

Article

Full Transfer and Segmental Emergence in the L2 Acquisition of Phonology: A Case Study

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Abstract: In this paper, we discuss a child Kazakh speaker's acquisition of English as her second language. In particular, we focus on this child's development of the English segments |f, v, θ, ð, ɹ, ʃ, tʃ|, which are not part of the Kazakh phonological inventory of consonants. We begin with a longitudinal description of the patterns that the child displayed through her acquisition of each of these segments. The data reveal patterns that range from extremely rapid to rather slow and progressive acquisition. The data also reveal patterns that were unexpected at first, for example, the slow development of |tʃ| in syllable onsets, an affricate that occurs as a contextual allophone in syllable onsets in Kazakh. We analyze these patterns through the Phonological Interference hypothesis, which was recently extended into the Feature Redistribution and Recombination hypothesis. These models predict the transfer into the L2 of all of the relevant phonological features present within the learner's first language and their recombination to represent segments present in the L2. We also discuss contexts where feature-based approaches to L2 acquisition fail to capture the full range of observations. In all such contexts, we show that the facts are modulated by phonetic characteristics of the speech sounds present in either the child's L1 or her L2.

Keywords: second language acquisition; phonology; child language; phonological features; phonetic implementation



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1. Introduction

In this paper, we discuss approaches to the acquisition of second language (L2) segmental phonology that make formal reference to phonological features as the building blocks of phonological (segmental) knowledge. As mainstream models of phonology are unified in their reference to phonological features as the 'atoms' of speech sound representations, one central question concerns the origins of a speaker's knowledge about features and feature combinations. In the context of L2 acquisition, models build on the availability of phonological features from the learner's already-acquired language(s), and the hypothesis that these features are readily transferrable into the learner's L2 grammar. As we will see, while these models do capture the most significant observations within the data, they are at times too rigid to accommodate some of the more subtle patterns present within the data. In such contexts, we supplement these models by taking a closer look at the factors that may govern the appearance of these more subtle patterns within the data. As we discuss below, these factors appear to primarily belong to the realm of speech phonetics, and may also interact with the learner's own analyses of allophonic variation present in the L2. How learners actually interpret the phonetic facts relevant to the speech sounds of their L2, and learn to map this knowledge into specific windows of phonetic articulation, may indeed determine at least some of the patterns observed within their speech productions.

Since its original formulation and subsequent development, the Full Transfer, Full Access (FTFA) theory of second language acquisition enables the formulation of clear hypotheses and related predictions about the course of L2 development. In a nutshell, the 'full

transfer' component of this theory predicts that the learner's first language (L1) knowledge is fully transferred and constitutes the initial state of their L2 (interlanguage) grammar; the 'full access' component captures that this knowledge can be modified or supplemented through full access to the same learning devices that benefit L1 learners. Consistent with standard assumptions about learnability, the predictions of this model are modulated by the learner's own interpretation of the L2 evidence to which they are exposed. In a nutshell, for all properties of the L2 that the learner can relate to their L1, transfer is predicted to play a central role in the L2 acquisition process; conversely, each time the learner must compose with L2 properties that they interpret as absent from, or incompatible with, their L1, then learning is predicted to take place in ways more similar to that observed in the context of L1 acquisition.

The predictions of FTFA have been most significant in the area of morpho-syntactic development (e.g., [Schwartz and Sprouse 1994, 1996](#); [White 1985, 1989](#)), including studies in child L2 acquisition ([Schwartz 2003](#); [Unsworth 2005](#)). This body of literature provides explanations for syntactic errors commonly observed in the language constructions of L2 learners as well as in the types of morphological errors that the same learners can make, even in the context of target-appropriate syntactic constructions. In the area of phonology, this approach has been successfully applied to studies of prosodic development (e.g., [Goad and White 2009](#); [Mobaraki et al. 2008](#); [Özçelik 2018](#)). The metrical approach to prosodic systems employed in these studies, described in terms of categorical domains and units, indeed offers apt parallels with the acquisition of syntax and morphology.

In contrast to this, however, there have been relatively few studies of the L2 acquisition of speech sounds published within the FTFA framework. This is paradoxical, given that within the more general literature on L2 phonological development, "it is probably the segment that has attracted the most attention" ([Archibald and Young-Scholten 2003](#), p. 163). Indeed, within the current literature, issues in the L2 acquisition of speech sounds have been considered predominantly within phonetically oriented frameworks such as the Speech Learning Model (e.g., [Flege et al. 1995](#)). This is in contrast with a smaller yet significant body of literature that focuses on formal aspects of L2 segmental development, in particular that of phonological units such as the segment and the phonological feature (e.g., [Hancin-Bhatt 1994](#); [Brown and Matthews 1993](#); [Brown 1998](#); [Martinez et al. 2021](#)), in addition to prosody. Finally, in explorations of relationships between speech phonetics and more formal aspects of phonological systems, the literature also offers discussions of formal models in light of perceptual and articulatory aspects of speech (e.g., [Brannen 2002](#); [Teasdale 1997](#); see also [Martinez et al. 2021](#) for recent discussion).

Within mainstream approaches to phonology, phonological features encode functional contrasts between different segments. The question as to how children encode knowledge about these contrasts and, by extension, about the representation of these contrasts within their phonological systems, has motivated early experimental research on infant speech perception. The literature on this topic reveals that, during their first six months of life, infants can perceive all sorts of phonological contrasts found among the sound systems of the world's languages ([Werker and Tees 1984](#)). Infants then gradually become more and more sensitive to the phonological contrasts relevant to their native languages. This gradual specialization in perceptual abilities, also referred to as perceptual narrowing, results in the relative loss, especially during the second half of the infants' first year, in their ability to perceive phonological contrasts that do not exist within their native language(s) ([Werker and Tees 1984](#)).

Perceptual narrowing, which results from the infants' development of categorical speech perception, a language-specific skill, results in an optimized system whereby speaker-listeners can easily distinguish members of different native phonemic categories (i.e., /t/ vs. /d/ in English), including their positional (allophonic) variants across all relevant phonological contexts.

Building on this theoretical proposal, [Brown \(1998\)](#) proposed that the symmetry between the increase in the ability to distinguish sounds phonologically in the children's

native languages and the gradual decline in universal perceptual capacities is the result of the same internal, feature-driven mechanism. In a nutshell, perceptual development can be encoded as the emergence of phonological features within the child's system of representations, while perceptual narrowing effects relate to the absence of features, within that system, to perceive speech sounds (and related phonological contrasts) irrelevant to the learner's language. In turn, this predicts that the ability of an L2 learner to even perceive a non-native contrast ultimately depends on aspects of his/her L1 phonological system; depending on the phonological features and feature combinations it contains, this system may indeed facilitate, or undermine, the accurate perception or representation of non-native contrasts. In this view, a speaker's phonological knowledge of speech sounds is thus construed in terms of phonological features and feature combinations.

Brown (1998) illustrates this hypothesis by discussing how the features represented in L1 phonological systems may impinge upon L2 perception (and production). She examined the acquisition of segmental contrasts (/l~r, b~v, and f~v/) by Japanese and Chinese learners of English. She focused on three types of contrasts that learners are likely to encounter during the course of L2 acquisition, as follows:

Type 1 contrast: Each member of the contrast in the L2 is similar to distinct segments in the learner's L1. For example, the glottalized /t'/ and /k'/ of Salish may correspond to /t/ and /k/ in English. The L2 learner can acoustically discriminate these non-native contrasts, but this ability is based not on the phonetic (physical) characteristics of the segments, but on them being perceived as distinct phonemes in the L1. Thus, the learner can categorize the members of the non-native contrast into phonemic categories corresponding to those of his/her L1; no new phonological structure is established in the interlanguage grammar.

Type 2 contrast: Neither of the sounds involved in the L2 contrast exists or has direct correspondents in the learner's L1. An example of this would be the acquisition of Zulu clicks by English speakers. Because no phonological structure is available in the learner's L1 to represent these segments, their perception will not be blocked by the learner's L1. Acquisition of this type of contrast is predicted to most closely resemble L1 acquisition; the L2 learner should not encounter any difficulties during the acquisition process, and should thus be able to construct representations for this non-native contrast.

Type 3 contrast: when only one member of the non-native contrast has a corresponding phoneme in the learner's L1. The L2 learner may be able to perceive this non-native contrast if the feature that distinguishes the two segments is present in his/her L1 grammar for independent reasons (i.e., the feature is involved in the representation of other L1 contrasts). This also predicts that acquisition of the accurate phonological representations for this non-native contrast is possible. On the other hand, the L2 learner may not be able to perceive (or produce) the contrast if the L1 grammar lacks the feature needed to distinguish the L2 pair of phones.

In sum, Brown (1998) suggests that a feature-based examination of a speaker's L1 phonological representation offers the required foundation to predict an L2 learner's ability to perceive and eventually produce the non-native contrasts.

Building on Brown's original proposal, Martinez et al. (2021) expand the scope of feature-based approaches to L2 acquisition by showing that L2 learners have the possibility to recombine features that already exist in the L1, whether these features function contrastively or allophonically within the L1. Further, Martinez et al. show that recombinations involving allophonic features involves more difficulty than those based on phonologically contrastive features only. This proposal thus extends and modulates the original proposal by Brown (1998), especially through an incorporation of the L2 learner's knowledge of features that may be active allophonically. Finally, in their discussion of some of the variation observed within their results, Martinez et al. (2021) hint at the potential for phonetic conditioning to influence the L2 learner, given that different features and feature combinations may carry different acoustic cues across different languages, or involve different speech articulations. For example, rhotic liquids may be represented phonologically in similar ways across languages, for example through the feature [rhotic], yet different

types of rhotics (e.g., taps, trills, approximants) can be phonetically very different from one another, a fact that eludes their featural representations.

In the sections below, we address these theoretical proposals in light of the L2 phonological development of Nura, a Kazakh child who began to acquire English around the turn of her fourth birthday. As we will see, the general approach set by [Brown \(1998\)](#) and [Martinez et al. \(2021\)](#) makes robust predictions concerning Nura's recombinations of L1 phonological features as part of her developing phonological productions in English. However, this approach at times fails to predict how Nura acquired the sounds of her L2. In our discussion of these cases, we follow the suggestion by [Martinez et al. \(2021\)](#) that speech phonetics may at times influence acquisition; we supplement our analysis through an incorporation of issues in speech articulation as well as in speech perception, as we strive to identify the sources of the patterns observed. This is the essence of phonological emergentism as an area of investigation within the large field of language acquisition. As recently discussed in [Rose et al. \(2021\)](#) and [Rose and Penney \(2022\)](#) (and references therein), emergentist analyses take into consideration not only the formal aspects of the phonological systems of the learner's L1 and L2 but also issues in the perception and production of the speech forms relevant to these systems. We begin in Section 2 with a summary of the methodology we used to document Nura's early journey into her second language. In Section 3, after a brief comparison of the Kazakh (L1) and English (L2) phonological systems, we make predictions about the child's acquisition of the consonants of English that do not have a direct equivalent within the Kazakh system. We offer a relatively detailed description of her acquisition of the consonants [f, v, ɹ, θ, ð, ʃ] in Section 4. We discuss these results in light of the current hypotheses in Section 5. As we will see, predictions based on phonological features and feature combinations are generally borne out by the data each time L1 featural knowledge can be transferred into the L2. However, a full understanding of the data must also consider the learner's own interpretation of the speech cues present in the L2, in addition to challenges inherent to the pronunciation of feature combinations not present in her L1.

2. Methodology

As mentioned in the introduction, in the sections to follow, we discuss production data from Nura, a monolingual Kazakh-speaking child who moved to Newfoundland, Canada when she was three years and eleven months old (3;11). Prior to this, Nura had extremely little direct experience with English, if at all, except for being exposed to the odd isolated English loanword, as her home language environment was situated within a Kazakh-speaking community in Western China until the day she moved to Canada. Nura began interacting with native speakers of English as of the 2nd day after her arrival; our first recording session took place approximately one week later.¹

Following the basic tenets of naturalistic approaches to the study of language acquisition, Nura was recorded in her own home while interacting with an English-speaking nanny who visited her on a regular basis (several days per week) to engage in English-language interactions. This same person was also running a camera recorder to capture samples of these interactions at regular intervals. While the interactions aimed at encouraging the child to learn and produce speech in her L2, no specific elicitation protocol was followed; key to this was to provide the child with a normal environment where she could benefit from the active presence of an English speaker to take her first steps into her L2.

Ethics approval for this work was obtained from Memorial University as part of a larger research project titled "Factors influencing phonological development: A cross-linguistic, cross-learning context empirical study" (ICEHR #20170104-AR), directed by Y. Rose, which aimed at broadening the empirical scope of child language studies by including participants of various language settings. Nura's parents gave their informed consent to participate in this larger study on a volunteer basis. Table 1 provides a summary of the recordings used for the current study, including their duration and the child's exact age. As shown in this table, during the earlier period of data recording, we sampled

Nura’s speech on a weekly basis. This relatively high density of sampling was motivated by the observation from research that child second language learners between the ages of four and six may move rather rapidly through early language acquisition milestones (Abrahamsson and Hyltenstam 2009). We will see an example of this with the labio-dentals |f, v| below, an observation we attribute to feature transfer.

Table 1. Summary of the recordings.

Age	Min	Age	Min	Age	Min	Age	Min
03;11.11	49	04;04.18	49	04;09.19	71	05;07.25	68
03;11.28	63	04;05.02	67	04;10.19	61	05;08.22	59
04;00.19	74	04;05.16	69	04;11.21	63	05;09.19	65
04;00.30	69	04;05.30	62	05;00.07	57	05;10.05	91
04;01.16	58	04;06.18	99	05;00.28	62	05;10.26	61
04;02.02	67	04;07.09	62	05;02.16	57	05;11.16	63
04;02.16	68	04;07.30	64	05;04.11	91	06;00.07	75
04;03.04	59	04;08.13	77	05;05.09	96	06;00.28	77
04;03.08	63	04;08.29	87	05;06.06	72	06;01.11	78
04;04.02	63	04;09.12	67	05;06.27	86	06;01.25	64

We engaged in the orthographic and phonetic transcription of these recordings using Phon, a specialized software program designed for the building and analysis of linguistic databases (<https://www.phon.ca>, accessed on 31 January 2024).² Phon is a software program that supports the building of textual and phonological data corpora. Among other functions, Phon includes all of the tools required to transcribe speech using the standards of the International Phonetic Alphabet and to query the transcriptions to qualitatively and quantitatively describe the patterning of units such as phones and phonological features across different phonological positions within syllables and words, or relative to stress. Phon also incorporates database functions to extract longitudinal data from series of transcripts recorded over time.

The steps described next follow standard procedures commonly utilized within the field (e.g., Rose and Hedlund 2021): Identification of each participant involved in the recording; identification of the time intervals on the recorded media that are relevant for research (i.e., speech turns for each participant involved in the recording); orthographic transcription of the child’s and adult’s productions; phonetic transcription of the child’s productions. The transcriptions were performed by undergraduate students in linguistics specifically trained for this task; these transcriptions thus offer a look into Nura’s productions as they were perceived by native speakers of English.

Below, we describe and analyze Nura’s acquisition of the six English consonantal segments that are absent from the Kazakh inventory of phonemes, namely |f, v, ɹ, θ, ð, ʃ|. Our analyses are based on inventories of the different speech sounds produced by Nura throughout the observation period, which we compared, on a sound-by-sound basis, against the corresponding model (expected) sounds of English. We then interpreted the data primarily based on the linguistic profile and language learning context specific to Nura. Further, because this study is not about the child’s social or psychological development, the database transcriptions and annotations are limited to phonological and phonetic descriptions of the child’s linguistic productions. Finally, to maximize the lines of inquiry that our data corpus makes possible, we made it openly available to all interested researchers and students through the PhonBank database (<https://phon.talkbank.org>, accessed on 31 January 2024).

3. L1 vs. L2 Phonological Inventories

To understand the system of contrasts and related phonological features relevant to both Nura’s L1 and L2, we must first consider the inventory of each language. Focusing on consonants, we present the inventories of Kazakh and English in Tables 2 and 3, respec-

tively. Among other details, we note that the voiceless affricate of Kazakh, [ʧ], functions as the surface allophone of /ʃ/ in word-initial position. We also highlight that the rhotic of Kazakh is an apical trill, and that the language displays no pattern of aspiration for voiceless stops.

Table 2. Kazakh Consonants.

	Bilabial	Alveolar	Alveo-Palatal	Velar	Uvular	Laryngeal
Stop	p b	t d		k g		
Fricative		s z	ʃ (ʒ)		χ ~ ʁ	h
Affricate			(ʃʃ) ʧʃ			
Nasal	m	n		ŋ		
Lateral		l				
Trill		r				
Glide	w		j			

/ʒ/ is only present in words borrowed from other languages; it thus has a limited distribution within the lexicon of the language.

Table 3. English Consonants.

	Bilabial	Labio-Dental	Inter-Dental	Alveolar	Alveo-Palatal	Velar	Laryngeal
Stop	p b			t d		k g	
Fricative		f v	θ ð	s z	ʃ ʒ		h
Affricate					ʧ ʤ		
Nasal	m			n		ŋ	
Liquid				l	ɹ		
Glide	w				j		

Within the English inventory that follows, we underscore the six consonants that are absent from the Kazakh inventory. Note as well that the obstruent stops of English, /p, t, k/, are produced with prosodically determined degrees of aspiration, most prominently within syllable onsets (e.g., [Jensen 1993](#) and references therein).

Superficially, only the [f, v, θ, ð] segments of English are missing from the Kazakh inventory. However, given the important differences between the rhotic of Kazakh and that of English, we anticipated that Nura would have difficulty in her acquisition of English [ɹ]. First, the acquisition of this consonant yields robustly attested patterns of errors in the speech of L1 learners of English. Second, as we describe in more detail below, this rhotic is phonetically very different from the rhotic of Kazakh, an apical trill that also yields its own, very robust patterns of errors in L1 acquisition (e.g., [Rose and Penney 2022](#) for a recent summary). Contrary to expectations based on these phonetic differences, however, Nura acquired the English rhotic rather easily. Finally, as mentioned above, there is no phonemic /ʧ/ in the Kazakh inventory; [ʧ] occurs within the language as an allophonic variant of /ʃ/ in word initial onsets. As we will see, it appears that the child misinterpreted the speech cues related to this consonant in English over a relatively long period of time, something we attribute to the interference of competing speech cues related to the aspiration of voiceless stops in syllable onsets.

In the interest of space, we restrict our descriptions below to Nura's productions of the English consonants in initial and medial singleton onsets, and also the locus of affrication (word-initially) in Kazakh and (prosodically determined) aspiration in English. These data provide the evidence needed to illustrate our analyses below, and also avoid tangential issues related to her acquisition of (tautosyllabic) consonant clusters.³ Finally, because

a study of voicing development should ideally involve acoustic measurements of the different voicing cues of English, in order to determine the true extend of consonantal voicing (or lack thereof) in Nura's productions, we ignore issues pertaining directly to the acquisition of obstruent voicing contrasts, leaving them open for future investigation.

4. The Acquisition of Consonants in Singleton Onsets

In the subsections that follow, we represent Nura's productions of each target consonants using color-coded bar graphs, organized along time (age) in the x-axis and token counts in the y-axis. We consistently represent accurate productions in green and use a range of other colors to represent patterns of substitutions (specified as $|x| \rightarrow [z]$) in the legend of each bar graph. The symbol $\emptyset$ represents cases where the child omitted the sound altogether from her productions. Our observations all stem from the general patterns displayed by the child; we also discuss deviations from the main patterns displayed by the child each time relevant. However, because of space constraints, we could not systematically include examples as part of our descriptions. Such examples can be found in [Nulahan \(2023\)](#) as well as through our published dataset on PhonBank.

We begin with the labiodental $|f, v|$ that, as we show next, Nura mastered very rapidly.

4.1. $|f, v|$

Starting with $|f|$, as we can see in Figure 1, Nura had seemingly acquired the target phone at the time of our first recording sessions, at age 3;11.28, which took place a mere 10 days after she was introduced to her new, English-speaking environment.

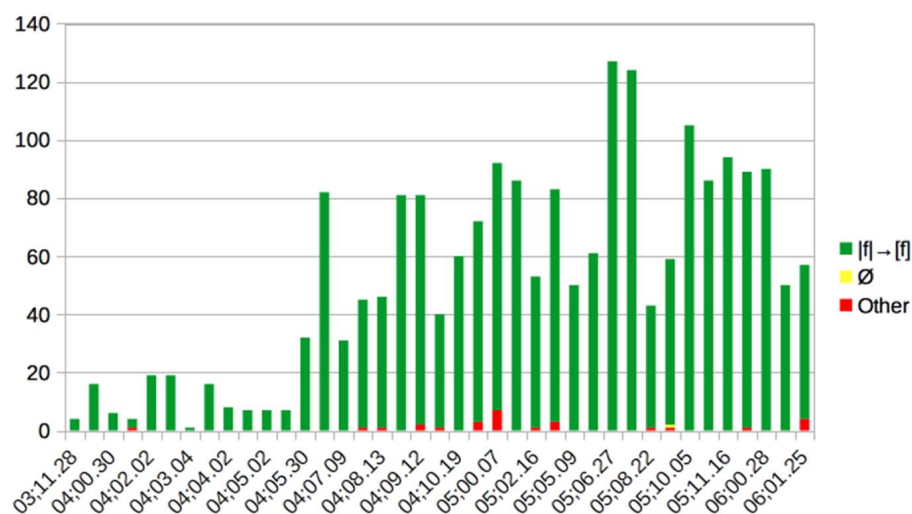


Figure 1. Acquisition of $|f|$ in singleton onset.

Similarly, as we can see in Figure 2, Nura displayed some variation in her early attempts at $|v|$, but very quickly attained target-like productions. Her later substitutions to $[w]$ and $[\partial]$, attested between 5;00 and 5;10, originated from her variable productions of the word *very*, especially when she was excitedly repeating this word in rapid successions. We ignore this observation in our analyses below, as it more likely relates to the type of tongue twister induced by the rapid repetitions within the string.

In sum, the acquisition of the labio-dental fricatives of English posed no significant challenges to Nura. As we describe in the next section, she displayed much more difficulty in her acquisition of the interdental fricatives $|\theta, \delta|$.

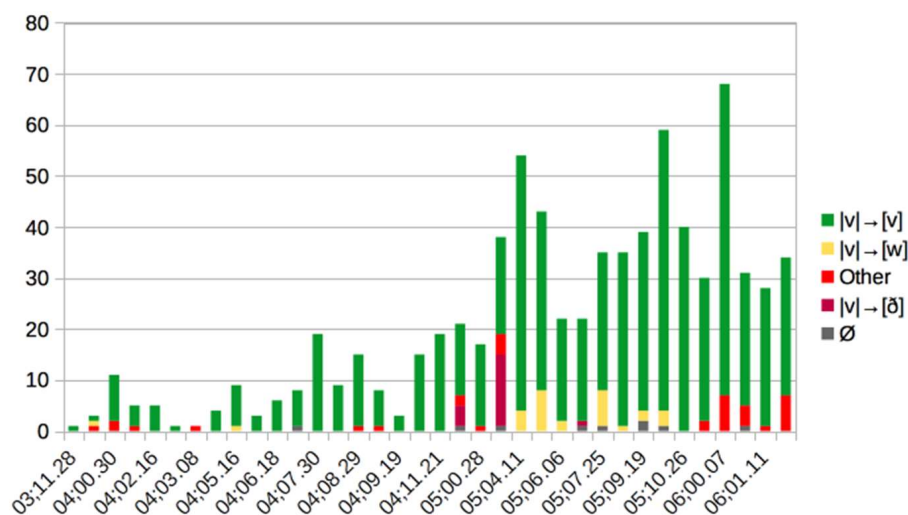


Figure 2. Acquisition of |v| in singleton onset.

4.2. |θ, ð|

Starting with |θ|, Nura initially went through a general substitution stage before she attained mastery of this phone. As we can see in Figure 3, between 3;11 and 4;03, Nura mostly produced |θ| as [s] (a sound of Kazakh). Between 4;03 and 4;08, her productions then mostly alternated between [s] and [θ], and from there Nura was attaining target-like productions of |θ| in a much more accurate fashion, however, with variable substitutions by [t] or [d] extending throughout most of the remaining observation period.

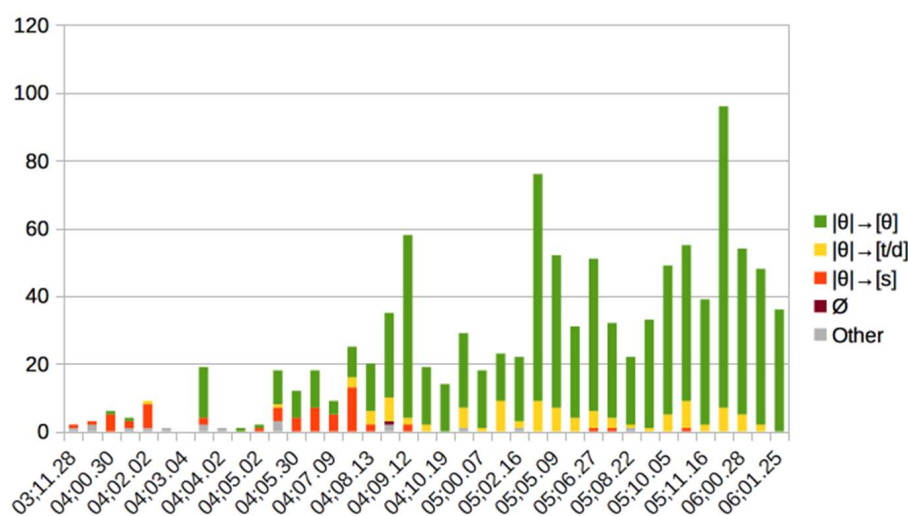


Figure 3. Acquisition of |θ| in singleton onset.

Compared to |θ|, Nura attempted words containing |ð| in singleton onsets much more frequently. As we can see in Figure 4, she substituted a stop for |ð| from the very earliest sessions, a pattern that gradually receded toward the end of the recording sessions. From 5;06 onward, she became able to reach the target in a majority of her attempts.

In our analysis below, we attribute the variation observed in Nura's attempts at |ð| to the fact that most of her attempts at producing this consonant were confined to the production of function words, which themselves tend to appear in prosodically weak environments, a context that poses a number of perceptual and related analytic challenges to the learner.

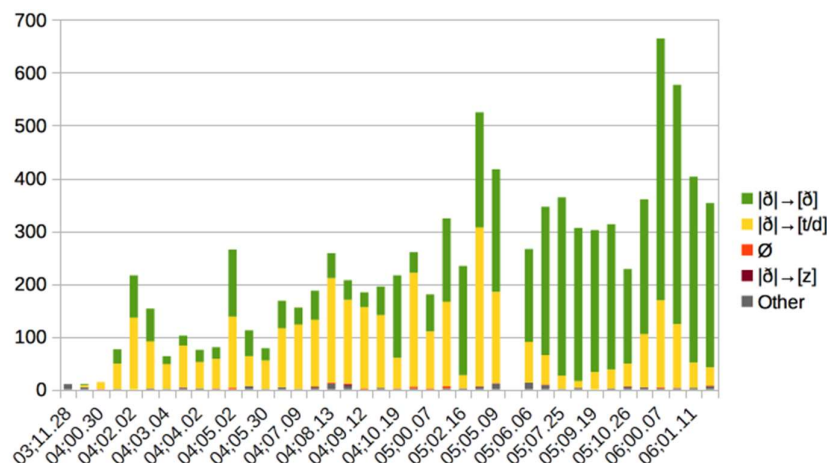


Figure 4. Acquisition of |ð| in singleton onset.

4.3. |ɹ|

Nura's development of the rhotic approximant of English is illustrated in Figure 5. We can see that, initially, Nura primarily substituted [l] for |ɹ|. Soon after, starting at 4;00.30, she was able to articulate [ɹ] and maintained a strong accuracy rate throughout the remainder of the observation period, however, with a variable pattern of labialization affecting a noticeable portion of her attempts.

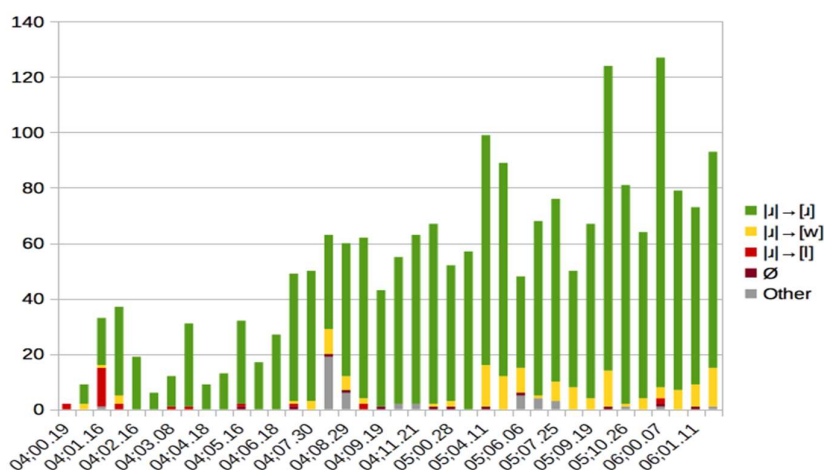


Figure 5. Acquisition of |ɹ| in singleton onset.

Nura's pattern of labialization was in fact largely restricted to the word-initial position, while she displayed virtually no difficulty in her production of |ɹ| in medial (intervocalic) onsets. We exemplify this distinction in (1) with examples of labialized productions in initial onsets and target-like productions in medial onsets.

- (1) Variable trends in |ɹ| production (4;00.19 to 5;02.16)
- a Word-initial (substitution by [w])

rock	'ɹɑk	['wɑ:k]	4;00.30
rainbow	'ɹeɪn·boʊ	['wɪn·bɔ]	4;08.13
really	'ɹɪli:	['wɛɹi]	5;04.11
ready	'ɹɛɹi:	['wɪli:]	5;10.05
 - b Word-medial (accurate)

coloring	'kʌləɪŋ	['kʌlə:ɪ:ŋ]	4;04.02
library	'laɪ·bɹɛɹi:	['laɪ·bɛɹi:]	5;00.28
very	'vɛɹi	['wɛɹi]	5;05.09
alright	əl 'ɹaɪt	[əl 'ɹaɪt]	6;01.25

We further note that her more accurate performance in medial positions mirrored that observed by Nulahan (2023) in syllable codas, where Nura also showed high levels of proficiency. In our analysis below, we link these two contexts to the phonetics of English |ɹ| in pre-vocalic vs. post-vocalic positions.

We complete our data description in the next section, where we turn to Nura's acquisition of the English affricate |tʃ|.

4.4. |tʃ|

Figure 6 illustrates Nura's general development of |tʃ| in singleton onset. From 3;11 to 5;02, Nura predominantly replaced the target phone by stops. This stopping pattern was also characterized by extremely heavy aspiration of the consonant release. Below, we interpret this pattern of aspiration in terms of substitution for the fricative release of the target consonant.

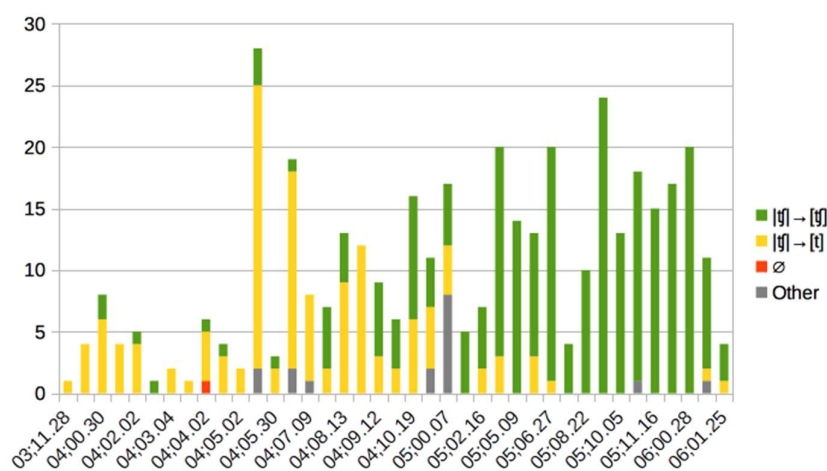


Figure 6. Acquisition of |tʃ| in singleton onset.

From 5;02, Nura's performance with |tʃ| then improved drastically, as she began to produce the target phone accurately in a consistent manner.

4.5. Summary of Observations

In summary, in singleton syllable onsets, Nura encountered virtually no difficulties in her acquisition of |f, v|. Her acquisition of |ɹ| was also very rapid, after a brief stage of [l] substitutions, but also characterized by a pattern of labialization affecting this consonant in word-initial positions. In contrast to this, her acquisition of the interdental fricatives |θ, ð| proved more challenging, while her acquisition of |tʃ| contradicted expectations based on the presence of [tʃ] as an allophone of /ʃ/ in her L1; we indeed observed a persistent pattern of strong aspiration in lieu of the target affricate release through the first year of data collection.

In the next section, we analyze each of the developmental patterns described above from the perspective of phonological features. As we will see, the original proposal by Brown (1998) and its recent extension by Martinez et al. (2021) enable us to capture how the child could be so proficient at acquiring |f, v| as well as, to a lesser extent, the rhotic |ɹ|. To capture the variation observed in the context of |ɹ| as well as the slower rates of development we observed for the interdental fricatives |θ, ð| and affricate |tʃ|, however, we argue that an approach based on phonological features alone cannot capture all of the facts. In this context, we build on the suggestion by Martinez et al. that issues in speech phonetics may at times be considered to account for the full range of the facts exhibited within the speech data. As we will see, these issues can arise from (mis-)analyses of the input signal by the learner as well as from difficulties in identifying the precise articulation needed to produce the target phone.

5. Analysis

To acquire the speech sounds of English, Nura had to, first, identify the place and manner features of these sounds, in each of their positions within the string. (Recall that we focus primarily on consonants in singleton onsets.) Second, she had to approximate the phonetics of each new feature and feature combination involved in these phones in order to reproduce the consonants in a target-appropriate way within her English speech productions. In the lines below, we analyze the production patterns described above, which we contextualize in light of the phonological (featural) and phonetic (acoustic, articulatory) properties of both her L1 and her L2. We begin our analysis with Nura's rapid acquisition of the labial fricatives |f, v|.

5.1. |f, v|

Recall from the [Brown \(1998\)](#) 'type 2' contrast that an L2 learner should have no difficulties perceiving non-native contrasts that do not exist or have no direct correspondents in the learner's L1. This is because there should be no interfering phonological structure in the L1 to undermine perception of the new contrast. Recall as well that there are no labiodental fricatives such as /f, v/ in Nura's L1, nor is there any other form of labial fricatives in the language. In addition, fricatives are documented to have high acoustic prominence (through their frication noise). [Ladefoged and Maddieson \(1996, p. 142\)](#) further show that, among labial fricatives, the labiodental /f, v/ offer perceptually more robust auditory cues than their bilabial counterparts (/ɸ, β/).

Because of the possibility of recombining phonological features from the L1 to represent new segments in the L2, and in the absence of significant challenges from a phonetic standpoint, [Brown \(1998\)](#) and [Martinez et al. \(2021\)](#) both predict Nura's rapid acquisition of the English labial fricatives, on grounds that Kazakh includes both [labial] and [+continuant] within its system of features. However, this feature combination does not supply the fine phonetic characteristics of the actual labial constriction, which, as mentioned above, can be labiodental or bilabial. While this possibility could in theory pose an issue to the learner, trends observed typologically suggest that the labiodental articulation required to produce the labial fricatives of English is the least marked, in other words, the most likely to be selected by the learner. Within the UCLA Phonological Segment Inventory Database (UPSID) database of 451 languages, /f/ is attested in 135 languages, and /v/ is attested in 67 languages. In contrast, /ɸ/ and /β/ are attested in only 21 and 32 languages, respectively ([Maddieson 1984, p. 45](#)). We note as well the salient visual cues that the learner could take advantage of to determine the target constriction for the English labiodentals. Together, these facts about both Nura's L1 system of features and the high (acoustic and visual) perceptibility of these sounds account for Nura's rapid acquisition of |f, v| in her L2.

While the typological observations above can capture the child's mastery of the labiodental articulation, her extremely rapid acquisition of the labial fricatives suggests that she was not drawing from a blank slate; the facts rather suggest (perhaps a textbook case of) feature transfer, enabling the rapid acquisition of new sounds (and the contrasts they support) within the L2. Whether Nura's young age contributed to this development is, however, a matter for debate in the absence of comparisons involving speakers at different ages; the data from [Smit \(1993\)](#), however, suggest that /f, v/, similar to all fricatives, are not within the earliest acquired sounds by English learners (which are typically stops, nasals and glides). This further suggests the contribution of Nura's L1 phonological knowledge to her early L2 abilities.

5.2. |θ, ð|

In contrast to the labial fricatives, the phonetic cues that characterize the interdental fricatives of English are not as salient to the learner and are also generally more variable, at times to the point of being potentially confusing to the learner. Indeed, non-sibilant fricatives offer relatively weak auditory cues to their places of articulation (e.g., [Mielke 2012](#)). As [Ladefoged and Maddieson \(1996, p. 144\)](#) report, the overall perceptibility of

these consonants can vary considerably across different phonological contexts and even between speakers. These facts are also compounded by the high frequency of occurrence of interdental within function words in English, which also tend to be prosodified in unstressed syllables, where speech articulations are generally undershot, further undermining the acoustic cues carried by these consonants. This is evidenced by [Anrich \(2008\)](#), who reports that adult speakers of Cuban Spanish variably produce the voiceless interdentals of English as stops or fricatives, across both syllable onsets and codas, yet with /θ/ produced as [f] in specific words such as ethnic [ɛfnik], suggesting that the ‘same’ targets may in fact present differently to the learner. Further, we note that the interdentals of English loanwords can be adapted as either stops or fricatives across different languages or even different dialects of particular languages, and parallel behaviors can be observed across different populations of L2 learners of English ([Brannen 2011](#); see [Brannen 2002](#) for an earlier discussion). For example, Japanese learners of English substitute [s] for |θ|, while Russian learners substitute [t] for |θ|, also in the context where both these languages have /s/ and /t/ in their phonemic inventories ([Weinberger 1988](#)). Together, these studies suggest that the interdental fricatives of English offer impoverished perceptual cues to their manners and places of articulation, which can yield to different patterns in their adaptation by non-native speakers of the language (see [Carden et al. 1981](#); [Levitt et al. 1987](#) for additional evidence from perceptual studies).

These facts are also reflected in Nura’s data. As we reported above, Nura’s early productions involved mostly [s] substitution for |θ| between 3;11.11 and 4;08.13, but then variably involved stop substitution between 4;08.13 and 6;01.25. In contrast, Nura’s attempts at |ð| were mainly replaced by coronal stops in singleton onsets. Recall that there are no interdental fricatives (/θ, ð/) in Kazakh, nor are there any stops employing the dental place of articulation. However, in the face of the weak perceptual cues carried by the English interdentals, both the /s, z/ alveolar fricatives and the /t, d/ alveolar stops of Kazakh present the potential for a ‘type 1 contrast’ as defined by [Brown \(1998\)](#), as they can be interpreted by the learner as similar enough to act as corresponding categories at the initial stage of acquisition.

At the level of phonological representation, however, in line with [Brown \(1998\)](#) and [Martinez et al. \(2021\)](#), Nura needed to master the unique combination of phonological features involved in the representation of interdentals, which can be described as [+anterior] and [+distributed] continuants (e.g., [Clements 1985](#); [Sagey 1986](#)). Within this feature combination, [+anterior] specifies a constriction within the anterior portion of the coronal area, and the feature [+distributed] captures the broad constriction that these consonants involve between the tongue corona and the teeth. Other features such as [+continuant] and [−strident] are used to further categorize these sounds in terms of their manner of articulation and degree of fricative noise intensity also relevant to the English consonantal system, for example, in the context of suffixal allomorphy involving anterior coronals (e.g., [Jensen 1993](#); [Hammond 1999](#)). While transfer of the relevant features enabled the child to quickly categorize the sounds as coronals, Nura could not benefit from her L1 knowledge to learn the actual implementation of the relevant feature combinations in English; in the face of the weak cues that interdentals present to the learner, this acquisition was, predictably, slow and subject to variation.

Given that Kazakh includes both anterior and posterior coronal fricatives in its inventory, and given that the posterior fricatives (and affricates) involve broad constrictions, both [+anterior] and [+distributed] are arguably active within the system. In a more restrictive analysis, one could further posit [+distributed] as redundant through the [−anterior]. In this view, the ‘distributed’ nature of palatal frication and affrication would pertain to the Kazakh allophonic system. According to [Martinez et al. \(2021\)](#), under both analyses, [+distributed] is thus arguably available to the learner. This hypothesis should in turn predict rapid acquisition of the new phones, through a recombination of features already available to the learner, as we saw above for |f, v|. However, in line with previous research on the

perception and acquisition of interdentals, Nura evidently had to compose with the much more challenging phonetic characteristics of this consonant.

In sum, while an approach based on phonological features makes compelling predictions for acquisition, these predictions must be modulated in light of both acoustic properties of the input and the fine-grained articulatory development required to encode these features within spoken forms. We pursue a similar line of thinking in our discussion of |ɹ| in the next section.

5.3. |ɹ|

The rhotic approximant |ɹ| is typically one of the last phones acquired by L1 learners of English (Ingram 1989; Smit 1993). This observation has been attributed to the complex (retroflexed/bunched) lingual articulation that this consonant involves, in combination with variable degrees of lip protrusion, argued to auditorily enhance the perceptibility of the lingual articulation (e.g., Gick et al. 2008; Keyser and Stevens 2006). In the speech of L1 learners, this articulatory complexity, combined with the glide-like quality of the rhotic's airflow, often yields patterns of labialization (e.g., rabbit [wæbɪt]) also with prominent patterns of palatalization, the latter especially prominent in post-vocalic positions (e.g., car [kɑɹ]) (Smit 1993).

Nura, at the beginning of her L2 acquisition of English, was already past the peak age when we normally observe these patterns of substitution in the speech of L1 learners of English. From a phonological standpoint, she also had, within her L1 system of representation, the relevant phonological features encoding the general coronal place of articulation of the target consonant as well as its rhoticity, given that Kazakh, just like English, displays a contrast between rhotics and laterals among liquids.

However, Nura also had to contend with the fact that the rhotics of Kazakh and English are phonetically very different from each other. The rhotic of Kazakh is an apical trill: “there is no muscular action that controls each single vibration, but a sufficiently narrow aperture must be created and an adequate airflow through the aperture must occur” (Ladefoged and Maddieson 1986, p. 217). In contrast to this, the rhotic approximant of English involves precise muscular action, with the tongue-tip gradually curling back towards the roof of the mouth (retroflexion) or more generally retracting backward (bunching) (King and Ferragne 2020). As mentioned above, this lingual movement combines with degrees of lip protrusion to enhance the perceptibility of the consonant. We also note that this enhancement is phonetically much more prominent in pre-vocalic than in post-vocalic articulations of |ɹ|: “in initial allophones, gestures occur front-to-back, with the lip gesture occurring first, then the tongue body, then the tongue root. In final position, there is little timing effect, but spatially, the lip gesture is often obscured or reduced” (Gick and Campbell 2003, p. 1911).

As stated above in the context of |θ, ð|, according to Brown (1998), the child should have initially engaged in producing English |ɹ| using the Kazakh corresponding liquid [r]. However, we did not observe any substitutions of trills for English /ɹ/ in Nura's productions, which used [l] as a substitute during the initial stage. We argue that this stems from the fact that the rhotics of English and Kazakh are phonetically quite dissimilar, making the lateral a better substitute for English |ɹ|.

Building on these initial approximations, Nura quickly managed to achieve target-appropriate rhotic productions within a mere few weeks after her initial exposure to English. It was only later, particularly during between 5;04 and 6;01, that she attained the fine tuning of the lip protrusion, which we take as the source of her emerging pattern of labialization during this period. This analysis is also supported by the observation that labialization mostly affected her pre-vocalic productions of |ɹ| where, as noted above, lip protrusion is most salient in English. In sum, while Nura could benefit from feature transfer to acquire the rhotic of English, her mastery of this consonant was also affected by the more subtle and variable aspects of the speech articulations inherent to this consonant.

In the next section, we complete our analysis of Nura's development of English consonants with that of the voiceless affricate [tʃ], which presented much more difficulty than we were expecting, given that this phone exists as an allophone in Kazakh. However, as we will see, it appears that the child initially did not analyze this consonant as an affricate, instead confusing its fricative release with aspiration cues in English.

5.4. [tʃ]

As mentioned above, the Kazakh phonemic inventory includes the affricate /dʒ/, while [tʃ] occurs as the allophone of /ʃ/ in word-initial position. At the level of featural representation, this implies, as predicted by [Martinez et al. \(2021\)](#), that Nura's L1 offered all of the necessary features and feature combinations needed to encode [tʃ] within her L2, thereby predicting her rapid development of this consonant. This prediction was further reinforced by data we independently recorded on Nura's production of Kazakh during the first few months after her arrival in Canada. As we can see in the examples in (2), she was fully able to articulate word-initial [tʃ] in her Kazakh word productions.

- (2) Nura's accurate production of word-initial [tʃ] in Kazakh
- | | | | |
|----|-----------|---------|-----------|
| a. | [tʃæʃ-ɪm] | my hair | (4;00.20) |
| b. | [tʃənə] | Cup | (4;01.06) |
| c. | [tʃæj] | Tea | (4;01.06) |

However, to our initial surprise, Nura instead displayed a long-lasting stage of [tʃ] substitution to strongly aspirated alveolar stops in her English productions. This pattern was even more puzzling given that, as documented in [Nulahan \(2023\)](#), Nura had in comparison rapidly mastered [tʃ] in singleton codas in her English productions. This rapid acquisition in fact validates the prediction by [Martinez et al. \(2021\)](#), also in the absence of obvious phonetic interference. The asymmetry between Nura's poor performance in onsets and high proficiency in codas thus ran counter to all expectations: [tʃ] is a Kazakh sound in word-initial onsets, and Nura knew how to produce it reliably.

At this juncture, we take as a key observation the very strong aspiration that we observed across Nura's stop productions for the target affricate. Building on this observation, we propose that Nura's acquisition of [tʃ] in syllable onsets was in fact hindered by her acquisition of the allophonic system of aspiration in English whereby voiceless stops are realized with perceptually salient aspiration in word-initial onsets as well as in medial onsets of stressed syllables. This argument builds on the observation that the consonant release of both affricates and aspirated stops involves acoustically similar acoustic cues, characterized by aperiodic noise resulting from turbulent airflow ([Ladefoged and Maddieson 1996](#)). We hypothesize that, initially, in the face of these similar acoustic cues, Nura was unable to disentangle aspiration from affrication in syllable onsets, which led her to analyze (and represent) target affricates as aspirated stops. This analysis is further supported by the observation that the strongly aspirated coronal stop characteristic of Nura's productions of [tʃ] did not have a correlate in syllable codas. We note, however, that Nura's behaviors across each context should ideally be described quantitatively by means of acoustic measurement. Should the current description hold, it may also be that Nura's emerging rule was delineated based on an onset-coda distinction more than by the otherwise relatively intricate aspects of the English stress system. We leave the investigation of these possibilities for further research, as they raise specific questions and methods that extend beyond the scope of the current work.

In sum, Nura's acquisition of [tʃ] was not constrained by the phonological features or feature combinations involved in this consonant; it was hindered by the allophonic rule of aspiration of English, the distribution of which overlaps with that of [tʃ] in syllable onsets. This also highlights that feature transfer is ultimately constrained by the learner's analysis of the system of speech cues, whose proper interpretation is required before the learner can assign the correct set of features to represent the relevant contrasts.

This concludes our analysis of Nura's segmental development of English. As we highlighted throughout this discussion, many factors interacted in the unfolding of the data produced by Nura. While our analyses provide general support for approaches to L2 seg-

mental development based on phonological feature specifications, as originally proposed by Brown (1998) and further expanded by Martinez et al. (2021), we argued that feature-based analyses of L2 acquisition must also be modulated in light of acoustic and articulatory properties of the L2 and how these properties may be interpreted based on the L1 learner's own system.

6. Conclusions

The research we discuss above has implications for theoretical models of second language acquisition as well as for models of phonological development more generally. The results of this study also have implications for our understanding of concrete challenges that speakers may face when they begin to learn new systems of sounds and sound combinations. We briefly touch on these issues in the brief discussion that follows.

In the sections above, we focused on the L2 acquisition by Nura, a child speaker of Kazakh, of the English consonants /f, v, θ, ð, ɹ, ʃ/. We uncovered a series of developmental patterns that highlight how L2 learners can easily recombine phonological and/or allophonic features present in their L1s to rapidly acquire new segments (Brown 1998; Martinez et al. 2021). We also discuss the need to consider issues in speech phonetics, also in light of allophonic properties of the languages involved, which may at times hinder predictions made solely on the basis of phonological features. These factors include perceptual interference, which may yield confusion between phonetically similar target forms, and the precise motor plans associated with given phonological features and feature combinations, the fine tuning of which may yield further patterns of substitution.

That is not to say, however, that phonetic approaches to L2 acquisition should have primacy over phonological models. As highlighted in the descriptions above, Nura's early representations of English consonants were generally accurate, if we consider them from the general places and manners of articulation involved in the production of these consonants. The only apparent exception to this is in the context of /ʃ/. Even in this context, however, the child's productions must ultimately be understood in phonological terms, as the child was in the process of learning the prosodically driven, allophonic system of consonant aspiration affecting obstruent stops in English. This understanding in fact provides additional support for the immediate availability of representational units, encoded here in terms of phonological features, at the onset of L2 acquisition. Going full circle, the learner's acquisition of the details that transcend these features can itself be compared to what we observed in the L1 acquisition of speech sounds, again with the difference that, even if older by only a few years, the child L2 learner is likely to have overcome all articulatory constraints that typically interfere with early child speech production (Rose et al. 2021). These articulatory constraints can indeed be interpreted as inherent to the process of phonological emergence, and are expected to manifest themselves most prominently during early stages of L1 development, when the learner has not yet mastered all of the speech articulations and coarticulatory skills involved in the reproduction of the phones and phone combinations present within their target language(s) (McAllister Byun et al. 2016). This line of research also compels us to explore how theories of phonological emergence can be integrated, at a more formal level, within traditionally more formalist models such as the Full Transfer, Full Access theory of second language acquisition, itself grounded within generative theories of linguistics (e.g., Schwartz and Sprouse 1996; Brown 1998). In parallel with this literature, similar questions about the origins of phonological knowledge are raised within recent emergentist proposals based on the typology of adult phonological systems (e.g., Archangeli and Pulleyblank 2022; Dresher 2014). Together, these converging bodies of literature offer new and promising opportunities to understand the nature of phonological knowledge as well as the factors that govern its acquisition by first and subsequent language learners.

Finally, from a more general perspective, this paper offers a series of observations directly applicable to Kazakh learners of English and, by extension, to all second language learners of English coming from languages that have phonological and phonetic properties

similar to that of Kazakh. As we saw above, observations about phonological contrastiveness within the learner's native languages offer a series of hypotheses concerning the type of phonological features they can transfer from their L1. Further, a consideration of the phonetic implementation of the relevant featural contrasts within each language can reveal additional possibilities for how the learner may initially interpret the sounds of their L2 within and across phonological contexts.

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Notes

- ¹ Since the recordings were conducted in Newfoundland, Canada, we cannot ignore Nura's exposure to the varieties of English spoken in this province, which may have factored in the child's linguistic development. However, our descriptions below focus on consonantal aspects of English phonology that are largely irrelevant to the type of dialectal variation relevant to Newfoundland English. By comparison, a study of vowel acquisition would have involved a much higher risk of being influenced by the local dialects.
- ² While we do not have systematic inter-transcriber reliability scores, we can attest that all of the data utilized in a subset of the current study (Cooze 2020) were fully validated by an independent speaker of English. Because we found no noticeable differences between the data from these transcripts and the remainder of our dataset, we believe that our data provide firm grounds for all current intents and purposes.
- ³ For a description of Nura's acquisition of syllable codas, as well as a comparison between syllable onsets and codas, see Nulahan (2023).

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