014; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Wood, Pillinger, & Jackson, 2010; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). Eight of the articles (16.7%) were reviews of literature (Blomert, 2011; Goswami, 2008; Hansen, & Milligan, 2012; Kuhl, & Rivera-Gaxiola,

2008; Neville, & Mills, 1997; Ruston, & Larkin, 2001; Slavin, Lake, Davis, & Madden, 2011; Stevens, 2006). Six of the articles (12.5%) were descriptive works (Biemiller, 2003; Casbergue, & Harris, 1996; Corno, 2008; Meo, 2008; Perfetti, & Bolger, 2004; Wan, 2000). Two of the articles (4.1%) were guides (Beck, & McKeown, 2001; Hudson, Lane, & Pullen, 2005). Two of the articles (4.1%) were opinion pieces (Rushton, Juola-Rushton, & Larkin, 2009; Zadina, 2015). One study (2%) was a theoretical work (Indrisano, & Chall, 1995).

Table 1

Author(s) & Year of Publication	**Publication Type**
Aaron, Joshi, Gooden, & Bentum, 2008	Quantitative Study
Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009	Quantitative Study
Beck, & McKeown, 2001	Guide
Biemiller,	Descriptive Work
Blomert, 2011	Review of the Literature
Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008	Quantitative Study
Carlisle, & Felbinger, 1991	Quantitative Study
Casbergue, & Harris, 1996	Descriptive Work
Ciampa, 2012	Qualitative Study
Conboy, & Mills, 2006	Quantitative Study
Corno, 2008	Descriptive Work
Crowe, 2005	Mixed Methods
Esteves, & Whitten, 2011	Mixed Methods

Fernald, & Marchman, 2012	Quantitative Study
Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008	Quantitative Study
Fuchs, & Fuchs, 2005	Quantitative Study
Goswami, 2008	Review of the Literature
Hansen, & Milligan, 2012	Review of the Literature
Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010	Mixed Methods
Hudson, Lane, & Pullen, 2005	Guide
Indrisano, & Chall, 1995	Theoretical Work
Jordan, Snow, & Porche, 2000	Mixed Methods
Karemaker, Pitchford, & O'Malley, 2010	Mixed Methods
Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011	Mixed Methods
Kuhl, & Rivera-Gaxiola, 2008	Review of the Literature
Lewandowski, Begeny, & Rogers, 2006	Quantitative Study
Lucas, & Gromko, 2007	Quantitative Study
Meo, 2008	Descriptive Work

Mills, Coffey-Corina, & Neville, 1997	Quantitative Study
Morra, & Tracey, 2006	Qualitative Case Study
Neville, & Mills, 1997	Review of the Literature
Perfetti, & Bolger, 2004	Descriptive Work
Roy-Charland, Saint-Aubin, & Evans, 2007	Mixed Methods
Rushton, Juola-Rushton, & Larkin, 2009	Opinion Piece
Rushton, & Larkin, 2001	Review of the Literature
Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010	Quantitative Study
Slavin, Lake, Davis, & Madden, 2011	Review of the Literature
Spörer, Brunstein, Kieschke, 2009	Mixed Methods
Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014	Quantitative Study
Stevens, 2006	Review of the Literature
Van Keer, 2004	Quantitative Study
Vlachos, Andreou, & Delliou, 2013	Mixed Methods
Wan, 2000	Descriptive Work

Wanzek, 2014	Qualitative Study
Wise, Sevcik, Morris, Lovett, & Wolf, 2007	Quantitative Study
Wood, Pillinger, & Jackson, 2010	Quantitative Study
Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011	Quantitative Study
Zadina, 2015	Opinion Piece

3.2. Research design, participants, data sources, and findings of the studies

As previously noted, I located 29 research studies that met my selection criteria (Aaron, Joshi, Gooden, & Bentum, 2008; Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Carlisle, & Felbinger, 1991; Ciampa, 2012; Conboy, & Mills, 2006; Crowe, 2005; Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Mills, Coffey-Corina, & Neville, 1997; Morra, & Tracey, 2006; Roy-Charland, Saint-Aubin, & Evans, 2007; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Spörer, Brunstein, Kieschke, 2009; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Van Keer, 2004; Vlachos, Andreou, & Delliou, 2013; Wanzek, 2014; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Wood, Pillinger, & Jackson, 2010; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). The research design, participants, data sources, and findings of each of these studies are identified in Table 2.

Table 2

Authors	Research Design	Participants	Data Sources	Findings
Aaron, Joshi, Gooden, & Bentum, 2008	Quantitative	204 2nd to 5th grade students from 7 different schools in the SW states, from middle class, English speaking families, 10% minorities. Study 2: 330 children, grades 2 to 5. 171 in the treatment group received remedial reading instruction based on the CMR, 159 (comparison group)	Gates-MacGinitie Test of Reading (MacGinitie & MacGinitie, 1989), Woodcock Language Proficiency Battery (Woodcock, 1991),	● Authors propose using CMR (Component Model of Reading, which states there are three domains; cognitive, psychological and ecological, impacting reading) which focuses intervention to the source of the reading difficulty. ● Cognitive component includes decoding and comprehension, which are independent components. (Simple View of reading, Gough and Tumner (1986)). ● Focused training provided to students with word recognition deficits is more beneficial than differentiated instruction, provided in resource rooms, which authors found to be broad and unfocussed. ● Children who received word recognition training also had gains in comprehension. This was an unexpected outcome. Authors concluded, “poor word recognition skills might have functioned as a factor that limited reading comprehension.” (p. 80) ● Limited vocabulary and low-comprehension skills often will coincide.

Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009	Quantitative	63 children ages 7 to 15, 28 females, 35 males. All passed hearing screening. 62 had IQ scores higher than 80. 1 was not tested, but had reading and spelling scores in the normal range. Participants had a score at or below the 15th percentile on either Word Identification or Word Attack subtests of WRMT-R and an IQ of at least 90 on either the Verbal or the Performance subscales of the WISC-R.	Perceptual and neural measures; Comprehensive Test of Phonological Processing (Wagner et al. 1999). Subtests of [WRAT-3], or [WJ-III]); Neurophysiological responses to Auditory stimuli were recorded with the Bio-logic Navigator Pro System (Natus Medical Inc., Mundelein, IL).	● Data established a significant link between reading, a cortical process and subcortical auditory function. ● Children who score low on tasks of phonological awareness and rapid naming are characterized by poor timing of subcortical auditory encoding, or the ability to store sounds and words for later retrieval, and impoverished representation of speech sounds. ● "Good readers are characterized by more temporally precise encoding and more robust representation of speech harmonics." (P. 2703) These characteristics were found to be on a continuum from poor readers to good readers. ● Reading and phonological measures were not significantly correlated with pitch.
Boets, Wouters, van Wieringen, De Smedt, Ghesquiere, 2008	Quantitative	62 children, age 5, (36 boys/26 girls), pre-readers, Dutch speaking, no history of brain damage, vision or hearing problems, half from a family history of dyslexia.	Preschool measures of auditory and visual dynamic sensory processing, speech perception, orthographic & phonological ability, and 1st grade measures of reading and	● There is a relationship between speech perception and phonological processing. ● The data demonstrated a relationship between auditory sensitivity and phonological skills and a relationship between visual sensitivity and orthographic skills. ● Preschool measures of auditory and visual timing significantly predicted first grade reading achievement. ● Sensory problems generally precede the literacy problem.

			writing achievement.	
Carlisle, & Felbinger, 1991	Quantitative	166 4th, 6th & 8th graders, 72 males, 94 females, ethnically mixed, middle class, suburban Chicago	Standardized test scores; Profiles in Listening and Reading, (PILAR); Wide Rande Achievement Test-Revised, (WRAT-R)	● Students' strategies differed for listening and reading. ● There was a .52 correlation between listening and reading. ● It is important for teachers to have an understanding of students performance in both listening and reading to have a clear understanding of students instructional needs. ● Groups differed significantly on the listening and reading subtests. ● The authors caution against using listening as a measure of reading performance.
Ciampa, 2012	Qualitative	4 1st grade and 4 2nd grade studentsl (4 girls, 4 boys), from two Ontario schools, recommended for study by teachers, English speaking, caucasion	Questionnaires, interviews, observations, field notes, from students, teachers, and parents	● Features of the computer based intervention, such as the animations, helped to capture students attention, assist in the learning of new words, and support sustained attention. ● Participants appeared to be encouraged by immediate feedback, and reported enjoying the software. ● Increased student engagement was observed. ● Students reported placing a higher value on reading after the intervention.
Conboy, & Mills, 2006	Quantitative	30 children, 19-22 month old, 17 girls, 13 boys, 16 from English dominant homes, 14 from Spanish dominant homes, additional 15	Parent language survey; English and Spanish versions of the MacArthur-Bates	● Response timing provided evidence that the two languages are processed by non-identical brain systems. ● The results of this study lend support to the theory that increased experience with a language, and vocabulary

		children were tested, but excluded due to excessive artifact in the data.	Communica-tive Development Inventories – Words and Sentences; ERP, Event-Related Potentials,	growth, influence brain organization and the development of the language circuit located in the left hemisphere. ● Asymmetrical left lateralized activity was observed in the left hemisphere for the dominant language.
Crowe, 2005	Mixed Methods	8 children, ages 8-11, in grades 3-5, from 1 school in a Midwestern city of approximately 50,000, middle to low socioeconomic status, (SES)	Gray Oral Reading Test-Revised (GORT-R; Wiederholt & Bryant, 1986); Comprehensiv e Receptive and Expressive Vocabulary Test (CREVT; Wallace & Hammill, 1994); Assess-ment of Sound Awareness and Production, (Mattes, 1998).	● Communicative Reading Strategies, (CRS), including dialog and meaning based feedback, was more beneficial for comprehension and recall of story related details than traditional decoding based feedback.
Esteves, & Whitten, 2011	Mixed Methods	20 4th-6th grade students with IEPs, documented Reading disabilities, from 5 schools in a Mid-western suburban district, 96% white, randomly assigned to either Control or	Dynamic Indicators of Basic Early Literacy Skills® (DIBELS); oral reading fluency measurements (Good & Kaminski, 2002); Elementary	● Students in the treatment group, who used assistive reading devices demonstrated an average increase in reading fluency of 17.03 words correct per minute, while control group students, who participated in Sustained Silent Reading, (SSR), in creased by a average of 4.57 words correct per minute.

		Treatment groups of 10	Reading Attitude Survey (ERAS) (McKenna & Kear, 1990).	● The use of assisted reading (digital audiobooks) in the curriculum is supported.
Fernald & Marchman, 2012	Quantitative	82 children, 41 female, ages 15-17 months, no significant exposure to a language other than English, most parents college educated and professional or semi-professional, Typically developing, (TD), group, 46 children, Late Talkers, (LT), group of 36	Parent questionnaire; MacArthur-Bates Communicative Development Inventory, (MB-CDI) Words and Gestures (Fenson et al., 2006); MB-CDI: Words and Sentences.	● Researchers revealed speed and accuracy of real time spoken language processing at 18 months predicted vocabulary for both typically developing children and for those in the "late talkers" group. ● Children identified as "late talkers" who were faster and more accurate in word recognition at 18 months showed a steeper rate of growth than "late talking" children with slower processing. ● Child directed talk impacts speed of processing and "sharpens the processing skills used in comprehension." (p. 219)
Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008	Quantitative	44 children at an average age of 6.52 years, who were enrolled in and ongoing study, completed a phonemic awareness test at baseline and after 31 months, 32 of these comprised the music group	Parental questionnaire; Vocabulary subtest of WPPSI-III and WISC-III, (Wechsler, 1991 2002); Auditory Analysis Test (Rosner & Simon, 1971); Audiation	● There is a strong correlation between auditory musical discrimination abilities and language related skills in children. ● Findings added support to the existing claims that music training enhances phonemic awareness, which are tied to reading abilities.

			(PMMA, Gordon 1986)	
Fuchs, & Fuchs, 2005	Quantitative Study	33 Kindergarten teachers, with classes intact, located in 8 schools, totaling 404 children, schools were 50% Title 1, and 50% served mostly middle income children. 25 of the students were identified with disabilities; subsequent study included 32 teachers, classes intact, located in 10 schools, totaling 442 children.	Pre and post tests; measures of phonological awareness, beginning reading and spelling; class observations and collections of treatment fidelity data at multiple pointes were used. The same outcome measures were used in the subsequent study.	● Students who participated in Peer-mediated groups outperformed controls on post treatment phonological awareness tasks. ● Contrary to general practices, authors state, decoding and word recognition skills can and should be taught in kindergarten and fluency building can and should be taught in first grade. ● This study demonstrated that the value of peer-mediated instruction, which the researchers have previously shown to enhance reading outcomes, is consistent in kindergarten and first grade as well. ● Kindergartners who received training in word reading skills outperformed those participating in both word-reading and comprehension activities. The authors believe that the comprehension activities interrupted reading practice.
Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010	Mixed Methods	21 4th grade, general education students, ages 9-11. 13 male students, 8 female, all with < proficient score on the winter benchmark test, urban charter	Dynamic Indicators of Basic Literacy, (DIBELS) reading fluency measure (Good & Kaminski, 2007); 5-item teacher and	● Sentence by sentence listening preview of text, and sentence by sentence listening preview of text with vocabulary preview, had moderate to large positive effects on comprehension, as compared to the control group, sustained silent reading. ● The addition of vocabulary preview to the sentence by

		school, Midwest, 96% black	student questionnaires	sentence pre-reading, had a large effect compared to listening preview alone.
Jordan, Snow, & Porche, 2000	Mixed Methods	248 kindergarten students and their families from 4 Title I schools in a middleclass, English speaking, Euro-American, Minnesota school district; 177 students in 8 classes received the intervention. 71 students in 3 classes were the controls.	Questionnaires ; Pre and post language and literacy measures: Peabody Picture Vocabulary Test-Revised (PPVT-R) (1981), Comprehensive Assessment Program (CAP)	● Subsequent to parent training provided over the course of 5 months, addressing book discussions, vocabulary enrichment, and supporting expressive and receptive language abilities; participants made statistically significantly greater gains than the control group on posttests. ● Benefits were greater for children who scored lower at the pre-test. ● The benefits of the intervention had more positive effects on language skills than it had on print or sound awareness. ● Increased participation in the program correlated with increased effect sizes.
Karemaker, Pitchford, & O'Malley, 2010	Mixed Methods	Participants included 17 year 1 students from 2 UK primary schools, considered by their teachers to be struggling readers, having standardized reading scores of 90 or below.	Questionnaire; Wechsler Individual achievement Test (WIAT) (Wechsler, 2005); LDT (lexical decision task); Word Oral Reading Task (SWORT); Phonological Awareness Test (PAT)	● Results showed that both ORT (Oxford Learning Tree) interventions, Clicker, a multimedia reading device, using highlighted text with an audible narration feature, and traditional Big Book, lead to significant gains for struggling readers in word recognition, word naming and phonological awareness. ● The Clicker intervention resulted in greater gains at the group level, and participants made significant gains in word recognition.

			(Robertson & Salter, 1997)	● Participants using Clicker reported more enjoyment of computers. ● Struggling readers frequently accessed the Clicker audible word reading feature.
Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli & Gabrieli, 2011	Quantitative	51 students, a sub group of a larger study, including typically developing readers, and dyslexic readers, ages 7-13, & age and ability control groups; native English speakers, normal hearing, no history of cognitive or motor developmental difficulties or brain injury, no current regimen of medication affecting the nervous system, average verbal IQ scores	Standardized measures of cognitive, language, and reading abilities; parents questionnaire detailing their child's previous and current language, reading, cognitive, and motor development, as well as any family history of learning difficulties; fMRI scanning, including 3 block conditions: a phonological awareness task (Rhyme task), a control task (Match task), and fixation (Rest).	● Researchers compared active regions of the brain that participate in phonological awareness for spoken language. ● When processing spoken language typically reading children show general, bilateral, brain activation, however, for explicit phonological analysis of spoken language, (rhyme, match, & contrast tasks) these children showed greater activation only in the left dorsolateral prefrontal cortex (DLPFC) ● This specific recruitment of left hemisphere regions was not observed for dyslexic readers. ● Typical readers showed significantly greater activation in the (DLPFC) than dyslexic readers for rhyme task. ● These observations indicate that the DLPFC, which dyslexic children do not engage, may play a key function in phonological awareness. ● Dyslexic readers tend to rely on the right posterior cortex to process phonological information.

Lewandowski, Begeny, & Rogers, 2006	Quantitative	66 3rd grade students; average age 9, from urban central New York elementary, 37 female and 29 male, 14 eligible for special education services, 59 received free or reduced cost lunch	Pre and post tests in curriculum based reading measures; fluency tests on reading passages and word lists.	● Students in the tutor led and in the computer based interventions both performed better on posttests than students in the control group. ● The tutor led groups gained 13.4 words per minute on the word lists, and the computer based group gained 11.1 words per minutes. ● The tutor led groups gained 42.3 words per minute on the passage reading, and the computer based group gained 47.6 words per minutes. ● Controls made minimal gains. ● The key factor underlying gains was the auditory pronunciation coupled with the sight of a word.
Lucas, & Gromko, 2007	Quantitative	27 students from a rural Midwestern elementary school	Dynamic Indicators of Basic Early Literacy Skills (DIBELS); Primary Measures of Music Audiation (PMMA) (Gordon	● First grade students' judgment of tonal and rhythmic patterns was significantly correlated with their ability to segment words into discrete phonemes. ● "The findings suggest that musical pattern discrimination and phoneme segmentation both require aural perception ability," (p.15).
Mills, Coffey-Corina, & Neville, 1997	Quantitative	39 children, ages 13 to 17.5 months, useful data obtained from 16 girls and 12 boys, additional 11 could not successfully wear the electro cap, or could not remain	Language/behavioral observation, to determine which words to present during the electrophysiological testing; MacArthur Communicativ	● When children at 13 to 17 months were presented with known and unknown words brain activity was widely distributed across left and right, but greater in right hemisphere regions and greater in posterior than anterior regions. ● By 20 months when the same children were tested known

		still for the testing	e Development Inventories (CDI); Vocabulary checklist rating scales; EEG	words elicited activity in the left hemisphere temporal parietal regions. Unknown words elicited activity largely over the right hemisphere.
Morra, & Tracey, 2006	Qualitative Case Study	Single subject, 8.5 yr. old, Caucasian female, attending a public elementary, middle class suburban, Northeastern community, subject receives reading services from a reading specialist, was chosen for the study due to difficulties in fluency	Writing and Reading Assessment Profile (W.R.A.P.)(Learning Media Limited, 2001); fluency baseline established, observation	● Independent interventions using multiple fluency strategies at appropriate levels of text difficulty were shown to increase reading skills. ● Level of reading materials used should be "manageable". Students should be slightly, not overly challenged with texts. ● Use of repeated reading, and audible books among other strategies helped the participant develop fluency on all measures.
Roy-Charland, Saint-Aubin, & Evans, 2007	Mixed Methods	30 French speaking children, attending a French school, in a bilingual community, and their parents; 6 children from each grade level from kindergarten to Grade 4	Home Literacy Experiences Questionnaire (Levy et al., 2006) French translation; Eye movements were measured with an SR Research Ltd EyeLink II system, Observation, Curriculum based	● The results showed that students show greater attention to the text as grade level increases and when the text is within the student's reading level. ● The results point to the importance reading books to children which are within their reading level. The authors suggest this provides students with needed scaffolding to read along, increasing fluency. ● Children must have some knowledge about words in the text to impact of fluency in this way.

			comprehension tests	
Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010	Quantitative	166 children, from two cohorts (n = 85 and n = 81; 88 girls and 78 boys); All were followed from school entry to the beginning of Grade 3.	Nationally normed, pre-reading screening (ALLU; Lindeman, 1998); Rapid Automatized Naming Test (RAN; Ahonen, Tuovinen, & Leppäsaari, 1999); parent questionnaire	● The results indicated that the computer-assisted reading intervention (CARRI) was the most effective of the three methods used, (the other two were traditional remedial reading instruction, and a group without intervention served as the control). ● The computer assisted remedial reading intervention contributed to permanent gains made in word-level reading fluency, by the children, at-risk for reading failure. ● Early computerized intervention, administered in brief sessions, targeting pre-reading skills, such as letter–sound connections, letter names, and phonological abilities, seemed to have a positive impact on future word-level reading fluency skills.
Spörer, Brunstein, Kieschke, 2009	Mixed Methods	210 3rd- to 6th graders, two schools, German, students, reported having 26-100 books in the home	Pre and post standardized scholastic achievement test; experimenter-developed task, designed to tap specific story information and main ideas; students questionnaire	● Strategies, both using questions, summarizing, clarifying and predicting; and the use of reciprocal teaching, resulted in gains in comprehension, as tested by the researcher designed assessment. ● Only students, who practiced reciprocal teaching in small groups, achieved higher reading comprehension scores as assessed by the standardized test.

Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014	Quantitative	236 German primary school children, (121 males, 115 females), ages 5.5 to 7.4 at the beginning of the study, with a mean IQ of 108, native speakers of German	Pre and post auditory testing via headphones, and visual testing via 17" computer monitor. Reading and spelling abilities were assessed at the end of Grades 1 and 2 using standardized German reading and spelling tests.	● Temporal order thresholds (Temporal order Thresholds, or TOTs are measurements of processing speed) decreased, response times became shorter, over the course of 20 months, for both auditory and visual stimuli. ● TOTs in grade 1 were related to TOTs in grade two, suggesting a growth trajectory which remains consistent. Children's ranking or placement within their cohorts did not change. ● Rapid temporal processing at the beginning of grade 1 was shown to be a predictor of spelling ability, and more correlated to spelling at the end of grade 2 than at the end of grade 1. ● Researchers determined rapid auditory processing to be a "cause rather than a mere correlate of literacy development." (p. 1724) ● Researchers did not think their findings were generalizable, in particular, they felt their findings might be less applicable to individuals with lower general abilities for whom temporal order thresholds could not be determined.
Van Keer, 2004	Quantitative	22 fifth grade teachers and their 454 students from 19 schools throughout	3 Structured interviews and observations, pre-, post- and retention tests using	● Results revealed the benefits of both same age and cross age peer tutoring. ● Cross age tutoring was found to be more beneficial than same age tutoring for the older

		Flanders, Belgium	traditional, Dutch standardized tests	"tutor" in the pair. (This is noted, even though the older tutors were working with texts below their level.) ● Authors observed that students who have been trained to use a structured peer tutoring format are heard talking about what they are doing and thinking when they read, in other words they are using meta-skills. ● This dialog, focused on process, was shown to benefit both older and younger members of peer tutoring pairs.
Vlachos, Andreou, & Delliou, 2013	Mixed Methods	135 Greek students, 102 boys, 33 girls, 13-18 years old; 45 of these, were formally assessed, and received a statement of dyslexia	PT (Zenhausern, 1978), a self-report questionnaire that comprises 20 items to id/pinpoint Left/Right preference; fMRI	● Significantly more dyslexic students demonstrated a preference for a right hemisphere thinking style, compared to peers who demonstrated a preference for a left hemisphere thinking style.
Wanzek, 2014	Qualitative	Second grade teachers/programs in 3 Title I schools in urban, suburban and rural communities, located in the Midwest, South and Southeast	Observation data; teacher interviews; audio recorded lessons; focus group discussions	● This study focused on the nature of vocabulary instruction, finding that students in supplemental programs, have less opportunity to gain vocabulary because the teachers in supplemental programs focus more on word recognition and building fluency. They consider teaching vocabulary to be the domain of the regular education teachers. The regular education teachers consider the teaching

				vocabulary to be in their domain as well.
Wise, Sevcik, Morris, Lovett, Wolf, 2007	Quantitative	279 students, 2nd to 3rd grade from Atlanta, Boston and Toronto, met research criteria for reading disability, (108 girls, 171 boys). 135 Black, 144 Caucasian	Measures of pre-reading skills, word identification, reading comprehension, and general oral language skills; Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981); Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991) vocabulary subtest.	● Findings aligned with the suggestion that vocabulary knowledge drives the development of pre-reading skills. ● Findings indicated receptive and expressive language involve distinct skill sets and influence pre-reading skills in distinct ways. ● Oral language skills correlated to reading achievement.
Wood, Pillinger, & Jackson, 2010	Quantitative	80 children, from a single primary school, in the UK, 40 five-year-olds and 40 six-year-olds, 20 of the 5 year olds and 20 of the 6 year olds comprised the treatment "talking books" group, remaining	British Picture Vocabulary Scales II (BPVS II; Dunn, Dunn, Whetton, & Burley, 1997); Phonological Assessment Battery (PhAB; Frederickson, Frith, & Reason, 1997); Neale Analysis	● Researchers observed different interventions, (talking book - computer based reading and feedback/adult led reading and feedback), benefit different literary skills. ● The children in the talking book group were observed engaging in "bookbinding," a term, taken from Guppy and Hughes' (1999), referring to silent watching and listening, with minimal commenting, while the computer or adult reads. Children with little or

		children in the control group	of Reading Ability: Revised (NARA II; Neale, 1997)	no experience with books are introduced, in this way, to the nature of stories, reading, and text. ● The children in the adult led, comparison group were observed "chiming in" more than in the talking book group. ● The children participating in talking book group made significantly better improvements in phonological awareness relative to the children in the adult-led sessions. ● The children in the adult led group utilized an interactional style with the adult tutors and made strategy adaptations. This was not seen in the computer based groups.
Yamada, Stevens, Dow, Harn, Chard, & Neville 2011	Quantitative	18 5 and 6 year olds and 13 adults, from Eugene, Oregon, 14 of the children with useable data, divided into 2 groups, "on track" for reading development (OT), & "at some risk" (AR) for reading difficulties, both adults and children were healthy, right-handed, native English speakers, with no known	Parent questionnaire; Stanford-Binet Non-verbal fluid reasoning and Verbal knowledge; DIBELS Letter naming fluency and Initial sound fluency tests; fMRI	● Difference in "at risk" (AR) and "on track" (OT) groups became evident by the second scan session. The first scan took place at the beginning of kindergarten. The second scan took place at the end of the first semester. ● The "at risk" students showed recruitment of areas in the right hemisphere. This was not seen in the "on track" group. ● Students in the "on track" group showed a reduction in the use of right hemisphere areas. ● This study provides evidence of the emergence of a left hemisphere "reading network"

		neurological disorders including ADHD.		in the first semester of kindergarten. ● This study aligns with previous studies finding reduced activity in right hemisphere regions, homologous to the left hemisphere reading network, related to a higher level of reading ability.

3.2.1. Research design

Seventeen of the 29 studies (58.6%) used a quantitative research design (Aaron, Joshi, Gooden, & Bentum, 2008; Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Carlisle, & Felbinger, 1991; Conboy, & Mills, 2006; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Mills, Coffey-Corina, & Neville, 1997; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Van Keer, 2004; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Wood, Pillinger, & Jackson, 2010; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). Nine of the studies (31%) utilized a mixed methods research design (Crowe, 2005; Esteves, & Whitten, 2011; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Roy-Charland, Saint-Aubin, & Evans, 2007; Spörer, Brunstein, Kieschke, 2009; Vlachos, Andreou, & Delliou, 2013). Three of the studies (10.3%) used a qualitative research design (Ciampa, 2012; Morra, & Tracey, 2006; Wanzek, 2014). The study by Morra, & Tracey, (2006), was a qualitative case study.

3.2.2. Participants and Data Sources

The majority of the 29 research studies included in this meta-synthesis analyzed data from elementary school students. Eleven of the 29 studies (37.9%) analyzed data collected from beginning readers, at the kindergarten to second grade levels (Boets, Wouters, van Wieringen, De

Smedt, & Ghesquiere, 2008; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Roy-Charland, Saint-Aubin, & Evans, 2007; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Vlachos, Andreou, & Delliou, 2013; Wood, Pillinger, & Jackson, 2010; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). Another 10 studies (34.4%) analyzed data from higher elementary grades, or all elementary grades (Aaron, Joshi, Gooden, & Bentum, 2008; Crowe, 2005; Esteves, & Whitten, 2011; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Morra, & Tracey, 2006; Spörer, Brunstein, Kieschke, 2009; Van Keer, 2004; Wise, Sevcik, Morris, Lovett, & Wolf, 2007). Three of the studies (10.3%) analyzed data from very young children, ages 13 to 22 months (Conboy, & Mills, 2006; Fernald, & Marchman, 2012; Mills, Coffey-Corina, & Neville, 1997). Three of the studies (10.3%) analyzed data from students whose ages spanned elementary and middle school grades, grades 1 to 9 (Banai, Hornickel, Skoe, Nicol, Carlisle, & Felbinger, 1991; Zecker, & Kraus, 2009; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011). One study (3.4%) analyzed data from students in middle to high school grades (Ciampa, 2012). In addition to studies whose participants were children, one study (3.4%) analyzed data from teachers and programs (Wanzek, 2014).

The majority of the participants from the 29 research studies in this meta-synthesis were from North America. The participants in 20 of the 29 studies (69%) were from the United States and Canada (Aaron, Joshi, Gooden, & Bentum, 2008; Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Carlisle, & Felbinger, 1991; Ciampa, 2012; Conboy, & Mills, 2006; Crowe, 2005;

Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Mills, Coffey-Corina, & Neville, 1997; Morra, & Tracey, 2006; Wanzek, 2014; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). The participants from 9 of the 29 studies (31%) were from European countries, Belgium, France, Finland, Germany, Greece and the United Kingdom (Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Karemaker, Pitchford, & O'Malley, 2010; Roy-Charland, Saint-Aubin, & Evans, 2007; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Spörer, Brunstein, Kieschke, 2009; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Van Keer, 2004; Wood, Pillinger, & Jackson, 2010; Vlachos, Andreou, & Delliou, 2013).

Data sources used in the research studies for this meta-synthesis included standardized and content-based measures of abilities, neural and perceptual measures, and data drawn from surveys, observations and interviews. The majority of the studies used a combination of theses types of data. Standardized tests and content-based measures were the most frequently used type of data source. Twenty-five of the 29 studies (86.2%) used some form of standardized test or content based measure (Aaron, Joshi, Gooden, & Bentum, 2008; Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Carlisle, & Felbinger, 1991; Conboy, & Mills, 2006; Crowe, 2005; Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008;

Fuchs, & Fuchs, 2005; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Lewandowski, Begeny, & Rogers, 2006; Lucas, & Gromko, 2007; Morra, & Tracey, 2006; Roy-Charland, Saint-Aubin, & Evans, 2007; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Spörer, Brunstein, Kieschke, 2009; Spörer, Brunstein, Kieschke, 2009; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Van Keer, 2004; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Wood, Pillinger, & Jackson, 2010; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). Nineteen of the studies (65.5%) used surveys, observations or interviews (Ciampa, 2012; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Conboy, & Mills, 2006; Esteves, & Whitten, 2011; Fernald, & Marchman, 2012; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Fuchs, & Fuchs, 2005; Hawkins, Musti-Rao, Hale, McGuire, & Hajlley, 2010; Jordan, Snow, & Porche, 2000; Karemaker, Pitchford, & O'Malley, 2010; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Mills, Coffey-Corina, & Neville, 1997; Morra, & Tracey, 2006; Roy-Charland, Saint-Aubin, & Evans, 2007; Spörer, Brunstein, Kieschke, 2009; Spörer, Brunstein, Kieschke, 2009; Van Keer, 2004; Vlachos, Andreou, & Delliou, 2013; Wanzek, 2014; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011). Eleven of the studies (37.9%) used neural or perceptual measures (Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Ciampa, 2012; Conboy, & Mills, 2006; Crowe, 2005; Forgeard, Schlaug, Norton, Rosam, Iyengar, & Winner, 2008; Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, Wolf, Whitfield-Gabrieli, & Gabrieli, 2011; Mills, Coffey-Corina, & Neville,

1997; Roy-Charland, Saint-Aubin, & Evans, 2007; Steinbrink, Zimmer, Lachmann, Dirichs, & Kammer, 2014; Yamada, Stevens, Dow, Harn, Chard, & Neville, 2011).

3.2.3. Findings of the studies

The findings of the 29 research studies included in this meta-synthesis can be summarized as follows.

1.Educational neuroscience has brought insight to the development of language abilities, in particular, reading skills. Research has revealed language related neural changes and researchers have been able to distinguish typical development from atypical development.

2. Neuroscientists have established significant correlations between sensory and pre-reading skills. Speed and accuracy of auditory and visual processing in preschoolers, has been shown to predict pre-reading skills. Auditory sensitivity is related to later reading abilities. Aural abilities and deficits, including musical pattern discrimination, correlate with phonemic awareness.

3. The brain is responsive to environmental factors. Language experiences, which occur in the home, and social experiences in the classroom, have a significant impact on learning. The experiences and knowledge, with which children enter kindergarten, are vastly different.

4. Educational research supports the importance of aural experiences in the classroom. Skilled educators, also realize that experience and relationship significantly influence learning, and incorporate practices, which utilize aural strategies and relational learning.

3.3. Emergent themes

Seven themes emerged from my analysis of the 48 articles included in this meta-synthesis. These emergent themes, or theme clusters, include: (a) the development, or lack of development of a left hemisphere "reading network"; (b) links between sensory and literacy skills; (c) correlations between language and musical abilities; (d) environmental factors impacting language and literacy; (e) vocabulary acquisition; (f) aural and oral strategies, or strategies involving listening and speaking; and (g) computer aided instruction. These seven theme clusters and their formulated meanings are represented in Table 3.

Table 3

Theme Clusters	Formulated Meanings
The Development or Lack of Development of a Left Hemisphere "Reading Network"	● A variety of non-invasive, brain scan techniques have multiplied the information available regarding how learning, and reading in particular takes place in the brain. ● By the age of 1 babies begin to adapt to the language or languages which they experience. They become more attentive to distinctions that occur in their own language and less attentive to patterns and sounds that are characteristic of other languages. ● The emergence of a language system occurs between 13 and 20 months. This language system, sometimes referred to as a "reading network" represents typical development. ● Neuroscience suggests that there is a critical period in language development during which the brain is building key structures. ● A rapid increase in vocabulary size coincides with the emerging language system. ● Research involving babies who experience bi-lingual environments has shown that bilingual learning environments have a unique influence on neural patterns. ● For babies living in bi-lingual environments, scientists observed greater activity in the left hemisphere when babies were presented with known words from the dominant language, whereas known words from the non-dominant language did not specifically activate left hemisphere regions. ● Response times differ for known words from the dominant and non-dominant languages for babies living in bi-lingual environments.

	● Scientists have observed the dorsolateral prefrontal cortex, or DLPFC, is accessed for tasks involving phonemic awareness, such as rhyme or match and contrast tasks. ● Brain research has shown reduced activation in the right hemisphere as "typically developing" readers progress. ● Certain children do not develop typical left hemisphere specialization for reading related tasks. These children appear to develop alternative pathways and access right hemisphere structures for reading related tasks. ● Dyslexic individuals do not utilize the specialized left hemisphere, language system as typically developing readers do. Instead, dyslexic individuals tend to rely on the right posterior cortex to process phonological information. ● Dyslexic individuals respond to print in the same way they respond to ordinary shapes. ● These differences in the patterns observed in typically developing readers and children "at risk" for reading difficulties begin to appear by the end of the first semester of Kindergarten.
Links Between Sensory and Literacy Skills	● Observations and measurements regarding processing speed, comparisons within individuals over time, and across groups of individuals allow neuroscientists to make predictions regarding ability and performance. ● Research reveals a correlation between sub-cortical auditory processing and reading. ● Rapid temporal processing is correlated, perhaps causally, with higher levels of reading ability. ● Children who demonstrate low skills in phonemic awareness and rapid naming have difficulty with the short-term ability to store sounds and words for later retrieval. ● Dynamic auditory and visual sensitivities are related to different aspects of literacy. ● Processing speed impacts emergent literacy. Children identified as "late-talkers" who had faster processing speed also showed a steeper learning trajectories and were able to make significant gains on their typically developing peers. ● Preschool measures of auditory and visual temporal order judgments correlate to first grade reading achievement. ● Sensory problems usually precede literacy problems.
Correlations between	● Oral skills are related to reading achievement. ● Aural skills, the ability to distinguish sounds, are central to music ability as well as language.

Language and Musical Abilities	● There is a correlation between musical pattern discrimination and the ability to segment phonemes. ● It has been shown that music training enhances phonemic awareness and impacts reading. ● Beginning readers must re-code from print to sound. ● Novice readers access cortical structures involved in spoken language when first engaging with print. As individuals become more skilled readers these patterns change.
Environmental Factors Impacting Language and Literacy	● Neuroscience reveals a substantial impact experience has upon language development. ● Exposer to rich dialogue in the home highly impacts reading development. ● Conversation directed to children impacts their processing skills and comprehension. ● The practice of reading to children is highly correlated with literacy. ● Reading aloud to children is most beneficial to literacy when it is accompanied by discussions, which encourage reflection. ● The nature of the learning environment; the interest level generated, and the opportunity to participate and engage, impacts learning. ● Social learning, the opportunity to engage in dialog with peers, contributes intrinsic motivation to learning experiences.
Vocabulary Acquisition	● Experience impacts vocabulary. ● Exposure to complex vocabulary impacts the rate and development of vocabulary acquisition. ● Expressive and receptive vocabulary knowledge influence pre-reading skills. ● There is a correlation between the amount and quality of talk a mother directs to her child and the size of the child's vocabulary. This has also been observed among orphans if there is consistent one-to-one conversation with a concerned care taker. ● There is a great amount of diversity in the vocabulary sizes of children entering kindergarten. ● Limited vocabulary often coincides with low-comprehension.
Aural and Oral Strategies, or Strategies Involving Listening and Speaking	● Listening comprehension is highly correlated with reading comprehension. ● For most students, listening comprehension is more advanced than reading comprehension, until middle school. ● Listening to a fluent example, including digital examples, helps a child develop fluency and promotes comprehension. ● Listening to literature introduces imbedded vocabulary.

	● Best practices incorporate phonemic awareness with meaning based instruction. ● Dialogue and interaction are central aspects of learning. ● One-to-one tutoring, by a trained professional has been shown to be the most beneficial means of intervention. ● Gains are maintained when tutoring is followed up in whole class activities. ● Social interaction, including thoughtful dialogue with peers promotes learning. ● Students benefit from opportunities to lead in cooperative groups and pairs. ● Cooperative groups and pairs provide students an opportunity to talk about meta-skills they use when reading.
Computer Aided Instruction	● Students benefit from computer assisted instruction, in a variety of formats and devices, for a variety of purposes. ● Multi-media learning experiences, which simultaneously access more than one modality, and in particular visual and auditory, have been shown to promote learning. ● Researchers have observed struggling readers frequently accessing and benefiting from features of assistive technology which provide the opportunity for children to see and hear words and text simultaneously. ● There are conflicting opinions about the impact of computer-assisted instruction.

4. Discussion

In this section, I summarized the major themes that emerged from my analysis of the 48 articles included in this meta-synthesis. I then connected these emergent themes to my teaching practice, and to my personal and professional experiences as a special education teacher.

4.1. The development or lack of development of a left hemisphere reading network

Over the last 20 years there have been advances in the field of neuroscience, which have contributed greatly to our knowledge of brain functions related to language and literacy. We know that the growth, taking place in infants' and young children's brains, is unlike any other time in their lives. Because of non-invasive methods of examining language processing, in infants and children, such as ERPs, event-related potentials, which track electrical activity, or NIRs, near-infrared spectroscopy, which uses light to measure concentration of blood to indicate neural activity, windows into the brain have been opened and we are able to make significant observations, (Mills, et al., 1997).

An early twentieth century theory regarding reading development, proposed by William S. Gray, in 1925, identified "reading readiness," as the beginning stage in reading, (Indrisano, & Chall, 1995, p. 65). Reading readiness was considered to be the point at which a child, was ready and moved from being a non-reader to being a reader. In 1947 Arthur I. Gates added "Pre-reading" as the first stage, however, we did not have an understanding of the neurological activity taking place in the brains of infants; building structures, organizing, connecting, and specializing in language skills. Now, because of current methods in neurology, we know that by

the time a baby is one year old they have begun to adapt to the language, or languages, to which they are exposed, (Mills, et al., 1997). They have ceased to take note of all possible sounds, voiced in all the world's languages, and have begun to hear the subtle distinctions in the languages which they hear spoken each day. Preparations for pre-reading skills have begun to develop.

Neuroscientists refer to a "critical period" in language development, during which the brain is building key structures. Between 13 and 20 months, coinciding with a rapid increase in vocabulary, (Neville, & Mills, 1997), a language system begins to emerge. When presented with known words, prior to this time period, children respond with generalized brain activity, throughout both hemispheres of the brain, in frontal, temporal, parietal, and occipital regions. After 13 months of age, typically developing children, when presented with known words begin to elicit responses which are limited to the temporal and parietal regions in the left hemisphere. Similar studies, with children from bi-lingual homes, have established reason to believe that it is experience, the rapidly multiplying number of words a child knows and understands, that drives and shapes the development of this left hemisphere language system, (Conboy, & Mills, 2006). Conboy, and Mills, studying the brains of children just over 1 year old, being brought up in bi-lingual homes, found that the dominant language, the language the child hears more of, and knows more words in, is the language which elicits activity in the emerging, left hemisphere, language center. The non-dominant language continues to elicit activity in a more generalized pattern, across both hemispheres. It is as if the brain, experiencing a flood of vocabulary acquisition, happening at 18 to 30 months, gets busy problem solving, and creates the needed organization to accommodate the new vocabulary.

Typically developing readers show reduced activation in the right hemisphere for language tasks. Scientists have observed the left dorsolateral prefrontal cortex, or left DLPFC, is accessed for tasks involving phonemic awareness, such as rhyme or match and contrast tasks, (Kovelman, et al., 2011). These typical patterns of development are not present in children who are described as dyslexic, a term, which is commonly used to describe individuals who experience difficulty reading. Some children do not develop typical left hemisphere specialization for reading related tasks, (Vlachos, et al., 2013). These children appear to develop alternative pathways and access right hemisphere structures for reading related tasks. Some refer to these alternative pathways as compensatory, (Vlachos, et al., 2013; Wood, et al., 2010). Rather than using the specialized left hemisphere reading network, dyslexic individuals respond to print in the same way they respond to pictorial symbols, relying on right hemisphere regions, (Blomert, 2011). Differences in the patterns observed in typically developing readers and children, at risk for reading difficulties, begin to appear by the end of the first semester of kindergarten, (Yamada, et al., 2011). Timing of developing patterns and neural changes, coinciding with an increase in lexical experience, is similar to the 13 to 20 month-old initial organization of a language center. As the brain encounters more vocabulary it begins to organize, and when in kindergarten, the brain is presented with a large amount of reading related experiences, the brain responds by increasing the specialization for reading tasks in the left hemisphere.

4.2 Links between sensory and literacy skills

Research reveals a “significant link between reading (a cortical process) and subcortical auditory function,” (Banai, et al., 2009, p. 2705). Rapid speed and accuracy of sensory processing, highly correlate with reading ability, (Boets, et al., 2008, Steinbrink, et al, 2014).

Sensory processing, refers to the ability to understand or interpret the signals our senses are taking in. This happens at a subcortical level, rather than on a cognitive level, where meaning is imputed. Researchers refer to this sensory level understanding as, being able to produce accurate "representations" of audio and visual signals, (Blomert, 2011). To accurately represent sensory input, is to distinguish critically unique features of input; in spoken language, the phonemes and dynamics, in print, the visual orientation and relative size and shape of visual symbols.

Efficiency, or speed, in producing accurate speech sound representations is a foundational skill for the development of phonemic awareness, and eventually developing pre-reading skills. (Blomert, 2011). Delayed processing of speech sounds is often characteristic of poor readers, (Banai, et al., 2009). This slowness in formulating sound representations, impacts one's ability to effectively map connections between letters and sounds. Sensory problems usually precede literacy problems, (Boets, et al., 2008).

Researchers suggest rapid temporal processing is causally correlated with higher levels of reading ability, (Banai, et al., 2009; Steinbrink, et al., 2014). Preschool measures of auditory and visual temporal order judgments, or the ability to distinguish sequential order, correlate to first grade reading achievement. Rapid naming tasks, quickly naming objects, pictures, colors or symbols, are used to judge temporal order processing. In a study by Steinbrink, et al., to determine if temporal order processing had a causal effect on reading abilities, processing speed was found to be a crucial factor, (2014). In this study, some children, identified as "late-talkers", but who had faster processing speeds than "late-talking" peers, showed steeper learning trajectories than their peers, and were able to make significant gains on their "typically developing" peers by the end of second grade.

This important relationship, between sensory processing and comprehension of speech, is considered to be bi-directional, (Boets, et al., 2008). In other words, the repeated production of clear speech sound representations enables the listener to recognize distinct words, and their meanings. Grasping meaning and context, a listener's ability to further distinguish sounds, is heightened.

4.3. Correlations between language and musical abilities

Aural, refers to the sense of hearing. Aural skills, the ability to distinguish sounds, are central for both music and language. Musicians require aural skills to discriminate rhythm, pitch and intonation. Rhythm refers to stress, and pitch refers to highness or lowness of sounds. Musical intonation describes the accuracy of pitch. Spoken language, like music, has rhythmic patterns and fluctuations in pitch. In language, intonation refers to the rise and fall of the voice during speech. Words of two or more syllables have stressed and unstressed sounds. Stressed sounds are typically louder, longer, and higher in pitch. For example, when we say "paper" we stress the first syllable, /pā/, is held longer, it is higher in pitch and it is louder than the second syllable, /pər/. Each language has unique patterns of intonation. The ability to hear and distinguish the precise sounds in spoken language is fundamental to reading.

Aural skills play a basic role for beginning readers, who must recode from print to sound. Research indicates that novice readers access cortical structures involved in spoken language when first engaging with print, (Goswami, 2008). The beginning reader must use sounds to give meaning to the print. Although more research into the relationship between music education and literacy is needed, there are many studies which support the benefits of music training interventions for struggling readers, (Banai, et al., 2009; Forgeard, et al., 2008; Hansen,

& Milligan, 2012; Lucas, & Gromko, 2007). Lucas, & Gromko refer to several studies in which students, who were provided music instruction made increases in reading test scores. In a 2007 study of their own, in which they discovered a significant correlation between musical pattern discrimination and the ability to distinguish phonemes, they concluded, "Music instruction with an emphasis on aural perception of tonal and rhythmic patterns may be an effective intervention for children who need to improve their phoneme segmentation skills," (p. 15)

4.4. Environmental factors impacting language and literacy

Aaron, et al., refer to three components in reading development, cognitive, ecological and psychological, (2008). Environmental factors fall under the ecological component, and refer to the living environment in which a child is developing. This includes the language or languages heard, the amount of conversation others in the home direct toward the child, the dialogue children are exposed to, the attitude toward and accessibility of books, and the amount and quality of reading modeling a child experiences. Research reveals a substantial impact experience has upon language development. Project EASE, a study conducted in 2000 by Gail E. Jordan, Catherine E. Snow, and Michelle V. Porche, investigated the effects of parental training provided over the course of five months. Parent training addressed book discussions, vocabulary enrichment, and supporting expressive and receptive language abilities. Conversation that might be thought of as incidental such as extended dinner conversations, narratives and explanations, were shown to be directly related to development of language skills, (2000). Gains made by participants in the study were significant. Participants whose children had lower pre-test scores demonstrated the greatest gains. Conboy and Mills, in the study mentioned earlier, investigating

distinctions in the processing of languages for infants in bi-lingual homes, attributed the differences they observed to experience, (2006). The developing brain in many ways shows itself responsive and adaptive to its environment. In a 2009 article, by Rushton, et al., discussing the components of a stimulating learning environment, the authors refer to several articles, each giving examples of the importance experience has on learning and its influence on brain developments and changes.

The practice of reading to children is highly correlated with developing literacy. Indrisano, & Chall, in an article discussing theories of reading development, referred to Carol Chomsky's finding that children whose parents had read to them were the best readers, (1995). Wan, in a review of research, on reading aloud to children, quoted Durkin, "children who learned to read before entering first grade were ones who were read to by siblings, parents, or another caring adult. Neither race, ethnicity, socioeconomic level, nor I.Q. distinguished between readers and nonreaders; access to print, being read to, parents valuing education and early writing did," (2000, p. 151). Gaining familiarity with the underlying structure of literature, literary language, and embedded vocabulary, are significant benefits of reading aloud to children, (Casbergue, & Harris, 1996; Wolf, 2007). Children who already expect the stories, in books, to introduce characters, including heroes and villains, describe a conflict, and present a resolution, and who are accustomed to the unique way words in books are combined, in contrast to everyday language, have taken their first steps into the world of reading.

4.5. Vocabulary acquisition

As noted before, experience impacts vocabulary. There is a correlation between the amount and quality of talk a mother directs to her child and the size of the child's vocabulary.

Research shows that differences in processing speed in infancy predict vocabulary growth from 18 to 30 months, and that across a wide spectrum of socioeconomic conditions, babies whose mothers talk more with them, learn more vocabulary, (Fernald, & Marchman, 2012). This positive effect on vocabulary size, due to conversation, has also been observed among orphans if there is consistent one-to-one conversation with a concerned care-taker, (Biemiller, 2003). Furthermore, a child with a relatively large vocabulary will gain new vocabulary more easily than a child with a smaller vocabulary, (Wanzek, 2014). By the time children enter kindergarten there are large discrepancies in the sizes of children's vocabularies.

Slow processing speed in infancy, and the lack of a vocabulary rich environment in the home amount to cascading negative effects for some children. Limited vocabulary often coincides with low-comprehension. As children move into higher grades, content related vocabulary becomes more complex. The disadvantage widens as struggling readers in pull out programs receive support, which neglects vocabulary instruction. Jeane Wanzek, in a study focused on the nature of vocabulary instruction, found that students in supplemental programs, have less opportunity to gain vocabulary because the teachers in supplemental programs focus more on word recognition and building fluency. They consider teaching vocabulary to be the domain of the regular education teachers, a view, which was found to be held by the regular education teachers as well, (2014). Providing exposure to complex vocabulary, has been shown to impact the rate and development of vocabulary acquisition, (Indrisano, & Chall, 1995). In the previous discussion of environmental influences on literacy, reading to children and talking with children were both shown to influence vocabulary gains.

4.6. Aural and oral strategies, or strategies involving listening and speaking

Research shows there is a relationship between understanding spoken language, and understanding written language, (Aaron, et al., 2008). Generally, listening comprehension is more advanced than reading comprehension, until the high school grades. Most students better understand material when it is read to them than when they read it, (Indrisano, & Chall, 1995). Listening comprehension, as a predictor of reading comprehension, increases as readers become more proficient and texts become more complex, however, there are many variables, which have not been sufficiently tested and researchers are cautious to draw firm conclusions regarding the "nature of the relationship between different linguistic skills and different aspects of reading achievement," (Wise, et al., 2007, p. 1094). An example of a contrasting opinion, which cautions the use of listening comprehension as a measure of reading comprehension, is given by Carlisle and Felbinger, in which they state that "memory representations for ideas" in texts and strategies, differ for reading comprehension and listening comprehension, (1991, p. 353). It is important to note that they affirm a significant relationship between listening and reading, while cautioning reliance upon listening comprehension as a measure of reading comprehension.

Combining listening and reading strategies, may prove to be more helpful than comparing them, or measuring one with the other. Listening, as a tool to assist in reading comprehension, had a positive effect, in a study by Hawkins, et al., which used sentence-by-sentence, modeled reading, and repeated whole class reading, (2010). Two groups, using modeled and repeated reading of text, had a positive effect over the control group, which read passages silently. One of the two treatment groups added a review of target vocabulary, resulting in a greater positive

effect. A fluent model, as the Hawkins study provided, has a positive impact on developing fluency, and fluency is shown to positively impact comprehension, (Hudson, et al., 2005; Lewandowski, et al., 2006; Morra, & Tracey, 2006; Stevens, 2006; Vlachos, et al., 2013).

Dialog, one-on-one and within group contexts, happening between teacher and student and between fellow students, plays a central role in learning. Perhaps it is dialog that causes one-to-one tutoring, by a trained professional, to be considered the most beneficial means of intervention, (Slavin, et al., 2011). Dialog provides the learner an opportunity to personally construct meaning, or in other words, to propose and test meaningful ideas. Reading aloud to children is most beneficial to literacy when it is accompanied by discussions, which encourage reflection, (Beck, & McKeown, 2001). In a 2005 study, Linda K. Crowe found that dialog, including discussion about meaning, proved to impact reading comprehension more than a decoding based process administered without reflective discussion. Slavin, et al. observed that when tutoring was followed up with whole class activities, providing authentic application, gains were maintained, (2011).

Social interaction, an integral component in dialog, plays a powerful role in human learning. Usha Goswami, stated, “The social nature of human learning means that learning with others is usually more effective than learning alone, and that language and communication are central to this process,” (2008, p. 392). The social component is a factor in providing a scaffold for children to advance to higher levels of text difficulty, which they could not attain individually, (Roy-Charland, et al., 2007). This idea was first expressed in Lev Vygotsky’s zone of proximal development. Goswami, elaborates on the social nature of learning by referring to a 1995 study by Melzoff, in which 14-month-old babies are observed imitating actions by adults,

which were implied and not fully completed, but would not imitate completed actions of robots.

Cooperative groups and pairs provide students an opportunity to talk about processes, or meta-skills used when reading. Hilde Van Keer conducted a study of explicit reading strategy instruction, in which comparisons were made between three groups, one group received whole group instruction, the other two groups participated in same age and cross age peer tutoring, (2004). The results of this study indicated a benefit for the tutoring partner, or the older student in cross age pairs, even though the material used was below this student's reading level. Van Keer attributed this to the monitoring and regulating nature of tutoring. The lower level material gave the tutoring partner the opportunity to thoroughly engage in thinking about the process. Fuchs & Fuchs in a review of several related studies found peer tutoring to enhance students' reading outcomes, (2005). Structured cooperative groups, and reciprocal teaching have several benefits. Leading dialog in peer groups, seems to promote motivation for engagement, in addition to causing the student tutor to think deeply about the process of reading and interpreting text. (Spörer, et al., 2009). Students also benefit from the opportunity to hear input from multiple peers in small group settings.

4.7. Computer aided instruction

The use of computer-based, reading support devices in the classroom is supported by the research, (Esteves, & Whitten, 2011). Katia Ciampa, in a qualitative study of the benefits of e-books for 8 primary-grade students, demonstrated the value of computer-aided instruction, alongside traditional reading, (2012). Her study indicated a multi-media, computer based intervention increased student engagement and motivation. Observations indicated students were encouraged by immediate feedback and maintained focus on word-by word highlighting of text.

The benefits of highlighted text were also demonstrated in a study of ORT (Oxford Learning Tree) intervention, Clicker, a multimedia reading device, using highlighted text with an audible narration feature, (Karemaker, et al., 2010). This study resulted in significant gains for struggling readers in word recognition, word naming and phonological awareness. Interestingly, struggling readers in this study, were observed frequently accessing the ORT highlighted text features. Researchers observe, specially designed computer interventions benefit different literary skills. A study comparing computer based and adult led interventions, found that children in a "talking-book" group showed significantly better improvement in phonological awareness, whereas children in an adult led intervention utilized an interactional style with the adult tutors and made strategy adaptations, (Wood, et al., 2010). This was not seen in the computer-based groups. Saine, et al., (2010), suggested that some children need more drill and practice than they receive in traditional interventions, a possible reason why the "talking-book" intervention supported improvement in phonological awareness.

The key factor underlying gains seen in both tutor led and computer based interventions is the auditory pronunciation of a word coinciding with the sight of the word. These interventions re-enforce mapping between letters and sounds. Multi-media learning experiences, which simultaneously access more than one modality, and in particular visual and auditory, have been shown to support reading skills.

Perhaps the most powerful quality of computer-aided instruction is its influence on student access to, and enjoyment of, reading. Kelli Esteves, and Elizabeth Whitten, in a study investigating the usefulness of assisted reading technology, indicated teachers should balance skills focused instruction, by making use of digital tools to support students' exposure to

authentic literature, (2011).

5. Conclusion

In regard to my first question, "What does research show regarding how, learning to read, takes place in the brain?": There was a large amount of information, and the scope of educational neuroscience continues to grow. Much of the scholarly work was frequently above my understanding. It is fortunate that some of the outstanding researchers are using more easily accessed methods of reporting their findings, through books and documentaries. I have drawn hope from the findings, which point to the importance, of experience in learning. I was impacted, to realize, the responsiveness of the brain. It is exciting to think that a baby's brain is taking note, of spoken sounds it is exposed to, in infancy, selecting useful sounds from those which are not needed, and that a young toddler's brain responds to a flood of new vocabulary, by building a specialized language center. It is important to note the roll, of home environments; the importance of rich communication and access to literature, situated in strong, caring relationships. As teachers, it is important to utilize the power of social learning, and meaningful relationships with students. Utilizing strategies of authentic conversations with students, engaging with them in topics they are experts in, and prompting them with questions, which require thought and consideration, are never incidental or inconsequential strategies.

In regard to my second question, "What does research show regarding the impact of listening on literacy?: I had anticipated, much of the research would indicate, listening has a significant impact on reading and literacy. Many of the studies demonstrated correlations between listening and reading comprehension. Many participants were shown to benefit from

aural strategies, including those, which incorporate computers. However, much of what is written on this subject describes correlations, rather than explanations. The literature, which shed the most light on the importance of listening, was the brain research regarding processing speed. At an early pre-reading stage, when a reading code is being built, it is very important for a child to be able to hear and distinguish the unique features of phonemes in "real time", or as quickly as normal speech occurs, in order to build a lexicon of sight words, and turn attention to meaning and reflective discussion.

Opinions regarding the impact of computer-aided instruction differ. Studies that find specific uses, for which computers are well suited, and avoid a "winner takes all" sort of mind set, are most helpful. Some of the literature seemed to miss discussion of the benefits listening contributes to reading, and instead compared and contrasted reading comprehension and listening comprehension. Having disagreed at times, with some of the perspectives I encountered in the articles, summarized here; *listening strategies are not as helpful as visual text strategies,* or *computer aided instruction is distracting and ineffective,* the Wise, et al. quote, rang true for me. The full quote stated, "Without contrasting measures of oral language skills, it is not possible to draw firm conclusions concerning the nature of the relationship between different linguistic skills and different aspects of reading achievement." (2007, p. 1094). There are many questions left to answer regarding how and why listening impacts literacy, and why some readers find they must hold on to listening, to fully comprehend texts.

There were three important findings that I would like to repeat, for consideration. First that an auditory cue presented with the visual text was a key factor in observed gains for some children. This sight/sound combination is key for building letter sound connections and

supporting comprehension. A second important finding, was that rapid auditory processing is highly correlated with literacy development and considered by some to be a "cause rather than a mere correlate of literacy development," (Steinbrink, et al., 2014, p. 1724). Finally, that at a very young age, conversation can impact a child's processing abilities.

In regard to my third question, "What implications do these findings hold for educators?": It is important to believe that our students are capable of complex and detailed thought; that their brains are, and will be, working on solutions, at their own speeds; and that words are bridges which they need to access concepts. Words are a big deal! As a special education teacher I must not forego my part in providing vocabulary. Building and using vocabulary in meaningful, reflective conversations will have a positive effect on reading.

Finally, the uniqueness of each student was made evident, in the wide variety of successful methods, reported in these articles. Rushton, & Larkin, (2001) elaborate on children's many unique facets by eloquently stating, "Each child's uniqueness is expressed in a number of ways: personality, temperament, learning style, maturation, speed of mastering a skill, level of enjoyment of a particular subject, attention, and memory," (p. 29). It is important to utilize a variety of methods to reach the wide variety of instructional needs represented in our students. This meta-synthesis highlighted a few instructional tools, which can support beginning readers. Music is a powerful tool in developing phonemic awareness. It is worthwhile to identify and learn about successful methods, which incorporate music. Incorporating computer-aided instruction provides access to the benefits of multimedia resources. There are no methods, which will meet the needs of all students, but many students will benefit from the inclusion of strategies, which reinforce aural skills

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