Characteristics of Second Language Reading Processing

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ABSTRACT: Several studies mostly focus on a specific area of research, the current paper's aim is to bring together the various research in a single volume, indicating their particularities as well as demonstrate their inter-relations. Phonological, lexical and syntactic processing Second Language Processing (SLP) are discussed as SLP is a cognitive form of acquisition, and is debated o be bottom-up processes, up-down processes, or a combination of both resulting in integrated interactive processes. SLP faces more complicated issues and involves more factors in comparison with L1 processing as L2 reading comprehension observes the effect of higher-order processes and chances of crosslinguistic transfer in relation to the reader's L2 linguistic knowledge, L2 proficiency levels, or other language-general reading processes. Furthermore, the major reading process models are mentioned in categories of word identification, syntactic parsing and discourse processing, as well as text and reader related variables are reviewed. Finally, some of the main pedagogical associations with teaching reading comprehension are examined.

KEYWORDS: Second Language Processing, Reading Processes, Cognitive Processes, Reading Comprehension, Psycholinguistics, Cognitive Linguistics.

I. INTRODUCTION

The study of Second languages processing (SLP) attempts to provide clarification on the cognitive actions that are fundamental in the processing of the second language (Jiang, 2018). Adoption of a different language other than the native language is common, a practice evident in the number of people who can use a language other than their native language. According to a survey by the European Commission published in February 2006, 56% of the 450 million people in the European Union "are able to hold a conversation in a language other than their mother tongue" (2006, p. 8). In the USA, the number of people who speak a language other than English in their homes has always been on the rise. This has increased significantly over the past four decades, from 23.1 million in 1980 to 61.7 million in 2013. A majority of these people often speak their native language at home and use English to communicate outside their home (Camarota & Zeigler, 2015). However, these numbers do not include English native speakers in the USA who are able to speak another language such as Spanish, French, Japanese, and Chinese. Additionally, there is even a bigger number of ESL speakers in other parts of the world. Heng Hartse and Jiang (2015) state that, the reported estimate of English language learners in China approximates to 400 million learners.

II. CHARACTERIZING SLP RESEARCH

Jiang (2018) identifies three main areas in the field of SLP research: (1) phonological processing addresses speech perception and production primarily at the segmental levels; (2) lexical processing which examines word recognition and lexicosemantic representation and development, and (3) sentence processing that studies syntactic structure building and the representation and processing of morphosyntactic and lexicosemantic knowledge in understanding sentences. Each of the three areas of Second Language Processing investigates different aspects of language that may be distinctive to that area. For example, the impact of age on perception and production accuracy in regard to processing degraded input (e.g., Mayo, Florentine, & Buus, 1997; Meador, Flege & MacKay, 2000), is a topic unique to phonological processing. For example, the impact of degraded input on processing is among the topics which are unique to phonological processing research, while the issue of decomposition, is mainly examined in lexical processing, and the importance of syntactic and semantic information in language processing is primarily a feature of sentence processing. Despite the distinctiveness of the three subfields of language processing, they share many features as they all focus on the same general phenomenon of language, looking at the same population, sharing the general methodological approach of comparing first (L1) and second language (L2) speakers to understand the differences and similarities in processing, as they share the same experimental approach and often draw from the same repertoire of experimental techniques and paradigms, dealing with very comparable research questions. Hence, Jiang highlights four key shared characteristics that help define the relationship between Second Language Processing and other fields, e.g., psycholinguistics.

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A. A Cognitive Acquisition

The main aim of SLP researches is to know the mental processes involved in Second Language use, even though its use can be viewed from several different points of view. The study of foreign accent, for example, is explored to pinpoint the acoustic features as depicted in the mental representations of phonological categories and the representational deviation, the "cognitive underpinnings," that promoted to accented speech (Jiang, 2018, p. 3). Looking more closely to reading, in studying lexical processing, SLP researchers attempt to understand how lexical knowledge is represented and accessed in L2 word recognition and what factors that may potentially affect lexical representation and access. Early L2 processing studies, according to Richards and Kennedy (1977) came from general language processing issues in developmental psycholinguistics and the study of interlanguage and error analysis (Corder, 1973; Selinker, 1972), later on, studies focused on exploring elements of lexical processing (Chen & Leung, 1989), sentence processing within the competition model (Gass, Harrington, Kilborn, & Cooreman, 1987; MacWhinney, 1987).

B. A Broader Scope Than L1 Psycholinguistics

More recent studies started expanding their scope in pursuit of a much clearer picture. Some researchers focused on other features such as the effect of text and discourse types on L2 comprehension (Wolff, 1989), while others attempt to establish a broader picture of language processing (Schwartz, 1986; Proulx, 1985; Dechert, 1989; Sajavaara, 1984). However, in L2 processing research, many reside to psycholinguistics for conceptual frameworks, empirical findings, and research methods, and a large sum of the body of literature build on that of L1 psycholinguistic research and examines L1 influence on L2 acquisition and production (Koda, 2000; Dowens & Carreiras, 2006; Holtgraves, 2007; Roberts, Gullberg & Indefrey, 2008; Van Hell & Tokowicz, 2010).

C. From Processing Data to Representation and Acquisition Issues

SLP research regards representation, acquisition, and processing to be closely related. Winn, (2013) states that the term 'mental representation' refers to how information is stored in memory, represent it in the mind's eye, or manipulate it through the processes of reasoning. Research presumed that this is achieved as a "direct mapping" of what one perceives, visually or audially (Cassidy & Knowlton, 1983). Thus, Jiang (2018) states that the mental representation of the linguistic knowledge determines the linguistic behavior, and consequently, changes may include formation of new categories and items in phonological, lexical and/or syntactic knowledge. Hence, research attempting to identify universal processing principles is found to directly link to those of L2 acquisition (Cuetos & Mitchell, 1998; Dussias, 2003). Thus, SLP studies L2 processing in order to understand acquisition as well.

III. SECOND LANGUAGE READING

Nunan (1999) describes reading as a means of obtaining information and making sense of the text. Research on L1 and L2 reading aptitudes have examined reading via the component-skills approach (Carr & Levy, 1990; Grabe, 2009; Koda, 2005, 2007; Stanovich, 2000), observing reading to include multiple cognitive processes (e.g., orthographic decoding, lexical knowledge, syntactic processing) and contains separate dimensions of reading subskills, which enable researchers to observe how different processes interact with one another (Gough, 1972; Stanovich, 1980; Goodman, 1976) interactive-compensatory model of reading) and their effects on reading comprehension. To formulate a clearer account on reading, one must examine models of reading processes, reading comprehension, models of reading comprehension, reading strategies, and the Role of Reader Characteristics.

IV. MODELS OF READING PROCESSES

Researchers have aimed to establish an identifying of the processes that trigger the understanding of a printed text and concluded with three models: bottom-up, top-down and interactive models (Gough, 1972; Goodman, 1976; Stanovich, 1980; Samuels and Kamil, 1984).

A. Bottom-Up Processing

In the bottom-up processing model, known as Gough's (1972) Model, perception is considered to be data-driven as perception starts at the stimulus triggered through sensory input. This model consists of lower level reading processes since learners start with the fundamental basis of orthography and sound recognition, followed by morpheme recognition, then word recognition, leading to the identification of grammatical structures, sentences and longer texts and finally meaning to achieve comprehension (figure 1)

B. Top-Down Processing

In contrast to bottom-up processing, top-down processing model believes that the development of pattern recognition is achieved via the use of contextual information, thus, is considered to be knowledge-driven. These models begin with the idea that comprehension resides in the reader. The reader uses background knowledge, makes predictions, and searches the text to confirm or reject the predictions that are made. A passage can then be understood even if all of the individual words are not understood. Within a top-down approach to reading what the teacher should focus on is meaning generating activities rather than the mastery of word recognition (Field, 1999).

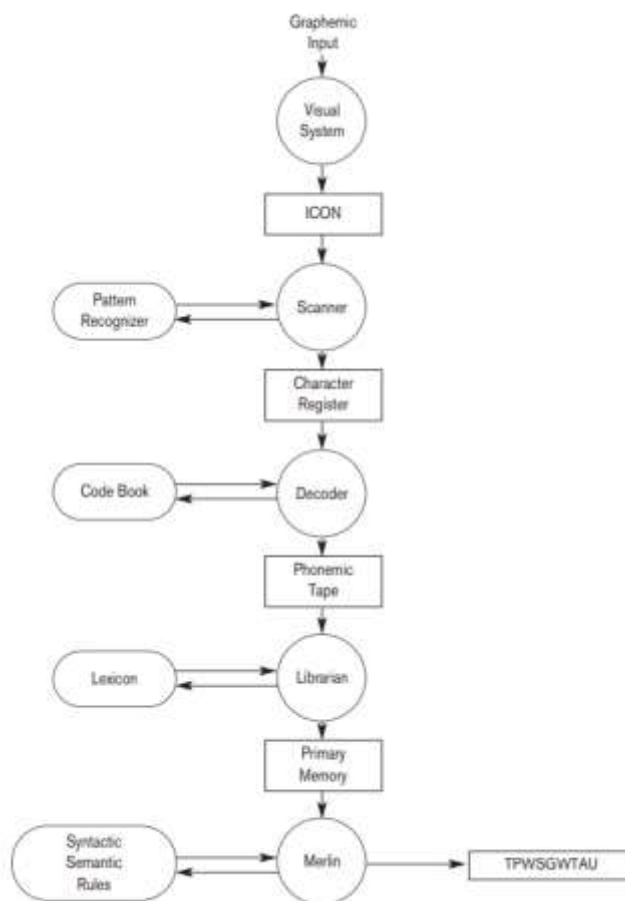**Characteristics of Second Language Reading Processing**

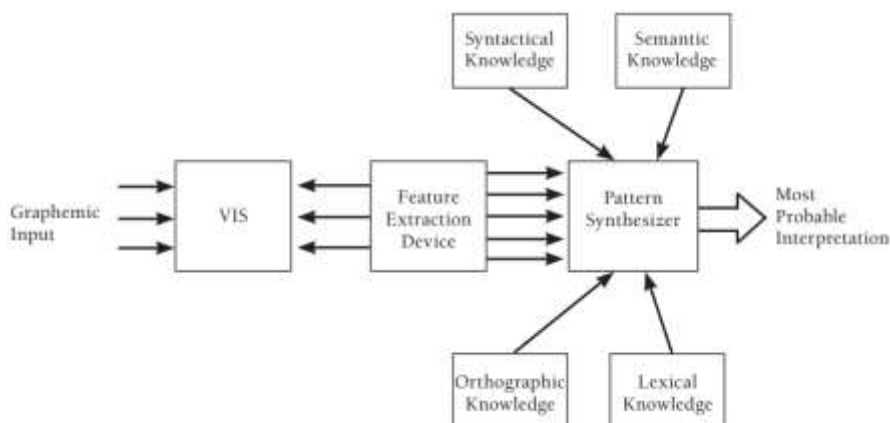**Fig. 1. Gough's (1972) Reading Model (Rumelhart, 1994)**

Fig. 2. Rumelhart's (1994) Interactive Reading Model

C. Interactive Processing

Goodman (1976) asserts that L2 should be approached as a whole, not to be dichotomized. Thus, an interactive approach to reading (figure 2), which combines bottom-up and top-down, must be considered to include aspects of both intensive and extensive reading (Stanovich, 1980; Rumelhart, 1994).

V. READING COMPREHENSION

The study of reading comprehension has examined the effect of higher order processes (e.g., reading strategies, inferencing) and specific metalinguistic skills (Cummins,1981). The likelihood for crosslinguistic transfer has been investigated to shed light on some difficulties of reading in L2 in relation to the reader's linguistic knowledge of L2 (e.g., vocabulary, grammar) or other, language-general reading processes (Alderson, 1984; Bernhardt & Kamil, 1995; Bribois, 1995; Hacquebord, 1989; Wagner, Spratt & Ezzaki, 1989; Wurr, 2003). In addition, researchers have inspected the level of L2 proficiency by which transfer is essential to happen, which was presented under the Language Threshold Hypothesis (Cummins, 2000).

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Reading comprehension, according to Jeon and Yamashita (2014) is dependent upon both lower-level and higher-level processing synchronously. The former is viewed to help the reader to understand the presented information while in the latter, the reader uses previously established knowledge, combined with the ability to formulate interpretations concerning word meaning. The major difference between interpreting information in L1 and L2 largely depends on the rate of language interpretation, which, according to Jeon and Yamashita's (2014) meta-analysis, showed a highly correlated association between decoding, lexical and syntactic information fed into lower-level processing and second language reading comprehension. Thus, a simultaneous reliance on multiple cognitive and linguistic skills exists that contributes to effective comprehension.

VI. READING STRATEGIES

On the one hand, most language research in reading has mainly focused on the strategies used by good readers such as, skimming, scanning, guessing and predicting. On the other hand, Munby (1978) claims it all strategies used by good readers, e.g. skimming, scanning, guessing and predicting, relates to intensive and extensive reading. In the former, learners need to understand semantic aspects and pay close attention to the text, while in the latter, the main goals are the speed of reading and the overall gist. Grellet (1981) favors focusing on specific skills to be developed while reading, such as skimming, speed reading for gist, and scanning, swift searching of one piece of information.

VII. SCHEMA THEORY

The concept of schema is employed in literature to inspect the interaction of key factors affecting the comprehension process as the "schema theory states that all knowledge is organized into units based on how we categorize information due to existing interpretations of reality and the relationships between different aspects" (Anderson and Pichert, 1978). Information, then, is stored within these schemata, which represent knowledge about concepts or objects and the relationships they have with other ones. As all individuals develop schemata about everything they experience, which affects the way information is interpreted, which in turn affects comprehension. Thus, how a reader uses schemata reflects the importance of schema theory to reading comprehension, as discussed in the top-down, and the interactive processing models.

In his discussion, Silberstein (1994) introduced two kinds of schemata; formal and content schemata. Formal schemata include knowledge of rhetorical structures and conventions, and content schemata concerns knowledge of the world beyond the presented texts.

Snow (2002) presented a conceptual framework that identified three broad areas that impact reading processing and comprehension in relation to the socio-cultural context (figure 3). This model recognizes that comprehension of text is the product of a complex combination of four main interactive factors, each of which needs to be considered when designing reading tasks.

Fig. 3. Snow's (2002) socio-cultural context of interactive variables affecting reading performance.

VIII. READING PROCESS MODELS

Models of reading, according to Norris (2013) are perpetually computational models. A number of models were presented to establish the most important concepts contributing to word recognition, syntactic parsing, communication expression and how certain SLP aspects act in combination with others (McClelland & Rumelhart, 1981; Grainger & Jacobs, 1996; Whitney & Cornelissen, 2008; Diependaele, Ziegler & Grainger, 2010; Norris and Kinoshita, 2012; Reichle, Pollatsek & Rayner, 2012).

A. Models of Word Identification

Several models of word identification have been postulated in literature like the Interactive-Activation (McClelland & Rumelhart, 1981), Activation-Verification (Paap, Newsome, McDonald & Schvaneveldt, 1982), Multiple-Levels (Norris, 1994), Multiple Read-Out (Grainger & Jacobs, 1996), Multiple-Trace Memory (Ans, Carbonnel, & Valdois, 1998), Connectionist Dual-Process (Zorzi, Houghton & Butterworth, 1998), and Bayesian Reader (Norris, 2006) models. The Interactive-Activation model of language processing adopts a view that all levels of representation freely influence each other, which contrasts with modular

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accounts that suggest a tandem sequence (Field, 2004).The Parallel Distributed Processing (PDP) models (Seidenberg and McClelland, 1989), also known as the Triangle models and the single-route models, explain that the pronunciation of words is produced through activations from units processed that represent orthographic input in connection with other units that represent phonological output (figure 4). Paap, et, al. (1982) state that the Activation-Verification model addresses the effects of prior and concurrent context on word and letter recognition in a variety of experimental paradigms (figure 5). In contrast, the Dual Route (DRC) model, enables a one to identify words within single set of connections (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). In a dual route model of reading, a lexical route permits the reader to match known words on a 'whole word' basis; but a second (sub-lexical) route is also available which draws upon the reader's knowledge of GPC rules. The two routes appear to operate in parallel and the ability to apply GPC rules rapidly has been shown to be a characteristic of a skilled reader (figure 6).
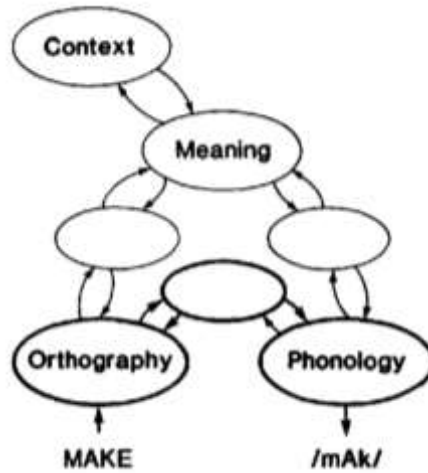

Fig. 4. Seidenberg and McClelland's (1989) PDP framework for lexical processing.
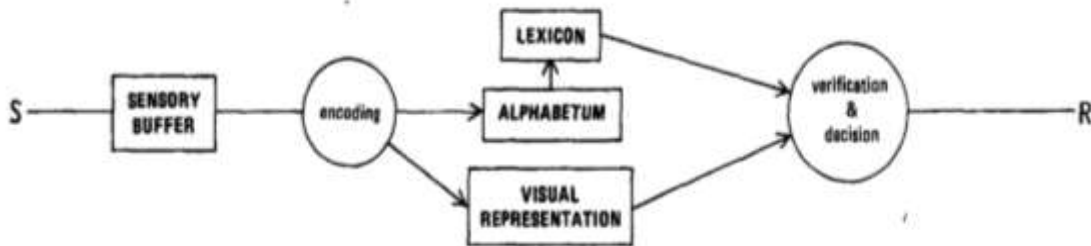

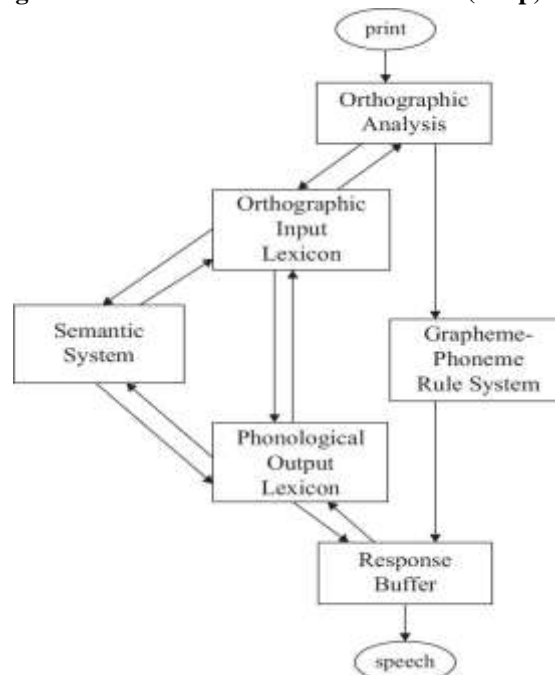**Fig. 5. The Activation-Verification model (Paap, et al., 1982).**

Fig. 6. Coltheart et al.'s (2001) DRC model of visual word recognition.

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B. Models of Syntactic Parsing

There are several ways of presenting information in a sentence which is useful in comprehension. Therefore, Jiang (2018) states that the experimental approach is adopted on the assumption that the basic mental processes involved in language use are the same regardless of the circumstances of language use. Visual word recognition (Neely, 2012; Rastle, 2015) involves the analysis of physical features of visual input, the recognition of letters, and the activation of a mental representation, regardless of whether the word appears in isolation or in a context, regardless of whether the word appears on a book page, on a computer monitor, or on a cell phone screen, and regardless of the socioeconomic background of the reader. Building a syntactical structure is a basic and essential part of sentence comprehension regardless of the listener–speaker relationship (Gernsbacher, 2013). More recent research suggests that learning an additional language can also affect the representation and processing of a learner's L1 (Yamashita, 2004). Thus, language interaction is exhibited to be bidirectional in nature (Park, Kim, & Kim, 2000). The influence of an individual's L1 on L2 learning and use, or simply L1 effects, is probably the most prevalent finding in L2 processing research.

Similar to the word-identification models, many models exist targeting sentence-level processing to explain how the syntactic structures and constraints direct the construction of the mental representations essential to understanding. Hence, it is noted that models of syntactic parsing follow a bottom-up input. These models may be synthesized into three broad categories; (1) garden-path models (Ferreira & Clifton, 1986; Frazier & Clifton, 1996; Frazier & Fodor, 1978; Frazier & Rayner, 1982; Rayner, Carlson, & Frazier, 1983), (2) constraint-based models (Jurafsky, 1996; MacDonald, Pearlmutter, & Seidenberg, 1994; McRae, Spivey-Knowlton, & Tanenhaus, 1998; Spivey & Tanenhaus, 1998; Tanenhaus & Trueswell, 1995), and (3) models implemented using connectionist frameworks (Elman, 1991; McClelland, St. John, & Taraban, 1989; Tabor, Juliano, & Tanenhaus, 1997). However, Rayner and Reichle (2010) claim that all sentence-processing models suffer from the same limitations as they generate predictions about reading times by converting some arbitrary measure of processing difficulty for arbitrary regions of text. Thus, they fail to make direct predictions about the time required to process meaningful units in real units of time.

C. Models of Discourse Processing

These models are perceived to be more difficult to categorize into defining groups (Rayner and Reichle, 2010) as they tend to identify aspects of the processes and representations required to connect the meanings of individual sentences into more global representations that support text comprehension. This results in the production of different models, each describing some aspect of discourse processing, while none is comprehensive, e.g. Construction-Integration (Kintsch & Van Dijk, 1978), Situation-Space (Golden & Rumelhart, 1993), Landscape (Van den Broek, Risden, Fletcher and Thurlow, 1996), Resonance (Myers & O'Brien, 1998), and Distributed Situation Space (Frank, Koppen, Noordman, & Vonk, 2003) models.

IX. OTHER VARIABLES AFFECTING READING PROCESSING AND COMPREHENSION
A. Text Variables

Research found two main factors, related to text variables, that may affect comprehension; (1) what readers bring to the reading task (top-down focus) in terms of their reading skill, language, cognitive processes, background knowledge, interests, goals, and understanding of the requirements of a reading task (Horiba, Van Den Broek, & Fletcher, 1993). (2) how textual features contribute to determining the comprehensible level of difficulty (bottom-up focus) such as content, style, linguistic, and cognitive features (Fry 2002). The difficulty that a reader experiences while negotiating a particular text will be determined by the interplay of these elements. In addition, text organizational features, such as italics, underlining, and subheadings along with illustrations, figures, graphs, and maps were found affecting L2 reading processing of the text content into working memory more efficiently (Baddeley & Hitch 1993). Additionally, other text features such as headings and subheadings, can help readers to cognitively organize information (Armbruster and Anderson, 1985). Moreover, various types of text genres may affect processing and comprehension as they obtain predictable text structures, and readers need to be acquainted with them (Whaley, 1981). Moreover, text readability is another factor that is one of the most important text properties affecting text comprehension. Gavora (2012) defines it as the ease in which a text can be read and understood.

B. Reader Variables

In studying reading processing, one must study the readers as well as the texts. Robinson and Gilabert, (2007) claim that learning difficulties are often the result of a complex interaction between underlying reader factors as well as the environmental. Frith (1995) identified three factors that related to reader difficulties: Biological, Cognitive and Behavioral.

1) Biological

Bender (2008) proposes a possible genetic root cause for many reading problems of some children. Wood and Grigorenko (2001), for instance, reported that when reading problems exist in one identical twin, they are more likely to exist in both identical twins, while that is not to be expected in fraternal twins. Another example proposed by Woolley (2011) discusses the effects of mothers' consumption of alcohol or smoking on unborn infant in fetal alcohol syndrome studies performed on children who characteristically show moderate to severe cognitive disabilities as the effects may be long-lasting on children's reading

performance at school, as well as case of premature birth. Robinson (2002) suggests that neurological and biochemical abnormalities will be influenced by other environmental factors, such as diet, food and environmental toxins, and bacterial or viral infections, which, in turn, may lead to reading difficulties.

2) Cognitive

At the cognitive level, many students identified as having reading difficulties often to be associated cognitive difficulties (Gersten & Baker, 2000; de Lemos 2005). Kamhi and Catts (2002) state that children who have difficulties in one or more of syntactic, morphemic, semantic, and whole text structural knowledge functions will have considerable difficulty learning to read. Another reported finding is that skilled readers outperformed less skilled readers on measures related to working memory, processing speed, and updating information (Hulme, Hatcher, Nation, Brown, Adams & Stuart, 2002; Swanson and Jerman 2007). In addition, problems in higher order comprehension skills, such as prediction and summarizing, using background knowledge, and forming mental imagery are viewed to rely on information organization and storage of in memory (Cain and Oakhill, 2007).

3) Behavioral

Text difficulty for an individual may be influenced by other factors within the reader such as: the reading skill level, age (Collins & Matthey, 2001; Chapman & Tunmer, 1997), gender, interests (Hareli and Weiner, 2002), background knowledge (Brown and Cambourne, 1987), socio-cultural variables (Freebody and Frieberg, 2001), by the purpose behind text selection (Burg, 1977), by how well the text itself is written and organized (Keene 2002), and by the reader's engagement and attitude towards the activity, reading self-concept, and reading motivation (Bong & Skaalvik, 2003; Chapman & Tunmer, 1997).

X. PEDAGOGICAL IMPLICATIONS

One of the most dominant issues in SLP research is learners' ability to achieve second language command (Jiang, 2018). Han and D'Angelo (2009) proposed a dual approach to teaching second language reading that emphasizes reading for comprehension along with reading for acquisition, to help learners develop both semantic and syntactic processing skills. Furthermore, they reviewed three strategies; (1) textual input enhancement (Smith, 1993), (2) processing instruction (VanPatten & Cadierno, 1993; VanPatten & Sanz, 1995), and (3) narrow reading (Krashen, 2004). The first refers to typographically enhancing target linguistic constructions (e.g., underlining, capitalization, italicizing) to make them more salient and more noticeable to learners, as noticing is considered a critical condition for L2 learning (Schmidt, 1990, 1995). The second strategy discussed focuses on altering learners' natural, L1-primed input processing strategies to promote better intake as learners are (a) provided with explicit information about the target form, (b) informed of the input-processing strategies that might negatively affect processing of the target structure, and (c) engaged in structured input activities that promotes understanding and processing target forms during comprehension (VanPatten & Oikkenon, 1996). The third strategy refers to reading in one subject matter or texts by the same writer, following Krashen's Input Hypothesis (1985), that claim exposure to large amounts of meaningful text leads to incidental language acquisition (Gass & Selinker, 2008).

CONCLUSIONS

In discussing Second Language Processing, three main areas are prominent; phonological, lexical and syntactic processing, which focus on different aspects of language whether distinctive to them or shared amongst them. SLP has been reviewed in literature to be cognitive, having a broader scope than psycholinguistics and is directly connected to L2 acquisition.

Research on reading processes discussed them to be a bottom-up processes, up-down processes, or integrated interactive processes through which processes are performed in parallel to achieve comprehension. Upon extending language processing research from L1 to L2 speakers, SLP faces more complicated issues and involves more factors. The study of L2 reading comprehension examines the effect of higher order processes and chances of crosslinguistic transfer to reveal some of its difficulties in relation to the reader's linguistic knowledge of L2 (e.g., vocabulary, grammar) or other language-general reading processes, as well as the effect L2 proficiency levels. Thus, major reading process models are presented in relation to word identification, syntactic parsing and discourse processing. In addition, variables that are text and reader related are briefly discussed. Then, the main pedagogical implications in relation to teaching reading comprehension are examined.

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