Empatheme Data Collection Method and Applications of English Learner Data

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The field of L2 acquisition continues to flourish, with researchers unceasingly testing captivating theories and developing constructive methodologies. However, the dialogue surrounding data and data collection approaches remains vastly limited relative to their substantial significance. In particular, there is an evident potential for acquiring new forms and patterns of data yet to be considered by traditional strategies. Accordingly, the Empatheme data collection method is introduced as a unique and promising approach. Alongside an elaboration of the foundations and implementation, numerous significant advantages are presented. Finally, following a brief illustration of the amassed data, two specific avenues of application are demonstrated.

Keywords：L2 Acquisition, Data, Data Collection, Empatheme

1. Introduction

Research surrounding L2 acquisition, particularly the English language, has maintained its pertinency as a vital domain of study in a cosmopolitan society. An inherently intricate matter by nature, researchers have considered a wide range of approaches to better understand and facilitate second language learning. Where an emphasis on vocabulary and grammar is conventional, Yusuf (2020), for instance, challenges such standard methodological models to encourage a lexical approach integrating lexical phrases instead. A separate study pinpoints the notion of domain-general auditory processing, hypothesizing a favorable effect on successful L2 pronunciation learning in adulthood (Saito et al., 2020). Research in the field also frequently employs experiments as an instrument to manipulate specific variables of interest and approach causality. In the case of Sakata (2011), a masked priming experiment was conducted to distinguish the factors underlying the differences in both the mental representation and processing of derivatives between native English speakers and Japanese EFL learners. Notably, the abundance of compelling, contemporary studies on second language acquisition stems from decades of continual development. Discussion around the significance of memory in relation to foreign language learning dates back over fifty years when Pimsleur (1967) introduced the theory through the graduated interval recall.

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L2 acquisition research necessarily emphasizes the inquiry of novel hypotheses alongside the development of theories leaving the dialogue concerning data rather limited. Specifically, data is an equally vital element of second language acquisition studies that currently receive dramatically less consideration. The nature of the data, stemming from the data collection method, directly impacts the implications of studies. Appropriate data collection guides the path toward potentially valuable findings; ineffective data, on the other hand, serves as a fundamental limitation and an impediment to the research objective. In the context of developmental L2 pragmatics research, Taguchi (2018) sheds light upon three particularly conventional data collection methods: discourse completion tasks, role plays, and naturalistic recordings. DCTs elicit written or spoken responses and serve as a medium to observe the learner across varied contexts. Diversely, role plays permit two-way interactions, although circumscribed in situational variety; naturalistic recordings provide insight into real-life interactions. More broadly, the majority of L2 acquisition studies employ data collection strategies in the form of tests and tasks catered to the underlying research purpose. Lange (2018) utilizes a partial dictation test to measure the ability of L2 listeners to identify function words in connected English speech, while Saito et al. (2020) consider a timed picture description task as part of the larger longitudinal study. While traditional methods predominantly suffice, there remains a potential for acquiring new forms and patterns of data, which can subsequently help unfold invaluable research opportunities. In recognizing the significance of data and the prospect for an innovative perspective in the domain of second language acquisition research, this pa-

per introduces the Empatheme data collection method alongside several demonstrative data applications.

2. Empatheme Data Collection Method

The Empatheme data collection method stems from the philosophies of Empatheme deep-rooted within Ei Pra: a service dedicated to guiding the learning and practice of the English language. A patented invention, Empatheme serves to instill the unlearning of self-judgment into the learning process and harness innate human abilities (Yoshida et al., 2021). Breathing, vocalization, and the creation of intentional pauses constitute the core of such inherent capacities. Empatheme specifically helps create a repeatable natural flow in cultivating and effectively drawing on the natural abilities during the act of routine practice. Abstractly, Ei Pra embodies the foundations of Empatheme, simultaneously characterizing a digital transformation innovation driven by empathy and commitment. The notion of learning to practice English, disparate from the routine nature of studying, illustrates the crux of the service. In essence, the daily practice of Ei Pra contents by English learners translates directly into the data collection process.

As a service and implementation of Empatheme, Ei Pra offers a unique approach in parallel with corresponding contents to facilitate English practice. Naturally, Ei Pra is catered towards the pool of beginner and intermediate English speakers; more advanced learners, however, can similarly benefit from the provided guidance. The contents of Ei Pra are composed of one hundred cards, each emphasizing a distinct theme. The themed cards are partitioned evenly by number into three separate trails: the first thirty-three cards, as an illustration, form the first trail. A single card comprises an assortment of individual and conversational phrases aligned with the particular theme. In particular, each phrase is considered a distinct seed: a unit of vocalized expression. Comprehensively, Ei Pra features a total of 2520 seeds encompassing 1857 unique words, 19,851 syllables, and 49,139 phoneme sounds, among other eminent characteristics.

Ei Pra offers three independent courses considering the varying language capacities and circumstances of potential new learners. Accordingly, the practice frequency of a particular learner is directly contingent upon the preferred path. The first option, branded "walking slowly," given the comparatively casual nature, directs learners to complete half a card each day: such pace culminates in the conclusion of a trail every three months. The "steadily" course involves pursuing one card per day coupled with the repetition of a trail on three occasions prior to advancement. Exhaustive trail completion requires four months and the entire course a year. The most prompt of the three selections, the "quickly" route, implies concluding one card daily absent any reiteration and hence the consummation of all three trails in four months. While the progression speed varies, all three courses are designed to maximize repetitive processes and further integrate an opportunity for weekly reviews to encourage the reflection of daily practice.

Ei Pra further promotes an approach embracing Empatheme, which helps direct the practice of English learners. The recurring flow of vocalization, reflection and the nurturing of habits constitute the foundations of the learning process. Precise guidance also ensures that the practice of Ei Pra contents is invariably conducted in a controlled and comparable manner. Every occurrence of practice is initiated by preparing a calm environment free of surrounding noise and distractions. Maintaining a clear mind, learners proceed to review the collection of seeds contained in the appropriate themed card. In addition to a visual examination, the availability of corresponding native voice samples provides an opportunity for imperative auditory review. Both the listening to of native samples and subsequent deed of practice occurs through a companion smartphone application accompanying the Ei Pra service. Following the initial act of review commences the essence of the Ei Pra practice: the vocalization of seeds. Serving as an extension of the serene environment, the application provides a dedicated space to carry out the practice through the initiation of a new session. Bearing in mind the notion of calmness and empathy, learners begin to vocalize each seed one breath at a time, acknowledging room for short pauses in between. Execution of the final seed in the germane themed card signals the conclusion of practice, although Ei Pra offers several purposeful opportunities for further reflection. A single instance of practice is deliberately short in time and manageable: the accumulation of minimal moments engenders powerful effects. Most importantly, the habitual act of practice by English learners through Ei Pra contents contributes directly to the collection of data. The foundations of Ei Pra, combined with its implementation, define the Empatheme data collection method (Figure 1).

Contrasted with conventional schemes in the field of L2 acquisition, the Empatheme data collection method presents an assortment of distinct advantages. The first class of merits represents the natural implications of imposing a controlled environment. More specifically, the methodical practice approach of Ei Pra ensures that all data are acquired in an identical manner under equivalent conditions: both across learners and within

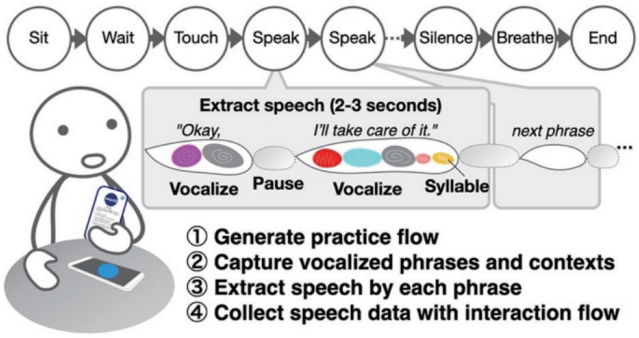

Figure 1　The Empatheme data collection method generates a controlled environment

a particular individual. Accordingly, the Empatheme method yields data appropriate for meaningful comparisons and further pertinent analysis. Both the contrasting of characteristics between various learners in a designated period and within a particular individual over an extended interval is sensible. On a similar note, native samples primarily available as a source of review are also collected in a fashion tantamount to the practice sequence of learners. The result is the emergence of an opportunity to directly compare differences inherent between learners and native speakers from an analytical perspective. A clear distinction of intrinsic disparities can serve as a reference for offering targeted advice to English learners.

The nature of the obtainable data constitutes another cornerstone benefit of the Empatheme method. Above all, the particular data collection approach enables the accumulation of repeated data on the same individual. Consequently, even a tiny sample of Ei Pra learners yields a considerable volume of data; a more copious pool of learners naturally contributes to the return of data colossal in scale. Recurring data on learners also render the prospect of analysis over an extended timeframe. A paramount example includes the measurement of overall progression and potential improvements in English ability. The virtually self-generating essence of the data spotlights a further asset: every instance of practice by learners translates directly into additional data. The Empatheme method solely relies on the integration of learners into the Ei Pra network, absent the necessity of deliberately initiating specific occasions for data collection. More subtly, the overall structure, alongside the coherence of Ei Pra, also contributes to the accumulation of considerably clean and complete data.

The final collection of advantages illustrating the capacity of the Empatheme method involves the content of the resulting data. By construction, the attainable data is equivalent to the Ei Pra practice material; ergo, the data piggyback the numerous fruitful characteristics of Ei Pra, which help guide the learning process. Engineered through a methodological approach, the seeds contained in the Ei Pra practice echo meaningful phrases considering the communicative element of English speech. In particular, the Ei Pra corpus accounts for over ninety percent of the conversational vocabulary employed by native speakers. On a similar note, the seeds are abundant in variety and encompass colloquial phrases beyond a strictly formal implementation of the English language. The notion of working memory constitutes a further factor of significance pertaining to the apparatus provided by Ei Pra. Notably, all seeds available to learners for practice conform to the basic principles of working memory: short two-three second phrases expressible in a single breath (Cowan, 2010). Given that L2 processing burdens working memory resources (Bloomfield et al., 2010), the seeds are sensible both from the perspective of learners and the output data. By design, the content of the data arising from the Empatheme data collection method mirrors all of the favorable properties inherent in Ei Pra seeds. The data reflect a substantial share of vocabulary spoken by natives, present richness in variety, and maintain appositeness in exhibiting the theories of working memory.

3. Data

Gradual implementation of the Empatheme data collection method over the past several years has resulted in the accumulation of an appreciable amount of data. L2 learners utilizing the Ei Pra service compose most of the data; student data through collaborative projects with schools and universities also account for a portion of the total volume. Stored and administered in a cloud database, voice audio constitutes the raw data. However, data remaining in such form presents obvious complications in conducting a broad spectrum of analyses. Accordingly, the speech recognition technology for language learners developed by Speechace is considered a natural solution. The notion that the Speechace API performs ideally with short sentences guarantees compatibility with the phrase-based nature of the data gathered using the Empatheme method. Through the API, various quantitative characteristics of the original data are extracted, allowing for unique use cases and analyses. For both a more detailed elaboration in addition to subsequent demonstrations of several promising applications, a specified subset of the entire pool of available data will be considered.

The designated subset data consists of eight different Ei Pra learners alongside two distinct sets of native samples. Middle-aged Japanese individuals, both males and females, characterize the general demographics

of the learners involved; the native samples are synonymous with the auditory review material provided to learners as a resource. The subset data encompass content from the first trail in Ei Pra, namely the maiden thirty-three themed cards, and range from August 2019 to February 2022. Notably, the subset data is partitioned into five discrete parts forming an intrinsic hierarchy based on observational unit size. All components primarily convey differing information, although basic details remain consistent across the partitions. Key shared variables include the ID of learners and source sessions, as well as an indication of time. Seed data constitute the largest scope of the five partitions and offer overarching information at the seed level. Third, in order, word data likewise resemble a small database storing relevant information as opposed to providing analytical power. The former contains a row for every instance of a seed, while the latter for each and every occasion of a word.

The remaining three partitions of the entire subset data comprise information that provides an opportunity to implement a wide range of analyses. Sentence data follow as the second largest in scope, provided that a single seed occasionally contains multiple sentences strung together. A sentence within a particular seed constitutes the observational unit; frequently, however, a sentence and seed are interchangeable. In addition to a text characterization, syllable count, duration, and the space in time between sentences of the same seed exemplify essential variables. The second smallest in unit of the pack, syllable data portray information at the syllabic level. Leading variables include score and duration alongside a time measurement of space separating consecutive syllables. Analogous to all other partitions, there also exists a specific column carrying the text of the syllable under consideration. Phoneme data, the smallest in scope and most compact, complete the natural hierarchy. As the title implies, a row is designated for each instance of a phoneme and represented by the corresponding element from the International Phonetic Alphabet. Handy columns closely resemble the key features in syllable data: score, duration, and quantification of the space in time between successive phonemes.

Examples of applications to be demonstrated in the subsequent section rely exclusively on the above three partitions of the subset data. Accordingly, a straightforward data preprocessing procedure was also implemented in preparation. For all three partitions, errors reflected in the final data attributable to problems during the initial data collection step were carefully removed. In the same vein, observations with inaccuracies caused strictly by the peculiarities of the Speechace API were likewise omitted. Several new and overlapping variables were also crafted for each partition to facilitate forthcoming analyses. Sentence data experienced a reduction in the number of rows from 16,667 to 12,903 and a simultaneous increase in columns from 31 to 35. The dimensions of syllable and phoneme data transformed from 80,162 by 40 to 79,473 by 43 and 198,667 by 42 to 191,688 by 45, respectively. As suggested by the aggregate sum of columns, the partitions forming the subset data encompass numerous other variables with potential applicability in analyses. Moreover, partitions of a smaller scope necessarily contain more rows of data, as corroborated by their respective dimensions.

4. Discussion

The nature of the data amassed through the Empatheme data collection method provides an opportunity to consider a broad spectrum of applications pertaining to the field of L2 acquisition. This paper, in particular, introduces two potential avenues of application: identification of common difficulties among Japanese EFL learners and evaluation of long-term progression. As aforementioned, all examples of applications employ the subset data presented in the prior section. The former exploits a direct comparison between learners and native samples to spotlight specific challenges, utilizing the first three months of available data to mitigate the effect of potential improvements in English ability over time. The latter considers an internal comparison within individuals, applying the first and last three months of data for each learner to gauge development. Given that one Ei Pra learner in the subset lacks data spanning an extended period, seven rather than the complete eight individuals are incorporated in the analyses of progression.

The notion of rhythm constitutes one critical element of acquiring a second language. As noted by Kyriakopoulos et al. (2019), the rhythm of learners is anticipated to deviate from their L1 and approach the L2 in conjunction with overall improvements in ability. Furthermore, the degree to which learners can match the natural L2 rhythm serves as a measure of proficiency. While imperative in successful L2 acquisition, rhythm also embodies an obstacle frequently challenging for new learners to overcome. Referenced alternatively as speed and tempo, underlying differences with that of the L1 generate hindrances for non-native speakers (Ribble, 2000). Concerning Japanese EFL learners specifically, words with certain characteristics can provide considerable difficulties in maintaining the rhythm necessary for natural-sounding speech: namely, rhythm breakers. Words absent of stress and vocabulary inducing kana-based pronunciation, in particular, shape two

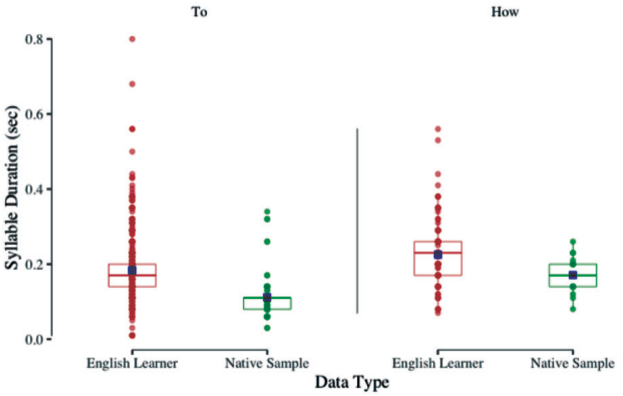

Figure 2 A comparison of syllable duration between English learners and native samples for the words "to" and "how"

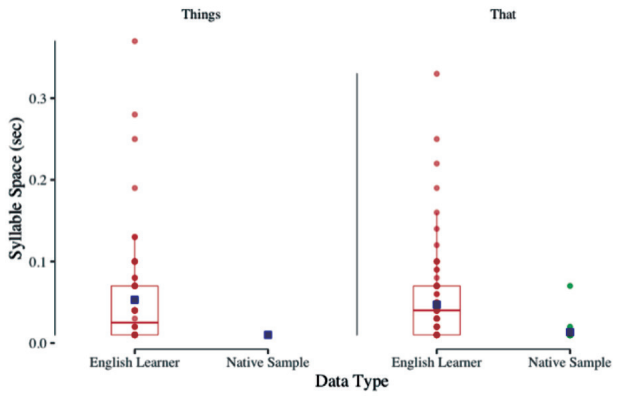

Figure 3 A comparison of syllable space between English learners and native samples for the words "things" and "that"

big categories of the larger rhythm breaker family.

Stressless words, patently implied by the name, lack the deliberate use of stress when pronounced by native English speakers. There remains a tendency, however, for Japanese EFL learners to place unnecessary stress on such words; as a result, the vocalization duration should, in theory, be unnecessarily stretched. Drawing on the subset data, two explicit examples from the group of stressless words that seemed notably challenging were identified: "to" and "how." Since both represent one-syllable words, a comparison of syllable duration between learners and native samples suffices. Illustrated in Figure 2, the duration in seconds taken to vocalize the two words appear longer overall for learners relative to native speakers.

Numerically, learners, on average, take 64.31% and 31.95% more time to pronounce the words "to" and "how," respectively: a pattern likewise observed among a broad spectrum of stressless words. Even a flat difference of 0.07 and 0.05 seconds feels minimal at first glance yet creates a substantial distinction in practice. The noticeably greater variability in syllable duration on the end of Japanese EFL learners also lends further support to the difficulties these two words present and the consequent obstruction to the natural English rhythm.

Although syllable duration could help pinpoint patterns from the kana-based pronunciation category of rhythm breakers, an alternative variable is considered for illustration purposes. Introduced beforehand, the syllable space variable measures the time gap between consecutive syllables. The nature of kana-based pronunciation by Japanese EFL learners elicits additional sounds not present in the vocalization by native speakers, producing a noticeable gap in the context of the syllable space variable. While kana-based pronunciation frequently manifests itself multiple times within a word, the focus remains solely on the final sound to effectively employ the data on syllable space. Isolating the syllable space variable of the subset data, two examples, "things" and "that," were extracted as notably challenging words from the category. As depicted in Figure 3, the space in time present after the two words is overwhelmingly longer for learners to a large extent. Even considering the limited sample size on the end of natives, the notion that natural pronunciation produces minimal space at the conclusion of the two words remains evident. On average, kana-based pronunciation results in a 5.29 and 3.53 larger time gap following the words "things" and "that," respectively.

Excess sounds stemming from kana-based pronunciation, reflected in part as syllable space on data, adversely impact the ability of learners to match the native English rhythm. Targeted practice, possibly beginning with the two examples identified through the subset data, could hugely benefit Japanese EFL learners in overcoming the current rhythmic obstacle.

Another barrier in L2 acquisition for Japanese EFL learners, presumably more commonly regarded than the notion of rhythm, centers around pronunciation. For instance, Ohata (2004) mentions that learners would likely struggle to vocalize English vowels nonexistent in the typical five-vowel system utilized in Japanese. Furthermore, the tense versus lax distinctions present in English is spotlighted as a decidedly problematic factor hindering natural-sounding pronunciation for Japanese EFL learners. Ribble (2000) similarly points to challenges in sensing differences in certain English sounds as a contributor to the apparent pronunciation hurdle. The phoneme partition of the subset data, primarily the phoneme score variable, enables detailed applications pertaining to pronunciation. Given that the position of a particular sound and the nature of adjacent sounds can both influence the difficulty of pronunciation, a word-

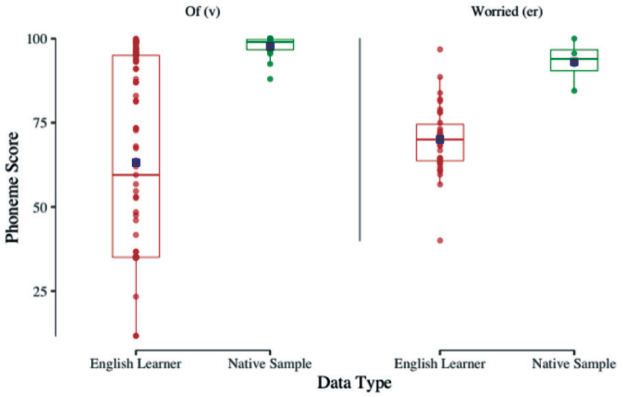

Figure 4 A comparison of phoneme score between English learners and native samples for the "v" and "er" sounds in the words "of" and "worried," respectively

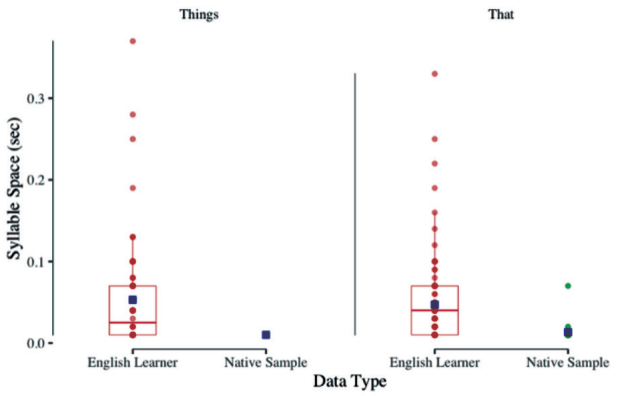

Figure 5 Long-term progression of English learners in the mean syllable duration of the words "to" and "how"

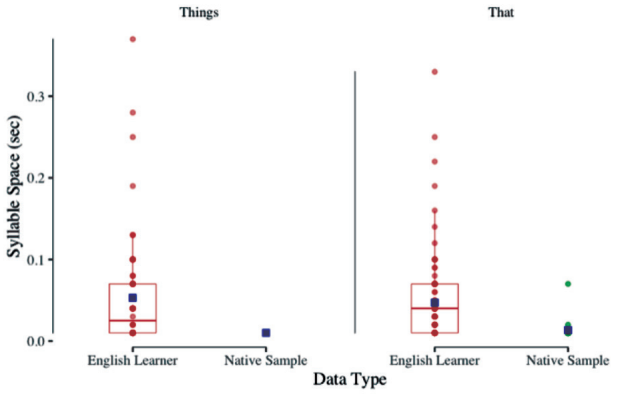

Figure 6 Long-term progression of English learners in the mean phoneme score of the "v" sound in the word "of"

phoneme combination together with the accompanying score is considered. Echoing the previous pattern, two phonemes within a particular word that appeared notably troublesome to pronounce for Japanese EFL learners were identified. The "v" sound contained in the word "of" constitutes the first example, while the "er" phoneme in "worried" comprise the latter. Figure 4 visualizes a clear contrast, with learners predominantly receiving lower scores for both phonemes. Moreover, even the lowest scores among natives reside comfortably in the higher percentiles of the learner distribution. On average, learners scored 34.49 points lower for the "v" phoneme in the word "of" and 23.1 fewer points for "er" in "worried." The minimal variability on the end of native samples also demonstrates a high level of consistency in pronunciation. On the other hand, despite a decent share of high-scoring observations, the larger variance and the presence of low scores further signal the evident challenges the two phonemes present to learners.

Analogous to the case of rhythm breakers, the data provide the potential to identify specific difficulties faced by Japanese EFL learners in the domain of pronunciation.

Transitioning from the identification of challenges among Japanese EFL learners, the second avenue of application involves a view of long-term progression. Correspondingly, an internal comparison is adopted instead of a direct contrast between learners and native samples. To maintain coherence and transparency, long-term development is measured across several of the examples already introduced in the first extensive application. Specifically, the two cases of stressless words and the "v" phoneme contained within the word "of" are considered.

Concerning the former, improvements should manifest as a decrease in syllable duration. As portrayed in Figure 5, all but one of the learners in the subset data experienced at least some reduction in the mean syllable duration of the word "to" over time. On the contrary, signs of positive progress with respect to the word "how" appear somewhat mixed. Several learners saw a decrease in mean syllable duration between the first and last three months of their respective data, although slightly less than half surprisingly endured an increase. A handful of factors could potentially explain the evident lack of improvement among a few learners; for instance, a straightforward comparison of means remains suspect to significant outliers. Notably, the fundamental difficulties stressless words pose for Japanese EFL learners in the first place constitute a particularly plausible interpretation. Shifting the focal point, pronunciation improvements over time in the context of the data would emerge as an increase in phoneme score. Figure 6 illustrates a long-term increase in mean phoneme scores across all but one learner.

Hence, practice and repetition, among other critical elements of learning, appear effective in helping Japanese EFL learners with the initially challenging pronun-

ciation of the "v" sound in "of."

Identification of difficulties shared by Japanese EFL learners and consideration of progression in the long term was presented as two possible directions of applications employing the data acquired through the Empatheme data collection method. Although the former stemmed exclusively from the topic of rhythm breakers and pronunciation, the possibilities, both in terms of the broader category and the specific examples within, are abundant. Moreover, while the choices for examining long-term progression were drawn from the preceding application, the data also allow for a more direct determination of specific points of improvement and stagnation. A further consideration, the two particular applications could employ alternative methods of analyses than the demonstrated implementation. The nature of the data also implies the potential for numerous other forms of powerful applications. A detailed examination of speech speed and mistake frequency represents practical candidates. Analysis of practice attitude, harnessing information hidden within the data, comprise another available application area.

5. Conclusion

The established field of L2 acquisition remains ever so prevalent, with researchers unceasingly evaluating new theories and developing transformative methodologies. Nonetheless, the conversation surrounding data alongside associated data acquisition procedures appears disproportionately limited relative to its significance. Moreover, the literature implicitly suggests the possibility of obtaining new types and patterns of data yet to be considered. In light of the current framework, the Empatheme data collection method was introduced as a novel and unique approach. Harmonizing with Ei Pra, a service facilitating English learning on the surface, the daily practice of the provided contents by learners translates directly into the accumulation of data. The Empatheme method offers numerous advantages; for instance, the collection of data under identical conditions at all times allows for meaningful analytical comparisons, not to mention the presence of native samples. The virtually self-generating nature of the data and the content itself represent further merits. Two specific applications, the identification of particular challenges among Japanese EFL learners and the evaluation of long-term progression, were also presented, employing a designated subset of the data acquired through the Empatheme method over the past several years. Notably, the characteristics of the data denote the opportunity for a host of other instructive applications, including both a broad analysis and specific examination into the variability of speech speed, mistake frequency, and practice attitude.

Given the inherently observational nature of the attainable data, a broad implementation of randomized control trials in conjunction with Ei Pra constitutes one primary future consideration. A crucial step towards inferring causality at the analytical level in applications, such an initiative also facilitates a statistical quantification concerning the efficacy of Ei Pra as a resource for English acquisition. Another notable ambition for the near future involves an expansion of the Ei Pra platform, particularly with respect to the learner base. Besides a healthy increase in the overall availability of data, a more comprehensive range of demographics remains imperative for external validity and the generalization of potential findings. Finally, a more general enhancement of Ei Pra and associated tools embody a further objective to continue to refine the data acquisition approach. While the abovementioned considerations define future endeavors, both the fundamental ideas behind the Empatheme data collection method and the available data itself can be directly referenced or built on by researchers at any time to further their works in the field of second language acquisition.

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