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Distinctive Features and Digital Filtration System (DFS)

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Abstract

This study aimed to evaluate the potential of DFS to help identify distinctive sound features easily and quickly. Through 20 participants in a between-group format, ten of whom were placed into each group, the researcher wanted to answer the main question of the study: How effective is using DFS to identify distinctive sound features? The participants in the study were tasked with identifying sounds through their distinctive features using either the paper-assisted matrix or the Excel filter matrix. The results show how the Excel filtering cohort outperformed the paper-based matrix one in accuracy and speediness. Group one using the Excel filtration performed perfectly with 100% accuracy in comparison to group two, which used a matrix on a piece of paper and gave accuracy that fluctuated between 40% and 80%. The group employing Excel filtration had better response time, with speed scores ranging between 0.4 min and 0.15 min compared with the paper-based matrix that demonstrated speed scores ranging from 1 to 3 min. The results showed that significant differences existed among the medians of accuracy ($p < 0.05$) and speed ($p < 0.05$) between the two studied groups. It thus proved to be a better approach because of its increased precision and faster reactive speed compared to the paper-based matrix, which was used for this test.

Keywords: DFS, distinctive sounds, matrix, Wilcoxon signed-rank test

1. Introduction

Two fundamental branches of linguistics – phonetics and phonology – deal with how the sounds of a language have evolved in relation to each other (Chomsky & Halle, 1968). Phonetics looks at the features with respect to articulation, acoustic traits, and hearing of speech sounds. However, in contrast, phonology involves the analysis of the theoretical frameworks and rules that guide speech in every particular language. For many years, the multifaceted and complicated interaction between phonetics and phonology has constituted an area of argument and study in the sphere of linguistics (Stevens, 1989). The Distinctive Features Matrix was developed by Roman Jakobson and Morris Halle in 1952 and it has been a popular tool in examining sound systems and pointing out their unique features. The process of picking essential data out of the matrix is challenging and within the scope of perceivable systems. DFS is another method put forward by the researcher for the filtration of distinctive sound features, which focuses on the necessary features needed for analysis. It is a methodology that uses Excel filters and slicers. The DFS introduces a new approach to analyzing phonetic systems with the aim of enhancing our understanding of the relations between phonetics and phonology. The present research investigates the efficacy of the DFS as a tool for facilitating the analysis of phonological and phonetic data. The text endeavors to address three inquiries:

(1) What precisely is the DFS, and what are its operational mechanisms?

(2) What are the potential advantages of using the Discrete Fourier Transform (DFS) in the analysis of phonological and phonetic data?

(3) In what ways can the DFS (Document Frequency Score) be utilized in practical applications to facilitate the examination of linguistic data?

Phonology and phonetics play the most significant role in the proper understanding of the sound structure of languages. The DFS tackled in this study offers a new approach to the study of phonological systems, simplifying the process of analysis and focusing on relevant data. The aim of this study is to take a step towards developing new ways in which sound systems can be investigated and contribute to an understanding of the link between phonology and phonetics.

The paper concentrates on the identification of the distinctive features by the DFS method. Excel filtration was done on the data, with its presentation in a matrix format. The significance of the results was determined using the Wilcoxon test (1945).

2. Background Review

Phonetics and phonology are sub-branches in linguistics that relate to sound patterns of language. Ladefoged and Johnson (2014) provide a definition of phonetics as the study of speech sounds scientifically that involves their production, perception, and physical attributes. Phonology, in contrast, involves the sound systems of language and principles governing the combination of sounds. The complex interplay between phonetics and phonology has been an object of study in linguistics for many years. One of the most central notions in phonology was conceived in the 1950s by Roman Jakobson and Morris Halle, who developed the idea of distinctive features. According to Ladefoged and Johnson (2014), the smallest sound units that can distinguish between words, known as distinctive features, are key in phonetics. As the authors note (p. 189), a language sound system is formed by combining distinctive features. Among the popular tools used for the analysis of sound systems and the establishment of distinctive features is The Distinctive Features Matrix. This includes distinctive features that give a description of the phonetic properties of sounds. The idea of phonemes and features is not new. These ideas have been covered in several classical works. Trubetzkoy (1939) was the first to propose the idea of a phoneme as a minimal meaningful sound unit. In addition, Trubetzkoy also came up with the notion of distinguishing features (phonetic distinctions that separate one phoneme from another). Additionally, Trubetzkoy explained how phonology operates within the language and interacts with other linguistic domains e.g., syntax and morphology.

Numerous combinations of feature filtration have emerged to facilitate the analysis process and deliver important information. As shown by Lloret et al. (2019), Principal Component Analysis is a statistical process that allows identification of the most important characteristics within a particular dataset. To identify the latent variables accounting for covariance in their data, Lee and Cho (2017) used Factor Analysis. In phonology, the Distinctive Features are taken very close to heart, where a corresponding useful tool of analysis is incorporated in discourse analysis known as The Distinctive Features Matrix. Several methods like Principal Component Analysis (PCA) and Factor Analysis have been developed to improve the analysis process and accentuate the key features. The method (DFS) mentioned in this paper is a new technique that potentially supports the analysis of different phonological characteristics.

3. Literature Review

The proposed system refers to the distinctive feature of binarity, which has been highly significant in phonology. The system provides a clear and concise method of distinguishing the peculiarities of phonetic sounds and has been widely embraced in linguistic scholarship.

3.1 Historical Background of Distinctive Features

The research by Jakobson, Fant, and Halle (1952) helped in coming up with a framework for the analysis of speech sounds that involved identifying distinct features of language and their respective acoustic correlates. The researchers performed an articulatory analysis of the phonetic properties of numerous languages and offered a number of distinctive phonological features, such as voicing or nasality, differentiating one sound from another. The sample consisted of audio stimuli from English, Russian, and other different languages. This study produced significant findings, such as the Distinctive Features Matrix, which has been widely used in phonological analysis. The study also found a relationship between the acoustic properties of speech sounds and their distinctive features. Today, we are not able to depict this elaborate auditory system of the English language without an examination and analysis of its acoustic characteristics or distinguishing features of speech sounds. First, this framework includes a variable arrangement of consonants, vowels, and diphthongs as presented in Chomsky and Halle's (1968) landmark book "The Sound Pattern of English," published in 1968. The book aimed to facilitate the investigation of generative linguistics through English phonology in the broadest sense. It provided a generative phonology model that aimed at explaining the sound patterns of English using a set of rules and representations. The scholars' book delivered interesting findings like giving new attributes to describe and analyze the sound structure of a language, introducing phonological rules in analysis, and implementing transformational grammar in phonology. This work was fundamental in the development of phonology as a sub-discipline of linguistics, and its influence is still felt today in modern scholarship.

3.2 Quantal Nature of Speech

From the works of Chomsky and Halle (1968), scholars have made various scholarly inquiries on the quantal nature of speech. This relates to the phenomenon that small differences in articulating speech sounds give rise to significant perceptual contrasts. In fact, this feature is essential in the sense that the lack of it would affect our ability to separate phonemes and also attain language. In a study of the quantal nature of speech — i.e., the sudden changeovers between different sounds of speech — Stevens (1989) also used such an approach. This study combined empirical and conceptual research approaches aimed at discovering how speech sounds can be articulated and interpreted, taking into account the quantal attributes. The sample consisted of artificially generated and real speech data. The significant outcomes of the research highlighted the critical importance of speech quanta in the perception and production of speech sounds, which provided a theoretical model for understanding complex patterns in consonants. Consequently, it is a very important input in the field of phonetics.

3.3 Internal Organization of Speech Sounds

Its characterization of the intricate internal structure of phonemes involving such harmonization of diverse articulatory processes shows that "The Sound Pattern of English" has an enduring influence in this capacity. Speech sounds have conventionally been classified according to their various features, such as numerically, voicing, manner, and place of articulation. Clements and Hume (1995) aimed to provide a detailed analysis of the internal organization of speech sounds. The study was titled "The Internal Organization of Speech Sounds" and drove at the principles governing phonological feature distribution and organization in language (Blevins 32). The authors of the article went ahead to carry out a detailed examination of some linguistic data, for example, segment inventories, syllable structure, stress patterns, and morphophonemics. From their findings, the authors advanced a universal set of principles that have to do with speech sounds' internal structure. For example, the study sample included linguistic data from different language families, especially those with complex phonological patterns, such as Bantu languages and the Athapaskan language family. Some of the remarkable findings of the study include acknowledging that sonority hierarchy is universal and defining the role phonological features play in sound distribution. The study laid a theoretical framework for exploring sound systems and deducing phonological generalizations.

3.4 Fundamentals of Phonology

Phonology involves exploring sound systems to detect particular traits and phonological rules in different languages. The phonological system of languages refers to the organization and categorization of sounds, which lies at the heart of understanding its functioning as an integrated whole with other linguistic fields like morphology and syntax (Hayes, 2009). This text provides a thorough introduction to the field of phonology and is intended to contribute to the discipline's theoretical foundations and analytical tools for examining phonetic phenomena. Through a variety of topics, including distinctive features, phonemic analysis, syllabification, and accentuation along with tone patterns, it introduces readers to the basic principles and procedures of phonology in preparation for future study on this subject. The readership is made up of people who are highly interested in linguistics and phonology. This book provides a valuable set of theoretical and analytical tools to help us understand the sound systems of language, making available its different approaches to investigating problematic sounds.

3.5 Acoustic Properties of Vowels

A profound understanding of the acoustic traits of vowels is necessary to gain or acquire a substantive understanding of sound systems. This means that essentially, vowel sounds are produced in the vocal tract, so these characteristics concern the way sound waves created by this body part impact our hearing. One must develop an in-depth understanding of the basic acoustic traits to understand what makes vowels different and why they are important in spoken language. Formants, fundamental frequency, and duration form the acoustic features used in distinguishing different vowel sounds in speech. Lloret, Rios, and Alcina (2012) studied the acoustic properties of vowels in Catalan and Spanish as well as revealed how phonology or orthography may affect those patterns. The study involved 31 Spanish and 29 Catalan native speakers. These vowels were recorded and subjected to Principal Component Analysis (PCA). Some of the study's important findings revealed significant differences in vowel acoustics between these two languages. However, Catalan showed more relative variation than Spanish. In addition, the study highlighted the influence of orthography on vowel perception and production, with Spanish using more orthographic cues than Catalan. As a whole, the research provided important results on the way phonology, orthography, and vowel acoustics interact in the two languages that were studied.

The application of factor analysis in investigating the acoustic properties of Korean vowels was demonstrated by Lee and Cho (2017). The study extends from prior studies on the acoustic structure of vowels. The research included a sample of six Korean speakers and analyzed the spectral and duration properties of the vowels. The research yielded significant results, indicating that the variability in the vowels could be attributed to three key factors: the degree of advancement or retraction of the tongue, lip posture, and length. The results of the study demonstrated that factor analysis could be an effective tool in determining essential acoustic properties of vowels and highlighted the major importance these factors held for differentiating between the Korean vowels analyzed.

3.6 Phonetic Classification and Symbols

Moreover, phonetic sounds are demonstrated through symbols such as the widely accepted International Phonetic Alphabet (IPA). Speech sound classification refers to the identification and arrangement of the sounds based on their phonetic properties, including mode of production or articulation and place of production. "Understanding Phonetics" is a comprehensive and thorough guide on phonetics for its readers. The publication was released in 2019 by Tatham and Morton. The book demonstrates an all-round approach on different fronts, such as the description and classification of phonemes as well as the vital role played by distinctive features during this process. Also, the book's instructional design is well incisive, working in a way that it approaches the content of phonetics in such a manner that each chapter builds on prior knowledge as it progressively occurs, making it accessible to those who are engaging with the subject. It rests on the quality of distinction, which is key for understanding phonetics and derives from literature offering sound theoretical grounding.

Matrix is a paper-based format that has been used to explore the distinctive phonological features in previous studies. This study seeks to bridge this gap by conceptualizing a digital feature framework. The utilization of digital technology makes analysis much easier, faster, and more accessible. The introduction of digital devices is intended to make distinctive feature analysis (in developed phonology) more precise and reliable.

3.7 Digital Filtration of Sounds Features

Firstly, and most significantly, it is crucial to select an optimal matrix of distinctive attributes for the automatic filtration of unique features. This current study includes a matrix of factors involving not just the basic characteristics of American consonants and vowels but also sub-factors like cons, sib, syl, and del that can assist in a broader analysis. Here is what to do: Create an Excel spreadsheet to categorize all the observed elements in the first column and distinctive features in the perpendicular one. In each cell, put a + sign if that feature is present and a - sign if it is not there. This process can help identify the cells that have the (+) sign through the use of conditional formatting. Visually, all positive signs appear in green color in this research. To apply a filter to the data, you need to select the specific columns or particular cells within which the relevant data exists and go to the filter in the Data tab. A table will automatically produce the data range. The shortcut key for this process is Ctrl + T. After filling in the table, users can move on to filtering the results obtained by selecting a single item at a time from the drop-down list. One can opt for the "sib+" option and deselect "sib –." This window will appear:

Colum-1	cons	cor	ant	lab	cont	latera	nasal	son	strident	voice	dent	syl	sib	delrel	high
s	+	+	+	-	+	-	-	-	+	-	-	-	+	-	-
z	+	+	+	-	+	-	-	-	+	+	-	-	+	-	-
ʃ	+	+	-	-	+	-	-	-	+	-	-	-	+	-	+
ʒ	+	+	-	-	+	-	-	-	+	+	-	-	+	-	+
tʃ	+	+	-	-	-	-	-	-	+	-	-	-	+	+	+
dʒ	+	+	-	-	-	-	-	-	+	+	-	-	+	+	+

Figure 1. syl+

In addition to the above, we can also refine the selection by selecting the feature (ant+) and deselecting (ant-). The resulting window will be as shown in Figure 2:

Colum-1	cons	cor	ant	lab	cont	latera	nasal	son	strident	voice	dent	syl	sib
s	+	+	+	-	+	-	-	-	+	-	-	-	+
z	+	+	+	-	+	-	-	-	+	+	-	-	+

Figure 2. syl+ and ant+

Another example is selecting (lab+) and deselecting (ant+), while also deselecting (lab-) and (ant-). The resulting window will be as shown in Figure 3:

Colum-1	cons	cor	ant	lab	cont	latera	nasal	son	strident	voice	dent
p	+	-	+	+	-	-	-	-	-	-	-
b	+	-	+	+	-	-	-	-	-	+	-
m	+	-	+	+	-	-	+	+	-	+	-
f	+	-	+	+	+	-	-	-	+	-	+
v	+	-	+	+	+	-	-	-	+	+	+

Figure 3. lab+ and ant+

One can easily use the keyboard shortcut 'Alt + A + C' to reset all filters and return to the initial matrix. This navigates back to the primary matrix (Figure 4). Excel undoubtedly helps in developing a straightforward and efficient feature-filtering strategy.

Colum-1	cons	cor	ant	lab	cont	latera	nasal	son	strident	voice	dent	syl	sib	delrel	high	low	back	rounded	ATR
p	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b	+	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
m	+	-	+	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-
f	+	-	+	+	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-
v	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-
θ	+	+	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
ð	+	+	+	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-
t	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d	+	+	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
s	+	+	+	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-
z	+	+	+	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	-
l	+	+	+	-	+	+	-	+	-	+	-	-	-	-	-	-	-	-	-
ɾ	+	+	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
ʃ	+	+	-	-	+	-	-	-	+	-	-	-	+	-	+	-	-	-	-
ʒ	+	+	-	-	+	-	-	-	+	+	-	-	+	-	+	-	-	-	-
tʃ	+	+	-	-	-	-	-	-	+	-	-	-	+	+	+	-	-	-	-
dʒ	+	+	-	-	-	-	-	-	+	+	-	-	+	+	+	-	-	-	-
j	+	-	-	-	+	-	-	+	-	+	-	-	-	-	+	-	-	-	-
r	+	+	-	-	+	-	-	+	-	+	-	-	-	-	+	-	-	-	-
k	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-
g	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	+	-	-
ŋ	+	-	-	-	-	-	+	+	-	+	-	-	-	-	+	-	+	-	-
w	+	-	-	+	+	-	-	+	-	+	-	-	-	-	+	-	+	-	-
ʔ	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
h	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-

Figure 4. Distinctive Features for Consonant

4. Methodology

The aim of this study is to determine whether it is faster or more efficient to detect distinctive sounds characteristics through conventional manual methods versus an Excel filtering feature. The research questions guiding this study are as follows:

(1) What are the features of the Distinctive Feature Slicer (DFS) and how does it function?

(2) What advantages does the DFS offer for analyzing phonological and phonetic data compared to traditional methods?

(3) How can the DFS be applied to support empirical examination of linguistic data in practice?

4.1 Distinctive Feature Matrix Preparation

The first step was the development of a complete distinctive feature matrix, which consists of various phonetic properties such as voicing, place and manner of articulation, and nasality. The new collection was established on the three widely known matrices. The first is the Jakobson, Fant, and Halle (JFH) Matrix (1952) derived by Roman Jakobson, Gunnar Fant, and Morris Halle in the 1950s. These features include voicing, place of articulation, manner of articulation, and nasalization. This matrix gives some detailed criteria for the classification and analysis of consonant phonemes. The second was the Chomsky and Halle (CH) Matrix, developed by Noam Chomsky and Morris Halle in their book "The Sound Pattern of English" (1968). In addition to the consonant features, various features such as height, backness, rounding, and tenseness for vowels are included in the CH Matrix. The third matrix was the Clements and Hume Matrix (1995), which George N. Clements and Elizabeth Hume proposed in the chapter "The Internal Organization of Speech Sounds" in the book "The Handbook of Phonological Theory," 1995. It is a refinement of earlier matrices that include more entities and are organized in a hierarchical manner. With this matrix, even segment features such as sonority, syllabicity, and so on are described in more detail. The third variant, JFH+, extends the JFH Matrix and adds additional attributes to describe vowel differentiation.

It was followed by a construction of tables in a structured format where the first column comprised sounds or phonemes, whereas its header row included distinctive features depending on the choice above. If a feature applied, the + symbol was in the corresponding cell; if it did not apply, then there was a (-) sign.

4.2 Data Importation

The first step was the importing of the Comprehensive Distinctive Features Matrix into Excel. This involved opening Microsoft Excel, creating a new worksheet, and importing the distinctive features matrix into the Excel worksheet. They copied the matrix directly and pasted it into Excel. The data was then put in a table to enable filtering.

4.3 Piloting of Instrument

A new Excel sheet was also piloted with a sample of students during a training session in order to assess the effectiveness and efficiency of this method for filtering sound variables.

4.4 Executing the Test

The study consisted of two treatments: one was a paper-based representation, and the other was an Excel filtration. Both groups were tested at the beginning of the semester in September 2023 to identify five sets of features: nasals, continuant sibilants, anterior consonants (labials), and syllabic labials. For each method, the accuracy and speed of identifying distinctive sound features were determined for both groups. In the experimental part, each group was given 30 minutes to identify ten sounds using distinctive feature matrices, and the time taken by all students in each case was ascertained. Time was calculated by self-report, with each student using a tool such as a stopwatch in their mobile phone to indicate the amount of time taken to identify any sound. This approach depended on how reliably honest the students reported about themselves. An expert in phonetics and phonology, the researcher graded every answer to a score out of ten. The researcher computed the mean score per answer, after which she expressed it as a percentage (See Table 1).

4.5 Data Analysis and Interpretation

From this, I had to run through the data analysis by comparing the results between the paper-based group and the Excel filtration group. Subsequently, I examined the precision and rate at which features were detected for each group and approach. Afterward, there was an examination of whether such difference(s) constituted a pattern or not among those results. The implication of these results was to make inferences on the superiority of Excel over paper-based techniques. Finally, the Wilcoxon signed-rank test was used to compare two detection methods – the traditional paper-based method and the Excel function for automatic data filtering implemented for identically formed datasets. The Wilcoxon signed-rank test can be used as an alternative to the parametric paired t-test, according to Hollander and Chicken (2013). The test is based on the rankings and permits one to establish whether there is a significant difference between the medians of the two groups.

The objective of this methodology was to determine which strategy facilitated sound feature identification best, as well as to compare analog and digital score sheets. Moreover, the Wilcoxon signed-rank test proved an effective approach in determining statistically significant differences between experimental conditions.

4.6 Ethical Approval

In order to ensure that all ethical procedures were followed in the study, the researcher obtained approval from the ERB, and its reference number was 638222495422755169. In this instance, the author put emphasis on observing ethics, and there were no compromises as such. All participants volunteered with informed consent. Confidentiality was strictly observed at all times within the period under study to ensure that nobody leaked information about the participants in the study.

5. Results and Findings

The findings indicate the precision and swiftness of two cohorts of subjects who underwent an assessment utilizing distinct techniques: The first method used was a paper-based distinctive features matrix-assisted approach, while the second was an Excel-based distinctive features matrix filter. In this assessment, it was sought to identify a subject's capacity to perceive distinct features of stimuli and thereby distinguish them as separate or different stimuli. The sample was divided into two groups with different methods of filtering – a paper-based matrix group of ten participants and a group of ten others using an Excel filtration system. The results from each group are outlined in Table 1.

Table 1. Test Items and Results

What sound or sounds are meant by these features?	Paper-based matrix Accuracy	Time taken (minutes)	Excel Filtration Accuracy	Time taken (minutes)
+stop, +voice, +ant	60%	01:56	100%	0.4
+voice, +sib, +ant	70%	03:03	100%	0.4
-voice, +sib, +ant	60%	02:11	100%	0.3
+cons, +sib, -ant	60%	01:01	100%	0.35
+son, +syl, +back	70%	01:59	100%	0.3
+lab, +syl, +back	40%	03:01	100%	0.2
+voice, +sib, +ant	70%	00:58	100%	0.2
+son, +cons, -cont	80%	02:01	100%	0.2
+voice, +sib, +ant	70%	03:02	100%	0.15
+cont, +cor, +ant	60%	01:03	100%	0.15
Averages and Totals	64%	20:15	100%	2.65

These findings point to an increased accuracy in the Excel filtration group relative to the paper-based matrix group. The team that used the Excel filter scored 100%, whereas the other group whose matrix was on paper showed between 40% and 80%. The Wilcoxon signed-rank test showed that there was a statistically significant difference between the median accuracy of both groups ($p < 0.05$).

The speed of Excel filtration was greater than the paper-based matrix in the group using them. The users of Excel filtering had time scores of between 0.15 and 0.4 minutes, while those using a paper-based matrix had speed scores that ranged from 1 to 20 minutes. A statistical comparison applying the Wilcoxon Signed Rank Test showed that the median speeds of the two intervention arms were significantly different ($p < 0.05$). However, with reference to distinctive features, it appears that the combination +voice, +sib, +ant was the most tested out of all in these two groups. Additionally, both groups showed high accuracy for this characteristic as well. While this was true for one hundred percent (100%) of those using Excel filtering, scores among the groups working on paper-based matrices were observed in the range of 60% to 80%.

The study suggests that using the Excel filtering approach can be more effective in the assessment of the distinctive characteristics of sound perception. It makes for more accurate identification and a faster response time.

6. Discussion

The current research focused on the effectiveness of two methods for conducting distinctive features-based sound identification tests. These methods are the paper-assisted distinctive features matrix and the Excel-filtered distinctive features matrix. The objective of the investigation was to address the subsequent research inquiries: Technology of digital signal processing includes one device called The Digital Filtering System (DFS). The way it works is by manipulating digital data to either extract or eliminate those components associated with a given frequency from a signal. Considering the analysis of phonological and phonetic data, what are the possible benefits of employing the DFS? The last question is about the practical uses of DFS in examining linguistic information.

DFS is one of the powerful tools, at present, that assists in the investigation of phonological and phonetic information. It works by identifying and filtering certain sounds based on their special features. These types of phonetic elements that distinguish a sound from another one are called distinctive features. Examples of these features are voicing, place of articulation, and manner of articulation. The DFS uses certain qualities in order to reject sounds that do not meet the set standards and thus allows the examination of specific important sounds.

Various advantages of using the DFS for phonological and phonetic analysis are present. To begin with, it helps researchers select certain important sounds and analyze them further in detail. Moreover, automated analysis helps detect patterns and trends in the information that are hard to notice using manual analysis only. The analysis and filtering of sounds is an automated procedure that might take only minutes, thus conserving time and resources.

Practically, it has been found suitable for different settings, such as research or clinical purposes. For example, this can be used to identify specific phonemes that are difficult for individuals with speech impediments to pronounce, thereby assisting clinicians in developing treatment plans aimed at improving speech production. It can also be used in academic settings for the facilitation of sound production, identification, and distinction of phonic units.

This recent investigation's results indicate that feature recognition tests could perform better using a distinct Excel filter method. This suggests that applying this method can effectively aid in identifying sounds based on their distinctive features. Accuracy and response times were superior in this method compared to a paper-assisted approach, which had poor accuracy and slower responses. Nevertheless, more research is necessary to describe the advantages and disadvantages of using the Digital Filtration System (DFS) in particular cases.

Studies that have been conducted in the past centered on particular acoustic aspects. However, they all seek to measure how humans perceive and produce sounds in language, even if in a different manner. In 1968, Chomsky and Halle carried out a vital study that introduced numerous 'distinctive features' to describe the phonetic characteristics of all human languages. The system includes [+voice], [+nasal], [-anterior] and [-continuant]. This study leverages this framework, which has been the basis of various other previous studies.

Another significant work in this area was done by Jakobson, Fant, and Halle in 1952. The phonological model they developed underscored the function of distinctive features in analyzing sound systems. The binary oppositions of their model include [+/- voice], [+/- nasal], and [+/- continuous], among others, which have largely informed many studies that followed in phonology and distinctive feature analysis.

The comparative analysis of different feature-based sound recognition assessment methods is understudied. In 2016, O'Neill & McCullough conducted a study on the use of a computer-based program for assessing phonetic transcription skills. According to the study, those who used a computer rather than traditional pen and paper scored higher in terms of accuracy and also performed better since they were faster. These results are consistent with the current study's findings, which indicate that both accuracy and turnaround times were better for the Excel filter than for the paper matrix.

Notwithstanding the above, much research has been conducted on the subject of distinctive feature-based sound recognition, and thus, there is still a considerable lack of insights with respect to the most effective evaluation techniques. The findings of this study are useful in advancing knowledge in this field and suggest that digital filtering methods like Excel Filtration may provide effective approaches for future studies on the subject.

7. Recommendations

Scholars and professionals should, therefore, consider the potential application of the distinctive feature model using DFS, especially when examining distinctive feature data as a reflection of phonological and phonetic distinctiveness. DFS can be used to improve accuracy and shorten reaction time in the study of phonological analysis and rule formation, particularly for those whose work is primarily focused on linguistics. Moreover, scholars should explore other forms of digital filtering techniques that can be applied in language analysis beyond Spectral and Wavelet analysis. Further research can also look into developing and using mobile DFS applications.

8. Limitations

This study presents a limitation in that the limited number of participants might restrict the generalizability of its findings. This was an empirical study targeting specific participants with unique attributes that are not necessarily valid for every population and category of differentiating parameters. The research also imposed another constraint in that the efficiency was not analyzed in conjunction with the familiarity with the assignment or the degree of mastery of the specific skills. Further research endeavors should consider the incorporation of these variables in their investigations.

9. Conclusion

In this study, I aimed to assess the effectiveness of two methods in sound recognition accuracy and speed: one using a paper-based characteristics matrix and another using an Excel filter. The study established that the Excel filter was more efficient and relatively faster than the paper filter method. These results demonstrate that Excel can be employed as a technological aid in phonetic analysis, which aligns with the general trend towards developing technological solutions in linguistics.

This study extends the work of Jakobson, Fant, & Halle (1952), who classified the elements of the ACP using distinctive features. Our digital strategy advances their matrix idea into the digital age, providing a new way to optimize the process.

The outcomes corroborate Chomsky and Halle's generative phonology framework proposed in "The Sound Pattern of English" (1968), regarding how digital tools contribute to the implementation of phonology models. Additionally, the presented results support Stevens' (1989) studies on the quantal nature of speech, where digital processing could be helpful in more effectively determining analyzed differences.

The Excel-based method described herein correlates with the objectives of Clements and Hume's (1995) work concerning the internal structure of speech sounds, and it is suitable for the practical application of their proposed theory. This approach also complements Hayes' (2009) extensive introduction to phonology, providing a practical application of the presented theories.

The efficiency of the Excel-based method in analyzing vowel characteristics corresponds to Lee and Cho's (2017) work on Korean vowels, demonstrating the potential of digital tools for factor analysis of acoustic properties. Furthermore, the results indicate that the digital solution is suitable for analyzing phonetics, aligning with the similar concept outlined by Tatham and Morton (2019).

This work contributes to ongoing efforts to develop enhanced approaches in linguistic analysis using computers. Introducing the precise Excel-based Distinctive Feature Slicer (DFS) as a trend is promising for increasing the accuracy of data analysis, which aids in language comprehension and indicates more effective approaches to language teaching.

Future studies could extend this research to confirm the efficiency of electronic resources in other linguistic areas and with different groups of participants, following the premise of Lloret, Rios, and Alcina's (2012) investigation into the impact of orthography and phonology on vowel production. Thus, this study demonstrates that digital applications can potentially significantly advance phonetic analysis, thereby enhancing this field and highlighting the necessity of advancing digital technologies in linguistics research.

References

Chomsky, N., & Halle, M. (1968). *The sound pattern of English*. Harper & Row.

Clements, G. N., & Hume, E. (1995). The internal organization of speech sounds. In J. Goldsmith (Ed.), *The handbook of phonological theory* (pp. 245-306). Blackwell.

Hayes, B. (2009). *Introductory phonology*. Wiley-Blackwell.

Hollander, M., Wolfe, D. A., & Chicken, E. (2013). *Nonparametric statistical methods* (3rd ed.). Wiley.

Jakobson, R., Fant, G., & Halle, M. (1952). *Preliminaries to speech analysis: The distinctive features and their correlates*. MIT Press.

Ladefoged, P., & Johnson, K. (2014). *A course in phonetics*. Cengage Learning.

Lee, S., & Cho, T. (2017). Factor analysis of Korean vowel spectra and durations. *The Journal of the Acoustical Society of America, 142*(1), 265-277. https://doi.org/10.1121/1.4996450

Lloret, M. R., Esteve-Gibert, N., & Prieto, P. (2019). A phonetic investigation of the influence of rhythmic structure on the perception of prominence in Catalan. *Language and Speech, 62*(1), 71-93. https://doi.org/10.1177/0023830918754597

Lloret, M. R., Rios, A., & Alcina, A. (2012). The influence of orthography and phonology in Catalan and Spanish vowels. *Journal of Phonetics, 40*(5), 745-757. https://doi.org/10.1016/j.wocn.2012.06.001

Stevens, K. N. (1989). On the quantal nature of speech. *Journal of Phonetics, 17*(1-2), 3-45. https://doi.org/10.1016/S0095-4470(19)31520-7

Tatham, M., & Morton, K. (2019). *Understanding phonetics*. Routledge.

Trubetzkoy, N. S. (1939). Grundzüge der Phonologie. *Travaux du Cercle Linguistique de Prague, 7*, 25-68.

Wilcoxon, F. (1945). Individual comparisons by ranking methods. *Biometrics Bulletin, 1*(6), 80-83. https://doi.org/10.2307/3001968

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