# The Impact of Gender on the Acquisition of VOT of English Plosives Produced by Bilingual Emirati Children

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ABSTRACT

*Gender differences play a crucial role in shaping bilingual phonological development, particularly in multilingual societies like the United Arab Emirates (UAE). This study explored the influence of gender on the acquisition of Voice Onset Time (VOT) for word-initial English plosives among bilingual Emirati preschool children, examining how boys and girls acquired and differentiated voicing contrasts in English as their second language (L2). The study included 20 typically developing Emirati children aged 2:00 years to 5:11 years, all native speakers of Emirati Arabic and bilinguals with English as their second language (L2). Data were collected through a picture-naming task in a controlled acoustic environment, and the audio recordings of voiced and voiceless plosives were analyzed using PRAAT software. The results revealed significant gender-based differences in VOT patterns. Boys displayed stronger interference from their first language (L1), Emirati Arabic, in their English plosive production, whereas girls exhibited VOT values more closely aligned with English norms. These findings suggest that gender influences bilingual phonetic development, potentially due to biological, social, and developmental factors. The study emphasizes the importance of incorporating gender as a variable in educational strategies and clinical interventions, providing valuable insights into bilingual phonological acquisition and its implications for language teaching and the assessment of phonological disorders.*

*Keywords: Voice onset time (VOT); bilingualism; gender differences; Emirati Arabic; phonetic acquisition*

INTRODUCTION

The population of The United Arab Emirates (UAE) is notable for its rapid growth and extraordinary diversity. Emirati nationals account for only 11.9% of the total population, with expatriates comprising the remaining 88.1%, making the UAE one of the most expatriate-dominated nations globally (Federal Competitiveness and Statistics Centre [FCSC], 2020, p. 12). The expatriate population is highly diverse, with significant communities from South Asia, the Philippines, Iran, and Western countries. Among expatriates, it is common to maintain their native languages while acquiring proficiency in English—and, to a lesser extent, Arabic—further enriching the UAE's complex and dynamic linguistic environment (Buckingham, 2016, p. 104). This unique demographic structure significantly influences social dynamics, cultural exchange, and language practices (Al Abed & Vine, 2005, p. 45).

For Emiratis, the linguistic environment, marked by widespread multilingualism, fosters proficiency in both Arabic and English. Arabic, the official language of the UAE, is widely used in government, media, and education, with Emirati Arabic, a Gulf Arabic dialect, serving as the primary spoken form among locals (Al-Issa, 2019, p. 35). Emirati Arabic is characterized by distinct phonological features such as the affrication of /k/ to [tʃ] in certain environments and the use of [g] for Classical Arabic /q/ (Al-Wer, 2024). These traits differentiate it from neighbouring dialects (e.g., Najdi Arabic) and may influence L2 phonetic transfer. However, the UAE's multinational population has elevated English to the status of a dominant lingua franca, playing a

vital role in business, education, and everyday communication (Buckingham, 2016, p. 102). English is introduced early in education and is a key requirement for professional advancement, fostering a deeply ingrained bilingual culture (Al-Issa & Dahan, 2011, p. 243).

Given the UAE's bilingual context, it is crucial to explore various dimensions of bilingualism, beginning with a clear understanding of its definition and scope. Linguistically, bilingualism is often defined as the ability to use two languages proficiently (Bloomfield, 1933, p. 56). Bloomfield (1933) provided a strict definition, describing bilingualism as having native-like mastery of two languages, a standard few individuals meet (p. 59). Alternatively, Macnamara (1967) proposed a more flexible view, suggesting that a person is bilingual if they possess minimal competence in one of the four language skills—listening, speaking, reading, or writing—in a second language (p. 78). In addition, Grosjean (1989) introduced a functional perspective, defining bilinguals as individuals who use two or more languages in their daily lives, regardless of their proficiency level (Grosjean, 1989, p. 3). This broader definition aligns with the idea that bilingualism exists on a continuum, ranging from early bilinguals who acquire two languages simultaneously in childhood to late bilinguals who learn a second language later in life (Grosjean, 1989, p. 5). The criteria for identifying someone as bilingual often depend on the context, such as academic, social, or professional settings, and the level of fluency required to function effectively in those environments (Macnamara, 1967, p. 79).

Consequently, one of the primary reasons to study bilingual phonological development is its relevance to education. English, as the de facto lingua franca in the UAE, is introduced early in education, while Arabic, the official language, remains a core part of the curriculum (Al-Issa & Dahan, 2011, p. 243). Understanding bilingual phonological development is crucial for educators aiming to support Emirati children's language learning effectively. Emirati children often face the task of developing two separate phonological systems — one for Arabic and one for English — each with distinct articulatory and phonological rules. Alternatively, some children form a hybrid system where features of both languages blend together. Recognizing whether a child maintains a distinct system or a merged one helps educators provide more targeted support to minimize cross-language interference and promote accurate production in both languages (Fabiano-Smith & Bunta, 2012).

Bilingual phonological studies provide valuable insights into cross-linguistic transfer. Studies like Paradis and Genesee (1996, p.39) have shown that bilinguals often transfer phonological features between their two languages. In the UAE, Emirati Arabic and English have distinct phonological structures, and understanding how these systems interact in bilingual individuals can deepen our understanding of language acquisition processes. This is particularly relevant in contexts where bilingual individuals are expected to switch seamlessly between languages in different social and professional settings (Buckingham, 2016, p. 104).

Understanding bilingual phonological development is critical for speech-language pathologists aiming to differentiate between typical bilingual speech patterns and true speech-language disorders. This distinction is especially important in highly multilingual environments like the United Arab Emirates, where children are often exposed to multiple languages from an early age, increasing the complexity of phonological development. Research has shown that bilingual children's speech patterns can reflect cross-linguistic interaction, such as transfer or phonological blending, which are normal aspects of bilingual acquisition rather than signs of disorder (Goldrick et al., 2014; Paradis, 2021). Comparative studies with monolingual benchmarks are essential to accurately interpret these differences, ensuring that bilingual children are not misdiagnosed due to developmental patterns typical of bilingualism (Hambly et al., 2013).

The analysis of Voice Onset Time (VOT) is particularly significant, as it provides fundamental insights into the phonological development of bilingual speakers. VOT serves as a critical feature in the production of stop consonants, enabling the distinction of phonemic contrasts across languages. It measures the temporal interval between the release of a stop consonant and the onset of voicing, or vocal fold vibration (Lisker & Abramson, 1964, p. 422), making it an indispensable tool for understanding how bilingual individuals acquire and manage distinct phonological systems.

In English, voiceless stops such as /p/, /t/, and /k/ are typically aspirated, which results in long lag VOT, where the vocal cords begin vibrating significantly after the release of the stop. Depending on the context, VOT for voiceless stops in English can exceed 30 milliseconds or more (Abramson & Whalen, 2017, p. 345). In contrast, voiced stops like /b/, /d/, and /g/ have a much shorter VOT, known as short lag VOT, where the vocal cords begin vibrating almost immediately after the release of the stop. In some cases, English-voiced stops may even exhibit leading voicing, where the vocal cords vibrate before the release of the stop closure. Arabic stop consonants, in contrast to English, generally lack aspiration. Voiceless stops such as /t/ and /k/ in Arabic are characterized by short-lag Voice Onset Time (VOT), meaning that vocal cord vibration begins shortly after the release of the stop closure. Recent acoustic studies have confirmed these features. For instance, Tamim and Hamann (2021) found that in Palestinian Arabic, the voiceless stops /t/ and /k/ had mean VOTs of approximately 29 milliseconds, indicating minimal aspiration. In the same study, voiced stops such as /b/, /d/, and /g/ exhibited negative VOT values (around -93 milliseconds), demonstrating leading voicing, where vocal fold vibration starts before the articulatory release. Similarly, Al-Tai and Kasim (2021), in a study of Iraqi Arabic, reported short-lag VOT values for voiceless stops (/t/ at 41 ms and /k/ at 53 ms) and clear prevoicing for voiced stops, with /b/ showing an average VOT of -75.6 milliseconds. Together, these findings highlight that across Arabic dialects, the phonetic realization of stops consistently involves short-lag or negative VOTs, distinguishing them from the aspirated voiceless stops commonly found in English.

Thus, Emirati Arabic-English bilinguals need to adjust to producing long lag VOT for English voiceless aspirated stops while maintaining short lag or leading voicing for Arabic stops. The extent to which bilinguals succeed in acquiring language-specific VOT patterns provides valuable insights into the influence of their first language (L1) on their second language (L2). For bilingual Emirati children, whose linguistic environment includes Arabic and English, VOT analysis offers critical insights into the interaction between their two phonological systems. Research on Chinese-English bilinguals demonstrates that exposure to both languages can result in hybrid phonetic patterns, with VOT values deviating from monolingual norms and forming a unique bilingual system (Yang & Fox, 2014, p. 278). Similarly, studies on Spanish-English bilinguals have demonstrated that these speakers often produce intermediate Voice Onset Time (VOT) values for voiceless stops, reflecting phonetic blending between the two languages (Flege, 1991, p. 403). In monolingual speech, English voiceless stops (/p/, /t/, /k/) are typically produced with long-lag VOTs, meaning there is a noticeable delay between the release of the stop and the onset of vocal cord vibration, resulting in aspiration. Conversely, Spanish voiceless stops are produced with short-lag VOTs, characterized by a shorter delay and minimal aspiration. This phonetic distinction poses challenges for bilingual speakers, who may exhibit VOT values that fall between the norms of each language. Recent research by Younes and Mueller Gathercole (2022) supports this, indicating that Spanish-English bilinguals exhibit cross-linguistic influence in their

VOT productions, particularly in cognate words, leading to intermediate VOT values that reflect a blending of phonetic features from both languages.

A comparable phenomenon was observed in Arabic-English bilingual children, where English voiceless stops had shorter VOT values than those of monolingual English speakers, influenced by Arabic phonetic norms (Khattab, 2002, p. 21). These findings highlight the complex phonetic adjustments bilinguals make when acquiring distinct phonological systems, reinforcing the importance of targeted language instruction that explicitly addresses cross-linguistic influence and supports the development of clear phonetic distinctions.

In the context of bilingual phonological development, particularly regarding parameters such as VOT, gender plays a significant role in shaping language acquisition outcomes. Research has consistently demonstrated that boys and girls exhibit differences in phonological development. For example, boys often show greater influence from their first language (L1) when acquiring VOT patterns in a second language (L2), resulting in more frequent transfer effects, whereas girls tend to approximate the phonetic norms of the target language closely at an earlier stage (Flege et al., 1995; Roberts, 1997;). These differences are influenced by both biological and sociolinguistic factors. Biologically, variations in neurological development and speech-motor control between genders may contribute to differences in speech timing and coordination. Sociolinguistically, girls are often exposed to stronger social pressures to conform to standard language norms, leading to earlier adoption of phonologically accurate patterns (McCarthy et al., 2014, p. 112).

Biological factors, such as differences in brain organization and hormonal influences, contribute to gendered patterns in language acquisition. Research indicates that female children often outperform male children in tasks related to phonological awareness and language comprehension, which can affect the pace and accuracy of acquiring new phonological systems (Burman et al., 2008, p. 215). Girls frequently demonstrate earlier mastery of phonological features, including segmental distinctions and prosody, which are essential for bilingual speakers managing distinct phonetic systems (Tenenbaum & Leaper, 2002, p. 67). This biological advantage is reflected in studies on Voice Onset Time (VOT) production, where girls tend to achieve more accurate and native-like articulation earlier than boys (Khattab, 2002, p. 21). However, biological predispositions alone do not fully account for these differences; environmental and sociolinguistic factors also play a critical role. Greater verbal engagement from caregivers toward girls, as well as societal expectations that emphasize higher verbal proficiency among females, can further accelerate phonological development. Supporting this view, Wilsenach and Makaure (2018) found that bilingual girls outperformed boys in phonological processing tasks, such as phoneme isolation and elision, highlighting the combined influence of both innate biological differences and enriched linguistic environments on gendered patterns of bilingual phonological development.

Another area where gender differences manifest is in cross-linguistic transfer. Studies have indicated that boys may exhibit higher rates of phonetic transfer from their first language into their second language compared to girls. For instance, male bilingual speakers often display the greater influence of their first language's phonological system on their second language's VOT patterns, whereas girls tend to maintain clearer distinctions between their two languages, demonstrating greater adaptability in managing dual phonological systems (Flege, 1991, p. 403). This disparity may be attributed to sociolinguistic factors; research suggests that girls are generally more responsive to social cues and feedback, which can enhance their ability to adjust speech patterns to align with second language norms. Conversely, boys may be less influenced by such social

feedback, potentially leading to increased first-language interference in their second-language phonological production.

While the study of VOT has provided valuable insights into bilingual phonological development and the influence of gender on language acquisition, a significant research gap persists regarding the role of gender in VOT acquisition among bilingual Emirati children. Despite the UAE's unique linguistic and cultural environment, where Arabic and English coexist, No systematic studies have examined VOT patterns in the Emirati Arabic-English bilingual pair, nor how gender influences VOT acquisition in this bilingual population. While previous research has explored VOT acquisition in Arabic-English bilinguals from regions such as Lebanon, Egypt, and Saudi Arabia (Khattab, 2002; Saadah, 2011; Al-Tamimi & Khattab, 2011; Olson & Hayes-Harb, 2019), these studies have largely overlooked gender differences and have not examined Emirati Arabic-English bilinguals specifically. These studies consistently highlight the impact of cross-linguistic transfer and language exposure on VOT production but seldom address gender-specific variations.

The lack of research on this topic is particularly concerning, given the practical implications for education and clinical interventions. Speech-language pathologists working with bilingual Emirati children may encounter gender-specific patterns in VOT production that require targeted approaches (Fabiano-Smith & Goldstein, 2010, p. 210). Similarly, educators designing language curricula for Emirati bilingual students could benefit from understanding how gender interacts with phonological development, including VOT acquisition. Without data specific to the Emirati context, these professionals are left to rely on generalizations from other bilingual populations, which may not account for the unique linguistic and cultural dynamics of the UAE. Beyond its applied significance, this study contributes to the broader field of bilingual phonetics by examining how gender mediates phonological acquisition in a diglossic environment where Arabic and English coexist.

Therefore, the primary objective of this study is to examine the influence of gender on the acquisition of VOT in word-initial English plosives (/p/, /t/, /k/, /b/, /d/, /g/) among bilingual Emirati children. Specifically, the objective of this study is to:

•　　Investigate gender-based variations in VOT patterns for word-initial English plosives produced by bilingual Emirati children.

To achieve this, the study addresses the following research question:

•　　Are there significant differences in the VOT values of English plosives produced by male and female bilingual Emirati children?

## LITERATURE REVIEW

In a previous study, Khattab (2002) investigated the role of gender in VOT acquisition among Lebanese Arabic-English bilingual children, focusing on the interaction between sociolinguistic and linguistic factors in phonological development. The study included bilingual children aged 8–11, analyzing their production of English voiceless stops (/p/, /t/, /k/) in word-initial positions. Female participants consistently produced longer VOT values for these stops, averaging between 45–70 milliseconds (ms), aligning closely with monolingual English norms, where voiceless stops

are aspirated and typically exceed 30 ms. In contrast, male participants demonstrated shorter VOT values, averaging 20–40 ms, reflecting a stronger influence of Arabic phonetic norms, where voiceless stops are unaspirated with short-lag VOT values around 10–20 ms (Khattab, 2002, pp. 1–37).

In a study focusing on Jordanian Arabic-English bilinguals, Al-Tamimi and Khattab (2011) examined gender differences in VOT production among 20 participants (10 males and 10 females), all of whom were university students with advanced proficiency in English. Participants were recorded producing English voiceless stops (/p/, /t/, /k/). Female speakers produced these stops with longer VOT values, averaging around 60 milliseconds (ms), aligning closely with monolingual English norms. In contrast, male speakers exhibited shorter VOT values, averaging approximately 40 ms, indicating stronger influence from Arabic phonetic norms, whereas voiceless stops typically have shorter VOT durations. While language exposure may partially explain this pattern, other factors such as motivation, language attitudes, and sociolinguistic identity likely contribute to female participants' greater phonological adaptation. Notably, this study differs from previous research by focusing on young adult bilinguals with sustained exposure to academic English, highlighting the role of educational level and language use contexts in shaping bilingual phonological outcomes. These findings reinforce the importance of considering both linguistic and social variables, including gender, when investigating bilingual phonological development (Al-Tamimi & Khattab, 2011).

Additionally, Saadah (2011) investigated VOT production in six Najdi Arabic-English bilingual children (three boys and three girls) aged 7–9 years, focusing on their articulation of voiceless stops in both English and Najdi Arabic. While consistent with previous findings (Al-Tamimi & Khattab, 2011; Khattab, 2002;) showing that girls produced longer English VOTs (40–70 milliseconds) aligning closely with English monolingual norms, and boys produced shorter VOTs (20–40 milliseconds) reflecting greater L1 influence, Saadah's study offers important new insights. Specifically, it demonstrated that even at a young age, bilingual children are capable of maintaining distinct phonetic systems across languages, as evidenced by their appropriate short-lag VOT production (10–20 milliseconds) for Najdi Arabic voiceless stops, with no significant gender differences observed. By examining a younger age group and directly comparing first- and second-language VOT patterns within the same participants, Saadah (2011) contributed to a deeper understanding of how early bilinguals negotiate phonetic boundaries under sociolinguistic influences such as gender (Saadah, 2011, pp. 245–268).

Moreover, Wasmiah Alsuhaim's (2022) study investigated VOT production for English bilabial stops (/p/ and /b/) among Saudi Arabic-speaking ESL learners. The study involved 20 participants, equally divided by gender, who produced the target stops in word-initial positions, with their VOT values analyzed acoustically using Praat software (Alsuhaim, 2022, p. 102). The findings revealed a significant gender-based difference in the production of the voiced stop /b/, with male participants displaying longer VOT values than females. This deviation from native English norms, where /b/ is characterized by short-lag VOT, was attributed to greater first-language (L1) interference among males, as Arabic /b/ typically features lead voicing, differing phonetically from its English counterpart (Alsuhaim, 2022, p. 105). Conversely, no significant gender-based differences were observed in the production of the voiceless stop /p/. Both male and female participants produced /p/ with native-like VOT values despite the absence of this phoneme in Arabic. This result may be explained by the fact that /p/ represents a novel phonetic category for all learners, requiring equal acquisition efforts across genders without pre-existing L1 interference, thereby facilitating more uniform adaptation (Alsuhaim, 2022, p. 106).

## METHODOLOGY

This study employed a purposive sampling method, selecting participants based on specific criteria to ensure the reliability and credibility of the results. Children were recruited from various preschools and nurseries in Dubai, chosen for their consistent use of English as a second language alongside Arabic, minimizing variability in English exposure. All participants shared a homogeneous background, characterized by native Emirati parentage, enrollment in English-medium early education settings, and early exposure to English beginning in preschool. Language dominance was verified through parental surveys and teacher reports, confirming Arabic as the primary home language and English as the language of formal instruction, thereby reducing confounding variables related to bilingual exposure. A total of 20 typically developing preschool children aged between 2, 0, and 5, 11 years participated in the study, with an equal number of males and females to ensure balanced gender representation. Additionally, two adult Emirati bilinguals (one male, one female), whose first language was Arabic and second language was English, were included as a control group to provide reference VOT values for mature bilingual speakers, as shown in Table 1. Informed consent was obtained from all parents prior to participation.

TABLE 1. Participant Data

| Subject Type | Number of Subjects | Gender | Age Range |
|---|---|---|---|
| Adult–Reference | 1 | Male | +18 |
| Adult–Reference | 1 | Female | +18 |
| Child | 10 | Male | 2: 5–11 |
| Child | 10 | Female | 2: 5:11 |

Prior to data collection, a background survey was administered to parents and homeroom teachers as a screening tool to ensure that potential participants met the inclusion and exclusion criteria for the study. This survey also aimed to confirm that the participants exhibited typical development across physical, cognitive, social, and behavioural domains. All participants predominantly spoke Arabic as their first language (L1), were acquiring English as their second language (L2), and had been exposed to English since preschool, as shown in Table 2.

TABLE 2. Participant Inclusion and Exclusion Criteria

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Emirati children aged 2;0 years to 5;11 years old | Children who are not Emirati citizens or Emirati children with at least one parent who is not a native of the UAE. |
| Emirati children who speak Arabic as their first language and English as their second language | Emirati children who speak English or any other language as their first language |
| Typically/normally-developing children | Children with articulation and/or phonological disorders, receptive or expressive language delay/disorders, and/or fluency disorders |

During data collection, the researcher selected a set of words comprising three exemplars for each plosive consonant in the word-initial position. Word-initial plosives were prioritized due to their acoustic salience (Lisker & Abramson, 1964) and pedagogical relevance in early L2

instruction (Fabiano-Smith, 2019). Medial and final plosives were excluded to reduce task complexity for preschoolers. The selection criteria were guided by considerations of high frequency and simple syllabic structure, typically acquired by subjects within the chosen age range. These words were subsequently utilized in a picture-naming task administered to the participants, wherein they were instructed to verbally identify the depicted objects without prompting in the initial phase. When participants encountered difficulty, minimal prompts and cues, including verbal prompts, visual aids, semantic cues, and feedback, were provided as needed, fostering engagement and accurate responses. Table 3 shows the list of the stimuli words.

TABLE 3. The list of stimuli words

| /b/ | /p/ | /d/ | /t/ | /g/ | /k/ |
|-----|-----|-----|-----|-----|-----|
| Baby | Pen | Dog | Two | Girl | Car |
| Ball | Pizza | Duck | Toy | Good | Cat |
| Bed | Pink | Dad/Daddy | TV | Go | Key |

The researcher captured audio data using the Sony ICD-PX370 Digital Voice Recorder. The PX370 was chosen for its superior mono recording capabilities, advanced noise reduction technology, and enhanced clarity, ensuring precise and high-quality audio recordings (Sony Corporation, n.d.).

The recorder was strategically positioned in a controlled acoustic setting to ensure optimal audio capture during a structured picture-naming task. Children articulated words featuring target plosive consonants in the initial position, with each word recorded three times. This approach enabled the selection of the most accurate recording while reducing potential variability in pronunciation across multiple attempts. Sessions were conducted individually in a quiet room to eliminate background noise and maintain efficient recording conditions.

For data analysis, PRAAT software was employed for the acoustic analysis of the recorded speech samples. PRAAT provides tools for analyzing key speech features such as pitch, intensity, formants, and Voice Onset Time (VOT) through visualizations like waveforms and spectrograms (Boersma & Weenink, 2021). VOT was measured in milliseconds by identifying two specific points on the waveform and spectrogram: the release burst of the stop consonant, marked by a sudden spike in the waveform and the onset of high-frequency noise in the spectrogram, and the initiation of periodic voicing, indicated by the beginning of regular vertical striations corresponding to vocal fold vibration. PRAAT's zoom and cursor tools were used to precisely locate these points. The VOT measurements for each sample are illustrated in Figures 1 and 2.
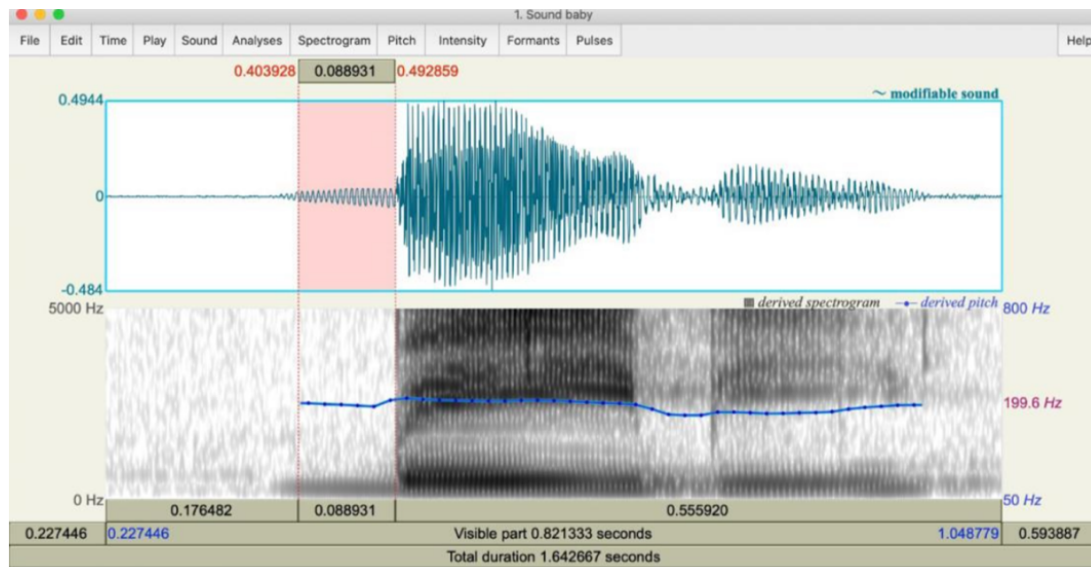
FIGURE 1. PRAAT analysis for the VOT of the sound /b/ in the word "baby."
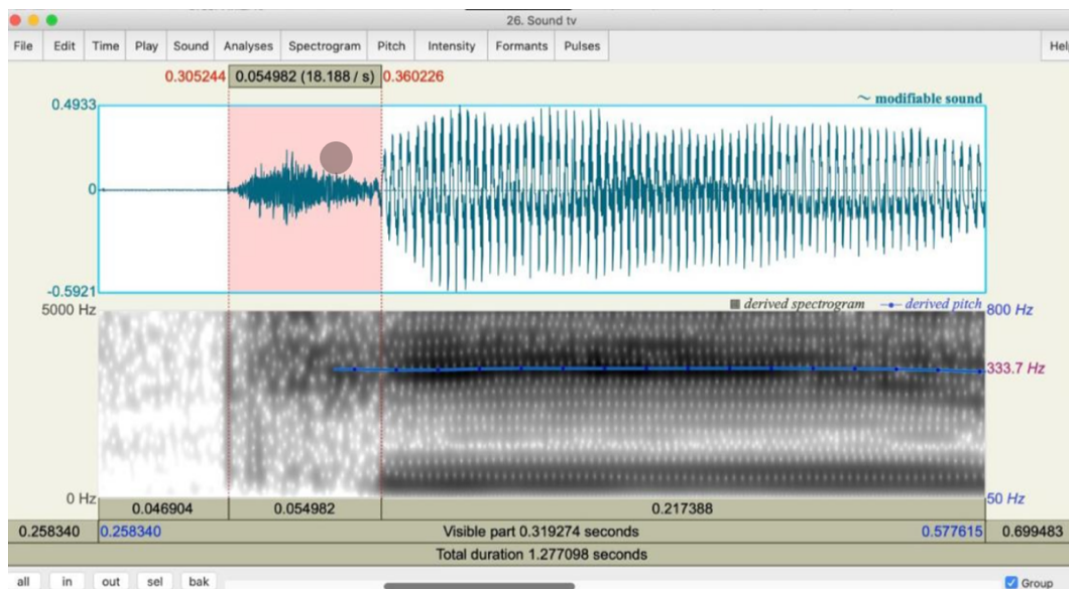


FIGURE 2. PRAAT analysis for the VOT of the sound /t/ in the word "TV."

Following the PRAAT analysis, mean VOT values (in milliseconds) were calculated for each plosive across male and female bilingual children and the adult control group, using Microsoft Excel. Separate averages were computed for male and female participants within each group to capture central tendencies and identify potential gender-based differences, as detailed in Table 4. To assess the statistical significance of these differences, a Mann-Whitney U test was applied. A non-parametric test was selected because preliminary analyses indicated that the VOT data violated the assumptions of normality required for parametric tests, such as the independent samples t-test. Specifically, the VOT distributions were skewed and exhibited unequal variances between groups. Given these conditions, the Mann-Whitney U test provided a more appropriate alternative, as it does not assume normal distribution and is robust for comparing median values

between two independent groups. The results of this statistical analysis are presented in the Results section. As shown in Table 4, female children produced longer VOTs for voiceless stops (/t/, /k/) than males, while males exhibited stronger L1 transfer in voiced stops (/b/, /d/, /g/).

TABLE 4. Mean VOT values of English plosives in bilingual Emirati children and adults

| GENDER | /b/ | /p/ | /d/ | /t/ | /g/ | /k/ |
|---|---|---|---|---|---|---|
| FEMALE   CHILDREN | 78.94 | 22.95 | 135.63 | 69.93 | 102.1 | 102.76 |
| FEMALE ADULT | 105.46 | 36.54 | 184.58 | 94.1 | 106.35 | 98.9 |
| MALE CHILDREN | 106.76 | 23.03 | 157.02 | 48.82 | 127.65 | 57.29 |
| MALE ADULT | 81.70 | 92.79 | 117.19 | 80.28 | 64.85 | 71.08 |

## RESULTS AND DISCUSSION

Analysis of mean VOT values revealed gender-based differences in the production of voiced and voiceless plosives among bilingual Emirati children. Male participants consistently produced longer VOTs for voiced stops compared to females, with /b/ averaging 106.76 ms versus 78.94 ms, /g/ 127.65 ms versus 102.1 ms, and /d/ 157.02 ms versus 135.63 ms. These results align with previous findings (Whiteside & Marshall, 2001; Koenig, 2001), where males produced longer VOTs, often attributed to physiological factors such as larger vocal tracts and differences in laryngeal timing. However, physiological explanations alone are insufficient; sociophonetic factors, such as greater articulatory precision typically observed among females, may also influence VOT. Bilingual studies (Flege, 1991; Saadah, 2011) similarly report greater L1 transfer effects among males, suggesting that the observed gender differences result from a combination of biological, linguistic, and sociocultural influences rather than anatomical factors alone.

On the other hand, female participants exhibited longer VOTs for voiceless stops compared to males. For the voiceless stop /t/, females produced an average VOT of 69.93 ms, while males produced a significantly shorter VOT of 48.82 ms. A similar pattern was observed for /k/, with females showing an average VOT of 102.76 ms, compared to 57.29 ms for males. These findings are consistent with earlier studies, such as Byrd (1992) and Whiteside & Marshall (2001). Physiologically, females typically exhibit greater muscle tension and articulatory precision, which may lead to longer durations between the release of the stop and the onset of voicing. This increased tension and precision are thought to result in longer VOTs, particularly for voiceless stops (Koenig, 2001, pp. 1058–1068). Additionally, girls' earlier mastery of phonological features, such as VOT, may also be attributed to their greater attentiveness to linguistic input and superior phonological processing abilities (Tenenbaum & Leaper, 2002).

In addition to physiological factors, sociophonetic elements are considered potential contributors to gender differences in VOT. Research by Byrd (1992) and Eckert and McConnell-Ginet (2003) suggests that females often adopt more careful speech styles, particularly in contexts where clarity is socially emphasized. However, since the participants in this study are preschool-aged, such self-driven sociophonetic behaviour may not yet be fully established. Instead, gendered speech patterns at this stage are likely influenced by socialization processes. Studies have shown that teachers and caregivers tend to provide more linguistic scaffolding and clearer feedback to girls than to boys, reinforcing articulatory precision from an early age (Foulkes et al., 2005; Ochs,

1992). Peer interactions may also contribute, as young girls are often socialized into language practices emphasizing clarity and careful articulation. Thus, even before self-regulation emerges, external social reinforcement may significantly shape early gender differences in phonological production.

Furthermore, the results showed no significant gender-based differences in the production of the voiceless stop /p/, with males producing an average VOT of 23.03 ms and females producing an almost identical VOT of 22.95 ms. The lack of significant variation may be attributed to the articulatory characteristics of bilabial stops like /p/, which involve relatively straightforward and symmetrical closure of both lips, requiring less complex coordination compared to alveolar or velar stops. In contrast, alveolar and velar stops involve more intricate tongue placements and varying aerodynamic demands, which can introduce greater individual variability in timing and precision. As bilabial articulation tends to be biomechanically simpler and more uniform across speakers, it minimizes opportunities for gender-based differences to emerge (Alsuhaim, 2022, p. 15; Sweeting & Baken, 1982, p. 109). Moreover, this pattern aligns with the concept of phonetic universals, which suggests that certain phonetic properties—such as the basic articulatory ease and acoustic stability of bilabial stops—are consistently observed across languages and speaker groups. Thus, the near-identical VOT values for males and females in producing /p/ underscore how universal biomechanical factors can constrain variability even in bilingual contexts (Flege, 1991, p. 403).

The Mann-Whitney U statistical results demonstrate that for /b/, the U-statistic was 58 with a p-value of 0.307434 (r = 0.58); for /p/, the U-statistic was 46 with a p-value of 0.967436 (r = 0.46); for /d/, the U-statistic was 51 with a p-value of 0.653379 (r = 0.51); for /t/, the U-statistic was 19 with a p-value of 0.037336 (r = 0.19); for /g/, the U-statistic was 58 with a p-value of 0.307434 (r = 0.58); and for /k/, the U-statistic was 15 with a p-value of 0.016011 (r = 0.15), as shown in Table 5. Upon interpretation of these results, it becomes clear that the p-values for the plosives /t/ and /k/ are less than 0.05, indicating statistically significant gender-based differences in VOT values for these sounds. The associated effect sizes suggest that the differences for /t/ and /k/ are of moderate magnitude, while the other plosives exhibit small or negligible gender effects.

The results indicate meaningful gender-based differences in the production of /t/ and /k/, with females producing significantly longer VOTs than males. For /b/, /p/, /d/, and /g/, however, no significant gender differences were observed. This lack of significance suggests that gender-based variation may be less influential for certain plosives, possibly due to the articulatory simplicity of bilabials and the aerodynamic constraints on voiced stops, which promote greater cross-gender uniformity (Flege & MacKay, 2011; Goldstein, 2020). Additionally, shared bilingual exposure and phonetic universals may contribute to the stability of VOT patterns for these sounds across genders. The gender differences observed for /t/ and /k/ align with previous findings in bilingual phonological development, such as Khattab (2002), who reported that Arabic-English bilingual girls produced English voiceless stops with more native-like VOTs compared to boys, reflecting greater phonetic accuracy and a clearer separation of phonological systems.

TABLE 5. Mann-Whitney test results

| Plosive | U-statistic | p-value |
|---------|-------------|---------|
| /b/ | 58 | 0.307434 |
| /p/ | 46 | 0.967436 |
| /d/ | 51 | 0.653379 |

| | | |
|---|---|---|
| /t/ | 19 | 0.037336 |
| /g/ | 58 | 0.307434 |
| /k/ | 15 | 0.016011 |

The following section examines potential factors underlying the significant gender differences observed in the VOT production of voiceless plosives. For boys, the shorter VOT values for English voiceless plosives may result from their predominant use of Arabic in informal settings, reinforcing Arabic phonological norms (Khattab, 2013), reinforcing Arabic phonological norms. Boys may also exhibit higher rates of cross-linguistic transfer, consistent with findings by Flege (1991), who reported greater phonetic interference from the first language among male bilinguals. This difference underscores the role of language exposure and usage patterns in shaping bilingual phonological outcomes.

Additionally, other researchers such as Sundara et al. (2006, p. 507) and Fabiano-Smith and Goldstein (2010, p. 45) highlighted that females demonstrated greater adaptability and phonetic precision, enabling them to manage distinct phonological systems more effectively. Additionally, Gardner (1985, p. 120) emphasized that females' positive attitudes and stronger motivation toward second language acquisition contribute to their superior performance in phonetic tasks.

The findings underscore the importance of longitudinal research to better understand how gender influences bilingual phonological development over time. Tracking VOT acquisition in Emirati children from early childhood to adolescence could clarify whether boys' higher rates of cross-linguistic transfer persist or diminish with increased exposure to English and academic engagement (Sundara et al., 2006). Such studies could also identify critical periods for intervention, with boys potentially benefiting from early phonetic training, while girls may require advanced exercises to refine their phonological precision (Gardner, 1985).

Interventions should address the distinct needs of boys and girls in managing bilingual phonological systems. Boys may require explicit instruction and practice in producing aspirated voiceless stops in English, such as /p/ and /k/, to reduce cross-linguistic transfer. Practical strategies include contrastive drills that emphasize the aspiration in English stops compared to their Arabic counterparts. Girls, who tend to exhibit more native-like VOT patterns, can benefit from advanced exercises that refine their phonological precision, such as activities targeting consonant clusters or complex syllable structures. In addition to educators, Speech-language pathologists (SLPs) can implement these strategies using evidence-based therapy techniques, such as auditory discrimination tasks followed by production exercises. For instance, boys might first listen to and identify aspirated versus unaspirated stops before practising their production in minimal pair exercises (e.g., "pat" versus "bat").

In addition, the findings emphasize the importance of distinguishing between typical bilingual patterns, such as cross-linguistic transfer, and speech sound disorders. Boys' shorter VOT values for English voiceless stops may be misdiagnosed as a phonological delay without an understanding of typical bilingual transfer patterns. Clinical tools that incorporate bilingual norms, such as VOT ranges for Arabic-English bilinguals, can help SLPs make more accurate diagnoses. Practically, SLPs can use bilingual-specific assessment frameworks, like the Dynamic Assessment of Phonological Skills (DAPS), which evaluates phonological abilities within the context of bilingual language development (Fabiano-Smith & Goldstein, 2010). These tools should include culturally relevant stimuli, such as words frequently used in Emirati contexts, to ensure accurate and meaningful assessments.

Given the multilingual environment of the UAE, SLPs should consider the influence of additional languages, such as Hindi or Urdu, on children's phonological development. Multilingual assessments, like the Multilingual Assessment Instrument for Narratives (MAIN), can help clinicians evaluate speech patterns across multiple languages. These tools should be adapted to include Arabic-English bilingual norms and reflect the cultural and linguistic diversity of the UAE (Paradis & Genesee, 1996). In practice, SLPs can work with families to identify the dominant and secondary languages in a child's environment and design therapy plans that address specific linguistic needs. For example, an Emirati child speaking Arabic, English, and Hindi might require separate exercises for each language to ensure balanced phonological development.

Parental involvement is crucial for reinforcing therapy goals at home. Educating parents about typical bilingual development, including gender-specific patterns, can empower them to support their children's language learning. For example, parents can be encouraged to engage in structured activities, such as reading English storybooks or practising minimal pairs, to reinforce VOT production. Workshops and informational materials tailored to Emirati families can provide practical guidance on how to create a linguistically rich home environment.

The findings underscore the need for clinical tools that reflect the cultural and linguistic context of the UAE. Therapy materials should include Emirati-specific vocabulary and culturally relevant scenarios to engage children effectively. For example, materials could incorporate words and phrases commonly used in Emirati culture to make therapy more relatable. Developing bilingual speech sound inventories that include typical VOT ranges for Arabic-English bilinguals can further enhance diagnostic accuracy and intervention efficacy.

CONCLUSION

This study investigated the influence of gender on the acquisition of Voice Onset Time (VOT) in English plosives (/p/, /t/, /k/, /b/, /d/, /g/) among bilingual Emirati children, focusing on how biological and cognitive factors shape bilingual phonological development. Compared to neighbouring contexts such as Jordan, Saudi Arabia, and Lebanon—where English exposure is often limited to formal educational settings—the United Arab Emirates offers a unique linguistic landscape characterized by pervasive early English exposure across home, educational, and societal domains (Boyle, 2012; Troudi & Jendli, 2011). The widespread use of English alongside Arabic from early childhood provides an ideal context for examining how children negotiate the phonetic demands of two typologically distinct languages with differing voicing and aspiration patterns.

The findings revealed significant gender-based differences in VOT production. Female participants produced longer VOT values for English voiceless stops, particularly /t/ and /k/, exhibiting VOT durations that were closer to the expected range reported for English monolingual speakers. This suggests that female participants demonstrated greater phonetic accuracy and a more effective separation of the two phonological systems. In contrast, male participants exhibited shorter VOT values for the same voiceless stops, reflecting a stronger influence of Arabic phonetic norms. In Arabic, voiceless stops are unaspirated and characterized by shorter VOT durations, leading to greater cross-linguistic transfer among boys (Flege & Port, 1981, p. 151; Khattab, 2002, p. 21). These findings underscore the role of gender in bilingual phonological development, with potential implications for understanding how sociolinguistic, biological, and cognitive factors intersect in the acquisition of second-language phonetic features.

This research holds significant theoretical, educational, and clinical value. By contributing to models of bilingual phonological development, the study enhances our understanding of how children acquire and manage distinct phonetic systems in multilingual contexts. Furthermore, the insights gained can inform educational practices by identifying gender-specific needs in language instruction, such as incorporating contrastive phonetic drills, targeted auditory discrimination activities, and structured production practice to address cross-linguistic transfer, particularly in male learners. Clinically, the findings support the development of intervention strategies aimed at improving speech clarity and phonological differentiation rather than promoting native-like production, recognizing that functional intelligibility is the primary goal in bilingual speech development. This perspective aligns with AlShamsi's (2020) findings, which emphasize the importance of integrating sociocultural aspects into bilingual education to enhance language acquisition among Emirati students. Beyond advancing the understanding of bilingualism in the UAE, this study offers broader implications for supporting bilingual children in multicultural settings globally. Future research should further investigate how sociolinguistic factors, language dominance, and educational exposure interact with biological influences in shaping bilingual phonological acquisition across different language pairs and sociocultural environments.

## REFERENCES

Abramson, A. S., & Whalen, D. H. (2017). Voice onset time (VOT) at 50: Theoretical and practical issues in measuring voicing distinctions. *Journal of Phonetics*, 63, 75–86. https://doi.org/10.1016/j.wocn.2017.05.003

Al Abed, I., & Vine, P. (2005). *United Arab Emirates: A new perspective*. Trident Press Ltd.

Al-Issa, A. (2019). English language teaching in the United Arab Emirates: Challenges and future directions. *Learning and Teaching in Higher Education: Gulf Perspectives*, *16*(2), 33–48. https://doi.org/10.18538/lthe.v16.n2.272

Al-Issa, A., & Dahan, L. (2011). Global English and Arab learners: A sociolinguistic study of ESL teachers' perceptions. *Theory and Practice in Language Studies*, *1*(3), 243–251. https://doi.org/10.4304/tpls.1.3.243-251

Alsuhaim, W. (2022). Gender differences in the acquisition of VOT of English bilabial stops among Saudi ESL learners. *3L: Language, Linguistics, Literature® The Southeast Asian Journal of English Language Studies, 28*(3), 99–115. https://doi.org/10.17576/3L-2022-2803-08

AlShamsi, A. S., & Alsheikh, N. O. (2020). Sociocultural integration of bilingualism and biliteracy of Emiratis: Exploratory study in a group of fifth-grade students. *3L: Language, Linguistics, Literature*, *26*(3), 66–80. https://doi.org/10.17576/3L-2020-2603-06

Al-Tai, F., & Kasim, Z. (2021). Acoustic analysis of VOT in Iraqi Arabic stops. *Journal of Language and Linguistic Studies*, *17*(2), 689–703. https://doi.org/10.17263/jlls.889472

Al-Tamimi, F., & Khattab, G. (2011). VOT production in bilingual and monolingual Jordanians: Language contact and phonetic convergence. *International Journal of Bilingualism*, *15*(4), 446–470. https://doi.org/10.1177/1367006910371025

Al-Wer, E. (2024). Phonological conditioning of affricate variability in Emirati Arabic. *Journal of the International Phonetic Association*, 54(1), 146–164. https://doi.org/10.1017/S0025100323000166

Bloomfield, L. (1933). *Language*. Holt, Rinehart & Winston.

Boersma, P., & Weenink, D. (2021). PRAAT: *Doing phonetics by computer* (Version 6.1.41) [Computer software]. http://www.praat.org

Boyle, J. (2012). The challenge of teaching English in multilingual contexts: A case study from the UAE. *TESOL Arabia Perspectives, 19*(2), 18–23.

Buckingham, L. (2016). English as a lingua franca in the Gulf. *World Englishes, 35*(1), 104–121. https://doi.org/10.1111/weng.12140

Burman, D. D., Bitan, T., & Booth, J. R. (2008). Sex differences in neural processing of language among children. *Neuropsychologia, 46*(5), 1349–1362. https://doi.org/10.1016/j.neuropsychologia.2007.12.021

Byrd, D. (1992). Sex differences in vocal tract variations in vowel production. *The Journal of the Acoustical Society of America*, *91*(1), 300–311. https://doi.org/10.1121/1.402758

Eckert, P., & McConnell-Ginet, S. (2003). *Language and gender*. Cambridge University Press.

Fabiano-Smith, L. (2019). Standardized tests and the diagnosis of speech sound disorders. Perspectives of the ASHA Special Interest Groups, 4(1), 58–66. https://doi.org/10.1044/2018_PERS-SIG1-2018-001

Fabiano-Smith, L., & Bunta, F. (2012). Voice onset time of voiceless bilabial and velar stops in 3-year-old bilingual children and their monolingual peers. *Clinical Linguistics & Phonetics, 26*(2), 148–163. https://doi.org/10.3109/02699206.2011.632943

Fabiano-Smith, L., & Goldstein, B. (2010). Phonological acquisition in bilingual Spanish–English-speaking children. *Journal of Speech, Language, and Hearing Research, 53*(1), 160–178. https://doi.org/10.1044/1092-4388(2009/08-0135)

Federal Competitiveness and Statistics Centre. (2020). Annual report 2020: Population and demographics. Abu Dhabi: FCSC.

Flege, J. E. (1991). Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language. *The Journal of the Acoustical Society of America, 89*(1), 395–411. https://doi.org/10.1121/1.400473

Flege, J. E., & MacKay, I. R. A. (2011). What accounts for 'age' effects on second-language learning? *Studies in Second Language Acquisition, 33*(3), 635–668. https://doi.org/10.1017/S0272263111000303

Flege, J. E., Munro, M. J., & MacKay, I. R. A. (1995). Factors affecting strength of perceived foreign accent in a second language. *The Journal of the Acoustical Society of America, 97*(5), 3125–3134. https://doi.org/10.1121/1.413041

Flege, J. E., & Port, R. (1981). Cross-language phonetic interference: *Arabic to English. Language and Speech, 24*(2), 125–146. https://doi.org/10.1177/002383098102400203

Foulkes, P., Docherty, G. J., & Watt, D. (2005). *Phonological variation in child-directed speech. Language, 81*(1), 177–206. https://doi.org/10.1353/lan.2005.0010

Gardner, R. C. (1985). *Social psychology and second language learning: The role of attitudes and motivation*. Edward Arnold.

Goldrick, M., Runnqvist, E., & Costa, A. (2014). Language switching makes pronunciation less nativelike. Psychological Science, 25(4), 1031–1036. https://doi.org/10.1177/0956797613518352

Goldstein, L. (2020). Phonological universals and language-specific variation. Annual Review of Linguistics, 6, 319–338. https://doi.org/10.1146/annurev-linguistics-011619-030525

Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Brain and Language, 36*(1), 3–15. https://doi.org/10.1016/0093-934X(89)90048-5

Hambly, C., Wren, Y., McLeod, S., & Roulstone, S. (2013). The influence of bilingualism on speech production: A systematic review. *International Journal of Language & Communication Disorders, 48*(1), 1–24. https://doi.org/10.1111/j.1460-6984.2012.00178.x

Khattab, G. (2002). VOT production in English and Arabic bilingual and monolingual children. In A. Skarabela, S. Fish, & A. Do (Eds.), BUCLD 26: Proceedings of the 26th Annual Boston University Conference on Language Development (pp. 336–347). Cascadilla Press.

Khattab, G. (2013). Phonetic convergence and divergence strategies in English-Arabic bilingual children. *Linguistics, 51*(2), 439–472. https://doi.org/10.1515/ling-2013-0017

Koenig, L. L. (2001). Laryngeal factors in voiceless consonant production in men, women, and 5-year-olds. *Journal of Speech, Language, and Hearing Research, 44*(5), 1051–1066. https://doi.org/10.1044/1092-4388(2001/083)

Lisker, L., & Abramson, A. S. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. *Word, 20*(3), 384–422. https://doi.org/10.1080/00437956.1964.11659830

Macnamara, J. (1967). The bilingual's linguistic performance: A psychological overview. *Journal of Social Issues, 23*(2), 58–77. https://doi.org/10.1111/j.1540-4560.1967.tb00522.x

McCarthy, M., Evans, G., & Giegerich, H. J. (2014). *The Routledge handbook of phonological theory*. Routledge.

Ochs, E. (1992). Indexing gender. In A. Duranti & C. Goodwin (Eds.), *Rethinking context: Language as an interactive phenomenon* (pp. 335–358). Cambridge University Press.

Olson, D. J., & Hayes-Harb, R. (2019). VOT production and perception in Arabic-English bilinguals. *Bilingualism: Language and Cognition, 22*(1), 88–102. https://doi.org/10.1017/S1366728917000561

Paradis, J. (2021). Bilingual children's acquisition of English verb morphology: Effects of language exposure, structure complexity, and L1 properties. *Language Learning, 71*(1), 169–211. https://doi.org/10.1111/lang.12426

Paradis, J., & Genesee, F. (1996). Syntactic acquisition in bilingual children: Autonomous or interdependent? *Studies in Second Language Acquisition, 18*(1), 1–25. https://doi.org/10.1017/S0272263100014662

Roberts, J. (1997). Acquisition of variable rules: A study of (-t,d) deletion in preschool children. *Journal of Child Language, 24*(2), 351–372. https://doi.org/10.1017/S030500099700306X

Saadah, E. (2011). Voice onset time production in Najdi Arabic and English: A cross-linguistic study of adult and child bilingual speakers. In E. Benmamoun (Ed.), Perspectives on Arabic linguistics XXII–XXIII (pp. 245–268). John Benjamins Publishing Company. https://doi.org/10.1075/sal.1.12saa

Sony Corporation. (n.d.). ICD-PX370 digital voice recorder user guide. https://www.sony.com/electronics/support/articles/00008352

Sundara, M., Polka, L., & Baum, S. R. (2006). Production of coronal stops by bilingual French-English children. *Journal of Phonetics, 34*(4), 499–517. https://doi.org/10.1016/j.wocn.2005.10.001

Sweeting, P. M., & Baken, R. J. (1982). Voice onset time in normal subjects: A comparative study of two measurement techniques. *Journal of Speech and Hearing Research, 25*(1), 99–109. https://doi.org/10.1044/jshr.2501.99

Tamim, A., & Hamann, S. (2021). Voice onset time in Palestinian Arabic: Effects of dialect, gender, and context. *Journal of the International Phonetic Association, 51*(2), 259–276. https://doi.org/10.1017/S0025100319000200

Tenenbaum, H. R., & Leaper, C. (2002). Are parents' gender schemas related to their children's gender-related cognitions? A meta-analysis. *Developmental Psychology, 38*(4), 615–630. https://doi.org/10.1037/0012-1649.38.4.615

Troudi, S., & Jendli, A. (2011). Emirati students' experiences of English as a medium of instruction. *Learning and Teaching in Higher Education: Gulf Perspectives, 8*(1).

Whiteside, S. P., & Marshall, J. (2001). Developmental trends in voice onset time: Some evidence for sex differences. *Phonetica, 58*(3), 196–210. https://doi.org/10.1159/000028712

Whiteside, S. P., & Marshall, J. (2001). Developmental trends in voice onset time: Some evidence for sex differences. *Phonetica, 58*(3), 196–210. https://doi.org/10.1159/000056199

Wilsenach, C., & Makaure, P. (2018). Gender effects on phonological processing and reading development in Northern Sotho children learning to read in English: A case study of Grade 3 learners. *South African Journal of Childhood Education, 8*(1), Article a546. https://doi.org/10.4102/sajce.v8i1.546

Yang, C.-L., & Fox, R. A. (2014). The effect of dialect and bilingualism on VOT production in Mandarin-English bilinguals. *Journal of Phonetics, 47*, 279–296. https://doi.org/10.1016/j.wocn.2014.10.005

Younes, R., & Mueller Gathercole, V. C. (2022). Cross-linguistic influence on voice onset time in Spanish-English bilingual children. *Bilingualism: Language and Cognition, 25*(2), 357–372. https://doi.org/10.1017/S1366728921000186