

Research into Syntactic Development: A Study Using Implicational Scaling

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Abstract: Processability Theory (PT) is a theory to explain the developmental course of the acquisition of L2 (second language) or other additional language. Although several language acquisition studies have supported PT validity, data from Dyson (2009) showed some counter evidence with Mandarin speaking ESL learners. In her study, the two participants showed a developmental course different from PT. However there is a problem in PT methodology. Furthermore, the course shown by Dyson revealed the possibility that the learners acquire the target structures of syntax and morphology separately. Through testing PT validity by reanalyzing Dyson's data, the current study also reveals problems with "implicational scaling" used in a developmental study.

Key words: Processability Theory, implicational scaling, L2 learner, syntax, morphology

1 Introduction

Processability Theory (PT) is a theory of second language acquisition (SLA) developed to explain developmental sequences in SLA as well as some other phenomena. The original theory is mainly described in Pienemann (1998) and further developed in Pienemann (2011a; 2011b; 2011c; 2011d) and Kefler and Pienemann (2011). Pienemann has consistently emphasized that all language learners develop their own linguistic system through the same developmental course. The course assumed in PT has 5 procedures which learners may develop. They are

1. Word / lemma
2. Category procedure (lexical category)
3. Phrasal procedure (head)
4. S (sentence) - procedure
5. Subordinate clause procedure (if applicable).

PT has also explained this developmental schedule based on the architecture of the language processor following Levelt's (1989) model of language generation. Pienemann thinks a hierarchy of processability according to a psycholinguistic mechanism is applicable to all languages; the hierarchy forms the core component of PT. As processing is incremental through the hierarchy, all learners can only process the structures in the stage where they are. As one example I show the developmental pattern for ESL (English as a Second Language) learners in Table 1. From stage 1 to 6 (bottom to top), English learners acquire syntactic structures and morphological structures.

Based on PT, many empirical studies have been done in the field of language acquisition and many of them have supported the developmental course of PT (e.g., Di Biase and Kawaguchi, 2002; Sakai, 2008; Itani-Adams, 2011; Spinner, 2011). For English learners, PT stages as in Table 1 are consistent with the stages of L2 learners who have L1 language of Arabic, Korean, Chinese, Spanish, Thai and Japanese (Spinner, 2011), and partly consistent with Sakai's results (2008) for Japanese-speaking English (EFL) learners.

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Table 1. ESL acquisition (cf. Pienemann, 2011b)

Stage	Syntax		Morphology	
6	Cancel inversion	I wonder where he is. I wonder what he wants to eat.		
5	Do-2nd Aux-2nd Negation-do2nd	Why did she eat that? Where have you lost it? Why didn't you tell me?	3rd person singular -s	he eats
4	Yes/No inversion Copula inversion	Have you seen him? Is he at home? Where is she?		
3	Do-fronting Adverb-fronting Negation+Verb	do he live here? Today he stay here	plural agreement	two-cat-s
2	Negation+SVO Canonical word order (SVO)	no me live here me live here you live here	past -ed plural -s possessive -s	she play-ed cats Pat's cat
1	Single word Formulae	How are you? -Where is X? -Hello -Five Dock -Central		

On the other hand, Dyson's (2009) Mandarin-speaking English (L2) learners provide some counter evidence against PT and show developmental gaps between syntactic and morphological development. She concluded with regard to the two participants' developmental patterns that one was "more syntactic" and the other was "more morphological". The large quantity of data presented by Dyson provides opportunities to test PT validity. The important result from Dyson (2009) is the possibility that learners do not develop both syntactic and morphological structures at the same time when developing their linguistic system. They do not put both syntactic and morphological structures into a single sentence at the same time as postulated by PT.

Several PT studies have used "implicational scaling" for their analyses to test the validity of PT prediction and have required two figures for validity (e.g., Sakai, 2008; Spinner, 2011). Implicational scaling was originally used for morpheme acquisition studies in the 1970s as discussed by Hatch and Lazaraton (1991: 204-213). In PT studies, this scaling has also been used for the developmental stages of morphology and syntax.

In the current study, the data from Dyson (2009) are reanalyzed. Though reanalyzing, two problems are found: the limitation of the implicational scaling and the course of learners' syntactic development which has two sides, namely morphological development and syntactic development.

2 Previous studies

Several studies have tested PT validity with empirical data; the research field has extended from L2 (Second language) studies (e.g., Pienemann, 1998; Di Biase and Kawaguchi, 2002; Baten, 2011), to bilingual language acquisition (Itani-Adams, 2011), to a study for children with language impairment (Håkansson, Salameh and Nettelbladt, 2003). Many of the studies have supported the developmental stages of PT.

Dyson (2009) provides important evidence with regard to PT. In her research, oral data was collected for one year via communication tasks and interviews with two Mandarin speaking adolescents. They were ESL (English as a second language) learners: the girl (Philomena) was 12 years old at the beginning of the study and the boy (Daniel) was 13 years old. According to her study, in the course of Philomena's development, she acquired syntactic structures before morphological structures contrary to the theory of PT. On the other hand, through his developmental course, Daniel produced more morphological structures in various contexts than syntactic structures. Dyson argued that these sequences contrary to PT, were the result of the properties of Universal Grammar (UG)¹.

Based on her observations, two other possibilities exist. Firstly, L2 learners may, in some way, develop their language systems of syntax and morphology separately. If learners acquire them separately, is the order of each according to PT? A second possibility is that, if her data is analyzed by a method based on the developed version of PT (Pienemann, 2011a, 2011b; Keßler and Pienemann, 2011), the results may show accordance with PT. Her analysis is unclear because it was done without statistical calculations for implicational scaling.

Implicational scaling is a method based on the assumption that all grammatical structures are acquired in a cumulative manner. It has been used to test the validity of PT prediction. Table 2 shows an example of the implicational scaling in accordance with Pienemann (2011b: 50-54) and Hatch and Lazaraton (1991: 204-213). In Table 2, Structures A, B, C, D and E are analyzed based on the data from 5 learners (1, 2, 3, 4 and 5). Learner 1 produced Structure E only, whereas Learner 5 produced all structures from A to E. An order of acquisition is shown; Learners produced structure E before D, which was needed to produce C, which was needed to produce B which was needed for A. The table shows an implicational relation between the vertical structures E to A.

Table 2. An example of implicational scaling

	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5
Structure A	-	-	-	-	+
Structure B	-	-	-	+	+
Structure C	-	-	+	-	+
Structure D	-	+	+	+	+
Structure E	+	+	+	+	+

One more step is needed for the analysis. According to Hatch and Lazaraton (1991), two calculations are done to judge whether a set of data is truly developmental: the coefficient of reproducibility (Crep) and the coefficient of scalability (Cscal). When the first calculation, Crep is done and the figure is over .90, and, in addition, when the second calculation, Cscal is over .60, we can claim the data are scalable. In Table 2, because there is a cumulative process, we can find a marginal line there. When I draw the line in Table 3 (which shows the same productivity as Table 2), an error is shown at Structure C by Learner 4. However the coefficient of reproducibility (Crep) is .96 and the coefficient of scalability (Cscal) is .83. This figure adequately satisfies the standards of Hatch and Lazaraton (1991). This implicational table shows a developmental pattern.

Table 3. An example of implicational scaling (2)

	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5
Structure A	-	-	-	-	+
Structure B	-	-	-	+	+
Structure C	-	-	+	-	+
Structure D	-	+	+	+	+
Structure E	+	+	+	+	+

Although implication scaling with the two calculations were used in the formulation of PT developmental stages in some studies (e.g., Sakai, 2008; Spinner, 2011), this statistical step was not adopted by Dyson. In general, her study was done according to Pienemann (1998) with some target structures being different from Pienemann (2011b). Can a developmental course be predicted by extracting data for PT from the plentiful data in Dyson's longitudinal study and using the two calculations for the analysis?

3 Study

3.1 Hypothesis

If analysis based on Keßler and Pienemann, (2011) using statistical calculations is done for Dyson's (2009) data, the results will be different from her conclusion. Before the analysis is done, the arranging of some structures in accordance with PT (Pienemann, 2011a; 2011b), an arrangement which was developed from the original PT (Pienemann, 1998), is needed.

3.2 Data

The data from Dyson (2009) is used for this analysis. Two Mandarin speaking ESL learners participated in the study. The boy (Daniel) was 13 years old at the beginning of the study and the girl (Philomena) was 12 years old. Dyson's observations continued for one year. The data were collected 6 times, through communication tasks and interviews.

3.3 Procedure and Data analysis

I arranged and extracted Dyson's data according to Table 1 based on Pienemann (2011b). Target structures are all in Table 1. To test the validity of PT, implicational scaling was used for this study, and two calculations were done to judge whether the data revealed valid developmental stages as in Hatch and Lazaraton (1991). If the figure of the coefficient of reproducibility (Crep) is over .90 and the figure of the coefficient of scalability (Cscal) is over .60, the set of data will be scalable (Hatch and Lazaraton, 1991: 210-214).

4 Results

4.1 Implicational scaling for syntax and morphology

Tables 4 and 5 show Daniel's and Philomena's developmental patterns according to PT (Pienemann, 2011b)². However, past tense marked verbs (-ed), cancel inversion, negation do-2nd and negation SVO were not observed in Dyson's PT study, so these structures were removed from this study.

Dyson's analysis adopted emergence as the criterion for acquisition following Pienemann (1998:144-145) "emergence is defined as one productive token of a structure in at least four contexts (Dyson, 2009: 362)." With respect to morphology, she also adopted one more criterion: the existence of two tokens with different lexical items and different structural/morphological forms. Her original data showed the number of each structure produced out of context, and she distinguished when numeral data was given and reached "acquired" and when the structure was very frequent but numeral data was not given. In this research, the former showed as bold font "+" (= acquires), the latter was just "+" in the table.

First, in Table 4 for Daniel, I drew a marginal line. Two calculations were done in accordance with Hatch and Lazaraton (1991). The coefficient of reproducibility (Crep) is .95: as indicated above, over .90 on the scale can be considered "valid". So the results for individuals can be predicted based on the table. On the other hand, the coefficient of scalability (Cscal) is .70; when this number is greater than .60, the data are scalable. As both conditions are satisfied, Table 4 truly shows a PT developmental pattern.

Table 4. Daniel's developmental course from Dyson (2009)

PT Stage	Sample		Sample					
			1	2	3	4	5	6
5	Do, Auxiliary 2nd		-	-	/	-	-	+
	3SG		-	-	-	-	-	+
4	Yes/No inversion		/	/	/	/	/	/
	Copula inversion		-	-	/	-	-	+
3	Adverb fronting		/	/	-	+	+	+
	Do fronting		/	-	-	/	+	+
	Negation + Verb		-	+	+	+	+	+
2	PL-Agr		/	-	/	+	+	+
	SVO		+	+	+	+	+	+
	PL		-	-	+	+	+	+
1	Poss Pro		+	+	+	+	+	+
	Single words		+	+	+	+	+	+

Note. SVO = canonical word order. PL = regular plural(-s). PossPro = Possessive pronoun. PL-Agr = Plural agreement. 3SG = third person singular inflection(-s). "/" = there is no context. "+" = the structure has been acquired. "+ (bold)" = the structure reaches the acquisition criterion by Dyson (2009). "-" = Dyson's criteria were not satisfied.

Table 5. Philomena's developmental course from Dyson (2009)

PT Stage	Sample		Sample					
			1	2	3	4	5	6
5	Do, Auxiliary 2nd 3SG	Syntax	-	-	/	-	-	+
		Morphology	-	-	-	-	-	-
4	Yes/No inversion Copula inversion	Syntax	/	/	-	/	+	+
		Morphology	-	-	-	-	+	+
3	Adverb fronting Do fronting Negation + Verb	Syntax	/	-	-	+	+	+
		Morphology	/	/	+	+	+	/
		PL-Agr	-	+	+	+	+	+
2	SVO PL Poss Pro	Syntax	/	/	-	-	+	+
		Morphology	+	+	+	+	+	+
		PL	/	-	-	-	+	+
1	Single words	Syntax	+	+	+	+	+	+
		Morphology	+	+	+	+	+	+

Note. SVO = canonical word order. PL = regular plural(-s). PossPro = Possesive pronoun. PL-Agr = Plural agreement. 3SG = third person singular inflection(-s). "/" = there is no context. "+" = the structure has been acquired. "+ (bold)" = the structure reaches the acquisition criterion by Dyson (2009). "-" = Dyson's criteria were not satisfied.

Next in Table 5 for Philomena, I also found a marginal line before the two calculations were done. The coefficient of reproducibility (Crep) is .90, the coefficient of scalability (Cscal) is .47, this figure does not satisfy the standards of Hatch and Lazaraton (1991) and Table 5 does not show a PT developmental pattern.

Here, my hypothesis was that, if based on Pienemann and Keßler (2011), statistical calculations were done for Dyson's (2009) data, the results would be different from her conclusion. The results followed my hypothesis.

5. Discussion

In this study using implicational scaling, two calculations were done. As a result, Daniel's developmental course was found to be in accordance with PT. On the other hand, Philomena's implicational scaling for developmental stages did not satisfy the standards of Hatch and Lazaraton (1991). Supporting my hypothesis, the results from reanalysis for Dyson (2009) data were different from her original results. Where do these differences come from? I think they mainly come from the research methods used: cross-sectional study and longitudinal study with implicational scaling. Do both methods have "implicational scaling"? This is not clear here.

There is an important difference between a longitudinal study and a cross-sectional study in the field of acquisition studies. In a longitudinal study, the data used for analysis may be collected several times in every few days, weeks or months. Gradual changes in the participants' proficiency are captured. In many cases, a small number of participants are observed or tested; thus the differences between individuals in their own developmental course are necessarily emphasized. On the other hand, in many cross-sectional studies, a large number of participants are tested at once (in some cases, two research methods are used in combination), to catch the developmental patterns in common. From the view of data collection, specific structures cannot be uttered by a participant in a natural setting in a longitudinal study but the specific structures can be elicited from the participants in a cross-sectional study. Thus, the problem is also the amount of data.

Dyson's (2009) study was done as a longitudinal study for 1 year via tasks and interviews; her precise observations revealed detailed developmental stages. However when we try to ascertain development by the statistical methods proposed by PT, the results are partly different from the observations in a longitudinal study. Dyson's detailed observations may not have appeared in the case of a cross-sectional study. Rather than saying which method is better for showing true developmental patterns, it is better to note the differences between the two research methods.

Table 6. Daniel's developmental course of morphology

PT Stage	Morphology	Sample 1	2	3	4	5	6
5	3SG	-	-	-	-	-	+
3	PL-Agr	/	-	/	+	+	+
2	PL	-	-	+	+	+	+
	Poss Pro	+	+	+	+	+	+

Note. PL = regular plural (-s). Poss Pro = Possessive pronoun. PL-Agr = Plural agreement. 3SG = third person singular inflection (-s). "+" = acquired. "-" = not acquired. "/" = there is no context.

Table 7. Philomena's developmental course of morphology

PT Stage	Morphology	Sample 1	2	3	4	5	6
5	3SG	-	-	-	-	-	-
3	PL-Agr	/	/	-	-	+	+
2	PL	/	-	-	-	+	+
	Poss Pro	+	+	+	+	+	+

Note. PL = regular plural (-s). Poss Pro = Possessive pronoun. PL-Agr = Plural agreement. 3SG = third person singular inflection (-s). "+" = acquired. "-" = not acquired. "/" = there is no context.

The other possibility from Dyson's study which I propose is that learners develop syntactic and morphological structures separately while developing their own linguistic system, Dyson (2009) observed that Daniel's developmental course was "more morphological" and Philomena's developmental tendency was "more syntactic". Resulting from her observations, I show each morphology and syntax separately in Tables 6 through 9. For morphology, Table 6 is for Daniel and Table 7 is for Philomena. For syntax, Table 8 is for Daniel, Table 9 is for Philomena.

Two calculations were done for each table. Concerning morphology, in Table 6 the coefficient of reproducibility (Crep) is .10 (100%); the coefficient of scalability (Cscal) is .10 (100%). In Table 7, both the coefficient of reproducibility (Crep) and the coefficient of scalability (Cscal) are also .10 (100%). In addition, for syntax, in Table 8, both figures are .10 (100%). In Table 9, the coefficient of reproducibility (Crep) is .97, the coefficient of scalability (Cscal) is .81. From just these figures, can we say each set of data (Tables 6-9) truly shows the developmental pattern of PT? When PT prediction is divided into morphological structures and syntactic structures, does each developmental course agree with PT?

In relation to this question, we should keep in mind what Hatch and Lazaraton (1991: 206) said about implicational scaling. That is, if all the items are roughly at the same level, and participants' language proficiency levels are roughly at the same level, no scale will be found and no scale in terms of their position in relation to each other will be discovered. Based on this view, I can say that sample participants who have a range of language proficiency levels will be needed for a study and an adequate number of participants who demonstrate different proficiency levels will be needed for the horizontal axis in the implicational table. Similarly, on the vertical axis in the figure, target items which can show different difficulty levels are needed. When we plan tasks to elicit data from participants, it is possible to judge the difference of difficulty. An emergence criterion can also be considered, I cannot conclude that the results shown in tables 6 through 9 accurately reflect development. A little evidence for this is from Table 7, PL (regular plural (-s)) in PT stage 2 and PL-Agr (Plural agreement) in PT stage 3 have the same number of "+ (acquired)" in each horizontal line; this means when these two items are reversed in order, we will get same figures statistically. So, more data will be needed for these analyses.

However, even without statistical figures, we can see the patterns Dyson described as "more morphological" and "more syntactic" and a tendency towards PT validity to some degree when language acquisition is divided into morphology and syntax.

Table 8. Daniel's developmental course of syntax

PT Stage	Syntax	Sample 1	2	3	4	5	6
5	Do, Aux 2nd	-	-	/	-	-	+
4	Cop Inv	-	-	/	-	-	+
	Y/N, Inv	/	/	/	/	/	/
3	Do fronting	/	-	-	/	+	+
	Adv fronting	/	/	-	+	+	+
	Neg + Verb	-	+	+	+	+	+
2	SVO	+	+	+	+	+	+
1	Single word	+	+	+	+	+	+

Note. SVO = canonical word order. Neg + Verb = Negation + verb. Adv fronting = Adverb fronting. Cop Inv = Copula inversion. Y/N Inv = Yes/No inversion. Do, Aux 2nd = Do, Auxiliary second. "+" = acquired. "-" = not acquired. "/" = there is no context.

Table 9. Philomena's developmental course of syntax

PT Stage	Syntax	Sample 1	2	3	4	5	6
5	Do, Aux 2nd	/	-	/	-	-	+
4	Cop Inv	-	-	-	-	+	+
	Y/N Inv	/	/	-	/	+	+
3	Do fronting	/	/	+	+	+	/
	Adv fronting	/	-	-	+	+	+
	Neg + Verb	-	+	+	+	+	+
2	SVO	+	+	+	+	+	+
1	Single word	+	+	+	+	+	+

Note. SVO = canonical word order. Neg + Verb = Negation + verb. Adv fronting = Adverb fronting. Cop Inv = Copula inversion. Y/N Inv = Yes/No inversion. Do, Aux 2nd = Do, Auxiliary second. "+" = acquired. "-" = not acquired. "/" = there is no context.

6. Conclusion

Dyson's (2009) study in which two ESL learners participated produced results which appear to counter PT. However, in this study, when a new analysis was done with Dyson's data, one of participants data showed an agreement with PT. In addition, when the target structures were divided into syntactic structure and morphological structure, each developmental course was in accordance with PT prediction to some degree.

I intend to test PT validity in a future study based on the supposition that the syntactic and morphological language systems of learners may be separated. It is important also to keep in mind Hatch and Lazaraton's statement that similarities in levels of items and in levels of proficiency will result in no scales being found. More detailed data and analysis are needed for the study.

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Notes

1. Dyson suggested that the different results as above were because of the Universal Property Hypothesis she proposed quoting Howkins' (2001).
2. In Table 5 for Philomena I thought a blank cell at sample 6 shows single word utterances did not appear. I discarded this cell from my calculations. Moreover, in Philomena's sample 3, Do, Auxiliary second (Do, Aux 2nd) was only produced once as a formula. I decided that Dyson's formula cannot reveal productivity and there was no obligatory context for Do, Auxiliary 2nd at the stage.

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