Reassessing second language reading comprehension: Insights from the psycholinguistics notion of sentence processing

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Abstract

Theories and practices in second language reading pedagogy often overlook the sentence processing description from the psycholinguistics perspective. Second language reading comprehension is easily associated with vocabulary learning or discourse strategy. Yet, such activities can lead to an unnatural way of reading such as translating vocabularies or pointing out information as required. Meanwhile the authentic way of reading should encourage a natural stream of ideas to be interpreted from sentence to sentence. As suggested by the sentence processing notion from the psycholinguistics point of view, syntax appears to be the key to effective and authentic reading as opposed to the general belief of semantic or discourse information being the primary concern. This article argues that understanding the architecture of sentence processing, with syntactic parsing at the core of the underlying mechanism, can offer insights into the second language reading pedagogy. The concepts of syntactic parsing, reanalysis, and sentence processing models are described to give the idea of how sentence processing works. Additionally, a critical review on the differences between L1 and L2 sentence processing is presented considering the recent debate on individual differences as significant indicators of nativelike L2 sentence processing. Lastly, implications for the L2 reading pedagogy and potential implementation in instructional setting are discussed.

Keywords: L2 sentence processing; syntactic parsing; second language reading pedagogy

INTRODUCTION

Reading may concern a varied length of writing, be it a word, a phrase, a paragraph, or a whole text. Reading comprehension, however, makes a special case for the reading of a sentence. A single detached word such as 'who' may be read, but no communicated ideas would come out of it. Yet, capitalize the first letter and put a punctuation mark following the word as in "Who?", then the reader might interpret that it is a complete message communicating an inquiry about a person or people. Even without any explicit context provided, the reader would automatically picture several possibilities of interpretations

in which such sentence may take place. When a writing system of a language introduce markers, which signify that a piece of writing begins and ends at a certain point, i.e. that an idea is complete, only then a comprehension process will proceed.

Other than representing a complete idea, a sentence also contains a working syntactic rule. It is syntax after all that constructs a meaning from a word or chain of words in a sentence. Without rules, these words would only be some scattered lexemes. Similarly, two sentences cannot have a single meaningful syntactic construction as syntactic rules cannot exist outside of a sentence. Within a discourse of multiple sentences, syntax resides within each sentence, giving meaning to the overarching interpretations of the discourse. Sentence is thus the beginning of a meaningful comprehension and lays the foundation for discourse comprehension.

Nevertheless, second language reading pedagogy often rely heavily on vocabulary and discourse learning (Jiang, 2012; Laufer & Ravenhorst-Kalovski, 2010; Zhang, 2012). A reading task would be accompanied by a list of vocabularies and followed by a comprehension questions concerning the whole text. It is as if reading activity is a process of translating individual vocabulary or pointing out specific information as required. Activities such as skimming and scanning for information or identifying the purpose or main idea of a text may be adequate for collecting information when someone asks for it. However, it makes a habit of repeated reading where readers would constantly need the text by their side so that they can keep coming back to it to search for information. In other words, it does not encourage an actual or authentic reading activity in which readers would comprehend the text in its natural flow of ideas from sentence to sentence in its actual continuity.

Sentence level comprehension in second language pedagogy is generally categorized as beginner level reading, which in practice often turns into vocabulary learning. Meanwhile intermediate learners are already presented with combinations of sentences in a discourse level reading comprehension. There appears to be a discrepancy in which sentence comprehension is being overlooked, whereas psycholinguistics studies suggest that there is more than just vocabulary interpretation in the comprehension of a sentence. It is therefore only plausible that reassessing second language reading comprehension begins with the comprehension of sentences, a notion that is systematically defined in the field of psycholinguistics as *sentence processing*.

The split-second processing of a sentence is actually a complex process involving various aspects of linguistic information in a systematic computational model. The complexity of sentence processing is made more intricate when it concerns the sentence processing of a second language as more variables are introduced. These variables come from the fact that L2 sentence processing deals with the readers who are native to a different language, the L1. Cross-linguistic difference in sentence processing is a long-debated issue in itself where two different languages are found to have different processing strategies beyond the universal grammar (Bornkessel-Schlesewsky et al., 2011; Cuetos, Mitchell, & Corley, 1996; Hemforth et al., 2015). When readers of an L1 read an L2 sentence, it is only natural to question which processing strategy used by these readers, whether it is the same processing strategy that they use with their L1, or alternatively, the one

associated with the L2. Attempts to answer this question led to more questions than a single plausible answer. Researchers have since then explored such topics as syntactic processing, proficiency, and working memory, among others, as possible variables which may explain the underlying mechanism for L2 sentence processing. While research on these topics is still largely developing, latest findings have shown a promising direction with insightful implications for the second language reading comprehension.

This article acknowledges that reading strategies such as vocabulary analysis, ideas identification, skimming, and scanning are important for second language reading comprehension. However, it argues that an understanding of the underlying mechanism behind L2 sentence processing precedes the implementation of learning and teaching of the strategies. Reading strategies can be learned or taught in the way that they are not restrictive towards achieving authentic reading by taking into consideration the theories of L2 sentence processing. To achieve its goal, this article first elaborates the importance of syntax in sentence processing and the nature of reanalysis. It will, then, compare the difference of L1 and L2 sentence processing, discussing the seminal proposal of shallow structure hypothesis and the challenges to the hypothesis by the quantitative attributes of proficiency and working memory. Alternatives in the way that reading activity is viewed with the intention leading to potential pedagogic implications will follow. Organized in such a way, this article would offer some insights which could help L2 learners to read texts in its natural stream by understanding the variables which influence the effectiveness of comprehending L2 sentences.

The significance of syntax in sentence processing

The first step to reassessing L2 reading comprehension is to understand the architecture of sentence processing, or how exactly an interpretation process is mapped out as it unfolds within the readers' mind. Researchers have pursued a working computational model to explain the architecture of sentence processing from how a sentence is inputted, how the information is processed, to how an interpretation is achieved. Only by understanding the way sentence processing works in detail, one can take advantage of the nature of sentence processing for pedagogical purposes or diagnose a problem when one manifests. The gateway to understanding this architecture appears to lie substantially on the role of syntax in sentence processing.

As pointed out earlier, syntax exists within a sentence. Syntactic rules could not apply to any lexemes outside a sentence nor could it govern two separate sentences under a single syntactic entity. Sentence is the smallest and the largest unit of language in which syntactic rules make sense and are able to give meaning to the semantic properties of the words within the sentence. This fact alone is reasonable to foresee the significance of syntax in sentence processing.

The first major misconception in L2 reading comprehension pedagogy seems to be the emphasis on semantic information in sentences, as shown by the great deal of literature focusing on vocabulary learning in L2 reading. Contrary to this popular belief, studies in psycholinguistics place importance on syntax in the sentence processing architecture. Chomsky makes a case for

this point with his well-known sentence construction, "*Colourless green ideas sleep furiously*" (Chomsky, 2002, p. 15) which is a semantically meaningless, but syntactically sound construction. With this example, he argues that native English speakers would easily recognize the syntactic rules and attempt to make sense of the otherwise nonsensical semantic relation, as opposed to "*Furiously sleep ideas green colourless*" which simply defies the syntactic convention. Further, in a study comparing the sentence processing of children and adults, Clahsen and Felser (2006a) found that non-syntactic information such as lexical-semantic information makes little use in children's sentence processing, who managed to process sentences mostly using the syntactic information alone. They observe that while syntactic information has been prominent since the early development of literacy, other information does not make a major contribution to sentence processing until later. The exceptionally quick manner of sentence processing appears to favor syntax as the sine qua non of information processing, providing an initial structured segmentation of sentence, before further linguistic information is processed.

Fundamentally, one of the main questions in sentence processing research has been whether sentence processing begins with syntactic parsing in modular or interactive manner. This has been the core question of sentence processing studies for decades which apparently has yet to yield a conclusive answer. Researchers are divided into those who believe that syntactic parsing is a modular process without any interplay between syntax and other linguistic information in the initial stage of processing, and those who claim that syntax is processed in conjunction with other linguistic information since the beginning of the processing. The former account eventually invented the *syntax-first model* (Frazier, 2013; Frazier & Clifton, 1997; Friederici, 2011), while the latter developed the *interactive* or *constraint-based model* (McRae & Matsuki, 2013). It is of interest that the latest cutting-edge research in the neurocognitive field of study seems to support the modularity of initial syntactic parsing with their ERP and fMRI evidence (Bornkessel-Schlesewsky et al., 2011; Fedorenko, Duncan, & Kanwisher, 2012; Friederici, 2011, 2017). Nevertheless, both accounts agree that syntax is essential and processed early in the course of sentence processing. Only when the syntactic information is parsed, other linguistic information such as semantic, pragmatic, prosodic, and contextual information would administer to a meaningful interpretation.

It is also worthy of notice that there are a few exceptions where other linguistic information may dominate initial syntactic parsing, as in the case of L2 sentence processing (Clahsen & Felser, 2006a, 2006b), and individual differences in proficiency and working memory (Cunnings, 2017; Hopp, 2014; Nakano, Saron, & Swaab, 2010; Reichle, Tremblay, & Coughlin, 2016). These exceptions will be discussed later in their own dedicated section since they might hold some key insights for the L2 sentence comprehension. Regardless, they do not undermine the importance of syntax in sentence processing. On the contrary, they emphasize its significance as they represent the consequences of weak syntactic parsing under certain circumstances. In the end, syntax is substantial in the descriptions of sentence processing, and the discussions that follow will be inaccessible without understanding its value in the sentence processing architecture.

The nature of reanalysis

There will be no cause for concern if a plausible interpretation can always be achieved after only reading the sentence once. However, sometimes it is inevitable that after reading a sentence word by word to a full stop, a reader may not arrive at a clear interpretation or the interpretation turns out to be implausible. In this case, re-reading the sentence or parts of the sentence, i.e. reanalyzing the processing of all necessary linguistic information, is a requisite for a successful interpretation.

After the initial parsing of syntax which basically results in the identification of syntactic categories, early sentence processing is immediately complemented by the processing of semantic information. Aided by semantic information, syntactic parsing assigns what is called the thematic roles to each word in the sentence so that these individual words assume their respective part in the configuration of a whole meaningful sentence. These roles may concern some layered syntactic features such as syntactic constituency, case marking, syntactic agreement, etc. aligned with the semantic features such as semantic agency and animacy (Friederici, 2017). These two types of linguistic information make the minimum required information to yield a plausible interpretation.

A problem arises when the semantic processing does not align with the earlier syntactic parsing in the thematic role assignment, leading to an inadequate and/or implausible interpretation which calls for a reanalysis process. Such problems in the thematic role assignment can be caused by the sentence construction itself which may be ambiguous, or the reader's own individual characteristics such as limitation in proficiency or working memory. Ambiguous sentences are more common than people might expect. For example, in "Andy sent her letter," it can either be interpreted as Andy sending a letter to her, or Andy running an errand to send a letter of hers. A sentence can also have partial ambiguity, as in "When Greta ate the cookies that were in the oven were ready," where it is possible to misinterpret that Greta ate the cookies, only to realize that she did not eat the particular cookies that were in the oven once the sentence is read in its entirety. In such cases, a successful interpretation can be achieved by a reanalysis process which may involve more linguistic information such as context or alternate prosodic cues.

It is to be noted that the processing of linguistic information into thematic role assignment is an *incremental* process. These linguistic sources of information are not processed based on necessity basis as in waiting for all the necessary information to be available. Rather information processing begins as soon as it becomes available without delay, with the processing of subsequent partial information begins before the processing of the current information is completed. This is due to the predictive feature of syntactic parsing, as supported by its hierarchical parsing nature (Fossum & Levy, 2012), which essentially leads the processing of the entire linguistic information. This incrementality in sentence processing also makes possible for a reader to sense an implausible working interpretation mid-sentence which consequently stimulates the need for a reanalysis either immediately or after the end of the sentence. At this point, the reanalysis process depends on how a sentence processing model explains the processing of all the relevant linguistic information.

From the two fundamental architectural perspectives of modular versus interactive as previously discussed, sentence processing models emerge, seeking to provide the best explanation on how the processed linguistic information translates into a working interpretation. Early into the development of sentence processing model, the *garden-path model* came to prominence as the pioneer of syntax-first model, introducing a serial processing framework (Frazier, 1987). Meanwhile the interactive processing is associated with the *constraint-based model* which employs a parallel processing mechanism (McRae & Matsuki, 2013). Discussions on modularity and interactivity of initial sentence processing evolve into discussions of serial processing and parallel processing. Serial processing proposes a single syntactic analysis at a time with the rest of information processing follows in confirmatory manner. On the other hand, constraint-based model allows for multiple syntactic analyses to be processed simultaneously in parallel with other relevant information, all of which may influence or "constrain" each other's processing.

With the serial garden-path model, there is only one room for a working interpretation. A reanalysis process therefore replaces the previous interpretation with a new interpretation by revising the syntactic analysis and the thematic role assignments. As for the constraint-based model, multiple information processing leads to multiple interpretations. These interpretations are then weighted using the information constraints, resulting in only one interpretation in the highest rank of plausibility. Still, since the model relies on probabilistic activation, implausible interpretation may occur which calls for reanalysis or in this case, *re-ranking*. Figure 1 and 2 illustrate the garden-path model and the constraint-based model with their respective reanalysis/re-ranking process. The garden-path model and the constraint-based model are two prominent sentence processing models which inspire the sentence processing models which came afterwards. These later models mostly refine or extend the garden-path or the constraint-based model, and thus share similar descriptions of reanalysis process depends on whether the core information processing is computed in a serial or parallel processing.
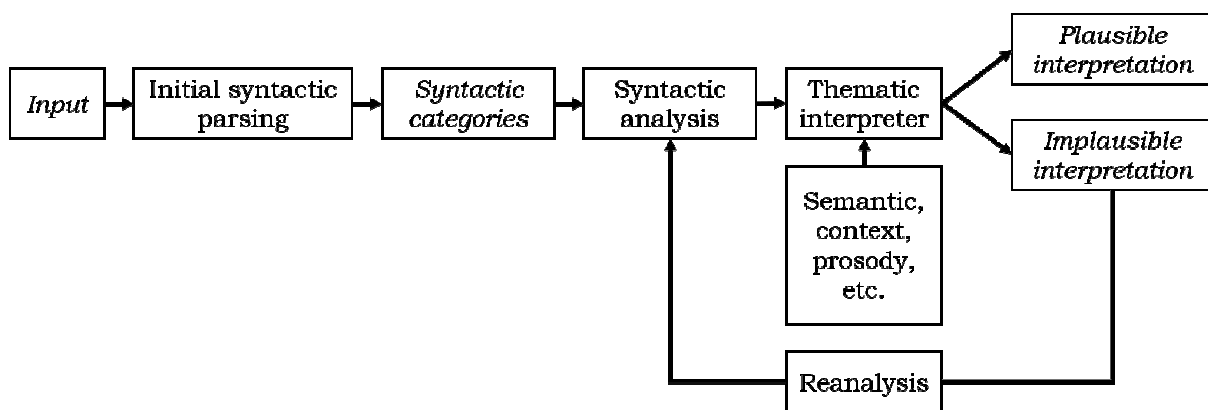
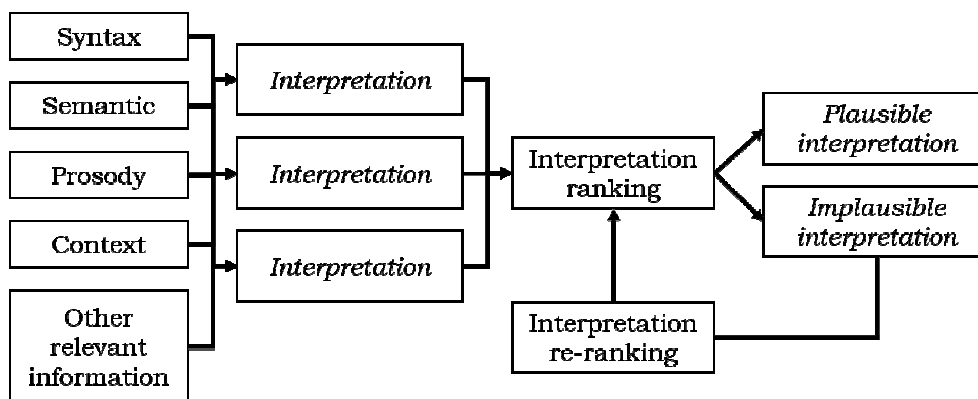

Figure 1. Garden-path Model

Figure 2. Constraint-based Model

Another thing to consider concerning the property of reanalysis is the concept of *cost*. What differentiates between easy reanalysis and difficult reanalysis is how 'expensive' the cost of the revision. In this matter, (Fodor & Inoue, 1998, 2000) introduce the notions of diagnosis and repair in a two-stage model of reanalysis. They suggest that the cost of reanalysis lies in the diagnosis stage, in which costly reanalysis follows a difficult problem diagnosis. Meanwhile the repair stage does not identify with any intrinsic reanalysis cost. This proposition recalls the significance of syntax as there needs to be a chain of syntactic dependencies between the symptoms which signal an error and the node demanding the repair. These symptoms, however, may not only come from syntactic information alone, as thematic role assignment may also involve other information such as semantic, prosody, or context. When the symptoms extend to more information than syntax, the reanalysis cost may be more expensive considering the amount and type of information corroborating the problem diagnosis (Frazier, 2013).

L1 and L2 sentence processing difference
Shallow structure hypothesis
With the theories on sentence processing architecture and reanalysis laying the foundation for the underlying mechanism of sentence processing, the next question is how the sentence processing of L1 and L2 differ. Some accounts have reported evidence of similarity between the L1 and L2 sentence processing in the way that they both unfold incrementally (Dussias & Scaltz, 2008; Felser & Cunnings, 2012; Jackson & Roberts, 2010; Jackson & Van Hell, 2011; Roberts & Felser, 2011). On the one hand, this indicates a fundamental similarity in the way information is processed during the sentence processing of both L1 and L2. On the other hand, these accounts also point out some limitations on how the incrementality in L2 sentence processing may falter when syntactically complex constructions are involved. It appears that syntactic parsing remains the center of sentence processing discussions as it becomes the root of L1 and L2 sentence processing difference.

As hinted earlier, there are exceptions where initial syntactic parsing is dominated by other sources of information. One of these exceptions is believed to be the case of L2 sentence processing. A ground-breaking article by Clahsen

and Felser (2006a) sparks a new-born interest in the discussion of processing difference between the L1 and L2 sentence processing. Their proposition, dubbed the Shallow Structure Hypothesis (SSH), suggests an idea that L2 processors are less guided by syntactic information during sentence processing, rather, they rely more on the lexical-semantic information to arrive at an interpretation. This contrasts with how native speakers' sentence processing is largely governed by the syntactic parsing as previously discussed. They propose that this reliance on non-syntactic information is due to the L2 processors' difficulty in the real-time parsing of syntactic information. This parsing difficulty also disregards the L2 processors' syntactic knowledge, as they observe that L2 learners with good understanding of syntactic principles also struggle with the parsing of L2 syntax (Clahsen & Felser, 2006b). The conclusion then leads to the SSH, in which the problem lies not in the syntactic knowledge of the L2 processors, but the *shallow* or less-detailed hierarchical representation of L2 syntax generated by the L2 processors as the incremental processing unfolds. This hypothesis therefore represents a qualitative difference between L1 and L2 sentence processing, where shallowness in L2 syntactic parsing is given, even for the syntactically literate L2 learners, and that it is the nature of L2 sentence processing.

Clahsen and Felser's (2006a, 2006b) hypothesis inspire later studies to seek more evidence of SSH and explain the L1 and L2 processing difference in further details. In support of SSH, Felser, Cunnings, Batterham, and Clahsen (2012) confirm that the L2 processing of semantic information happens since the initial stage of processing, taking the place of initial syntactic parsing demonstrated in L1 sentence processing. With regard to the non-syntactic information processed in the initial L2 sentence processing, Roberts and Felser (2011) note that the information which guides and potentially dominate the initial syntactic parsing is not limited to the lexical-semantic information as reported by Clahsen & Felser (2006a), but extends to the discourse-pragmatic information as well. Felser and Cunnings's (2012) study further adds that this processing of non-syntactic information also appears to be faster in L2 processing than L1 processing. All these proponents of SSH emphasize the notion of qualitative difference between L1 and L2 sentence processing, implying that nativelikeness cannot be the case in L2 sentence processing. However, a more optimistic point of view emerges as a number of recent studies found evidence of similarity between L1 and L2 sentence processing when taking into consideration the variables of proficiency and working memory, revealing possibilities for nativelike L2 sentence processing.

Second language proficiency
As opposed to SSH, a quantitative difference between L1 and L2 sentence processing acknowledges that there are variables which can neutralize the processing difference, given enough resources of said variables. It offers an alternative hypothesis that the lack of initial syntactic parsing in the processing of L2 is not a characteristic of L2 sentence processing as claimed by the SSH, but a matter of individual differences. Convincing accounts perhaps come from the neurocognitive research, in which fMRI and ERP studies enable observation on the processing behavior and neural pattern of L2 processors while sentence processing is underway. Tolentino and Tokowicz

(2011) reviewed a number of such studies focusing on L2 morpho-syntactic processing and found that non-native speakers exhibit similar neural patterns and syntactic processing behavior to those of native speakers. Reichle and Birdsong's (2014) ERP study also observes similar ERPs between their L2 participants and native speakers in focus structure processing. Meanwhile quantitatively less nativelike processing is only found among the low-proficiency learners (Reichle & Birdsong, 2014; White, Genesee, & Steinhauer, 2012).

These neurocognitive studies uncover a weakness in SSH's claim, that even though L2 processors' tendency to initially process non-syntactic information leads to a shallow syntactic parsing, it does not necessarily diminish their ability to parse syntactic information like native speakers when the circumstances call for it. On the variables in question which affect the *depth* of syntactic representation, and consequently the initial syntactic parsing or lack thereof, two variables have been frequently reported, i.e. proficiency and working memory. Earlier, Roberts and Felser (2011) account for a qualitative difference between L1 and L2 sentence processing, proposing that L2 sentence processing relies on discourse-pragmatic information. However, the author's later study admits the possibility of L2 processors engaging in nativelike deep syntactic parsing when they possess higher working memory capacity or grater proficiency (Roberts, 2012). Similarly, Lim and Christianson's (2013) comparative studies between English native speakers and Korean learners of English recognizes the L2 processors' tendency to rely on semantic information more than the L1 counterparts. Yet, their data also showed that L2 processors were able to use syntactic information during real-time processing, while emphasizing the crucial role of proficiency.

As SSH makes a case for shallow syntactic parsing in L2 sentence processing, it was not long until studies relate the shallowness with the quantitative nature of proficiency. Omaki and Schulz (2011) directly challenged the SSH by employing highly proficient English learners in their study and found that advanced L2 processors are capable of rapidly building abstract syntactic representation. Witzel, Witzel, and Nicol (2012) also provide evidence of similarity between L1 and proficient L2 processors, noting that they are both guided by structure-based parsing strategies when encountering temporarily ambiguous sentence construction. Comparing L2 learners at high and mid-level of proficiency as well as native speakers, Coughlin and Tremblay (2013) further reveal that both high level L2 processors and native speakers demonstrate some sensitivity to L2 syntactic violations, which is otherwise absent in mid-level L2 processors. These results resonate with the studies of predictive nature in L2 sentence processing in terms of incremental processing aptitude. These studies describe that the anticipatory behavior in both L1 and L2 processing essentially works under the same mechanism, with the case where L2 processors' predictive ability is weaker than natives' being associated with proficiency, among other things (Foucart, Martin, Moreno, & Costa, 2014; Kaan, 2014).

Working memory

As multiple studies begin to establish proficiency as a significant variable which modulates nativelikeness in L2 sentence processing, researchers recall how L2 proficiency development is positively associated with working memory (Juffs & Harrington, 2011; Linck & Weiss, 2011; Martin & Ellis, 2012; Williams, 2013). Working memory is described as a system in charge of reserving certain information in short-term memory while other ongoing tasks are performed (Reichle et al., 2016). In the case of sentence processing, this reserved information refers to the building up interpretation while processors are actively parsing and confirming information to arrive at a plausible final interpretation. Such reserved interpretation also includes the one being reanalyzed when an implausible interpretation is encountered in the processing attempt. Working memory's influence on proficiency development implies that individuals with higher working memory capacity would be benefited from the likelihood of having higher proficiency compared to those with lower working memory capacity. Considering the modulatory role of proficiency in L2 sentence processing, it is suggested that working memory may have a more substantial role in modulating nativelikeness in the way that it influences proficiency development (Juffs, 2015; Linck, Osthus, Koeth, & Bunting, 2014). Studies have then verified this notion as they found that proficient L2 processors which demonstrate nativelikeness in L2 sentence processing appear to possess high working memory capacity, while the opposite is observed in L2 processors with lower working memory capacity (Coughlin & Tremblay, 2013; Hopp, 2014; Reichle & Birdsong, 2014; Roberts, 2012).

Further studies apparently show that the contribution of working memory to L2 sentence processing is not only through its indirect influence on proficiency, but also its own immediate effect on L2 sentence processing (Juffs, 2015; Linck et al., 2014; Reichle et al., 2016). The discussions address the mechanism of holding and refining working interpretation in short-term memory while continuously processing inputted information to achieve a plausible interpretation. Such mechanism entails some propositions in which working memory becomes a significant variable modulating nativelikeness in L2 sentence processing. Looking back to SSH, although it has been refuted by a number of recent studies revealing a possible deep syntactic parsing in L2 processing, it delivers a widely acknowledged idea that L2 processors are sensitive to non-syntactic information. Unlike SSH's claim, however, the studies supporting L1 and L2 quantitative difference argue that this sensitivity concerns the non-syntactic information in the confirmatory phase, while the initial syntactic parsing remains quantitatively modulated by individual differences. The significance of working memory in this scenario, is that the confirmatory phase which involves non-syntactic information may encompass a number of types of information such as semantic, pragmatic and/or discourse information that they may overwhelm working memory (Linck et al., 2014; Williams, 2013). Processing these types of information in confirmatory phase would require constantly accessing the working interpretation from memory, therefore processors with higher working memory capacity would be advantaged by the ability to maintain multiple working interpretations and access them as necessary.

The next significance of working memory deals with the concept of retrieval interference (Martin & McElree, 2011; Phillips, 2013; Van Dyke, Johns, & Kukona, 2014). During incremental sentence processing, a successful final interpretation would require previous information to be retrieved from memory and matched with the final processed information. In retrieving such information, processors utilize certain cues to pick the most suitable information for a plausible interpretation. Retrieving the suitable information based on cues causes interference as candidates for the best match, or *distractors*, interfere with the desired information, the *retrieval target*, during the retrieval operations (Cunnings, 2017). With respect to L2 sentence processing, it is argued that L2 processors are more susceptible to retrieval interference than native speakers (Van Dyke et al., 2014; Van Dyke & McElree, 2011). Related to the L2 processor's developed sensitivity to non-syntactic information, L2 processors' vulnerability to retrieval interference is believed to be caused by difficulty in eliminating distractor information from memory as they rely on discourse-based cues in retrieving the target information. This is later associated with the next importance of working memory in L2 sentence processing which concerns the reanalysis process. Similar to the difficulty in retrieving the target information due to the reliance on discourse-based cues, reanalysis process which require erasing previous interpretation from memory can face the same problem (Cunnings, 2017). As L2 processors arrived at the end of the processing and found their interpretation implausible, they would not only need to retrieve the next best match leading to a plausible interpretation, but also erase the information which misled them to the implausible interpretation. Despite demonstrating difficulty in fully erasing the already assigned interpretation, this notion actually strengthens the deep syntactic parsing proposition since the problem is initially caused by the firm syntactic parsing early into the L2 sentence processing.

Working memory has been reported to be language-independent, which means that an individual's working memory capacity stays the same regardless of the language being processed (Coughlin & Tremblay, 2013; Reichle et al., 2016). Nevertheless, processors may demonstrate a lower working memory capacity when measured in L2 due to the previous intricacies in L2 sentence processing. Higher memory load when processing L2 sentences therefore represents the cognitively more demanding L2 processing compared to L1 processing (Hopp, 2010, 2014). As working memory on its own can predict the individual differences in L2 sentence processing apart from proficiency, the exact relationship between working memory and proficiency in terms of their modulatory roles in L2 sentence processing has thus far been largely unclear. Low proficiency in L2 may lead to a burden in working memory load, while high proficiency in L2 assists the retaining and accessing of working interpretation from memory. On the other hand, high working memory capacity supports the development of L2 proficiency and enables the benefit of proficiency during L2 sentence processing, as observed otherwise in low working memory capacity processors. Nevertheless, working memory is said to be less dependent on proficiency or only partially dependent on proficiency as seen in the variability of working memory capacity in native speakers. Future research on L2 sentence processing is expected to clarify the

interaction between proficiency and working memory as two major variables modulating nativelikeness and deep syntactic parsing in L2 processing. Descriptions on the relationship between the two variables will be able to explain the L1 and L2 differences as they are incorporated into the L2 sentence processing architecture.

Putting things together: Implications for L2 reading pedagogy
The previous discussions make a case for the significance of syntax in sentence processing, description of sentence processing architecture and its relevance in reanalysis, the shallow structure hypothesis representing the qualitative difference between L1 and L2 processing, as well as proficiency and working memory which challenge the SSH as variables modulating nativelikeness in L2 sentence processing. Implications of these descriptions of L2 sentence processing may offer insights into the L2 reading instructions. However, it is to be noted that these implications concern the potential, and not what will happen without first being tested through instructional research.

The significance of syntax in sentence processing as the core of processing mechanism and the glue that join words into meaningful sentences implies the need for emphasis on syntax learning. It is necessary to understand that syntactic parsing leads the flow of information processing. Nevertheless, it does not necessarily mean that syntactic rules are to be learned exclusively in isolation from reading texts. In this case, automaticity in syntactic parsing is desired to develop sensitivity for deep syntactic parsing. Providing reading texts which contains exposures of necessary syntactic structures is key. Selection of texts depends on the learners' level of proficiency with beginners starting with texts containing simple and common syntactic construction, then increasing in variation and complexity as learners moving to intermediate and advanced level.

Explicit learning of syntactic rules is also important, but it needs to be derived from texts and depends on the salience of the syntactic structures. In this case, reading texts serves a purpose of providing opportunities to present syntactic structures to learn. When the presence of a certain syntactic structure troubles or catches learners' attention, having a discussion on the structure and learn it explicitly can help with the encounters of similar structure in future reading. Therefore, it is also recommended that after the discussion, such structure is to appear in learners' following reading texts so that repetition may lead to priming effect and for learners to familiarize themselves with the structure in the working memory. Learning the syntactic structures within texts helps learners see a pattern of how or when such construction appears in texts and connects to other sentence constructions which adds to the automaticity.

Intermediate to advanced learners may begin to learn and discuss salient syntactic construction in its hierarchical parsing nature. As noted early on in the article, syntactic parsing is fundamentally incremental and predictive as processors actually see the construction as hierarchical which resembles a tree diagram, instead of sequential. Yet, some individual differences in L2 processors such as having low working memory capacity can cause them to be more of sequential readers when in reading in L2, which is associated with the shallow syntactic parsing. Understanding how different types of syntactic

elements within a sentence work and connect to each other can give the learners the idea of how each element plays its role in various potential constructions. This is also how semantic and prosodic information, two kinds of information closely associated with the initial syntactic processing, are best learned by first acquiring automatic syntactic parsing instead of the other way around.

Segmentation or chunking of sentences based on syntactic rules is also a potential learning implication of the sentence processing architecture description. Hierarchical syntactic parsing basically segments words into phrases, phrases into clauses, and clauses into a coherent sentence. This way of thinking while comprehending sentences train L2 learners to parse sentences hierarchically like native speakers. Segmentation can also put less demands on working memory which later benefits the reanalysis process. Syntactic parsing is closely related to prosodic phrasing in the way that readers' ability to phrase words while applying some prosodic contour or intonation to the sentence, even in silent reading (Breen, 2014; Fodor, 2002; Frazier & Gibson, 2015), develops along with the automaticity of syntactic parsing. Reading aloud for beginner and intermediate learners to prime the correct segmentation from prosody can help learners see the pattern easier and develop their own parsing ability. In a silent reading, having the sentences coded for clausal segments, using color marking or other visual marking, may also have the same advantage.

The knowledge on proficiency and working memory and their modulatory roles in L2 sentence processing is important to understand learners' individual differences. Understanding and diagnosing learners' limitation or advantage in both variables will give an idea on what to work on and what to deal with for certain individuals. As syntactic parsing becomes a potential starting point in developing natural and automatic reading comprehension skill, confirmatory information such as semantic, prosody, discourse information, etc. are to follow considering their importance in the confirmatory phase and reanalysis process, as well as building the general proficiency in readers. Learning how to incorporate these pieces of information will be significantly easier as learners develop automaticity in syntactic parsing which eventually guides these types of information. Unfortunately, extensive reading activity is probably the most effective way of getting the learners used to employing these confirmatory pieces of information. Setting reading goals and working on reading motivation will be the next concern, albeit not directly related to the present discussion on the psycholinguistics aspect of reading comprehension.

CONCLUSION

Syntactic parsing is the driving force behind an effective L2 sentence processing, which initiates and guides the processing of other types of information such as semantic, prosody, and contexts, towards a plausible interpretation. Syntax is also a prominent information in the architecture of sentence processing, leading the natural flow of information which is incremental and hierarchical in nature. Non-syntactic information may then be processed in the confirmatory phase or reanalysis process when necessary

or influence initial syntactic parsing under certain circumstances depends on the sentence processing model.

On the difference of L1 and L2 sentence processing, the argument of qualitative difference proposed by Shallow Structure Hypothesis has been challenged by later studies suggesting proficiency and working memory as variables modulating nativelikeness in L2 sentence processing. As SSH claims that L2 processors shallow parse the syntactic information regardless of individual differences, the proponents of quantitative difference believe that high L2 proficiency and large working memory capacity can lead to deep syntactic parsing, and thus a nativelike sentence processing. The relationship between L2 proficiency and working memory which are found to positively associate with each other is still largely unclear. Future research on the modulatory roles of the two variables as well as their relationship which incorporates into L2 sentence processing model is encouraged.

The implications of the L2 sentence processing descriptions discussed in the article suggest the potential advantage of syntactic parsing automaticity in learning L2 reading. This can be achieved through providing necessary exposure to syntactic structures in reading texts, in which the variety and complexity depends on the level of learners' proficiency and experience. Salient syntactic construction encountered in texts may be emphasized and learned explicitly to be stored in memory. Intermediate to advanced learners are also encouraged to analyze the salient syntactic structure in the way syntactic information is supposed to be parsed, i.e. hierarchically, by way of syntactic segmentation. Learners' limitation on proficiency and working memory can be diagnosed, so that language instructors can anticipate and prepare the best method to deal with learners' individual differences which are substantial to L2 sentence processing. As of now, the psycholinguistics perspective on L2 sentence processing has yet to inspire adequate instructional studies in the L2 learning and teaching settings. Such studies which put theories in L2 sentence processing to practice are therefore highly encouraged.

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