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Can L2 speech rate surpass L1? Evidence from Mandarin learners of Japanese with and without immersion

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Abstract

This study investigates the intriguing scenario where L2 learners can outpace their L1 speech rate. Prior research indicates a faster speech rate in Japanese compared to Mandarin. However, the question remains whether native Mandarin learners can overcome their inherently slower L1 speech rate when speaking L2 Japanese. We assessed 15 N1-certified Mandarin learners of Japanese, divided by immersion experience—seven with at least a year in Japan, and eight without immersion. Their speech rates in both languages were measured against those of ten native speakers per language, including reading and spontaneous speech.

Challenging the L1 superiority belief, our findings reveal that the immersed group could match the faster speech rates of native Japanese speakers, thereby exceeding the speech rates of their L1 Mandarin, which are similar to other native Mandarin speakers. Conversely, the non-immersed group's Japanese speech rate was comparable to or slower than their L1 Mandarin.

Subsequent analysis probed how speech rate correlated with learner variables such as Study Duration of Japanese and Length of Residency in Japan. The findings also highlight immersion as the critical factor of speech rate. This study extends our knowledge of bilingual fluency, providing new perspectives on L2 prosody mastery.

Index Terms: speech rate, Mandarin learners of Japanese, language immersion, L2 Japanese, L2 prosody

1. Introduction

In L2 prosody acquisition, existing research has primarily focused on acquiring L2 suprasegmental features such as speech rhythm, stress, intonation, and tone [1]. However, the acquisition of L2 speech rate, a critical temporal indicator of language fluency [2], has received limited attention. Nevertheless, empirical evidence suggests that the utilization of synthesized, accelerated L2 speech rates can effectively enhance perceived accent ratings [3]. To date, current research on L2 speech rate uniformly reports that L2 speech rate is slower than L1 speech rate, with some literature positing that this discrepancy is consistent and invariable [4][5][6]. A representative explanation for a slower L2 speech rate is the theory of automaticity, which posits that attention is needed only for speech planning and monitoring in L1 production, with other speech processes being automatic and parallel. In contrast, L2 speakers may not have automated syntactic and phonological encoding, resulting in a slower speech due to the inability to process in parallel as in L1 [7].

However, previous studies pertaining to L2 speech rate have two notable deficiencies. First is the oversight of intrinsic speech rate difference between L1 and L2. Second, these studies have mainly focused on beginners in L2, with a relative lack of research on highly proficient L2 speakers, particularly for those deeply immersed in the L2 environment. Less proficient L2 speakers tend to have more unexpected pauses in their speech (i.e., pauses not at the expected clause or phrase boundaries) [8]. Consequently, there is a prevailing belief that L2 speech is invariably slower than L1. Nevertheless, this study seeks to explore, in the case that L2 speech rate is inherently faster than L1, is it possible for advanced L2 speakers to speak L2 faster than their L1?

Based on the above question, this study focuses on L1 Mandarin learners of Japanese. Previous research suggests that Japanese is spoken faster than Mandarin [9]. However, it is unknown if native Mandarin speakers can exceed their slower L1 speech rate when speaking L2 Japanese. Thus, the Japanese-Mandarin contrast provides an ideal opportunity to investigate if L2 learners can outpace their L1 speech rate.

Moreover, this research also focuses on the effect of language immersion. Previous studies have posited Length of Residence (LoR) as an index capable of predicting L2 attainment success and influencing perceived foreign accent [10] [11] [12]. In our study, we used residence in Japan for over a year (LoR >1 year) as a criterion to categorize Mandarin speakers of Japanese into two groups: an immersed group and a non-immersed group. Our objective is to discern any potential disparities in Mandarin and Japanese speech rates between the immersed and non-immersed groups. Beyond the LoR factor, this study explicitly examines the effects of Study Duration of Japanese as individual factors on L2 speech rate. Research suggests an extended study duration can enhance L2 fluency [13]. However, there remains a scarcity of investigations that directly compare the impact of Study Duration and LoR on the L2 attainment success. Thus, this study will incorporate Study Duration and LoR as independent variables into a unified statistical model to analyze and compare the predictive power of each factor on L2 speech rate.

2. Method

2.1. Participants

This study consisted of four groups: 7 Mandarin speakers of Japanese with at least one-year immersion in Japan (immersed speakers,1M, *Mean age* = 26.29 years, *SD* = 1.70; *Mean study duration of Japanese* = 97.71 months, *SD* = 31.63; *Mean LoR* = 37.43 months, *SD* = 21.62), 8 Mandarin speakers of Japanese without immersion (non-immersed speakers, 1M, *Mean age* = 24 years, *SD* = 1.85; *Mean study duration of Japanese* = 69.25 months, *SD* = 23.99; *Mean LoR* = 1.5 months, *SD* = 2.20), 10 native Beijing Mandarin speakers (NM speakers, *Mean age* = 24.2, *SD* = 1.31) and 10 native Japanese speakers (NJ speakers, *Mean age* = 36.5, *SD* =7.49). All the Mandarin speakers of

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Japanese, regardless of immersion in Japan, have obtained the N1 degree (the highest proficiency level for L2 Japanese learners). Notably, the immersion of the immersed group was due to one of the following reasons: 1) undergraduate education in Japan, 2) studying Japanese in China but with over a year's exchange in Japan, or 3) long-term work experience in Japan. In contrast, the non-immersed group consisted of participants who majored in Japanese at universities in China but do not have long-term exchange experience in Japan, with at most short-term travel experiences.

For the immersed and non-immersed groups, the study posits two hypotheses: 1) the immersed group will exhibit faster Japanese speech rates than the non-immersed group, with no significant difference in Mandarin speech rates between these two groups. 2) The immersed group's Japanese speech rate will surpass their Mandarin speech rate, while the non-immersed group's Japanese rate will be equal to or slower than their Mandarin. These hypotheses are based on the premise that the immersed group's fluency can parallel native Japanese speakers, while the non-immersed group's fluency may be limited, due to insufficient Japanese exposure and the negative influence of L1 Mandarin slower speech rate.

2.2. Tasks and Materials

This study examined speech rates in both controlled reading and spontaneous speech scenarios, since past studies have indicated that L2 learners spoke quicker when reading than in speech [14]. The reading task employed the standardized text, "The North Wind and the Sun," with participants reading versions in both Japanese and Mandarin. The Japanese text contained 226 syllables (or 254 morae) [15], and the Mandarin text had 166 syllables [16]. The participants were instructed to read the texts three times. For the spontaneous speech task, participants answered two questions in Japanese and Mandarin, respectively. The first question required a self-introduction, while the second question asked about their learning experience in Japanese or other L2 languages. Participants were asked to speak on each topic for over two minutes in both languages.

2.3. Recording procedure

The data collection for the experiment was split between two settings: offline and online. Most participants engaged in the study offline, with only two immersed speakers participating through an online platform. For the offline part, the recording sessions took place in a linguistics laboratory in Hong Kong and Beijing, respectively. The participants were seated comfortably, and the experimental content was presented to them on a laptop through PowerPoint slides. The procedure commenced with the passage reading task and proceeded to the spontaneous speech task. The audio was recorded using a high-quality solid-state recorder with a sampling rate of 44.1kHz/16-bit. The online part took place on Zoom [17] and followed the offline procedure. Experimental materials were presented using shared PowerPoint slides on Zoom. Due to possible network delays affecting Zoom's recording feature, participants were asked to use their smartphones to record their responses locally. As a result, the data from the online sessions consisted of these local smartphone recordings. Subsequent t-tests revealed that there was no significant difference in speech rates between immersed speakers who participated online and those who participated offline in all Language and Task conditions ($p > .05$).

In addition, the materials presented for the NJ and NM groups were exclusively in their native languages. In contrast, experimental materials in both Japanese and Mandarin were provided for those in the immersed and non-immersed groups.

2.4. Acoustic measurements and data analysis

For each repetition of the tasks, the speech rate was calculated by dividing the total syllable count by the overall duration of the utterances. The initial step in processing the spontaneous speech data involved transcribing the audio recordings to texts using automated transcription. After this, a detailed manual inspection was carried out to confirm the accuracy of the transcribed content and to count the syllables precisely. Besides, for the Japanese materials, this study also assessed speech rate using mora as the unit of measurement. Given that Japanese is a mora-timed language [18], this approach allows for a more comprehensive speech rate comparison between native Japanese and L2 learners.

The speech rates were analyzed using linear mixed-effects (LME) models. These models were fitted in R [19] using the lme4 package [20]. The fixed effects in the models were Group, Task, and the interaction between Group and Task, with Subject and Utterance as random intercepts separately. For the immersed and non-immersed groups, another set of models was made to account for the differences in speech rates due to Language within each group. These models included Language, Task, and the interaction between Language and Task as fixed effects, with Subject and Utterance as random intercepts. The terms of the model were added in a forward stepwise fashion, with the significance of each term determined through comparative model analysis.

Also, a multiple regression analysis was conducted to investigate the relative contribution of each factor on L2 Japanese speech rate. The independent variables included in the analysis were the Study Duration of Japanese and the Length of Residency (LoR) in Japan. The lm function in R [19] was utilized to perform the regression analysis.

3. Results

3.1. Speech rates of Japanese and Mandarin by the learner groups

Figure 1a shows the non-immersed group's speech rates of Japanese and Mandarin. Model comparison showed that there was a main effect of Task ($\chi^2(1) = 59.598$, $p < .001$) and significant two-way interaction between Task and Language ($\chi^2(1) = 11.071$, $p < .001$), but no main effect of Language ($\chi^2(1) = 2.315$, $p > .05$). Post-hoc pairwise comparisons for Language showed that for the reading task, the speech rate difference between Japanese and Mandarin was not significant ($t(100) = 0.627$, $p > .05$). For the speech task, the speech rate of Japanese was significantly slower than that of Mandarin ($t(100) = -3.673$, $p < .001$). Post-hoc pairwise comparisons for Task showed that for Japanese, the speech rate of the reading task was significantly higher than that of the speech task ($t(100) = 9.219$, $p < .001$). For Mandarin, the speech rate of the reading task was significantly higher than that of the speech task as well ($t(100) = 4.098$, $p < .001$). The findings indicated that for the non-immersed group, there was no significant difference in the speech rates between Japanese and Mandarin in reading tasks. In contrast, the speech rate in Mandarin exceeded that of Japanese during speech tasks. In addition, for both languages, the speech rate was consistently higher in the reading task than in the speech task.

Figure 1b shows the immersed group's speech rates of Japanese and Mandarin. Model comparison showed that there was a main effect of Task ($\chi^2(1) = 12.882$, $p < .001$) and a main effect of Language ($\chi^2(1) = 11.390$, $p < .001$), but no significant two-way interaction between Language and Task was found ($\chi^2(1) = 0.398$, $p > .05$). Post-hoc pairwise comparisons for Language showed that for the reading task, the speech rate of Japanese was significantly higher than that of Mandarin ($t(83.3) = 3.160$, $p > .05$). However, for the speech task, the speech rate between Japanese and Mandarin was not significant ($t(83.3) = 1.476$, $p > .05$). Post-hoc pairwise comparisons for Task showed that for Japanese, the speech rate of the reading task was significantly higher than that of the speech task ($t(83.3) = 3.260$, $p < .01$). For Mandarin, the speech rate of the reading task was significantly higher than that of the speech task as well ($t(83.1) = 2.292$, $p < .05$).

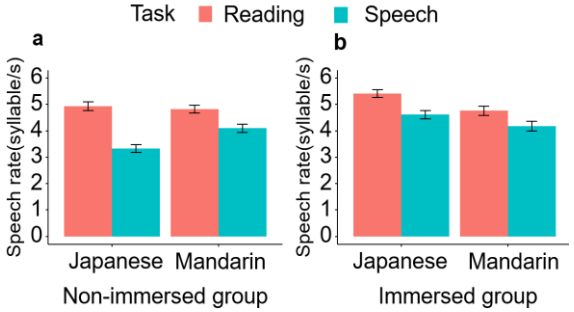

Figure 1: *Speech rates of Japanese and Mandarin by the non-immersed (a) and immersed group (b).*

Unlike the non-immersed group, immersed speakers displayed significantly faster Japanese speech rate in the reading task than Mandarin. For the speech task, despite a lack of significance between Japanese and Mandarin speech rates, the averaged Japanese speech rate (4.612 syllable/s) was still higher than that of Mandarin (4.172 syllable/s) by the immersed group. Also, upon examining individual performance, it was found that within the group of immersed speakers, 5 out of 7 speakers spoke Japanese faster than Mandarin during the speech task, suggesting that the immersed group possesses a higher level of fluency in Japanese compared to the non-immersed group. Additionally, a commonality between the two groups is that, for both languages, the speech rate in the reading task exceeded that in the speech task, indicating that the speech task require more mental effort than the reading task.

3.2. Speech rate comparisons between native speakers and the learner groups

Figure 2a shows the Japanese speech rates (syllable/s) by the NJ, immersed and non-immersed groups. Model comparison found that there was a main effect of Task ($\chi^2(1) = 54.832$, $p < .001$), a main effect of Group ($\chi^2(2) = 13.346$, $p < .01$) and significant two-way interaction between Group and Task ($\chi^2(2) = 7.360$, $p < .05$). Post-hoc pairwise comparisons for Task showed that for both speech and reading tasks, the speech rates between the NJ and immersed groups remained non-significant ($p > .05$). However, the speech rate of the non-immersed group was significantly slower than that of the NJ group in the speech task, ($t(79.5) = 4.361$, $p < .001$), Also, for the reading task, the speech rate of the non-immersed group was marginally slower than that of the NJ group as well ($t(44.4) = 2.423$, $p = .052$). Post-hoc pairwise comparisons for Group showed that for all the three groups, the speech rate of the reading task was significantly higher than of the speech task ($p < .01$).

Figure 2b shows the Japanese speech rates (mora/s) by the NJ, immersed and non-immersed groups. Model comparison showed that there was a main effect of Task ($\chi^2(1) = 40.808$, $p < .001$), a main effect of Group ($\chi^2(2) = 13.397$, $p < .01$) and significant two-way interaction between Group and Task ($\chi^2(2) = 8.319$, $p < .05$). Utilizing either mora or syllable as units for calculating speech rate yielded identical outcomes: the speech rate of the immersion group matched that of native Japanese speakers for both the reading and speech tasks. In contrast, the non-immersed group's speech rates were slower than those of the NJ group in both tasks. Also, across all three groups, speech rates were consistently faster in the reading than the speech task.

Figure 2c shows the speech rates of Mandarin by the NJ, immersed and non-immersed groups. Model comparison found that there was a main effect of Task ($\chi^2(1) = 30.438$, $p < .001$), but no main effect of Group ($\chi^2(2) = 0.129$, $p > .05$) and no significant two-way interaction between Group and Task ($\chi^2(2) = 0.269$, $p > .05$) was found. Post-hoc pairwise comparisons for Group within each level of Task showed that, for both reading and speech tasks, there was no significant difference between each group pair in both tasks ($p > .05$).

In summary, the results revealed no significant difference between the Japanese speech rates of the immersed group and NJ group for both tasks. However, the Japanese speech rate of the non-immersed group was significantly slower than that of the NJ group, particularly in the speech task. For Mandarin, L2 Japanese learners, either the immersed or non-immersed group, spoke Mandarin at rates comparable to native Mandarin speakers, indicating that Japanese did not influence their Mandarin speech rate.

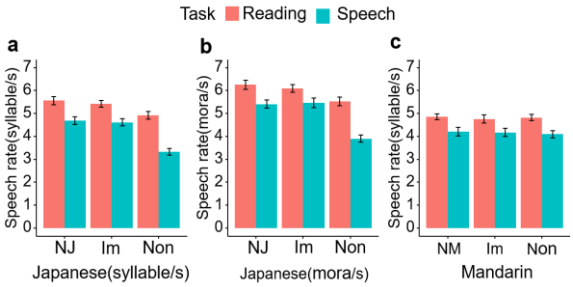

Figure 2: *(a) Speech rates of Japanese (syllable/s) by the NJ, immersed and non-immersed groups, (b) Speech rates of Japanese (mora/s) by the NJ, immersed and non-immersed groups, (c) Speech rates of Mandarin by the NJ, immersed and non-immersed groups (Im and Non represents the immersed group and non-immersed group respectively).*

3.3. Correlation of Japanese speech rates with Study Duration of Japanese and LoR in Japan.

The multiple regression model significantly predicted speech rate ($F(2, 80) = 7.16$, $p < .01$). The model accounted for approximately 15.18% of the variance in L2 Japanese speech rate (Multiple R-squared = 0.15, Adjusted R-squared = 0.13). As indicated in Figure 3, LoR was a significant predictor of speech rate (*Estimate* = 0.0122, *SE* = 0.0042, $t = 2.86$, $p < .01$). This suggests that a longer LoR in Japan is associated with an

increase in L2 Japanese speech rate. However, Study Duration was not found to be a significant predictor of speech rate (*Estimate* = 0.0035, *SE* = 0.0034, *t* = 1.05, *p* = 0.29). In summary, the data suggest that LoR had a positive effect on speech rate, whereas Study Duration did not have significant effects.

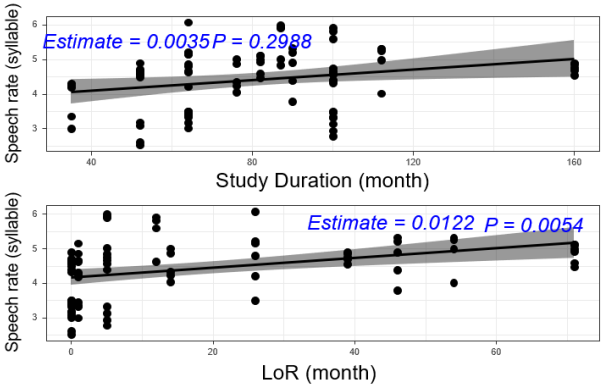

Figure 3: Correlation of Japanese speech rates with Study Duration of Japanese and LoR in Japan.

4. Discussion

L2 speech rate can surpass L1: contrary to prior studies that reported L2 speech was consistently slower than L1 speech [4][5][6], our findings clearly demonstrate that L2 speech rate can exceed that of L1. Direct evidence comes from the immersed group of Japanese learners, who displayed significantly faster L2 Japanese speech rate in the reading task compared to their L1 Mandarin. Furthermore, while at the group level, the immersed speakers did not show significant differences between L2 Japanese and L1 Mandarin speech rates in spontaneous speech task, a detailed look at individual data revealed that 5 of the 7 immersed speakers generally spoke faster in Japanese than in Mandarin in speech task. These findings highlight that L2 speech rates can exceed those of L1 for proficient individuals. These findings challenge the theory of automaticity, which posits that automaticity in L2 speech is inherently inferior to L1 due to less automatic syntactic and phonological encoding processes [7]. Our study finds that highly immersed L2 speakers can achieve the same level of automaticity as native speakers, evidenced by the non-significant differences in Japanese speech rates between the immersed group and native Japanese speakers.

Preliminary accounts for faster speech rates in Japanese than in Mandarin: this research confirms that Japanese is generally spoken more quickly than Mandarin, as established by earlier comparisons of native speakers from each language [9]. Our results reveal that L2 Japanese learners can maintain this pattern, speaking more rapidly in Japanese than in their L1 Mandarin. These findings challenge the notion that speech rate is not language-dependent but a product of individual speaker differences and speech styles [21]. Our study substantiates the hypothesis that speech rate is influenced by both the language's inherent characteristics and the speaker's unique traits [22]. The reasons why Japanese has an innately faster speech rate than Mandarin can be multifaceted due to the following: 1) phonetic traits: Japanese, as a mora-timed language, has a higher frequency of CV structures and often employs vowel reductions, contributing to shorter syllable durations [22],[23]. 2) Information density: Japanese generally exhibits lower information density compared to Mandarin, necessitating a greater number of syllables to convey equivalent content. This lower density may necessitate a faster speech rate to maintain communicative efficiency [24],[25]. 3) Cultural communication norms: the social context within Japanese culture places value on proper speech rate. A slower speech rate can be interpreted as impoliteness and disinterest [28]. This cultural expectation is likely to play a role in the speech rate of Japanese.

Factors impacting L2 speech rate: when examining the effects of Study Duration, and LoR on L2 speech rate, this research identified LoR as the most significant factor. First, classifying L2 Japanese learners based on the LoR > 1-year criteria, the results showed a stark contrast between the immersed speakers (whose Japanese speech rate could surpass L1 Mandarin) and non-immersed speakers (whose Japanese speech rate was comparable or slower than their Mandarin L1). Second, multiple regression analysis indicated that only LoR was a significant predictor, with Study Duration not showing significance. These findings corroborate previous research suggesting LoR as a predictor of L2 attainment success [11]. Previous studies have typically focused on the impact of LoR on phonetic learning at the segmental level (e.g., the acquisition of English /r/ and /l/ by Japanese learners [10],[12]). This study extends the understanding of LoR by demonstrating its influence on L2 prosody acquisition.

In addition, despite the lack of significance in the model results, Study Duration was found to positively correlate with speech rate. Contrary to our initial interpretation, which mainly attributed this non-significance to the limited sample size of participants, an anonymous reviewer has suggested that the range of Study Durations investigated in this study may also be a contributing factor. It is conceivable that a more extensive range, capturing learners from beginning levels at 10 months to advanced levels at 100 months or beyond, would reveal a stronger correlation. Consequently, future research should aim to include a broader spectrum of Study Durations, with a particular focus on examining the potential differential impacts on learners at various levels of proficiency. Additionally, incorporating variables such as gender, age of acquisition (AoA), language attitude, and language dominance could provide a more comprehensive understanding of the factors that influence L2 speech rate.

5. Conclusion

Our investigation centered on whether L2 learners can achieve speech rate surpassing their L1, focusing on Mandarin learners of Japanese. The findings suggest that, indeed, L2 speech rate can exceed that of L1, particularly when learners are immersed in the L2 environment for over one year. These findings challenge the claim of automaticity discrepancies between L1 and L2, suggesting that L2 speakers can be as fluent as L1 speakers. While the influence of Study Duration on speech rate was not substantial, the critical role of immersive learning experiences was clear. LoR proved to be an effective factor in enhancing L2 speech rate and fluency. These results affirm the transformative impact of immersion on L2 proficiency, providing valuable insights for L2 prosody acquisition.

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