THERE IS NO INNATE TROCHAIC BIAS: ACOUSTIC EVIDENCE IN FAVOUR OF THE NEUTRAL START HYPOTHESIS

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1. Introduction

In this paper, we argue that the trochaic bias, first proposed by Allen & Hawkins (1978, 1980), should be eliminated from phonological theory. First, we demonstrate that the cross-linguistic evidence supporting this construct is far from conclusive. Second, we discuss the fact that babbling and early acquisition data do not provide any independent proof for such a grammatical bias in phonological development. Finally, even in situations where everything is in place to favour the manifestation of a bias towards trochaic footing, no convincing evidence can be found to support the presence of this bias.

We begin by providing an overview of the predictions made by the trochaic bias as well as a brief survey of the relevant literature in the context of child language phonology. Building on this discussion, we introduce the current study, based on acoustic data from a bilingual English-French child. As we will see, the data from this child also fail to provide any support for the trochaic bias. We conclude with a brief summary and discussion supporting the Neutral Start Hypothesis (e.g. Klein 1984, Hochberg 1988), according to which no innate bias favours any kind of foot form in language development.

2. The Trochaic Bias Hypothesis: Empirical Challenges

The Trochaic Bias Hypothesis, as its name indicates, implies that Universal Grammar should favour the trochaic, i.e. strong-weak (SW), foot form over other types of feet. As observed by Allen & Hawkins (1978, 1980), English-learning children tend to preserve stressed and final syllables in the truncated forms they produce (e.g. *banána* → *nána*;

tomáto → *máto*), thereby producing a SW, trochaic word form. These results were later supported in works such as Fikkert (1994) and Demuth (1995), who provide bottom-up accounts of the development of prosodic words based on data from Dutch- and English-learning children, respectively. However, neither of these authors explicitly claims that at the stage when feet are developing in children's prosodic representations, there is a bias for trochaic footing. This is especially true of Fikkert (1994), who claims that the hypothetical presence of a universal trochaic bias cannot be tested on a (trochaic) language like Dutch. In contrast to this, Kehoe (1997, 1998), based on acquisition data from English learners, takes a stronger theoretical stance in favour of a universal basis for trochaic effects found in these learners' productions.

While the research reported above could, at first glance, lend support to the Trochaic Bias Hypothesis, we argue that none of the evidence put forth should be considered conclusive. Indeed, the vast majority of the supporting evidence comes from the acquisition of Dutch and English, two target languages that are uncontroversially analyzed as trochaic (e.g. Booij 1995, Hammond 1999). As discussed by Fikkert (1994), the exposure to trochaic input is indeed likely to yield trochaic output patterns without the need of any universal or innate bias. Furthermore, a closer look at the literature on phonological development fails to provide any convincing evidence for a trochaic bias, even at the earliest stages of development, irrespective of the metrical properties of the target language.

Focusing first on English, Pollock, Brammer & Hageman (1993) investigate the acoustic properties of word forms produced by young learners of this language. Their study yields two important conclusions. First, they demonstrate that these learners have no generalized preference for trochaic stress patterns. Second, they show that at the production level, learners master the three main acoustic parameters of stress (fundamental frequency, intensity and duration) independently. This second finding is important given that stress is realized through a combination of these parameters, whose realization is itself dependent on the system of segmental contrasts that exists in the language (see discussion below).

Keeping with the Trochaic Bias Hypothesis, one could hypothesize that trochaic bias effects are rather subtle and short-lived, and are rapidly hindered through language acquisition (e.g. Rose 2000:38). In this context, it is necessary to look at the earliest linguistic productions, those found during the babbling stage. However, the evidence from such studies also generally supports the Neutral Start Hypothesis. For example, Klein (1984) shows that both trochaic and iambic patterns are attested in babbles produced by an English-learning child. Klein concludes that stress is

acquired lexically by children, at least during the initial stages of phonological development. In a similar way, Vihman, DePaolis & Davis (1998) demonstrate from perceptual and acoustic evidence that children have their own rhythmic preferences in babbling, thereby contradicting predictions made by the Trochaic Bias Hypothesis. The evidence they discuss from English-learning toddlers shows a nearly bipolar distribution between trochaic and iambic patterns in disyllabic babbles (only 56% of the disyllabic babbles displayed a trochaic pattern), even though both a purported trochaic bias and the general rhythmic properties of English should in theory conspire to yield trochaic patterns in babbling. As Vihman et al. argue, the emergence of iambic patterns in their data may originate from words or phrases that constitute evidence for iambic footing, for example determiner + monosyllabic noun combinations, which form disyllabic phrases with final stress (e.g. *a báll*). From an analysis of the rhythmic properties of child-directed speech from two caregivers in the same corpus, Vihman et al. show that children learning English are indeed exposed to a significant portion of iambic stress patterns (in approximately half of the child-directed utterances).

Similarly, Hochberg (1988), who focuses on the acquisition of Spanish, finds no preference for trochaic or iambic footing in either non-word imitation tasks or real-word spontaneous production tasks. The same holds true of Greek. Tzakosta (2004) shows that learners of Greek may truncate WSW forms to either WS (iambic) or SW (trochaic) forms in early word productions. The only safe conclusion one can reach from these observations is that there is simply no innate bias influencing children's early foot forms.

An implication of the above findings is that no trochaic bias effect should be found in non-trochaic languages. A survey of the literature on the acquisition of such languages fully supports this expectation. No trochaic bias appears to be found in the stress patterns, syllable truncation patterns or the development of complex word forms in iambic languages. These observations hold in languages such as Turkish (e.g. Aksu-Koç & Slobin 1985), Yucatec Mayan (e.g. Archibald 1996) and French (e.g. Paradis, Petitclerc & Genesee 1997, Vihman et al. 1998, Archibald & Carson 2000, Rose 2000), whether the evidence comes from naturalistic investigations or from experimental approaches.

First language acquisition data thus generally fail to provide convincing evidence for any kind of bias in the early production of stress by first language learners. This conclusion, however, is challenged by a study of a bilingual English-French learner's stress patterns by LaBelle (2000). LaBelle argues that this learner displays a trochaic stress pattern in

both languages. However, as discussed in detail in Champdoizeau (2006) and Rose & Champdoizeau (in press), the results from LaBelle's study cannot be taken as conclusive, because of a number of methodological issues that may have affected the interpretation of the results, for example the fact that LaBelle's results are largely based on fundamental frequency, an acoustic cue that relates more to intonational focus and emphasis than to actual stress in French, as will be discussed below.

In the next section, we introduce our current study, also based on a bilingual English-French learner. As we will see, even though everything appears to be in place to favour the emergence of a trochaic bias in the child's speech, no evidence for such a bias can be found in the data.

3. Current study

Our study is based on one learner, code-named Anne, who was raised in a bilingual English-French household in St. John's, Canada. St. John's is the capital city of the province of Newfoundland and Labrador where English is clearly the predominant language. The French-speaking population of St. John's is restricted to a few hundred individuals, virtually all of whom also speak English as a second language. We recorded Anne's linguistic development on an approximately fortnightly basis following a one-speaker, one-language protocol, i.e. alternating English and French interlocutors across recording sessions, from 2;00.04 to 4;02.25. Our study focuses more specifically on the first year of recordings. At the time of the study, Anne could understand virtually everything that was spoken to her in French. However, she was showing a clear preference for English as her language of expression. She avoided using French as much as possible, even with French interlocutors. As a result, most of her French productions arose from code switching, mostly in the case of words for which she did not know the English equivalent (Champdoizeau 2006). We believe that this dominance arose at the time from her (then recent) entry into a monolingual English day care centre, where she was in regular contact with a monolingual community of English-speaking peers.

In order to control for intonational factors, we analyzed declarative utterances only. We performed acoustic analyses of Anne's stress patterns in both French ($n = 36$) and English ($n = 38$) disyllabic words. We excluded from our analysis English words with final stress such as *ballóón*, since comparisons between penultimate and final syllables in such words would incorrectly suggest iambic patterning. In addition, we measured and considered all three cues that are potentially relevant for stress assignment: FØ and intensity peaks as well as vowel duration. We

measured both the final and the penultimate vowels of each utterance-final word and then compared the measurements obtained across syllable positions. For each parameter, larger values on the penult indicated trochaic stress while larger values on the final syllable were interpreted as evidence for iambic stress.

A consideration of all three acoustic cues is paramount in such a study since the acoustic manifestations of stress in English and French involve significantly different cue combinations. In English, stressed syllables involve higher FØ and intensity values (Fry 1955, Lieberman 1960, Beckman 1986) in addition to increased duration, modulo the tense/lax contrast between vowels, which is in part manifested through vowel length. As opposed to English, stressed syllables in French are primarily characterized by increased vowel duration (Delattre 1966, Léon 1996, Vaissière 1997). Intensity and FØ in French are mostly related to intonation (sentential focus and/or emphasis; e.g. Poiré 2000 and references cited therein).

As can be inferred from the above, virtually everything needed to encourage the emergence of trochaic bias effects was in place in this study. First, our participant, despite living in a bilingual household, was raised in a predominantly English-speaking environment. Second, at the time of the study, she had started attending a monolingual English-speaking day care centre, to which we attribute her generalized preference for English and obvious avoidance of French productions. In this context, while the emergence of a trochaic bias in her productions could be attributed to her linguistic environment, the absence of such an emergent property in her speech should provide empirical evidence against the existence of a trochaic bias. We discuss our results in the next section.

4. Results and Interpretation

We analyzed the results from two different perspectives. First, we examined the overall differences observed between the penultimate and final syllables for each acoustic parameter. As we can see in Figure 1 below, a falling curve between the penultimate and final syllables is found for each acoustic parameter in English productions. These results generally correspond to what should be expected in this language. In contrast to this, we find mixed and relatively flat results for FØ (slightly falling) as well as intensity (slightly rising) in French, but a clearly rising curve for duration. Again, the results closely match the parameters of the target language, in which, as previously mentioned, stress is mainly realized through increased vowel duration.

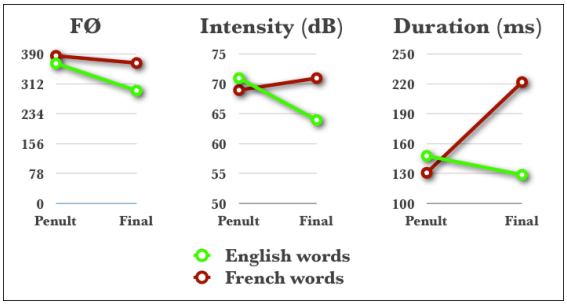

Figure 1: Overall results per acoustic parameter

The general tendencies depicted in Figure 1, which are already suggestive of a separation between the two languages in the child's productions, and of a relatively native-like behaviour in each language, do not however provide indication of stress patterns produced in individual words.

This second perspective on the data is illustrated in Figure 2 below, which provides a classification of trochaic versus iambic patterns for both English and French target word productions. As we can see, the child's English target productions generally followed a trochaic pattern if one considers FØ and intensity, the two clearest acoustic parameters of stress in this language.

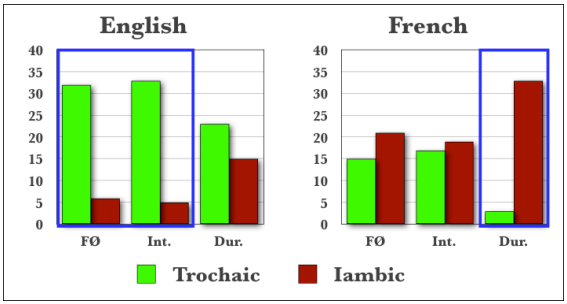

Figure 2: Comparison between English and French target word productions

In contrast to this, the results from duration are more mixed. We attribute these results to a combination of potential factors. As already mentioned, vowel duration in English is relevant not only to stress but also to the phonological contrast that exists between tense and lax vowels. In

addition, vowel duration in English is also influenced by factors such as the voicing of post-vocalic consonants (e.g. Borden, Harris & Raphael 2003). Finally, other general influences such as the lengthening of utterance-final vowels may have further influenced these results.[1] Despite all of these complications, we still observe a slight majority of trochaic patterns based on duration.

A comparison of the stress patterns found in Anne's English words with those in her French target words reveals clear qualitative and quantitative differences. First, we see the overall stress pattern shifting to an iambic one. In addition, instead of displaying distinct tendencies for FØ and intensity, the only dominant stress pattern found in her French target productions relates to duration. These data demonstrate that when uttering French words, the child correctly produced an iambic stress pattern, generally using the only acoustic correlate relevant to French stress, an increased duration of the final syllable.

As noted above, there appears to be a universal tendency for vowel lengthening in utterance-final syllables across languages (Hayes 1995). It is possible that this tendency for final lengthening, which presumably has articulatory or aerodynamic sources, conspires with the acoustic properties of French stress to yield such a clear result. However, this possibility should not detract us from the observation that the child's French productions are nonetheless largely compatible with the metrical and acoustic properties of French stress and, in this regard, much different from her English productions. In this context, it is also important to note the marginal patterns found with the other two acoustic parameters in her French productions, especially in light of the fact that these two parameters are the ones that are most relevant to the realization of stress in the English data.

The results emerging from the measurements of the English and French productions provide us with compelling indications about both the child's metrical analysis and overall mastery of the acoustic correlates of stress that are relevant to each language, in addition to demonstrating great control of the acoustic correlates of stress in each of the two languages. These results thus contradict the Trochaic Bias Hypothesis. Indeed, while the child displayed trochaic stress patterns in her English production, no such patterns were found in the French data. This is particularly significant in light of the general context of the study, which is based on a clearly English-dominant learner who was raised in an English-dominant environment.

5. Discussion

In this paper, we discussed the controversial status of the trochaic bias, a theoretical construct suggesting an inborn bias towards trochaic footing in child language. We first provided a survey of the background literature on the topic. Based on this survey we concluded that there is currently no independent evidence supporting the presence of this bias in child language. While all of the evidence available in support of such a bias is confined to the acquisition of trochaic languages, thereby posing a circularity problem, a significant body of evidence, coming from the acquisition of both trochaic and iambic languages, contradicts the existence of this purported bias. We then introduced our study, which consists of a metrical and acoustic analysis of words produced by a bilingual English-French learner. Based on acoustic measurements of the fundamental frequency, intensity and duration of the penultimate and final vowels produced by this child in both English and French words, we demonstrated that she had mastered both the basic metrical properties and the main acoustic correlates of stress for each of the target languages.

The results of our investigation clearly fail to provide empirical support for the trochaic bias. In fact, these results overwhelmingly suggest that the only biases that the learners are subject to come from the phonological and acoustic properties of her two target languages. In light of this evidence, only the Neutral Start Hypothesis can be maintained. This conclusion is also compatible with that of Adam and Bat-El (this volume), who argue that a trochaic bias observed in the early speech of a Hebrew-learning child is not innate, but rather grounded, and that the interpretation of the grounding properties is done via universal principles. In this sense, the bias does not need to be posited in Universal Grammar but rather emerges as a grammatical interpretation of the evidence that the child is exposed to.

Acknowledgements

A longer yet more preliminary version of this paper was published in the *Proceedings of the 33rd Meeting of the Berkeley Linguistics Society*. We would like to thank the attendants to both *BLS* 33 and *GALA* 2007 for their useful feedback. All errors or omissions are our own.

Notes

[1] Full testing of such influences would require analysis of variance based on a larger number of examples for each relevant context. This issue, which extends beyond the scope of this case study, is left for future investigation.

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