Appears in M. Wrembel, M. Kul & K. Dziubalska-Kołaczyk (2011) *Achievements and perspectives in SLA of speech, Vol II*. Frankfurt: Peter Lang, pp. 217-225.

Prosodic Transfer: An Event-Related Potentials Approach

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ABSTRACT

This study investigates electrophysiological evidence of the possible influence of L1 prosodic structure on a speaker's second language, specifically in the context of the Prosodic Transfer Hypothesis of Goad & White (2004, 2009), with Turkish as the L1 and English as the L2. Turkish prosodic structure differs from English in its treatment of articles in ways that suggest that Turkish articles are affixal clitics whereas English articles are free clitics. Crucially, it follows that a correct English article-adjective-noun sequence violates Turkish prosody, since adjectives cannot intervene between articles and noun heads in Turkish, and therefore that Turkish speakers will be unable to correctly prosodify the sequence. Prior behavioural production evidence – in which Turkish speakers stress or delete the English article in asymmetrical ways predictable by prosodic structure – has provided robust support for this claim. The current experiment uses ERP recording to elucidate the online processing of Turkish speakers hearing English sentences that either do or do not violate Turkish prosodic structure, with the aim of demonstrating real-time neural responses to L1-L2 prosodic mismatch. Results of Turkish speakers' ERP waveforms show that they process English sentences differently than English speakers, in such a way to be consistent with the Prosodic Transfer Hypothesis.

Keywords: Prosodic Transfer, ERP, articles, Turkish

1. INTRODUCTION

Second language acquisition (SLA) research frequently investigates the possible impact of a speaker's first language (L1) on learning a second language (L2). Recent studies debate whether the structural organization of L1 prosody may influence the prosody of the L2 (e.g. Goad et al 2003; Trenkic 2007; Kupisch and Snape 2009). There have so far however been no studies on the topic using event related potentials (ERPs), in spite of this technique having been effective in investigating L1 transfer effects in other subdomains of linguistics such as morphosyntax (e.g. Sabourin and Stowe 2008). By ascertaining the real-time brain response to L2 processing, an ERP study demonstrating the relevance of L1 prosodic cues in guiding L2 comprehension could provide robust support for a theory where L1 prosody influences L2 acquisition in systematic ways, such as the Prosodic Transfer Hypothesis (PTH) (Goad et al 2003; Goad and White 2004, 2009). The present paper addresses a subset of data collected during such a study, and presents a preliminary analysis of two specific ERP waveforms obtained therein, which we argue demonstrate an influence of L1 prosody on L2 processing.

2. CONTEXT

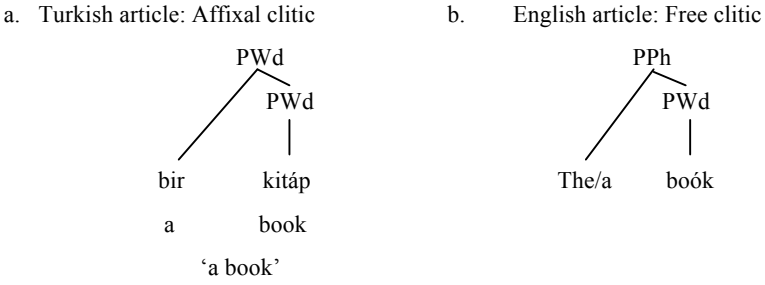
2.1. Difference in prosodic structure of Turkish and English articles

One well-studied case of prosodic mismatch from the linguistic literature is that of L1 speakers of Turkish learning English as their L2. The prosodic structure of Turkish DPs differs from that of English as follows. Turkish lacks a definite article, having only an indefinite article, *bir*, which always surfaces as unstressed (Kornfilt 1997). Stress is required for other Turkish determiners, such as numerals – among them *bír*, 'one',

which although homophonous with the indefinite article has an unambiguously different meaning (Özturk 2005). The unstressed indefinite article is adjoined to the prosodic word (PWd) of its host as an 'affixal clitic', as shown in (1a). (All examples are adapted from Goad and White 2009.)

Unlike Turkish, English has two articles, definite and indefinite. Moreover, English articles link directly to the phonological phrase (PPh) as 'free clitics' as in (1b) (Selkirk 1996); Turkish is argued to lack this possible representation (Goad and White 2004). Goad and White (2010) further support this observation by arguing that the Turkish article is lexically represented with the property of being [+bound], unlike articles in English, thus making affixation to the head noun a lexical requirement.

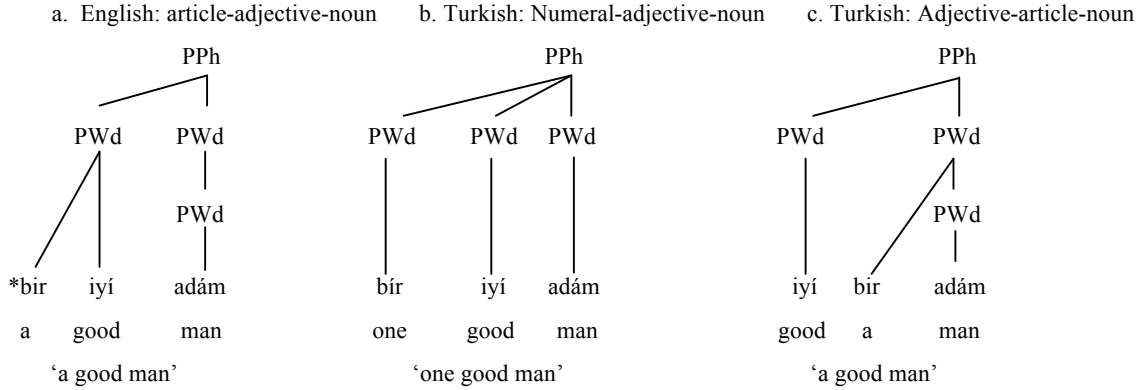
Figure 1: Article structure



2.2. Predictions for L2 acquisition

Crucially, the PTH predicts a systematic asymmetry in the production of English articles by Turkish speakers, arising from the assumption of transfer of L1 prosodic characteristics to the L2. Since affixal clitics (such as the [+bound] Turkish article) must immediately precede the head noun if they are to attach to it, only English DPs *without adjectives* will be able to surface as target-like, while production of DPs with adjectives will be impaired. According to the PTH, the reason for this asymmetry is that the word order in English constructions of this type requires a prosodic representation that is unavailable in the L1: since Turkish does not allow free clitics, the prosodic structure required in (2a) below is not immediately available for subjects to build. It has been robustly attested in behavioural studies that Turkish speakers of L2 English stress or delete articles in these contexts (Goad and White 2004, 2009). Comparable Turkish constructions with adjectives appear in (2b, c): the numeral always precedes the adjective as an independent PWd, bearing stress, whereas the indefinite article must follow the adjective, and never bears stress.

Figure 2: Word order



2.3. ERP context and precedent

The experiment undertaken herein presents itself as a preliminary neurolinguistic investigation of the prosodic structure violations hypothesized above. There exists some prior electrophysiological evidence that

aspects of the L1 can transfer into the L2 grammar, for instance in terms of feature agreement (Sabourin and Stowe 2008) and word order (Steinhauer et al in preparation). Although previous ERP work has investigated aspects of prosodic processing (e.g. Steinhauer et al 1999; Isel et al 2005), prosodic interference itself, especially in speech perception, remains an understudied area. The experiment discussed herein presents L1 Turkish/L2 English speakers with English sentences in the auditory modality, the key conditions of which prohibit the binding of articles as affixal clitics, as in (2a) above, and measuring the minute electrical differences on the scalp time-locked to cognitive events via electroencephalography (EEG). Electrophysiological correlates of online sentence processing are subsequently investigated in order to determine whether any adherence to L1 prosodic structure is in play during L2 sentence comprehension. The excellent temporal resolution of this method will also help in testing if the effects predicted in terms of production by the PTH also apply to comprehension, thus potentially laying the groundwork for further related behavioural and ERP research in second language acquisition.

3. METHODOLOGY

3.1. Participants

The test population discussed in this paper is comprised of 15 right-handed speakers of L1 Turkish/L2 English of intermediate or advanced English proficiency, with a control population consisting of 17 English monolinguals. All participants were healthy adults between the ages of 18 and 40, equal proportions of men and women, screened for no known history of neurological or speech/language disorders, and with normal hearing and normal or corrected-to-normal vision. After discarding results for reasons of noise, the remaining number of participants included in the current analysis is 11 for the English group, with a mean age of 24, and 11 for the Turkish group, with a mean age of 25.

3.2. Stimuli

Stimuli for both groups consisted of grammatical and ungrammatical sentences of English, in two sentence structures and stress patterns, as shown in Table 1. All sentences were recorded by a female native speaker of English and controlled for length and syntax. Individual words were selected according to frequency, intonational contour, and phonological properties of Turkish so as to avoid potential confounds in the brain response. Article stress was determined according to intensity and pitch, the cues most relevant to stress in Turkish (Levi 2005). Measurements using Praat (Boersma and Weenick 2010) confirmed discrete pitch and intensity ranges for the stressed and unstressed article. Each participant was presented with 192 sentences in pseudorandom order, comprised of equal numbers of all sentence types (including two additional conditions primarily serving as distracters). The sentences were constructed in pairs, one with article stress and one without. Sentence types 1 and 2 do not contain an adjective, as in (1). The unstressed case, T1, is felicitous in English whereas the stressed case is not (at least in non-focus contexts, i.e. all sentences in this study). In Turkish, analogues to both T1 and T2 are acceptable, albeit with different interpretations. T3 and T4 correspond to the structure in (2a). In English this construction is prosodically licit when the article is unstressed (T3) but illicit when it is unstressed (T4). The inverse exists in Turkish, where T4 is allowed but prosodic wellformedness constraints make T3 ungrammatical.

Table 1: Stimuli and grammaticality in Turkish and English (boldface indicates stress on the article)

Sentence type	WORD ORDER	stressed article	GRAMMATICALITY		EXAMPLE SENTENCE
			Turkish	English	
T1	S V art O	N	Y	Y	Kristin fought a bear.
T2		Y	Y	N ?	Kristin fought **a** bear.
T3	S V art ADJ O	N	N	Y	Kristin fought a wild bear.
T4		Y	Y	N ?	Kristin fought **a** wild bear.

3.3. Procedure

Participants were fitted with a standard electrode cap according to the international 10-20 system, with reference electrodes at the mastoid bones and bipolar electro-oculograms recorded to control voltage differences due to eye movement; trials with EOG interference above 40 μV were excluded from analysis. The experiment was run in a sound-attenuated booth. Participants were seated comfortably and followed the instructions displayed on a computer monitor while listening to recorded stimuli on headphones. There was no experimental task for the participants to accomplish other than listening attentively. The experiment was divided into six five-minute blocks, separated by self-paced breaks. After a short practice session, EEG data was recorded continuously from 19 electrode sites. Electrode impedance was kept between 1 and 5 kΩ and a bandpass filter applied post-recording in order to reduce noise. For the purposes of presenting a consistent baseline, each sentence pair was comparable up to the point of violation, and the ERPs were time-locked to the critical word in the violation condition and its corresponding word in the control condition.

3.4. Predictions

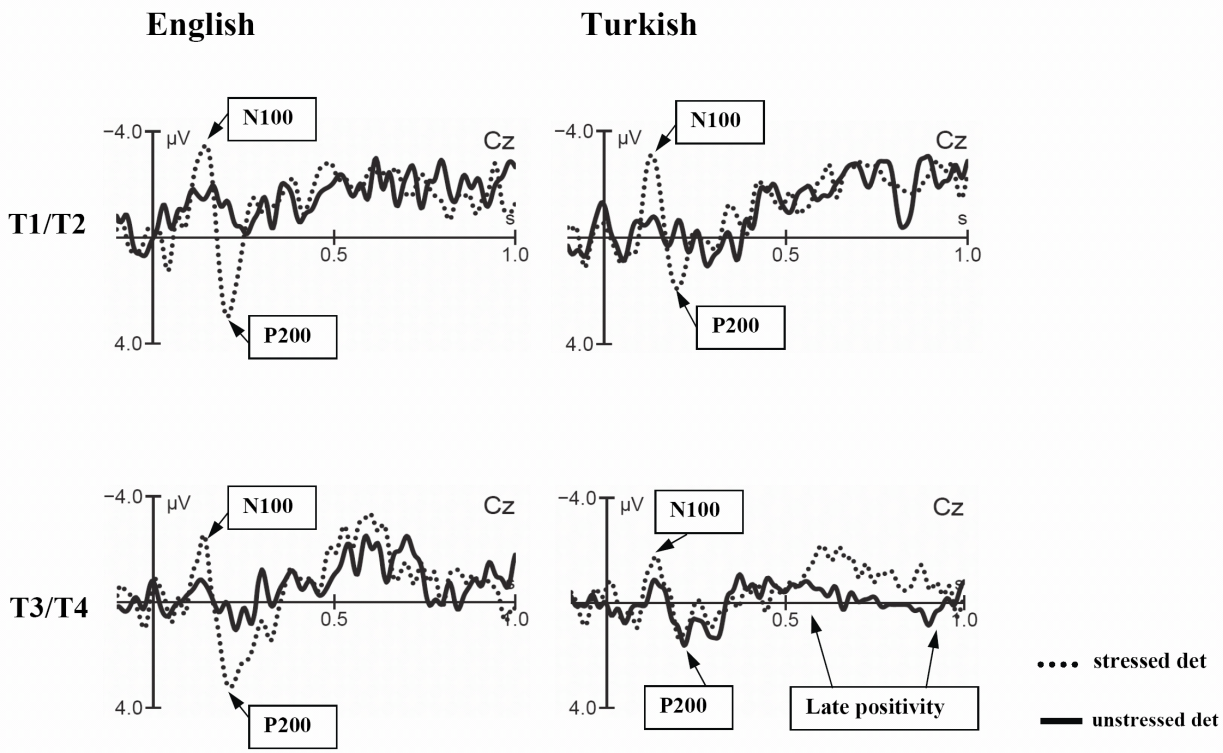
To our knowledge, there have not yet been perception studies on how speakers integrate morphemes into the prosodic structure of their L2. However, if the results follow what has been seen in production data of Goad and White (2004, 2009), and under the assumption that there is a correspondence between production symmetries and perception, then a number of predictions can be made. We expect a measurable ERP response in the Turkish population for T3 (where the DP contains an adjective and an unstressed article) as compared to T4, the specific nature of which should not appear in the EEG data of the controls. Recall that T3 corresponds to the licit English prosodic structure hypothesized as unavailable to Turkish learners, as evidenced by their significant behavioural difficulties for this specific sentence type. This predicted effect ought to be sharper and qualitatively different from any effect between T1 and T2, neither of which present the Turkish group with a specifically prosodic implausibility. We also expect to observe a reaction to the increased pitch and intensity of the stressed article compared to the unstressed article, in all condition pairs and language groups.

4. RESULTS

4.1. ERP data in English and Turkish participants

Averages were computed for each sentence type and each language group, for a one-second interval time-locked to the onset of the critical article. The preliminary statistical analysis of the observed ERP differences presented here is based on running *t*-tests calculated with the EEProbe software package. First, we found a predicted amplitude increase in the N100-P200 complex (a negative peak rapidly followed by a positive peak, taking place within 200 ms of the onset of the article). This biphasic ERP response is related to physical characteristics of the stimulus; in the present case, it likely arises in response to the increased acoustic salience/intensity of the stressed article and is seen in both groups across sentence pairs, albeit more pronounced for the English participants (Figure 3). Secondly, and most importantly, only the Turkish group shows and additional late ERP effect, and only for the T3/T4 comparison: a sustained positivity in the 500-900 ms time window for the unstressed (prosodically illicit in Turkish) condition, with a widespread scalp distribution. This effect is likely to reflect the processing difficulties in the unstressed condition (T3), which represents a prosodic pattern that is ungrammatical in Turkish. In terms of its latency and broad scalp distribution, this positive-going waveform is reminiscent of a P600 component, although future research will be needed to further identify the component. We suggest that this result represents a response to a specifically prosodic violation, being carried over from the L1 to the L2 – in other words, that L1 prosodic representations have been transferred onto the L2 grammar in such a way that they contribute to and even restrict the processing of L2 sentences, therefore granting support to the PTH.

Figure 3: ERP group averages at a central midline electrode (Cz) for stressed and unstressed conditions, time-locked to the critical article/determiner. Negative polarity is plotted upwards.



4.2. Direction of ongoing work

An identifiable difference in the ERP response T1 vs T2 and T3 vs T4 may indicate that prosodic transfer is at work in Turkish learners' real-time processing of English sentences, supporting a prosodic transfer account of the Turkish behavioural asymmetry mentioned above. However, there exists a second interpretative possibility. The prosodic structure in (2a) not only violates Turkish prosodic wellformedness, but necessarily Turkish word order as well. In order to rule out the possibility that the observed effect represents a word-order violation rather than a prosodic one, analysis will be completed of the EEG readings during the distractor conditions, which contain a word order violation while allowing cliticization of the article onto the head noun, as seen in Table 2 below. Moreover, a third language group will be included in the analysis. The addition of French controls should serve to demonstrate that the results obtained for the Turkish group truly reflected a dependence on L1 prosody, and not simply a general L2 difficulty, since French prosody patterns with English and not with Turkish on the points under discussion.

Table 2: Additional conditions

T5	S V art O ADJ	N	N	N	Y	Kristin fought a bear wild.
T6		Y	N	N	N	Kristin fought **a** bear wild.

4.3. Conclusion

The present study has investigated the hypothesis that if L1 prosodic structure is responsible for differences in L2 article production, as argued by the PTH, and if comprehension is affected in the same way as production, then evidence of this dependence on L1 structures should be visible on the time-locked event-related potential data. By investigating the brain responses of Turkish speakers learning English as a second language by contrasting a 'prosodic mismatch' condition pair (T3/T4) to prosodically acceptable pairs where similar article-stress variation results only in a meaning difference (T1/T2), this study isolated a

neurocognitive pattern of response corresponding to prosodic structure violation. This presented as a sustained negativity in the prosodic violation condition starting at approximately 500 ms after the onset of the unstressed determiner in those sentences with prenominal adjectives. The observed pattern was similar to the one arising in all other conditions and language groups wherein inappropriate article stress generated mild prosodic violations for English, but the reaction was more widespread and longer in duration in the L2 sentences severely violating the L1 (Turkish) prosodic structure. This study therefore confirms the hypothesis that Turkish speakers of L2 English will evidence an electrophysiological correlate of dependence on L1 prosody in their processing of L2 DPs containing adjectives, in support of the Prosodic Transfer Hypothesis. Furthermore, a first mapping of the electrophysiological response to violations of prosodic structure has been undertaken, paving the way for further research in this area.

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Acknowledgments: This research was supported by grants awarded to L. White (PI) et al by the Fonds québécois de la recherche sur la société et la culture (FQRSC; #2010-SE-130727), to K. Steinhauer by the Canadian Institutes of Health Research (CIHR; MOP-74575), the Natural Sciences and Engineering Research Council of Canada (NSERC; RGPGP 312835), and the Canada Foundation for Innovation (CRC/CFI; # 201876), and to Adèle-Elise Prévost by the Social Sciences and Humanities Research Council of Canada (SSHRC; CMS #766-2009-0382).