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Recoverability vs. Bisyllabicity: A Study of L2 Consonant Clusters

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ABSTRACT

Deletion and epenthesis are the main recoverability strategies that second language (L2) learners use to simplify consonant clusters. Some researchers argued that advanced learners usually display a larger amount of epenthesis than non-advanced learners. However, referring to the concept of bisyllabicity, some argued that L2 learners usually prefer words of two syllables, meaning that while words of one syllable would be mostly epenthesized, other strategies would be used for words of two syllables. This paper investigated recoverability and bisyllabicity through a corpus study followed by an experimental study. In the corpus study, the data were from L2 English learners from different L1 backgrounds. Results showed that advanced learners used epenthesis more than deletion, but non-advanced learners used the same strategy as advanced learners, confirming only one part of the recoverability claim. Similarly, words of one syllable involved more epenthesis than deletion, as suggested by the bisyllabicity principle, but words of two syllables also showed more epenthesis than deletion. The experimental study tested these two claims on Arabic-speaking L2 learners of English. Participants were provided with one-, two-, and three-syllable words containing initial, medial, and final consonant clusters. The advanced learners used epenthesis slightly less than deletion, while non-advanced learners demonstrated a significantly higher tendency to employ epenthesis compared to deletion. The results therefore suggested that although recoverability and bisyllabicity principles could not ultimately predict what modification strategy L2 learners used, they were still capable of predicting some of the participants' behavior.

Keywords: Bisyllabicity; Consonant Cluster; Deletion; Epenthesis; Recoverability

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1. Introduction

As an essential part of second language (L2) acquisition, phonological processes constitute the patterns and methods by which L2 learners adapt and produce L2 sounds. At the heart of these processes lie what has been termed recoverability[1] and bisyllabicity[2]. Flege[3] defined recoverability in terms of the learner's ability to accurately perceive, process, and produce phonological elements of the target language after initial exposure or learning attempts. According to this definition, recoverability concerns the three major aspects of the phonological processes involved in L2 acquisition.

First of all, the concept of phoneme clusters is important for the study of recoverability. In this respect, Abrahamsson[4] stated that studying the acquisition of phonology by first language (L1) or L2 learners involved not only individual speech sounds such as /s/ and /t/ in "star" but also how sounds are combined into sequences or clusters, such as /st/ in the same word. Moreover, studies have shown that certain phoneme clusters are particularly difficult for learners, referred to as "unfavorable clusters"[5, 6]. Deletion (the omission of one or more sounds), epenthesis (the insertion of one or more sounds), and feature change are among the main strategies that L2 learners employ to simplify clusters[1, 7–10]. In this context, Weinberger[10] argued that deletion causes a high degree of ambiguity. In the case of the word "bed" for example, if the final segment were deleted, many possible final segments could occur to the listener, such as "bet," "ben," "beck," "bell," and "bed." Another clear example illustrating this ambiguity is [wɛ], which could be understood as "when," "wet," "web," "wed," "well," and "Wes." Thus, deletion causes forms to be unrecoverable, resulting in ambiguity.

On the other hand, if the same word were to undergo vowel epenthesis: [bɛdə], the possibilities of perception, according to Weinberger[10], decrease to fewer words, such as "bedding" and "bedded." Vowel epenthesis thus generates recoverable forms, which means that the underlying form is preserved after adding an extra sound to the word. In the case of children's production, Weinberger claimed that deletion always preceded epenthesis and that "advanced learners typically should show a greater degree of epenthesis than non-advanced learners" (p. 299). This happens after adults become aware of the ambiguity their deletions could cause, in which case they employ epenthesis more often. Moreover, Abrahamsson[4] stressed the relationship between epenthesis/deletion and L2 proficiency level, claiming that epenthesis in particular correlated positively with increasing L2 proficiency.

In relation to recoverability, bisyllabicity is another major aspect of L2 phonological processes. It refers to the learner's use of bisyllabic forms. Wang[2] and Broselow et al.[11] stressed the preference of bisyllabicity among learners and that the choice of epenthesis or deletion was related to this preference; if the input is monosyllabic, the output should be bisyllabic, which requires speakers to epenthesize. Based on this argument, it would be tempting to assert that learners will choose epenthesis with monosyllabic forms, but if the input is bisyllabic, learners will prefer using strategies other than epenthesis. It can then be concluded that the foremost predictor of modification strategy is the number of syllables in a word, with individuals favoring bisyllabic over monosyllabic or trisyllabic forms[2, 11, 12].

This paper examined L2 learners' modifications of consonant clusters to identify which strategies were more likely to be employed by advanced and non-advanced learners and to what extent these learners employed particular strategies, focusing on the two types of modification outlined above. Numerous studies have dealt with this issue of modification and the types of modification used by L2 learners, but the reasons learners use one type and not the other is not thoroughly explained[11]. As such, the paper sought to answer the following research questions:

1. Do advanced L2 learners of English display more epenthesis or deletion when simplifying clusters?
2. Do non-advanced L2 learners of English display more epenthesis or deletion when simplifying clusters?
3. Does the number of syllables affect the modification strategies used by L2 learners?

Following the recoverability principle[1], the study suggests that advanced learners should show more epenthesis than non-advanced learners. By contrast, based on the principle of bisyllabicity, the study predicts that advanced and non-advanced learners both prefer bisyllabic words, and hence epenthesizing one-syllable words and using other strategies, apart from epenthesis, for words of two or three syllables[2, 11, 12]. The paper examined recoverability and bisyllabicity by drawing data from a corpus study and an experimental study.

2. Materials and Methods

2.1. The Corpus Study

2.1.1. Instrument and Participants

Using corpus data, the researcher sought to include as many participants from different language backgrounds as possible. The stimulus items contained 19 onsets. The data were extracted from a passage that was read by L2 learners from the Speech Accent Archive[13]. In this corpus, participants were asked to read a passage and were recorded. The passage had several instances of word-initial consonant clusters. The L1s of the learners tested in this study were Arabic, Cantonese, Farsi, Japanese, Korean, Mandarin, and Spanish. These languages were chosen for two reasons. First, the available data in the archive for them were greater than other languages. More importantly, these languages were considered to be more restricted than English in allowing clusters in the onset. There were two groups for each language: advanced and non-advanced learners. For each language sample, only those that were already phonetically transcribed were included in the study.

2.1.2. Procedure

The data were collected manually in an Excel sheet. Every occurrence of epenthesis and deletion in an onset cluster was counted and documented. Thus, there was no intention to consider the correct production or modifications to the onset clusters other than epenthesis and deletion. The observed clusters included **pl**ease, **St**ella, **br**ing, **st**ore, **sp**oons, **fr**esh, **sn**ow, **sl**abs, **bl**ue, **sn**ack, **br**other, **sm**all, **pl**astic, **sn**ake, **fr**og, **sc**oop, **thr**ee, **tr**ain, and **st**ation. Four of the words had two syllables (Stella, brother, plastic, and station), whereas the rest consisted of one syllable each.

The collected data were divided into two sets according to proficiency, advanced and non-advanced, after referring to the demographic information for each participant. Advanced learners referred to those who were exposed to English at the age of five or younger, whereas those who were six or older when they were first exposed to English were regarded as non-advanced. This followed from previous studies that have highlighted the significance of age of onset in L2 proficiency[14–18].

In a study by Granena and Long[18], age of onset was a robust determining factor in L2 acquisition. Although older children and adults have the tendency to progress faster through the initial stages of acquiring L2 morphology and syntax, the chance of achieving a high level of L2 proficiency is reduced as age of onset increases. The length of stay in the L2-speaking country was not a significant factor. Thus, only age of onset was considered when determining the proficiency of participants based on the demographic information accessible to the researcher in the corpus.

Some of the data had transcriptions available in the corpus, which were trusted by the researcher and built upon. The rest had no transcriptions and so were removed from the data.

2.1.3. Data Analysis

A total of 4,598 onset cluster samples were analyzed. Each of the 242 participants produced 19 samples. Any correct production of the onset clusters or modification other than epenthesis or deletion was coded and ignored. Thus, only those modified by deletion or epenthesis were considered. **Table 1** displays the languages featured in this study and the number of onset clusters that were tested and analyzed for each language.

The Speech Accent Archive[13] had transcriptions available for most of the recorded samples in the corpus. In an Excel worksheet, the occurrence of epenthesis and deletion was manually calculated.

Table 1. Onset clusters analyzed by L1 and number of speakers.

Language	Number of Speakers	Onset Cluster	Total
Arabic	61	19	1,159
Cantonese	21	19	399
Farsi	16	19	304
Japanese	16	19	304
Korean	26	19	494
Mandarin	29	19	551
Spanish	73	19	1,387
Total	242		4,598

2.2. The Experimental Study

2.2.1. Instrument

The stimuli consisted of 21 items with consonant clusters word initially, medially, and/or finally. Of these, 13 items had only one position to be tested, e.g., "stream," seven items had two positions, e.g., "prince," and one item had three positions ("practiced"). Each item was produced twice in the carrier phrase "I said [target] once." The clusters that were included in this experiment were **cl**ue, co**nf**ide**nt**, **fl**ag, **plast**ic, su**btract**, **str**eam, **draft**, **tr**aceable, boa**rd**, **prince**, e**xtr**eme, **fl**awless, **practiced**, **tr**ouble, **fruitf**ul, **cl**assify, **gr**ocery, **prac**tical, a**rmed**, **cr**ucial, and **gr**own. Only one had a four-consonant cluster (in medial position), three had a three-consonant cluster (one initial and two medial), and 26 had a two-consonant cluster (15 initial, five medial, and six final).

2.2.2. Participants

Participants consisted of 42 Saudi Arabic speakers who learned English as a foreign language; 21 were non-advanced learners and 21 were advanced. Their proficiency was determined based on their level in studying English. Non-advanced learners included diploma students who enrolled in the first year of their studies and the placement test determined their basic English level. Advanced learners, on the other hand, were English-major undergraduate students in their final year and students in the second year of their master's in applied linguistics.

2.2.3. Procedure

Participants were invited to participate through word of mouth by their instructors during their regular classes. They were asked to articulate certain English sentences, and they were informed that they would be audio recorded while producing them. The recording process was supervised by the researcher in a lab in Majmaah University. Each participant spent less than five minutes producing the stimuli, and each was recorded individually. PRAAT was used for recording and analyzing the data[19]. The researcher annotated every pronunciation of consonant clusters (initially, medially, finally) and determined whether it was pronounced correctly or with modification. Modifications were labeled as prothesis, anaptyxis, C1 deletion, C2 deletion, C3 deletion, or something else. The stimuli were randomly organized with a few distracters. Participants were asked to read the target words twice within the carrier phrase.

2.2.4. Data Analysis

A total of 1,764 consonant cluster samples were analyzed. Each of the 42 participants produced 21 samples twice. In this experiment, every correct and incorrect production of the consonant clusters was coded and analyzed. **Table 2** displays the number of participants in this study, their proficiency level, and the number of consonant clusters that were tested and analyzed for each participant. In an Excel worksheet, the occurrence of correct and incorrect alongside the strategies used (epenthesis, deletion, or other) was manually calculated.

Table 2. Items analyzed by L1 and number of speakers.

Proficiency Level	Number of Speakers	Total Items Analyzed
Advanced	21	882
Non-advanced	21	882
Total	42	1,764

3. Results

3.1. Corpus Study Results

Table 3 presents the languages used in this study, speaker proficiency, number of speakers, and the type of modification used by each group of learners.

The results revealed that advanced learners modified onset clusters using epenthesis more often than deletion, answering the first research question. Epenthesis was used 82% of the time to modify an onset cluster, while deletion was used only 18% of the time. The results for the advanced learners appeared to support the prediction of the study. The paper suggested that advanced learners would show a greater amount of epenthesis than deletion when modifying clusters, which followed from the recoverability principle[1].

Table 3. Onset clusters analyzed by L1, proficiency level, and modification occurrences.

Language	Proficiency	Number of Speakers	Deletion	Epenthesis
Arabic	Advanced	10	0	9 (100%)
	Non-Advanced	51	3 (6%)	44 (94%)
Cantonese	Advanced	14	2 (50%)	2 (50%)
	Non-Advanced	7	4 (67%)	2 (33%)
Farsi	Advanced	1	1 (100%)	0
	Non-Advanced	15	3 (5%)	64 (95%)
Japanese	Advanced	0	–	–
	Non-Advanced	16	2 (33%)	4 (67%)
Korean	Advanced	0	–	–
	Non-Advanced	26	3 (20%)	12 (80%)
Mandarin	Advanced	3	0	0
	Non-Advanced	26	6 (29%)	15 (71%)
Spanish	Advanced	5	0	3 (100%)
	Non-Advanced	68	4 (3%)	138 (97%)
Total	Advanced	33	3 (18%)	14 (82%)
	Non-Advanced	209	25 (8%)	279 (92%)

The second research question asked whether non-advanced learners would use epenthesis or deletion more often. As the results showed, epenthesis (92%) was used more than deletion (8%), which was the opposite of what this paper predicted. It was anticipated that non-advanced learners would show more deletion than epenthesis, according to the recoverability principle [1].

As for the third question, regarding bisyllabicity, epenthesis was used the most across the board. That is, both one- and two-syllable words showed epenthesis more frequently than deletion. For instance, the two-syllable word "Stella" showed epenthesis eight times and deletion only once. A more rigorous study at this point was needed to test the principle of bisyllabicity more precisely.

Thus, an experimental study was also carried out to include words of one, two, and three syllables, which would mainly answer the third research question. Another objective was to have a clear definition of which learners should be considered advanced or non-advanced. While age of onset is a significant predictor and was the basis of the corpus study data, a more precise categorization was needed to test the principles of recoverability and bisyllabicity, as they based their assumptions mainly on these two categories, advanced and non-advanced. Finally, because the data in the corpus had all these consonant clusters in different environments, an experimental study where the environment for all these consonant clusters could be controlled was needed for more robust findings.

3.2. Experimental Study Results

A high number of instances were tested on advanced and non-advanced learners in the laboratory to ensure the reliability of the results. Each group was exposed to 882 instances with the purpose of identifying the dominant strategy being employed by each group when modifying them. One of the most significant findings obtained was provided by the pronunciation proficiency test. For instance, **Figure 1** indicates that advanced learners articulated 84% of the given instances correctly. By contrast, non-advanced learners were able to produce only about 45% of the instances correctly. The employed test validated the study's approach in the initial group classification, thereby contributing to the reliability of the results.

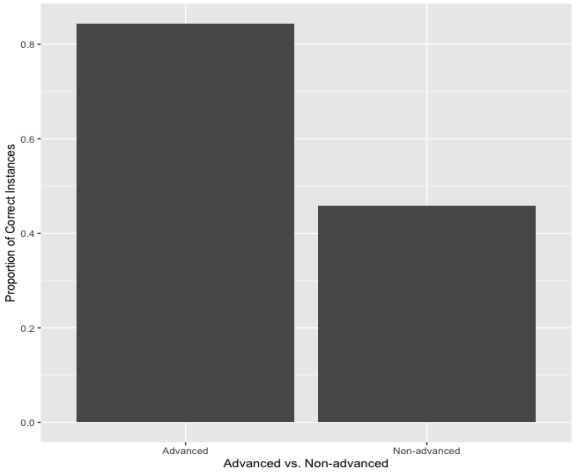

Figure 1. Results for proportion of correct responses.

Advanced learners exhibited a slight preference for deletion (27% out of total incorrect instances) over epenthesis. This preference was substantiated by an insignificant proportion of advanced learners employing only epenthesis (less than 19%). Non-advanced learners, in contrast, showed a preference for epenthesis, with over 27% of total incorrect instances, over deletion, employed in less than 11%. All participant responses were analyzed qualitatively and quantitatively.

4. Discussion

This study investigated the principles of recoverability and bisyllabicity by testing related assumptions on L2 learners. Recoverability suggests that between deletion and epenthesis, advanced L2 learners will tend to opt for epenthesis when modifying complex structures, while non-advanced learners are expected to favor deletion.

Bisyllabicity, on the other hand, suggests that L2 learners' preference when modifying complex structures, e.g., consonant clusters, is based on the number of syllables; that is, learners prefer to have words of two syllables. Thus, when provided with one-syllable words, they will probably epenthesize more frequently, but when provided with three-syllable words, they will probably delete a syllable.

4.1. Recoverability

In the corpus data, the principle of recoverability was tested on several L2 learners from different backgrounds. The first claim concerning the advanced learners was confirmed. That is, as Weinberger[1] suggested, advanced learners used epenthesis more often than deletion. Although the use of modification in general within this group was not high, the difference between using deletion and epenthesis was confirmed, with epenthesis used 82% of the time and deletion only 18%.

Comparing advanced and non-advanced learners' responses, it was not surprising to find the latter modifying clusters more (in 304 instances) than the former (in 17 instances). Excluding Japanese and Korean speakers, who did not have advanced learners, only learners of two out of the five backgrounds (Cantonese and Farsi) used deletion. Similarly, only speakers of Arabic, Cantonese, and Spanish used epenthesis.

The data appeared to contradict the second part of the recoverability claim. **Figure 2** shows that the non-advanced learners for the most part showed the exact opposite of what was expected, as they displayed more instances of epenthesis than deletion. Only Cantonese L1 speakers showed more deletion than epenthesis. The rest exhibited more epenthesis; the Spanish group showed the biggest difference with 97% of modifications being epenthesis, followed by Farsi (95%) and Arabic (94%). In general, the difference between deletion and epenthesis among non-advanced learners was also high, with 92% favoring epenthesis and only 8% deletion.

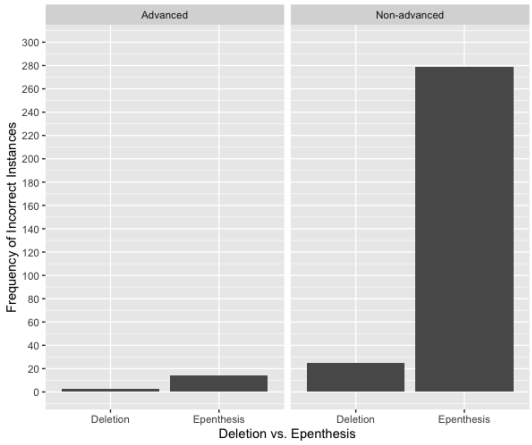

Figure 2. Results of corpus study for advanced vs. non-advanced learners.

The experimental study supported the corpus data. All L2 learners in the experimental study were native Arabic speakers who learned English as a foreign language. The experimental data were meant to have more instances where errors could be found. The comparison between deletion and epenthesis for advanced and non-advanced learners would thus be more vividly apparent. Out of 141 instances where advanced learners made errors, **Figure 3** indicates that only 26 instances (18%) displayed epenthesis and 38 (27%) deletion. On the other hand, non-advanced learners showed 485 errors, in which epenthesis was used as a strategy to simplify clusters 132 times (27%) while deletion was used only 52 times (10.7%). The results did not entirely conform to the assumptions of the recoverability principle.

4.2. Bisyllabicity

Another assumption that was tested was whether speakers' modification of words tended to result in two-syllable

words, as suggested by Broselow et al.[11]. The corpus study contained one-syllable words, which were expected to be epenthesized more frequently, and two-syllable words, which were not expected to be epenthesized. However, this claim was not entirely supported by the data. While words of one-syllable showed more epenthesis (91%) than deletion (9%), words of two syllables also showed more epenthesis (89%) than deletion (11%).

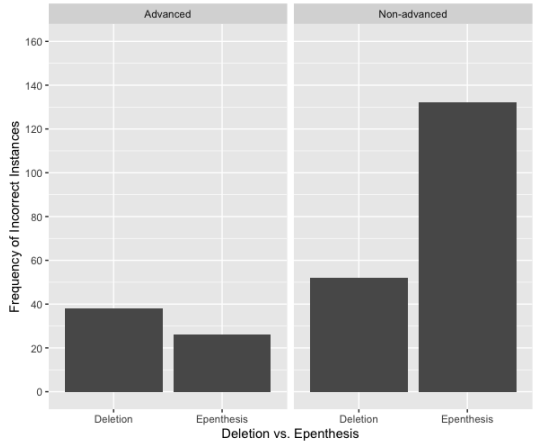

Figure 3. Results of experimental study for advanced vs. non-advanced learners.

The second experiment contained one-, two-, and three-syllable words. Again, the claim of bisyllabicity was not fully supported by the data, especially with words of two and three syllables. Only words of one syllable demonstrated some conformity with the claim; participants epenthesized in 85 words, making them two-syllable words, and deleted sounds in only 33 words. As for two-syllable words, 80 were epenthesized and 62 showed deletion. Similarly, 14 three-syllable words were epenthesized and 13 employed deletion. Taking the grand total of 575 two-syllable words introduced to the participants and the grand total of 587 two-syllable words they produced, this did not support the claim of bisyllabicity. However, bisyllabicity could effectively explain the behavior of one-syllable words, as participants frequently preferred simplifying them into two-syllable words.

4.3. Potential Solution

Since neither principle put forward by Weinberger[1] and Broselow et al.[11] fully explained the data, it might be that one principle could explain some behaviors and the second could explain the others. That is, non-advanced learners encountering one-syllable words containing consonant clusters may epenthesize more, confirming the two-syllable constraint suggested by bisyllabicity. When they delete, less often, this confirms the recoverability constraints. Another interesting explanation could be that modifying structures by deletion, epenthesis, or feature change is based on the L1 of the learners. That is, some languages may prefer one simplification strategy over another[20–23].

5. Conclusions

This study tested whether the principle of recoverability could explain L2 learners' strategies for simplifying complex structures in various languages. This principle claims that advanced L2 learners should show epenthesis as a simplification strategy more often than deletion, while non-advanced learners should show more deletion than epenthesis[1]. The principle of bisyllabicity was also tested. It claims that L2 learners prefer words of two syllables, so their strategies when simplifying consonant clusters are based on this preference, i.e., result in two-syllable words[11]. The paper used a corpus-based study and an experimental study to answer the research questions.

In the corpus study, several languages were tested, including Arabic, Cantonese, Farsi, Japanese, Korean, Mandarin, and Spanish. These languages were chosen because they were considered more restrictive than English in allowing consonant clusters[24]. In addition, they had the largest data available in the Speech Accent Archive[13], compared to other languages. The results confirmed one part of the recoverability claim but failed to support the other. Namely, advanced learners showed more use of epenthesis, but non-advanced learners did not show more use of deletion, as the claim predicted.

In a similar vein, only part of the bisyllabicity principle's claim was observed in the data. That is, the resulting syllables after modification were not always two syllables as predicted. Only words of one syllable were mostly modified by epenthesis—making them two syllables—compared to deletion. This trend of preferring two-syllable words was not observed across the board, as words of two syllables showed more epenthesis than deletion, and three-syllable words showed a similar number of epentheses and deletions. In sum, the total number of two-syllable words produced

by the participants was not larger than the number of words they had been given, as the bisyllabicity principle would suggest.

The experimental study revealed that the advanced and non-advanced learners showed opposing tendencies. While advanced learners marginally favored deletion over epenthesis, non-advanced learners tended to use epenthesis as their dominant strategy. To some extent, this study corroborated the corpus study results and challenged the claims of Weinberger[1] and Broselow et al.[11]. The recoverability and bisyllabicity principles were not fully supported, which might be due to the learners' backgrounds. The interference of L1 in L2 appeared noticeable, opening the door to further research on this issue. Moreover, L2 teachers are recommended to highlight these simplification strategies in order to significantly enhance the learners' overall communication skills and intelligibility in their L2.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of MUREC, and approved by the Institutional Review Board of Majmaah University (protocol code H-01-R-088 and date of approval 25-12-2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data and materials used in the corpus study can be found at http://accent.gmu.edu. Data and materials used in the experimental study are available upon reasonable request from the author.

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Conflicts of Interest

The author declares no conflict of interest.

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