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A Contrastive Study of The Effect of Initial /s/ on the Voice Onset Time (VOT) of Following Stops in English, Kurdish and Kurdish EFL Learners

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Abstract

When an initial /s/ precedes a voiceless stop in English, the aspiration is lost, and the voice onset time (VOT) is significantly shortened. This causes an allophonic variation of English stops based on context. This paper intends to comparatively investigate this phenomenon in English, Kurdish and Kurdish EFL learners from two proficiency levels. (40) participants which are divided among four groups (Kurdish, English, learners G1 and learners G2) are asked to read lists of words including voiceless stops preceded by /s/, constructed in English and Kurdish. Each stop in the list has two examples followed by a high and a low vowel. All the participants are asked to repeat each word three times to provide three tokens. These productions are recorded and VOT values are acoustically measured. Results are then statistically analyzed to check the significance of variable interactions.

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Results have shown that Kurdish voiceless stops preceded by /s/ are more aspirated than those of English in similar contexts and thus produced with longer VOT values. This indicates that Kurdish learners need to modify their voiceless stop production when speaking English. Results also show that advanced Kurdish learners have improved at pronouncing the aspirated English stop variety, but they still produce it with a noticeably extended VOT.
Keywords: Voice onset time, stops, and learners.

مقارنة بين تأثير /s/ الأولي على وقت بدء الجهر (VOT) للاصوات الانفجارية التالية في الإنجليزية والكردية والاكراد متعلمي اللغة الإنجليزية لغة اجنبية

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المستخلص

عندما يسبق الصوت الأولي /s/ صوت انفجاري مهموس باللغة الإنجليزية، يفقد الصوت الانفجاري الصفة الهائية، ويتم تقصير وقت بدء الجهر (VOT) بشكل كبير. ينتج عن هذااشكال مختلفة لهذا الصوت بناء على السياق. يهدف هذا البحث إلى التحقق من هذه الظاهرة فى اللغة الكردية واللغة الإنجليزية ولدى الاكراد متعلمي اللغة الإنجليزية لغة اجنبية في مستويين من الكفاءة. طلب من (40) مشاركا موزعين على أربع مجموعات (الكردية والإنجليزية والمتعلمين G1 والمتعلمين G2) قراءة قوائم كلمات تبدأ بالاصوات الانفجارية المهموسة مسبوقة ب / s / ، والتي تم إنشاؤها باللغتين الإنجليزية والكردية. كان لكل صوت انفجاري في القائمة مثالين متبوعين بصوت متحرك مرتفع ومنخفض. طلب من جميع المشاركين تكرار كل كلمة ثلاث مرات لتوفير ثلاثة امثلة. تم تسجيل هذه الاصوات وتحليلها صوتيا وإحصائيا. أظهرت النتائج أن الاصوات الانفجارية المهموسة المسبوقة ب /s/ فى اللغة الكردية هائية أكثرمن تلك الموجودة في اللغة الإنجليزية في سياقات مماثلة وبالتالي يتم إنتاجها بقيم VOT أطول. يشير هذا البحث إلى أن المتعلمين الأكراد بحاجة إلى تعديل نطقهم للاصوات الانفجارية عند التحدث باللغة الإنجليزية. تظهر النتائج أيضا أن المتعلمين الأكراد المتقدمين قد تحسنوا في نطق الاصوات الانفجارية المهموسة في اللغة الإنجليزية، لكنهم ما زالوا ينطقونها باستخدام VOT ممتد بشكل ملحوظ.
الكلمات الدالة: وقت بدء الجهر، الاصوات الانفجارية، المتعلمين.

1. INTRODUCTION

All speech sounds utilize a number of invariant distinctive acoustic properties that define them, in such a way that categories can be separated based on their acoustic features. Cho et al. (2018) state that phonetic properties provide perceptual and articulatory cues to sound recognition. Voice onset time (VOT) is one of the features that contribute to stop category distinction. VOT is a durational measure of the time between stop release and vocal fold vibration. It differs from one language to another. A VOT measurement of approximately 20-25 msec serves as the distinguishing factor between voiced and voiceless stops in English. When the measurement falls below this range, it indicates a voiced stop, implying that the release of the consonant and the onset of voicing in the following vowel occur almost simultaneously. Conversely, a measurement exceeding this range is indicative of a voiceless stop, suggesting a temporal gap between the release of the consonant and the onset of voicing in the subsequent vowel.

Voiceless stops are characterized by the presence of aspiration noise which perceptually contributes to recognition of stop type. In voiceless stops, aspiration noise is generated close to the glottis at lower cavities. It is the result of the wide apart vocal folds approaching each other after release to get ready for voicing initiation for the next voiced sound. Thus, the decreased size of the glottis creates noise which in turn excites the vocal tract resulting in the production of aspiration. So, voicing is delayed as a result of slow spectral change which is one of the key cues in voiceless stop perception. In English, when a voiceless stop is preceded by an initial /s/ sound, the aspiration typically disappears, and the voice onset time (VOT) is notably reduced (Klatt, 1975). This leads to the occurrence of different allophones for English stops depending on the surrounding context.

2. RELATED LITERTURE

Voice onset time (VOT), which is one of the differentiating durational acoustic properties of stop consonants, has a prominent significance in studies related to the acquisition of a second language phonology (Lisker & Abramson, 1964). In languages which contrast aspirated and unaspirated voiceless stops phonemically, the challenge for learners is to distinguish the allophonic variation in the target language based on context. Syed (2014) investigated stops produced by Saraiki learners of English. He found that learners, even at advanced levels, failed to apply the phonemic difference of aspiration in their L1 to the allophonic variation of the TL and tended to produce voiceless stops with aspiration regardless of context. The same conclusions were obtained by Schmid (2012) who investigated the ability of Swiss German learners to acquire the voice distinction found in French which is equivalent to a tensity distinction in their L1. He found that about 85% of the voiced sounds were devoiced in certain contexts specific to devoicing in their L1. This means that these learners were not able to correctly acquire the precise explicit details of the TL.

Bahdini Kurdish distinguishes aspirated and unaspirated voiceless stops phonemically (Al-Bamirni, 1980; Öpengin, 2020). This L1 laryngeal contrast is expected to be problematic for Kurdish EFL learners, since they are required to produce the English voiced stops with a short lag, which is normally characteristics of the Kurdish unaspirated voiceless stops. One of the most characteristic features of an English accented speech of Kurdish learners is the aspiration of stop consonants that should not be aspirated. Similarly, failure to aspirate stops in the appropriate environments can contribute to a foreign accented English. The objective of this research is to answer these questions.

- Is the context-based allophonic variation of English voiceless stops in aspiration problematic for Kurdish EFL Learners?
- Are Kurdish EFL learners' productions in English similar to those of Kurdish, indicating L1 transfer, or to English, showing developmental progress towards the TL?
- Does the level of learners effect on their performance?
- Are the variables of gender and following vocalic context significant?

3. METHODOLOGY

- **Wordlists**

Two lists of words with voiceless stops preceded by /s/, were constructed in English and Kurdish, Table 1. Each stop had two examples followed by two vowel types, a high and a low vowel.

Table 1. Words Used in the Research Experiment

English Words		**Kurdish Words**	
		IPA	**Gloss**
/p/	speak	/spilk/	egg white
	spark	/spɑɾtɨn/	handing out
/t/	steal	/stin/	pillar
	start	/stɑnd/	stand
/k/	ski	/skinət/	tranquility
	scar	/skɑlɑ/	Complaint

- **Speakers**

Four groups of individuals were chosen to take part in the experiment: An English and a Kurdish control group and two other research groups. Control groups were chosen to serve as norms against which the learners' VOT's could be compared. The first group of participants consisted of ten native Bahdini Kurdish speakers from Duhok City, with equal numbers of males and females. VOT measurements provided by this group provide norms for Native Kurdish. The second group consists of ten native English speakers, with equal numbers of males and females. This group's data provide norms for English VOT. The research groups consist of adult Kurdish learners of English at university level, one from stage one and another from stage four. Each group includes ten students, with equal numbers of males and females. VOT measurements provided from these two groups will be compared to those of the control groups to assess the development of the performance of these learners for our studied variables.

- **Acoustic Procedures**

The participants of the two control groups read the list of words discussed in the previous section, each group read the words in their native language. The two groups of Kurdish learners of English read the English wordlist. All the participants were asked to repeat each word three times so that each word will have three tokens. A zoom H1n digital portable audio recorder was used to record these productions in WAV format with a sampling rate of 44.1 kHz. VOT measurements of stops were acoustically measured in Praat using a script. Results are statistically analyzed and plotted in R Studio for statistical computing.

4. RESULTS

Results of statistical analyses, indicated in Table 2, has shown that Kurdish voiceless stops preceded by /s/, with mean averages of (46, 11 and 22) ms for /sk/, /sp/ and /st/ respectively, are more aspirated than those of English in similar contexts with mean averages of (31, 10 and 20) ms for /sk/, /sp/ and /st/ respectively. The beginner Kurdish learners of English group (KEFL1) has also produced VOT values which are more aspirated than those of English. The advanced Kurdish learners of English group (KEFL2), however, has produced VOT values which are less aspirated but still different from those of English. This means that Kurdish learners of English need to adjust their production of voiceless stops when speaking in the target language. The LME model output is included in Appendix A. These results are also visualized in Figure 1.

Table 2. Mean VOT Values and Standard Deviations of Voiceless Stops Preceded by /s/

		/sk/	**/sp/**	**/st/**
Native Kurdish	***Mean***	46	11	22

	Std.D	19	8	9
Native American	***Mean***	31	10	20
	Std.D	9	3	6
KEFL1	***Mean***	57	13	25
	Std.D	27	10	18
KEFL2	***Mean***	39	11	26
	Std.D	15	4	16

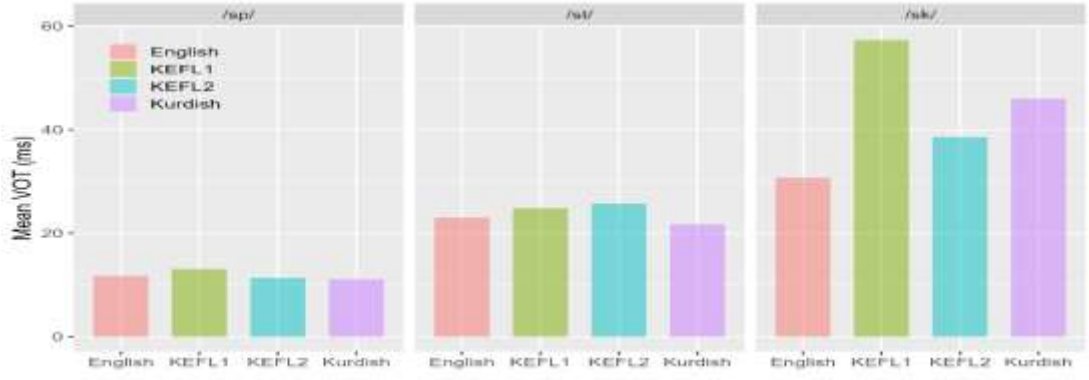

Figure 1. Distribution of VOT for Voiceless Stops Preceded by /s/ for all Studied Groups

A post-hoc Dunnett's test was utilized to determine whether the VOT values generated by the research groups, Kurdish Learners G1 and G2, are more similar to Kurdish or English, the two control groups. It reveals important statistical variations between each of the four groups. The test's results, which are presented in Table 3, show that the mean VOTs of Kurdish Learners G1 (KEFL1) are closer to Kurdish than to English, with a mean difference of 5.2 and a matching p = .999 compared to -83.3 and a p = .211 respectively. However, the Kurdish Learners G2's (KEFL2) mean VOTs show shift away from Kurdish and towards English, with mean differences of -47.5 and -41.0, respectively, and corresponding p = .623 and p = .716. This leads us to the conclusion that although Kurdish learners have improved at pronouncing the aspirated English stop variety, they still produce it with a noticeably extended VOT.

Table 3. Post-hoc Dunnett's Test Showing Significance Differences Between all Four Groups

	diff	**lwr.ci**	**upr.ci**	***p* val**
KEFL1-English	-83.3	-202.0	36	= .211
KEFL2-English	-47.5	-166.0	71	= .623
KEFL1-Kurdish	5.2	-113.8	124	= .999
KEFL2-kurdish	41.0	-78.0	160	= .716

4.1. Place of Articulation (POA)

Place of articulation of initial voiceless stops preceded by /s/ showed a significant effect on VOT with a p < .001 for all studied groups (Appendix A). VOT tends to be longer the more posterior the place of stop articulation is. These results are visualized in Figure 2.

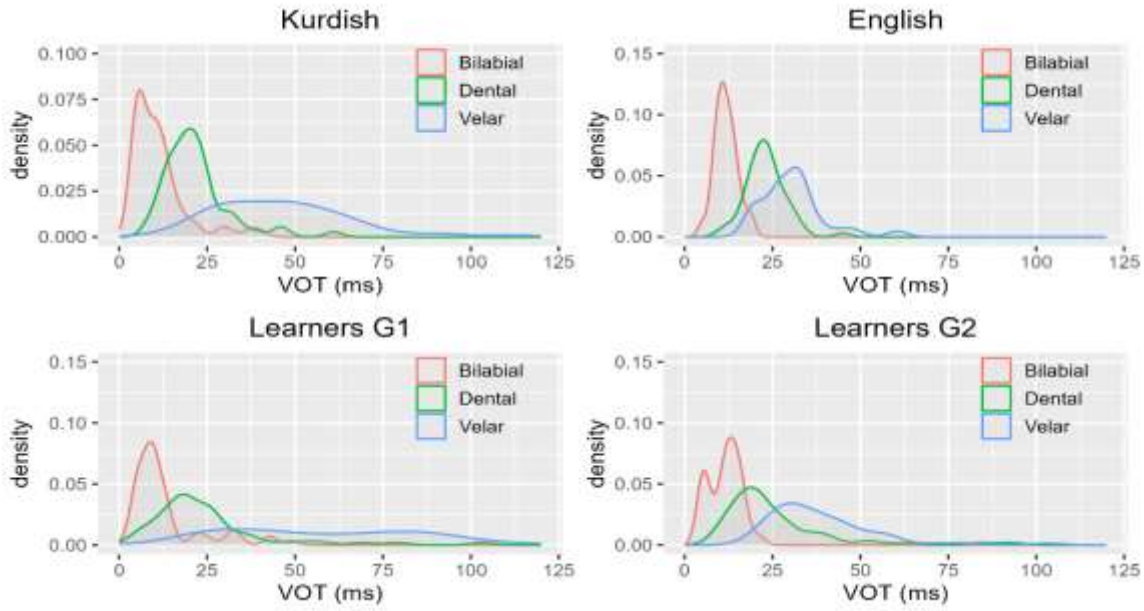

Figure 2. Mean VOT Values of Voiceless Stops Preceded by /s/ based on POA for all Groups.

4.2.Post Vowel Height

The analysis of the LME model results has shown that VOT is significantly affected by the height of a following vowel only for the Kurdish speaker group with a $p < .001$, meaning that VOT is longer after high vowels. However, following vowel height didn't show such a significant effect on VOT in the other studied groups with a $p = .143$ for English, $p = .370$ for Kurdish learners G1 and $p = .113$ for Kurdish learners G2 (Appendix A). The distinction is displayed in Figure 3.

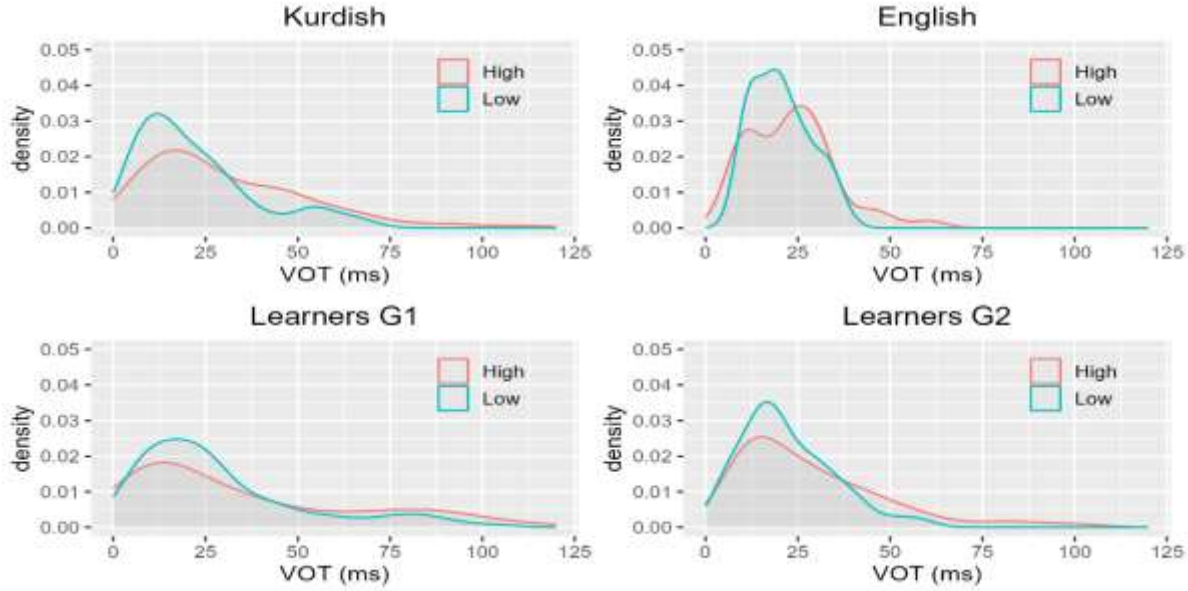

Figure 3. Mean VOT Values of Voiceless Stops Preceded by /s/ based on Vocalic Context for all Studied Groups.

4.3.Gender

The gender of participants didn't show a significant effect on VOT of initial voiceless stops preceded by /s/ in any of the studied groups with a p = .181 for Kurdish, p = .258 for English, p = .517 for Kurdish learners G1 and p = .075 for Kurdish learners G2 (Appendix A). The distinction is displayed in Figure 4.

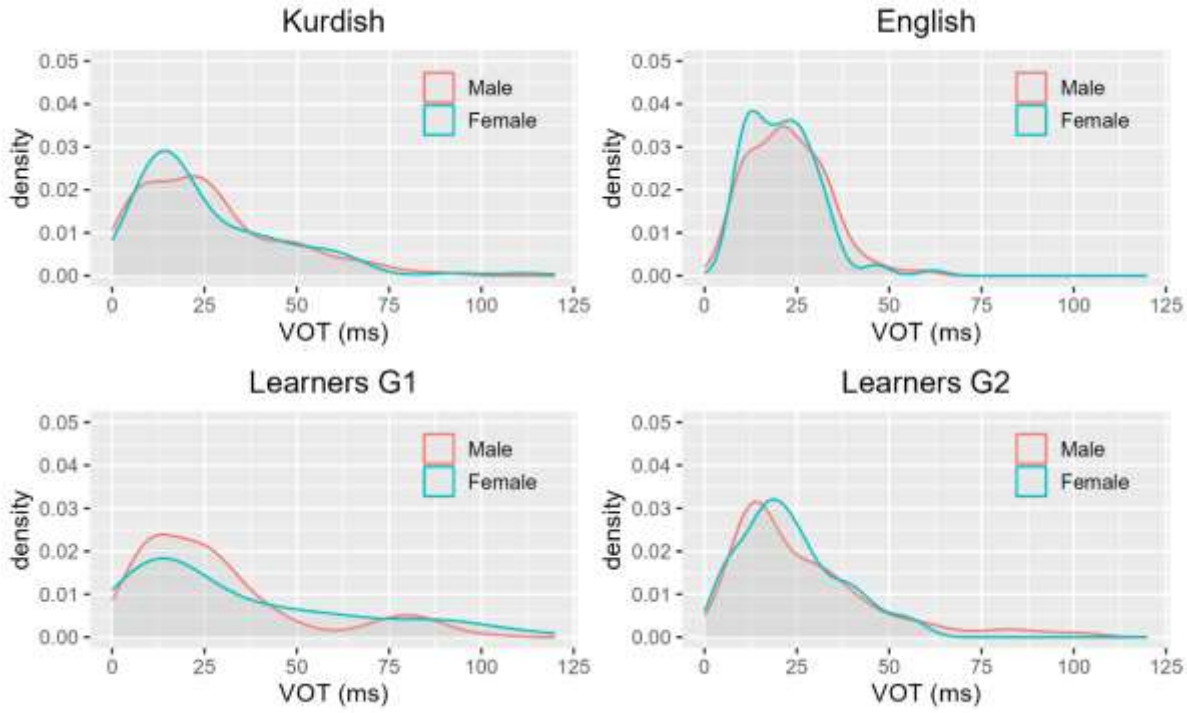

Figure 4. Mean VOT Values of Voiceless Stops Preceded by /s/ based on Gender for all Studied Groups

5. DISCUSSION

This study investigates how L1 Kurdish EFL learners produce English voiceless stops with and without an initial /s/. In order to do so, two control groups of 10 English and 10 Kurdish native speakers are chosen to measure their productions of the investigated stops in both languages. The study also contrasts 20 EFL students from two proficiency groups to compare their productions to the control groups and test whether any existing differences would be challenging for learners based on their proficiency level.

According to the results of this study, Kurdish voiceless stops that are followed by /s/ are generated with more aspiration and thus longer VOT values than their English counterparts in comparable settings. The reason may be due to the fact that Bahdini Kurdish contrasts aspirated and unaspirated voiceless stops phonemically. So, its speakers produce the aspirated voiceless stop with aspiration and with long VOT values, regardless of context, to maximally differentiate it from its unaspirated counterpart.

Additionally, the findings also demonstrate that Kurdish EFL students typically produce English voiceless stops with more aspiration and a longer VOT than native English speakers, especially at lower levels, and thus transfer their native language VOT values to the target language (TL). However, for more advanced levels, this transfer tends to be less but still not identical. Kurdish students have gotten better at pronouncing the aspirated English stop variety in a more advanced level, but they still do so with a visibly extended VOT. This suggests that Kurdish language learners of

English need to alter the way they produce voiceless stops when speaking English through more exposure and practice of the target language.

6. CONCLUSIONS

The current study comes up with the following conclusions:

- Kurdish voiceless stops preceded by /s/ are produced with more aspiration than those of English in the same contexts and thus produced with longer VOT values.
- The allophonic aspirated variants of English voiceless stops are problematic for Kurdish EFL Learners. They need to adjust their production of these stops when speaking in the target language to avoid speaking with a foreign accent.
- The level of learners did influence their performance but only to a certain extent.
- Gender of the participants did not affect the VOT values with reference to their context.
- Vocalic context was only significant for the Kurdish stops but not for their English counterparts.

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Appendix A

Analysis of Variance for Fixed Factors in All LME Models with Satterthwaite's Method, Indicating *F* statistic, Denominator Degree of Freedom and *P* Values.

Group	Fixed Factors	Sum Sq	Mean Sq	NumDF	DenDF	*F* value	*Pr*(>F)	
Kurdish	Gender	920	920	1	8	2.14	= .181	
	POA	18006	9003	2	328	20.96	< .001	***
	Vowel.Height	5373	5373	1	328	12.51	< .001	***
	Gender:POA	11151	5575	2	328	12.98	< .001	***

	Gender:Vowel.Height	424	424	1	328	0.99	= .320	
	POA:Vowel.Height	678	339	2	328	0.79	= .455	
	Gender:POA:Vowel.Height	968	484	2	328	1.13	= .325	
English	Gender	757	757	1	8	1.48	= .258	
	POA	46224	23112	2	328	45.20	< .001	***
	Vowel.Height	1101	1101	1	328	2.15	= .143	
	Gender:POA	1016	508	2	328	0.990	= .371	
	Gender:Vowel.Height	49	49	1	328	0.100	= .756	
	POA:Vowel.Height	1488	744	2	328	1.460	= .235	
	Gender:POA:Vowel.Height	174	87	2	328	0.17	= .844	
KEFL1	Gender	316	316	1	8	0.46	= .517	
	POA	14353	7177	2	328	10.41	< .001	***
	Vowel.Height	553	553	1	328	0.80	= .370	
	Gender:POA	6889	3445	2	328	5.00	= .007	**
	Gender:Vowel.Height	109	109	1	328	0.16	= .690	
	POA:Vowel.Height	373	187	2	328	0.27	= .762	
	Gender:POA:Vowel.Height	149	74	2	328	0.11	= .897	
KEFL2	Gender	4170	4170	1	8	4.18	= .075	.
	POA	38027	19013	2	328	19.07	< .001	***
	Vowel.Height	2513	2513	1	328	2.52	= .113	
	Gender:POA	2709	1355	2	328	1.36	= .258	
	Gender:Vowel.Height	264	264	1	328	0.27	= .606	
	POA:Vowel.Height	2388	1194	2	328	1.20	= .303	
	Gender:POA:Vowel.Height	1378	689	2	328	0.69	= .501	