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Brazilian Learners' Production of Initial /s/ Clusters: Phonological Structure and Environment

por

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To the person who, even knowing
very little about academic life, understood
what I needed through the language of love:
my mother

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Abstract

Brazilian Learners' Production of Initial /s/ Clusters: Phonological Structure and Environment

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This study is a partial replication of Rebello (1997a, 1997b) and Rauber (2002) on the production of English initial /s/ clusters by 20 Brazilian learners, who recorded a list of unrelated sentences containing the initial /s/ clusters immediately preceded by environments of vowels and obstruent (fricative and stop) consonants. Some inconsistent findings of these two previous studies motivated the development of this research. Vowel epenthesis was found to be the most common strategy used by the participants to produce the target pattern. The hypothesis that, according to the Markedness Differential Hypothesis (MDH), the more marked /sCC/ structures would yield a higher rate of epenthesis than the /sC/ clusters was neither confirmed nor rejected. The prediction that clusters in violation of the Syllable Structure Condition (SCC) – /s/ + stop – would yield more epenthesis than clusters not in violation – /s/ + sonorant – was not confirmed either. On the contrary, clusters not in violation proved to be more inclined to yield epenthesis than clusters in violation of the SSC. An important aspect revealed was that voicing assimilation proved to be a more powerful constraint influencing the rate of epenthesis than markedness concerning cluster length or sonority sequencing. Voiced environments were also shown to result in epenthesis more frequently than voiceless ones. The results confirmed that vocalic contexts yielded a higher rate of epenthesis than consonant contexts. Major's Ontogeny Model (OM) was strongly supported by the findings as the more proficient the participants, the less frequent the production of epenthesis.

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Resumo

A Produção de Encontros Consonantais Iniciados por /s/ em Inglês por Estudantes Brasileiros: Estrutura Fonológica e Ambiente

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Este estudo é uma réplica parcial de Rebello (1997a, 1997b) e Rauber (2002) sobre a produção de encontros consonantais iniciados por /s/ em inglês por 20 estudantes brasileiros, os quais gravaram uma lista de sentenças contendo os encontros consonantais iniciados por /s/ imediatamente precedidos por ambientes de vogais ou consoantes fricativas e oclusivas. Algumas descobertas inconsistentes destes dois estudos anteriores motivaram o desenvolvimento desta pesquisa. Verificou-se que a epêntese vocálica é a estratégia mais comum usadas pelos participantes para produzir o padrão desejado. A hipótese que, de acordo com a Hipótese do Diferencial de Marcação (MDH), as estruturas mais marcadas /sCC/ produziriam uma proporção maior de epêntese que os encontros consonantais /sC/, não foi nem confirmada nem rejeitada. A previsão de que os encontros consonantais que violam a Condição de Estrutura Silábica (SSC) – /s/ + oclusiva – produziriam mais epêntese que os encontros consonantais que não violam tal condição – /s/ + soantes – não foi confirmada tampouco. Pelo contrário, os encontros consonantais que não violam a SSC mostraram estar mais propensos a produzir epêntese que os encontros que a violam. Um aspecto importante revelado foi que a assimilação do vozeamento provou ser uma restrição mais forte que a marcação ao influenciar a proporção de epêntese em relação ao comprimento dos encontros consonantais ou à seqüência de sonoridade. Os ambientes vozeados também resultaram em epêntese mais freqüentemente que os não vozeados. Os resultados confirmaram que os ambientes vocálicos produziram uma proporção maior de epêntese que os ambientes consonantais. O Modelo de Ontogenia (OM) de Major foi fortemente sustentado pelas descobertas já que quanto mais proficiente era o participante, menor a freqüência na produção de epêntese.

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Chapter 1
Introduction

The acquisition of a foreign or second language can be a difficult and intriguing task, especially concerning the acquisition of certain pronunciation patterns. As a matter of fact, that can be easily noticed in EFL and ESL classrooms, where many students reach the point of native-like competence in grammar and lexicon, but few of them will reach the same competence in pronunciation.

There are some constraining factors on the acquisition of a native-like pronunciation in a foreign or second language. Leather & James (1996) mention some constraints: motivation, social acceptance and social distance, personality variables, sex, and oral and auditory capacities. Thus, the more the learner is concerned with the achievement of a "good" pronunciation the more successful s/he is likely to be. The authors, citing Abercrombie (1963), state that " for the majority of school and nonspecialist adult learners, a reasonable goal is to be 'comfortably intelligible' and to sound socially acceptable" (Leather & James, 1996, p. 270).

Besides the individual and social constraints pointed out by Leather and James (1996), there are also some internal factors that are responsible for the occurrence of certain linguistic variants in the learner's interlanguage[1]. As internal constraints, Carlisle (1994) points out *markedness* and *environment.* According to Eckman (1991), investigators have followed two linguistic theories in the study of second language acquisition (SLA). One of them is to explain SLA through typological universals, whose basis of formulation is the world's primary languages, and the other one is through principles of Universal Grammar (UG), which explain facts about the acquisition of a first language and can be used to explain facts regarding the acquisition of a second language.

[1] The language actually spoken by the learner at any particular stage of development.

The present research is concerned with the production of the pronunciation of initial /s/ clusters by Brazilian EFL learners, having as a pre-established hypothesis that the environment preceding the initial /s/ clusters plays a special role in the hierarchy of difficulty of their pronunciation. Carlisle (1994) demonstrated in his study that epenthesis is a common strategy used by Spanish-speaking ESL learners trying to pronounce initial /s/ clusters. He also schematized a hierarchy of difficulty in which epenthesis would be more or less likely to occur, depending on the environment preceding that cluster.

Important studies done with Brazilian EFL learners on the production of English initial /s/ -clusters were carried out by Rebello (1997a, 1997b) and Rauber (2002). The data were analyzed "based upon universals of syllable structure, strength relations within the syllable and syllable contact (Hooper, 1976; Murray & Vennemann, 1983) with the Markedness Differential Hypothesis (MDH) and the Structural Conformity Hypothesis (SCH) (Eckman, 1977; 1991) as the predictors of learner's difficulties" (Rebello, 1997, p. 336).

One of the reasons for this research is that Rebello's and Rauber's findings were quite different from Carlisle's concerning the preceding environment: Rebello's and Rauber's results contradict those of Carlisle (1991,1994), who found the frequency of epenthesis to be greater after word-final consonants than after word-final vowels. Another important difference is related to the length of the cluster: there was no significant difference[2] in percentage in the frequency of epenthesis for /sC/ clusters and /sCC/ clusters in Rebello's study, while in Rauber's and Carlisle's findings the results support the MDH; that is, longer clusters are more frequently modified. Besides that, in Carlisle's study epenthesis was found to happen less frequently before the initial /s/ + nasals and liquids than before /s/ + stops,

[2] An statistical test (chi-square) was applied using her numbers to get this conclusion.

whereas in Rebello's it was the opposite. I want to confirm whether Brazilian EFL learners do have a different hierarchy of difficulty from that of Spanish speakers.

The thesis is organized in five chapters: Chapter two contains the review of the literature about syllable structures of English and Portuguese as well as some theories concerning SLA. Chapter 3 describes the hypothesis, material and procedures for data collection, and statistical analysis. Chapter 4 presents results with their analysis and discussion. Chapter 5 reports the conclusion regarding theoretical and pedagogical implications, limitations and suggestions for future research.

Chapter 2
Review of the Literature

For those who have little or no knowledge of what learning a language means, this process is most commonly seen as a task of memorizing words and their corresponding sounds, and placing them in a "correct way" in order to communicate ideas. From this simplistic perspective, we can perceive two important views of what learning a language may involve. First, people have intrinsically the notion of rules. You do not only put words together, but they have to come in a permissible structure so that they are able to express logical thoughts. Second, a language consists of units, that is, people in general understand that the words are the units of a language.

When we think of expressing thoughts, this can be done in at least two forms, written and oral. For the purpose of this study, oral speech discourse is the medium that will be the object of analysis. Kreidler (1989) states that a discourse is composed of utterances, which are composed of tone units. He also states that "a tone unit consists of at least one SYLLABLE and usually a number of syllables" (p. 06). For a phonological study, which is the aim of this thesis, it is of primordial importance to understand the structure of a syllable in its universal aspects, as well as the aspects of the languages that are object of this study. As Kreidler (1989) points out, the syllable consists of a vocalic element(s), with the possibility of non-vocalic element(s) before and after it.

2.1 – Aspects of Syllable Structure

It is a very hard task to try to define the syllable because there is not a single definition agreed upon among phonologists. What we can do is to analyze some aspects concerning the syllable. It can be compared to an atom, which is the smallest particle of a chemical element and yet divided into smaller parts internally. For phonological purposes, the syllable is the

smallest pronounceable part of words. It can be a word itself. Nevertheless, syllable structure contains internal segments. As Major (2001) states, "all languages have syllables composed of consonants and vowels. Many languages can have syllables of only vowels, (e.g., English *owe*) but only a very few languages can have syllables and even whole words composed exclusively of consonants, (e.g., Berber *trkst* 'hide', *txdmt* 'gather wood')."

Among the possibilities of syllable formation, the universally preferred structure is CV. Carlisle (1994) states that "this syllable type is an absolute substantive universal, and the presence of any other syllable type implies the presence of the CV syllable" (p. 226). Therefore, it is a typological universal and also the most basic level of an implicational hierarchy of syllable formation. "On a universal level, the CV syllable is the optimal syllable. There is no language that does not allow a syllable type CV, and there are some languages that allow this type and no other" (Hooper, 1976: 199). Corroborating the above statements, Major (2001) points out that a VC type syllable implies CVC and CV syllables, but the opposite is untrue. Katamba (1989) claims that many languages have syllables with only a V:

> Such languages may be assumed to have a rule at the entry to the phonological component which deletes the syllable initial C and thus allows canonical syllables with V only. Languages may also have CVC syllables which are obtained by a rule which adds a C after the V element to form canonical CVC syllables (Katamba, 1989; p. 160).

Hooper (1976) points out that there are many other complex syllable structures besides the favored CV. There are syllable-initial and syllable-final consonant clusters of different lengths in different languages. The length of the syllable does not happen in a random manner. According to Hooper (1976), strength relations influence syllable formation and the possible consonantal positions in a syllable. *Strength* and *sonority* are inversely related compared on a scale of values. For the purpose of this thesis, *strength* refers to the manner of articulation, the strongest consonant sound being the one which most obstructs the air stream, so we could say that voiceless stops are the strongest consonant sounds, and glides the weakest ones. *Sonority*, then, is related to voicing: "the greater the propensity a sound has of

spontaneous voicing, the more sonority it has" (Katamba, 1989: 104). Contrastively, in a sonority hierarchy, vowels and glides are the most sonorous while the voiceless stops are the least sonorous. Hooper (1976, p. 206) establishes the following universal strength hierarchy:

Glides	liquids	nasals	Voiced continuants	voiceless continuant voiced stops	voiceless stop
1	2	3	4	5	6

If we compare the strength hierarchy above with the sonority scale provided by Selkirk (1984, p. 112) it will be possible to verify that they are inversely related. When justifying her theory for the elimination of the major class features [+syllabic], [+consonantal], and [+sonorant], she proposes that all major class features be replaced by a sonority hierarchy, as follows:

Sound	Sonority Index (provisional assignment)
a	10
e, o	9
i, u	8
r	7
l	6
m, n	5
s	4
v, z, ð	3
f, θ	2
b, d, g	1
p, t, k	.5

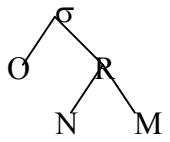
Selkirk (1984) defines natural class in terms of a sonority continuum, or hierarchy: "Any set of segments with the *same sonority index* or with *consecutive sonority indices within designated limits* forms a natural class" (p. 111). She states that "natural classes defined in this way, and only these, are relevant for characterizing syllable structure in natural language" (1984, p. 112).

Hogg and McCully (1987) provide a similar sonority scale, reproduced in Table 1. In this scale, the authors illustrate the relative degree of sonority of a number of specific sounds.

Table 1: Sonority scale according to Hogg & McCully (1987)

Sounds	Sonority values	Examples
low vowels	10	/a,ɑ/
mid vowels	9	/e,o/
High vowels	8	/i,u/
Flaps	7	/ɾ/
Laterals	6	/l/
Nasals	5	/m,n,ŋ/
Voiced fricatives	4	/v,ð,z/
Voiceless fricatives	3	/f,θ,s/
Voiced stops	2	/b,d,g/
Voiceless stops	1	/p,t,k/

While Natural Generative Phonology may have been the first phonological theory to give due importance to the syllable, two recent models describe the syllable in a non-linear approach: the autosegmental and the metrical. Katamba (1989) reports that metrical phonology, which is concerned principally with stress phenomena, complements autosegmental phonology, which was originally conceived for the description of tone. As the two concepts are not diverging, they will be helpful for understanding the strength relations in syllable structure described by Hooper (1976), within the theory of Natural Generative Phonology. Katamba (1989) shows that syllable structure can be represented as follows:



Note: σ = syllable, O = onset, R = rhyme, N = nucleus and M = margin (coda)

Hooper (1976) points out that as a universal position, the nucleus of the syllable is the dominant part and is usually a vowel. She adds that "the margins of the syllable (the onset and the coda) provide a contrast with the nucleus: The consonantal release produces the minimum amount of energy and the vocalic nucleus the maximum amount of energy"(p. 198). We can conclude that the higher the sonority (the more vowel-like) of a consonant, the closer to the nucleus it is expected to be.

Based on her universal strength hierarchy, Hooper (1976, p. 229) proposes the universal SSC (syllable structure condition) as follows:

Universal condition on preferred syllable structure:
P (C): $\$C_mC_nC_pC_qVC_rC_sC_t\$$
Where $m > n > p > q$
$r > s > t$ [sic][3]
$m > t$
$m > ø$

Since the nucleus is the most sonorous part of the syllable, the consonants are usually placed in a descending order from the edges to the nucleus, regarding the strength value (or ascending order, regarding sonority). "The condition m > t means, in this context, that for the SSC of any given language, the strongest C permitted in syllable-initial position must be stronger than the strongest C permitted in syllable-final position" (Hooper, p. 230). And the condition m > ø means that the structure \$CV\$ is present in any given language. In general, most languages follow this principle, although we will find a few cases of languages that violate it for a particular motivation. An example is the English /s/ + stop clusters. Selkirk (1984) names this condition the *Sonority Sequencing Generalization* (SSG): "In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values" (p. 116). As can be noticed, some languages allow long consonant clusters in initial position and in final position. Arbitrarily,

Hooper (1976) decided for an example of four consonants in initial position and three in final position to demonstrate her SSC.

Greenberg (1978) presents, in his universals regarding initial and final clusters, the property of resolvability, which is particularly important to observe in the structure of syllables. Greenberg (1978, p. 250) states that "every initial or final sequence of length $\underline{m}$ contains at least one continuous subsequence of length $\underline{m - 1}$". The resolvability can be complete or partial. It is considered completely resolvable if every continuous subsequence also occurs, for instance, if in a language the initial cluster /spgr/ occurs, then it will be completely resolvable if /sp/, /pg/, /gr/, /spg/, and /pgr/ also occur. If one or more of these do not occur, then it is partially resolvable, and if none occurs, it is non-resolvable.

Regarding general syllable structure, I believe the most prominent considerations have been made here. Further information about the structure of the languages involved in this research will be provided in the following sections.

2.1.1 – English Syllable Structure

According to the structure proposed by Selkirk (1982), the syllable is composed of the *onset* and the *rhyme*. A consonant or consonant cluster placed at the beginning of the syllable forms the *onset* and the rest of the syllable is the *rhyme*, which is divided into two parts: the *peak* and the *coda*. The peak or nucleus is the syllabic part and the coda is the final consonant or consonant cluster.

English Syllable Structure allows up to three onset consonants and up to four coda consonants (Anderson, 1987). As the initial clusters are the concern of this study, I will present some considerations regarding the onset. Giegerich (1992) states that syllables do not need to have onsets and if there is an onset, it may contain one consonant position or two.

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[3] The arrows should be pointing toward the opposite direction.

Three consonant positions in the onset give some ill-formed syllables. “The two-position onset constitutes some kind of upper limit on the complexity of this phonological unit” (Giegerich, 1992; p. 138). However, what can be said about the well-formed syllables in the words *spray, strange, screen*? In Giegerich’s (1992) point of view, the /s/ in /st/, /str/, etc. has an odd behavior as “it violates the sonority-based definition of the syllable” (p. 138), and where there are three consonant positions in the onset, the /s/ will always be the first one.

Adapting Hooper’s (1976) SSC to English syllable structure, the following schema would be possible: $\$C_mC_nC_pVC_qC_rC_sC_t\$$. There will be always a vowel (or in some cases a sonorant consonant), which is the nucleus. English syllables allow longer consonant clusters in final position than in initial position. From this perspective, it is possible to state that English codas have a more marked structure than English onsets. Here, besides the consideration regarding the strength scale, whose values would decrease from the edges to the nucleus (or the sonority scale, whose values would increase from the edges to the nucleus), it would be important to remark that, according to Giegerich’s (1992) claims, C_m must be /s/.

Some possible syllable structures would be:

CV = *see*
CCV = *sky*
CVC = *sit*
CVCC = *sand*
CCCV = *spry*
CCVCC = *stand*
CCCVCC = *sprint*
CCVCCC = *twelfth*
CCCVCCC = *strength*

2.1.2 – Brazilian Portuguese Syllable Structure

Brazilian Portuguese syllable structure follows more closely the universal tendency for a CV syllable formation. As we will see below, it does not allow more than two consonants in initial and/or final positions, and very few consonants can occur in final position or in clusters. Collischonn (1999, p. 107) gives us some examples of Portuguese syllable patterns, as follows:

V = *é*

VC = *ar*

VCC = *instante*

CV = *cá*

CVC = *lar*

CVCC = *monstro*

CCV = *tri*

CCVC = *três*

CCVCC = *transporte*

VV = *aula*

CVV = *lei*

CCVV = *grau*

CCVVC = *claustro*

Baptista (1987) proposes a distribution chart concerning strength relations in Portuguese based on those described by Hooper (1976) for Spanish. According to Baptista (1987), Portuguese allows up to two consonants in syllable initial and final positions:

$$\$C_mC_nVC_pC_q\$$$

C_m1 = /p, t, k, b, d, g, f, v/ = initial, may be followed by C_n

C_m2 = /s, ʃ, z, ʒ, m, n, ŋ, l, ʎ , r, ɾ/ = initial, may not be followed by C_n

C_n = /r, l, w/ = may follow C_m1 (/w/ follows only /k/ and /g/)

C_p = /y, w/ = may follow V; may be followed by C_q1 (as in Spanish, /r/ occasionally occurs in this position)

C_q1 = /s/ = may follow V and/or C_p

C_q2 = /s, m, n, l, r or ɾ/ = may follow V (/m/, /n/, and /l/ are doubtful in this position).

However, Baptista's (1987) analysis does not account for word-internal occurrences of syllable-final nasal plus /s/ or /r/ plus /s/.

As we are concerned with syllable initial clusters, it is appropriate to give some examples of the ones occurring Portuguese, having the above chart as reference. Some examples are: ***preto, trazer, cravo, bravo, dragão, grade, frio, lavrador, planeta, atleta, tecla, tablado, glacial, flácido, quando e igual.***

2.2 – Aspects of Syllable Contacts

Besides being concerned with syllable structure, it is important to be aware that the words are not all monosyllabic, many of them are polysyllabic and therefore we have to analyze the contact between syllables. This contact may cause odd implications in addition to those related specifically to a single syllable. Hooper (1976) claims that a syllable structure condition for syllable boundaries is necessary, stating that "a syllable-initial C be stronger than the immediately preceding syllable-final C"…" if XVCr$CmV, and there is no pause between Cr and Cm, then m>r" (p.220).

2.3 – Theories of L2 Acquisition

As it is my intention to analyze the production of initial /s/ clusters by Brazilian Portuguese speakers who are learning English, it is obviously essential that some theories concerning L2 acquisition be presented here.

2.3.1 – Contrastive Analysis Hypothesis

The Contrastive Analysis Hypothesis (CAH) has two versions. The first one, named the strong form, had as a principal exponent Lado (1957; cited in Eckman 1977). Basically, he claimed that when learning a second language, the differences between the two languages would predict difficulties for the learner, whereas similar structures would be easy to acquire. The second one, named the weak version, was less predictive and tried to explain the facts after they had happened. In both versions, the idea is that nonnative substitutions are due to transfer: "The exact nature of the substitutions did not matter, because they were unquestionably due to transfer" (Major, 1994; p. 185). Later, the CAH started being put aside, as transfer could not explain all the substitutions or certain phenomena in L2 acquisition and many predicted errors did not occur.

2.3.2 – Markedness Differential Hypothesis

As the CAH, or language transfer only, could not explain all the difficulties in second language acquisition, some other explanation should arise. Eckman (1977) proposes the Markedness Differential Hypothesis (MDH) as follows:

The areas of difficulty that a language learner will have can be predicted on the basis of a systematic comparison of the grammars of the native language, the target language and the markedness relations stated in universal grammar, such that,

(a) Those areas of the target language which differ from the native language and are more marked than the native language will be difficult.

(b) The relative degree of difficulty of the areas of the target language which are more marked than the native language will correspond to the relative degree of markedness.
(c) Those areas of the target language which are different from the native language, but are not more marked than the native language will not be difficult. (p. 61)

In order to understand the hypothesis, it is essential to understand Eckman's (1977) explanation of *markedness*: "A phenomenon A in some language is more marked than B if the presence of A in a language implies the presence of B; but the presence of B does not imply the presence of A" (p.60). Thus, speakers of a language (X) whose structure is more marked than a corresponding structure in another language (Y) will have less difficulty in learning the structure of language (Y), while speakers of language (Y) will have more difficulty in learning the structure of language (X).

2.3.3 – Interlanguage Structural Conformity Hypothesis

In an attempt to explain second language acquisition (SLA), some researchers have tried to use primary language acquisition as a parameter. It is helpful to know whether secondary language holds some of the same principles as the primary language. Some typological universals have been formulated to explain facts about SLA. To test if interlanguage conforms to universal generalizations, Eckman (1991) has postulated the Interlanguage Structural Conformity Hypothesis (Interlanguage SCH), which states that: "the universal generalizations that hold for primary languages hold also for interlanguages" (p. 24). He justifies the hypothesis in the claim that (1) interlanguages are languages, and (2) 'universal' means that all human languages are influenced by the universal generalizations. Compared to the MDH, Eckman claims that the Interlanguage SCH is stronger because it is more easily falsified. The author also states that the Interlanguage SCH is more explanatory than MDH.

2.3.4 – Ontogeny Model

It is recognized by researchers that errors in the phonology of a second language can be attributed to negative transfer or to developmental factors. The Ontogeny Model proposed by Major (1986a) claims that the errors due to transfer processes decrease while errors due to developmental processes increase and then decrease over time. In other words, for the less proficient learners at beginning levels of learning a second language, transfer errors will be more present than developmental errors. The tendency is that the former decrease chronologically, but not necessarily implying the increase of correct performance because the latter start becoming more apparent. More proficient learners will have a higher percentage of developmental errors than transfer errors in their interlanguages. However, this kind of error also decreases chronologically up to a certain point, where the level of correct performance is higher.

Chapter 3
Method

3.1 – Hypotheses

The aim of the present thesis was to investigate the production of English initial /s/ clusters by Brazilian EFL students, in a near replication of Rebello (1997a, 1997b). This object of research was chosen because, according to some previous studies (Abrahamsson, 1997; Carlisle, 1991, 1994, 1998, 2002; Major, 1996; Rauber, 2002; Rebello, 1997a, 1997b), some speakers of Portuguese and Spanish languages have particular difficulties in acquiring the correct or native-like pronunciation of these clusters. Furthermore, there have been some inconsistencies in the results of the different studies, and I hoped to contribute to the resolution of these inconsistencies, in addition to investigating additional variables. Brazilian Portuguese speakers and Spanish speakers who learn English may use, in their interlanguage phonology, some strategies in order to produce what for them is a possible target pronunciation. One of these strategies noticed by investigators is the insertion of an epenthetic vowel before the English initial /s/ clusters, as this type of cluster is not permitted in either of these two languages. I have tried to answer, then, some questions related to the variation in frequency of use of this strategy in different phonological structures and environments.

The first question to be investigated was whether the length of the cluster, that is, the difference between /sC/ and /sCC/, would be a factor influencing the frequency of production of epenthesis by Brazilian learners of English. According to the CAH, the acquisition of the two lengths of /s/ clusters would be difficult since they do not occur in the native language (Portuguese). The MDH, however, leads to a more specific hypothesis: that the /sCC/ clusters would yield a higher rate of epenthesis, as this is a more marked structure. I decided to investigate this aspect again because the two previous studies carried out by Rebello (1997a,

1997b) and by Rauber (2002) showed different outcomes, leaving the answer to this question inconclusive.

The second question to be investigated was whether the sonority relationship within the cluster would influence the frequency of epenthesis by the learners. Here it is imperative to remember that the /sC/ cluster where C is a STOP violates the SSC proposed by Hooper (1976), since the stops are stronger (less sonorous) than the /s/ (a FRICATIVE). The /sC/ cluster where the second element is a sonorant, on the other hand, does not violate the SSC, since the liquid /l/ and the nasals /m, n/ are weaker (more sonorous) than the fricative /s/. Therefore, the hypothesis was that the /s/ + stop would yield a higher rate of epenthesis than the /s/ + sonorant because of this violation. Previous studies (Abramsson, 1997; Carlisle, 1991, 1994, 1998, 2002; Major, 1996; Rauber, 2002; Rebello, 1997a, 1997b) have given strong evidence for this hypothesis only in the case of Spanish speakers.

The third question to be investigated was whether the Brazilian tendency to voice the /s/ of /s/ + sonorant clusters would influence the frequency of epenthesis by the learners. The inconsistencies of the previous studies (Rebello, 1997a, 1997b; Rauber, 2002), compelled me to investigate this aspect. Voicing was found to be important in both studies, but doubts remained as to which constraint, voicing assimilation or strength relations, would act more powerfully in the production of epenthesis.

The fourth question to be investigated was which environment preceding the initial /s/ cluster, that is, consonant or vowel, would cause the Brazilian EFL learners to produce epenthesis more frequently. Carlisle (1994) found that with Spanish speakers, a consonant in the environment caused more epenthesis than a vowel. However, two other studies carried out with Brazilian Portuguese speakers (Rauber, 2002; Rebello, 1997) arrived at a different and

rather surprising outcome: the Brazilian learners produced a higher rate of epenthesis in /sC/ clusters preceded by vowels than in clusters preceded by consonants. Based on the latter studies, the hypothesis for this research was that the Brazilian Portuguese learners would show a tendency to produce epenthesis more frequently in clusters preceded by a vocalic context.

3.2 – Participants

The data analyzed were collected among students from (a) two different university undergraduate courses: four Administration students with a major in Foreign Trade and ten International Relations students, all from UNIVALI – Universidade do Vale do Itajaí – Campus VII, São José, Santa Catarina; and (b) two different language schools in Florianópolis, Santa Catarina: three from CNA (Instituto Cultural Norte Americano), and three from SLES (Special Language and Educational Service), both located in the center of Florianópolis. The students from UNIVALI were chosen because they have English as part of their curriculum and the classes involve the general study of the language, developing the four main skills (listening, speaking, reading and writing). The participants were chosen from among those students who were classified as lower-intermediate, intermediate and upper-intermediate, based on an interview conducted with them by the researcher, who was also the teacher of all but the CNA students. Beginners were not included in the study because they would probably have difficulty in reading the material.

Table 2 : Subjects

Participants	Sex	Age	Learning context	Pre-reading and listening	level
1	F	21	Univali - RI	NO	UI
2	M	21	Univali - RI	NO	UI
3	M	21	Univali - RI	NO	LI
4	M	20	Univali - RI	NO	LI
5	M	21	Univali - RI	NO	UI
6	M	21	Univali - RI	NO	UI
7	M	26	Univali – CE	NO	LI
8	F	18	CNA	NO	UI
9	M	17	CNA	NO	UI
10	M	15	CNA	NO	UI
11	M	23	Univali – CE	YES	UI
12	M	21	Univali – RI	YES	UI
13	F	23	Univali – CE	YES	I
14	F	21	Univali - CE	YES	LI
15	F	23	Univali - RI	YES	LI
16	F	20	Univali - RI	YES	LI
17	F	20	Univali - RI	YES	LI
18	F	39	SLES	YES	I
19	F	24	SLES	YES	LI
20	F	30	SLES	YES	I

M = Male F = female
RI = Relações Internacionais
CE = Administração com habilitação em Comércio Exterior
CNA = Instituto Cultural Norte Americano
SLES = Special Language and Educational Service
I = Intermediate
LI = Lower-intermediate
UI = Upper-intermediate

3.3 – Material

The material to be read consisted of a list of sixty-five topically unrelated sentences, forty-four of them containing initial /s/ clusters borrowed from Rebello (1997), and twenty-one of them serving as distractor sentences. For each cluster /sp, st, sk, sm, sn, sl, spr, spl, str, skr, skw/, there were four sentences, two containing a vowel in the preceding environment, one a stop, and one a fricative.

3.4 – Procedure

The participants were recorded reading the sentences in random order, as they were printed on separate strips and were picked up out of a box by the participants. The participants from UNIVALI were recorded in a quiet room or in the language lab, the CNA students were recorded in a classroom in the school, and the SLES students were recorded in a room in the company where they work and have English classes. All recordings were made using a Panasonic cassette recorder model RQ-L10. Because of the reading difficulty noted among several of the first ten participants, participants 11 through 20 were asked to practice by reading each sentence after hearing a recording of that sentence spoken twice by a male native speaker of American English. Only after the practice session were the sentences read and recorded by this second group. The practice session had the desired effect of reducing the number of pauses produced before the initial /s/ clusters.

3.5 – Transcriptions

Transcriptions of the target words and the preceding context word were made by the researcher during a one-week period, and later independently by a second rater, also within one week. After that, both listeners met to listen to the material again where there had been discrepancies and decide whether or not epenthesis had actually been produced. From a total of 880 sentences assumed to be recorded and analyzed, one was not read, thirty-nine were eliminated for having been misread, and two were eliminated because of continued disagreement between the transcribers.

3.6 – Statistical Analysis

Since my objective was to look at frequencies of some predetermined variables as explained in section **3.1**, an appropriate statistical test was applied, the Chi-square (X^2); with this test it is possible to make claims with some degree of certainty.

The calculation of the X^2 involves the following steps: First, we have to find the expected frequency value for each observed value. It is done by multiplying the total of the row by the total of the column and dividing the score by the general total. Then, we subtract the expected frequency values from the observed values and the difference is squared. Next, we divided the squared value by the expected values. Finally, we add the results of each variable. If we get a small X^2 number, it indicates that the variables may be independent, "on the other hand, a large number in the X^2 statistics shows that the differences between the observed and expected frequencies must not be merely coincidental, that is, there must be an association between the two variables [my translation]" (Barbetta, 2002; p. 250).

Eventually, we need to place the final result in a distribution table in order to judge correctly the significance of the frequencies. But, to find the correct place in the table of critical values for Chi-square (X^2), we have to know the number of *degrees of freedom*. This number is obtained by subtracting one from the number of lines and subtracting one from the number of columns; the differences must then be multiplied by each other. We will have the following formula: df = (no. of lines – 1) (no. of columns – 1).

For the present study, when a statistical analysis was applied, the degree of freedom was always 1, since in all cases only two classes of two variables were compared (df = (2-1) (2-1) = 1). The significance of the test represented by the p value is described as follows: (X^2 (1, N = 617) = 3.13, $p > .05$). To understand the statement, 1 represents the degree of freedom, N is the total number of items, 3.13 is the result obtained with the Chi-square test, and p indicates the significance of the frequencies after using the distribution table. Barbetta

(2002) states that in social studies to consider a result significant, the p value should be less than .05.

As in the present study the tables were all of the type 2X2 and the frequencies were not so large, I decided to apply the Yates Correction Factor (YCF) as recommended by Barbetta (2002) for these situations. The YCF consists of reducing .5 units from the difference between the observed and expected frequencies before squaring it.

Chapter 4
Results and Discussion

This chapter reports and discusses the results obtained, which will be done according to the hypotheses formulated in chapter 3. The results concerning the variables will be reported and discussed in the following order: For each variable I will first analyze general results including all the participants; then, an analysis regarding each of the two groups according to their proficiency level will be done. This procedure will not be followed in section 4.4, where I will analyze rates of voicing assimilation and epenthesis, for there the comparison will be centered on /s/ + nasal and /s/ + liquid, without dividing the participants into two groups. Just once in the beginning I will analyze the results divided by the procedure described in the method chapter, one group that heard and read the sentences and another that did not do the exercise. In the first section, I will analyze total rates of epenthesis by the participants (section 4.1). Next, I will be concerned with the length of the cluster - hypothesis 1 (section 4.2). After that, the focus will be the sonority within the cluster - hypothesis 2 (section 4.3). Then, I will check voicing assimilation - hypothesis 3 (section 4.4). Finally, I will look at phonological contexts - hypothesis 4 (sections 4.5, 4.6, 4.7, and 4.8).

4.1 – Production of epenthesis by participant group and level

As stated in chapter 3, this research dealt with two different groups of participants, the ones (participants 1 to 10) who did not hear or read previously any of the sentences used as material for the study, and the ones (participants 11 to 20) who listened to and read the sentences previous to the recording. Since both of these groups were heterogeneous in terms of proficiency in English, the only aspect of the study noticeably influenced by this procedure was that the number of pauses was much lower among those who did the exercise previous to the recording. Although participants 11 to 20 had previously heard and read the sentences, they actually produced a higher rate of epenthesis (66.12%) than participants 1 to 10, who

produced a rate of (50.24%), as can be seen in Table 3a, resulting in a very significant Chi-square ($X2$ (1, N = 837) = 21.04, $p < .0001$).

Since it is very unlikely that the listening and practice exercises before recording would have caused poorer performance, the most likely explanation for this result is that most of the participants 11 to 20 were of a lower proficiency level than participants 1 to 10. Thus, I decided to group the participants for analysis only regarding their level of proficiency: lower-intermediate and intermediate students (LI/I) in the first group and upper-intermediate students (UI) in the second.

Table3a: Individual and total rates of epenthesis production (1-10 with no pre-reading and/or listening exercises; 11-20 with pre-reading and listening exercises).

Participant	# productions	# epenthesis	% epenthesis
1	43	12	27.91
2	42	27	64.29
3	41	19	46.34
4	41	29	70.73
5	41	16	39.02
6	41	14	34.15
7	39	28	71.79
8	41	11	26.83
9	42	21	50.00
10	41	30	73.17
Subtotal	**412**	**207**	**50.24**
11	44	18	40.91
12	43	06	13.95
13	40	24	60.00
14	43	30	69.77
15	44	35	79.55
16	40	32	80.00
17	42	27	64.29
18	42	37	88.09
19	44	37	84.09
20	43	35	81.39
Subtotal	**425**	**281**	**66.12**
Total	**837**	**488**	**58.30**

Regarding the participants divided by proficiency level, independent of the previous exercise as described above, the production of epenthesis was much higher for the group

consisting of lower-intermediate and intermediate participants (72.55%) than for the group consisting of upper-intermediate participants (41.01%), which resulted in a very significant chi-square (X2 (1, N = 837) = 83.55, p < .0001), as can been seen in Table 3b. This result supports Major's (1986a) Ontogeny Model, in which he claims that errors due to transfer decrease chronologically.

Table3b: Individual and total rates of epenthesis production (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

Participant	# productions	# epenthesis	% epenthesis
3	41	19	46.34
4	41	29	70.73
7	39	28	71.79
13	40	24	60.00
14	43	30	69.77
15	44	35	79.55
16	40	32	80.00
17	42	27	64.29
18	42	37	88.09
19	44	37	84.09
20	43	35	81.39
Subtotal 1	**459**	**333**	**72.55**
1	43	12	27.91
2	42	27	64.29
5	41	16	39.02
6	41	14	34.15
8	41	11	26.83
9	42	21	50.00
10	41	30	73.17
11	44	18	40.91
12	43	06	13.95
Subtotal 2	378	155	**41.01**
Total	**837**	**488**	**58.30**

Results in relation to the participants' total production of epenthesis for all /□C/ and /□CC/ clusters varied from 13.95% (participant 12) to 88.09% (participant 18). The average production of epenthesis for all the participants was 58.30%. This result is compatible with Rebello's (1997a, 1997b) results, which were 56% at level 3, 54% at level 6, and 47% at

level TOEFL. However, Rauber's (2002) total result for all the Brazilian participants was only 33.02%, a considerably lower percentage compared to the other studies. This may be explained by the level of the subjects invited to participate in the research. The subjects invited to participate in the present study and in Rebello's were probably less fluent in the target language than those of Rauber's study. In Rauber's study the participants were not only EFL learners, but also undergraduate students of a "Letras" course and may have had Phonetics and Phonology as subjects in their course.

4.2 – Analysis of bi-literal clusters (/sp/, /st/, /sk/) in violation of the SSC versus tri-literal clusters (/spC/, /stC/, /skC/)

Prior to the presentation and discussion of the results of this section, two important considerations must be given. First, the analysis here was not done taking the results of all bi-literal and tri-literal clusters because all English tri-literal clusters, but not all bi-literals, violate the SSC. Although Rebello (1997a, 1997b) and Rauber (2002) included as part of the analysis a comparison of the results regarding just the length (collapsing, within the bi-literal category, clusters violating and not violating the SSC), I will not do so as I do not see any basis that would support an analysis comparing tri-literal clusters (all in violation) and bi-literal clusters not in violation of the SSC. The results would be affected by confounding variables, as the second hypothesis predicts that clusters in violation of SSC will cause a higher frequency of epenthesis than the clusters not in violation. Second, I will not analyze the clusters grouped by the second components, for the number of productions of each cluster is too small to be statistically valid. In addition, the two previous studies showed extremely small differences in rate of epenthesis among the three second components.

As an overview of the results, the participants produced an average rate of 50.00% of epenthesis in bi-literal clusters in violation and 57.66% of epenthesis in tri-literal clusters. Although these results show a difference of 7.66%, this difference did not prove to

be statistically significant using the chi-square test (X2 (1, N = 617) = 3.13, p > .05). Even separate calculations by proficiency level failed to yield significant results, although longer clusters yielded higher rates of epenthesis in both groups.

Table 4: Individual and total rates of epenthesis production of clusters /sp/, /st/, and /sk/ versus /spC/, /stC/, and /skC/ (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	/sp/, /st/, /sk/			/spC/, /stC/, /skC/		
Participant	# productions	# epenthesis	% epenthesis	# productions	# epenthesis	% epenthesis
3	12	03	25.00	20	11	55.00
4	12	07	58.33	19	15	78.95
7	10	06	60.00	18	12	66.67
13	11	07	63.64	18	11	61.11
14	11	06	54.55	20	15	75.00
15	12	08	66.67	20	15	75.00
16	12	07	58.33	18	15	83.33
17	11	07	63.64	20	09	45.00
18	12	08	66.67	19	18	94.74
19	12	09	75.00	20	16	80.00
20	12	11	91.67	20	15	75.00
Subtotal 1	**127**	**79**	**62.20**	**212**	**152**	**71.70**
1	12	03	25.00	19	04	21.05
2	12	09	75.00	19	11	57.89
5	10	02	20.00	19	08	42.11
6	12	05	41.67	18	07	38.89
8	12	02	16.67	18	05	27.78
9	12	04	33.33	20	11	55.00
10	11	06	54.55	20	14	70.00
11	12	06	50.00	20	08	40.00
12	12	00	00.00	20	02	10.00
Subtotal 2	**105**	**37**	**35.24**	**173**	**70**	**40.46**
Total	**232**	**116**	**50.00**	**385**	**222**	**57.66**

As Table 4 shows, subgroup 1 produced 62.20% of epenthesis for bi-literal clusters in violation and 71.70% of epenthesis for tri-literal clusters, a non-significant chi-square (X^2 (1, N = 339) = 2.87, p > .05). Subgroup 2 produced 35.24% of epenthesis for bi-literal clusters in violation and 40.46% of epenthesis for tri-literal clusters, a non-significant chi-square of (X^2 (1, N = 278) = .55, p > .05). Furthermore, some participants produced more epenthesis in bi-

literal clusters: participant 1 (25% in bi-literal and 21.05% in tri-literal), participant 2 (75% in bi-literal and 57.89% in tri-literal), participant 6 (41.67% in bi-literal and 38.89% in tri-literal), participant 11 (50% in bi-literal and 40% in tri-literal), participant 13 (63.64% in bi-literal and 61.11% in tri-literal), participant 17 (63.64% in bi-literal and 45% in tri-literal), and participant 20 (91.67% in bi-literal and 75% in tri-literal). Actually, the difference in percentage for participants 1, 6, and 13 is very small and may be the result of the lower number of sentences produced. Again Major's OM is significantly supported by the results. On the other hand, the MDH is not supported by the results: the longer clusters did not yield a significantly greater rate of epenthesis than the shorter ones.

The results corroborate Rebello's (1997a, 1997b) findings. Calculating the totals of Rebello's (1997a: p.66) results comparing the groups of /sC/ clusters (in violation) and /sCC/ clusters, we find rates of epenthesis production of 54.43% and 54.90% respectively, which will certainly result in a non-significant chi-square. However, Rauber's (2002) results diverge, as she found a very significant chi-square regarding the difference between /sC/ custers in violation and /sCC/ clusters, with a higher rate of epenthesis for the latter. Analyzing the three studies, the hypothesis regarding the production or acquisition of initial /s/ clusters remains without conclusive support or rejection, as the results do not follow converging directions and no prediction was consistently supported. Possibly the length of cluster makes a greater difference for students at a more advanced level, who produce a lower frequency of epenthesis.

4.3 – Analysis of bi-literal clusters in violation of the SSC (/s/ + stop) versus bi-literal clusters not in violation (/s/ + sonorant)

Just as it was not methodologically sound to analyze bi-literal clusters not in violation versus tri-literal clusters regarding length (since all of these are in violation), it is essential to analyze bi-literal clusters not in violation of the SSC (/sm/, /sn/, and /sk/) in comparison only with bi-literal clusters (not tri-literal) in violation (/sp/, /st/, and /sk/) to investigate whether the sonority within the clusters influences the rate of epenthesis.

As shown in Table 5, the total rate of epenthesis was higher for /s/ + sonorant clusters (68.18%) than for /s/ + stop clusters (50%). The difference was 18.18%, which yielded a very significant chi-square (X^2 (1, N = 452) = 14.67, $p < .0005$). The results corroborate neither the SSC nor Rauber (2002), who reported the production of 30.89% of epenthesis for bi-literal clusters in violation versus 27.57% of epenthesis for bi-literal clusters not in violation. This difference of 3.32% was not found to be significant, and the author pointed out that four participants out of ten produced more epenthesis for bi-literal clusters not in violation than for bi-literals in violation and suggested that the effects of markedness by sonority may have been neutralized by the effects of markedness regarding voicing.

On the other hand, the results corroborate Rebello (1997a, 1997b), who reported a rate of epenthesis of 63% for bi-literal clusters not in violation and 54% for bi-literal clusters in violation, a difference of 9%, but with no statistical tests to prove significance.

In the present study, participants 2, 6, 11, 13, and 20 are the only ones who behaved contrary to the general tendency. The rate of insertion of an epenthetic vowel for these participants was higher before bi-literal clusters in violation than before bi-literal clusters not in violation. Coincidently, all of them had behaved contrary to the general tendency

regarding cluster length as well, producing more epenthesis before bi-literal clusters in violation than before tri-literal clusters.

A possible explanation for the results obtained in this study is that the frequency of voicing assimilation was very high in /s/ + sonorant clusters, which may have influenced the rate of epenthesis.

Table 5: Individual and total rates of epenthesis production of /s/ + stop clusters /sp/, /st/, and /sk/ versus /s/ + sonorant clusters /sm/, /sn/, and /sl/ (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	/sp/, /st/, /sk/			/sN/, /sl/		
Participant	# productions	# epenthesis	% epenthesis	# productions	# epenthesis	% epenthesis
3	12	03	25.00	09	05	55.56
4	12	07	58.33	10	07	70.00
7	10	06	60.00	11	10	90.91
13	11	07	63.64	11	06	54.55
14	11	06	54.55	12	09	75.00
15	12	08	66.67	12	12	100.00
16	12	07	58.33	10	10	100.00
17	11	07	63.64	11	11	100.00
18	12	08	66.67	11	11	100.00
19	12	09	75.00	12	12	100.00
20	12	11	91.67	11	09	81.82
Subtotal 1	**127**	**79**	**62.20**	**120**	**102**	**85.00**
1	12	03	25.00	12	05	41.67
2	12	09	75.00	11	07	63.64
5	10	02	20.00	12	06	50.00
6	12	05	41.67	11	02	18.18
8	12	02	16.67	11	04	36.36
9	12	04	33.33	10	06	60.00
10	11	06	54.55	10	10	100.00
11	12	06	50.00	12	04	33.33
12	12	00	00.00	11	04	36.36
Subtotal 2	**105**	**37**	**35.24**	**100**	**48**	**48.00**
Total	**232**	**116**	**50.00**	**220**	**150**	**68.18**

If we compare the two groups regarding the level of proficiency, we can notice that in percentages both produced a higher rate of epenthesis in /s/ + sonorant clusters than in /s/ + stop clusters, but only one group's results were significant, group 1, the least proficient students (LI/I). This group obtained a rate of 62.20% of epenthesis in /s/ + stops clusters and

85.00% in /s/ + sonorant clusters, which resulted in a very significant chi-square (X^2 (1, N = 247) = 15.23, p < .0001). Although group 2, the most proficient (UI), obtained a rate of 35.24% in /s/ + stop clusters and 48.00% in /s/ + sonorant clusters, it resulted in a non-significant chi-square (X^2 (1, N = 205) = 2.93, p > .05). It should be pointed out that three of the five participants who did not follow the general tendency were from the more proficient group and one of them had the lowest rate of epenthesis of the less proficient group.

Anyway, voicing assimilation seems to be a more powerful constraint for Brazilian Portuguese speakers than the SSC. In studies that dealt with Spanish speakers (Carlisle, 1994; Rauber, 2002), a significantly higher rate of epenthesis was found in /s/ + stop clusters than in /s/ + sonorant clusters. Since in Spanish the voiced fricative /z/ does not occur, voicing assimilation does not exist as a constraint in Spanish-English interlanguage, thus allowing the SSC to act more powerfully. This explanation can enlighten the difference between the more and less proficient groups of Portuguese speakers. It seems that as a Portuguese speaker becomes more proficient in English, the occurrence of voicing assimilation may decrease, which may cause the rate of epenthesis to decrease in /s/ + sonorant clusters. Again Major's OM is supported by the results, as the errors provided by negative transfer decrease chronologically while the learner's proficiency continues to develop.

4.4 – Comparison of /s/-nasals versus /s/-liquid and voicing assimilation

Contradicting the SSC, the /s/ + sonorant clusters produced a higher rate of epenthesis, in this study, than /s/ + stop clusters, as discussed in the previous section. Thus, a comparison between /s/-nasals (/sm/ and /sn/) and /s/-liquid (/sl/) was made in order to investigate whether markedness regarding sonority would make the right prediction in this case and to

verify the influence of voicing assimilation on the epenthesis rate of /s/ + sonorant clusters. In chapter 2, the third hypothesis was that the tendency of Brazilian Portuguese speakers to voice the /s/ in /s/ + sonorant clusters might cause the frequency of epenthesis to increase. The explanation for this expectation is that the resulting voiced obstruent + sonorant sequence is more marked than a voiceless obstruent + sonorant.

Table 6: Rates of voicing assimilation and epenthesis.

	# prod.	# epen.	% epen.
/s/ - nasal [+vd]	107 (71.81%)	95	88.79
/s/ - nasal [-vd]	42 (28.19%)	16	38.10
/s/ - nasal total	149	111	74.50
/s/ - liquid [+vd]	48 (67.61%)	34	70.83
/s/ - liquid [-vd]	23 (32.39%)	04	17.39
/s/ - liquid total	71	38	53.52

In Table 6, it is noticeable that the frequency of epenthesis was much higher for /s/-nasals (74.50%) than for /s/-liquid (53.52%), which resulted in a very significant chi-square (X^2 (1, N = 220) = 8.74, $p < .005$). If Hooper's (1976) SSC failed in predicting a higher rate of epenthesis for /s/ + stops than for /s/ + sonorants, its prediction was correct concerning the comparison of /s/-nasals versus /s/-liquid, since nasals are stronger than liquids in the universal strength hierarchy. Studies carried out by Carlisle (1992) and Rebello (1997a, 1997b), with Spanish and Portuguese speakers respectively, also report that obstruent + nasal

onsets resulted in more epenthesis than obstruent + liquid. However, Rauber's findings showed a very insignificant difference between /sN/ (36.80%) and /sl/ (36.59%) clusters by Portuguese speakers.

Observing Table 6, we can see that the percentage of voicing of /s/ was very high in both types of clusters, 71.81% in /s/-nasal and 67.61% in /s/-liquid, in both cases possibly due to assimilation. This explanation is supported by the extremely significant difference between the rates of epenthesis where the sibilant was voiced (88.79%) and where the sibilant was not voiced (38.10%) for /s/-nasal clusters, resulting in a significant chi-square (X^2 (1, N = 149) = 38.17, $p < .0001$), and the extremely significant difference between the rates of epenthesis where the sibilant was voiced (70.83%) for /s/-liquid and where the sibilant was not voiced (17.39%) for /s/-liquid clusters, also resulting in a very significant chi-square (X^2 (1, N = 71) = 15.77, $p < .0001$). Thus, the results strongly support the hypothesis that voicing assimilation is responsible for the higher rate of epenthesis production before /s/ + sonorant clusters and corroborate both Rebello and Rauber in this regard.

4.5 - The production of epenthesis in different phonological environments

Phonological environment proved to be an important constraint influencing the production of epenthesis as reported in studies by Carlisle (1991, 1992, 1994), Rebello (1997) and Rauber (2002). Carlisle's studies reported that Spanish EFL speakers produced epenthesis more frequently in /sC/ clusters preceded by word-final consonants than in those preceded by word-final vowels. Carlisle (1994) schematized, then, a hierarchy of difficulty for two member onsets, from easiest to most difficult:

Vocalic environment with /sl/.

Vocalic environment with /sm/ and /sn/.

Vocalic environment with /st/, /sp/, and /sk/.

Consonantal environment with /sl/.

Consonantal environment with /sm/ and /sn/.

Consonantal environment with /st/, /sp/, and /sk/.

"Because environment is a more powerful constraint than is the markedness relationships among the onsets, all onsets are more easily acquired first before the vocalic environment" (Carlisle, 1994; p. 245).

A similar result was found by Rauber (2002), who found that Spanish EFL speakers produced a higher frequency of epenthesis in /sC/ clusters preceded by a word-final consonant (39.64%) than in those preceded by a word-final vowel (22.65%), and her study included the null environment, where the cluster appeared at the beginning of a sentence, which yielded the lowest rate of epenthesis (16.88%). However, the Brazilian Portuguese EFL speakers in Rauber's study followed the opposite pattern regarding consonants and vowels, producing more epenthesis after word-final vowels (40.70%) than after word-final consonants (32.12%), although the lowest rate of production was in the null environment, as with the Spanish speakers (21.80%). Rauber's (2002) results with Brazilian Portuguese speakers corroborate Rebello's (1997a, 1997b) results regarding the comparison of vowels and consonants in the environment: Rebello obtained a rate of 57% after vowels and 49% after consonants. In Rebello's study, however, the null environment resulted in the highest rate of epenthesis (72%).

The present study did not include sentences beginning with an /s/ cluster (null environment), but corroborates Rebello's (1997a, 1997b) and Rauber's (2002) results

concerning the comparison between vowel versus consonant environments. Since most of the participants were not very fluent in the TL and did not know some of the vocabulary used in the sentences, the occurrence of pauses was counted as neither a vowel nor a consonant environment, but was excluded from the analysis because a segment before a pause is not likely to influence the pronunciation of the target sequence. Table 7 shows the results obtained with the verification of epenthesis production in the two different environments: vowels and consonants. The participants showed a tendency to produce epenthesis more frequently after a vocalic context (68.29%) than after a consonant context (43.55%), which resulted in a very significant chi-square (X^2 (1, N = 718) = 43.61, p < .0001).

Table 7: Rates of epenthesis production in different environments: vowels versus consonants (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	Vowels			**Consonants**		
Participants	# prod.	# epen.	% epen.	# prod.	# epen.	% epen.
3	17	09	52.94	15	05	33.33
4	20	18	90.00	21	11	52.38
7	10	09	90.00	06	01	16.67
13	19	11	57.89	13	05	38.46
14	20	18	90.00	20	09	45.00
15	21	19	90.48	21	15	71.43
16	18	16	88.89	18	13	72.22
17	19	15	78.95	17	09	52.94
18	19	16	84.21	18	16	88.89
19	22	20	90.91	22	17	77.27
20	18	17	94.44	22	16	72.73
Subtotal 1	**203**	**168**	**82.76**	**193**	**117**	**60.62**
1	21	05	23.81	17	03	17.65
2	18	14	77.78	16	07	43.75
5	18	08	44.44	19	07	36.84
6	19	09	47.37	22	05	22.73
8	19	06	31.58	16	03	18.75
9	18	15	83.33	16	03	18.75
10	13	08	61.54	09	05	55.56
11	19	15	78.95	19	00	00.00
12	21	04	19.05	22	02	09.09
Subtotal 2	**166**	**84**	**50.60**	**156**	**35**	**22.44**
Total	**369**	**252**	**68.29**	**349**	**152**	**43.55**

Dividing the participants into two groups, the results obtained in the first subtotal, the least proficient participants, follow the general results, the frequency of epenthesis being much higher after in the context of vowels (82.76%) than after in the context of consonants (60.62%), resulting in a very significant chi-square (X^2 (1, N = 396) = 22.95, p < .0001). In the second group, the most proficient participants, the results also show a higher frequency of epenthesis after vocalic environments (50.60%), than after consonant environments (22.44%), also obtaining a very significant chi-square (X^2 (1, N = 322) = 26.19, p < .0001). In a comparison between the production of epenthesis in /sC/ clusters preceded by vowels and preceded by consonants, all the participants show more frequency of epenthesis in onsets preceded by vowels, confirming, thus the fourth hypothesis. Since vowels are voiced, perhaps this result is also influenced by the voicing assimilation, as the results show that voiced obstruents yield a higher rate of epenthesis than voiceless obstruents in the following section.

4.6 - Epenthesis production in the context of voiced versus voiceless obstruents

Examining the frequency of epenthesis in initial /s/ clusters in the environment of voiced and voiceless obstruents, the rates were twice as high in the voiced context (59.65%) than in the voiceless context (28.25%), as can be seen in Table 8, resulting in a very significant chi-square (X^2 (1, N = 348) = 33.59, p < .0001). Voicing again proves to be a very strong variable constraint inducing the insertion of an epenthetic vowel.

The first group (LI/I) followed the general tendency: the rate of epenthesis was 79.12% in the context of voiced obstruents and 44.12% in the context of voiceless obstruents, a difference of 35%, resulting in a very significant chi-square (X^2 (1, N = 193) = 23.24, p < .0001). The second group also produced a greater rate of epenthesis in the environment of

voiced obstruents (37.50%) than in the environment of voiceless obstruents (6.67%), a difference of 30.83%, which obtained a very significant chi-square (X^2 (1, N = 155) = 19.32, p < .0001). Not a single participant behaved counter to this tendency. Thus, the hypothesis that voiced obstruents in the environment would result in a greater rate of epenthesis than voiceless obstruents can be considered confirmed.

Table 8: Rates of epenthesis production in the context of voiced versus voiceless obstruents (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	[+vd] obstruents			**[-vd] obstruents**		
Participant	# production	# epenthesis	% epenthesis	# production	# epenthesis	% epenthesis
3	06	03	50.00	09	02	12.50
4	10	08	80.00	11	03	27.27
7	03	01	33.33	03	00	00.00
13	07	04	57.14	06	01	16.66
14	09	06	66.67	11	03	27.27
15	09	09	100.00	12	06	54.54
16	07	06	85.71	11	07	63.63
17	09	07	77.78	09	03	33.33
18	10	10	100.00	08	06	75.00
19	11	10	90.91	11	07	63.63
20	10	08	80.00	11	07	54.54
Subtotal 1	**91**	**72**	**79.12**	**102**	**45**	**44.12**
1	09	02	22.22	07	01	14.28
2	08	07	87.50	08	00	00.00
5	09	05	55.56	10	02	20.00
6	13	04	30.77	09	01	12.50
8	08	03	37.50	08	00	00.00
9	08	03	37.50	08	00	00.00
10	05	04	80.00	04	01	25.00
11	09	00	00.00	10	00	00.00
12	11	02	18.18	11	00	00.00
Subtotal 2	**80**	**30**	**37.50**	**75**	**05**	**6.67**
Total	**171**	**102**	**59.65**	**177**	**50**	**28.25**

4.7 - Epenthesis production in the context of fricatives versus stops

As reported in Chapter 3, the corpus consisted of unrelated utterances containing initial /s/ clusters preceded by three different environments: for each cluster two sentences

with vowels, one sentence with a fricative, and one sentence with a stop. So far, it has been found that vowels in the preceding environment induced a higher rate of epenthesis than consonants, and voiced obstruents a higher rate than voiceless obstruents. Among the obstruents, it is still essential to analyze the frequency of epenthesis in initial /s/ clusters in the two different consonant contexts: fricatives and stops.

Table 9 shows the following results: fricatives caused more frequent epenthesis (53.21%) than stops (35.60%), a difference of 17.61%, which resulted in a very significant chi-square (X^2 (1, N = 347) = 10.12, $p < .005$). This result, added to the result that voiced obstruents in the environment induced more frequent epenthesis than voiceless obstruents, leads to the suggestion that the strength of the environment consonant seems to be acting as an important constraint: the stronger (the less sonorant) the consonant in the preceding context of the initial /s/ clusters, the smaller the influence in the production of epenthesis. It is worthwhile to mention Baptista and Silva (1997)'s results concerning epenthesis after final consonants: more after voiced than voiceless obstruents and more after labiodental fricatives than after stops (interdentals were not included in that study because of articulatory difficulty and sibilants should not be considered in this comparison because they are permitted in final position in Portuguese).

Among all the participants, only four (participants 4, 7, 8, and 12) produced more epenthesis in the environment of a stop consonant. Group 1, the least proficient participants, produced 73.03% of epenthesis in the environment of fricatives and 49.51% in the environment of stops, a difference of 23.52%, which resulted in a very significant chi-square (X^2 (1, N = 192) = 10.08, $p < .005$). Group 2, the most proficient participants, also produced more epenthesis in the environment of fricatives (26.87%) than in the environment of stops (19.32%); however, the difference of 7.55% did not result in a significant chi-square (X^2 (1, N

= 155) = .845, p > .05), showing the lesser importance of this variable for more proficient learners.

Table 9: Individual and total rates of epenthesis production in the context of fricatives versus stops (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	Fricatives			Stops		
Participant	# productions	# epenthesis	% epenthesis	# productions	# epenthesis	% epenthesis
3	05	02	40.00	10	03	30.00
4	10	05	50.00	11	06	54.54
7	02	00	00.00	04	01	25.00
13	05	04	80.00	08	01	12.50
14	10	05	50.00	10	04	40.00
15	10	08	80.00	11	07	63.63
16	09	07	77.78	09	06	66.66
17	07	06	85.71	10	03	30.00
18	09	09	100.00	09	07	77.77
19	11	11	100.00	11	06	54.54
20	11	08	72.73	10	07	70.00
Subtotal 1	**89**	**65**	**73.03**	**103**	**51**	**49.51**
1	06	03	50.00	10	00	00.00
2	07	04	57.14	09	03	33.33
5	08	03	37.50	11	04	36.36
6	11	03	27.27	11	02	18.18
8	06	00	00.00	10	03	30.00
9	06	02	33.33	10	01	10.00
10	04	03	75.00	05	02	40.00
11	08	00	00.00	11	00	00.00
12	11	00	00.00	11	02	18.18
Subtotal 2	**67**	**18**	**26.87**	**88**	**17**	**19.32**
Total	**156**	**83**	**53.21**	**191**	**68**	**35.60**

4.8 - Epenthesis production in the context of [+ sibilant] fricatives versus [- sibilant] fricatives

Another important factor judged to influence the production of epenthesis was the feature [± sibilant] in fricatives. The results in Table 10 show a higher frequency of epenthesis in initial /s/ clusters in the context of [+ sibilant] fricatives (63.64%) than in the context of [- sibilant] fricatives (39.13%), resulting in a very significant chi-square (X^2 (1, N = 157) = 8.36, p < .005).

Nevertheless, once again the two groups obtained different significance scores, although the rate of epenthesis was higher in the context of fricatives [+ sibilant] for both groups. Group 1 produced an epenthesis rate of 78.43% in the environment of [+ sibilant] fricatives and 65.79% in the environment of [- sibilant] fricatives, a difference that resulted in a non-significant chi-square (X^2 (1, N = 89) = 1.18, p > .05); whereas group 2 produced **a** frequency of 43.24% in the environment of [+ sibilant] fricatives and a much lower rate of 6.45% in the environment of [- sibilant] fricatives, which resulted in a very significant chi-square (X^2 (1, N = 68) = 9.92, p < .005).

Table 10: Individual and total rates of epenthesis production in the context of [+sib] fricatives versus [-sib] fricatives (subtotal 1 = intermediate and lower-intermediate levels and subtotal 2 = upper-intermediate level).

	[+sib]			[-sib]		
Participant	# productions	# epenthesis	% epenthesis	# productions	# epenthesis	% epenthesis
3	03	01	33.33	02	01	50.00
4	06	03	50.00	04	02	50.00
7	01	00	00.00	01	00	00.00
13	03	03	100.00	02	01	50.00
14	05	04	80.00	05	01	20.00
15	06	05	83.33	04	03	75.00
16	05	03	60.00	04	04	100.00
17	04	04	100.00	03	02	66.66
18	06	06	100.00	03	03	100.00
19	06	06	100.00	05	05	100.00
20	06	05	83.33	05	03	60.00
Subtotal 1	**51**	**40**	**78.43**	**38**	**25**	**65.79**
1	04	03	75.00	03	00	00.00
2	04	04	100.00	03	00	00.00
5	04	02	50.00	04	01	25.00
6	06	03	50.00	05	00	00.00
8	02	00	00.00	04	00	00.00
9	04	02	50.00	02	00	00.00
10	03	02	66.66	01	01	100.00
11	04	00	00.00	04	00	00.00
12	06	00	00.00	05	00	00.00
Subtotal 2	**37**	**16**	**43.24**	**31**	**02**	**6.45**
Total	**88**	**56**	**63.64**	**69**	**27**	**39.13**

The explanation for such results may be that while at a less proficient level, the context of all fricatives seems to impose a certain degree of difficulty regardless of the feature [+sibilant]; as the learner improves in the TL, the constraint acting seems to be the difficulty in pronouncing two sibilants together as one (or the lack of knowledge that this is permitted). The learner seems to feel compelled to pronounce the two sibilants separately and in their entirety, which is only possible with the insertion of a vowel.

4.9 - Summary of Results

To sum up and taking into account the hypotheses formulated in chapter 3, it may be said that: (1) the length of the cluster influenced the production of epenthesis: the participants tended to produce more epenthesis in longer clusters, that is, initial /sCC/, than in shorter clusters, that is, initial /sC/, but the results were not significant enough to claim that this constraint was responsible; (2) the sonority relationship within the cluster influenced the production of epenthesis; however, contrary to the expectation, initial /s/ clusters (/s/ + stop) that violate the SSC proposed by Hooper (1976) yielded a lower rate of epenthesis than those clusters (/s/ + nasal or liquid) that do not violate the SSC; (3) the tendency of Brazilian learners to voice the /s/ of /s/ + sonorant clusters influenced the frequency of epenthesis; and (4) Brazilian learners produced more epenthesis after a vocalic environment than after a consonant. Also regarding the preceding consonant context, (5) voiced obstruents yielded a higher frequency of epenthesis than the voiceless ones; (6) a fricative environment yielded more epenthesis than a stop context; and (7) a preceding environment with [+sibilant] fricatives produced more epenthesis than a context with [-sibilant] fricatives.

Chapter 5
Conclusion

5.1 – Theoretical implications

Few have been the studies in phonology compared to other areas of second language acquisition, especially related to Brazilian Portuguese speakers learning English. The decision to partially replicate Rebello's (1997a, 1997b) study, and consequently Rauber's (2002), was valid since the findings in this research are particularly important, as they corroborate, in some aspects, the two other previous studies about the same subject and enlighten some unresolved questions as well.

The conclusion regarding the first hypothesis, which dealt with the investigation of the length of the cluster, remains unresolved, as it is not possible to state that tri-literal clusters certainly yield a greater production of epenthesis. The statistical analysis gives no support to the MDH, as the results were not significant. What can be inferred, though, is that the higher the proficiency level of the participant, the lower the production of epenthesis, thus supporting Major's OM.

Regarding the second hypothesis, the general results show that /s/ + sonorant clusters caused a higher rate of epenthesis than the /s/ + stop, which goes against the hypothesis, since the prediction was that /s/ + stop clusters would be more difficult because they violate the SSC. A possible explanation for this fact is that the voicing assimilation of the initial /s/ neutralized the SSC and was a more powerful constraint. This can be confirmed as we look at the results of the most proficient group, whose voicing assimilation percentage was lower, consequently resulting in a non-significant difference in the production of epenthesis in the two kinds of clusters.

The conclusion regarding the third hypothesis helps to enlighten the results concerning the second one. Voicing assimilation proved to be a more powerful constraint influencing the production of epenthesis. A very expressive frequency of epenthesis was produced when voicing assimilation occurred, independent of the level of proficiency.

The conclusion regarding the fourth hypothesis is important to show differences between Spanish and Portuguese speakers learning English, regarding the environment that most influences the production of epenthesis. The three studies of initial /□/ cluster production by Brazilian Portuguese speakers, Rebello (1997a, 1997b), Rauber (2002) and this one, found that a preceding vocalic environment caused a higher rate of epenthesis than a consonant environment. This result is of particular importance, since the studies with Spanish speakers (Carlisle, 1994; Rauber, 2002) show the contrary: greater frequency of epenthesis after consonants. Concerning obstruents as a preceding environment, the voiced ones were responsible for a much more frequent occurrence of epenthesis, showing strong evidence that voicing in the preceding context really influences the insertion of an epenthetic vowel by Brazilian Portuguese speakers. Since vowels are all voiced, this may also explain the greater frequency of epenthesis after vowels by the Brazilian Portuguese speakers. Regarding fricatives versus stops as preceding environment, fricatives were found to cause epenthesis more frequently than stops. These results lead us to the conclusion that the stronger the consonant in the preceding environment, the smaller the production of epenthesis.

In sum, the findings do not give strong support to the MDH; however, they strongly support Major's OM, which suggests that markedness cannot be seen as necessarily the most powerful constraint responsible. Rather, it seems that, at least in the production of epenthesis by Brazilian Portuguese learners, transfer of native language processes can take priority in the early stages of learning.

5.2 – Pedagogical implications

EFL teachers have often neglected the systematic teaching of pronunciation or phonology. Some of the reasons for that are the following:

(a) Time constraints: Depending on the place where the language is being taught, quantity often prevails over quality, and the teacher is obliged to complete a very demanding curriculum.

(b) Teacher competence: The teacher is not skilled or well enough informed to competently inform his/her students about the sound patterns they have difficulty with or even to propose exercises for them.

(c) Lack of concern: Many teachers do not worry about whether their students' lack of phonological competence is causing any problems in communication.

(d) Lack of proper material for dealing with the subject: It is difficult to find material that informs the way the teaching of pronunciation or phonology should be dealt with in specific L1 environments.

Regarding (d) above, this kind of research is valuable in providing information of how the acquisition and production of specific sounds occur, thus supplying the teachers with reliable and useful information. Concerning specifically the learning and teaching of initial /s/ clusters, some recommendations can be made: (1) EFL teachers and pedagogical materials writers should be aware of how important the notion of voicing is and prepare classes and material which can adequately induce the learners to perceive and produce voiced and voiceless sounds as correctly as possible; (2) in initial /s/ + sonorant clusters the unvoiced pattern of the /s/ should be emphasized; (3) the environment preceding the initial /s/ clusters should be provided following a hierarchy, from the easiest to the most difficult: for Brazilians, first voiceless obstruents, then, voiced obstruents, and at last vowels; (4) when the preceding

environment is a sibilant, the learners should be informed that the two sibilants should be pronounced together, otherwise the insertion of an epenthetic vowel will be inevitable.

I did not recommend less marked clusters to be taught before more marked clusters because, as this study shows, more marked clusters do not consistently prove to be more difficult to produce.

5.3 – Limitations of the research

One limitation of this research has to do with control of the groups. Each group should have the same number of participants at each proficiency level, so that the listening and reading exercise could be analyzed as constituting an influencing factor or not.

Another kind of limitation is related to the style of data collection. Another kind of data gathering method could be provided besides sentence reading. It is possible that topic related conversations could provide a more natural context to investigate production of epenthesis, but this should be done with more proficient students, and more than one meeting might be necessary.

5.4 – Future research

The influence of the reading and listening exercise would have been more effective if it had been applied to groups of the same level or if the number of participants of different levels had been the same in the two groups. Thus, my suggestion for future research is that an exercise similar to the one reported be done using two groups consisting of participants of the same level or that the number of participants at each level be the same in the two groups.

As three cross-sectional studies have been done focusing on the same subject, a longitudinal study would be reasonable to validate these studies. There might be a control group having classes with conventional material and a test group with material that could

make explicit the phonological rules and provide practice. This would help verify whether the explicit teaching of phonological rules and awareness of differences and problems can modify behavior and improve learners' performance

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Appendices

Appendix A – Corpus

1 - /sp/ clusters

1- /eɪ/ They spoilt everything.
2- /oʊ/ No spitting on the floor.
3- /p/ That map specially attracted me.
4- /f/ People's life span in Brazil is getting longer.

2 - /st/ clusters

1- /u/ Those guys are too stubborn.
2- /aɪ/ My staff is better trained.
3- /t/ Don't get stuck there.
4- /s/ Hamley's is a famous store in London.

3 - /sk/ clusters

1- /aɪ/ That guy skin-dives every weekend.
2- /oʊ/ You should go skiing.
3- /k/ The book skips over adult life.
4- /z/ She is skeptical about it.

4 - /sm/ clusters

1- /i/ They always see smugglers crossing the border.
2- /oɪ/ She gave a coy smile.
3- /d/ His dad smacked him on the bottom.
4- /ʒ/ She wore a beautiful beige smock.

5 - /sn/ clusters

1- /eɪ/ They snatched the paper from the man's hand.
2- /oɪ/ I enjoy snuggling close to him.
3- /g/ There are many big snails around here.
4- /θ/ They both snicked their fingers with the knife.

6 - /sl/ clusters

1- /i/ Paul uses many slang words.
2- /u/ Sue slapped him across the face.
3- /b/ Bob slunk away to his room.
4- /v/ She is fond of slap-up meals.

7 - /spr/ clusters

1- /eɪ/ They sprawled out on the bed last night.
2- /oʊ/ That old man is so spry, it's unbelievable!
3- /d/ The door of the safe had sprung open.
4- /f/ Jeff spread out the newspaper.

8 - /spl/ clusters

1- /i/ He splashed the water.
2- /u/ They do splendid clay work.
3- /b/ Little Kathy's bib split.
4- /ʒ/ She wore a beige splint on one leg.

9 - /str/ clusters

1- /aɪ/ My strategy is to avoid the enemy.
2- /eɪ/ Don't say strange things.
3- /g/ The big streetlamp was out.
4- /z/ These strawberries are delicious.

10 - /skr/ clusters

1- /aʊ/ You don't know how scrupulous he is.
2- /oɪ/ The oldest boy scribbled all over the floor.
3- /k/ He does not like scrambled eggs.
4- /s/ The police scrawled on a piece of paper.

11 - /skw/ clusters

1- /oʊ/ No squads will be located at the border.
2- /aɪ/ That guy squandered his savings last weekend.
3- /t/ They eat squash at every meal.
4- /v/ There are people living in conditions of squalor.

Appendix B - Transcriptions

Symbol: “+” short pause

Subjects with no pre reading and/or listening: 1 - 3

/sp/ clusters

	Participant 1	Participant 2	Participant 3
/eɪ/ They spoilt	[deɪspɔɪoʊt]	[deɪispɔɪoʊtʃ]	[deɪspɔɪoʊt]
/oʊ/ No spitting	[noʊspitiŋ]	[noʊispɪrɪŋ]	[noʊspitiŋ]
/p/ map specially	[mɛpspɛʃoʊlɪ]	[mɛpspɛʃəli]	[mæpspɛʃɪoli]
/f/ life span	[laɪvspɛn]	[laɪf+ispɛn]	[laɪfispɛn]

/st/ clusters

	Participant 1	Participant 2	Participant 3
/u/ too stubborn	[tustʌbbɔrn]	[tʃuistʃubʌrn]	[tustʊbɔrn]
/aɪ/ My staff	[maɪistɛf]	[maɪistɛfs]	[maɪstɛf]
/t/ get stuck	[gɛtstʌk]	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[feimoʊzɪstɔr]	[feɪmoʊzɪstɔr]	[feimoʊstɔr]

/sk/ clusters

	Participant 1	Participant 2	Participant 3
/aɪ/ guy skin-dives	[gaɪskindaɪvs]	[gaɪiskindaɪvs]	[gaɪiskindaɪvs]
/oʊ/ go skiing	[goʊskɪng]	[goʊiskin]	[goʊskiŋ]
/k/ book skips	[bʊkskips]	[bʊkskips]	[bʊkɪskɪp]
/z/ is skeptical	[is+iskɛpɪtikaʊ]	[iziskɛptkaʊ]	[iːskɛptɪkaʊ]

/sm/ clusters

	Participant 1	Participant 2	Participant 3
/i/ see smugglers	[si+ɪsmʌglers]	[ʃizmʌglers]	[sismʌglers]
/ɔɪ/ coy smile	[kɔɪizmaɪoʊ]	[kɔɪizmaɪoʊ]	[kɔɪizmaɪo]
/d/ dad smacked	[dɛdsmɛkəd]	[dɛd+zmɛkəd]	[dædzmeɪkəd]
/ʒ/ beige smock	[beɪʒ+ɪsmoʊk]	[beɪʒ+izmoʊk]	Eliminated

/sn/ clusters

	Participant 1	Participant 2	Participant 3
/eɪ/ They snatched	[deɪsnɛtʃəd]	[deɪiznɛtʃəd]	[deɪiznɛtʃed]
/ɔɪ/ enjoy snuggling	[endʒɔɪsnʌglɪŋ]	[endʒɔɪɪznʌgliŋ]	[endʒɔɪ+iznʌgliŋ]
/g/ big snails	[bɪgsneɪoʊz]	[bigɪzneɪoʊz]	[bigɪsnɛɪərs]
/θ/ both snicked	[boʊθ+ɪsnɪked]	Eliminated	Eliminated

/sl/ clusters

	Participant 1	Participant 2	Participant 3
/i/ many slang	[menizlengs]	[meni+izleng]	[meni+izleng]
/u/ Sue slapped	[suəslɛpt]	[suizlɛpɪd]	[suzlɛpɪd]
/b/ Bob slunk	[bobslʌnk]	[bɔbzlʌnk]	[bɔbzlʌnk]
/v/ fond of slap-up	[fond+ɔfslæpʌp]	[fondɔfzlɛpʌp]	Eliminated

/spr/ clusters

	Participant 1	Participant 2	Participant 3
/eɪ/ They sprawled	[deɪspraʊd]	[deɪsprɔləd]	[deɪ+ispraʊləd]
/oʊ/ so spry	[soʊəspraɪ]	[soʊəspraɪ]	[soʊəspraɪ]
/d/ had sprung	[hɛdsprʌng]	[hæd+isprʌng]	[hɛdsprung]
/f/ Jeff spread	[dʒɛfsɪsprid]	[dʒɛfsprɛd]	[dʒɛf+sprɛd]

/spl/ clusters

	Participant 1	Participant 2	Participant 3
/i/ He splashed	[hisplɛʃɪd]	[hisplɛʃəd]	[hiəsplɛʃəs]
/u/ do splendid	[dusplendɪd]	[du+isplendɪd]	[doəsplendɪd]
/b/ bib split	[bibsplit]	[bibisplit]	[bib+split]
/ʒ/ beige splint	[beɪʒsplint]	[beɪʒɪsplint]	[beiʒ+ɪsplint]

/str/ clusters

	Participant 1	Participant 2	Participant 3
/aɪ/ My strategy	[maistrɛteʒɪ]	[maɪstrɛteʒi]	[maɪəstratɛʒi]
/eɪ/ say strange	[seɪstrendʒ]	[seɪistreɪnd]	[seɪstreɪndʒ]
/g/ big streetlamp	Eliminated	[bigistritlɛmp]	[bɪgəstrentlæmp]
/z/ These strawberries	[dizɪstrɔberis]	[dizistroʊbɛrɪs]	[dizistrɔbɛris]

/skr/ clusters

	Participant 1	Participant 2	Participant 3
/aʊ/ how scrupulous	[haʊɪskrʊpʊlus]	[haʊɪskrʊpʊlus]	[haʊəskrʊpulous]
/ɔɪ/ boy scribbled	[bɔɪskrɪboʊd]	[bɔɪ+skribɪləd]	[bɔɪ+skrinbɪlɪd]
/k/ like scrambled	[laɪkskremboʊd]	[laɪkskremboʊ]	[laɪkskrenbles]
/s/ police scrawled	[ˈpɔlisi+skrɔld]	[poˈlis+iskrɔləd]	[ˈpɔlis+iskrɔlɪd]

/skw/ clusters

	Participant 1	Participant 2	Participant 3
/oʊ/ No squads	[noʊskwɛds]	[noʊɪskwɛds]	[noʊiskwɛds]
/aɪ/ guy squandered	[gaɪskwenderd]	Eliminated	[gaɪ+skwendered]
/t/ eat squash	[itskwɛʃ]	[itskwɛʃ]	[itskwɛʃ]
/v/ of squalor	[ɔfskwɛlor]	[ɔfskweɪlor]	[ɔfskwɛlor]

Subjects with no pre reading and/or listening: 4 - 6

/sp/ **clusters**

	Participant 4	Participant 5	Participant 6
/eɪ/ They spoilt	[deɪspɔɪoʊt]	[deɪspɔɪoʊt]	[deɪispɔɪlət]
/oʊ/ No spitting	[noʊɪspiɾiŋ]	[noʊspɪɾiŋ]	[noʊspɪriŋ]
/p/ map specially	[mɛpspɛʃoli]	[mɛpspɛʃolɪ]	[mɛpspɛʃolɪ]
/f/ life span	[laɪfspɛn]	[laɪfispɛn]	[laɪfspɛn]

/st/ **clusters**

	Participant 4	Participant 5	Participant 6
/u/ too stubborn	[tʃuɪstubɔrn]	[tustʌbʌrn]	[tʃustʃubʌrn]
/aɪ/ My staff	[maɪistɛf]	[maɪistɛf]	[maɪstʌf]
/t/ get stuck	[gɛtstʃʌk]	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[fʌmoʊzistɔr]	was not read	[feɪmoʊzɪstɔr]

/sk/ **clusters**

	Participant 4	Participant 5	Participant 6
/aɪ/ guy skin-dives	[gaɪiskindaivs]	[gaɪ+skindaɪvs]	[gaɪiskindaɪvs]
/oʊ/ go skiing	[goʊɪskiŋ]	[goʊskɪiŋ]	[goʊɪskɪiŋ]
/k/ book skips	[bʊkskips]	[bʊkskips]	[bʊkskips]
/z/ is skeptical	[iskɛpitikaʊ]	Eliminated	[izɪskɛptikaʊ]

/sm/ **clusters**

	Participant 4	Participant 5	Participant 6
/i/ see smugglers	[siɪzmʌglers]	[sizmʌglers]	[siɪzmʌglers]
/ɔɪ/ coy smile	[kɔɪsmaɪoʊ]	[kɔɪizmaɪoʊ]	[kɔɪsmaɪoʊ]
/d/ dad smacked	[dɛdɪzmɛkəd]	[dɛdɪzmɛkt]	[dɛdzmɛkt]
/ʒ/ beige smock	[beɪdʒsmoʊk]	[beɪdʒsmɔk]	[bɪdʒzmɔk]

/sn/ **clusters**

	Participant 4	Participant 5	Participant 6
/eɪ/ They snatched	[deɪiznɛtʃɛd]	[deɪiznetʃed]	[deɪsnɛtʃt]
/ɔɪ/ enjoy snuggling	[əndʒɔɪiznʌgliŋ]	[əndʒɔɪ+ɪsnʌgliŋ]	[əndʒɔɪiznʌgliŋ]
/g/ big snails	[bigiɪzneɪoʊs]	[bɪgiznɛoʊs]	[bɪgsneɪoʊs]
/θ/ both snicked	[bɔfiznikəd]	[boʊθ+snikt]	[boθsnikəd]

/sl/ clusters

	Participant 4	Participant 5	Participant 6
/i/ many slang	[menizlengs]	[menizleng]	Disagreement
/u/ Sue slapped	Eliminated	[suɪzlɛpt]	[suslɛpt]
/b/ Bob slunk	[bɔbɪzlʌnk]	[bɔbslʌnk]	[bɔbzlʌnk]
/v/ fond of slap-up	Eliminated	[fondɔfslɛpʌp]	[fondəvslɛpʌp]

/spr/ clusters

	Participant 4	Participant 5	Participant 6
/eɪ/ They sprawled	[deɪsprɔləd]	[deɪsproʊd]	[deɪsprɔd]
/oʊ/ so spry	Eliminated	[soʊspraɪ]	[soʊspraɪ]
/d/ had sprung	[hɛdɪsprʌŋ]	[hɛgsprʌŋ]	[hɛdsprʌŋ]
/f/ Jeff spread	[dʒɛfisprɛd]	[dʒɛfsprɛd]	[dʒɛfsprɛd]

/spl/ clusters

	Participant 4	Participant 5	Participant 6
/i/ He splashed	[hiɪsplɛʃed]	[hiɪsplɛʃt]	[hisplɛʃt]
/u/ do splendid	[duispleɪndɪd]	Eliminated	Eliminated
/b/ bib split	[bɪbɪsplɪt]	[bɪbsplɪt]	[bibsplit]
/ʒ/ beige splint	[beɪdʒsplint]	[beɪʒisplint]	[beɪdʒsplint]

/str/ clusters

	Participant 4	Participant 5	Participant 6
/aɪ/ My strategy	[maɪistrateʒi]	[maɪstrɛtədʒɪ]	[maɪistrɛtədʒi]
/eɪ/ say strange	[seɪistrendʒ]	[seɪəstrendʒ]	[seɪistrendʒ]
/g/ big streetlamp	[bigəstrimplæmp]	[bigistritlɛmp]	[bɪgɪstritlɛmp]
/z/ These strawberries	[dizɪstroʊbɛris]	[ðizɪstroʊbɛris]	[dizɪstrɔbəris]

/skr/ clusters

	Participant 4	Participant 5	Participant 6
/aʊ/ how scrupulous	[haʊɪskrʊpulus]	[haʊəskrʊpulus]	[haʊɪskrʊpʊlus]
/ɔɪ/ boy scribbled	[bɔɪiskraɪblɛd]	[bɔɪskrɪboʊd]	Disagreement
/k/ like scrambled	[laɪkskrembled]	[laɪkskrɛmboʊ]	[laɪkskrɛmboʊd]
/s/ police scrawled	[ˈpɔlɪsiskrɔlɛd]	[poˈlisskrɔld]	[poˈlisskrɔld]

/skw/ clusters

	Participant 4	Participant 5	Participant 6
/oʊ/ No squads	[noʊɪskwɛds]	[noʊskwɛds]	[noʊskwɛds]
/aɪ/ guy squandered	[gaɪiskwərɛd]	[gaɪ+skwenderd]	[gaɪiskwenderd]
/t/ eat squash	[itskwɛʃ]	[itɪskwɛʃ]	[itiskwɛʃ]
/v/ of squalor	[ɔfskwɛlor]	[ɔfskwɛlor]	[ɔvskwɛlor]

Subjects with no pre reading and/or listening: 7 - 9

/sp/ **clusters**

	Participant 7	Participant 8	Participant 9
/eɪ/ They spoilt	[deɪəspoɪoʊt]	[deɪspɔɪoʊt]	[deɪispɔɪoʊt]
/oʊ/ No spitting	[noʊ+spaitiŋ]	[noʊspiɾiŋ]	[noʊispitiŋ]
/p/ map specially	[meɪp+ɪspeɪsɪali]	[mɛpspɛʃəli]	[mɛpspɛʃoʊli]
/f/ life span	[laɪf+spæn]	[laɪf+spɛn]	[laif+spɛn]

/st/ **clusters**

	Participant 7	Participant 8	Participant 9
/u/ too stubborn	Eliminated	[tʃuɪstʌbʌrn]	[tu+stʌbʌrn]
/aɪ/ My staff	[maɪistɛf]	[maɪstaf]	[maɪistɛf]
/t/ get stuck	Eliminated	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[feɪmoʊstɔr]	[feɪmoʊstɔr]	[feimoʊstɔr]

/sk/ **clusters**

	Participant 7	Participant 8	Participant 9
/aɪ/ guy skin-dives	[gaɪiskindaɪvs]	[gaɪiskindaɪvs]	[gaɪiskindaɪvs]
/oʊ/ go skiing	[goʊisking]	[goʊskɪiŋ]	[goʊ+skɪiŋ]
/k/ book skips	[bʊk+skips]	[bʊkskips]	[bʊkskips]
/z/ is skeptical	[is+ɪskipɪtɪcal]	[is+skɛptikoʊ]	[iz+skɛptikaʊ]

/sm/ **clusters**

	Participant 7	Participant 8	Participant 9
/i/ see smugglers	[si+ɪzmʌglers]	[sizmʌglers]	[si+ɪsmʌglers]
/ɔɪ/ coy smile	Eliminated	[kɔɪzmaɪoʊ]	[kɔɪizmaioʊ]
/d/ dad smacked	[dɛd+izmeɪked]	[dædɪsmæked]	[dæd+zmɛkəd]
/ʒ/ beige smock	[beɪdʒ+izmoʊk]	Eliminated	[beɪdʒizmɔk]

/sn/ **clusters**

	Participant 7	Participant 8	Participant 9
/eɪ/ They snatched	[ðeɪ+iznɛtʃɛd]	[deɪiznætʃəd]	[deɪsnɛtʃəd]
/ɔɪ/ enjoy snuggling	[endʒɔɪ+əznʌgling]	[endʒɔɪiznʌgliŋ]	[endʒɔɪizmʌgliŋ]
/g/ big snails	[bigəzneoʊs]	[bigzneioʊz]	[bigizneioʊz]
/θ/ both snicked	[bɔθ+iznikɛd]	[boθsniked]	[boθ+ɪsneɪked]

/sl/ clusters

	Participant 7	Participant 8	Participant 9
/i/ many slang	[meni+əzlɛng]	[meni+izleng]	[menɪslɛng]
/u/ Sue slapped	[ʃu+ɪzliped]	[suslɛpd]	Eliminated
/b/ Bob slunk	[bɔbslʌnk]	[bɔbzlʌnk]	[bɔbzlʌnk]
/v/ fond of slap-up	[faʊndɔf+əzlæpʌp]	[fondɔvslɛp+ʌp]	Eliminated

/spr/ clusters

	Participant 7	Participant 8	Participant 9
/eɪ/ They sprawled	[deɪ+əspraʊled]	[deɪsprɔled]	[deɪspraʊləd]
/oʊ/ so spry	[soʊɪspraɪ]	[soʊspraɪ]	[soʊɪspri]
/d/ had sprung	[hɛd+sprʌŋ]	[hɛdsprʌng]	[hɛdsprʌng]
/f/ Jeff spread	[dʒɛf+əsprɛd]	[dʒɛfsprɛd]	[dʒɛfsprɛd]

/spl/ clusters

	Participant 7	Participant 8	Participant 9
/i/ He splashed	[hiɪsplɛʃed]	[hisplɛʃd]	[hiɪsplɛʃəd]
/u/ do splendid	[duəsplendid]	[duɪsplendid]	[duɪsplɛndid]
/b/ bib split	Eliminated	[bibɪsplit]	[bibsplit]
/ʒ/ beige splint	Eliminated	Eliminated	[beɪdʒisplint]

/str/ clusters

	Participant 7	Participant 8	Participant 9
/aɪ/ My strategy	[maɪ+istrɛteʒi]	[maɪstrɛteʒi]	[maɪstrɛtədʒi]
/eɪ/ say strange	[seɪstrendʒi]	[seɪistrendʒi]	[seɪistrendʒ]
/g/ big streetlamp	[bigstrɛtlamp]	[bigiʃtritlæmp]	[bigstritlæmp]
/z/ These strawberries	[diz+əstrɔʊbɛris]	Eliminated	[distrɔberis]

/skr/ clusters

	Participant 7	Participant 8	Participant 9
/aʊ/ how scrupulous	[haʊəskrʊpulus]	[haʊ+əskrʊpʊlus]	[haʊəskrʊpʊlus]
/ɔɪ/ boy scribbled	[bɔɪiskriboʊled]	[boɪ+skriboʊd]	[bɔɪiskrʌbled]
/k/ like scrambled	[laɪkskremboʊ]	[laɪkskremboʊd]	[laɪkskrɛmboʊd]
/s/ police scrawled	[ˈpɔlɪs+iskraʊled]	[ˈpɔlɪskrɔed]	[poˈlis+ɪskraʊled]

skw/ clusters

	Participant 7	Participant 8	Participant 9
/oʊ/ No squads	[noʊ+skweds]	[noʊskwɛds]	[noʊiskwɛds]
/aɪ/ guy squandered	[gaɪ+iskwaunderɛd]	[gaɪskwendered]	[gaɪiskwenderəd]
/t/ eat squash	[it+iskwɛʃ]	[it+skwɛʃ]	[itskwɛʃ]
/v/ of squalor	[ɔfskwelor]	[ɔvskwalor]	[ɔvskwɛlor]

Subject with no pre reading and/or listening: 10

Subjects with pre reading and listening: 11 - 12

/sp/ **clusters**

	Participant 10	Participant 11	Participant 12
/eɪ/ They spoilt	[deɪspɔɪd]	[deɪispɔɪoʊ]	[deɪspɔɪoʊt]
/oʊ/ No spitting	[noʊispitiŋ]	[noʊispiɾiŋ]	[noʊspiɾiŋ]
/p/ map specially	[mɛp+ispeʃɪali]	[mɛpspɛʃəli]	[mæpspɛʃəli]
/f/ life span	[laifispɛn]	[laɪvspæn]	[laɪfspɛn]

/st/ **clusters**

	Participant 10	Participant 11	Participant 12
/u/ too stubborn	Eliminated	[tʃuəstʌbʌrn]	[tʃustubɔrn]
/aɪ/ My staff	[maɪstɛf]	[maɪistɛf]	[maɪstæf]
/t/ get stuck	[gɛtstʌk]	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[feɪmoʊs+istɔrɪ]	[feɪmoʊstɔr]	[feimoʊstɔr]

/sk/ **clusters**

	Participant 10	Participant 11	Participant 12
/aɪ/ guy skin-dives	[gaɪ+iskindaɪvs]	[gaɪiskindaɪvs]	[gaɪskindaɪvs]
/oʊ/ go skiing	[goʊskɪiŋ]	[goʊ+iskɪiŋ]	[goʊskɪiŋ]
/k/ book skips	[bʊk+iskips]	[bʊkskips]	[bʊkskips]
/z/ is skeptical	[iskɛptikoʊ]	[iskɛptikol]	[iskɛpɪtkal]

/sm/ **clusters**

	Participant 10	Participant 11	Participant 12
/i/ see smugglers	[si+izmʌgler]	[siizmʌglers]	Eliminated
/ɔɪ/ coy smile	[kɔɪizmaioʊ]	[kɔɪizmaɪoʊ]	[kɔʊɪzmaioʊ]
/d/ dad smacked	[dɛd+izmɛked]	[dædsmæk]	[dædsmæked]
/ʒ/ beige smock	[beiʒizmoʊk]	[beiʒsmɔk]	[beiʒsmɔk]

/sn/ **clusters**

	Participant 10	Participant 11	Participant 12
/eɪ/ They snatched	[deɪiznɛʃed]	[deɪiznɛtʃ]	[deɪiznætʃ]
/ɔɪ/ enjoy snuggling	[endʒɔɪ+iznʌgliŋ]	[endʒɔɪ+isnʌgliŋ]	[endʒɔɪiznʌgliŋ]
/g/ big snails	[bigiizneioʊs]	[bigsneɪoʊs]	[bɪgiznɛoʊs]
/θ/ both snicked	Eliminated	[boθ+snik]	[boθsnikərd]

/sl/ **clusters**

	Participant 10	Participant 11	Participant 12
/i/ many slang	[meni+izleng]	[mɛnislɛng]	[manislɛng]
/u/ Sue slapped	[su+izlɛpəd]	[su+slæp]	[suslæpt]
/b/ Bob slunk	[bɔbizlʌnk]	[bɔbslʌnk]	[bɔbslʌnk]
/v/ fond of slap-up	Eliminated	[fondɔfslɛpʌp]	[fondɔvslæpʌp]

/spr/ **clusters**

	Participant 10	Participant 11	Participant 12
/eɪ/ They sprawled	[deɪsprɔled]	[deɪisprɔld]	[deɪsprɔlɛr]
/oʊ/ so spry	[soʊɪspraɪ]	[soʊispraɪ]	[soʊspraɪ]
/d/ had sprung	[hɛdsprʌng]	[hɛdsprʌŋ]	[hɛdɪsprʌng]
/f/ Jeff spread	[dʒɛf+isprid]	[dʒɛfsprɛd]	[dʒɛfsprɛd]

/spl/ **clusters**

	Participant 10	Participant 11	Participant 12
/i/ He splashed	[hiɪsplɛʃəd]	[hisplɛʃ]	[hisplɛʃ]
/u/ do splendid	[du+isplendid]	[duisplendɪd]	[dusplendɪd]
/b/ bib split	[bibi+isplaɪt]	[bibsplɪt]	[bibsplit]
/ʒ/ beige splint	[beiʒ+isplint]	[beiʒ+ɪsplint]	[beɪdʒsplint]

/str/ **clusters**

	Participant 10	Participant 11	Participant 12
/aɪ/ My strategy	[maɪstrateʒi]	[maɪistrɛtedʒɪ]	[maɪstrɛteʒi]
/eɪ/ say strange	[seɪɪstrendʒ]	[seɪistrendʒ]	[seɪistrendʒ]
/g/ big streetlamp	[big+stritlɛmp]	[bigstritlæmp]	[bigstrempoʊ]
/z/ These strawberries	[dizistraʊbɛris]	[dizstrawbɛris]	[dizstroʊbɛris]

/skr/ **clusters**

	Participant 10	Participant 11	Participant 12
/aʊ/ how scrupulous	[haʊiskrʊpʊlus]	[haʊɪskrʊpʊlus]	[haʊskrʊplə]
/ɔɪ/ boy scribbled	[bɔɪ+ɪskraibled]	[bɔɪskriboʊ]	[bɔɪskriblɛr]
/k/ like scrambled	[laɪkskremboʊd]	[laɪkskrembol]	[laɪkskremboʊ]
/s/ police scrawled	[ˈpɔlɪsɪ+skraʊled]	[poˈlis+skrɔld]	[poˈlisskrɔʊ]

/skw/ clusters

	Participant 10	Participant 11	Participant 12
/oʊ/ No squads	[noʊiskwɛds]	[noʊskwads]	[noʊskwɛds]
/aɪ/ guy squandered	[gaɪ+əskwendere]	[gaɪiskwʌndəred]	[gaɪskwenderd]
/t/ eat squash	[it+iskweʃ]	[itskwaʃ]	[itskwɛʃ]
/v/ of squalor	[ɔf+ɪskwalor]	[ofskwalor]	[ɔvskweɪlor]

Subjects with pre reading and listening: 13 - 15

/sp/ **clusters**

	Participant 13	Participant 14	Participant 15
/eɪ/ They spoilt	[deɪspɔɪoʊt]	[deɪispɔɪoʊt]	[deɪispɔɪoʊt]
/oʊ/ No spitting	[noʊɪspiɾiŋ]	[noʊɪspitiŋ]	[noʊspitiŋ]
/p/ map specially	[mæpspɛʃəli]	[mɛpspɛʃəʊli]	[mɛpispeʃɪali]
/f/ life span	[laɪfispɛn]	[laɪfspɛn]	[laɪfɪspɛn]

/st/ **clusters**

	Participant 13	Participant 14	Participant 15
/u/ too stubborn	[tʃuɪstʌbɔrn]	[tʃuɪstʃuborn]	[tuistɔborn]
/aɪ/ My staff	[maɪistɛf]	[maɪstɛf]	[maɪistɛf]
/t/ get stuck	[gɛtstʌk]	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[feimoʊzɪstɔr]	[feimoʊstɔr]	[famoʊstɔr]

/sk/ **clusters**

	Participant 13	Participant 14	Participant 15
/aɪ/ guy skin-dives	[gaɪiskindaɪvs]	Eliminated	[gaɪiskindaɪvs]
/oʊ/ go skiing	[goʊ+ɪskɪiŋ]	[goʊiskɪiŋ]	[goʊiskɪiŋ]
/k/ book skips	[bʊkskips]	[bʊkiskips]	[bʊkskips]
/z/ is skeptical	Eliminated	[iziskiptikol]	[isiskɛptikal]

/sm/ **clusters**

	Participant 13	Participant 14	Participant 15
/i/ see smugglers	[siizmʌglers]	[siizmʌglers]	[siizmʌglers]
/ɔɪ/ coy smile	[kɔɪzmaɪoʊ]	[kɔɪizmaɪoʊ]	[kɔɪizmailə]
/d/ dad smacked	[dædzmæked]	[dædizmeɪked]	[dædizmeiked]
/ʒ/ beige smock	[beidʒ+izmɔk]	[beiʒɪzmoʊk]	[beɪʒizmoʊk]

/sn/ **clusters**

	Participant 13	Participant 14	Participant 15
/eɪ/ They snatched	[deɪsnætʃed]	[deɪiznætʃəd]	[deɪiznætʃd]
/ɔɪ/ enjoy snuggling	[endʒɔɪznʌgliŋ]	[endʒoɪiznʌgliŋ]	[endʒɔɪiznʌgliŋ]
/g/ big snails	[bigizneioʊz]	[bigizneioʊz]	[bigizneɪous]
/θ/ both snicked	Eliminated	[bɔfizsniked]	[bɔfɪsniked]

/sl/ clusters

	Participant 13	Participant 14	Participant 15
/i/ many slang	[menisleng]	[meniizleng]	[meiizleng]
/u/ Sue slapped	[suɪizlæped]	[ʃizlæped]	[suizlæped]
/b/ Bob slunk	[bɔbzlʌnk]	[bɔbzlunk]	[bɔbizlʌnk]
/v/ fond of slap-up	[ɔf+əzlæpʌp]	[faundofzlɛpʌp]	[faund ɔvizlæpʌp]

/spr/ clusters

	Participant 13	Participant 14	Participant 15
/eɪ/ They sprawled	[deɪsprɛlɛd]	[deɪisprɔʊd]	[deɪisprauled]
/oʊ/ so spry	[soʊɪspraɪ]	[soʊɪspraɪ]	[soʊispraɪ]
/d/ had sprung	Eliminated	[hædspring]	[hɛdɪsprʌndʒ]
/f/ Jeff spread	[dʒɛfsprɛd]	[dʒɛfsprid]	[dʒɛf+isprɛdʒ]

/spl/ clusters

	Participant 13	Participant 14	Participant 15
/i/ He splashed	[hiisplɛʃɪs]	[hiisplɛʃəd]	[deɪisplɛʃed]
/u/ do splendid	[du+isplendɪd]	[duəsplendɪd]	[duisplendid]
/b/ bib split	[bibsplit]	[bibɪ+isplit]	[bibisplit]
/ʒ/ beige splint	[beiʒisplint]	[bɛʒisplint]	[beɪʒisplint]

/str/ clusters

	Participant 13	Participant 14	Participant 15
/aɪ/ My strategy	[maɪstrɛtedʒi]	[maɪistrɛtedʒi]	[maɪstrɛtedʒ]
/eɪ/ say strange	[seɪstrendʒ]	[seɪistrendʒ]	[seɪ+strendʒ]
/g/ big streetlamp	[big+istriplæmp]	[bigistritlæmp]	[bigistrɛlɛmp]
/z/ These strawberries	[dizistrobɛris]	[disistroʊbɛris]	[disistrɔberis]

/skr/ clusters

	Participant 13	Participant 14	Participant 15
/aʊ/ how scrupulous	[haʊɪskrʊpʊlus]	[hoʊiskrʊpʊlus]	[haʊiskroplos]
/ɔɪ/ boy scribbled	[bɔɪiskrɛblɛd]	[bɔɪiskraɪboʊd]	[bɔɪiskrɛbɛdʒ]
/k/ like scrambled	[laɪkskremboʊd]	[laɪkskremboʊd]	[laɪkskremblɛd]
/s/ police scrawled	[ˈpɔlɪs+iskrawlɛd]	[ˈpɔlis+iskrɔld]	[poˈlisiskrɔled]

/skw/ clusters

	Participant 13	Participant 14	Participant 15
/oʊ/ No squads	[noʊskwɛds]	[noʊiskwɛds]	[noʊiskwɛds]
/aɪ/ guy squandered	[gaɪ+iskwendered]	[gaɪ+iskwenderd]	[gaɪiskwenderəd]
/t/ eat squash	Eliminated	[itskwɛʃ]	[itskwɛʃ]
/v/ of squalor	[ɔf+iskwɛlor]	[ɔvskweilor]	[ɔfskweilor]

Subjects with pre reading and listening: 16 - 18

/sp/ **clusters**

	Participant 16	Participant 17	Participant 18
/eɪ/ They spoilt	[deɪispɔɪoʊt]	[deɪispɔɪoʊt]	[deɪspɔɪt]
/oʊ/ No spitting	[noʊispaɪtiŋ]	Eliminated	[noʊɪspaɪtiŋ]
/p/ map specially	[mæp+speʃɪali]	[mæpspɛʃɪali]	[mɛp+əspeʃɪəli]
/f/ life span	[laɪfispɛn]	[laɪfispɛn]	[laɪfispɛn]

/st/ **clusters**

	Participant 16	Participant 17	Participant 18
/u/ too stubborn	[tu+ɪstʌbɔrn]	[tuəstʌbʌrn]	[tʃuistʌbɔrn]
/aɪ/ My staff	[maɪistaf]	[maɪstɛf]	[maɪistaf]
/t/ get stuck	[gɛtstʌk]	[gɛtstʌk]	[gɛtstʌk]
/s/ famous store	[feimoʊstɔr]	[feɪmoʊzistɔr]	[feɪmoʊzistɔr]

/sk/ **clusters**

	Participant 16	Participant 17	Participant 18
/aɪ/ guy skin-dives	[gaɪiskindaɪvs]	[gaɪiskindaɪvs]	[gaɪskindaɪvs]
/oʊ/ go skiing	[goʊskɪiŋ]	[goʊiskiniŋ]	[goʊiskiŋ]
/k/ book skips	[bʊkiskips]	[bʊkskips]	[bʊkskips]
/z/ is skeptical	[iskiptikoʊ]	[is+iskɛptikal]	[iziskɛptikal]

/sm/ **clusters**

	Participant 16	Participant 17	Participant 18
/i/ see smugglers	[si+ɪsmʌglers]	[siizmʌglers]	[siizmʌglers]
/ɔɪ/ coy smile	[kɔɪizmaɪoʊ]	[kɔɪizmaɪoʊ]	[kɔɪizmaɪoʊ]
/d/ dad smacked	[dɛd+ismeɪk]	[dɛdizmɛked]	[dɛdɪ+izmɛked]
/ʒ/ beige smock	[beiʒizmɔk]	[beɪdʒismoʊk]	[beɪdʒizmoʊk]

/sn/ **clusters**

	Participant 16	Participant 17	Participant 18
/eɪ/ They snatched	[deɪiznʌtʃəd]	[deɪiznɛtʃed]	[deɪiznætʃ]
/ɔɪ/ enjoy snuggling	[endʒɔɪiznʌgliŋ]	[endʒɔɪiznʌgliŋ]	[endʒɔɪiznʌgliŋ]
/g/ big snails	[bigisnɛɪoʊs]	[bigisneɪoʊs]	[bigizneɪoʊz]
/θ/ both snicked	Eliminated	Eliminated	Eliminated

/sl/ clusters

	Participant 16	Participant 17	Participant 18
/i/ many slang	Eliminated	[meniizleng]	[meniəzleng]
/u/ Sue slapped	[sjuizleɪped]	[suɪslæped]	[suizlɛped]
/b/ Bob slunk	[bɔbizlʌnk]	[bɔbizlʌnk]	[bɔbizlʌnk]
/v/ fond of slap-up	[faund ofislɛpʌp]	[fondɔfizlæpʌp]	[fondɔf+ɪzlæpʌp]

/spr/ clusters

	Participant 16	Participant 17	Participant 18
/eɪ/ They sprawled	[deɪisprɔled]	[deɪsprɔled]	[deɪisprɔd]
/oʊ/ so spry	Eliminated	[soʊispraɪ]	[soʊɪspraɪ]
/d/ had sprung	[hɛdsprʌng]	[hæd+sprʌng]	[hɛdɪsprʌng]
/f/ Jeff spread	[dʒɛfəspred]	[dʒɛf+sprid]	[dʒɛfɪsprɛd]

/spl/ clusters

	Participant 16	Participant 17	Participant 18
/i/ He splashed	[hiɪsplɛʃəd]	[hisplɛʃed]	[hisplɛʃ]
/u/ do splendid	[duisplendid]	[duisplendid]	[duisplendid]
/b/ bib split	[bibisplit]	[bibsplit]	[bibisplit]
/ʒ/ beige splint	[beɪʒəsplint]	[beɪdʒ+isplint]	[beɪdʒisplin]

/str/ clusters

	Participant 16	Participant 17	Participant 18
/aɪ/ My strategy	[maɪstrɛteʒi]	[maɪstrɛteʒi]	[maɪ+əstrɛtəzi]
/eɪ/ say strange	[seɪistrendʒ]	[seɪ+ɪstrendʒ]	[seɪistrendʒ]
/g/ big streetlamp	[bigistritlɛmp]	[bigstritlɛmp]	[bigistritlɛmp]
/z/ These strawberries	Eliminated	[dizɪstrɔbɛris]	[dizistrobɛris]

/skr/ clusters

	Participant 16	Participant 17	Participant 18
/aʊ/ how scrupulous	[haʊiskrʊpʊlus]	[haʊiskrʊpʊlus]	[haʊiskrʊpʊlus]
/ɔɪ/ boy scribbled	[bɔɪəskripled]	[bɔɪ+skribled]	Eliminated
/k/ like scrambled	[laɪkskrembleɾe]	[laɪkskrembled]	[laɪkəskrembоʊ]
/s/ police scrawled	[ˈpɔlisiiskrʌmled]	[ˈpɔlisiskrɔled]	[poˈlisiskrɔd]

/skw/ clusters

	Participant 16	Participant 17	Participant 18
/oʊ/ No squads	[noʊɪskwɛds]	[noʊɪskwɛds]	[noʊiskwɛds]
/aɪ/ guy squandered	[gaɪiskwenderɛd]	[gaɪiskwenderd]	[gaɪ+iskwenderd]
/t/ eat squash	[itiskwaʃ]	[itskwɛʃ]	[itiskwɛʃ]
/v/ of squalor	[ɔfiskweɪlor]	[ɔfskweɪlor]	[ɔfɪskwɛlor]

Subjects with pre reading and listening: 19 - 20

/sp/ **clusters**

	Participant 19	Participant 20	
/eɪ/ They spoilt	[deɪspolt]	[deɪspɔɪoʊt]	
/oʊ/ No spitting	[noʊispitiŋ]	[noʊəspaɪtiŋ]	
/p/ map specially	[mapspɛʃɪəli]	[mɛpiʃpɛʃəli]	
/f/ life span	[laɪfispɛn]	[laɪfɪspɛn]	

/st/ **clusters**

	Participant 19	Participant 20	
/u/ too stubborn	[tʃuəstʌbɔrn]	[tʃuistʌborn]	
/aɪ/ My staff	[maɪistaf]	[maɪistɛf]	
/t/ get stuck	[gɛtstʌk]	[geɾistʌk]	
/s/ famous store	[feɪmoʊzɪstɔr]	[feɪmoʊzistɔr]	

/sk/ **clusters**

	Participant 19	Participant 20	
/aɪ/ guy skin-dives	[gaɪiskindaɪvs]	[gaɪ+iskindaɪvs]	
/oʊ/ go skiing	[goʊɪskin]	[goʊiskin]	
/k/ book skips	[bʊkskips]	[bʊkɪskips]	
/z/ is skeptical	[iziskɛptikol]	[iskɛptikal]	

/sm/ **clusters**

	Participant 19	Participant 20	
/i/ see smugglers	[siizmʌglers]	[siizmʌglers]	
/ɔɪ/ coy smile	[kɔɪizmaɪoʊ]	[kɔɪizmaɪoʊ]	
/d/ dad smacked	[hædizmeɪked]	[dædizmɛked]	
/ʒ/ beige smock	[beɪdʒizmoʊk]	[beɪdʒɪsmoʊk]	

/sn/ **clusters**

	Participant 19	Participant 20	
/eɪ/ They snatched	[deɪiznɛtʃed]	[deɪiznɛtʃəd]	
/ɔɪ/ enjoy snuggling	[endʒɔɪiznʌgliŋ]	[endʒɔɪznʌgliŋ]	
/g/ big snails	[bigizneɪoʊz]	[bigsnɛoʊs]	
/θ/ both snicked	[bɔθizniked]	[boʊfsnikəd]	

/sl/ **clusters**

	Participant 19	Participant 20	
/i/ many slang	[meniizleng]	Disagreement	
/u/ Sue slapped	[suizlæpt]	[suizlɛpɪd]	
/b/ Bob slunk	[bɔbizlʌnk]	[bɔbizlʌnk]	
/v/ fond of slap-up	[fond ɔfizlɛpt]	[fondɔfɪslæpʌp]	

/spr/ **clusters**

	Participant 19	Participant 20	
/eɪ/ They sprawled	[deɪispreled]	[deɪisprɔd]	
/oʊ/ so spry	[soʊɪspraɪ]	[soʊɪspraɪ]	
/d/ had sprung	[hædsprʌng]	[hædsprʌng]	
/f/ Jeff spread	[dʒɛfispreɛd]	[dʒɛfsprid]	

/spl/ **clusters**

	Participant 19	Participant 20	
/i/ He splashed	[hisple∫]	[∫isplɛ∫əd]	
/u/ do splendid	[duisplendid]	[duisplendid]	
/b/ bib split	[bibisplit]	[bibisplit]	
/ʒ/ beige splint	[bɛdʒisplint]	[beɪʒisplint]	

/str/ **clusters**

	Participant 19	Participant 20	
/aɪ/ My strategy	[maɪistratedʒi]	[maɪistrateʒi]	
/eɪ/ say strange	[seɪistreng]	[seɪ+strendʒ]	
/g/ big streetlamp	[bigistritlɛmp]	[bigistritlɛmp]	
/z/ These strawberries	[dizistrɔbɛris]	[dizistrɔbɛrɪs]	

/skr/ **clusters**

	Participant 19	Participant 20	
/aʊ/ how scrupulous	[haʊɪskrʊpʊlus]	[hauiskrʊpʊlus]	
/ɔɪ/ boy scribbled	[bɔɪiskrɪbled]	[bɔɪiskraɪbod]	
/k/ like scrambled	[laɪkskremble]	[laɪkskrembəd]	
/s/ police scrawled	[poˈlisiskrɔled]	[poˈlisiskraʊled]	

/skw/ clusters

	Participant 19	Participant 20	
/oʊ/ No squads	[noʊiskwɛds]	[noʊiskwɛds]	
/aɪ/ guy squandered	[gaɪskwenderd]	[gaɪ+ɪskwenderd]	
/t/ eat squash	[itiskwɛʃ]	[itiskwɛʃ]	
/v/ of squalor	[ɔfiskwelor]	[ɔfɪskwɛlor]	