The domination of the sound processing system of L1 over L2 in bilingual learning

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Abstract

The issue concerning whether the speech sound in bilingualism is activated by one system or two systems of different languages simultaneously requires further evidence. Thus, this study attempted to investigate the domination of sound systems across English and Balinese from the perspective of dual coding theory. This study applied a qualitative approach that describes the English speech of Balinese speaking students presented in the form of a segmental category. This study involved 76 students of English in Denpasar. The instruments were in the form of 65 English words list, picture lists, and 10 sentences. The phonetic features including formant value and voiced onset time (VOT) were analyzed with PRAAT. Each data were classified using the articulatory phonetic and referential technique. The study revealed that the students tended to activate the system of L2 independently but arrived at the phonetic realization of L1. The mental sound process occurs from coding, retrieval, and phonetic implementation. Balinese speaking students in articulating English activate L1 and L2. However, the phonetic implementation can be purely L2, mixed L1 and L2, or just purely L1. This tendency depends upon students' phonological awareness, learning experience, or their daily practice. This study suggests that the four levels of students' English articulation involve transmission, perception, phonological process, and phonetic realization. The activation of the sound system of L1 into L2 occurs in the perception level. This study suggests that the learners and teachers of English in Bali should adopt explicit learning to minimize the influence of L1 on L2.

1. Introduction

Incorrect English pronunciation by students of all education levels in Bali does not seem a prominent and unique issue to investigate because the errors are assumed by some scholars to be a natural process in bilingual learning and do not require any further debate. However, exploring the investigation of language sound processing does not only overview the natural truth of sounds but also provides a scientific vision about mental sound analysis. English and Balinese language sounds have a relatively identic articulation mechanism. However, some consonants such as /ʃ/, /tʃ/, /f/, and /v/ or consonant cluster /sp/ do not correspond with Balinese orthography. The structure of the English sound unit violates the consistency of orthography. In English, orthography is not the phonetic realization of the language because the relation of words and sounds is not always symmetric (Polinsky & Scontras, 2019). Harley (2001) states that English printed letters do not always correspond to specific sounds and vice versa. The letter "o" represents several different sounds (such as in the words "mock", "moon", and "mow").

Inconsistency between English orthography and its phonetic realization makes the Balinese students feel confused. Coding the speech sound may involve sound transmission, perception, mental phonology, and realization. The information from letters and speech sounds come from visual and auditory sensory. Furthermore, the system activates the coding system of two different languages through the interpretation of word sound and meaning. In bilingual learning, the coding sounds come from the dual language system; mother language (L1) and target language (L2). In the coding process, the separation of two language systems controls the mental process of sound from the underlying form into deriving form employing sound alteration and representation (Adnyani & Pastika, 2016). The final stage of coding the written symbols is the phonetic realization that covers two sound language systems (Clark & Paivio, 1991).

The phenomenon of incorrect English pronunciation by foreign students refers to linguistic, psycholinguistic, or neurolinguistic concerns (Amengual & Simonet (2019); Adnyani et al., (2018); Buckingham & Christman (2008). Vihman (2002) suggested that incorrect pronunciation of L2 by the speaker of L1 reveals from the influence of L1, learning experience, and habit formation as part of explicit learning 'direct learning'. Indirect learning means the knowledge of language sound structure is from unconscious learning since the baby is in the womb (Vihman, 2002). Furthermore, Hardlock (2019) states that conception and experience enable language learners to produce closely native-like pronunciation. However, amongst foreign language research findings and learning models, the emphasis on sound coding systems in bilingual learning of English by Balinese students requires more empirical studies and scientific evidence.

The articulation of English sound by Balinese learners who master their mother language does not only involve comparative cognition between two different language systems but also the anticipation of how to balance the system (Flege & Bohn, 2021). Domination of the language system of L1 on the articulation of L2 results in phonemic contrary. This domination occurs due to the information transmission process. The transmission ends up in a complicated perceptions mechanism (Dragger, 2010). The inaccuracy of articulation may result in confusion and miscommunication. The Balinese students produce inaccurate articulation of English in three ways (Wardana, 2014) including (1) letter-based articulation (/tired/ → [ti'red]), (2) direct interpretation of sound (/massage /məsadʒ/ → [masas]), and (3) misconception phonological rules (*has* /hæz/→ ['hæs]).

In the process of bilingual phonology, the sound system of L1 influences the phonological representation of L2. Therefore, the phonetic representation of two different languages describes the articulatory or conceptual phenomenon of two systems. The process of alteration may occur through substitution, deletion, insertion, or addition. There is an insertion of vowel /ə/ between the consonant cluster /s/ and /p/ in the initial position as in the sound of /spi:k/. So Balinese learners tend to say [sə'pɪk], or consonant cluster of /dʒt/ in medial position as /veɪdʒtəbl/ released as [vejəteɪbəl], or /help/ becomes [heləp]. The phenomenon triggers some questions about the insertion /ə/ in the middle position of words. The insertion is a conceptual phenomenon that can follow the phonological rules generalization (Odden, 2005). Balinese sound system does not recognize the cluster of /sp/, /bl/, and /lp/, so there is a sound simplification by inserting /ə/. So, a specific coding theory can solve the questions or the phenomenon.

From the language learning point of view, phonological awareness and habit formation may result in the appropriate English pronunciation (Wardana, 2014). Phonological awareness is crucial for constructing conceptual sounds, so the students recognize the sound system of the target language. Explicit learning may contribute a big impact on sound pattern formation. So, the activation of L2 achieves accurate goals. Balancing the interference of L1 on L2 requires a learning strategy. Phonological awareness may enable students to identify, differentiate, and implement phonetic realization correctly (Galles & Bosch, 2005). The physiology of articulation should be at an earlier age before the sound physiology of L1 does not dominate (Simonet, 2016). By communication habit formation, the movement of articulators seems unconsciously natural as L2.

Considering the phenomenon, this study aims to describe any types of English phonological alteration errors produced by Balinese students. Furthermore, this study examines the interference of the sound systems of L1 and L2 in bilingual learning. The third objective of the study is to describe how the dual coding theory examines the domination of the L1 sound system over L2 word sound processing. The role of dual coding theory describes the dominance of two different language systems. The combination of phonological theory and bilingual learning theory as the basic concept of dual coding theory may provide evidence of existing articulation phenomena of English by Balinese students. The phonological theory describes the articulatory phenomenon of both languages (Schane,

1973). Meanwhile, the dual coding theory may provide information on how the sound system activates L1 into L2 simultaneously, so the effective strategy in bilingual learning may result in better achievement.

1.1. Literature review

The majority of empirical study in bilingualism supports the insight that the system of two different languages in bilingual learning always seems integrated. Processing the two languages by bilingual speakers certainly sounds non-selective (Schwartz, 2020). The study which investigates visual and auditory words recognition in bilingualism reveals that lexicons of the two languages locate in the same brain area. The retrieval process in reading or listening comprehension does not go directly to the language selection but cultivates those words from two languages simultaneously. The individuals who learn their second language in the adult stage often face some phenomenon of (1) the new language category (the sound only exists in L2); (2) voice contrary or phonological distinction in L2 or new articulations; and (3) habitual perceptions, meaning the L1 of the bilingual speakers interact with L2. Interactions between two languages activate the two systems based on the modern theory of phonology and language learning model (Flege & Bohn, 2021).

The bilingual speakers face difficulties in sound identification, articulation, and interpretation of L2 because of the differences between phonological structure and rules from L1. The phonological categories are not directly copied from L2 and past them in L2 because phonetically the sounds are distinctive. Some shreds of evidence reveal that bilingual speakers develop the connection within identical sounds across languages, but sometimes the simplification occurs to avoid being stuck (Flege & Bohn 2021). The phonetic analysis reveals that the bilingual speakers are not identic with the control of one language, neither L2 nor L1 (Kegoe, 2002). In other words, like other studies, this study assumes the bilingual speaker establishes a formal relationship between the phonetic category of L2 and the close phonetic category of L1.

1.1.1 Phonological bilingualism

The objective of the phonetic and phonological study in bilingualism is to explore the new category formation in speech production based on the habitual and perceptual strategy; save and retrieve (Bybee, 2001; Harley, 2001). According to some notions from different schools, like Simonet (2016): Polinsky & Scontras (2019); Dragger (2010), phonological awareness consists of category determination one of which as phoneme and sequence of rules in the speech sound based on the status and system. In line with this statement, Balinese bilingual learners who learn English should acknowledge the language category of both languages. The awareness of the phonological category allows the students to pronounce every distinctive phoneme accurately. The previous chaptered studies have underlined the influence of phonetic and phonological structure in L2. The synthesis of the studies finds the keywords of structure and system from two different languages. Amengual (2011) suggested the difference of acoustic measurements of voiceless plosive sound (/p/, /t/, /k/) in the initial position of Spanish and English words. The phonetic variation for voiceless plosive sound should be aspirated [p^h, t^h, c^h] is not known in Spanish (Magloire and Green, 1999), however, some speakers acknowledge the rules (e.g., Flege & Bohn (2021); Vihman (2002); Fowler et al., 2008)It means that the voiceless plosive consonant generally occurs due to interaction across the languages. This rule does not also exist in Balinese sound structure so it might be the same evidence that Balinese learners may articulate the segments as the letter tells.

1.1.2 Dual coding system

Some scholars suggest that the mastery of dual system and sound structure have two dependent tracts in phonological learning; implicit and explicit. Implicit learning begins in the prenatal stage,

where the baby recognizes the first language, especially the rhythm pattern of the mother's speech (Simonet, 2016). Furthermore, with the development of phonological skills, the children begin conceptualizing the sound patterns and associate them with meaning from the sound reference. The process of sound conception enrichment also refers to routines as habit formation known as explicit learning (Flege & Bohn 2021). Some theoretical frameworks support the prominent roles in dual-modality in pronouncing the L2. The dual coding theory supports the role of nonverbal language in activating the systems. According to this theory, individuals process the verbal and visual cues through different lines but independently, heading to learning outputs because the constant verbal and nonverbal language across the languages can strengthen the learning (Clark & Paivio, 1991). Empirical studies found positive shreds of evidence of visual cues like lips shape for L2 articulation learning (e.g. Hardison, 2004; Hazan et al., 2005; Olson, 2014). This theory found by Paivio (1986) attempts to provide equal measurement in verbal and nonverbal processing. Clark and Paivio (1986) suggest that human cognition is uniquely specified for language and objects simultaneously. It means that the language system specifically relates directly with linguistic input and output in the form of spoken and written language. Meanwhile, simultaneously handle the symbolic function of nonverbal object, occurrence, and behavior. Any representational theory should accommodate dual functionality.

Dual coding theory identifies three types of processing, including (1) representational; direct activation from verbal and nonverbal clues; (2) referential, activation of the verbal system by the nonverbal system or vice versa; (3) associative processing, representation activation in the same verbal or nonverbal system. This theory elaborates on many cognitive phenomena, including mnemonics, problem-solving, learning principles, and language. Dual coding theory provides the significance of spatial ability in intelligence and elaboration of bilingual processing.

Therefore, this study attempts to identify, classify, and elaborate on the phenomenon of two speech sound coding mechanisms. This study assumes that the interference of the sensory system in stimulating the two different language symbols produces different outcomes or phonetic realization. Sound identification focuses on the comparison of two language pronunciations. The differences are classified into the phonological process in both language systems and this study observes the domination of one language over the other. From the phonological process, this study assumes that L1 influences the phonetic realization of L2 and can be balanced by implicit and explicit learning models.

1.2. Research questions

This study has three research questions.

Question 1: What type of English phonological alteration errors do Balinese students produce?

Question 2: How do the two sound systems of L1 and L2 interfere with one another in bilingual learning?

Question 3: How does dual coding theory describe the domination of the L1 sound system over L2?

2. Method

2.1 Sample

The study was carried out in May 2021. It involved EFL university-level EFL students in Denpasar from three different universities. The population was 95 students who have been learning English since they were 9-years old. The determination of sample amount referred to Slovin model with *a margin of error* was 5% or 0,05. Therefore, the samples were 76 students that were purposively gathered. The sample consisted of 25 or 33% boys and 51 or 67% girls. Where 20 students were the

age of 18 or 19 years old, 37 students were the age of 20 or 21, and 19 students were at the age of 22 or 23. The sample was considered representative enough for a case generalization.

2.2 Instrument

The instruments that were utilized to collect the primary data in this study were sixty English word and pictures lists and ten sentences. The students read the words and those sentences and recorded them with a sonny sound recorder. The words, word pictures, and the sentences were constructed containing consonants, consonant clusters, vowels, and diphthongs in different distributions; in initial, media, and final positions. The student's sound recordings were gathered and classified into types of distortion, segmental alteration, and four factors of misrepresented articulation. All the instruments were validated by expert judges in phoneticians, linguists, and language lecturers. To measure the accurateness of the English sounds production of the students, the acoustic features of the sound recordings were analyzed using PRAAT (Boersma & Weenink, 2020) to recognize if there were any sound distortion, sound alteration errors, and VOT for aspirated plosive consonants.

2.3 Data collection procedures

The data were analyzed and presented considering to the objective of the study, questions of the study, and characteristics of research approach. First objective was to describe the level and types of phonological alteration and factors that caused the phonological distortion and alteration. So, all the errors were calculated in form of percentage, the distribution were tabulated, and the results were presented in graphs. The second objective was supposed to analyze the alteration made by Balinese students and how the alteration might occur in perspective of generative phonology. Furthermore, in this section, the new finding was assumed concerning how the dual system theory worked in these cases. The third objective explored how the study revealed the new model to describe how the bilingual learners interpreted the L2 language sound and implemented into any types of realization. From these objectives, the implicit and explicit type of sound bilingual learning were applied and described for changing the student's problems and obtain more accurate and better English alteration.

2.4 Data analysis

Data collection procedures and data analysis can be combined under "Data collection and analysis". This section describes how the study was conducted. It explains, in as much detail as possible, what happened and how you carried out the investigation. This section is especially important in experimental studies that require a detailed description of the intervention. Examples of information to present in this section include a description of the training required to implement a new experimental teaching method and the types of instructions to be provided to respondents who were asked to complete a survey. This section should also contain a realistic timetable for the different phases of the study.

For the classroom action study, the data were analyzed descriptively to know the total score, mean, and standard deviation of the students' achievement after CBI, CLT, and TBLT was applied in distance learning. So, the students' achievements were categorized as very high, high, sufficient, poor, and very poor. A descriptive analysis was run to examine the students' levels of academic negative emotion. Pearson correlation was carried out to investigate the effect of CTS on students' learning intention, achievement, and their perception of depression, anxiety, and stress. Statistic multiple correlation tests were also used to describe the two independent correlations that might affect the dependent variable simultaneously. So, this analysis was used to see whether the strategy applied had a strong and positive correlation with learning intention and learning emotion. Furthermore, a t-test

with two-tailed was used to measure any correlation within variables if the coefficient correlation value was less than 0.05.

3   Results

Results were presented in three parts according to the three objectives and three research questions.

3.1 Type of incorrect English phonological alteration errors data is shown according to Objective 1 and Question 1.

Objective 1: To examine types of English phonological alteration errors produced by Balinese students.

Question 1: What type of English phonological alteration errors do Balinese students produce?

The data analysis begins with the comparison of Balinese students' English pronunciation to the English pronunciation of native speakers. The comparison of pronunciation can describe phonological phenomenon from the sound structure and system of both different languages. The study analyzes and describes the reconstruction of the mental concept of consonants and vowels, the phonological process of English produced by Balinese students, the domination of L1 and L2, and some factors the different realization of L1and L2 in phonetic points of view. The inaccurate English consonant articulation in initial, middle and final positions by Balinese students can be presented in Figure 1.
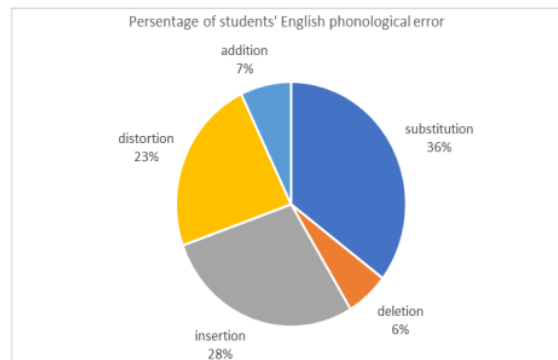

Figure 1. Graph of Inaccurateness of English consonant articulation by Balinese students

The students made 228 correct articulations or 30% from 760 students' total answers. The study revealed that the total number of incorrect articulations of English by 76 Balinese students was 532 or 70% of all data that consisted of 132 or 25% incorrect articulation of fricative consonants, 387 or 73 % incorrect allophones of the voiceless plosive consonant in the initial position, and only 11 or 2% incorrect vowel sound. All incorrect answers were classified into five types of incorrect pronunciation, such as substitution, insertion, addition, deletion, and inaccurate articulation. There were 188 or 35% substitution, 32 or 6,1 % deletion, 150 or 10% insertion, 124 or 9 % incorrect articulation, and 38 or 7,14% addition. Four factors that affect the errors consist of 128 or 18% overgeneralization, 133 or 25% incorrect rules, 138 or 26% false concepts, and 133 or 25% fossilized distortion.

factors of the phonological errors
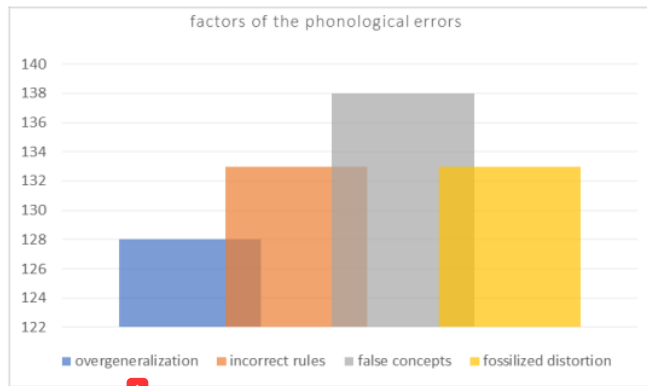
3.2 Comparison of L2 and L1 data are shown according to Objective 2 and Question 2.

Objective 2. To examine the interference of sound system of L1 and L2 in bilingual learning

Question 2: How do the two sound systems of L1 and L2 interfere with one another in bilingual learning?

Diphthong in Balinese can be found in initial and middle position of the words, but only few in final position, /iə/ like /tabiə/ 'pepper', /ai/ as in /sai/ 'often', /au/ as in /sau/ 'fishing net' and [uə] as in /muə/ 'face'. Balinese has mostly monophthong in the final position. This system might interfere with the phonemic coding and phonetic implementation for the target sounds. However, the syllabic system of English as the target language allows diphthong in the final position. The novel articulation direction in English diphthong may arise from low to high or from high to low vowel, but in Balinese, the direction goes mostly from high to low position. Some Balinese diphthongs that do not match with English diphthongs in final position are /ei/, /əʊ/, /oʊ/, /oi/. So, the Balinese students mostly delete the last vowel to monophthong. So, it becomes /e/, /ə/, and /o/. a monophthong. Some examples of diphthongs that are pronounced as a single vowel are presented below.

1) diphthong /eɪ/ becomes /e/ in final position

today /təˈdeɪ/ → [tude]

okay / əʊˈkeɪ/ → [oke]

From the three examples, the articulation of English diphthong /eɪ/ by Balinese students phonetically reveals theoretical and empirical facts. Theoretically, the Balinese sound system manages the direction of sequences of two vowels that moves from high vowel to low vowel in the final position, like front middle vowel /siə/ 'nine', but this system does not lead the gliding from low to high vowel as /eɪ/. For this reason, the students simplify diphthong /eɪ/ by deleting the high back vowel /ɪ/ in the final position. Empirically, the high vowel deletion is influenced by a perceptual formation that affects the mapping phonetic implementation in the brain (Schwartz, 2020).

2) Diphthong /əʊ/ becomes /o/ in final position

go /gəʊ/ → [go]

know /nəʊ/ → [no]

English diphthong of /əʊ/ phonetically glides from middle and central novel to high back rounded vowel. However, the Balinese sound system manages the movement of high to middle or low vowels, not from low or middle vowels to high vowels in the final position. Therefore, Balinese students apply their sound system by deleting the final vowel. So, diphthong /əʊ/ becomes monophthong [o]. When articulating /əʊ/, the tongue blade is in a middle and central position and anticipates articulating /ʊ/ by

moving the tongue blade backward and arriving in [o] position. Visual stimuli as orthography may affect the sound alteration into phonetic realization The process of word-finding may interfere with the mental process of phonological processing in bilingual learning. (Flege & Bohn, 2021). Some examples of the alteration of diphthong into monophthong are in the initial and middle positions in the words.

open /ˈəʊpən/ → [opən]

hope /həʊp/ → [hoʊp]

phone /fəʊn/ → [poʊn]

The sound system of two different languages for diphthong /əʊ/ in the middle position of words is integrated into one system. The tongue movement from a middle central position to high back rounded position /əʊ/ is altered by Balinese students into back rounded position /oʊ/. It can be an indicator of phonetic phenomenon and domination of L1. The alteration of [əʊ] for target sound (L2) becomes /oʊ/ because the sound system of L1 allows the rule that /o/is articulated as [o]. This phenomenon is in line with what (Flege & Bohn, 2021) suggests that the mechanism of word-finding in reading or listening comprehension does not lead to words selection but processes the words from different language simultaneously. The processing of diphthong /əʊ/ in the middle of the words by Balinese students tends to be the domain of conceptual articulation that the articulators may find it easier to articulate the middle back vowel [o] and goes up to articulate /ʊ/ rather than starting it with central middle vowel /ə/.

3.3 *Dual coding theory data analysis is* [1] *shown according to Objective 3 and Question 3.*

Objective 3: to describe how the dual coding theory examines the domination of the L1 sound

system over L2 word sound processing

Question 3: How does dual coding theory describe the domination of the L1 sound system over L2?

3.3.1 Insertion

Consonant cluster in English phonological rules may consists of (1) [+obstruent] and [+obstruent], such as voiceless fricative + voiceless plosive, like /sp/ in speak, /st/in steal, /sk/in sky; (2) [+obstruent] and [+sonoran], like /fl/, /fr/, /sl/, /sr/, /sn/, /sm/, /pr/, /tr/, kr/, /pl/, and /kl/. In Balinese, some consonant clusters of /sp/, /st/, dan /sk/ in initial position or /lp/ in middle position can not be normal so the insertion of /ə/ occurs to simplify the complexity of the articulation. The insertion of [14] /ə/may occur in the initial, medial, and final position. The mechanism of vowel insertion consonant clusters by Balinese students can be presented in Table 1.

Table 1. The mechanism of vowel insertion consonant clusters

Position	Target sound	-	coding activation	-	realization
	A consonant cluster of L2		The sound system of L1		The sound system of L1
	/sp/	-	Φ → [ə] /CC		[səp]
Initial	speak /spiːk/	-	/spiːk/ → [səpik]	-	[səpik]
middle	inspire /ɪnˈspaɪə(r)/	-	/ɪnˈspaɪə(r)/ → [ɪnˈsəpaɪə]	-	[ɪnˈsəpaɪə]
final	wasp /wɒsp/	-	/wɒsp/ →[wɒsəp]	-	[wɒsəp]

The insertion of /ə/ between English obstruent consonant clusters by Balinese students phonetically occurs because the articulators take a longer time to anticipate the coming consonant articulation and the tongue is in the middle and central position [-front, - high, - back]. The Balinese students tend to simplify the complexity of two consonants by inserting the vowel /ə/. The absence of the sound system

in L1 for articulating the sound of L2 influences the phonetic realization. In dual coding theory, different sound canal system ends at the junction so the sound simplification is implemented because at the moment the students are articulating /s/, the tongue anticipates the coming articulation of /p/ but it is too long and the insertion of /ə/ occurs.
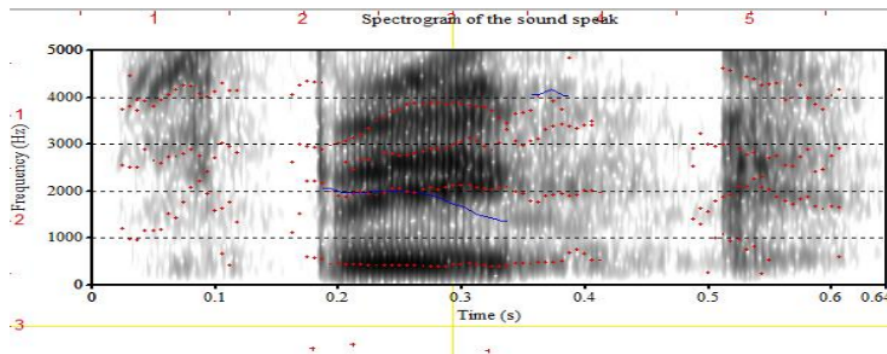

Figure 1. Effectiveness of CBI and increasing self-directed learning intention

3.3.2. Deletion

The English regular verb form can be recognized from the bound morpheme -ed that is articulated either /t/, /d/, or /ɪd/ depending on the final consonant. Some verbs that end with voiceless stop /p/, /k/ and voiceless fricative /f/, /s/, /ʃ/ dan /tʃ/ then the morpheme - ed is added and this morpheme is articulated as /t/. Other verbs that end with voiced stop /b/, /d/, /g/, voiced palatal fricative /dʒ/, and nasal /m/, /n/, /ŋ/ and then the morpheme - ed is added and this morpheme is articulated as /d/. However, the English regular verb form that ends with /t/ and /d/ is added with morpheme – ed, and this morpheme is articulated as /ɪd/. The Balinese language does not recognize this kind of morphophonemic process. So, the students articulate the regular verbs based on the orthography or delete the last segment of the consonant cluster. The phonological process of target sound (L2) by L1 students is presented below.

Tabel 2. Phonological process of consonant deletion of L2 into L1

Target sound	-	coding activation	→	realization
The sound system of L2		The sound system of L1		The sound system of L1
/d/ → [t]	-	/t/ → Φ/ - #		
stopped → /stɒpt/	-	/stɒpt/ → [stop]	→	[stop]
worked → /wɜ:(r)kt/	-	/wɜ:(r)kt/ → [wək]	→	[wək]
passed → /pa:st/	-	/pa:st/ →[pa:s]	→	[pa:s]
		/d/ → Φ / [+nasal] - #		
opened → /ˈəʊpənd/	-	/ˈəʊpənd/ → [ˈopən]	→	[ˈopən]
blamed → /bleɪm/	-	/bleɪm/ → [bleɪm]	→	[bleɪm]
meant → /mi:nt/	-	/mi:nt/ → [mi:n]	→	[mi:n]

The deletion of the consonant cluster at final position of words, like /pt///kt/, /tʃt/, /nt/, /nd/, /ʃt/, /st/, and / MD/ by the Balinese students because their language sound system does not allow any consonant cluster occur at the end of words. So, the students simplify the clusters by deleting the final segment. On the other hand, the students tend to pronounce the words as they are written. Referring to dual

coding theory (Paivio, 1990) that the dual coding concerns bilingual processing where the L2 underlying form of /t/ and /d/ are deleted in L1 due to the influence of the visual stimuli and the L1 sound system. This phonological process can be in the form of a phonological rule that the /t/ or /d/ is deleted. In the final position.

3.3.3 Substitution

English sound system manages the phonological process based on the segment neighborhood called assimilation. When the phoneme is in a qew with other phonemes to form morphemes, then the segments simultaneously influence one another and the alteration occurs. The feature of the segment is submitted by another segment by adopting similar phonetic features that appear before or after, such as place or manner of articulation or voicing. The assimilation that occurs by taking the features of the segment before the altered segment is called regressive assimilation and the segment that changes and takes the features of the coming segments is called progressive assimilation. For example, the segment with feature [–voiced] becomes [+voiced] if the segment appears after the [+voiced.] segment. The voiced consonants includes /b/, /d/, /g/, /v/, /z/, /dʒ/, /m/, /n/, /ŋ/, /y/, /w/, /r/, /l/. However, the underlying form /z/ is realized into deriving form /s/ by Balinese speakers who learn or speak English. So, the mechanism of the phonological process of phonological representation into phonetic realization by L1 speakers is described in Table 2.

Tabel 3. Phonological process of voicing alteration of L2 into L1

Target sound	→	coding activation	·	realization
The sound system of L2		The sound system of L1		The sound system of L1
/s/ → [z]	→	/z/ → [s]		
swims → [swɪmz]	→	/ swɪmz/ → [suwims]	·	[suwims]
changes → [ʧeɪndʒɪz/	→	/ʧeɪndʒɪz /→ [ʧeinʒes]	·	[ʧeinʒes]
goes → [gəʊz]	→	/gəʊz / →[goʊs]	·	[goʊs]

The voiceless alveolar fricative /s/ is articulated as voiced /z/when it occurs after voiced consonants /b, d, g, m, n, v, dʒ). However, in the Balinese sound system, voiceless consonants never change into voiced consonants. So, the underlying form of /z/ is represented as a deriving form of [s]. The phonetic realization of L2 by L1 speakers derives from the strong visual sensory of orthography of L2. It means that /s/ is articulated as [s] in any segmental environment.

3.3.4. Silent consonant

Silent consonant sound in English orthography refers to the letters that are not articulated or deleted in a specific position. In English pronunciation, there are letters or combinations of letters that are not mentioned. For example, /b/ in 'subtle', /c/ in 'scissors', /g/ in 'design', 't" in 'listen, /gh/ in 'thought'. Balinese students tend to articulate all letters based on the Balinese sound system or rules. There are some rules for the silent consonant; (1) b is silent in the cluster of /mb/ and bt at the end of words, such as comb, numb, bomb, limb, and debt; (2) d is alw3ays silent in the cluster of /dj/: adjective, adjunct, adjacent; (3) /g/ is silent in the spelling of gm or /gn/: phlegn, gnarl, champagne, sign, gnat, gnaw; (4) /h/ is silent in a cluster of /gh/ and in the word-final position: ghost, ghetto, aghast, ghastly, ah, eh, oh.; and (5) k is silent before /n/ in initial position: kneel, knee, knob, knight, knave, knowledge, knife, knock".

3.3.5 Aspirated vs non-aspirated

English sound system has a phonetic variation called allophone. One of them is aspirated voiceless plosive consonants. Each voiceless plosive consonant, such as /p/, /t/, /k/ in initial distribution of

words becomes aspirated [+aspirated]. Aspirated sounds are the sounds produced with a restriction between the release of closure of stop consonants, like [*h*] in [pʰ, tʰ, kʰ]. Phonetically, the software of Praat (Boersma & Weenink, 2020), the delay of periodic time of voicing or voice onset time (VOT) occurs between the moment of the release and plosion. The aspirated voiceless plosive consonants have a longer VOT (Johnson, 2011). It is between 30-40 ms. It means that the longer duration occurs when the closure is released, the voicing begins with the vibrating vocal cord (see Boucher, 2002; Whitfield et al., 2018).
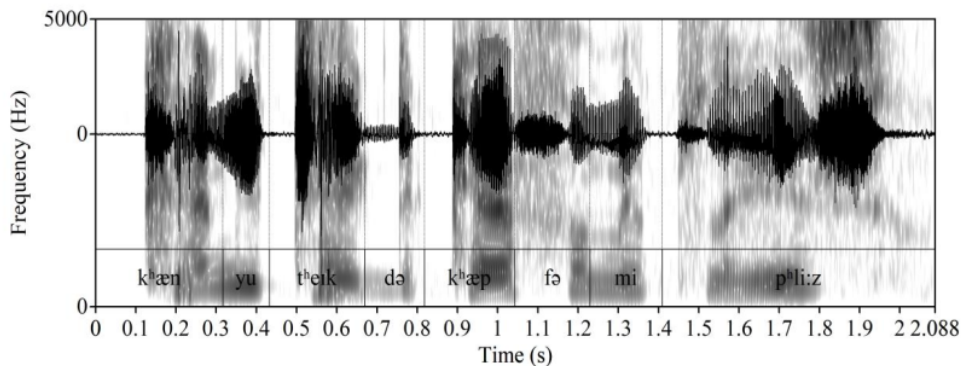

Figure 1. Effectiveness of CBI and increasing self-directed learning intention

However, the Balinese sound system does not recognize this phonetic variation, so the students articulate the aspirated sounds [pʰ, tʰ, kʰ] as the orthography or letters they read or sound concepts they have in their language. From the perspective of dual coding theory, this phonetic case belongs to the referential category; activating the sound system of L2 by the system of L1 (Clark & Paivio, 1991).
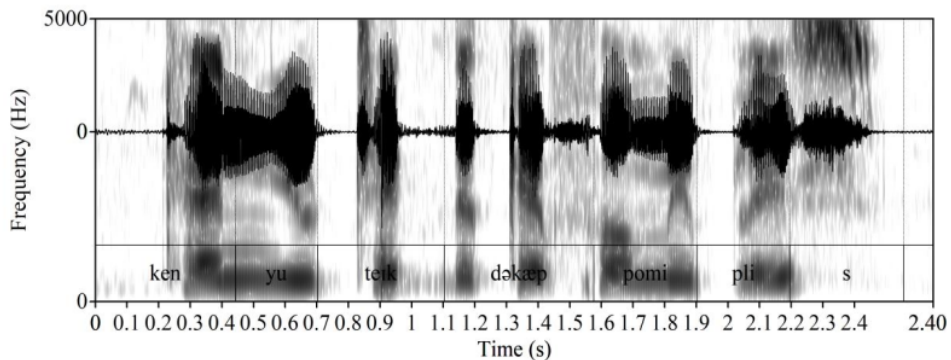

Figure 1. Effectiveness of CBI and increasing self-directed learning intention

4   Discussion

The results are discussed according to the types of phonological alteration, dual phonological coding model, and explicit phonological learning.

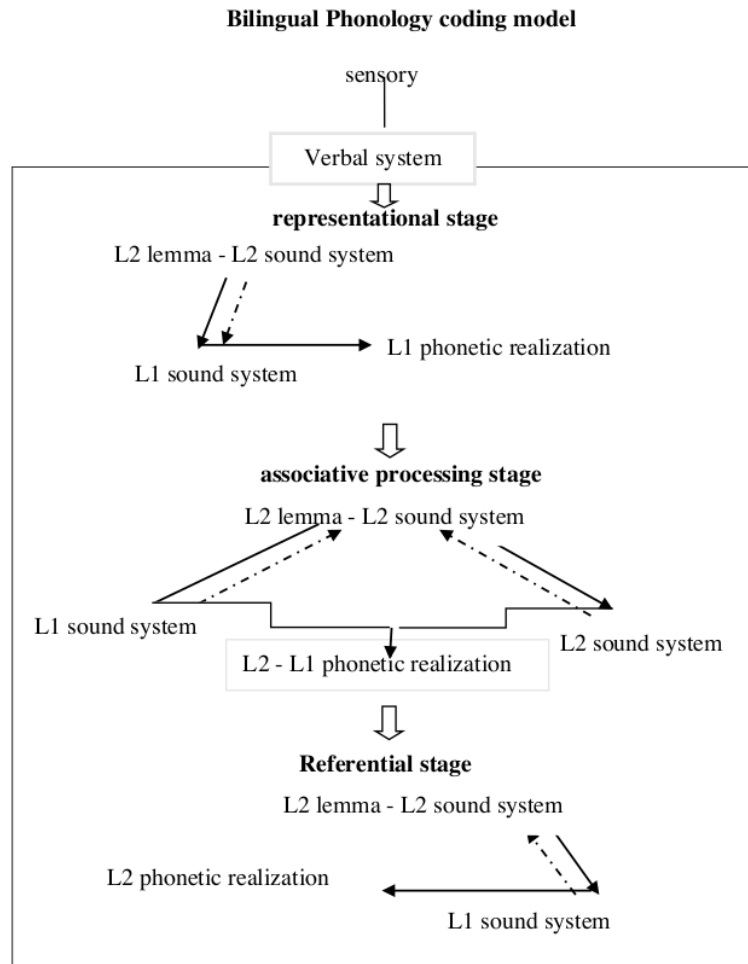## 4.1 The types of phonological alteration

The phonological alteration by Balinese students in coding English speech sound occurs not due to the purely phonetic level but phonemic processing level. Though in fact, the phonological process can be described as a phonetic phenomenon. Phonetically, many consonants of English were not accurately articulated by Balinese students due to the absence of those consonants in their orthography system. Phonemically, the English segments were altered for articulatory simplification. The types of phonological alteration found in the study include segment substitution, vowel insertion in consonant clusters, vowel and consonant deletion, and consonant addition. The segment substitution is concerned with the replacement of one segment with another segment, like diphthong is substituted by monophthong and the voiced alveolar fricative sound is substituted by voiceless sounds. Some features of phonological alteration between L1 and L2 in this study revealed that:

(1) the consonant addition in L2 results in deletion in L1;

(2) deletion in L2 can be an insertion in L1;

(3) voicing in L2 can be devoicing in L1;

(4) [+aspirated] in L2 can be [-aspirated in L1;

(5) diphthong in L2 can be monophthong in L1.

4.2 Phonological coding model

The dual coding theory emphasizes verbal and nonverbal language activation. However, these coding concepts in this theory also support sound phenomena in bilingual learning. This study proved that the two different languages, Balinese as L1 and English as L2, where the Balinese English learners activate the two-coding sound system in three ways. The first tendency is that direct activation of L1 for L2 that occurs either through a strong orthography stimulation of L2 or the absence of orthography of L1 results in L1 phonetic realization. The second tendency is that the two coding systems that are activated simultaneously due to language learning experience, phonological awareness, and language practice (Flege & Bohn, 2021) results in mixed L1 and L2 phonetic realization. The third tendency reveals that the stimuli of the L2 sound system is activated due to phonological awareness and results in L2 phonetic realization. In dual coding theory, Paivio (1990) states that the inputs of the sensory system connect L1 and L2 systems in representational, referential, and associative processing ways.

Based on the analysis of dual coding theory for the system of two different languages, this study established the sound system mechanism called the phonological coding model. The students activate the system of L2 independently but arrive at the phonetic realization of L1. For example, the Balinese students read the English word sit /sɪt/ and activate the L1 and pronounce it as [sit]. However, in L2, the tense vowel becomes a lax vowel if it is within consonants while the L1 does not. Mental sound processing occurs from coding, retrieval, and phonetic implementation. Some evidence revealed that Balinese speaking students in articulating English sounds activate both L1 and L2. However, the phonetic implementation can be purely L1, just purely L2, or mixed L1 and L2. This study suggests that the four levels of students' English articulation involve transmission, perception, phonological process, and phonetic realization. The activation of the sound system of L1 and L2 occurs in the perception level. The perception involves absorption and retrieval of the information and knowledge of both languages. The sound system mechanism in bilingual learning is presented in the Bilingual phonology coding model.

Bilingual Phonology coding model

sensory

Verbal system

representational stage

L2 lemma - L2 sound system

L1 phonetic realization

L1 sound system

associative processing stage

L2 lemma - L2 sound system

L1 sound system

L2 - L1 phonetic realization

L2 sound system

Referential stage

L2 lemma - L2 sound system

L2 phonetic realization

L1 sound system

4.3 Explicit phonological learning

Concerning the model established in this study, the L2 phonological learning strategy may depend on the students' L2 phonetic realization level. The representational stage in the bilingual phonology coding model shows that students' English pronunciation is purely affected by the Balinese language. Therefore, the students may adopt elementary explicit learning by acknowledging the phonological awareness of the English speech sound system. At the associative processing stage, Balinese and English systems have affected the students' English pronunciation simultaneously and resulted in inconsistent pronunciation; accurate on some occasions but inaccurate on another occasion. So, an intermediate explicit learning strategy might be worth applying by drilling or rehabilitating some aspects of phonological misconception with articulation practices. Finally, students whose phonetic realization are in the referential stage. requires the advanced explicit learning strategy to strengthen habit formation.

5   Conclusions

The sound coding system in bilingual learning in the present study refers to the phonetic realization of L2 into L1 and L1 into L2. The system of both languages may take control over the other through activating both language systems. The study reveals that the most dominant coding category is a referential coding system. Students activate the sound systems of L1 and L2 simultaneously. The activation results in incorrect English pronunciation or Balinese pronunciation of English. However, in conversation, the outcomes are still understandable. In this category, the sound of L2 was not in the same sound of L2, like voiceless and voiced fricative labiodental consonant /f/ and /b/ is articulated as voiceless and voiced plosive bilabial consonant /p/ and /b/. The referential coding category included the unaspirated voiceless plosive stop consonants in the initial position by L1 speakers. The influence of L1 resulted in the inaccuracy of L2. Therefore, there was the alteration of diphthong into monophthong. The direction of the low vowel to high vowel does not exist in L1. This study revealed that the dual coding theory in bilingual learning allowed the activation of L2 but realized the L1 outcomes. This study suggests the students and teachers apply explicit learning to form of communication habit in English by activating L2 to realize L2 in daily life speech interaction. This study recommends future research of bilingual learning for different linguistic branches, other language skills.

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