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Verifying the Phonological Permeability Hypothesis – L3 French's Regressive Impact on L2 English Aspirated Consonants

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Abstract: The provided study explores the impact of third language (L3) French acquisition on second language (L2) English pronunciation among native Chinese speakers, focusing on the influence of French on the articulation of aspirated consonants /p/, /t/, and /k/. Specifically, the research examines how learning French affects the voice onset time (VOT) of English voiceless plosives, thereby testing the Phonological Permeability Hypothesis (PPH). Voice onset time, a critical parameter in distinguishing voicing, was measured among 33 Chinese university students majoring in English, each with varying durations of French study. Findings reveal a significant reduction in VOT for English aspirated consonants as participants' French proficiency improved, particularly during the first two years of learning French, which saw the most substantial regression effect. This decline in VOT suggests that as learners develop proficiency in French, there is an observable influence of L3 French on their L2 English phonology, with effects stabilizing over time. The study provides empirical evidence supporting the PPH, highlighting a complex, dynamic interaction between multiple languages in multilingual learners. By shedding light on cross-linguistic phonological influence, this research contributes to the understanding of how L3 acquisition can influence previously acquired L2 sounds, emphasizing the permeability and adaptability of the multilingual phonological system.

Keywords: Third language acquisition, voiceless consonants, multilingual, cross language influence

1. Introduction

There is an estimated over 50% of the globe's population demonstrating multilingual proficiency to some degree [1]. More specifically, according to statistics issued by Journal of Neurolinguistics, whilst 43% of the world's populace is bilingual, signifying nearly half of individuals utilize two languages daily, 17% of the population worldwide is multilingual [2]. Given there is consensus that the acquisition of a third language (L3) is usually distinct from the teaching process of the mother tongue (L1) and the second language (L2) [3], this evident prevalence of bilingualism and multilingualism globally could engender more language acquisition-related challenges. In second language acquisition, learners can solely draw upon their existing knowledge of one language, whereas in L3/Ln acquisition, more than one linguistic system is accessible [4]. Therefore, the multi-directional interaction amongst disparate languages would present a more markedly task for language learners.

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Scholars have commenced to address the gaps outlined by Fouser [5] in his synthesis of L3 acquisition research, encompassing the absence of investigation into both process and product, production and comprehension, and facilitative and non-facilitative transfer [6]. The domains under scrutiny and the subsequently formulated supportive theories were also varied, covering areas such as lexical transfer (see [7] for review), syntactical transfer (see [8] for review) and phonological transfer [9-11]. Although linguists have discerned the fascination of L3, there remains substantial potential for its advancement, particularly concerning the influence of L3 on L2. From the stance of phonology, there appears to be only one provocative theory evolved—Phonological Permeability Hypothesis (PPH) [12], and a subsequent reassessment [13].

This article aims to bridge this gap by scrutinizing the phonological influence of L3 (French) on L2 (English) among native Mandarin speakers in terms of their production of initial stops, ascertained through their potentially variant Voice onset times, to compensate for the scarcity of data attained from Mandarin Chinese speakers. Moreover, considering that L2's interference would be more predominant in early stages of L3 acquisition and would decrease over time [10], this study also endeavors to examine the probability of a diminishing nature of the L3's regressive influence on L2. By selecting Chinese-English bilinguals as control group and Chinese-English-French trilingual with dissimilar durations of learning, it is envisaged this test could illustrate the effects L3 may have on L2 showcased in various learning stages.

2. Research hypothesis

Outlines the hypothesis or the expected outcomes of the study.

1) L3 (French) would affect regressively in the phonetic of L2 (English) in aspirated consonants, especially in terms of /p/, /t/, /k/ sounds.
2) This regressive effect exerted on L2 (English) would increase as the acquisition of L3 (French) progresses.

3. Literature review

3.1. Cross-linguistic influence (CLI) on phonological production

L3 research during the late 20th century primarily focused on cross-linguistic influence (CLI) [6]. Unlike L2 acquisition, which focuses on interaction between two linguistic backgrounds, L3 acquisition, considering bi-directional influence of adopted languages and their relationship with native tongues, is more complex. This multi-lingual phonetics mechanism has drawn increasing attention from diverse disciplines. Multiple L3 speech studies have identified complex CLIs between L1, L2, and L3. These include general phonology discussions, such as the impact of language typology and status on L3 phonology acquisition [11], VOT pattern in third language phonology acquisition [14], L1 and L2's contribution to L3 pronunciation learning by Cantonese speakers [15], CLI influence on L3 acquisition initiation [16], and various empirical studies examining different phonemes, including consonants [17], consonant clusters [18], and vowels [19].

However, the impact of L3 on L2 phonology remains understudied. Current research primarily targets morphosyntax, with some noting the presence of backwardness, such as Hui's [20] use of picture elicitation task to investigate groups' production of different relative clauses and Cheung's [21] analysis of backward transfer from L3 (German) to L2 (English) in tense-aspect production and perception. Others have tested the threshold that L3 learners may need to attain for backward transfer [22].

In contrast, regarding phonology, the sole theory is Phonological Permeability Hypothesis (PPH) [12]. This was developed and retested using English and Spanish speakers learning Brazilian Portuguese (BP) as an L3, showing immediate and pervasive L3 influence on their L2 Spanish

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production [23]. Subsequent research showed that the phonological system of BP can influence that of later acquired L2 Spanish in speech production, involving two mirror groups [3]. However, most tests have been conducted in Romanian and Germanic languages [24,25], with only minimal research in Cantonese [18]. This study was initiated to test whether backward transfer would occur in Mandarin Chinese speakers, offering more concrete examples for this theory.

3.2. Voice onset time in French and English aspirated consonants

Although both English and French feature two sets of stop consonants that contrast in voicing—voiced /b/, /d/, and /g/; and voiceless /p/, /t/, and /k/—the phonetic realization of these contrasts, particularly as measured by Voice Onset Time (VOT), differs between the two languages. VOT is an acoustic measure that quantifies the timing difference between the release of a stop consonant and the onset of voicing in the following vowel [26]. In English, voiceless stops typically fall into the "long lag" category, with VOT values greater than 30 ms [27]. In contrast, French voiceless stops are characterized by short-lag VOT values, ranging from 0 to 30 ms [28].

As illustrated in Figure 1, the VOT values for English voiced stops overlap with those of French voiceless stops. This overlap can present a significant challenge for learners of French, especially children, since the same acoustic space is indexed as different phonological categories in the two languages. This discrepancy makes it more likely for learners to produce erroneous L2 (French) sounds, as they may incorrectly map the acoustic properties of their L1 (English) onto the L2 [29].

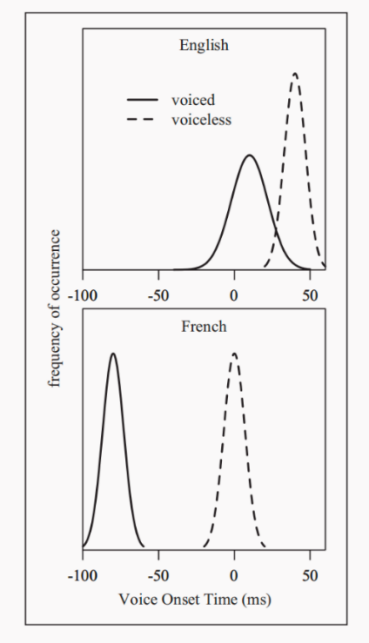

Figure 1: Hypothetical voice onset time ranges (in milliseconds) in the production of English and French voiced and voiceless stops (adapted from [29])

Empirical studies have demonstrated that French-English bilinguals exhibit an intermediate VOT production for aspirated consonants, compared to monolingual speakers of either French or English. Flege [28] provided evidence that native speakers of French and English, who had spent approximately 12 years in Chicago and Paris, respectively, showed altered VOTs for stop consonants in both languages, as compared to monolingual speakers. Specifically, native French speakers in Chicago produced English /t/ with a shorter VOT (49 ms) than monolingual English speakers (77 ms), while their French /t/ had a longer VOT (51 ms) than that of monolingual French speakers (33 ms).

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The findings from English speakers in Paris were complementary, showing similar patterns of VOT adjustment.

In addition to examining the production differences, researchers have also investigated learners' perception of these nuanced differences. Fowler et al. [30] reported on a group of French-English bilinguals in Canada who had learned both languages before the age of three. These bilinguals could clearly distinguish between French and English stops in perception, but their phonological realization was compromised. Both their English and French stop VOTs fell within an intermediate range between the two monolingual norms, indicating a bidirectional cross-linguistic influence.

These experiments and results clearly demonstrate that French and English have distinct VOT characteristics for aspirated consonants, which are further verified by the VOT patterns observed in French-English bilinguals. However, there is a notable gap in the literature regarding the application of these findings to the field of third language acquisition (TLA), particularly in testing whether backward transfer from L3 to L2 exists. Given the robustness of these findings, they provide an ideal method for validating under-explored theories, such as the Phonological Permeability Hypothesis (PPH) [12], which serves as the theoretical framework for this experiment.

4. Methodology

4.1. Research design

In this experiment, participants' perceived proficiency in their third language (L3) was not considered. Instead, the study focused on a single production experiment, with the independent variable being the participants' L3 proficiency level, operationalized as the length of time they had spent studying the language. The independent variable was manipulated by establishing comparison groups, consisting of one control group and four experimental groups.

The research employed both qualitative and quantitative methods. Qualitatively, prospective participants were asked to complete a questionnaire to facilitate their categorization into different groups. This method was used to review the general influence that English (L2) might have on the acquisition of French (L3), whether regressive or otherwise. Quantitatively, the collected audio recordings were analyzed using Praat software and statistical models. The quantitative analysis aimed to identify nuanced differences between the four experimental groups and the control group, specifically to determine if there was a significant stage in which L2 interacted with L3, potentially indicated by a distinct peak or valley in VOT values.

4.2. Participants

The participants in this experiment were 33 university students majoring in English, drawn from five Chinese universities: Fudan University, Shanghai Jiao Tong University, Zhejiang University, Nanjing University, and Shanghai International Studies University. The final sample was selected after excluding individuals who did not consent to the further recording process and those who submitted unrecognizable or vague recording data.

Table 1: Numbers of subjects from five different Chinese universities' English department

University Name	The Number of Participants Enrolled
Fudan University	21
Shanghai Jiao Tong University	1
Zhejiang University	9
Nanjing University	1
Shanghai International Studies University	2

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Table 1 shows the distribution of participants from various universities and lists the number of individuals enrolled from each institution.

The targeted universities are all top institutions that provide English major students with second foreign language courses. To better align with the research question and to mitigate potential negative effects from low L2 (English) proficiency on L3 (French) phonological production, participants were not selected randomly. Instead, a two-step screening process was employed:

a). Academic Background: Participants were required to be students from the English departments in the above-mentioned universities; b). English Proficiency: Participants had to meet a certain English proficiency level, as evidenced by scores from standardized tests such as IELTS, TOEFL, TEM-4, TEM-8, or the English test score for the High School Entrance Exam. The selected standard for English proficiency was equivalent to the C1 level on the Common European Framework of Reference for Languages (CEFR) [31].

Only participants who met these criteria were enrolled in the study. Additionally, to ensure that the influence on L2 was solely from L3 and not from any other additional languages, participants were confirmed to have French as their only L3.

Upon registration, they were subsequently categorized into five distinct groups, one control group (n=4), devoid of any French learning experience, and four experimental groups (n=8,9,9,3), with varying durations of time dedicated to French learning.

Table 2: Participant distribution by study duration

Group Number	Final Participant number	The Extent of Study Time (t= years)
1	4	t=0
2	8	0<t<=0.5
3	9	0.5<t<=1
4	9	1<t<=2
5	3	t>2

Table 2 presents data on number of subjects in different groups categorized by their varied durations of time dedicated to French learning.

4.3. Stimuli

Two sets of token lists, one in French and one in English, were designed for participants' recordings. Both sets included critical tokens with monophthongs paired with the targeted stop consonants /p/, /t/, and /k/, following a /CVC/ (consonant-vowel-consonant) structure (e.g., /pil/, /tu:l/). This simple consonant-vowel structure was chosen to minimize the potential complicating effects of vowels on the measurement of consonant VOT.

To account for the diverse influence of different vowels on VOT, the monophthongs selected included vowels from various places of articulation and with different levels of tenseness. This selection was made to mitigate the specific effects of certain distinguishing vowels. For example, English /i/ typically exhibits a longer VOT than other vowels, while /u/ shows the second-longest VOT [32]. Additionally, Weismer [33] noted that VOT is generally longer when the following vowel is tense. Given that both vowel articulation and tenseness can influence VOT to varying degrees, the final VOT analysis was based on the mean values across the selected tokens.

To ensure natural and consistent speech production, both the French and English tokens were embedded in a carrier phrase ("I can say … again" for English and "Je parle … encore" for French). This approach ensured that the tokens were articulated in a contextually appropriate manner reflective of everyday speech.

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Table 3: English tokens used in the experiments

Voiceless Stops	Categrory1 (/ɪ/)	Categrory2 (/u:/)	Categrory3 (/ɑ:/)
/p/	pill	pool	part
/t/	till	tool	tart
/k/	kill	cool	kart

Table 3 shows examples of French words containing voiceless stop consonants (/p/, /t/, /k/) paired with different vowel sounds. Each row represents a voiceless stop sound, while each column shows a word containing that sound paired with a specific vowel category.

Table 4: French tokens used in the experiment

Voiceless Stops	Categrory1 (/ɪ/)	Categrory2 (/u:/)	Categrory3 (/ɑ:/)
/p/	pipe	pour	passe
/t/	tisser	toute	tasse
/k/	qui	coûte	car

Table 4 shows similar examples in French, using the same voiceless stops (/p/, /t/, /k/) paired with corresponding vowel categories.

4.4. Procedure

The procedure for experimentation can be segmented into two stages. Prior to undergoing the token compilation phase, subjects were obligated to complete a comprehensive background survey. This encompassed their acceptance of Information Security protocols, their acquiescence towards the ensuing experiment, their attained proficiency level in English language, the duration of their studies pertaining to French, and their readiness to provide contact details for subsequent data provision. Only when the aforementioned declaration was duly signed and the pre-determined English proficiency threshold met, could participation commence. Post this, all eligible subjects were provided with an inclusive English token database. Additionally, two randomly chosen individuals from each test group would also acquire a French token list, intended to underline potential differences amongst groups with diverse lengths of French study. The two token lists were disseminated on separate occasions to prevent subjects from deciphering the intended objective of the experiment and thereby moderate the accuracy of their vocal recordings. It was mandatory for subjects to record the tokens in a quiet environment and routinely throughout the day, ensuring neither excessive haste nor exaggeration influenced their performance.

Prior to the evaluation of their recorded data via Praat, a specialized application frequently employed for multi-dimensional analysis of consonant and vowels acoustics such as their formants, pitches, amplitude levels, etc. [34], recordings exceeding prescribed ambient noise levels or falling short of established recording standards were deemed ineligible. This included instances where participants articulated tokens with insufficient inter-word intervals or presented anomalies in relevant acoustic elements.

To evade any conceivable bias during statistical data analysis, the evaluation was exclusively executed after thorough examination using Praat. Subsequently, the gathered data was hierarchically classified according to the participants' duration of linguistic education, enabling subsequent statistical evaluations facilitated by Statistical Package for the Social Sciences (SPSS). The primary objective was to verify if the generated statistical evidence indeed supported the hypothesis.

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4.5. Data analysis

4.5.1. Praat

The data were initially scrutinized via Praat [34]. Every initial consonant was segmented to gauge its voice onset time. Recordings with total devoicing or misspoken tones were excluded from scrutiny. Both waveform and spectrogram were meticulously depicted to facilitate labeling and timing measurements. The VOT measurement in this investigation strictly adheres to the definition of VOT and was derived by measuring the interval between the inception of energy in the formant frequency spectrum signifying the release of air pressure and the inaugural vertical striations denoting glottal pulsation [35,36]. The inaugural vertical striations were generated automatically by Praat. Prior to commencing any significance testing procedure, data filtration took place. Statistic outliers were discarded.

4.5.2. ANOVA test

The ANOVA test is employed when investigating areas requiring analysis of diverse influences on a specific outcome [37]. It employs means of three or more independent groups to ascertain if a statistically significant disparity exists amongst them. The independent variable in this case would be the duration of French instruction and the corresponding dependent variable would be the voiceless stop VOT production of different subject groups. To establish if there is substantial evidence to suggest that at least one of the group's means diverges from the rest, implying that the acquisition of French may adversely affect the production of English voiceless stops, the ANOVA test was utilized.

The F-test, also incorporated in the ANOVA test, is unidirectional and can solely assess the likelihood that the disparities between the means are disproportionately vast relative to the intra-group variation. Hence, the F-test was integrated into this experimental endeavor to reinforce the presence of discernible differences across certain groups specifically pertaining to voiceless consonants, which are not due to intra-group fluctuations but engendered by pre-existing inter-group variances. The result of the F-test represents a positive value, exceeding 1.0 denoting that differences do exist amongst the means [37].

Presuming here that if the F-test output surpasses 1.0, a confirmed inter-group disparity exists, indicating actual distinction in certain voiceless stops.

4.5.3. Post hoc test

Within the parameters of ANOVA, precise differentiation between distinct groups cannot be accomplished. To elucidate which group exhibits disparities, a post hoc test (also known as multiple comparison test), is endorsed. This permits experimenters to investigate the differential between multiple groups' means, whilst also maintaining a controlled family-wise error rate [38]. The post hoc test is not initiated until the p-value of the ANOVA test attains statistical significance.

Upon execution of the post hoc test, the findings are anticipated to corroborate with the second hypothesis, outlining the potential phase during which the influence of learners' French on their English stop consonant production peaks, subsequently diminishing thereafter and retaining stability.

5. Results

The findings of this study encompass the linguistic output of participants in French and English vernacular initial stop consonants. Nonetheless, owing to a marginal statistical disparity witnessed in French articulation within the ANOVA examination, the upcoming analysis will primarily focus upon the English voiced stops' manifestation. Despite the lack of statistical significance detected in French

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trials, it does not necessarily indicate a uniform production discrepancy amongst the experimental cohorts, as illustrated in Figure 2. A detailed exploration into this null finding will be presented in the subsequent discussions.

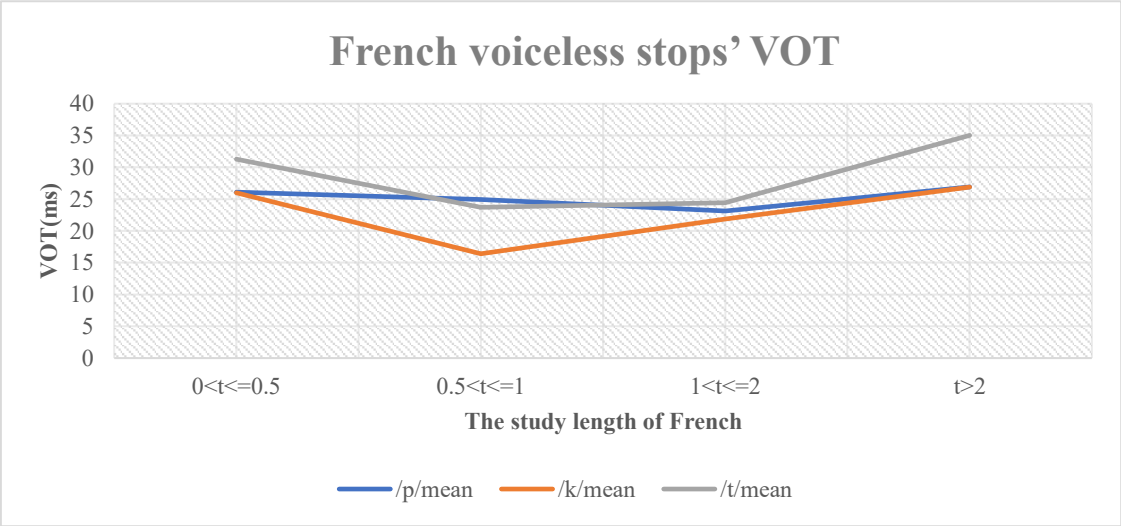

Figure 2: Randomly selected subjects from Trilingual experimental groups' voice onset time (VOT) (in milliseconds) in the production of the stops /p, t, k/

In relation to the outcome of English token production, Table 5 presents comprehensive statistics pertaining to VOT production of English consonants /p/, /t/, and /k/ sounds amongst trilingual participants from experimental groups and subjects proficient in Chinese-English. A more visualized graphical depiction of these data is illustrated in Figure 3.

Table 5: Mean voice onset time values and standard deviations of the stops /p, t, k/

The study length of French (t=years)	Mean (Standard Deviation)				
	t=0 (n=4)	0<t<=0.5 (n=8)	0.5<t<=1 (n=9)	1<t<=2 (n=9)	t>2 (n=3)
/p/_mean	99.299(3.055)	98.505(0.752)	93.039(1.925)	90.911(2.202)	96.193(2.094)
/k/_mean	104.761(1.887)	103.943(3.525)	101.166(5.073)	98.250(1.301)	104.679(2.098)
/t/_mean	107.971(3.359)	106.817(5.284)	103.511(2.638)	100.338(1.757)	80.431(3.892)

Table 5. Mean voice onset time values (in milliseconds) and standard deviations of the stops /p, t, k/ in word initial position produced by Chinese-English and Chinese-English-French participants, categorized into different groups according to their study length of French.

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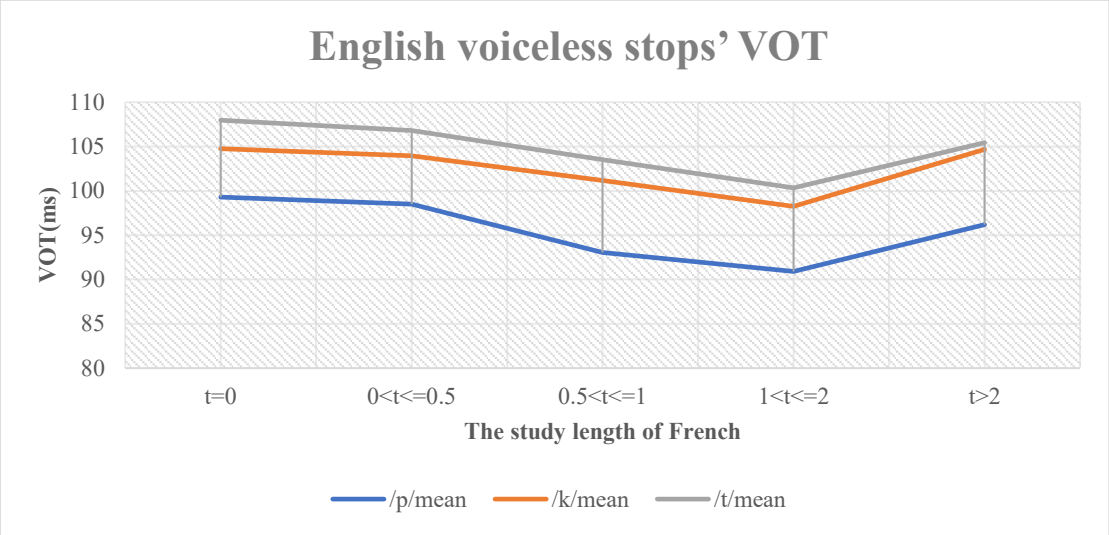

Figure 3: Bilingual control group and trilingual experimental group's voice onset time (VOT) (in milliseconds) in the production of the stops /p, t, k/

Observed from Figure 3, it is clear that prior to a notable decrease in initial voiceless stop production observed amongst trilingual participants who learned French for approximately two years, VOT exhibits a steady downtrend. Subsequent to establishing a minimum value, VOT starts to reverse direction and showcases an increasing trend consistent with the commencement phase of French language acquisition. Despite the substantial dip in the metric, a division solely on the basis of a one-to-two-year period as the apex of regressive influence from L3 to L2 is premature. Consequently, both an ANOVA analysis and subsequent post hoc testing were executed.

Table 6: F-test and post hoc test results

The study length of French (t=years)	F	Post Hoc Tests
/p/_mean	23.123***	0>2,0>3,0>4,1>2, 1>3,2>3,4>2,4>3
/k/_mean	4.591***	0>3,1>3,4>3
/t/_mean	5.545***	0>2,0>3,1>4,4>3

Table 6. F-test and Post hoc test results. The number presented in post hoc tests refers to the different group, from 0 to 5 representing from the control group, group studying French within 6 months, group studying French between 6 months to one year, group studying French between one year to two years, group studying French exceeding two years, respectively.

The outcomes of the F-test (as detailed in Table 6) exhibit positive values exceeding 1.0, signifying disparities between mean scores across various groups [37], coupled with p-values of 0.000, 0.006, and 0.002 respectively ($p < 0.01$), indicative of a statistically significant distinction in initial voiceless stop production amongst distinct groups [38]. This serves as substantiation for the manifestation of discernible disparity across the five examined groups, originating not from internal variances but rather inter-group discrepancies. Given the extraordinarily minimal p-value, the null hypothesis suggesting absence of correlation between a learner's proficient level in French and their articulation of English voiceless consonants can be categorically refuted.

Provisions arising from the post hoc tests contribute to a deeper understanding. Regardless of lack of significance among certain groups, the group classified as having studied French for one to two

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years (group 3) consistently displays statistical distinction compared to others (per Table 6). Similarly, while no overtly dominant group is identified based on post hoc test results, there appears to be no particularly distinctively superior group in terms of /t/ production.

6. Discussion

6.1. Interpretation of results

Upon examination of the results obtained through ANOVA testing, it becomes evident that there exists a substantial disparity among subjects belonging to various groups regarding the production of English voiceless explosive VOT, particularly concerning /p/ and /t/. The F-values observed were 23.123 and 5.545 for /p/ and /t/ sounds respectively, signifying a significant divergence above 1.0 and p-values substantially lower than 0.01 ($p < 0.01$), suggesting that these statistical variations stem not from sporadic instabilities between individual groups but are indeed influenced by the specific variances in individual subjects' periods of French acquisition time. More precisely, it was observed that individuals exposed to one or two years of French studying exhibited notable VOT decrements for both /p/ and /t/ sounds, lending credence to the experimental precept asserting that L3 French reception negatively impacts L2 English pronunciation.

Subsequent post hoc analyses unveiled statistically significant disparities across five distinct groups. Notably, the group subjected to one to two years of French instruction (Group 3) consistently demonstrated statistical significance when compared to the remaining groups. This observation signifies that member of this group displayed pronounced discrepancies in speech proficiency relative to the other groups, thereby corroborating the notion that the detrimental impact of French on English is most profound during this specific time frame. The marked disparity during this phase could potentially indicate that the participants' command of the French phonological system at this juncture was potent enough to influence their articulation of English voiceless plosives.

The empirical data pertaining to English consonant VOT provide substantial endorsement for the Phonological Permeability Hypothesis (PPH). The PPH proposes that interplay between different linguistic systems utilized by multilingual learners is possible, and such influence can be multifaceted [12]. In this experiment, the deleterious effect of French on English is illustrated via VOT reductions for voiceless plosives, primarily affecting /p/ and /t/ sounds. These observations substantiate the PPH proposition while concurrently offering novel insights into the effect of L3 on L2 phonological regression. Simultaneously, they elucidate potential pinpointing moments in the reciprocal influence between L3 and L2.

6.2. Comparison with existing literature

The experimental findings substantiate a striking divergence in phonetic output amongst tri- versus bi-lingual participants, aligning with prior finding results derived from English-French bilinguistics studies [28][30]. This data corroborates the existence of Cross-Linguistic Influence (CLI). Despite unavailability of Chinese-French testers, the tendency towards backward propagation is undeniably present. Furthermore, this article adds an innovative dimension to the comprehension of backward transfer, furnishing fresh empirical proof for the Phonological Permeability Hypothesis (PPH).

These outcomes concur with precursory research on CLI, typically highlighting auditory interference among the tongues of bilingual or multilingual individuals [10]. Concurrently, the apparent reduction in VOT exhibited by Chinese-English-French trilinguists as opposed to their Chinese-English counterparts corroborates former insights [28], thereby fortifying the manifestation of CLI. Nevertheless, whereas previous literature predominantly attributes significance to the influence of L1 and L2 on L3, this investigation explores the less scrutinized facet of backward transmission from L3 to L2. The outcomes resonate with those reported by Amaro [13], detailing

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regressive phonological repercussions in speakers of Spanish and Brazilian Portuguese. By incorporating the PPH within Mandarin Chinese - English - French tri-linguists, a seldom examined linguistic confluence, this research amplifies the applicability and explanative strength of the hypothesis considerably. These contributions augment our understanding of phonetic processing apparatus amidst multilingual environments and pave the way for subsequent explorations in this field.

7. Limitation acknowledgement

7.1. The ineradicable vowel effects

The extraction of VOT from initial stops is straightforward yet ambiguity persists in identifying closure onset [39]. Given the CVC structure of tokens, vowels are pronounced immediately after the stop consonants, limiting separate measurement. Summerfield [40] noted an interplay between the consonant and subsequent vowel's place of articulation—/ki/ shows longer VOT than /ka/; while /pi/ shows shorter VOT than /pa/. Vowel height and tenseness interact significantly, influenced by vowels' attributes such as laxity [41]. However, lax vowels /ɪ, ʌ, u/ showed no significant impact. For tense vowels, /ɑ/ exhibited shorter VOT than both /i/ and /u/.

Despite accounting for vowel variations through diverse places of articulation and tenseness in this experiment, the vowel effect still remains.

7.2. The sketchy estimation of participants' French proficiency

During this examination, subjects were classified into discrete cohorts based on their proficiency in the French language. Although the classification could potentially be corroborated by surveying the standardized phonetic expressions of French language amongst diverse cohorts, the investigation would be executed within a stricter questionnaire structure, if an integrated French proficiency survey is appended to each distribution of questionnaires to subjects, thereby enhancing the contrast between French proficiency levels across diverse demographics.

7.3. The unbalance sampling distribution in different groups

Due to logistical challenges, the group dedicated over two years to the study of French was relatively small. Furthermore, finding proficient students solely knowledgeable in English within the English Department proved challenging. These hurdles resulted in small participant sizes, potentially causing numerical insignificance. Referencing Ståhle and Wold [37], significance failures may reflect insufficient object numbers or non-fulfillment of ANOVA assumptions. Thus, the lack of significance between these two groups and the others may stem from this limited sample size.

This may also provide an explanation for the statistical inconclusiveness observed in the production of French lexical items.

8. Implications

The domain of Third Language Acquisition (TLA), predominantly within phonological investigations akin to the differentiation between French and English consonants, presents unique obstacles and prospects for students and educators alike. Although exhibiting superficial phonological parallels, these languages demonstrate discernible production attributes that learners are required to process. An integral facet of TLA is the complexity inherent in assimilating the phonological subtleties across languages, encompassing not merely acquiring novel sounds but also comprehending their interplay within the linguistic fabric of each language.

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It is imperative to enlighten language learners about the minute disparities between these two languages, initially in comprehension and subsequently in articulation. For instance, the research indicates certain multilingual respondents mispronounce French lexemes, such as articulating the French /p/ in "pipe" with aspiration, contrary to its unaspirated production nature. This nuance is an indispensable characteristic that demarcates French initial voiceless stops from their English counterparts. Learners should likewise be acquainted with the potential backwards contamination from French to English, a phenomenon that is prevalent and ought not engender excessive concern upon initiation.

For educators, the conundrum lies in effectively disseminating these phonological intricacies in a scholastic arena. This necessitates a profound comprehension of the phonological frameworks of the implicated languages, as well as the capability to transpose this expertise into pragmatic and efficient pedagogical methodologies. The utilization of multimedia assets, inclusive of visual and auditory aids, can prove particularly advantageous in this respect. These resources can furnish learners with a more exhaustive and captivating method to comprehend and execute accurate pronunciation.

Moreover, this investigation has unveiled significant insights into the correlation between study duration and the regressive impact on L3 acquisition. Specifically, the inaugural two years of L3 pursuit, notably the transition from the initial to the subsequent year, appear to be pivotal for phonetic refinement. Throughout this period, learners necessitate augmented tutelage and rehearsal to fortify their phonological competencies. Educators should concentrate on delivering tailored assistance and tasks to assist learners traversing this critical phase, assuring they establish a robust basis in the phonetics of the L3.

9. Conclusion

The objective of this investigation was to discern the retrogressionary phonetic implications of French (L3) on the articulation of English (L2) aspirated consonants /p/, /t/, and /k/ amongst native Mandarin Chinese (L1) individuals. Findings unequivocally endorse the Phonological Permeability Theory (PPH), revealing that L3 can dramatically impinge upon L2, as demonstrated through a perceptible attenuation in Voice Onset Time (VOT) for English unaspirated consonants subsequent to heightened proficiency in French.

Statistical scrutiny indicated that participants who had pursued French education for one to two academic years displayed the most substantial diminution in VOT, implying that this duration represents a pivotal stage in L3 acquisition. As their command of French augmented, VOT magnitudes progressively recuperated, mirroring the "stabilization phase" in multiple linguistic acquisitions, wherein initial interference in pre-existing phonetic systems is succeeded by reassertion of dominance.

Notwithstanding these observations, certain constraints demand recognition. The restricted sample size, notably in the cohort who completed French courses for over two years, might have compromised the statistical potency. Furthermore, the categorization was predicated exclusively on the duration of French tutorship without formal proficiency screening, engendering inherent disparity. The influence of vowel context on VOT determinations also introduced complexity, potentially tempering the accuracy of the findings.

The repercussions of this research underscore the ubiquity of cross-linguistic influences during the initial phases of L3 acquisition. Educators are urged to extend extra assistance to students, predominantly within the initial one to two years of L3 engagement, to aid in navigating these phonetic alterations. Such aid could encompass tailor-made exercises, multimedia references, and explicit guidance on phonetic nuances.

To conclude, this study offers a considerable advancement to the field of Third Language Acquisition (TLA) by presenting novel empirical data corroborating the retrogressionary phonetic

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influence of L3 on L2. Future endeavors should strive to augment the sample size, guarantee balanced representation across cohorts, and perform longitudinal investigations [6] to monitor the enduring evolution of these cross-linguistic effects. Examination of other phonetic attributes or scrutinizing regressive effects across diverse language pairs will further broaden our comprehension of the mechanisms underpinning multilingual phonetic interplay.

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