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Second Language Phonology as Redeployment of L1 Phonological Knowledge

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1. INTRODUCTION

Why do second language learners sound different from native speakers? Why do learners master some sounds but not others? These questions are central to the field of second language acquisition and any attempt to answer them requires that we take into account a multiplicity of factors (Major 2001).

An obvious characteristic of the speech of second language (L2) learners is that it is accented. For example, L2 speech is perceptually distinct, as evidenced by the fact that native speakers are able to recognize the characteristics of French-accented English as being distinct from German-accented English. This points to the fact that the specific characteristics of L2 speech are predictably influenced by the first language (L1) of the speaker. Another robust factor in determining certain aspects of L2 speech is age of acquisition: for the most part, early age of acquisition of an L2 is a good predictor for having less of an accent. However, there are also late learners of an L2 who can perform within the native speaker range even in the domain of phonology (Bongaerts et al. 2000).

The question of why L2 speakers sound different, and the related question of why some learners master some sounds better than others, can be tackled from a variety of theoretical perspectives (see Archibald 2000b for more discussion):

- Accents are social constructs that arise from the fact that people use language in a social context (Schumann 1986).
- Accents reflect universals of language typology (Eckman and Iverson 1993, 1994).

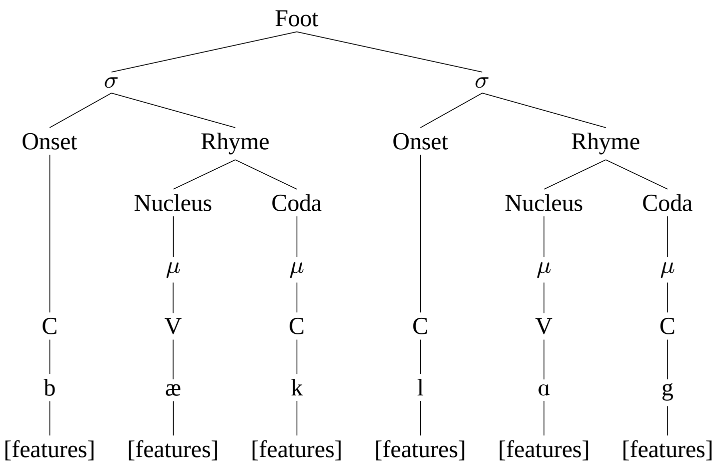
The research reported here is the product of collaboration with students that I have been lucky to work with at the University of Calgary. The true author credit of this paper should be, in alphabetical order, J. Archibald, S. Atkey, A. Gonzalez, K. Jesney, J. Mah, M. Nakayama, and T. Vanderweide.

- Accents result from phonetic phenomena (e.g., Flege 1995), either with respect to speech production (articulatory phonetics) or speech perception (acoustic phonetics).
- Accents result from phonological phenomena, where the latter are understood as the system of contrasts that yields the characteristic sound patterns of a language (herein).

In this paper, I argue that, consistent with the final approach, much of what constitutes a second language accent can be explained by the postulates of phonological theory (though the role of phonetics will also be discussed).

When looking at the acquisition of phonology in a second language one must consider what is being acquired, which in turn requires that we have a theory of what constitutes phonological knowledge. For the purposes of this paper, I assume that when speakers know the phonology of a language, they have knowledge of the featural and segmental inventory of that language, as well as knowledge of its moraic, syllablic, and metrical structure. On this view, as illustrated in (1), knowing the word *backlog* implies knowing something about features, segments, moras, syllables, and metrical feet. It follows that second language learners must acquire knowledge of the features, segments, moras, syllables and feet of the target language.

(1) *Some Aspects of Phonological Structure*:



In many second-language learning scenarios, we find that someone from a given L1 is attempting to acquire an L2 which has some different phonological properties. Perhaps a feature is lacking, or the onsets don't branch, or the codas don't project moras, or the feet are iambic rather than trochaic. The empirical question is: will second language learners be able to acquire structures that are not found in their first language? One line of research adopts the Deficit Hypothesis, which claims that if a speaker's L1 lacks features that are present in the target L2 language, then those features will not be accessible to the learner. One version of this hypothesis is given in (2). The deficit hypothesis turns out to be difficult to assess, because in most L2 learning scenarios there are in fact few (if any) instances of an element *x* being completely absent in a language.

(2) *Deficit Hypothesis*:

If element *x* is not found in L1, then *x* will be unlearnable in L2 acquisition.

In contrast to the deficit hypothesis, the position that I argue for recognizes the flexibility and robustness of the human multilingual capacity, and claims that a speaker's phonological knowledge of L1 can be redeployed to assist in the acquisition of the phonology of L2. I call this the Redeployment Hypothesis:

(3) *Redeployment Hypothesis*:

L2 learners are able to redeploy existing L1 features to acquire L2 features.

As I will demonstrate, the redeployment hypothesis accounts for a wide range of L2 acquisition data, including the redeployment of knowledge of phonological features (section 2), of syllable structure (section 3), and of metrical structure (section 4). I further propose that the redeployment hypothesis sheds light on the process of lexical access as it pertains to L2 acquisition (section 5).

2. Redeploying Knowledge of Phonological Features

From the point of view of phonological theory, the most immediate challenge that confronts the L2 learner is the task of acquiring knowledge of the featural and segmental inventory of L2. Here, I report on research in this area conducted by myself and my students at the University of Calgary, as well as elsewhere. These findings lend support to the redeployment hypothesis, which successfully accounts for the L2 acquisition of specific phonological features (section 2.1), for how phonetic cues can be recruited in the acquisition of L2 features (section 2.2), and for so-called "chain shifts" (section 2.3).

2.1. Acquiring the phonological features of L2

The cases of L2 acquisition of phonological features to be discussed include the acquisition of the [CORONAL] feature by Japanese and Mandarin speakers learning English (section 2.1.1), the acquisition of [CORONAL] and [POSTERIOR] features by English speakers learning Czech (section 2.1.2), the acquisition of [PHARYNGEAL] and [DISTRIBUTED] features by French speakers learning English (section 2.1.3), and the acquisition by English speakers of French and Spanish 'r' (section 2.1.4).

2.1.1. Acquisition of English /l/ and /r/ by Japanese and Mandarin speakers

Based on the acquisition of English /l/ and /r/ by speakers of Japanese and Mandarin Chinese (neither of which contrasts /l/ and /r/ phonemically), and in line with the deficit hypothesis, Brown (2000) argues that if featural representations are lacking from the L1, then they will be unacquirable in the L2. On this view, if the segment is taken to be the relevant level of analysis, then we might predict that, given their L1 feature geometries, both Mandarin and Japanese speakers should be unable to acoustically discriminate /l/ from /r/. The graph in Figure 1 shows the overall performance of Japanese and Mandarin subjects on an auditory discrimination task.

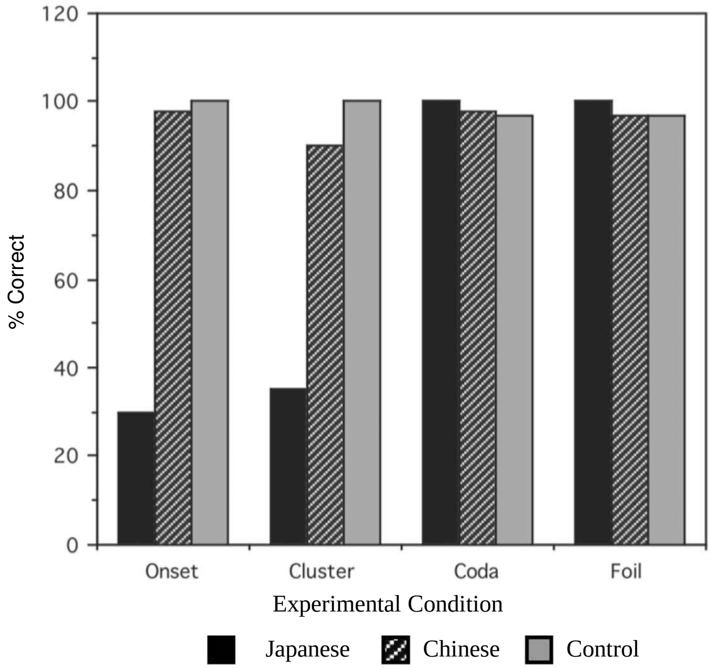


Figure 1: Performance on auditory discrimination task

Brown notes that, in onset position, there is a significant difference in performance, with Mandarin speakers performing better than Japanese speakers. As neither language has an /l/ versus /r/ contrast, she proposes that it is their featural inventory which accounts for the differential behaviour. For Brown, the feature [CORONAL] distinguishes /l/ from /r/. She argues that although Chinese does not has an active [CORONAL] feature for liquids, it does have an active [CORONAL] feature elsewhere in its segmental phonology, namely for fricatives. This contrasts with the Japanese phonological system, which does not require [CORONAL] to be active at all. Therefore, a strong interpretation of Brown's work is that if a feature is lacking from your L1, you will be unable to acquire that feature in an L2; this would account for the difference in the performance of the Mandarin and Japanese speakers in the discrimination task. However, note that the subjects are able to discriminate the contrast in coda position which suggests that there is more going on than just the lack of a phonological feature.

2.1.2. Acquisition of Czech palatal stops by English speakers

Looking at the acquisition of palatal stops in Czech by English speakers, Atkey (2001) demonstrates that existing L1 features can be redeployed in new ways in an L2. Atkey looks at both production and perception, but only the perception results are discussed here. Czech has two palatal stops [c, ɟ] as well as the alveolar stops [t, d], as in (4):

(4) *Examples of Czech palatal and alveolar stops*:

a. [**t**ɛka] ‘run (3sg)’
b. [**c**ɛka] ‘wander (3sg)’
c. [**d**ɛkovat] ‘to steal’
d. [**ɟ**ekovat] ‘to thank’

Atkey argues that palatals, like alveolars, are phonologically [CORONAL], and that the feature that distinguishes palatal from alveolar sounds is [POSTERIOR]. Accordingly, the Czech feature structures are as in (5):

(5) [POSTERIOR] *in Czech* (from Atkey 2001):

Alveolar	Palatal
/t, d/	/c, ɟ/
Root	Root
|	|
Coronal	Coronal
	|
	[POSTERIOR]

Based on the fact that English contrasts three coronal fricative places of articulation /s, z/ versus /ʃ, ʒ/ versus /θ, ð/, Atkey argues that English has the [POSTERIOR] feature. She proposes the representations in (6).

(6) [POSTERIOR] *in English* (from Atkey 2001):

Alveolar	Alveo-palatal	Dental
/s, z/	/ʃ, ʒ/	/θ, ð/
Root	Root	Root
|	|	|
Coronal	Coronal	Coronal
	|	|
	[POSTERIOR]	[DISTRIBUTED]

Thus, because English has the [POSTERIOR] feature, English speakers should have the building blocks necessary for acquiring the structure of the Czech palatals.

Table 1: Percentage of Czech palatal stops perceived correctly by English L1 speakers (exposure to Czech indicated by numbers in parentheses in terms of years;months)

	ML (0;3)	JD (0;5)	AD (0;11)	SW (0;11)	JA (1;0)	RK (10;0)
Position:						
Initial	70	90	80	85	80	95
Medial	70	70	80	90	85	90
Final	20	30	50	70	70	80

Atkey looks at six North-American-English speaking adults learning Czech in the Czech Republic who ranged in exposure to Czech from three months to 10 years. Subjects are given a forced-choice picture selection task that depends on the accurate discrimination of alveolar from palatal stops in all syllabic positions. Table 1 indicates the percentage of palatal stops perceived correctly by all subjects.

We see that the English learners of Czech perform this discrimination task at greater than chance levels. Czech native speaker controls scored 100%. The fact that the subjects were much less accurate in final position — with scores ranging between 20% to 80% — is due to the reduced saliency of the information on place of articulation recoverable at the end of a word. When a stop is released into a vowel — as it is in initial position where the scores range from 70% to 95% — it is much easier for a listener to recover the place of articulation of the stop. We will return to this issue in section 2.2.2.

Atkey's results, then, are consistent with Brown's: because English speakers already have the features [CORONAL] and [POSTERIOR] in their English L1 featural inventory, they are able to acquire these features in their L2 Czech phonology.

2.1.3. Acquisition of English [h] and [θ] by French speakers

In looking at French speakers acquiring English, LaCharité and Prévost (1999) refine Brown's model by proposing a hierarchy of difficulty for new sounds. Whereas Brown holds that if a feature is lacking from the L1 then any contrast dependent on that feature cannot be acquired, LaCharité and Prévost argue that a missing articulator node would be more difficult to acquire than a missing terminal node. French lacks [h] and [θ], so this means that French learners of English must acquire these sounds, for which LaCharité and Prévost propose the representations in (7).

(7) *Articulator nodes versus terminal nodes in English*:

	/h/	/θ/
	[CONSONANTAL]	[CONSONANTAL]
	|	|
	Place	Place
	|	|
articulator nodes	<u>Pharyngeal</u>	Coronal
		|
terminal nodes		[<u>DISTRIBUTED</u>]

The underlined features — Pharyngeal and [DISTRIBUTED] — are absent from the French inventory. LaCharité and Prévost predict that the acquisition of [h] will be more difficult than the acquisition of [θ] because [h] requires the learner to posit a new articulator node, namely Pharyngeal. This prediction is partially confirmed: on a discrimination task, learners were significantly less accurate in identifying [h] than in identifying [θ]; however, on a word identification task (involving lexical access) there was no significant difference between the performance on [h] versus [θ]. While it is not unusual for subjects to perform differently on discrimination versus word identification tasks (with discrimination normally being more accurate than word tasks), note that in this case the subjects did better on the task involving lexical access. If we assume that the phonological features are part of the lexical representation, this result is difficult to explain. The subjects did not find it more difficult to acquire the representation of the missing articulator node than the missing terminal node.

2.1.4. Acquisition of French and Spanish 'r' by English speakers

On the basis of an Event-Related Potential (ERP) study that looks at English speakers acquiring French and Spanish 'r' sounds, Mah (2003) presents an argument against the LaCharité and Prévost position. Under Mah's analysis, English lacks a pharyngeal node ([h] being analyzed as Laryngeal) while French [ʁ] is analyzed as Pharyngeal. Spanish [r], on the other hand, is Coronal. The acquisition of both French and Spanish 'r' requires that English speakers activate a new terminal node that Mah defines as [VIBRANT] (drawing on Colantoni 2001). In her analysis of the processing of these two 'r' sounds, Mah does not find any differences between the perception of a French 'r' as opposed to the Spanish 'r'.

Mah's study has two interesting corollaries. One is that some of her subjects were near-native speakers of the second language and they were definitely producing versions of French or Spanish 'r' that were notably different from English 'r'. So, they may well be producing distinctions that they are not perceiving in context-reduced stimuli. Secondly, the patterns that emerged from this study were consistent with the subjects increasing their discrimination abilities within a category. Even though speakers are not setting up a new phonological category, it nevertheless may be the case that their abilities — both in terms of production and discrimination — are improving. This is unexpected if L2 acquisition proceeds in accordance with the deficit hypothesis. But if L2 learners are redeploying their phonological knowledge, as claimed by the redeployment hypothesis, then we expect such improvement.

2.2. Redeploying knowledge of acoustic cues

Another factor to take into account when investigating how L2 learners acquire L2 phonology concerns acoustic cues and how these interact with faithfulness and markedness constraints. Here, I briefly report on evidence that indicates that the robustness of acoustic cues interacts with the learning algorithm, both for L1 acquisition (section 2.2.1), and for L2 acquistion (section 2.2.2).

2.2.1. L1 Acquisition of Dutch word-initial consonants

Vanderweide (2005) looks at the acquisition of word-initial consonants in children learning Dutch as a first language. Drawing on Wright (2001), she defines the robustness of acoustic cues as predictors of the specific paths that learners follow when acquiring CV and CCV sequences in Dutch. Looking at both internal cues (such as formant structure) and contextual cues (such as release burst) in segmental sequences, Vanderweide argues that the robustness of an acoustic cue determines when learners use these cues as intake in the constraint demotion process that structures the learning algorithm. The goal of any acquisition theory is to account for how a learner arrives at the target grammar. Within an optimality theoretic model of grammar, the learner has to arrive at the correct constraint ranking. It is commonly assumed that the method by which learners rerank constraints to approach the target grammar is to demote the constraints which are erroneously ranked too high (rather than *promote* the constraints which are erroneously ranked too low). A procedure which formalizes how a learner processes the data from the linguistic environment and makes changes to the existing grammar is called a *learning algorithm*. A theory of language acquisition must attempt to explain why it is that learners, who are exposed to a broad range of well-formed linguistic input, do not immediately utilize the positive evidence around them to arrive at the target grammar. Rather, they seem to take in certain kinds of data but not other data. Within the field of second language acquisition, the data found in the ambient language is known as the *input* to the learner. The subset of this data that is actually taken in and processed by the learner is known as the *intake*. For Vanderweide (2005), early intake will be that characterized by the most robust phonetic cues. As acquisition proceeds, less robust cues are able to function as intake. Therefore, children will first acquire segments that occur in contexts of greater perceptability.

The acoustic signal encodes articulatory information that must be recovered by the listener. Plosives have strong contextual cues but weak internal cues. Fricatives and approximants have strong internal cues but weak contextual ones. Vanderweide proposes that children tend to follow the perceptability scale in (8):

(8) *Perceptability Scale*:[1]

__ Vowel > __ Sonorant > __ Obstruent

Because of the relative ease with which segments can be recovered in each of these positions, the perceptability scale orders the acquisition sequence such that segments in pre-vocalic position are acquired first, followed by segments in pre-sonorant position, followed by segments in pre-obstruent position. This is an example of a fixed harmonic scale (here determined by perceptual salience) influencing the course of acquisition. With respect to current phonological theory, this raises the question of whether such a harmonic scale should be encoded as a faithfulness or as a markedness constraint. Within Optimality Theory, an output form is under a variety of conflicting constraints. One general type is known as a *faithfulness* constraint in that it values an output form which has remained faithful to the input form (i.e., the input form was changed minimally). A second general type is a *markedness* constraint which values forms which result in less-marked structures. Following Howe and Pulleyblank (2004), Vanderweide 2005) (argues that the harmonic perceptability scale is best analyzed as a hierarchy of faithfulness constraints, as in (9). This hierarchy reads as follows: faithfulness to a feature in pre-vocalic position is more highly ranked than faithfulness to a feature in pre-sonorant position, which is more highly ranked than faithfulness to a feature in pre-obstruent position.

(9) FAITH (αF /_ Vowel) >> FAITH (αF /_ Sonorant) >> FAITH (αF /_ Obstruent)

Following standard assumptions, markedness constraints (M_x) initially outrank faithfulness constraints (F_x), as in (10).

(10) $\{M_1, M_2, M_3\}$ >> F_1 >> F_2 ...

Learning proceeds, in part, by demoting the relevant markedness constraints based on the positive evidence of the ambient language. Under this model, when the child realizes that he or she has arrived at an incorrect grammar, the action taken is to rerank the constraints by making the relevant markedness constraint less-highly ranked. Putting aside the question of how the leaner knows how far down to demote a particular constraint (see Vanderweide 2005 for discussion), the generalization pertinent to our present concerns is that, in this model, children are predicted to first become faithful to the input in pre-vocalic positions, then to the input in pre-sonorant positions, and and then to the input in pre-obstruent positions.

2.2.2. Acquisition of Yucatec Maya ejectives by Spanish speakers

Building on the work of Wright (2004) and Vanderweide (2005), Gonzalez-Poot (in preparation) looks at the role of acoustic prominence and cues in the acquisition of Yucatec Maya ejectives by native speakers of Spanish. He hypothesizes

[1] ">" = more perceptually salient.

that the perceptual cues associated with the release of ejectives will enhance their perception by Spanish speakers, in spite of the fact that their L1 lacks the phonological feature [CONSTRICTED GLOTTIS] to make the contrast. Gonzalez-Poot argues that a phonological contrast relying on a feature absent from the L1 can be acquired when the acoustic cue is robust enough. Ejectives are characterized by an intense energy burst upon release and a long Voice Onset Timing (Wright 2004).

Data were gathered from 12 non-native speakers of Yucatec Maya and from three native speaker controls; subjects were found at the Universidad Autonoma de Campeche in Mexico. Subjects were given an AX discrimination task.[1] Subjects were also given a Forced-Choice Picture Selection task which I will not be reporting on here. L2 subjects listened to 120 minimal pairs of monosyllabic Yucatec Maya words. Thirty of the items contained plain versus ejective stops and affricates in singleton onset position, as in (11a); 24 items contained plain versus ejective voiceless stops and affricates in singleton coda position, as in (11b); nine were foil pairs of identical stimuli, as in (11c); and the remaining items consisted of minimal pairs involving contrasts other than ejectives (also involving features present in the first language).

(11) *Yucatec Maya plain/ejective contrasts*:

a.	onset contrast	/**k**a:n/	'snake'	vs. /**k'**a:n/	'land measure'
b.	coda contrast	/i:**k**/	'hot pepper'	vs. /i:**k'**/	'wind'
c.	foil	/i:**k'**/	'wind'	vs. /i:**k'**/	'wind'

The results of this test are given in Table 2, showing the mean number of correct responses per group.

Table 2: Correct identification of Yucatec Maya plain/ejective contrasts

	Native Speakers	Non-Native Speakers
Onset	96.6	82.5
Coda	92.7	65.0
Foil	100.0	100.0

The L2 learners' performance on discrimination in the onset position is very high (82.5%). It is worth comparing this performance to Brown's (2000) Japanese subjects who only scored 31% on the onset position. For Yucatec Maya, in the onset position, non-native speaker performance is not significantly different from native speaker performance (based on a Mann-Whitney U test, a non-parametric test of significance). Gonzalez-Poot argues that the L2 learners are able to overcome the negative effect of the L1 filter (lacking [CONSTRICTED GLOTTIS]) and accurately discriminate the plain versus ejective sounds. But, he also notes that

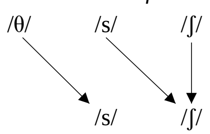
[1] In this type of task subjects hear two stimulus items and have to indicate whether the items are the same or different.

the non-native speaker performance in coda position is both much worse and significantly different from native speaker performance (p = .0004). Again this is contrary to the pattern found by Brown, whose learners did better in coda than in onset position. Gonzalez-Poot proposes that it is the nature of the acoustic cues that signal these differences that explains the results. Ejectives provide robust transitional cues in onset position when they are released into a vowel. The release burst allows the listener to recover the place and manner of the initial consonant. In contrast, a word-final ejective displays much subtler acoustic cues, making it much more difficult to recover the place and manner of the final consonant. If we contrast this with the properties of liquids, as studied by Brown, we note that the acoustic properties of liquids in coda position (via formant transitions in the preceding vowel) provide more robust cues that allow learners to recover the place and manner of the following consonant. In this light, we see that it is not the case that sounds are inherently easier or harder to recover in onset or coda position; rather recoverability of a given sound depends on the salience of the acoustic cues that the listener will process.

2.3. Redeploying knowledge of contrasts: Chain shifts

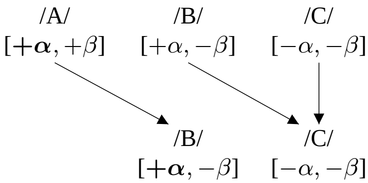
Several researchers (Eckman et al. 2003; Lee 2000) have described the phenomenon of a “deflected contrast” in second language learners. The phenomenon is better known in first language acquisition literature (Dinnsen and Barlow 1998; Macken 1980), and in phonological theory (Kirchner 1996), but there is evidence for it in L2 learners too. For example, some Korean learners of English display a chain shift pattern where target /θ/ is realized as [s], the target /s/ is palatalized to [ʃ] (before [i] and [j]), and target /ʃ/ is faithfully produced as [ʃ] (Lee 2000). This is diagrammed in (12).

(12) *Korean Chain Shift*:



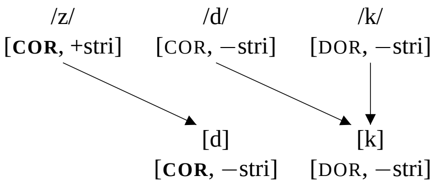
Korean lacks /θ/ so there is no L1 process that requires that /θ/ be posited to occur in the input representation. Korean learners of English consistently substitute the [s] sound for the /θ/ even before high front vowels and glides. This is the crux of the opacity problem of chain shift in Optimality Theory. If there is an output constraint that dictates that [s] should be realized as [ʃ] in certain contexts, then it cannot matter whether that [s] began as a [s] or as a [θ] in the input. So, why don’t Korean learners of English change the underlying /θ/ sounds to [ʃ] before [i] and [j]? The mechanism that Jesney (2005) proposes to account for this invokes “preferential feature preservation”, as in (13).

(13) *Preferential feature preservation*:



It is preferred to preserve the feature value [+β] in the context of [+β]. In the context of [−β], the value of the alpha feature does not have to be preserved. Example (14) shows how this could work in the *puzzle–puddle–pickle* phenomenon presented in Smith (1973). In these data, words like *puzzle* are pronounced with [d], words like *puddle* are pronounced with [k], as are words like *pickle*.

(14) *Feature preservation in the z → d → k chain shift*: puzzle–puddle–pickle

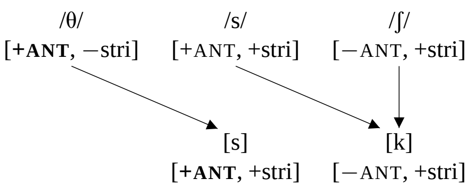


Smith's influential study was a longitudinal case study of child phonological acquisition. These data reveal that the mechanism of chain shift is not unique to second language learners; we find it in child language as well as in adult grammars of primary languages.

It is more important for this subject to preserve the coronality on strident sounds than it is to preserve the coronality on non-strident sounds. Jesney (2005) provides phonetic and typological justification for this privilege and motivates it within a harmony-as-faithfulness model of Howe and Pulleyblank (2004).

To return to L2 learners, Jesney proposes the following preferential feature preservation that leads to the chain shift shown in (15).

(15) *Feature preservation in the θ → s → ʃ L2 chain shift*:



The L1 grammar of Korean retains the anteriority of non-strident sounds, while not retaining the anteriority of strident sounds. Phonetically and typologically, we see a clear connection between [ANTERIOR] and [STRIDENT]. Phonetically, we know that stridency results from a turbulence in the airflow. This turbulence is much more easily created with the front of the tongue and at the front of the mouth (hence [ANTERIOR]). Typologically, we know that when languages have strident sounds, they tend to occur at the front of the mouth. Jesney shows us that, at times, the production of L2 learners may be the result of subtle phonological phenomena found in the first language. The chain shift is evidence of redeployment, not of a deficit.

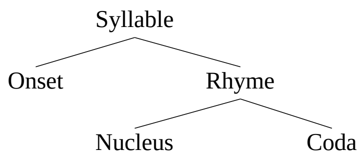
2.4. Summary

All of the studies related to L2 feature acquisition that we have looked at here demonstrate that second language learners are setting up grammars that are consistent with the properties of other natural languages. Consistent with the redeployment hypothesis, the nature of their L2 grammars is determined by L1 transfer, phonological universals, and properties of the acoustic signal. L2 learners are redeploying these properties to acquire the L2 grammar.

3. Redeploying Knowledge of Syllable Structure

We have so far discussed the acquisition of phonological properties at the featural and segmental level. I now consider examples of how hierarchical structure is acquired at the level of the syllable. For purposes of discussion, I adopt the model of syllable structure shown in (16).

(16) *Model of syllable structure*:



The languages of the world vary according to such things as whether syllabic nodes can branch. Some languages do not allow branching onsets or codas (e.g., Japanese). A common phenomenon in second language learning involves modifying an L2 word so that it fits the L1 syllable structure. Up to this point when we have been investigating the acquisition of a new structure in a second language, we have suggested that success can result from either having the relevant feature in your L1, or having the new structure be cued by a robust acoustic cue. But sometimes the reasons for success are more subtle.

3.1. L2 acquisition of syllable structure

Not only do the syllable structure properties of L1 transfer into L2, but learners are also able to acquire new structures (Young-Scholten and Archibald 2000). For example, even if a learner's L1 does not allow branching onsets, they are nevertheless able to acquire an L2 with branching onsets. In Archibald (2003), I outline how second language learners learn to parse these novel consonantal sequences. These studies reveal that, at times, what transfers from L1 to L2 may be quite subtle. On the surface, we might expect two languages like Finnish and Korean —

both of which lack onset clusters — to behave similarly when it comes to acquiring English consonant clusters. However, they do not. Finnish learners appear to be much more accurate than Korean learners in acquiring English consonant clusters. Therefore, it is obvious that a principle of "no clusters" is not what is transferring. Rather, Archibald (2003) argues that it is a combination of properties of the L1 segmental inventory and intraconstituent licensing properties that can explain the Finnish speakers' success.

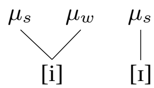
3.2. L2 acquisition of moraic structure

Acquiring syllable structure also includes the acquisition of moraic structure. To consider this scenario, let us look at the acquisition of Japanese length contrasts by speakers of English. Japanese has length contrasts in both its consonantal and vocalic inventories, as in (17).

(17) *Japanese length contrasts*:
  a. [t] vs. [tt]
  b. [ɔ] vs. [ɔː]

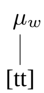
English has a contrast between monomoraic (lax) and bimoraic (tense) vowels, as in (18). However, English lacks consonantal length contrasts.

(18) *English length contrasts*:



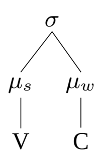
The question is: can English speakers acquire length contrasts in a second language? Is length a robust acoustic feature? Do English speakers have a feature for [LENGTH] in their L1 phonology? To make these questions more explicit, we need to fine tune what we mean by length contrast. It is a universal property of vocalic moras to project a syllable node. In addition, I assume that there is a difference between strong and weak moras (Zec 1995): a mora projected by a vowel is strong (μ_s), while a mora projected by a consonant is weak (μ_w). So, how are we to represent consonantal length? Hayes (1989) argues that non-geminate consonants are not associated with a mora, as in (19a), while geminate consonants are associated with a single mora, as in (19b).

(19) a. [t] b.

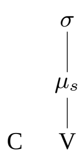


Quantity-sensitive languages allow certain coda consonants to project an additional mora (20a), while onset consonants are not mora-projecting (20b).

(20) a.



b.



Given this theoretical background, now consider two hypotheses about how L1 English speakers will acquire Japanese length contrasts:

(21) *Hypothesis A*:

a. Native speakers of English will be unable to acquire Japanese consonantal length contrasts because English does not contrast consonant length.

b. But, native speakers of English will acquire Japanese short and long vowel contrasts, since the feature for vowel length is present in the L1 grammar.

(22) *Hypothesis B*:

English speakers will be able to acquire both long consonants and vowels because their L1 maintains a length contrast. They can redeploy their L1 knowledge.

Now let's look at how non-native speakers of Japanese do when it comes to acquiring length contrasts. Han (1992) argues that English speakers often fail to produce the appropriate Japanese length contrasts, and when they succeed in doing so, the timing of the geminate stop closure differs significantly from that of a native Japanese speaker. She looks at four native speakers of English who were very advanced in Japanese proficiency, but who were not making a significant difference between their geminate and single stops.

Table 3 reports on the ratios of long to short consonants found by Han (1992) for native speakers of Japanese: long consonants remain closed up to three times longer than short consonants, with a range of 2.71 to 3.00. This contrasts with the ratios for non-native speakers of Japanese, shown in Table 4, where for some speakers long consonants were not much longer than their short counterparts (e.g., Subject D has a ratio of 1.05; Subject C has a ratio of 1.5). From these data, Han concludes that non-native speakers were not producing a native-like contrast when it came to closure time for obstruents.

Table 3: Native Japanese speaker ratios (from Han 1992)

	/tt/ vs. /t/	/pp/ vs. /p/	/kk/ vs. /k/
Mean Ratio	3.00	2.71	2.80

Table 4: Non-native-speaker length ratios (from Han 1992)

Subject	A	B	C	D
Ratio	1.7	2.8	1.5	1.05

Mah and Archibald (2003) argue, contra Han, that English speakers can make significant differences between long and short segments. In our study, we collected data from a single individual and measured the length of the produced consonants and vowels. The subject was a 22-year-old native speaker of Canadian

English who had enrolled in an introductory Japanese class at university. Classes were held four times a week for an hour per class. Fifteen Japanese sentences, written in hiragana script (to try to focus the subject's attention on decoding the script rather than on the phonological contrast), were designed to elicit the targeted contrasts. The data were collected four months after classes began.

The subject read each sentence three times from randomized index cards. The data were digitally recorded and then re-digitized at a sampling rate of 22.2 kHz using Soundscope 8. Wide-band spectrograms were made of the relevant sentences, and measurements were taken from these. Stop closure duration was measured by the absence of noise on the spectrogram. Fricative duration was measured from onset to endpoint of the characteristic noise burst on the spectrogram. Only intervocalic stops were included in the data analysis. Vowel duration was measured from the onset of glottal vibration to the following closure.

The results for consonantal length are given in Table 5.

Table 5: Non-native-speaker consonantal length

Sound	*Single*	*Geminate*	*Ratio*
[t]	.085	.332	3.95
[p]	.098	.392	4.00
[k]	.086	.333	3.87
[ɕ]	.171	.304	1.77
[n]	.102	.291	2.85
[m]	.088	.296	3.36

This subject produced a mean consonant closure duration of 3.26:1, which is close to the ratio of approximately 3:1 reported by Han (1992). A two-tailed t-test revealed that geminate contrasts were significantly longer than their corresponding singletons (all p values less than .001).

The results for the non-native vowel length are given in Table 6.

Table 6: Non-native-speaker vowel length

Sound	*Single*	*Geminate*	*Ratio*
[a]	.118	.295	2.50
[i]	.106	.341	3.21
[u]	.082	.219	2.67
[ɛ]	.114	.351	3.07
[ɔ]	.148	.339	2.29

The subject produced a mean vowel duration of 2.65:1, which falls within the native speaker range reported by Han of between 2:1 and 3:1. For all contrasts, a two-tailed t-test revealed that long vowels were produced significantly longer than short vowels (all p values less than .002).

These results suggest that this subject has acquired a length contrast: she consistently produced long consonants and long vowels that were significantly longer than their short counterparts. Why would this be possible if her English L1 phonology lacks the long versus short consonant distinction? Remember that English speakers have an L1 grammar where coda consonants are licensed by a weak mora for reasons of weight. In Japanese, geminate consonants are licensed by a weak mora. I would argue, then, that the English speakers are able to acquire both Japanese vowel length and consonantal length contrasts based on the licensing properties of their L1. They can redeploy the weak mora licensing from their L1 to new uses in the L2.

3.3. Summary

The cases we have seen in the acquisition of syllable structure show the subtlety of what needs to be acquired, the data that can cue this knowledge, and the properties of the L1 that can transfer. The acquisition of syllable structure provides good examples of how second language learners do not have a deficit. Rather, learners can move beyond their L1 grammars by redeploying their phonological knowledge to acquire the L2 grammar.

4. Redeploying Knowledge of Metrical Structure

Turning now to the question of how L2 learners acquire stress, my research supports the following conclusions. First, adult interlanguages do not violate metrical universals. Second, adults are capable of resetting their parameters to the L2 setting. Subjects are quite good at putting English stress on the correct syllable. Thus, their interlanguages are a combination of UG principles, correct L2 parameter settings (from resetting), and incorrect L1 parameter settings (from transfer).

Table 7 illustrates how languages may differ in their parameter settings with respect to metrical structure. The parameters include:

(i) whether the word tree is left or right branching;

(ii) whether the foot type is binary or not;

(iii) whether the metrical foot is strong on the left or the right;

(iv) whether metrification is from the right or the left edge;

(v) whether feet are quantity-sensitive or not;

(vi) whether quantity sensitivity is to the rhyme or the nucleus;

(vii) whether there is extrametricality or not; and

(viii) whether the extrametrical material falls on the left or right edge.

Table 7: Metrical parameters

Parameter	Spanish	Polish	Hungarian	English
word tree	right	right	left	right
foot type	binary	binary	binary	binary
strong on	left	left	left	left
built from	right	right	left	right
quantity-sensitive	yes	no	yes	yes
sensitive to	rhyme	(n/a)	nucleus	rhyme
extrametrical	yes	no	no	yes
extrametrical on	right	(n/a)	(n/a)	right

When the parameter settings are different in the first and the second language, we have the potential for transfer. Often, the L1 parameter settings transfer into the L2. L2 learners are able to reset their existing parameters to new values (Archibald 1993). However, it is less clear whether subjects whose first languages did not have stress but rather had tone were able to trigger these metrical representations. In earlier work (Archibald 1997), I argue that Chinese and Japanese subjects learning English do not compute metrical representations, but rather stored stress placement for each lexical item. However, more recently Ou and Ota (2004) argue that Chinese learners of English show sensitivity to syllable weight in a perception test of English words, and hence that these subjects are able to engage in a computational process to generate stress placement. If so, this would be further evidence that second language learners are able to create new representations that are not found in their L1. Kawagoe (2003) also argues that learners who do not have stress in their L1 can acquire it in a second language. While pitch accent may be stored in the L1, they acquire a computational system that builds upon the properties of Japanese loanword adaptation and results in a system much like the system of English stress assignment.

These studies show that metrical properties are just as amenable to study as segmental and syllabic properties and demonstrate that second language learners are able to subtly redeploy existing L1 features to acquire structures that are not present in their first language.

5. Lexical Access

There have been conflicting claims made in the literature as to whether bilinguals are able to selectively access the word store of a single language (selective lexical activation) or whether all languages are active all the time (nonselective lexical activation). Following Libben (2000) and others, we maintain that language comprehension is an automatic process that cannot be suppressed; this is true of both monolinguals and bilinguals. For bilinguals, the lexical items of both languages are going to be activated automatically regardless of linguistic context.

Our approach to study selective versus nonselective lexical activation is to investigate how bilinguals process interlingual homophones and homographs. Interlingual homographs, or orthographic false friends, are words from different languages that are spelled identically but are different in their pronunciation or meaning. For example, (23) shows an interlingual homograph between English and Dutch. Interlingual homophones, or phonological false friends, are words from different languages that are pronounced similarly, but are different in their spelling or meaning, as in (24).

(23) *Interlingual homograph*: angel

Dutch:	[aŋgɛl]	'sting' or 'hook'
English:	[ejndʒəl]	

(24) *Interlingual homophone*: [lif]

Dutch:	*lief*	'dear, lovable'
English:	*leaf*	

Dijkstra et al. (1999) asked Dutch–English bilinguals to perform a lexical decision tasks on items which included both interlingual homographs such as *angel* and interlingual homophones such as [lif]. The participants were not told about the bilingual nature of these words, and the study was conducted solely in English. The Dutch–English bilinguals responded to interlingual homographs significantly faster (21ms facilitation) and more accurately relative to the English control words, which had matching word lengths and similar frequencies with the homographs but did not have bilingual status. On the other hand, the participants responded to interlingual homophones significantly slower (a 34ms inhibition effect in the lexical decision task) relative to their control words.

Dijkstra et al. concluded that bilingual lexical activation is at least initially language nonselective, with orthographical information and phonological information contributing differently to the lexical retrieval process. The authors demonstrated that the overlap in orthography is faciliatory in lexical retrieval. In contrast, the overlap in phonology has inhibitory effects. The authors also argued that previous studies (Dijkstra, et al. 1998; Gerard and Scarborough 1989) that observed a null effect from interlingual homographs could be explained by the conflicting effects between phonology and orthography, as they did not systematically control the status of phonological overlap in the interlingual homographs.

The majority of cognitive studies that report evidence of lexical activation being language nonselective employ a single word presentation paradigm. Although this paradigm offers stringent experimental controls, one of its drawbacks is that it may not reflect natural lexical processes. For example, in a lexical decision task, the time to make a "Yes" response can consist of lexical access, plus the decision process. In some cases, the decision can be made solely on the basis of non-linguistic cues, such as word likeness (Grainger and Jacobs 1996) or sublexical cues (e.g., language specific bigram patterns). Furthermore, the presentation of one word at a time may not be optimal in studying natural lexical processing, since in normal reading words are almost always presented in context.

The aim of the current study (for more detailed discussion see Nakayama and Archibald 2004) is to further investigate bilingual lexical processing in context. In our study, Dutch–English bilinguals were asked to read English sentences for comprehension while their eye movements were recorded. Monolingual studies have shown that eye movements are sensitive measures of lexical processing (Kambe et al. 2001; see Rayner and Juhasz 2004 for a recent review), so it was assumed that eye movements would also be sensitive to bilingual lexical processing. The English sentences presented to the participants occasionally contained Dutch–English interlingual homographs or interlingual homophones. Although the bilinguals knew that the study was concerned with bilingual language processing, they were not told about the bilingual nature of the critical words. Rather they were simply told to read English sentences for comprehension. Participants were asked to read the sentences as they would normally do, so their eye movements were expected to reflect natural on-line lexical processing.

Eye movements are generally divided into two classes of qualitatively different processes: first pass processes and second pass processes. First-pass reading time includes the first fixation duration (initial fixation on a target word) and the gaze duration (the sum of fixations made on a target word before the eyes leave the word). Second-pass reading time includes regressions (re-fixations on a target word that are made after the eyes have left the word) and total reading time on the target. First-pass processes are associated with initial lexical retrieval processes, and second-pass processes are associated with advanced reading processes past the initial lexical retrieval, such as text integration (Deutsch et al. 2005).

If bilingual lexical processing is language non-selective in reading, then the first-pass reading time should reflect different eye movement patterns on interlingual targets from monolingual English control words. Based on the findings by Dijkstra et al. (1999) mentioned above, in this study, the interlingual homographs were predicted to be fixated on for a shorter amount of time relative to English controls, reflecting the faciliatory lexical retrieval from the orthographic overlap. On the other hand, interlingual homophones would be fixated on for a longer amount of time relative to control words, reflecting the inhibitory lexical retrieval from the phonological overlap. These hypotheses were tested with Dutch–English bilinguals (section 5.1), and with unilingual English controls (section 5.2).

5.1. Experiment 1: Dutch–English bilinguals

5.1.1. Method

Participants. Fourteen Dutch–English bilinguals participated in the study. The majority of participants were faculty members from the University of Calgary, or were Dutch immigrants recruited from a local Dutch church group.

Stimuli. Because we hoped to attribute any differences in effects that may be observed to the paradigms (single word presentation vs. reading), the stimuli for the current study were selected from Disjkstra et al. (1999). Thus, 15 interlingual homographs and 15 interlingual homophones and their respective control words were taken from Dijkstra et al. (1999). All words were nouns and adjectives and were three to five letters in length. For interlingual homographs, the average English word frequency was 40.2 occurrences per million and Dutch word frequency was 27.4 occurrences per million according to the CELEX database (Baayen et al. 1993). For interlingual homophones, the average English word frequency was 41.7 occurrences per million and Dutch word frequency was 29.1 occurrences per million. The average word frequency for control words was 40.4 occurrences per million for the interlingual homographs and 41.9 occurrences per million for the interlingual homophones. In Dijkstra et al. (1999), the interlingual homographs had been rated by Dutch–English bilinguals with regard to lexical similarities between Dutch and English. The interlingual homographs were rated as identical in orthography (7.0/7.0) but not similar in semantics (1.6/7.0) or in phonology (2.6/7.0). The interlingual homophones were rated as very similar in phonology (6.0/7.0) but not similar in semantics (1.2/7.0) or in orthography (2.8/7.0). (For further description of stimuli, see Dijkstra et al. 1999.)

Thirty short sentence frames were created in order to embed the test words and their matched English controls. All sentences were under 70 characters long. The sentence frames were created in such a way that the context made sense whether a test word or a control word was accommodated. The critical words (pairs of test words or control words) were embedded in varying positions within the sentence frame; a third of critical pairs appeared in the first third region of the sentence, a third in the middle region of the sentence, and a third in the last third region of the sentence. Thirty filler sentences were also created. These distractor sentences contained only English words. The filler sentences were presented so that the bilingual nature of the test words would be less salient, which would strongly bias the language context toward English.

When the context of a sentence makes the word easily predictable, previous eye movement studies report (Drieghe et al. 2004; Kliegl et al. 2004) that a word tends to be fixated on for a shorter period of time or skipped more often. Therefore, care was taken in creating the sentence frames to ensure that the context would be as neutral as possible. In addition, a group of 20 English-speaking students, who did not participate in the current study, rated how well both the interlingual words and their control words “fit” in their sentence frames from a scale of one to seven. As shown in Table 8, the interlingual homographs had a fit rating of 4.9 / 7.0, and the control words had a rating of 5.2 / 7.0; the interlingual homophones had a fit rating of 5.1 / 7.0 and their control words had a rating of 4.8 / 7.0. Only words placed at the middle and end of sentences were rated, as context should not affect the first pass fixation of words placed at the beginning of a sentence.

Table 8: Fit rating of interlingual words and control words

Interlingual homographs	*Control words*	*Comparison*
4.9/7.0	5.2/7.0	$t(9) = -1.05, p > 0.3$
5.1/7.0	4.8/7.0	$t(9) = .68, p > 0.5$

Thus, any statistical difference in the first pass fixations between the test words and control words should not be attributed the context of sentence frame biasing toward one word or another.

Fifteen sentence frames for the homograph condition were then divided into two groups (seven and eight items each). Each group embedded only test words or only control words. Word type (test or control) was alternated for the groups, resulting in two stimulus lists. Likewise, fifteen sentence frames for the homophone condition also yielded two stimulus lists. As a result, four lists of critical stimuli were created. The filler sentences were then added to these stimulus files. Each of the original stimulus files was then processed with Randomizer (SR research), producing two files with different item presentation sequences. Thus, in total eight stimuli files were created.

Apparatus. The eye movements were recorded by SR research, Inc. EYELINK I system (Ontario, Canada) with a sampling rate of 250 Hz. The gaze eye position resolution is .005° (20 seconds of arc, with an average error of 0.5° to 1.0°). Detection and analysis of saccades, fixations, and blinks occur in real time. Presentation of the stimuli was controlled by a Pentium II class computer at the refresh rate of 60 Hz with 800×600 resolution. Each sentence was presented in a single line on the centre of the 17-inch View Sonic (E90) monitor in a 16pt Times New Roman font.

Procedure. Participants were tested individually. Participants sat at a distance of approximately 60 cm from the monitor and their eyes were calibrated. The initial calibration process took approximately five to ten minutes. Except for the first five participants, the participants' eyes were re-calibrated after 30 sentences to ensure a good calibration quality.

After the calibration was completed, participants were told that they were going to be presented with a series of short English sentences. They were asked to silently read each sentence for comprehension. When they finish reading a sentence they were told to look down and press the escape key, which cleared the sentence display. When the participants were ready to read the new sentence, they fixated on the fixation dot on the centre of the screen. As the experimenter confirmed that the participants properly fixated on the dot, the new sentence was presented. Occasionally (15–25% of the time), the participants were asked a simple question about the sentence they had just read (e.g., "Where did Ken want to go?"). The participants answered every question with no difficulty. They were given eight practice sentences before experimental sentences were presented. Throughout the task, participants were never told about the bilingual property of words that appeared in some of the sentences.

Subsequent to the reading task, participants were asked to fill out a demographic information questionnaire, which asked about their background including Dutch and English language education along with demographic information. They also completed the Nelson-Denny vocabulary test, which objectively measures their level of knowledge of English words. Lastly, the participants were debriefed on the purpose of the study. Prior to the debriefing, hardly any participant had noticed that some sentences contained a word that was visually identical to a Dutch word (i.e., interlingual homographs), or sounded similar to a Dutch word (i.e., interlingual homophones). Quite a few participants commented that they "switch" language depending on an environment/task at hand, so they never read the interlingual words as Dutch words. The majority of the participants had to be shown the test words again to be convinced with the bilingual nature of the critical words.

5.1.2. Results

The raw data were trimmed prior to the data analyses. First, the mean and the standard deviation of the fixation durations were calculated for each participant. The fixation durations that exceeded 2.5 standard deviations of the participant data were treated as outliers and removed from the analyses (2.38% of the data). The gaze durations that were longer than one second were also considered outliers (Kambe et al. 2001) and removed from the analyses (0.48% of the data).

The fixations on words that were either initially skipped by participants or not fixated on at all were not included in the analyses (17.14% of the data). The remaining data were submitted to 2 (condition: orthography vs. phonology) $\times$ 2 (word status: test vs. control) repeated measures ANOVA. Separate analyses were conducted for the first fixation duration, and the gaze duration. Consistent with Dijkstra et al., only the subject analyses were conducted, as the stimuli "form nonrandom and almost exhaust selection of the item population" (1999:504), and thus conducting statistical analyses by item was not adequate.

First fixation duration. The main effect of condition (orthography vs. phonology) was not significant, $F(1,13) = 1.22, p > .20$, nor was the main effect of word type significant (test vs. control), $F(1,13) < 1$. However, there was a significant interaction between condition and word type $F(1,13) = 9.36, p < .05$. The descriptive statistics suggested that this interaction stemmed from interlingual homographs being fixated on for a shorter period of time than their controls, and interlingual homophones being fixated on for a longer period of time than their controls. Two paired comparisons were conducted to follow up this significant interaction. On the basis of the results by Dijkstra et al. (1999), we had general predictions as to the direction of the effects. For that reason, statistical significance was assessed by one-tailed tests. As shown in Table 9, interlingual homographs were fixated on significantly shorter (212 ms) relative to their control words (239 ms). On the other hand, interlingual homophones were fixated on longer (242 ms) relative to their control words (223 ms); the effect was marginally significant.

Table 9: First fixation duration of Dutch–English bilinguals

Interlingual homographs	*Control words*	*Comparison*
212 ms	239 ms	$t(13) = -3.34, p < .05$
242 ms	223 ms	$t(13) = \quad 1.69, p = .06$

Gaze duration. The main effect of condition (orthography vs. phonology) was not significant, $F(1, 13) < 1$. The main effect of word type (test vs. control) was not significant, $F(1, 13) < 1$. As in the first fixation duration, there was a significant interaction between condition and word type in gaze duration, $F(1, 13) = 16.21, p < 05$. As shown in Table 10, post-hoc paired comparisons revealed that the interlingual homographs were fixated on significantly shorter (255 ms) than their controls (284 ms), and the interlingual homophones were fixated on significantly longer (280 ms) relative to their controls (239 ms).

Table 10: Gaze duration of Dutch–English bilinguals

Interlingual homographs	*Control words*	*Comparison*
255 ms	284 ms	$t(13) = -2.66, p < .05$
280 ms	239 ms	$t(13) = \quad 3.01, p < .05$

5.1.3. Discussion

The aim of the current study was to explore whether bilinguals' eye movements reflect the nonselective language activation when reading English text. Both the first fixation and the gaze duration eye movements captured the different lexical retrieval processes associated with the reading of interlingual words compared to the reading of monolingual English words. Moreover, there was a significant interaction between the condition (interlingual homographs vs. interlingual homophones) and the word type (test vs. control). The first-pass reading time on interlingual homographs were significantly shorter than English controls, indicating that the lexical retrieval of homographs was facilitated. On the other hand, the first-pass reading time on interlingual homophones were significantly slower than the English controls, indicating that the lexical retrieval of homophones was inhibited. These results replicated Dijkstra et al. (1999), and lend additional support to the view that bilingual word recognition does not select for a particular language; in other words, it is language non-selective.

On average, the bilinguals in the present study had lived in Canada for more than two decades, and were very proficient in the English language. The patterns of the data obtained in Experiment 1 suggest that neither a strong environmental context (the participants are immersed in an English speaking society) nor very high proficiency in the second language is sufficient to override the language non-selective activation. In addition, the fact that almost none of the participants had any awareness of the bilingual nature of interlingual homographs and homophones gives further support to the automatic, bottom-up nature of the bilingual lexical processes.

5.2. Experiment 2: Monolingual English speakers

Could it be possible that the results of Experiment 1 were in fact due to some uncontrolled factors about the words, the sentence frames, or the interaction of the two? Although Dijkstra et al. (1999, Experiment 3) showed that a group of English speakers did not treat the interlingual words and control words any differently in a lexical decision task, these possibilities had to be addressed before any important theoretical implications could be discussed, as we employed a different paradigm, and also introduced a new variable — sentence frames.

In Experiment 2, a group of monolingual English speakers read the same sentences as the bilingual participants while their eye movements were monitored. A monolingual English speaker was defined as a native English speaker who does not speak Dutch; the participants were not necessarily limited to pure monolinguals who do not speak any other language. If the results observed in Experiment 1 were due to some unmatched characteristics of the stimuli, then the English monolinguals should show eye movement patterns that are comparable to the bilingual participants. On the other hand, if the results were indeed due to the activation of Dutch lexical representation influencing the reading of English text, then the English speakers, who do not speak Dutch, should not treat interlingual words and control words any differently.

More specifically stated, the predictions of Experiment 2 are as follows. If the findings of Experiment 1 truly support the view that initial lexical activation is language nonselective, then the monolinguals' first-pass reading time on interlingual homographs should not differ from that on English controls. Likewise, the first-pass reading time on interlingual homophones should not differ from that on their controls.

5.2.1. Method

Participants. Nineteen students of the University of Calgary participated in the study in exchange for a bonus credit toward a psychology course. All were native speakers of English. None of the participants spoke Dutch.

Apparatus and Procedure. The same apparatus as Experiment 1 was used in Experiment 2. The procedure was identical to Experiment 1, except that the

Nelson-Denny vocabulary test and demographic information questionnaire were not assigned to participants.

5.2.2. *Results*

As in Experiment 1, the raw data were trimmed prior to the data analyses. First, the mean and the standard deviation of the fixation durations were calculated for each participant. The fixation durations that exceeded 2.5 standard deviations for each participant were treated as outliers and removed from the analyses (2.25% of the data). There was no gaze duration that was longer than one second. The fixations on words that were either initially skipped by participants or not fixated on at all were not included in the analyses (20.37% of the data).

The remaining data were submitted to 2 (condition: orthography vs. phonology) $\times$ 2 (word status: test vs. control) repeated measures ANOVA. Separate analyses were conducted for the first fixation duration, and the gaze duration.

First fixation duration. The main effect of condition was not significant, $F(1, 18) < 1$; nor the main effect of word type, $F(1, 18) < 1$. There was no significant interaction between condition and word type $F(1, 18) = 1.15, p > .25$. As shown in Table 11, the paired comparisons showed that the average first fixation duration on interlingual homographs (225 ms) was not any shorter than the average first fixation duration on English controls (235 ms). Likewise, the first fixation duration on interlingual homophones was not any longer (233 ms) than the average first fixation on English controls (231 ms).

Table 11: First fixation duration of English monolinguals

Interlingual homographs	*Control words*	*Comparison*
225 ms	235 ms	$t(18) = -1.65, p > .05$
233 ms	231 ms	$t(18) < 1$

Gaze duration. The main effect of condition was not significant, $F(1, 18) = 2.17, p > .15$. The main effect of word type was not significant, $F(1, 18) = 1.11, p > 30$. There was no interaction between condition and word type, $F(1, 18) < 1$. A paired comparison revealed that the average gaze durations on interlingual homographs were not any shorter (260 ms) than the average gaze durations on their controls (249 ms). The average gaze durations on interlingual homophones was not any longer (250 ms) than their controls (241 ms).

5.2.3. *Discussion*

A group of English monolinguals participated in Experiment 2 in order to ascertain that the results of Experiment 1 were not due to some preexisting differences between the interlingual words and English controls. The results of Experiment 2

Table 12: Gaze duration of English monolinguals

Interlingual homographs	*Control words*	*Comparison*
260 ms	249 ms	$t(18) < 1$
250 ms	241 ms	$t(18) < 1$

clearly ruled out the possibility of such confounding. For both first fixation durations and gaze durations, the monolinguals did not fixate on interlingual homographs any shorter than the English controls, nor did they fixate on interlingual homophones any longer than the English controls.

Curiously, the overall first fixation durations of monolinguals (231 ms) were not any faster than for the bilinguals (228 ms), despite that fact that English was the second language for the bilinguals, and also the fact the bilinguals were on average much older than the monolinguals. The gaze durations were shorter for the monolinguals (250 ms) than for the bilinguals (264 ms), however, this 14 ms difference was not statistically significant, $t(130) = 1.45, p > .10$. These relatively short fixation durations of the bilinguals are probably due to their very high proficiency in English. With the Dutch–English bilinguals, Experiment 1 observed that the bilinguals' fixation patterns on interlingual words were significantly different from those on monolingual English words, even when the participants were reading English text. With the English monolinguals, the null effects in Experiment 2 confirmed that the results from Experiment 1 were indeed caused by the bilinguals' knowledge of the Dutch language. Further, replicating Dijkstra et al. (1999, Experiment 1), the present study observed that the between-language overlap in orthographic information and phonological information had opposite effects on bilinguals' first-pass reading time. The overlap in orthography had a facilitating effect in word recognition, while the overlap in phonology had an inhibitory effect in word recognition.

The preceding section reveals some of the properties of the bilingual lexicon which are pertinent to how multiple languages are stored, processed, and acquired. It is my contention that the redeployment hypothesis is bolstered by evidence showing that, even in automatic processing, we do not keep our languages compartmentalized. Even in a monolingual task, bilinguals are still bilingual.

6. Conclusion

All of the studies reported here point to the robust capacity of humans for acquiring other languages: the human language machine is always on; we can't turn it off. We access multiple meanings in a single language, and we activate the sounds and meanings of all our languages regardless of the context. And when we look at the properties of the phonological grammars of second language learners, we find very little evidence for a strong version of the deficit hypothesis, and quite a bit of support for the redeployment hypothesis.

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