

# Syntactic Development of Right-Brain and Left-Brain Dominant Iranian EFL Learners: Processability Theory in Perspective

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## Abstract

Processability Theory, a component of the cognitive approach to second language acquisition tries to enhance understanding of how the interlanguage knowledge systems can be restructured by second language learners. The present study intended to run an investigation into the syntactic development of Right-Brain and Left-Brain Dominant Iranian EFL learners based on Processability Theory. Iranian university students took part in this study. They received a Demographic Questionnaire, the Hemisphere Dominance Inventory (DHI), a validated researcher-made grammar test designed based on the stages of Processability Theory. To analyze the data classical item analysis was used. Results pertained to the research questions revealed that the stages predicted by Processability Theory did not account for the Iranian Left and Right-Brain Dominant EFL learners in learning syntax. Results of this study indeed showed that the difficulty level of different grammatical structures presented by Piensmann in PT did not match the difficulty order obtained in this study by Left and Right-Brain Dominant EFL respondents.

**Keywords:** Processability Theory, Syntactic Development, Left-Brain Dominant Learner, Right-Brain Dominant Learner

## 1. Introduction

Processability Theory (PT) is designed to concentrate on the developmental problem of language acquisition and also logical problem thereof (Piensmann, Di Biase, & Kawaguchi, 2005). PT tries to explain the current facts about acquisition sequences based on a set of processing procedures. On the basis of the computational model of Kempen and Hoenkamp (1987) and ideas from Levelt's (1989) work on speech production, Piensmann advances the idea that language production can only be explained by taking into account the following premises: "a) Processing components operate largely automatically and are generally not consciously controlled, b) Processing is incremental, c) The output of the processor is linear although it may not be mapped onto the underlying meaning in a linear way, d) Grammatical processing has access to a temporary memory store that can hold grammatical information" (as cited in Mystkowska-Wiertelak & Pawlak, 2011. p.45).

The original version of PT focused on the developmental problem of language learning and tried to explore worldwide steps of language acquisition followed by learners. However, Piensmann (2005), in the extended version, considers the courses in which learners expand knowledge of the constituents they have observed in the input which is called the logical problem of language learning. Mystkowska-Wiertelak & Pawlak (2011) believed that the original version of PT assumes language

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development controls L1 and L2 acquisition and influences interlanguage variation and L1 transfer as well, so Processability restricts it. They also asserted, from the extended version perspective, the default relationship between the meaning and the path through which this meaning is expressed depends on the fundamental form of L2 syntax. Processability Theory, based on the processing principle of grammatical information exchange and salience, puts forward a stratified morphosyntactic development. "According to PT, in the developmental dimension, learners of any second language and age group follow a shared trajectory due to the architecture of language processing" (Dyson, 2016, p.342). Essential features of this system are that analytical processing is incremental. In other words, just part of the message is processed at any point in time, and that processing has access to a grammatical memory store (Levitt, 1989).

Pienemann concerning the exchange of grammatical information suggested five processing procedures. The five procedures are: "1) word/lemma, 2) category procedure, 3) phrasal procedure, 4) S-procedure, and 5) subordinate clause procedure" (Pienemann, 2005, p.9). They are arranged implicationaly, and each procedure is essential for the next one. He then added the notion of perceptual saliency and established six stages: "1) word/lemma, 2) category procedure, 3) phrasal procedure, 4) S-procedure + saliency, 5) S-procedure – saliency, and 6) minor clause procedure. (If applicable)" (Pienemann, 2005, p. 24). The following are the fundamental qualities and fundamental principles of each stage of English as an L2 taking into account. These six procedures are ordered according to their effects: At the first stage, word or lemma, no language-specific procedures take place and the ability of word production or learned-chunk generation extends. At the second stage, the category procedure, identification, and arrangement of the lexical categories of words following the canonical word order develop. The third stage, the phrasal procedure, deals with the identification of a word string and moving or merging the features across the string. At fourth stage s-procedure with perceptual saliency develops and phrases can be put together as sentences, and the functional purpose of phrases can be established. At the fifth stage, the sentencing procedure without perceptual saliency, learners can produce the subordinate clause (Pienemann, 2005). L2 learners understand all components in a series of words and place a component in both an initial and internal position of the string at this stage. That implies, they can perform two linguistic operations in a string. At the final stage, L2 learners distinguish a subordinate clause in a series of words at this highest stage (Pienemann & Johnston, 1987; Pienemann, Johnston & Brindley, 1988).

The theory is centered on the idea that, regarding production and comprehension, appreciation of the architecture of language processor and the way it acts might help to predict the paths of second language development (Pienemann, 2007). Since Processability Theory bases the acquisition order of English structures on Polish and Vietnamese immigrants in Australia (ESL) data (Senecal, 2011), thus it is important to analyze if the order applies to EFL data as well.

Nowadays, with the aim of the syntactic development processes, educators try to achieve a new perspective in developing a new and more multifaceted approach. From this perspective, although several cognitive styles in theory, may exist, it seems that the second language researchers, in recent years, have paid attention to the only a few of the possible number of cognitive styles (Dulger, 2012). In this regard, the Left and Right Brain Dominance are crucial. According to Hellige (1990), each of the two halves of brain structure is specialized in different functions. Based on studies conducted by Gazzaniga (1983), Springer and Deutch (1993), the left hemisphere is usually involved with tasks that entail verbal strength. The right hemisphere, on the other hand, has its strengths especially in non-verbal areas. The left hemisphere processes information sequentially and conversely, the right brain hemisphere processes information globally, considering it as a whole (Springer & Deutch, 1998). The hypothesis that the cognitive style of students might vary based on their brain dominance has been the cause of using the different theory of learning and acquisition. Among educators, brain dominance has attracted the attentions of researchers, and the techniques of accommodating instructions to students' cognitive styles have frequently been considered by different educators (Dunn & Dunn, 1987; Price, 2005). A critical question that arises regarding the strength of the PT order, is that in what way the instruction in the classroom should be planned for the hierarchically

acquired constitutions. Since, keeping in mind the end goal to enhance the instructing of EFL language structure in Iran, comprehensive research is needed to understand the learners' grammar accuracy and to evaluate their achievement sequences as they progress through EFL programs in the educational system. Considering the issues mentioned above, more research seems to be needed to determine the essence and types of relationships that might exist between the PT and hemispheric dominance in an EFL context. All in all, given the significance of Processability Theory in shedding light on the process of second language acquisition and the importance of cognitive styles in this process, in order to validate Processability Theory order in EFL contexts, the current investigation aims at a comparative examination of the Syntactical Development of Right-Brain and Left-Brain Dominant EFL learners based on Processability Theory. The following research questions are posed in the present study:

1. To what extent are the stages predicted by Processability Theory applicable for Iranian Left-Brain Dominant EFL learners in learning syntax?
2. To what extent are the stages predicted by Processability Theory applicable for Iranian Right-Brain Dominant EFL learners in learning syntax?

## 2. Methodology

### 2.1. Participants

The sample participants consisted of 185 freshman university students majoring in medicine, pharmacy and dentistry who enrolled in a general English course at Shiraz University of Medical Sciences. The selection was based on convenience sampling procedure. Of all respondents, 93 students were female, and 92 were male in the age bracket 18–22 years old. They learned English as a foreign language, having prior EFL learning experience in language institutes less than three years with no free exposure to English. The rationale behind the selection of this student group was that they had already passed the Pre University English Course Test successfully, or based on their grades in the entrance exam, they did not need to take the Pre University English Course which was a grammar-based exam. Therefore, they had better interpretations of grammar skills and the features which might influence their performance.

### 2.2. Instruments

#### 2.2.1. Demographic Questionnaire

Participants took a demographic questionnaire which included gender, age, prior EFL learning experience and free exposure to English. In this study, English language background was critical and asking a respondent where she/he learned English was a vital question since it was supposed that respondents who completed English language courses or programs at an institute or abroad might answer questions differently than those whose English education ended in high school.

#### 2.2.2. The Hemisphere Dominance Inventory

The Hemisphere Dominance Inventory (HDI, hereafter) developed by McCrone (2000) was employed in this study to differentiate left hemisphere from right hemisphere dominant learners. The inventory contains 16 items. This questionnaire was translated into Persian and checked for accuracy.

#### 2.2.3. PT Test

The researchers designed a grammar test based on stages of Processability Theory (PT Test, hereafter) to investigate the difficulty order of different grammatical structures for Iranian learners predicted by Processability Theory. The items that fit the stages outlined in this theory were selected based on the structures listed in Appendix A (Pienemann, 1998). The test used a multiple-choice format with one correct answer and three distracters. The HDI and PT pilot Test, using Cronbach's alpha method, achieved an alpha coefficient of 0.71 and 0.68 respectively. This suggested that the items of the HDI and PT Test are internally consistent based on the data set. Besides, In order to evaluate the degree to which the content of the PT test matches a content domain of PT, six experts evaluated the test items against the test requirements and accordingly the researchers modified this measurement instrument from experts' judgments. Equally, the questionnaires were rewritten in Farsi and checked for accuracy. In order to make sure that the translated items of the questionnaires conveyed the same

meaning and elicited the same information as its original version in English, the researchers asked five experts in translation to back-translate the items of questionnaire into English. The back-translated questionnaires were finally compared with original versions and with translated versions in Farsi. Based on this comparison the researcher modified the Farsi translations of some of the items.

### 2.3. Data Collection and Analysis Procedure

Initially, the Grammar Test was administered to the participants of the study. HDI and Demographic Questionnaire were attached to the Grammar Test. The participants were instructed to do the Grammar Test within the time limit and following this they were requested to fill out the questionnaires. To analyze the data, classical item analysis was used. The SPSS software version 24 was utilized which are commonly used for analyzing the results of the studies in social sciences.

### 3. Results

Results of Demographic Questionnaire indicated that of all respondents 125 were medical students, 30 pharmacies and 30 were dentistry students. It also showed that 93 students were female and 92 students were male in the age bracket 18–22 years old. Results obtained from HDI also showed that 58 of the participants were left hemisphere and 106 of students were right hemisphere dominant and 21 of them were balanced hemisphere. The balanced hemisphere students were excluded from the study. Consequently, 164 students remained in this study. Table 1 displays the difficulty parameter of the 39 items of the PT test administered to left brain dominant students sorted in descending order.

Table 1: Item Difficulty of PT Test ( Left Brain Dominance Group)

Item	Type	PT Stage	Item Difficulty
5	REG_PL	3	0.713
26	REFLX(ADV)	5	0.669
11	(ADV)	3	0.647
24	3SG_S	5	0.622
38	CAUSATIVE	6	0.592
2	no+x	2	0.583
37	DAT_MOV	6	0.520
13	TOPIC	3	0.512
39	2SUB_COMP	6	0.486
29	SUPPLET	5	0.442
35	Q_TAG	6	0.431
22	PART-MOV	4	0.418
17	POSSESS	4	0.409
23	PREP- STRANDING	4	0.373
21	COMP_TO	4	0.362
18	PSEUDO_INV	4	0.319
15	AUX_EN	4	0.307
12	(more)	3	0.301
6	IREG-PL	3	0.295
34	RFLX(PN)	6	0.281
19	Y/N_INV	4	0.258
16	AUX_ING	4	0.240

9	WHX_FRONT	3	0.232
20	Better, best	4	0.218
28	DO_2ND	5	0.207
33	GERUND	6	0.203
8	DO_FRONT	3	0.191
32	DAT_TO	5	0.178
30	Ly	5	0.168
36	ADV VP	6	0.135
1	SVO?	2	0.096
4	IREG_ED	2	0.092
31	-er/ -est	5	0.065
27	AUX_2 <sup>ND</sup>	5	0.053
3	SVO	2	0.047
25	PL_CONCD	5	0.024
7	POSSESS	3	0.001
10	Don't+V	3	0.001
14	ADV_FRONT	3	0.001

From this table, it can be seen that item 5 (Difficulty= 0.713) is the most challenging item and items number 7, 10 and 14 (Difficulty= 0.001) are the easiest items for the Left-Brain Dominant students. As the table shows, the Stage 3 items are generally more difficult than the items measuring other stages. However, the items of Stages 3-4 are spread out and do not show any particular tendency. In other words, the items that fit Stage 4 of Processability Theory, for example, are not of similar difficulty and are not necessarily more difficult than the items that fit Stage 3. Item 5 which was in the third stage of PT was the most challenging item, and this was followed by the 26<sup>th</sup>, 11<sup>th</sup> and 24<sup>th</sup> items which were at the fifth and third stages of PT. On the other end of the table, three of the seven most natural items were from the fifth stage, and three items were from the third stage of PT. Therefore, it can be stated that the Processability Theory does not account for the difficulty order of the items used in this study. Table 2 displays the item difficulty of the 39 items of the PT test administered to right brain dominance students.

Table 2: Item Difficulty of PT Test (Right Brain Dominance Group)

Item	Type	PT Stage	Item Difficulty
36	ADV VP	6	0.832
1	SVO?	2	0.767
26	REFLX(ADV)	5	0.721
37	DAT_MOV	6	0.686
6	IREG-PL	3	0.677
13	TOPIC	3	0.641
35	Q_TAG	6	0.623
18	PSEUDO_INV	4	0.608
33	GERUND	6	0.601
23	PREP- STRANDING	4	0.572

29	SUPPLET	5	0.563
38	CAUSATIVE	6	0.558
21	COMP_TO	4	0.530
19	Y/N_INV	4	0.521
32	DAT_TO	5	0.513
20	Better, best	4	0.494
2	no+x	2	0.473
22	PART-MOV	4	0.440
17	POSSESS	4	0.421
12	(more)	3	0.381
15	AUX_EN	4	0.376
16	AUX_ING	4	0.354
9	WHX_FRONT	3	0.327
30	Ly	5	0.301
31	-er/ -est	5	0.269
39	2SUB_COMP	6	0.258
34	RFLX(PN)	6	0.240
4	IREG_ED	2	0.227
3	SVO	2	0.207
8	DO_FRONT	3	0.180
5	REG_PL	3	0.169
28	DO_2 <sup>ND</sup>	5	0.147
27	AUX_2ND	5	0.143
25	PL_CONCD	5	0.125
11	(ADV)	3	0.091
24	3SG_S	5	0.073
7	POSSESS	3	0.001
10	Don't+V	3	0.001
14	ADV_FRONT	3	0.001

Table 2 reveals that the item measuring Stage 6 was more difficult than the other items. The items measuring Stage 3 (i.e., Items 5, 6, 7, 8, 10, 11, 12, 13 and 14) were widely separated from each other. Item 36 (Difficulty= 0.832) was the most difficult, and Item 7, 10 and 14 (Difficulty= 0.001) was the easiest of the sentences. The other items (i.e., items measuring Stages 2, 4, and 5) were in moderate. Results revealed that the items measuring Stage 5 (i.e., Items 26) and Stage 2 (i.e., Item 1) were confusing, and, besides items 7, 10 and 14, the items measuring Stage 3 (i.e., Item 11) and Stage 5 (i.e., Item 24) were relatively easy. Item 36 which was at the 6<sup>th</sup> stage of PT was the most challenging item. This was followed by the 1<sup>st</sup>, 26<sup>th</sup>, and 37<sup>th</sup> items which were at the second, fifth and sixth stages of PT respectively. On the other end of the table, three of the seven easiest items were from the fifth, and the rest were in the third stages of PT. Based on the data obtained, the researchers categorized the structures into nine grammatical categories based on Appendix A (Pienemann, 1998) and compared the difficulty within each category. The nine categories are Verbs, Nouns, Pronouns, Question, Negative, Adverbs, Adjectives, Prepositions and Word Order.

### 3.1. Verbs

There were five verb items in this study, i.e., 4, 15, 16, 24 and 33. Table 3 explains their difficulty levels for Left Brain Dominance Group, and this table indicates that item 24 > item 15 > item 16 > item 33 > item 4 and this order for Right Brain Dominance Group can be stated as item 33 > item 15 > item 16 > item 4 > item 24.

Table 3: Item Difficulty of Verb Items

Item	Sentence Position	Item difficulty	
		Right	Left
4	S(V-ed) +Adv / past	0.227	0.092
15	Be/have +(V-ed)/ past participle	0.376	0.307
16	Be+ (V-ing)/ present progressive	0.354	0.240
24	S + (V) +O/ present	0.073	0.622
33	(V-ing)+ Adv+ V/ gerund	0.601	0.203

This table shows that surprisingly gerund in item 24 is the most difficult item for the Left Brain Dominance Group and the most accessible item for the Right Brain Dominance Group. The past perfect (item 15) and the present progressive tense (item 16) items were difficult and determining the third person singular '-s' in item 24 was much more difficult than determining irregular verb in item 4 when tested in a multiple-choice format. It is predictable that the present perfect tense (item 15) was reasonably the most difficult, as it is conceptually difficult for students, who often have difficulty distinguishing it from the simple past tense (Nishitani, 2012). Despite massive amounts of exposure to this structure in the classroom, it seems that the present perfect tense is difficult for Iranian students, and they often avoid using it (Taki & Hamzehian, 2016).

However, both past tense and present perfect items, in this test, had adverbials such as *last year* and *already* in the sentences, which might have made the items much easier. On the other hand, although, the present tense is the first tense taught in high school, in this study, distinguishing the third person singular '-s' was difficult for the Iranian students. In researchers' experience, many students use the simple present tense when the present progressive tense is appropriate. On account of the absence of adverbials such as *today* and *every day* in the sentences in item 24, the students might have had difficulty choosing the present tense.

Additionally, having the present perfect tense in the subordinate clause might have confused the Left Brain Dominance Students and, thus, influenced the item difficulty of item 24. Item 16, in the same way, evaluated the knowledge of the present progressive tense but did not contain keywords such as *right now* or *at the moment*, and had the present tense in the other clause in the sentence. This might have increased the difficulty of this item. In contrast, the item assessing knowledge of past tense (item 4) was relatively easy, and it may be because of the presence of the adverb *last year*. In sum, the presence or absence of adverbials such as *last year*, *already*, *now*, and *at the moment* appears to influence the difficulty of tense items. Concerning item 33, many students in this study indicated difficulties regarding whether to use the gerund form or infinitive form of a verb. Sometimes, in a sentence, either the gerund or the infinitive form can be used, either with the same or different meanings and sometimes there is only one form which is correct. Based on the researchers' experience, deciding which one to use is not easy for Iranian students since making a distinction between these two forms is conceptually difficult for students, but the more students read and listen in English, the easier it will become.

### 3.2. Nouns

There were four noun items in the PT test, i.e., 5, 6, 17 and 25. Table 4 demonstrates their difficulty levels for the Left Brain Dominance Group, and it can be expressed as item 5 > item 17 > item 6 > item

25 and this order for the Right Brain Dominance Group can be stated as item 6> item 17> item 5> item 25.

Table 4: Item Difficulty of noun Items

Item	Sentence Position	Item difficulty	
		Right	Left
5	Possessive pr+ (pl noun)	0.169	0.713
6	V+ (pl noun)	0.677	0.295
17	Article+ (noun)	0.421	0.409
25	Number or quantifier+ (pl noun)	0.125	0.024

Items 5 and 6 required test-takers to place a noun in an object position, but the presence of a possessive pronoun in item 5 makes the item much easier for the right-brained students and presence of quantifier before the noun in item 6 makes the item much easier for left-brained students. In answering the item 17, students might not perceive the combination of two nouns to show possession as occupying an adverb position but rather as something occurring after an adjective in choice c. It can be inferred that the apostrophe may be somehow a strange or meaningless punctuation mark for the Iranian EFL students. It is also interesting to note that both items 6 and 25 have quantifiers, but *regular plural* makes item 25 much more accessible than item 6. Besides, making a regular plural noun is one of the earliest structures taught in high school, this partly explains why item 25 was much easier than all noun items. Nishitani (2012) asserted that Nouns are the most comfortable notion of understanding and the earliest concept to learn; English textbooks for beginners usually start with an explanation of nouns.

### 3.3. Pronouns

There were three pronoun items in this study, i.e., 7, 26 and 34. Table 5 explains their difficulty levels for both Right and Left Brain Dominance Groups, So, it can be expressed as item 26> item 34> item 7.

Table 5: Item Difficulty of Pronoun Items

Item	Sentence Position	Item difficulty	
		Right	Left
7	V+ (POSSESSIVE Pr)	0.001	0.001
26	V + (REFLX Pr)	0.721	0.669
34	V + (REFLX Pr)	0.240	0.281

In item 26 a reflexive pronoun is required immediately after a verb as an adverb, however, in item 34 a reflexive pronoun is used as a true reflexivization. It is not surprising that the adverbial role of reflexive pronoun was more difficult than the true reflexivization since Iranian students were not familiar with the reflexive pronoun as an adverb or it might be because the students misunderstood it as an objective pronoun. The blank was in the middle of the sentence, followed by an infinitive phrase, and thus the presence of a past tense verb after the blank could have confused the students. If only reflexive pronouns were used, in item 26, as distracters, the difficulty might have been different. It is also surprising that the reflexive pronoun item was not easy. However, the reason may be that the students only knew it as a set phrase *by oneself*. In this study, requiring a reflexive pronoun right after an infinitive makes the items much more difficult. Item 7 was based on a structure of possessive pronouns. It was not assessed as an elementary question by the examination review committee (those who assessed the content validity of the PT test). However, all the students answered it correctly. This indicates that these participants are quite familiar with the structure of possessive pronouns.



### 3.4. Question

There were seven question items in this study, i.e., 1, 8, 9, 18, 19, 27 and 35. Table 6 shows their difficulty levels for the Left Brain Dominance Group and can be expressed as item 35 > item 18 > item 19 > item 9 > item 8 > item 1 > item 27 and this order for the Right Brain Dominance Group can be stated as item 1 > item 35 > item 18 > item 19 > item 9 > item 8 > item 27.

Table 6: Item Difficulty of Question Items

Item	Sentence Position	Item difficulty	
		Right	Left
1	S+V+O+?	0.767	0.096
8	(Aux)DO+ S+V+O+?	0.180	0.191
9	Wh + (Aux)do+ S+ V+?	0.327	0.232
18	Wh+ (Aux) is+ S+V+?	0.608	0.319
19	(Aux)is/have+ S+ V+ O+?	0.521	0.258
27	Wh+ O+ (Aux)Do+ S+?	0.143	0.053
35	S+V+O,(Aux)+ S+?	0.623	0.431

This table indicates that the question tag, item 35, was confusing and Placement of 'do' in *wh*-word question position, i.e., item 27, was easy when tested in a multiple-choice format. It is surprising that the question tag item was not easy. However, this could be because the students only knew it as a set phrase *positive/negative sentences, with negative/positive tags*. It is noteworthy that, as this table shows, item 1 in these two groups of students took different places. This item is relatively easy for the Left Brain Dominance while it is the most difficult one for the Right Brain Dominance Group. It seems recognition of *SVO* pattern from among the available choices was difficult for right-brained students. Besides, the sentence structures of items 8 and 19 and items 9 and 18 are moderately the same. Item 19 is more difficult than item 8 in both groups, and item 18 is more difficult than item 9, as well. This pattern, in some way, was not predictable for the researchers because learning yes/no questions precedes *wh*-word fronting and also making a question by modals (placing the Linking Verb or Auxiliary Verb at the beginning of the sentence) precedes main verbs (beginning the sentence with a form of *DO*) in high school.

### 3.5. Negative

There were three negative items in this study, i.e., 2, 10, 28 and 29. Table 7 shows their difficulty levels for the Left Brain Dominance Group, and it can be expressed as item 2 > item 29 > item 28 > 10 and this order for the Right Brain Dominance Group can be stated as item 29 > item 2 > item 28 > item 10.

Table 7: Item Difficulty of Negative Items

Item	Sentence Position	Item difficulty	
		Right	Left
2	No +(noun)	0.473	0.583
10	Don't + (V)	0.001	0.001
28	Wh + ( don't +S) +V	0.147	0.207
29	S +Negative V+ any (N)	0.563	0.442
	S+ positive V+ some (N)		

It can be seen from this table that item 28, placement of 'do' in the second position, in negation, was easy for both groups of students; however, item 2 and item 29 are in two different patterns. Items 2 and 29 required test-takers to read all choices carefully, recognize the grammar patterns and choose one choice. This recognition form of assessing, particularly in item 2 for the Left-Brained Group and in item 29 for the Right-Brained Group might be complicated and could have confused students. Item 10 was based on the negation of the main verb in simple present tense. All students chose the correct choice. It proved to be an easy item for participants.

### 3.6. Adverbs

Table 8 shows their difficulty levels for the Left Brain Dominance Group, and it can be expressed as item 11 > item 30 > item 14 and this order for Right Brain Dominance Group can be stated as item 30 > item 11 > item 14.

Table 8: Item Difficulty of Adverb Items

Item	Sentence Position	Item difficulty	
		Right	Left
11	Be + ( Adv) + present participle	0.091	0.647
14	(Adv) + S + V + O	0.001	0.001
30	S + (Adv) + V + O	0.301	0.168

There were three adverb items, i.e., 11, 14 and 30, two of which were grouped as sentence-internal adverbs and since all of the students answered item 14 correctly, it can be inferred that sentence-internal adverbs were found to be more difficult than a sentence-initial or sentence-final adverb, i.e., item 14. This means that sentence-internal > sentence-final or sentence-initial adverbs, and meets the order predicted by Processability Theory.

### 3.7. Adjectives

There were three adjective items in the PT test, i.e., 12, 20 and 31. Table 9 shows their difficulty levels for the Left Brain Dominance Group, and it can be expressed as item 12 > item 20 > item 31 and this order for the Right Brain Dominance Group can be stated as item 20 > item 12 > item 31.

Table 9: Item Difficulty of adjective Items

Item	Sentence Position	Item difficulty	
		Right	Left
12	Be +( more) +Adj	0.381	0.301
20	Noun+ (Adj) +than	0.494	0.218
31	Be+ (Adj)+ than	0.269	0.065

Items 12 and 20 indicate that an irregular superlative and comparative make the item far more difficult than placing regular superlative and comparative adjective in sentences. This can be because the students are not familiar with the irregular form of words, and thus less familiarity with adjectives might confuse some students and make answering item 20 difficult. On the other hand, placing "than" immediately after a blank makes the identification very easy. This structure is one of the earliest structures taught in high school.

### 3.8. Preposition

Just one item in this study represents preposition, which required the students to distinguish between 4 prepositions and place it between two verbs.

Table 10: Item Difficulty of preposition Item

Item	Sentence Position	Item difficulty	
		Right	Left
21	V + (preposition) +V	0.530	0.362

The item difficulty of this item is 0.362 for the Left Brain Dominance group and 0.530 for the Right Brain Dominance group. This table indicates that “insertion of *to* as a complementizer” for the Right-Brained student was much more difficult than the Left-Brained students in this research.

### 3.9. Word Order

There were nine Word Order items in this study, i.e., 3, 13, 22, 23, 32, 36, 37, 38 and 39. Table 11 shows their difficulty levels for the Left Brain Dominance Group and can be expressed as item 38 > item 37 > item 13 > item 39 > item 22 > item 23 > item 32 > item 36 > item 3 and this order for the Right Brain Dominance Group can be stated as item 36 > item 37 > item 13 > item 23 > item 38 > item 32 > item 22 > item 39 > item 3.

Table 11: Item Difficulty of Word Order Items

Item	Sentence Position	Item difficulty	
		Right	Left
3	S+V+(O)	0.207	0.047
13	(O) +S+V/ topicalization	0.641	0.512
22	S+(V)+O/ verb particle separation	0.440	0.418
23	S+V+(O)/ Stranding of prepositions in relative clauses	0.572	0.373
32	S+V+(O) / indirect object with <i>to</i>	0.513	0.178
36	S+(Adv)+V+O	0.832	0.135
37	S+(V)+O+O	0.686	0.520
38	S+V+O+(V)	0.558	0.592
39	S+V+O+(to V)	0.258	0.486

As this table shows item 38 is the most difficult one for the Left-Brain Dominant Group, and item 36 is the most difficult one for the Right-Brain Dominant Group, and item 3 is the easiest one for both groups. Although objects are not explained explicitly in the high school textbooks, it seems that, in item 3, placing a subject and a verb before a blank made this item much more accessible. Distinguishing a sentence-internal adverb and thus less familiarity with adverbs might confuse some students and make answering item 36 difficult. It is predictable that items 37 and 13 are in second and third place in difficulty order of word order because they are not explicitly explained in grammar books and in some way, have an incongruous syntactical process. Although topicalization is generally widespread in Persian, students are not familiar with this in English. Many phrasal or compound verb forms in English are relatively similar to separable verbs. With item 22, separable verbs are really challenging for students because a semantic unit cannot be understood based on the meanings of the individual parts and must be considered as a whole, and also these kinds of verbs do not follow any specific rule to be memorized. Item 23 is preposition stranding, sometimes called P-stranding, is relatively difficult for both groups of students. This might be because it is a syntactic structure in which the placement of an object preposition is at the end of the sentence rather than being positioned in the proximity of an object. In item 32 an indirect object is required immediately after *to*. The blank

was at the end of the sentence, preceded by *to*. Although the presence of *to* immediately before the blank could have confused the students, the difficulty level of this item is relatively low. Using both base form of the verb and infinitive in distracters, in item 38, confused students and made this item relatively tricky for both groups. About item 39, it is interesting to note that distinguishing an infinitive right after object seems difficult for the Left-Brained students; however, this item is relatively easy for the other group of students.

#### 4. Discussion

Analysis of the data pertained to the research question one revealed that the stages predicted by Processability Theory do not account for the Iranian Left-Brain Dominant EFL learners in learning syntax. In other words, the difficulty level of different grammatical structures presented by Pienemann in PT does not match the difficulty order obtained in this study by Left-Brain Dominant EFL respondents. The results also, revealed that the stages predicted by Processability Theory account less for the Iranian Right-Brain Dominant EFL learners in learning syntax. In fact, the difficulty level of different grammatical structures presented by Pienemann in PT does not match the difficulty order obtained in this study by Right-Brain Dominant EFL respondents. The first finding of the present study which showed that both Iranian Right and Left-Brain Dominant EFL learners did not develop their grammar based on the stages predicted by PT in learning syntax is in line with some of the previous study results. Nielsen (1997) who investigated PT claims on Arabic, for instance, found that gender agreement between a head noun and demonstrative pronouns appeared in neither of the two participants' interlanguage (IL) system. He concluded that his study supports the prediction made by the Processability Theory that morphological structures at level X+2 will be acquired before those of level X+3, while it provides evidence against the prediction that agreement within constituents takes place before the agreement between constituents as predicted by the sub-stages of X+3. The present finding can take support from some of the previous studies such as Pienemann and Håkansson (1999), Glahn, et al., (2001), and Kawaguchi (2005) who have found support for PT concerning prepositions infinitives, reflexive pronouns, and order of adjectives.

However, this finding does not concord with the result of some other studies such as Hakansson (2001), Håkansson, Pienemann and Sayehli (2002), Di Biase and Kawaguchi (2002), and Zhang (2004) who have found that word order structure in Japanese, Swedish or German follow PT principles. As the present study findings revealed, EFL learners have found word order (SVO) difficult. The reason might lie in the fact that the Persian word order is SOV and this might have interfered with the language production of the current learners. Contrary to the significance of this word order in PT, classified at the second stage and as one of the most likely natural notions for ESL/EFL such as German, Japanese, or Swedish, this word order plays an negligible and trivial role for the Iranian counterpart. The present study investigated the development of the interlanguage of Persian EFL learners from the Processability Theory perspective. In this study, the researchers observed that there was somehow stage missing among the participants and also there were several inconsistencies between constitutions within the same stage. For instance, both VS and SV were expected to develop at the fourth stage; yet it was not consistent for the Left and Bright-Brain Dominant Learners. These findings are partially consistent with the predictions made by Processability Theory. Although in other studies it was found that, in processing foreign language development, there were apparent stages which have stratified progression. These stages are acquired cumulatively in an order predicted by PT. Though there was not strong evidence for the above assumptions behind the theory, the Processability Theory showed to be partially valid for Iranian EFL learners.

#### 5. Conclusion

This study was conducted to investigate the difficulty order of different grammatical structures for Iranian learners predicted by Processability Theory. "According to the Processability Theory, there are clear stages in processing foreign language development which is progressed hierarchically" (Khansir & Zaab, 2015, p.348). The findings of this study empirically showed that there was somehow counterevidence for the assumptions of the theory. Analyses of the data firstly revealed that

both Left and Right-Brain Dominant EFL learners taking part in the study moderately, not wholly, develop their grammar based on the stages predicted by PT. This study tested the legitimacy and universality of the Processability Theory and its embraced universal acquisition hierarchy. In this research design, the limitations notwithstanding, the study has provided valuable moderate counterevidence for the PT hierarchy and has shown the different grammatical patterns for Iranian students compared with the previous PT-based studies. Processability Theory, as an innovative theory, requires more studies and experimental evidence to support its spirit. Likewise, more critiques should be addressed and explored for the healthy development and the extension of PT. Besides, PT's approach to information exchange needs to be further investigated with the concern of the internal and external factors. Only by pursuing all the required matters, PT can be considered more than a symbol of grammatical stages but the regularities in the continual change of production data. This research also demonstrated the difficulty involved testing the knowledge of the same grammar point in multiple-choice grammar items that would create different item difficulty estimates for the Right and Left Brain Dominance Students. Two items that are quite similar to the teachers had very different difficulty levels for these two groups. It recommends that, due to the thoughts and intentions underlying the evaluation of teaching materials, educators or test-writers do not consider their instincts or experiences as the best guide for composing viable grammar test items, particularly for university entrance examinations which are considered as high-stakes examinations. Obtaining statistical information about the function of each item and also gathering qualitative data through a pilot study, from students, in the form of an interview, a questionnaire or a think-aloud protocol is recommended. Also, it will be iniquitous to some students if one form of an entrance examination has easier or more difficult grammar items than the others. Moreover, educators should not only construct the content of the language instruction curricula properly but also the way learners should cope with the procedures of language learning (Nunan, 2003). The results of this study signify the point that the brain dominance draws on the learners' achievements. This suggests that EFL teachers can identify what kind of activities learners need to choose to develop the other part of their brain apart from the dominant one. By diagnosing the brain dominance of the learners and adopting suitable practical methods, the educators might also enhance the effectiveness of their own teaching, increase the success rate and also advise learners on learning strategies. It is considered highly important that a variety of methods and practices designed by taking the traits of both brain hemispheres and characteristics of the learners into consideration provide EFL learners with more positive attitudes towards learning and increase the success (Kök, 2007). All in all, some special pedagogical assessments could be of help in this case, and in order to write better grammar tests, the difficulty of a broader range of structures on a broader group of Right and Left Brain Dominance Students needs to be investigated. Further studies also are needed to confirm and extend these findings and also to test these potential explanatory results.

**References**

- Beck, C. R. (2001). Matching teaching strategies to learning style preferences. *The Teacher Educator*, 37 (1), 1-15.
- Bohnacker, C. (2006). When Swedes begin to learn German: From V2 to V2. *Second Language Research*, 22, 443–86.
- Bonilla, C.L. (2012). *Testing processability theory in L2 Spanish: Can readiness or markedness predict development?* (Doctoral dissertation, University of Pittsburgh). Retrieved from <http://d-scholarship.pitt.edu/11611/>
- Buyl, A., & Housen, A. (2015). Developmental stages in receptive grammar acquisition: A processability theory account. *Second Language Research*, 31(4), 523-550.
- Di Biase, B., & Kawaguchi, S. (2002). Exploring the typological plausibility of Processability theory: Language development in Italian second language and Japanese second language. *Second Language Research*, 18, 274–302.
- Dunn, K., & Dunn, R. (1987). Dispelling old beliefs about student learning. *Education Leadership*, 44(6), 55-63.
- Dulger, O. (2012). Brain dominance and language learning strategy usage of EFL learners. *Cognitive Philology*, 5, 1-23.
- Dyson, B, M. (2016). Variation, individual differences and second language processing: A processability theory study. *Linguistic Approaches to Bilingualism*, 6(4), 341–395.
- Eguchi, A., & Sugiura, M. (2015) Applicability of processability theory to Japanese adolescent EFL learners: A case study of early L2 syntactic and morphological development. *System*, 52, 115-126.
- Ellis, R. (2008). *The study of second language acquisition*. Oxford: Oxford University Press.
- Gazzaniga, M. S. (1983). Right-hemisphere language following brain bisection: A twenty- year perspective. *American Psychologist*, 38, 525-537.
- Glahn, E., Hakansson, G., Hammarberg, B., Holmen, A., Hvenekilde, A. & Lund, K. (2001). Processability in Scandinavian second language acquisition. *Studies in Second Language Acquisition*, 23, 389-416.
- Hakansson, G. (2001). Tense morphology and verb-second in Swedish L1 children, L2 children, and children with SLI. *Bilingualism: Language and Cognition*, 4(1), 85-99.
- Håkansson, G., & Norrby, C. (2010). Environmental influence on language acquisition: Comparing second and foreign language acquisition of Swedish. *Language Learning*, 60(3), 628-650.
- Håkansson, G., Pienemann, M., & Sayehli, S. (2002). Transfer and Typological proximity in the second language processing. *Second Language Research*, 18(3), 250-273.
- Hellige, J. (1990). Hemispheric asymmetry. *Annual Review of Psychology*, 41, 55-80.
- Hopper, P. (1998). *The new psychology of language cognitive and functional approaches to language structure*. New Jersey: LEA Press.
- Jafari, S. S. (2014). A cross-linguistic study of English and Persian prepositions. *Journal of Language Teaching & Research*, 5(3), 689-697.
- Jansen, L. (2008). Acquisition of German word order in tutored learners: A cross-sectional study in a broader theoretical context. *Language Learning*, 58(1), 185-231.
- Kawaguchi, S. (2000). Acquisition of Japanese verbal morphology: Applying processability theory to Japanese. *Studia Linguistica*, 54(2), 238–248.

- Kawaguchi, S. (2005). Argument structure and syntactic development in Japanese as a second language. In M. Pienemann (Ed.), *Cross-linguistic aspects of processability theory* (pp. 253-298). New York: John Benjamins Publishing Company.
- Kempen, G., & Hoenkamp, E. (1987). An incremental procedural grammar for sentence formulation. *Cognitive Science*, 11, 201-258.
- Khabiri, M., & Heidari, M. (2011). The relationship among EFL learners' left/right brain dominance, autonomy, and reading comprehension of the academic and general reading modules of IELTS. *Journal of Language and Translation*. 2 (1), 59-77.
- Khansir, A. A., & Zaab, M. (2015). The impact of processability theory on the speaking abilities of Iranian EFL learners. *Journal of Language Teaching and Research*, 6(2), 343-349.
- Kök, İ. (2007). The effects of more humanistic approaches to language teaching and hemispheric dominance on students' academic achievements and their attitudes towards learning English. *Education and Science*, 32(1), 49-58.
- Levelt, W. J. M. (1989). *Speaking from intention to articulation*. Cambridge, MA: MIT Press.
- McCrone, M. (2000). The neuropsychology of development: Hemispheric laterality, limbic language, and the origin of thought. *Journal of Clinical Psychology*, 38, 3-44.
- Mystkowska-Wiertelak A., Pawlak M. (2011). *Production-oriented and comprehension-based grammar teaching in the foreign language classroom*. New York: Springer.
- Nielsen, H. L. (1997). On acquisition order of agreement procedures in Arabic Learner language. *Al-Arabiyya*, 30, 49-94.
- Nishitani, A. (2012). *A hierarchy of grammatical difficulty for Japanese EFL learners: Multiple choice items and processability theory*. (Doctoral dissertation, Temple University). Retrieved from <http://digital.library.temple.edu/cdm/ref/collection/p245801coll10/id/176422>
- Nunan, D. (2003). Learner strategy training in the classroom: An action research study. *TESOL Journal*, 6(1), 35-41.
- Oflaz, M. (2011). The effect of right and left brain dominance in language learning. *Procedia Social and Behavioral Sciences*, 15, 1507-1513.
- Philipsson, A. (2007). *Interrogative clauses and verb morphology in L2 Swedish*. (Doctoral dissertation, Stockholm University). Retrieved from <http://www.diva-portal.org/smash/get/diva2:197193/FULLTEXT01.pdf>
- Pienemann, M. (1998). *Language processing and second language development: Processability theory*. Amsterdam: John Benjamins Publishing Company.
- Pienemann, M. (2003). Language processing capacity. In C. J. Doughty & M. H. Long (Eds.), *The handbook of second language acquisition*. Malden, MA: Blackwell Publishing.
- Pienemann, M. (Ed.) (2005). *Cross-linguistic aspects of processability theory*. Amsterdam: John Benjamins Publishing Company.
- Pienemann, M. (2007). Processability theory. In B. Van Patten & J. Williams (Eds.), *Theories in second language acquisition: An introduction* (pp. 137-154). Malden, MA: Blackwell Publishing.
- Pienemann, M. (2015). An outline of processability theory and its relationship to other approaches to SLA. *Language Learning*, 65(1), 123-151.
- Pienemann, M., Di Biase, B., & Kawaguchi, S. (2005). Extending Processability theory. In M. Pienemann (Ed.), *Cross-linguistic aspects of Processability theory* (pp. 199-251). Amsterdam: John Benjamins Publishing Company.

- Pienemann, M., & Håkansson, G. (1999). A unified approach towards the developmental of Swedish as L2: A processability account. *SSLA*, 21, 383-420.
- Pienemann, M., & Hakansson, G. (2007). Full transfer vs. developmentally moderated transfer: A reply to Bohnacker, *Second Language Research*, 23, 485-493.
- Pienemann, M., & Johnston, M. (1987). Factors influencing the development of language proficiency. In D. Nunan (Ed.), *Applying second language acquisition research* (pp. 45–141). Adelaide: National Curriculum Resource Centre.
- Pienemann, M., Johnston, M., & Brindley, G. (1988). Constructing an acquisition-based procedure for second language assessment. *Studies in Second Language Acquisition*, 10 (2), 217–243.
- Price, L. (2005). Individual differences in learning: Cognitive control, cognitive style, and learning style. *Educational Psychology*, 24(5), 681-698.
- Rahkonen, M., & Håkansson, G. (2008). Production of written L2-Swedish: Processability or input frequencies? In Kebler, J-U. (Ed.), *processability approaches to second language development and second language learning* (pp. 135-161). Cambridge: Cambridge Scholars Publishing.
- Senecal, A. (2011). *Processing the L2 comprehension process: Testing processability theory's predictions in an ERP study of adult learners of L2 Swedish*. (MA thesis, Lund University). Retrieved from <https://www.lunduniversity.lu.se/lup/publication/2439371>
- Springer, S. P., & Deutsch, G. (1993). *Left brain, right brain* (4<sup>th</sup> ed.). New York: W.H. Freeman.
- Springer, S. P., & Deutsch, G. (1998). *Left brain, right brain: Perspectives from cognitive neuroscience*. New York: Freeman.
- Steinberg, D. (1993). *An Introduction to psycholinguistics*. New York: University Press.
- Taki, S., & Hamzehian, M., (2016). Cross-linguistic validation of processability theory: The case of EFL Iranian students' speaking skill. *International Journal of Foreign Language Teaching & Research*, 4(15), 51-62.
- Wierzbicka, A. (1988). *The semantics of grammar*. Amsterdam: John Benjamins Publishing Company.



Appendix A

Tentative Developmental Stages of the Acquisition of Grammatical Structures for ESL Students

stage	VERB	NOUN	PN	Q	NEG	ADV	ADJ	PREP	W_ORDER
1	‘WORDS’ or FORMULAE								
2	IL-ING IRREG-ed	REG_PL IRREG_PL	1st 2nd 3rd	SVO?	no no+X			PP	SVO
3			POSSESS	DO_FRONT WHX_FRONT	don’t + V	(ADV)	(more)		TOPIC ADV_FRONT
4	AUX_EN AUX_ING	(POSSESS)		PSEUDO-INV Y/N_INV			(better) (best)	COMP_TO	PART_MOV PREP_STRDNG
5	3SG_S +	(PL_CONCD)	CASE(3rd) RFLX(ADV)	AUX_2ND SUPPLET	DO_2ND SUPPLET	-ly	-er -erst		(DAT_TO)
6	(GERUND)		RFLX (PN)	Q_TAG					ADV VP (DAT MVMT) (CAUSATIVE) (2_SUB_COMP)

*Note.* (Round brackets indicate tentative assignment only.) IL-ing = non-standard ‘ing’, PP = in prepositional phase, DO\_FRONT = yes/no questions with initial ‘do’, WHX\_FRONT = fronting of wh-word and possible cliticized element (e.g. ‘what do’), TOPIC = topicalization of initial or final elements, ADV\_FRONT = fronting of final adverbs or adverbial PPs, AUX\_EN = [be/have] + V-ed, PSEUDO\_INV = simple fronting of wh-word across verb (e.g. ‘where is the summer?’), COMP\_TO = insertion of ‘to’ as a complementizer as in ‘want to go’, PART\_MOV = verb-particle separation, AUX\_ING = [be] + V-ing, not necessarily with standard semantics, Y/N\_INV = yes/no questions with subject-verb/aux inversion, PREP\_STRDNG = stranding of prepositions in relative clauses, 3SG\_S = third person singular ‘-s’, PL\_CONCD = plural marking of NP after number or quantifier (e.g. ‘many factories’), CASE (3rd) = case marking of third person singular pronouns, AUX\_2ND = placement of ‘do’ or ‘have’ in second position, DO\_2ND = as above, in negation, SUPPLET = suppletion of ‘some’ into ‘any’ in the scope of negation, RFLX (ADV) = adverbial or emphatic usages of reflexive pronouns, RFLX (PN) = true reflexivization, Q\_TAG = question tags, DAT\_MVMT = dative movement, CAUSATIVE = structures with ‘make’ and ‘let’, 2\_SUB\_COMP = different subject complements with verbs like ‘want’. Adapted from *Language Processing and Second Language Development: Processability Theory* by M. Pienemann (as cited in Nishitani, 2012).