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Investigating the cognitive and social aspects of IELTS speaking performances across proficiency levels: Comparing the CAF-based and register-linguistic analyses

Xun Yan and Shelley Staples

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Investigating the cognitive and social aspects of IELTS speaking performances across proficiency levels: Comparing the CAF-based and register-linguistic analyses

This study is the first to investigate the linguistic features in IELTS speaking performance in both CAF and register-linguistic approaches, as well as incorporating acoustic-pronunciation features. It examined these features on 280 benchmark performances from Band 5 to 8 on the IELTS speaking test, to identify meaningful linguistic correlates of IELTS speaking ability.

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Introduction

This study by Yan and Staples was conducted with support from the IELTS Partners (British Council, IDP: IELTS Australia and Cambridge University Press & Assessment), as part of the IELTS joint-funded research program. Research funded by the British Council and IDP: IELTS Australia under this program complement those conducted or commissioned by Cambridge University Press & Assessment, and together inform the ongoing validation and improvement of IELTS.

A significant body of research has been produced since the joint-funded research program started in 1995, with over 200 empirical studies receiving grant funding. After undergoing a process of peer review and revision, many of the studies have been published in academic journals, in several IELTS-focused volumes in the *Studies in Language Testing* series (http://www.cambridgeenglish.org/silt), and in the *IELTS Research Reports* series. Since 2012, to facilitate timely access, the research reports have been published on the IELTS website immediately after completing the peer review and revision process.

Being able to identify the linguistic correlates of L2 speaking proficiency is of fundamental importance to understanding speaking ability as both a theoretical construct and as a practical enterprise. In contrast to previous research that often followed a single analytic approach, this study adopts a more comprehensive approach. It combines complexity, accuracy, and fluency-based (CAF) analysis, which focuses on the cognitive aspects of speech production, with register-linguistic analysis that delves into the social and functional aspects of spoken performance. Additionally, the study incorporates acoustic pronunciation features into its analysis.

This study offers a broader snapshot of observable performance differences among candidates at different score levels. Unlike a mono-methodological approach, it embraces the multi-componential and multi-dimensional nature of L2 speaking proficiency, moving away from solely psycholinguistic or sociolinguistic accounts. The research employs a corpus-based approach with 282 benchmark speech samples from IELTS candidates, ranging from Band 5 to Band 8 levels, representing Chinese, Punjabi, Arabic, and Hindi first language speakers.

The findings of this study provide an interesting, if fleeting, insight into the nature of proficiency across IELTS score bands. While some of these findings would seem intuitively true – such as the fact morphological error negatively correlates with proficiency – the researchers deserve credit for breaking down the corpus data into meaningful categories. Many of these categorisations suggest some correlation to proficiency as measured by the IELTS test and what it elicits. In the immediate term this research provides a much needed glimpse of the factors which may differentiate performance levels while also aiding rater training and scale development. It also provides a practical template for similar corpus-based validation activities.

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Investigating the cognitive and social aspects of IELTS speaking performances across proficiency levels: Comparing the CAF-based and register-linguistic analyses

Abstract

Identifying linguistic correlates of speaking ability is an important domain of research in second language (L2) speaking assessment, which contributes to the understanding of speaking ability as a theoretical construct.

The standard practice of linguistic analysis in validation research starts with quantifying an array of linguistic features of test performances, followed by dimension reduction techniques to identify underlying dimensions of speaking ability. However, existing research varies considerably in the selection of linguistic features, falling largely under one of three approaches, namely, (1) the CAF-based approach which operationalises speaking ability through form-focused features; (2) the register-linguistic approach which explores lexico-grammatical features in relation to linguistic functions; and (3) acoustic-pronunciation features related to speech intelligibility and comprehensibility.

While there is a large body of literature in each strand, fewer studies have combined features from all three strands.

The present study examined a wide range of linguistic features selected from all three approaches on 280 benchmark performances from Band 5 to 8 on the IELTS speaking test, to identify meaningful linguistic correlates of IELTS speaking ability.

Descriptive statistics and correlational analyses revealed a number of linguistic features in each category that correlate significantly with IELTS band scores. Findings of this study reflect the different subconstructs of speaking ability and provide validity evidence for the IELTS speaking test.

Authors' biodata

Xun Yan

Xun Yan is Associate Professor of Linguistics, Second Language Acquisition and Teacher Education, and Educational Psychology at the University of Illinois at Urbana-Champaign. He is a faculty member in the Beckman Institute for Advanced Science and Technology. His research interests include speaking and writing assessment, psycholinguistic approaches to language testing, and language assessment literacy. His work has been published in applied linguistics journals such as *Language Testing, TESOL Quarterly, Assessing Writing, System*, and the *Journal of Second Language Writing*.

Shelley Staples

Shelley Staples is Associate Professor of English and Second Language Acquisition and Teaching at University of Arizona. Her work focuses on corpus-based analyses of spoken and written corpora, for applications to language teaching, language testing, and to understand language development across situations of use (registers). Her publications can be found in *Applied Linguistics, TESOL Quarterly, Language Testing, Modern Language Journal*, and *English for Specific Purposes*, along with other applied linguistics journals.

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1. Introduction

The project examined the relationships among an array of performance features and holistic band levels of speaking proficiency. The performance features investigated in this study largely correspond to the four rating criteria used to score IELTS speaking performances and are features that have been found to characterise spoken discourse and advanced L2 speaking proficiency (e.g., Biber, 1988; 2006; Biber, Gray, & Staples, 2016; Jamieson & Poonpon, 2013; Kang, 2013; LaFlair, Staples, & Egbert, 2015).

Specifically, this project will examine speaking performance features in two approaches: complexity, accuracy, fluency-based (CAF-based) and register-linguistic analyses (Biber, 1988; Biber et al., 2016). While CAF-based analysis follows a more cognitively-oriented framework, register-linguistic analysis explicates language performance from more social and functional perspectives.

2. Theoretical framework and background

2.1. Socio-cognitive framework for test validation

This project is situated within the socio-cognitive framework for test development and validation (O'Sullivan & Weir, 2011; Weir, 2005). The validation framework contains five key components (i.e., cognitive validity, context validity, scoring validity, criterion-related validity, and consequential validity) and stresses the interaction among different types of validity evidence in building a coherent validity argument for language tests. This project will examine performance features on the IELTS speaking test from both cognitive and social perspectives, providing evidence of the cognitive, context, and scoring validity of the test. Specifically, an array of complexity, accuracy, and fluency (CAF) features will be examined to represent speech production under cognitive frameworks, e.g., the Cognition Hypothesis (Robinson, 2001) and the Trade-off Hypothesis (Skehan, 1998). The social aspects of speaking performance will be examined through register-based linguistic analysis of lexico-grammatical features (Biber, 1988; Biber et al., 2016). This analysis will explicate speaking performance from a more socially and functionally oriented perspective, thus providing evidence of the context validity of the test. While both approaches provide evidence of scoring validity for the IELTS speaking test, the comparison of the effectiveness of these two approaches will shed light on the interactions among these different types of validity evidence and contribute to a coherent validity argument for the test.

2.2. L2 speech production under cognitive frameworks: Complexity, accuracy, and fluency features

The construct of L2 performance and proficiency has long been recognised as multi-componential and multi-dimensional. A cognitive perspective operationalises proficiency as comprising three principal components: complexity, accuracy, and fluency (Ellis, 2008; Ellis & Barkhuizen 2005; Skehan, 1998). As such, CAF features have been widely used to characterise test performances and test-taker proficiency levels in both L2 speaking and writing assessments (Housen & Kuiken, 2009). The CAF framework is most notably tied to the cognitive perspective through the Cognition Hypothesis (Robinson, 2001) and the Trade-off Hypothesis (Skehan, 1998). Under both hypotheses, manipulation of task design is assumed to lead to greater cognitive complexity, which in turn has been associated with greater grammatical complexity, operationalised in terms of holistic T-unit measures for writing and C- or AS-unit measures for speech.

In Skehan's model, there is a trade-off between complexity, accuracy, and fluency due to constraints on performance, while in Robinson's model, task complexity can lead to increases in all three areas. In terms of lexical complexity, the most commonly included feature in the CAF framework is type-token ratio. Accuracy is generally operationalised as type and frequency of errors (e.g., percentage of error-free T-units, frequency of errors, types of errors) while fluency in the CAF approach has most often been examined at the macro level, measuring and correlating temporal features with other linguistic features or overall language proficiency. Although most validation studies from both perspectives have only included macro-level fluency features, micro-level fluency features that focus more on disfluencies (the cognitive processes of pausing and recovery) have been shown to be related to general language proficiency, reflecting speakers' automaticity in accessing lexico-grammatical resources while maintaining the flow of speech (see, e.g., Clark & Fox Tree, 2002; Corley & Stewart, 2008; Dornyei & Kormos, 1998).

2.3. Register-linguistic features of spoken discourse

Different from the CAF perspective, the register-linguistic perspective takes a functional approach to language use, and is based on sociolinguistic principles (e.g., Hymes, 1974; Biber & Conrad, 2019; Biber et al., 2022). Under this framework, a register is a situation of language use. Linguistic features vary according to contextual factors, such as setting, mode, topic, communicative purpose, and proficiency level, and can be interpreted functionally. Register-linguistic features of speaking performances were initially investigated mostly to highlight differences between spoken and written discourse. The foundation of this research is the work of Biber (1988; 2006) and his colleagues (e.g., Biber, Gray & Poonpon, 2011), who argue that complexity of spoken discourse is represented by clausal subordination, rather than phrasal features (e.g., attributive adjectives). Biber, Gray and Staples (2016) used this approach to investigate spoken and written performances on the TOEFL iBT and found different patterns of development based on both mode and task type (integrated or independent). This approach varies dramatically from the T-unit based measures found in CAF-based studies.

The register-linguistic approach not only examines the complexity of spoken discourse but also highlights its functional aspects. First, taking the clausal complexity features mentioned above (e.g., finite adverbial clauses, relative clauses), these have been found to differ depending on their function in spoken discourse. For example, studies of spoken language have shown that finite adverbial clauses expressing causation are used more at lower levels of proficiency (Biber et al., 2016; Thirakunkovit et al., 2019). This particular structure was highlighted by Biber et al. (2011) as "Stage 1" of development, and is used for creation of arguments but at a less sophisticated level when compared with other structures (i.e., verb complement clauses, relative clauses). On the other hand, relative clauses have been found to increase with proficiency level across oral texts (Thirakunkovit et al., 2019), as they allow speakers to incorporate more extended discussion of information (i.e., they elaborate the noun phrase). In addition, pragmatic skills such as expression of stance are known to be important aspects of spoken interactions and may vary across spoken registers (Biber, 1988; Biber, 2006; Staples & Biber, 2014). Using a register-based linguistic framework, LaFlair, Staples and Egbert (2015) showed that higher scoring test-takers on the MELAB speaking task used more stance features such as certainty and likelihood adverbs (*definitely, possibly, maybe*) and mental verbs (e.g., *think*) in their Oral Proficiency Interviews. On the other hand, Yan and Staples (2016) found that overt stance expressions such as mental verbs (e.g., *think*) were characteristic of lower-scoring argumentative essays. These differences reflect in part the relatively higher interpersonal functions found in speech, even within assessment contexts. Stance in academic writing is expected to be less overt and more nuanced, due to the need to appear objective.

2.4. Acoustic-pronunciation features relevant to spoken proficiency

Although L2 pronunciation constitutes an important domain of research in applied linguistics, the incorporation of acoustic-pronunciation features and constructs of comprehensibility, intelligibility, and accentedness in language testing research is relatively sparse. Previous L2 pronunciation research shows that perceptions of comprehensibility and accentedness are closely associated with speaker's fluency (e.g., Derwing, Rossiter, Munro & Thomson, 2004; Trofimovich & Isaacs, 2012) and complexity (e.g., Saito, Trofimovich & Isaacs, 2015). Pronunciation features were also found to significantly discriminate IELTS score levels in Isaacs, Trofimovich, Yu and Chereau (2015). In addition, Kang and Moran (2014) made a distinction between errors on high and low functional-load sounds and found that errors related to the former were more discriminating across learners of different proficiency levels. Therefore, we argue that micro-level fluency features and pronunciation features should be included as part of the validation process for speaking assessment.

There have been several studies that examined linguistic features of IELTS speaking performances in the domains of cohesion and coherence (Iwashita & Vasquez, 2015), lexical resources (Read & Nation, 2006), pronunciation (Isaacs et al., 2015), and discourse organisation (Seedhouse & Harris, 2011). Instead of examining an individual domain, Brown (2006) operationalised all four rating criteria for the IELTS speaking test in a wider range of CAF-based features, in order to identify individual linguistic features that best distinguish speaking performances across proficiency levels. However, to our knowledge, a register-linguistic approach to analysing language performance has not been applied on IELTS speaking performances to explore its ability to distinguish speaking performances across IELTS proficiency levels. This study will represent the first endeavour to investigate the linguistic features in IELTS speaking performance in both CAF and register-linguistic approaches. In addition, this study will incorporate acoustic-pronunciation features in the linguistic analysis of IELTS speaking performances.

3. Research design and method

Using a mixed-methods approach, this project aims to achieve three goals: (1) to identify salient CAF features that distinguish IELTS speaking performance across proficiency levels; (2) to identify salient register-linguistic features that distinguish speaking performances across proficiency levels; and (3) to identify salient acoustic-pronunciation features that distinguish speaking performances across proficiency levels.

3.1. Research questions

Specifically, this project seeks to address the following three research questions.

1. **What CAF-based features tend to distinguish test-taker performances at different band levels on the IELTS speaking test?**
2. **What register-linguistic based features tend to distinguish test-taker performances on the IELTS speaking test?**
3. **What pronunciation-acoustic features tend to distinguish test-taker performances on the IELTS speaking test?**

3.2. Corpus

The spoken corpus used for this study comprises 282 benchmark speech samples drawn from responses to the Long Run (Part II) task on the IELTS speaking test. Table 1 shows the specific breakdown of speakers across band levels. As can be seen, the data is mostly evenly spread across the four bands. Each speech sample was edited to include only the test-taker speech. In addition, we used only the initial response of the test-taker (i.e., when the examiner started to ask any follow up questions, we treated this as a shift to the next section of the exam and omitted that speech from our analysis). Trained transcribers segmented the audio file into speech and silence (using Praat), then adjusted pause boundaries as necessary and transcribed speech orthographically (using ELAN).

Table 1: *Corpus used for the study*

Level	L1 background	Gender	Total number of words	Mean length of interaction (words)
Band 5 (71 files)	Chinese (23) Punjabi (22) Arabic (26)	Female (24) Male (21) Unknown (26)	16,774	236.25
Band 6 (72 files)	Chinese (22) Punjabi (23) Hindi (1) Arabic (26)	Female (35) Male (11) Unknown (26)	20,329	282.35
Band 7 (74 files)	Chinese (24) Punjabi (24) Arabic (25)	Female (27) Male (21) Unknown (25)	23,118	312.41
Band 8 (65 files)	Chinese (18) Punjabi (20) Hindi (2) Arabic (25)	Female (24) Male (16) Unknown (25)	21,118	324.89

3.3. Data analysis

3.3.1 Linguistic analysis

Variables included in this study were divided roughly into three categories: register-linguistic features, CAF measures, and fluency and pronunciation features, which fell into both categories. Table 2 summarises the dependent variables included in the study.

3.3.1.1 CAF-based features

CAF features included a range of distinguishing features identified in previous research. In terms of complexity, syntactic complexity was operationalised in terms of commonly used AS-unit measures. These measures include: number of AS-unit (Foster et al., 2000). Lexical complexity was operationalised as type-token ratio. In terms of lexical appropriateness and grammatical accuracy, errors were identified in the domains of syntax, morphology, and lexicon. The frequency of errors were transformed into normalised frequencies of errors per type.

Fluency features included both rate and pausing features. Macro-level rate and pausing features of each speech sample (i.e., speech rate, articulation rate, number of silent pauses) were extracted using the combination of the mark-pause Praat script by Mietta Lennes (http://www.helsinki.fi/~lennes/praat-scripts/) and the "qdap" R package, a transcription-based syllable counter (https://www.rdocumentation.org/packages/qdap/versions/2.4.3). In addition, several micro-level pausing features were either manually coded or extracted directly from ELAN, which include (1) pause type (i.e., silent vs. filled pause); (2) pause duration; and (3) pause recovery (i.e., repetition and reformulation).

3.3.1.2 Register-linguistic features

Register-linguistic features were determined based on previous research on spoken corpora (e.g., Biber, 1988; Biber, 2006), as well as analysis of assessment-specific corpora (e.g., Biber et al., 2016; LaFlair et al., 2015; Thirakunkovit et al., 2019). These features fall roughly into three categories: clausal complexity features (e.g., finite adverbial clauses and relative clauses); phrasal complexity features (e.g., pre-modifying nouns, attributive adjectives); and stance features (e.g., modals, personal pronouns).

These features were identified using the Biber tagger and TagCount (Biber, 1988; Biber, 2006). The Biber tagger automatically identifies linguistic features, including those listed in Table 2. First, fixtagging scripts developed by Author 2 were run to improve the accuracy of tags using known issues with the tagger. Next, a 10% subset of the data was examined for accuracy (focusing on precision and recall). This led to several modifications to the text files (e.g., removing false starts and hesitation markers for this part of the analysis), which improved the accuracy of most of the features of interest to > 90%. However, further remediation was needed for verb complement clauses, and thus files were manually fixtagged to ensure accuracy of this feature.

3.3.1.3 Acoustic-pronunciation features

Pronunciation features were analysed manually with Praat. Two prosodic features that have been found to show meaningful differences across score levels from previous research were included in the analysis: tone choice (level, falling, or rising), and prominence (stressed syllables). Tone choice was manually coded by two coders, using the theoretical framework provided by Brazil (1987) and coding procedures established in Staples (2015). Two coders coded 10% of the data, and were able to reach a kappa of .77, which was deemed acceptable for proceeding with the analysis. The rest of the data was coded separately by one of the two coders. Prominence was similarly coded by two coders, and accuracy evaluated on 10% of the data. Intraclass correlation coefficients were used to establish accuracy of prominence. The two-way mixed, single measures reached an ICC of .83, which was deemed acceptable for proceeding with the analysis. The rest of the data was coded separately by one of the two coders.

In terms of pronunciation errors, we also manually identified pronunciation errors associated with high functional-load vowels, initial consonants, and final consonants. Upon identification of the errors, we transformed them into normalised frequencies.

Table 2: *Dependent variables included in the study*

Variable	Description/Example
CAF features	
Complexity	Type-token ratio, number/mean length of AS-unit
Accuracy	Number of morphological/syntactic/lexical errors
Fluency	Speech, articulation rate, mean length of run, number/duration of pauses, number of repair
Register-linguistic features: clausal complexity	
Finite adverbial clauses–causative	e.g., The source on internet are not that reliable **because** anybody can post on internet
Finite relative clauses–that	e.g., The first country **that** I really wanted to go to was Spain
Verb complement clauses–that	e.g., I think **that** it is a great experience to live there.
Verb complement clauses–to	e.g., Before I joined college I want **to** study economic
Register-linguistic features: phrasal complexity	
Attributive adjectives	e.g., **good** friend
Premodifying nouns	e.g., **graduation** ceremony
Register-linguistic features: stance	
First person pronouns	I, me, my, we, our, ours
Second person pronouns	You, your, yours
Modals–all	e.g., can, could, would, should
Stance adverbials–certainty	e.g., certainly, definitely
Stance adverbials–likelihood	e.g., maybe, possibly
Mental verbs	e.g., know, think, believe
Acoustic-pronunciation features	
Prominence (space)	Proportion of prominent words to total number of words. Prominence was determined manually, by two coders, using pitch height, length, and volume to identify prominent syllables.
Tone choice (level, falling, rising)	Proportion of each of the three tone choices. Tone choice is operationationalised as the pitch movement from the final prominent syllable in a tone unit to the end of the tone unit. Tone units were operationalised as runs for the purposes of this study. Tone choice was determined manually, by two coders.
Pronunciation errors	Number of high functional load errors – vowel, initial consonant, final consonant

3.3.2 Data analysis

Upon the identification of the linguistic features described above, frequencies for each performance feature were calculated for each speech sample. Descriptive statistics of individual performance features were examined. To address RQ 1, frequencies of all CAF features were subject to correlation analyses with IELTS band scores. To address RQ 2, frequencies of all register-linguistic features were subjected to correlation analysis with IELTS band scores. Similarly, to answer RQ 3, we correlated acoustic pronunciation features with IELTS band scores.

4. Results

4.1. CAF features

Table 3 shows the descriptive statistics by IELTS score level on the CAF-based features. In terms of complexity, there is an increasing trend in type-token ratio with proficiency level. In addition, test-takers with higher scores (Level 7 and 8) tend to produce more AS units.

With respect to accuracy, there is a gradually decreasing trend in normalised frequencies of syntactic, morphological, and lexical errors as proficiency level increases. However, the trend for morphological errors is more pronounced than syntactic and lexical errors.

For fluency features, the majority of features presented an expected trend with proficiency. That is, as proficiency level increases, test-takers tend to be able to produce speech at a fast rate, with fewer and shorter pauses and fewer repairs. Among these features, speech rate, mean length of run, and mean duration of pauses showed stronger associations with proficiency level.

Correlations between individual features and IELTS band scores corroborate with the descriptive statistics (see Table 4), suggesting the following most meaningful linguistic correlates with IELTS speak scores in this category: speech rate (.67), mean length of run (.40), mean length of pause (-.44), type-token ratio (.54), normalised morphological error (-.51). Figures 1 to 5 present the means plots for the meaningful correlations across IELTS band score levels. With the exception of mean pause length, all other features, i.e., type-token ratio, speech rate, mean length of run, and normalised morphological errors showed linear increasing or decreasing trends with IELTS band scores. In the case of pause length, although it is clear that higher scoring test-takers have shorter pauses, the decreasing trend is not linear.

Table 3: *Descriptive statistics for CAF-based features by score level*

Variable	Level 5 (N = 71) M (SD) 95% CIs	Level 6 (N = 71) M (SD) 95% CIs	Level 7 (N = 74) M (SD) 95% CIs	Level 8 (N = 65) M (SD) 95% CIs
Complexity				
Number of AS_unit	15.89 (5.51)	18.41 (5.64)	21.88 (7)	21 (5.82)
	(15.89, 5.51)	(17.1, 19.72)	(20.31, 23.45)	(19.22, 22.78)
Type-token ratio	19.45 (3.96) (18.51, 20.39)	22.26 (2.40) (21.69, 22.83)	23.79 (2.13) (23.29, 24.28)	24.43 (2.80) (23.74, 25.13)
Accuracy				
Syntactic errors	4.14 (2.98)	4.18 (3.15)	4.01 (2.85)	2.88 (2.35)
	(4.14, 2.98)	(3.45, 4.92)	(3.37, 4.65)	(2.16, 3.6)
Morphological errors	12.6 (6.8)	10.69 (6.36)	8.32 (5.94)	4.85 (3.74)
	(12.6, 6.8)	(9.21, 12.17)	(6.98, 9.65)	(3.71, 6)
Lexical errors	2.16 (2)	1.79 (1.48)	1.24 (1.21)	0.83 (0.9)
	(2.16, 2)	(1.44, 2.13)	(0.97, 1.52)	(0.55, 1.1)
Fluency				
Speech rate	2.6 (0.59)	3.14 (0.72)	3.41 (0.49)	3.68 (0.63)
	(1.44, 2.74)	(1.73, 3.3)	(2.45, 3.52)	(2.45, 3.83)
Articulation rate	3.43 (0.57)	3.95 (0.81)	4.14 (0.49)	4.4 (0.53)
	(2.32, 3.57)	(2.35, 4.14)	(3.18, 4.25)	(3.37, 4.53)
Mean length of run	8.06 (3.96)	9.5 (4.03)	10.75 (3.35)	12.94 (4.87)
	(0.3, 8.98)	(1.6, 10.44)	(4.19, 11.52)	(3.39, 14.12)

Number of filled pauses	31.04 (19.52)	29.51 (16.11)	26.4 (11.77)	23.43 (13.09)
	(31.04, 19.52)	(25.74, 33.29)	(23.7, 29.1)	(19.37, 27.48)
Number of silent pauses	24.23 (8.76)	26.76 (11.47)	23.99 (8.36)	21.08 (10.48)
	(24.23, 8.76)	(24.09, 29.43)	(22.08, 25.89)	(17.83, 24.32)
Mean duration of silent pauses	0.71 (0.28)	0.58 (0.17)	0.53 (0.12)	0.55 (0.21)
	(0.15, 0.78)	(0.25, 0.62)	(0.29, 0.56)	(0.14, 0.6)
Number of repetitions	11.05 (7.33)	9.03 (7)	7.63 (5.25)	7.65 (8.52)
	(11.05, 7.33)	(7.39, 10.67)	(6.43, 8.84)	(5.01, 10.29)
Number of reformulations	8.11 (4.73)	7.57 (4.1)	7.44 (3.63)	6.75 (4.08)
	(8.11, 4.73)	(6.6, 8.53)	(6.61, 8.27)	(5.49, 8.01)

Table 4: *Correlations between score level and CAF variables*

Variable	Pearson's correlation with score level	P value
Complexity		
Type-token ratio	0.54	<.001
Accuracy		
Morphological errors	-0.51	<.001
Fluency		
Speech rate	0.67	<.001
Mean length of run	0.40	<.001
Mean duration of silent pauses	-0.44	<.001

Figure 1: *Means and 95% CIs for type-token ratio across IELTS level.*

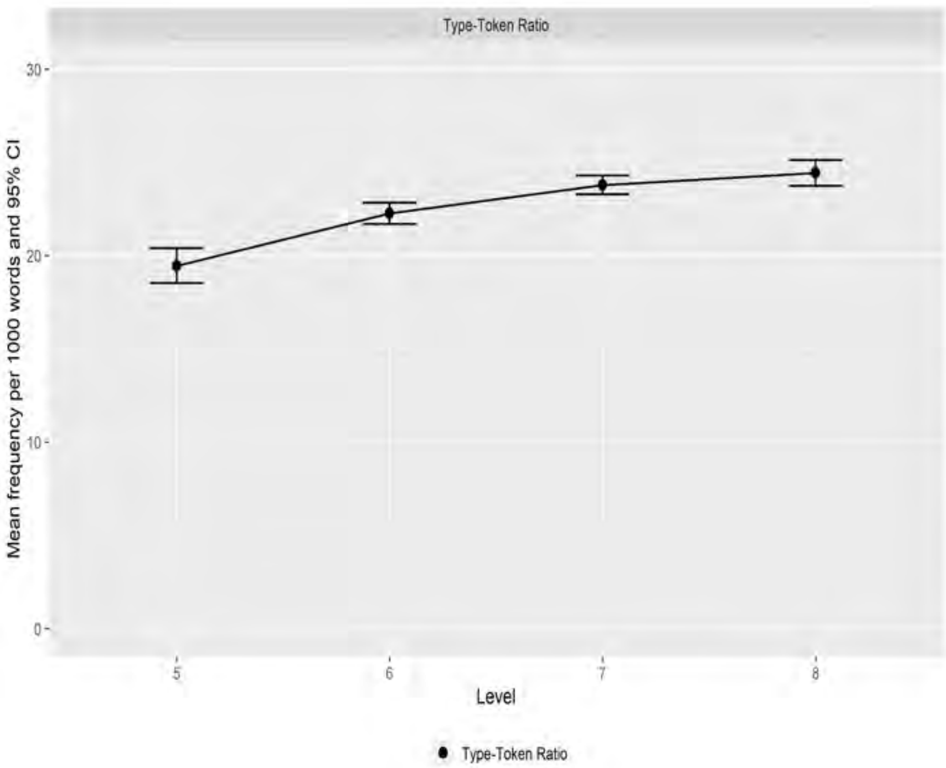


Figure 2: *Means and 95% CIs for speech rate across IELTS level*

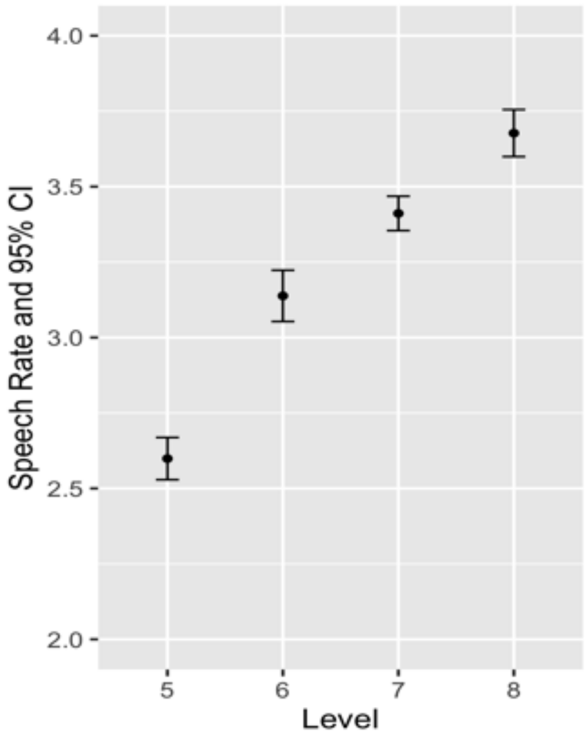


Figure 3: *Means and 95% CIs for mean pause length across IELTS level*

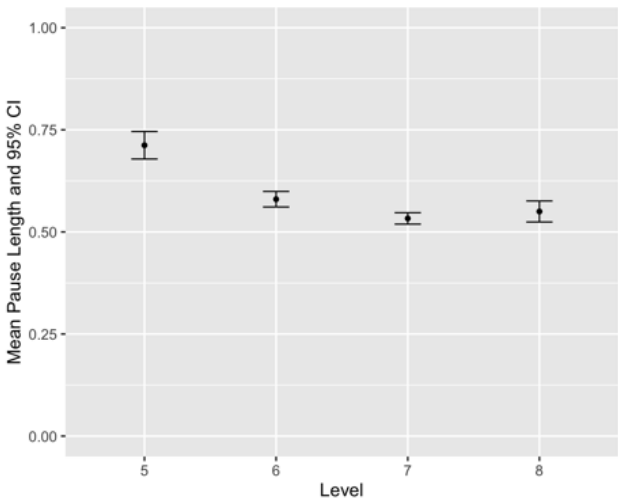


Figure 4: *Means and 95% CIs for mean length of run across IELTS level*

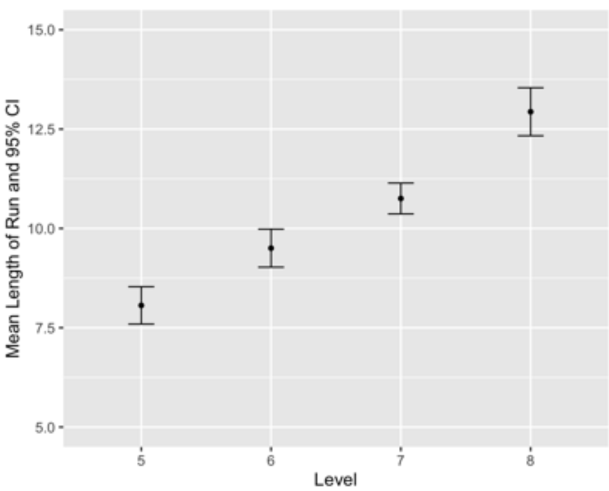
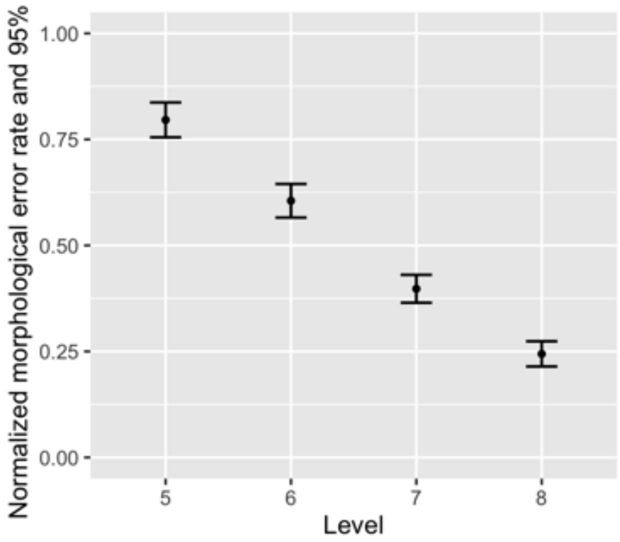


Figure 5: *Means and 95% CIs for normalised morphological error rate across IELTS level*



4.2. Register-linguistic features

Tables 5 and 6 below show the mean frequencies and correlations of each of the linguistic features across score level. As can be seen from Table 5, there were a number of differences across levels for clausal complexity features and stance features, but phrasal complexity features were used about the same across levels.

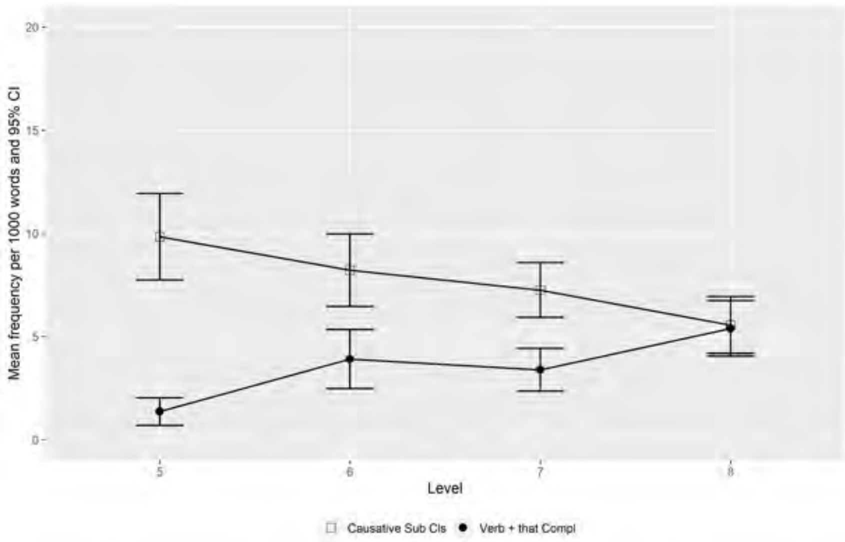
Table 5: *Descriptives of register-linguistic features by level*

Variable	Level 5 (N = 71) M (SD) 95% CIs	Level 6 (N = 71) M (SD) 95% CIs	Level 7 (N = 74) M (SD) 95% CIs	Level 8 (N = 65) M (SD) 95% CIs
Clausal complexity features				
Subordinate clauses–causative	9.83 (8.84)	8.21 (7.42)	7.24 (5.73)	5.55 (5.55)
	7.74–11.92	6.46–9.97	5.92–8.57	4.18–6.93
That relative clauses	3.06 (5.94)	5.34 (7.72)	5.49 (5.93)	6.05 (6.72)
	1.66–4.47	3.51–7.17	4.12–6.87	4.38–7.71
That verb compl clauses	1.36 (2.82)	3.90 (6.06)	3.39 (4.48)	5.38 (5.41)
	0.69–2.03	2.47–5.34	2.35–4.42	4.04–6.72
To verb compl clauses	12.21 (11.03)	8.70 (7.02)	9.47 (8.45)	8.74 (8.29)
	9.60–14.82	7.04–10.37	7.52–11.43	6.69–10.79
Phrasal complexity features				
Attributive adjectives	21.11 (14.68)	24.46 (15.73)	25.95 (14.27)	25.96 (14.62)
	17.63–24.58	20.74–28.18	22.65–29.26	22.34–29.58
Premodifying nouns	13.29 (10.74)	11.67 (9.28)	13.77 (9.07)	12.20 (7.94)
	10.75–15.83	9.50–13.85	11.67–15.87	10.23–14.17
Stance features				
First person pronouns	112.04 (49.37)	92.06 (34.04)	85.07 (34.10)	81.63 (33.88)
	100.35–123.72	84.00–100.12	77.17–92.97	73.23–90.02
Second person pronouns	6.11 (14.36)	6.20 (10.11)	8.51 (9.61)	13.04 (13.86)
	2.71–9.51	3.80–8.59	6.29–10.74	9.61–16.48
All modal verbs	17.17 (15.31)	16.31 (12.58)	17.71 (12.33)	18.09 (13.39)
	13.54–20.79	13.33–19.29	14.85–20.57	14.77–21.40
Stance adverbials–certainty	5.49 (9.48)	7.79 (9.17)	11.19 (10.47)	12.72 (10.31)
	3.24–7.73	5.62–9.96	8.77–13.62	10.16–15.27

Stance adverbials–likelihood	1.69 (4.11)	2.07 (4.18)	1.82 (3.81)	1.52 (3.20)
	0.72–2.67	1.08–3.06	0.94–2.70	0.72–2.31
Mental verbs	45.38 (27.51)	35.81 (19.31)	41.92 (20.66)	39.95
	38.87–51.90	31.24–40.38	37.13–46.71	35.56–44.34

Figure 6 shows the means and 95% CIs for the clausal complexity features that showed non-overlapping CIs (finite adverbial clauses-causatives and verb + that complement clauses). These two features showed different patterns: causative finite adverbials decreased across score level and finite verb complement clauses increased across score level.

Figure 6: *Means and 95% CIs for clausal variables across IELTS level*



Figures 7 and 8 show the stance features across score level (note the different scales for frequency of occurrence). As can be seen, second-person pronouns and certainty adverbials increase with score level while first-person pronouns decrease.

Figure 7: *Means and 95% CIs for second-person pronouns and certainty adverbials across IELTS level*

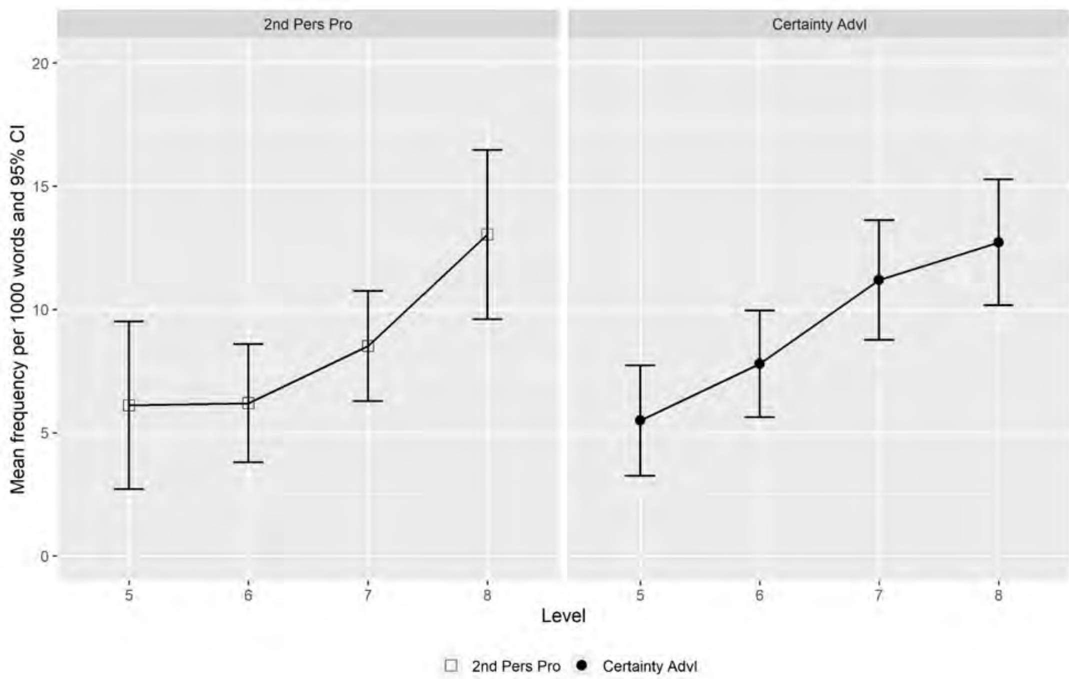
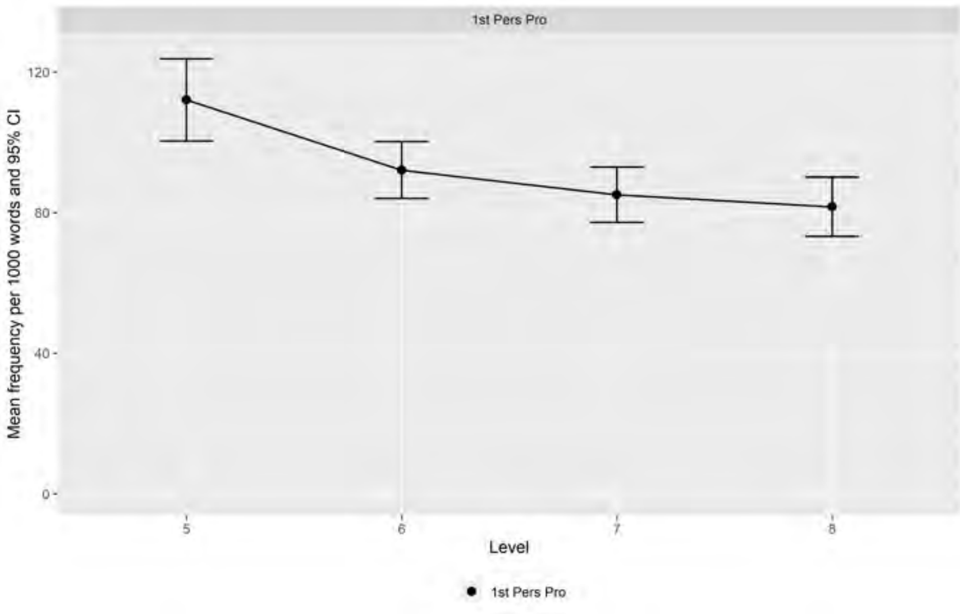


Figure 8: *Means and 95% CIs for first-person pronouns across IELTS level*



The descriptive findings are bolstered by the correlation results. As can be seen, all of the variables that showed meaningful differences across score levels show meaningful relationships with score level as well. In addition, we can see that relative clauses and attributive adjectives show significant positive relationships with score level and to verb complements show a significant negative relationship with score level.

Table 6: *Correlations between score level and register-linguistic variables*

Variable	Pearson's correlation with score level	P value
Clausal complexity features		
Subordinate clauses–causative	-0.22	<.001
That relative clauses	0.15	.02
That verb compl clauses	0.22	<.001
To verb compl clauses	-0.12	.04
Phrasal complexity features		
Attributive adjectives	0.12	.05
Premodifying nouns	-0.02	.79
Stance features		
First-person pronouns	-0.27	<.001
Second-person pronouns	0.20	.001
All modal verbs	0.03	.59
Stance adverbials–certainty	0.27	<.001
Stance adverbials–likelihood	-0.02	.68
Mental verbs	-0.06	.35

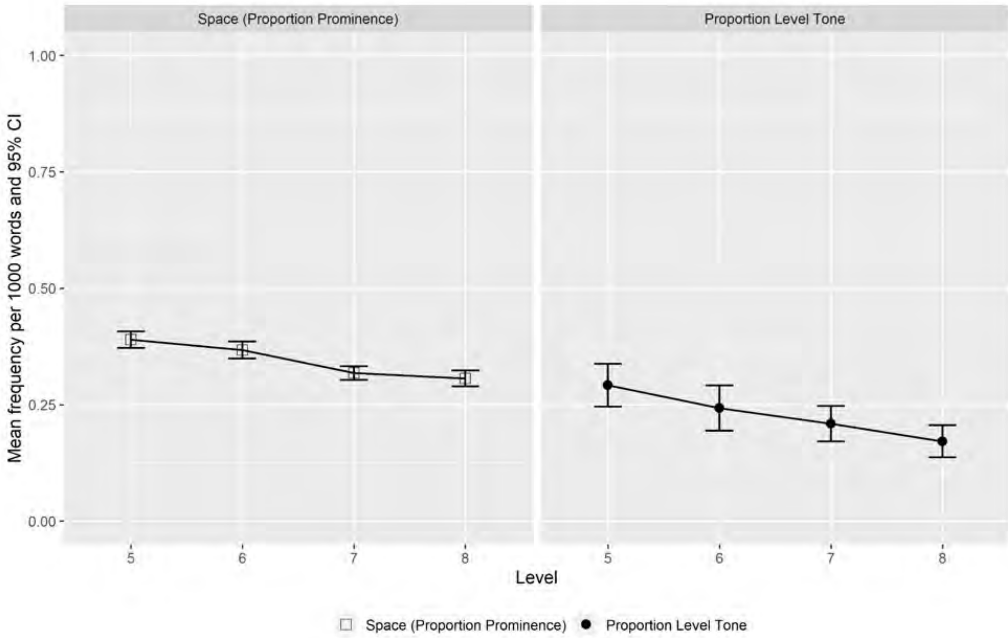
4.3. Acoustic-pronunciation features

As Table 7 shows, there was a steady decrease in both proportion of prominent words and level tone. Proportion of falling tone, conversely, rose as score level rose.
Figure 9 shows the proportions that represent non-overlapping CIs for at least two levels.

Table 7: *Descriptive statistics of prosodic features by score level*

Variable	Level 5 (N = 70) M (SD) 95% CIs	Level 6 (N = 71) M (SD) 95% CIs	Level 7 (N = 73) M (SD) 95% CIs	Level 8 (N = 65) M (SD) 95% CIs
Space (proportion prominent words to total words)	.39 (.07)	.37 (.08)	.32 (.06)	.31 (.07)
	.37–.41	.35–.38	.30–.33	.29–.32
Proportion rising tone	.31 (.22)	.35 (.24)	.32 (.21)	.34 (.21)
	.26–.36	.29–.40	.78–.37	.28–.39
Proportion falling tone	.40 (.21)	.41 (.21)	.47 (.23)	.49 (.21)
	.35–.45	.36–.46	.41–.52	.44–.54
Proportion level tone	.29 (.19)	.24 (.21)	.21 (.16)	.17 (.14)
	.25–.34	.19–.29	.17–.25	.14–.21

Figure 9: *Space and level tone across score levels*



The descriptive findings are bolstered by the correlation results. As can be seen, all of the variables that showed meaningful differences across score levels show meaningful relationships with score level as well, with space showing a particularly strong negative relationship with score level.

In addition to prosodic features, we also examined pronunciation errors that are related to high-functional load sounds and divided these errors into three types, namely, vowel, initial consonant, and final consonant errors. As Table 8 shows, we noticed that there is a meaningful trend with proficiency in the vowel errors but not so much for consonants. The correlations also aligned with the descriptives, suggesting that high functional-load vowel errors have a meaningful, negative correlation with proficiency level (r = -.43). Figure 10 presents the means plot for this feature across proficiency levels.

Table 8: *Pronunciation errors by score level*

Variable	Level 5 (N = 70) M (SD) 95% CIs	Level 6 (N = 71) M (SD) 95% CIs	Level 7 (N = 73) M (SD) 95% CIs	Level 8 (N = 65) M (SD) 95% CIs
High functional-load vowel errors	1.82 (2.5) (1.82, 2.5)	2.16 (2.32) (1.62, 2.7)	1.01 (1.6) (0.65, 1.37)	0.7 (1.02) (0.38, 1.01)
High functional-load initial consonant errors	0.69 (1.99) (0.69, 1.99)	0.66 (1.25) (0.37, 0.95)	0.81 (1.86) (0.39, 1.23)	0.34 (0.8) (0.1, 0.59)
High functional-load final consonant errors	0.15 (0.43) (0.15, 0.43)	0.39 (1.17) (0.12, 0.67)	0.13 (0.82) (-0.05, 0.32)	0.09 (0.25) (0.01, 0.16)

Figure 10: *Normalised high functional-load vowel errors across score levels*

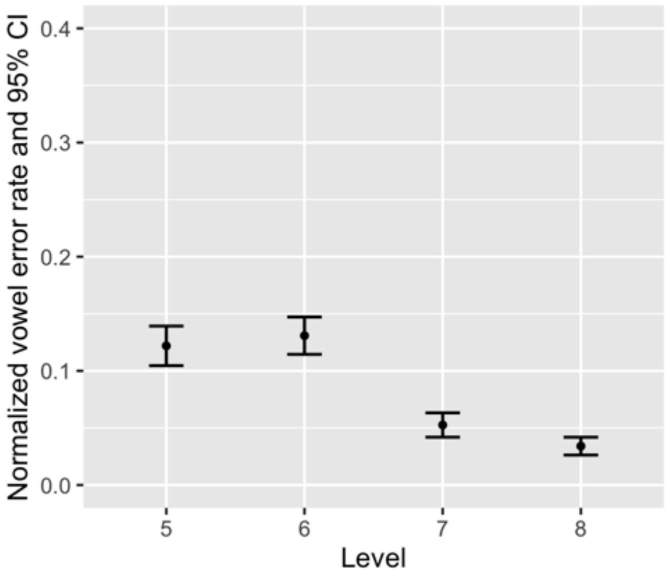


Table 9: *Correlations between score level and prosodic variables*

Variable	Pearson's correlation with score level	P value
Space (proportion prominent words to total words)	-0.42	<.001
Proportion rising tone	0.03	.60
Proportion falling tone	0.17	.004
Proportion level tone	-0.24	<.001
High functional-load vowel errors	-0.43	<.001

5. Discussion and conclusions

This study examines a wide range of CAF-based, register-linguistic, and acoustic-pronunciation features on the IELTS speaking test and their relationships with IELTS speaking scores. Findings of this study reveal a set of meaningful correlates with IELTS speaking ability in each of the three categories. As summarised in Table 10, these features correspond to the four scoring criteria for IELTS speaking test.

Under CAF features, whereas speech rate, mean length of run, and mean length of pause are related to fluency and coherence, type-token ratio and morphological errors are related to lexical resource and grammatical range and accuracy.

In terms of register-linguistic features, the meaningful features identified in the IELTS speaking data appear to be associated with the expression of stance and clausal complexity.

As to acoustic-pronunciation features, we also identified both segmental and suprasegmental features that are meaningful correlates with pronunciation.

Taken together, these findings provide supportive evidence for the construct and scoring validity of the IELTS speaking test.

Table 10: *Summary of meaningful linguistic correlates of IELTS speaking ability*

		Corresponding IELTS criteria	Meaningful features
1	CAF-based features	Fluency and coherence, Lexical resource, Grammatical range and accuracy	Speech rate, Mean length of run, Mean length of pause, Type-token ratio, Morphological error
2	Register-linguistic features	Lexical resource, Grammatical range and accuracy	Causative subordinate clause, Verb+that complement clause, First/second person pronouns, Stance adverbials
3	Acoustic-pronunciation features	Pronunciation	High functional load vowel error, Space, Level tone

The findings of this study also stand to have meaningful implications for quality control of the IELTS speaking test. The discriminating CAF features can help characterise speech production by test-takers at different proficiency levels; these characteristics can help raters identify test-taker proficiency level more efficiently. Thus, these features can also assist in rater training and calibration, scale development and validation, as well as other quality control procedures related to the scoring process of the IELTS speaking test.

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