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RHYTHM INSTRUCTION TO ENHANCE ESP STUDENTS' PROSODY: AN ACOUSTIC STUDY

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ABSTRACT

This study belongs to a broader project that examines the efficacy of rhythm instruction to enhance Spanish/Catalan engineering undergraduates' comprehensibility and fluency in English. To this end, a ten-week pronunciation module was designed and embedded within a technical English course. 42 students participated in the experiment: half of them received explicit rhythm instruction (experimental group), and half of them did not (control group). All the subjects were recorded before and after treatment. Ten sentences were analyzed acoustically, and measures of VarcoV and %V were obtained, as these have been considered better measures of rhythm in second language research. Previous studies showed that VarcoV values tended to increase after treatment for the experiential group, adopting a more stress-timed rhythm, whereas the control group showed several inconsistencies. This paper will present the results obtained when measuring %V, and how these complement previous findings. Results revealed that the experimental group tended to decrease their %V values, while the control group appeared to increase them. Besides, the comparison of the effect sizes of each group's differences in performance showed more and larger signs of improvement for the experimental group. These findings further support that rhythm instruction can be beneficial to enhance ESP students' prosody.

Keywords: *rhythm instruction, %V, pronunciation teaching, English as a foreign language (EFL), English for specific purposes (ESP)*

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1. INTRODUCTION

As a pronunciation feature, rhythm is a suprasegmental aspect at the core of language prosody which anticipates syntactic and lexical information [1]. It helps organize speech in a language: in fact, rhythmic patterns create an acoustic illusion (isochrony) that affects intelligibility, comprehensibility and fluency when communicating in a second language, influencing both production and perception [2, 3, 4, 5, 6, 7].
Adopting the correct rhythm when speaking a language, hence, becomes crucial to ease comprehension and avoid misunderstandings and further communication breakdowns that go beyond the meaning of words [8]. When two languages differ remarkably in terms of rhythm, it is common for misinterpretations to arise. That is the case of English and Spanish, which have traditionally been placed at the extremes of the rhythm continuum. Spanish is considered a syllable-timed language, i.e., a language that organizes information by means of similar syllable duration; by contrast, English is known as a stress-timed language, whose rhythm is based on interstress intervals that last approximately the same. These intervals are marked by two types of syllables, stressed and unstressed, which are different in length: while stressed syllables are pronounced longer, unstressed syllables tend to be reduced and pronounced shorter [9, 10, 11]. Catalan, on the other hand, shares some features with both rhythmic categories. However, even if the vowel quality gets reduced in unstressed syllables, syllables tend to have a similar length, approaching a more syllable-timed rhythm.
English as a foreign language students are not usually aware of the existence of these rhythmic differences. Consequently, Spanish/Catalan students of English tend to transfer their mother tongue's rhythm when speaking the L2, which negatively affects their fluency and comprehensibility.

2. THEORETICAL FRAMEWORK

2.1 Explicit rhythm instruction in the EFL classroom

There are several studies that have examined the effectiveness of teaching rhythmic features in the EFL class. Chela-Flores taught word-decontextualized rhythmic patterns to Spanish students at the university of Venezuela during one semester. Students were found to improve considerably both in perception and word recognition under controlled circumstances [12]. Hahn studied the relevance of placing the primary stress correctly. She designed three different versions of the speech of international teaching assistants: one where primary stress was correctly placed, another one in which it was incorrectly placed, and one last version in which it was omitted. Findings revealed that the speeches were more comprehensible and intelligible when stress had been correctly placed [13]. Couper examined epenthesis and absence among New Zealand immigrants whose origin was mostly Asian. Results showed that the error rate reduced considerably both for immediate and a delayed posttests [14]. Tsiartioni studied rhythm instruction among Greek students of English at three different age groups (6, 12 and 16 years old). After measuring vocalic and consonant pairwise variability index (PVI) values, results revealed that those who had received explicit rhythm instruction adopted a more English-like rhythm, while the control group's remain the same [15].

As observed, there is not a general agreement on which rhythmic aspects are most suitable to teach. In fact, choosing between one or another will depend on the students' mother tongue and the target language. When Spanish/Catalan EFL students are considered, rhythm can be tackled through vowel lengthening. As previously mentioned, vowel duration is a remarkable indicator of stress in English. Besides, it is a rather simple concept to introduce in the classroom. The study presented in this paper was designed under these assumptions. This decision will also influence the type of rhythmic measurements used to analyze results acoustically, which will be introduced in the following subsection.

2.2 Rhythmic acoustic measurements

Different attempts to measure the duration of rhythm have contributed to refuting the existence of language isochronism, challenging its traditional classification into the syllable- and stress-timed categories [16, 17]. Nevertheless, the emergence of the acoustic analysis of rhythmic phonological features has provided a new dimension to measurements of duration, shifting them into potential tools to correlate phonetic cues, such as vowels [18]. A characteristic of stress-timed languages is that their use of stress significantly increases the duration of stressed vowels in comparison to syllable-timed languages. Although some researchers are skeptical about the overall reliability of rhythmic metrics to classify speech rhythm due to a lack of consistency [16, 17, 19], several studies endorse the traditional classification [20, 21, 22, 23, 24, 25, 26, 27], relying on different metrics to measure rhythmic differences. This categorization, however, is not static: languages, indeed, can be more stress- or syllable-timed depending on their inner phonological and phonetic structure.

Not many studies have examined the veracity of these metrics to measure the evolution of L2 speakers, though. White and Mattys [26, 27] examined the metrics that capture the acquisition progress of L2 speakers of English and Spanish. The proportion of vocalic interval durations in a given sentence (%V) and the variation coefficient indices for vowel (VarcoV) were shown to be the most reliable. In second language pronunciation research, the effectiveness of rhythmic metrics to measure intelligibility has been questioned because of the lack of listener corroboration [1], leading to its rejection as an assessment tool of the learning progress. However, metrics could provide some instrumental estimation of the evolution that could alleviate the subjectivity load of which popular intelligibility assessment tools have been accused. For this reason, research in L2 pronunciation teaching is starting to advocate for studies that observe both subjective (ratings) and objective (acoustic analysis) data, providing a more holistic picture of learning progress [28; 29, 30, 31, 32, 33, 34].

2.3 The research project: Previous findings

The study presented in this paper belongs to a broader project that examines the effectiveness of explicit rhythm instruction to improve engineers' undergraduates' fluency and comprehensibility in English. To this end, both ratings and acoustic analysis were conducted.

On the one hand, native speakers' rated students' extemporaneous speech in terms of comprehensibility and fluency. Results did not show an improvement. However, several problems were detected in the rating process (ceiling effect, fatigue, etc.) and, thus, results were considered inconclusive [32]. On the other hand, VARCO-V means of read-aloud sentences were calculated. It was seen that those students who received explicit rhythm instruction increased their VARCO-V values, while learners who did not showed several inconsistencies [30, 31, 32, 33]. Besides, they also made fewer unfilled pauses, which suggests that they were pausing less within thought

groups [32, 34]. These findings suggest that those students who learned and practiced language rhythm explicitly adopted a more stress-timed pattern, approaching a more English-like rhythm and reducing the L1 negative transfer when using the target language. However, results did not always show statistical significance.
To provide more acoustic evidence of an improvement in rhythm adaptation when explicit training was offered, %V values were also measured, which are going to be presented in this paper. The research questions formulated for the study are the following:

RQ1 To what extent students' %V values decrease when they are trained in rhythm explicitly?

RQ2 To what extent %V and Varco-V values correlate?

3. METHOD

A pronunciation module was designed as part of a one-semester technical English course (B2 level) at Rovira i Virgili University. This course was compulsory for all first-year engineering undergraduates. The module was made up of ten weekly thirty-minute sessions held within the class schedule. Students were randomly distributed into six class groups, which were further divided into three experimental groups (receiving explicit rhythm instruction) and three control groups (not receiving explicit rhythm instruction) according to their discipline schedules and time preferences. Sessions were designed taking to account students' needs and course contents [35]. Additionally, sessions of both groups followed Celce-Murcia's steps to teach communicatively [6]. As mentioned in the previous section, this study focuses on the analysis of ten sentences recorded before and after training and compared by measuring their %V values.

3.1 Participants

298 students enrolled in the course. Due to the longitudinal nature of the study, only those students who attended at least 90% of the sessions were considered as subjects. Although attendance was controlled and doing the pre and posttest recordings were counted for their final grade, only forty-two learners finished treatment, twenty-one from the experimental groups and twenty-one from the control groups. These forty-four students were the final subjects under analysis.
Most of them were Spanish/Catalan bilinguals aged between 18 and 20 years old. Some learners were balanced bilinguals, but there were others who were dominant in one of the two languages. All the participants, though, pursued primary and secondary education in Catalonia, so they had studied and acquired both languages. As for their English level, there was a wider range of variability: While in the experimental group ten of the students were beginners, six intermediate, and 5 upper-intermediate/advanced, the control group consisted of four beginner, eleven intermediate, and six upper-intermediate/advanced learners.

3.2 Procedure

The pronunciation module took into account the vocabulary and grammar taught in regular lectures: students were introduced to difficult words and grammar concepts previously in class, so that they were familiar with them. Materials were both adapted from different existing pronunciation sources and designed from scratch using a diversity of resources available, such as videos/audios.
The module was scaffolded. First sessions focused on pronunciation issues at the word level, such as how to pronounce regular past tenses, derivational morphemes and compound nouns. The experimental group were explicitly taught about word stress and syllable length. Next, students worked with sentences, describing processes and graphs. At this level, those receiving explicit rhythm instruction were introduced to thought groups and the difference in stress between content and function words. Finally, students practiced with long speeches, like talks and debates. The experimental group worked on connected speech features, such as pausing, linking and sentence focus.
As previously mentioned, sessions followed Celce-Murcia's steps to teach communicatively [6]. First the feature to work with was explained, using different auditory, tactile and kinesthetic resources. Second, different audio sources were played to practice distinguish the feature. Lastly, they practiced producing it, starting with controlled activities (e.g., "listen and repeat"), followed by guided practice (e.g., gap exercises), and finishing with communicative tasks (e.g., picture narratives). All the materials and the outlines of the different sessions are available on the *SLA Speech Tools* teaching repository [36].
Students had to record themselves one week before and after the instruction. Recording sessions were conducted individually in three isolated rooms at the university library, using two Sony PCM-MIO and a Zoom Hynsp recorders. They had to read ten sentences and a text aloud, introduce themselves, and give their opinion on social media for a minute. This study focuses on the analysis and comparison of the pre- and post-test sentences. These were of an uncontrolled nature in terms of rhythmic cues, but they were outlined to represent a wide range of sentence

structure, and they contained technical vocabulary students had learned in class.

3.3 Data analysis

Olive, Greenwod and Coleman [37] and Ordin and Polyanskaya's criteria [22, 23] were followed to segment the sentences in PRAAT [38]. Then, Ordin and Polyanskaya's script [23] was run to measure %V values. Pauses were omitted when calculating rhythmic metrics.

3.4 Statistical analysis

The data were analyzed using mixed repeated measures ANOVAS and t-tests. First, general impact on learner's prosody was studied by running a mixed ANOVA with time (before and after instruction) and sentence as within-subjects factors, and group (experimental or control) as a between-subjects factor: %V values were the dependent variable. Second, the importance of the difference in production before and after treatment was examined. To this end, a second mixed ANOVA was run with the difference between each sentence performance before and after training as the dependent variable, sentence as the within-subjects factor and group as the between-subjects factor. Third, four t-tests were performed for each sentence to analyze the magnitude of the difference depending on the instruction received: two paired-samples t-tests that compared the groups' learning process, and two-independent-samples t-tests comparing the initial and final performance of the two groups. One more independent-samples t-test was run which compared the two groups' effect sizes for all the sentences. Finally, Pearson product-moment coefficiency tests between %V and VarcoV values per group and time were performed.

4. RESULTS

The means (*M*) and standard deviations (*SD*) of %V values for each sentence were measured and distributed according to time (T1 = pretest; T2 = posttest) and group (control; experimental), as displayed in Table 1. The experimental group decreased their %V means in eight out of ten of the sentences, while the control group showed a fall in %V values in five of them (See cells highlighted gray color).

Table 1. %V means (M) and standard deviations (SD) per sentence

	Control group				Experimental group			
	T1		T2		T1		T2	
S	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	49.91	4.98	51.65	3.95	51.81	2.83	50.97	5.28
2	34.12	3.74	34.15	3.55	34.80	3.83	33.67	4.32
3	45.24	5.01	46.12	5.23	46.07	6.29	47.08	5.45
4	45.19	5.76	45.38	5.39	44.68	6.77	43.13	6.23
5	36.83	3.52	35.89	3.65	37.34	4.39	36.82	3.35
6	39.54	2.62	39.51	2.75	40.30	2.51	39.28	3.28
7	45.93	3.78	45.80	3.98	47.57	4.43	47.06	3.34
8	39.92	3.75	39.40	2.71	39.80	3	37.30	3.48
9	35.52	4.19	35.45	3	35.27	3.57	35.55	3.28
10	45.18	3.42	45.35	4.28	47.57	3.27	45.82	4.02
Total	**41.74**		**41.87**		**42.52**		**41.84**	

Note. S = Sentence. *M* = Mean. *SD* = Standard deviation.

Hence, those who received explicit rhythm instruction seemed to adopt a more English-like rhythm after training. By contrast, those who did not, did not seemed to follow a clear pattern. These tendencies correlate with previous findings of VarcoV figures reported in former studies [30, 31, 32, 33]; however, there were some differences in the sentences that played a role: VarcoV values showed that experimental students performed a more English-like rhythm in sentence three, while %V figures did not; besides, VarcoV means remained the same in sentence five, while %V decreased after treatment. Regarding the control group, a VarvoV decrease was revealed in sentence seven, which suggested a more syllable-timed rhythm after instruction, while Table 1 shows a fall in %V, which alludes to a more stressed-timed rhythm. On the contrary, control students increased their %V mean in sentence ten, while their VarcoV mean decreased.

On the other hand, when comparing the average of all the sentences, it is shown that the experimental group decreased their %V values after treatment, whereas the control group increased them. Overall VarcoV means increased after treatment for both groups, although it increased more for the experimental group. Thus, both %V and VarcoV total means suggest that experimental students adopted a more stress-timed rhythm after treatment, while the control group followed a different trend depending on the metric used.

Several repeated-measures ANOVAS were further run to examine the improvement of the different groups. As shown in Table 2, an ANOVA was carried out with time and sentence and within-subjects factors and group as between-subjects factor to analyze the overall impact of treatment on each groups' performance.

Table 2. Mixed repeated-measures ANOVA with %V as the dependent variable

	Effect	df	Error df	*F*	*p*-value
	time	1	40	1.311	.259
Within-subjects	sentence	9	32	152.675	.792
Interaction	time*sentence	9	32	1.308	.252
Between-subjects	group	1	40	.175	.678

No statistical significance was found for time $F(1,40) = 1.311$, $p = .259$, sentence $F(9,32) = 152.675$, $p = .792$, nor group $F(1,40) = .175$, $p = .678$. The time*sentence interaction was not significant either $F(9,32) = 1.308$, $p = .252$. Nonetheless, Figure 1 shows that the %V mean of the experimental group decreased (orange line). Conversely, the control groups' remained almost stable (blue line), following an upward trend.

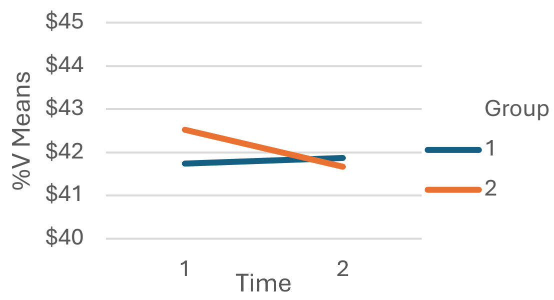

Figure 1. %V progress after treatment

These results do not fully correlate with previous findings of VarcoV measurements; although results did also show an improvement for the experimental group after treatment while the control group came to a standstill, the sentence factor showed significance [30, 31, 32, 33].
The importance of the difference in production before and after training was also examined. To this end, another ANOVA was performed, this time with the difference in %V values before and after treatment for each sentence as the dependent variable, sentence as the within-subjects factor, and group as the between-subjects factor. As shown in Table 3, again, results did not reach statistical significance for either sentence, $F(9,32) = 1.308$, $p = .252$, or group $F(1,40) = 2.420$, $p = .128$. VarcoV analysis did not revealed statistical significance for this condition either.

Table 3. Mixed repeated-measures ANOVA with %V difference over time as the dependent variable

	Effect	df	Error df	*F*	*p*-value
Within-subjects	sentence	9	32	1.308	.252
Between-subjects	group	1	40	2.420	.128

T-tests were further run to study the magnitude of the difference of students' performance after treatment. Two-paired samples t-tests (control T2 vs. control T1; experimental T2 vs. experimental T1) and two independent-samples t-tests (control T1 vs. experimental T1; control T2 vs. experimental T2) per sentence were calculated. Paired-sample t-tests only showed statistical significance for the experimental group in sentence eight $T(20) = -3.202$, $p = <.004$. As for independent-samples t-tests, there was statistical significance before instruction in sentence ten $T(40) = .364$, $p = <.026$, and after instruction in sentence eight $T(40) = -2.183$, $p = <.035$. T-tests conducted with VarcoV values only showed significance for the experimental group in sentence five [32]. However, some observations in the progress between groups could be made when examining the effect sizes of paired-sample t-tests with %V figures.

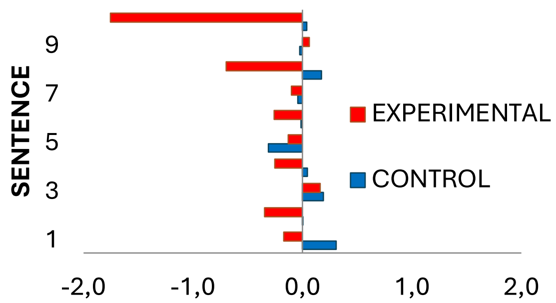

Figure 2. Effect sizes for %V paired-sample t-tests

As displayed in Figure 2, the size of the effect tends to be larger and negative for the experimental group, showing a decrease of %V values, while the control group shows small effects and generally positive. A further independent-sample t-test was performed with the effect sizes of paired-sample t-tests and, unlike VarcoV test, it did not showed significance $T(18) = -1.937$, $p = .079$.

Although the differences in results between %V and VarcoV values for the different tests conducted have been examined throughout the paper, Pearson product-moment coefficient tests were also conducted to further examine correlations between the results of both rhythmic measurements.

Table 4. %V – VarcoV Pearson product-moment correlation coeffcients

S	Group	T	*r*	*n*	*p*-value
		1	-.337	21	.135
	Control	2	-.182	21	.429
		1	-.543	21	.011*
1	Experimental	2	-.330	21	.145
		1	.112	21	.630
	Control	2	.275	21	.228
		1	.076	21	.743
2	Experimental	2	.001	21	.998
		1	-.023	21	.922
	Control	2	.231	21	.314
		1	.169	21	.464
3	Experimental	2	.249	21	.277
		1	.089	21	.702
	Control	2	-.049	21	.834
		1	.473	21	.030*
4	Experimental	2	.137	21	.554
		1	.281	21	.217
	Control	2	.476	21	.029*
		1	.319	21	.159
5	Experimental	2	.099	21	.668
		1	.453	21	.039*
	Control	2	.414	21	.062
		1	.014	21	.952
6	Experimental	2	.286	21	.209
		1	.166	21	.471
	Control	2	.337	21	.136
		1	.461	21	.035*
7	Experimental	2	-.249	21	.277
		1	-.067	21	.774
	Control	2	.079	21	.732
		1	-.116	21	.617
8	Experimental	2	-.319	21	.159
		1	-.147	21	.526
	Control	2	.154	21	.505
9	Experimental	1	.083	21	.721
		2	.052	21	.824
		1	.128	21	.580
	Control	2	1	21	.310
		1	-.194	21	.399
10	Experimental	2	.401	21	.072

Note. * p < .05. S = Sentence. T = Time.

As displayed in Table 4, correlation tests showed significance for the experimental group in sentences one, four and seven before treatment, and for the control group on sentences six before treatment and five after treatment. Thus, it seems that both time and sentence play a role and no clear and general correlation between the two measurements can be established.

5. DISCUSSION

The main aim of this paper was to investigate the extent to which receiving rhythm instruction help students adopt the more stress-timed rhythm of the English language. To this end, %V values were first examined (RQ 1). %V means decreased in more sentences for the experimental group than the control group after treatment (see Table 1). Additionally, the total mean also decreased for the experimental group, while the control group's increased. This suggests that rhythm instruction help students adopt the English rhythm more accurately when reading sentences aloud. These findings further support Tsiartioni's results, as students who received rhythm instruction also seemed to incorporate English rhythm more accurately in the L2 [15]. However, no statistical significance was found for the different ANOVAS conducted, and a very limited number of t-tests were significant. Thus, although it appears to be a progress when explicit rhythm instruction is offered, there are no conclusive findings of the impact of its effect: On the one hand, the study suffered from several limitations that affected the size of the population (see the next section for a detailed discussion). On the other hand, even if there were researchers who considered %V to be a valid measure of rhythm, especially when L2 was examined [26, 27], it might be not such a strong indicator as other measurements, such as VarcoV.

For this reason, the paper also aimed at studying the correlation between VarcoV and %V values (RQ 2). Both VarcoV and %V means seemed to show a progress towards an adaptation of a more English-like rhythm for the experimental group, while the control group appeared to remain rather stable. However, results obtained with each measurement diverge. VarcoV analyses did show significance for the sentence factor when considering

VarcoV as the dependent variable, and for the effect sizes of the independent-samples t-test conducted with all the paired-samples t-tests [30, 31, 32, 33]. In addition, Pearson product-moment correlation where conducted between %V and VarcoV results and they showed statistical significance just for a few sentences. Hence, although %V results further support a tendency for improvement in rhythm adaptation when explicit training is received, these do not fully interrelate with previous findings with VarcoV values. Hence, results show inconsistency between the two measurements, supporting previous researchers who have questioned the reliability of rhythmic metrics [16, 17, 19]. However, more studies should be conducted testing both metrics to reach a more solid diagnose.

6. CONCLUSION

%V values were calculated to examine the effect of rhythm instruction in EFL students' production as an attempt to provide more acoustic evidence to previous findings. Although results revealed progress when explicit rhythm instruction was received, these did not fully correlate with results taken from VarcoV measurements, which seemed to provide stronger results. Although the reliability of rhythmic metrics appears to be again on spot, the lack of consistency in the results might not be due to a futility of the acoustic measurements, but to the small size of the population under analysis. Only forty-two students finished the treatment, which might not provide enough data for the metrics to show robust results. It must be borne in mind that this is a classroom-based study conducted with first-year undergraduate students at Spanish universities. On the one hand, attendance is not fully compulsory even if it is considered for continuous assessment: not all the students decide to take this type of evaluation, and those who do they have some leeway to decide the sessions they attend. On the other hand, there tends to be a high number of dropouts among first-year students, as they might change degrees or start working, so they stop coming to class. In addition, some students of this study did not reach that 90% of attendance to be considered subjects of the study due to other external factors (e.g., a sick leave). Hence, more subjects are needed to really see whether rhythmic metrics are reliable.

Nonetheless, using acoustic analysis to provide objective evidence as a complement to more subjective tools such as listener ratings can help us detect progress. Previous findings of this project did not reveal improvement in terms of comprehensibility and fluency. However, when the results obtained from acoustic measurements are considered, progress seems to be there, a least, to some extent. Perhaps treatment was not long enough to affect students' overall prosody, but its impact began to show at a control level. Hence, a longer treatment could offer stronger results. Observing improvement in L2 learning progress is not an easy task, and time, among other external factors, play a crucial role. Thus, more classroom-based experiments should be conducted to better understand which features should be taught, the instruments to use and the analysis to run.

7. FUNDING

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