

How can foreign language learners improve perception of their own pronunciation?

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Contents

Introduction	2
Auditory processing	3
Production vs perception-based practice	4
Musical aptitude	5
Mirror neurons & cortical excitability	6
Somatosensory feedback	7
Speaking-induced suppression & enhancement	8
Feedback	9
Conclusion	10
References	11
Appendix	16
Personal Development Plan	16

Introduction

In my experience as a teacher of English pronunciation, students often complain that “they can’t hear their mistakes” or “they don’t know when they mispronounce a word”, despite understanding native speakers easily. For example, they can distinguish the words ‘cat’ [kat] and ‘cut’ [kʌt] spoken by a native speaker but consistently mispronounce them in their own speech. This hints at a lack of perception of their speech and may be the result of an overestimation of their pronunciation caused by an overfamiliarity with their accent (Mitterer et al., 2020).

Speech production starts with a feedforward control system which sends information about an utterance from the brain to the speech organs for articulation (Guenther & Vladusich, 2012; Houde & Nagarajan, 2011). Both auditory and somatosensory information is fed back to the brain and compared to the expected sound. If there is a discrepancy between the expected and resulting sounds, the feedforward control system is updated. This process is repeated until the discrepancy is eliminated and learning occurs.

Failure of a student to accurately perceive their own speech is problematic for two reasons. Firstly, it can lead to mispronunciations with consequences ranging from mild amusement to complete communication breakdown (Babatsouli, 2022; Collins et al., 2019). Secondly, it prevents students from improving their pronunciation independently – mispronunciations are a natural part of the learning process and a student’s inability to perceive them will hinder their progress (Bislick et al., 2012; Schmidt, 1975, 2003). In this paper I investigate why some students find it more difficult to perceive their own pronunciation and develop a strategy to overcome this challenge.

I settled on this research question after using Kolb’s Experiential Learning Cycle (Kolb, 1984) to reflect on the challenges I have encountered teaching English pronunciation. Kolb conceptualises experiential learning as a continuous cycle of experiencing, reflecting, thinking and acting. In this way, the lessons learnt from an experience are applied in real life and the cycle starts again. I was attracted to this model because of its emphasis on experiential learning (Kolb & Kolb, 2018; Morris, 2020) and its successful application to education (Bohon et al., 2017; Chiu & Lee, 2019). Each section of this essay will include a reflection using Kolb’s Experiential Learning Cycle under the following headings: experience, reflection, thoughts and action.



Experience: I have taught many students who struggle to distinguish foreign sounds in their own speech. **Reflection:** Students who demonstrate a lack of perception of their own pronunciation usually make slower progress. **Thoughts:** Good perception skills must be necessary for good pronunciation in foreign languages. **Action:** I will investigate how foreign language learners can improve perception of their own pronunciation.

Auditory processing

Several factors can influence the success with which an individual learns a foreign language including education, experience, age, motivation and anxiety (Doughty, 2019; Suzukida, 2021). However, all else being equal, differences in foreign language learning success are the result of differences in language and musical aptitude (Doughty, 2019; Suzukida, 2021). Aptitude is one's talent or ability to perform a skill and acts as a "ceiling on success" (Doughty, 2019, p. 101).

More specifically, auditory processing aptitude has proven to be the strongest predictor of foreign language learning success even after accounting for other cognitive variables such as short and long-term memory (Kachlicka et al., 2019; Saito, Cui, et al., 2022; Saito et al., 2020). Auditory processing is the ability to identify and distinguish temporal and spectral characteristics of sound. For example, the frequency of the formants in the [a] vowel and its duration in a word like 'cat' [kat]. Formants are frequencies which are amplified by the vocal tract and used to distinguish vowel sounds (Oganian et al., 2023).

Shao et al. (2023) explored two features of auditory processing in more detail: auditory acuity, which is the ability to encode the temporal and spectral characteristics of a sound, and audio-motor integration, which is the ability to remember and convert this information into speech. They tested 37 Chinese participants' auditory acuity and audio-motor integration aptitude before and after a total of 6 hours English shadowing training. Shadowing is when students listen and imitate someone else's speech as accurately as possible. The researchers discovered that all participants demonstrated an improvement in comprehensibility. However, individuals with a higher aptitude for audio-motor integration demonstrated more nativelike pronunciation compared to those with a greater aptitude for auditory acuity. The results of this study suggest that students with a greater aptitude for audio-motor integration may benefit more from production-based exercises whereas those with a greater aptitude for auditory acuity may benefit more from perception-based exercises.

Experience: I have taught several students who demonstrated a high aptitude for auditory acuity but a low aptitude for audio-motor integration, i.e. they could easily distinguish words when listening but struggled to pronounce them accurately when speaking. **Reflection:** I

gave these students more production-based exercises because I thought their problems stemmed from a lack of practice. **Thoughts:** Although their pronunciation improved, I realise now that they may have improved more quickly with more perception-based exercises.

Action: In view of this, I will screen my students using the test batteries at <https://sla-speech-tools.com/research> in the future and focus more on perception-based exercises if a student demonstrates a higher aptitude for auditory acuity than audio-motor integration.

Production vs perception-based practice

Perception-based practice is when comprehension is the goal whereas production-based practice is when articulation is the goal (Li, 2024). A meta-analysis of 30 studies showed that perception-based practice led to a small improvement in production performance (Sakai & Moorman, 2018). However, the researchers note that the average sample size was small, just 11.61 participants, and the languages and phonemes studied even smaller – 29 featured English while 10 contrasted the phonemes /l/ and /r/.

A relatively large study completed after this meta-analysis observed an advantage of perception-based practice in a group of 45 participants compared to a group of 47 participants who performed production-based practice (Lee et al., 2020). In view of this, the researchers recommend perception-based exercises such as kinaesthetic training (e.g. clapping along to the syllables of a word) and phoneme identification (e.g. listening and identifying the correct word from a minimal pair).

However, another study observed an advantage of production-based practice in a group of 28 participants compared to another group of 28 participants who performed perception-based practice (Li, 2024). Interestingly, the production-based group demonstrated a greater improvement in both production *and* perception skills despite following a similar method to Lee et al. (2020).

Since demographics were found to have no significant effects on the results of the two studies, the reason for the discrepancy may lie in the different stimuli used. Li (2024) only used consonant phonemes /θ/ and /ð/ whereas Lee et al. (2020) used consonant phonemes /f/ /h/ /v/ /b/ /s/ /θ/ *and* vowel phonemes /a/ /ɑ/ /o/ /ɜ:/ . Tactile feedback has proven to facilitate consonant articulation whereas vowel articulation relies mainly on proprioceptive acuity (Nip et al., 2023). Consequently, it is possible that the difference observed between the production-based groups is due to the relative difficulties of the stimuli. Unfortunately, Lee et al. (2020) did not break down the results by phoneme, so we do not know the improvement of vowels relative to consonants.

Experience: I usually follow a similar methodology when I teach pronunciation – I start with perception-based exercises then move onto production-based exercises. **Reflection:** I follow a similar methodology because I thought pronunciation features are learnt in a similar way. **Thoughts:** However, I realise now that each feature of pronunciation may interact differently with perception and production-based practice and following the same methodology may slow progress. **Action:** In view of this, I will be pay more attention to any problematic features and provide more perception-based practice where the problematic feature lacks tactile feedback.

Musical aptitude

Musical aptitude can also influence perception of foreign speech sounds (Suzukida, 2021). For example, Kempe et al. (2015) observed that the ability of 118 participants to distinguish musical sounds was correlated to their ability to distinguish foreign speech sounds. However, this correlation was limited to spectral and not temporal information. The researchers suggest that this is because changes in speech occur on a much smaller timescale than music (less than 100ms).

Saito, Petrova, et al. (2022) further demonstrated that general auditory training (i.e. non-speech) can improve specific auditory processing (i.e. speech). In their study, an auditory only group of 22 participants was trained to discriminate synthesised sounds of different frequencies while a phonetic only group of 22 participants was trained to discriminate the [æ] and [ʌ] vowels. Both groups were asked to discriminate both synthesised and speech sounds in pre and post-tests. Results showed that participants in the auditory only group improved their ability to distinguish both synthesised and speech sounds. In contrast, participants in the phonetic only group only improved their ability to distinguish speech sounds.

Results of these studies suggest that students with low auditory processing aptitude may benefit from auditory training in non-speech sounds. However, auditory processing is also influenced by attentional control, which is the ability to focus on relevant acoustic information and ignore irrelevant information (Saito et al., 2024). For example, Mandarin speakers may focus more on tones and their success learning English will partially depend on their ability to focus more on vowel length. Consequently, a student's musical aptitude may be moderated by their attentional control.

Experience: I usually use the target language in perception-based exercises. **Reflection:** Students usually improve their perception skills after this phonetic training. **Thoughts:** However, I realise now that training students in non-speech sounds may also be beneficial. **Action:** In view of this, I will incorporate non-speech sound perception-based exercises into

my lessons using a guitar and slide. In this way I can modulate the frequency of notes in a narrow range, much in the same way as Saito, Petrova, et al. (2022), and test my students' ability to distinguish them.

Mirror neurons & cortical excitability

The results of previous trials suggest an intricate link between perception and production of speech since transfer effects are observed after both perception and production-based practice (Lee et al., 2020; Li, 2024). This is consistent with the Motor Theory of Speech Perception (Galantucci et al., 2006; Liberman & Whalen, 2000), which posits that the motor system is employed in both speech production *and* perception. This theory was strengthened in 1992 with the discovery of mirror neurons – neurons in the motor cortex which are active when an action is both performed *and* observed (Gallese et al., 1996; Guenther & Vladusich, 2012; Heyes & Catmur, 2022).

Since this discovery, several studies have investigated the role of mirror neurons in speech. D'Ausilio et al. (2014) demonstrated a direct correlation between mirror neurons and speech perception in a group of 18 participants when they observed that participants with higher speech mirror neuron activity also demonstrated a better ability to identify speech in noise. Restle et al. (2012) observed an improvement in 18 participants' ability to produce foreign speech sounds after transcranial magnetic stimulation was applied to speech mirror neuron regions of the brain. Transcranial magnetic stimulation is when a current is applied to the brain by placing an electromagnetic coil over the relevant part of the scalp (Sy et al., 2023). Brisson & Tremblay (2021) further observed an improved ability to distinguish speech in noise in a group of 21 participants after transcranial magnetic stimulation was applied to speech mirror neuron regions of the brain. Similarly, D'Ausilio et al. (2009) observed an improved ability to discriminate bilabial sounds [p] & [b] and alveolar sounds [t] & [d] in a group of 10 participants when transcranial magnetic stimulation was applied to the part of the brain known to control the lips and tongue.

Foreign language students and teachers are unlikely to have the equipment or training necessary to apply magnetic stimulation to their brains. However, there may be other ways of stimulating mirror neurons in a way that improves perception. Perron et al. (2024) observed a similar effect in a group of 15 participants who produced syllable pairs before a perception task. Results showed a 5% improvement compared to another group of 15 participants who practiced perceiving the same syllable pairs before the perception task. Interestingly, this improvement appeared to transfer to syllable pairs which were not even practised in the training sessions. This suggests that priming the brain with production activities can improve perception skills.

Experience: I usually start my pronunciation lessons with some simple warm up exercises.

Reflection: However, I have always questioned the effectiveness of warming up before practising a foreign language since our speech organs are already likely to be warm from speaking in our native language. Occasionally I would omit warm up exercises if a student arrived late and we were short on time. **Thoughts:** I realise now that production-based exercises are effective at warming up the brain as well as the speech organs, and that targeted exercises can improve the perception of target speech sounds. **Action:** In view of this, I will allow more time for warm up exercises and tailor them to my students' specific needs by using the target pronunciation features in the exercises. In this way the students will prime their brain for the following perception exercises, much in the same way as Perron et al. (2024).

Somatosensory feedback

Although speech perception is often thought of as a purely auditory process, it also relies on somatosensory feedback (Guenther & Vladusich, 2012; Houde & Nagarajan, 2011). Ito et al. (2009) demonstrated this by using a robotic device to stretch the facial skin of 30 participants in a way that resembled either the [ɛ] or [a] vowels. Then, the participants were asked to identify a series of words which had had their formants shifted in such a way that they formed a continuum from 'head' [hɛd] to 'had' [had]. The results indicated that the 15 participants whose facial skin was manipulated in the direction of [ɛ] were biased towards 'head' [hɛd] whereas the 15 participants whose facial skin was manipulated in the direction of [a] were biased towards 'had' [had].

(Masapollo & Guenther, 2019) obtained similar results when they asked 32 participants to identify vowel sounds from silent film while engaging their speech organs. The 16 participants who held a tube between their lips were biased towards the [u] vowel whereas the 16 participants who held a bite block between their teeth were biased towards the [a] vowel.

Furthermore, Sato et al. (2013) observed an improvement in 16 participants' ability to identify syllables in noise when they silently articulated the syllables at the same time. The results of these studies are consistent with the Motor Theory of Speech Perception (Galantucci et al., 2006; Liberman & Whalen, 2000) and suggest that somatosensory feedback may be responsible for the priming effect observed by Perron et al. (2024).

Experience: When a student is struggling to perceive a sound, I usually give them more audio-based perception exercises. **Reflection:** Students usually improve their perception after performing audio-based perception exercises. **Thoughts:** However, I realise now that

engaging their articulators may also be beneficial. **Action:** In view of this, I will encourage my students to silently imitate the audio during perception-based exercises.

Speaking-induced suppression & enhancement

Although we use auditory feedback to perceive our speech, studies have shown that the auditory cortex is actually suppressed during speech (Chang et al., 2013; Houde & Chang, 2015; Ventura et al., 2009). For example, Heinks-Maldonado et al. (2005) measured the brain activity of 17 participants as they listened to their own voice, their own voice pitch-shifted, and a stranger's voice. The results showed greater activity in the auditory cortex when the participants listened to their own voice pitch-shifted and a stranger's voice compared to their own unperturbed voice. The researchers suggest that this suppression of the auditory cortex helps to distinguish between internally and externally produced sounds.

Behroozmand et al. (2009) performed a similar study with 15 participants but delayed their pitch-shifted voice by 500ms, allowing them to measure their brain activity without the influence of speaking-induced suppression, which is typically observed at the onset of speech. Results showed increased activity in the auditory cortex in response to pitch-shifted speech compared to unperturbed speech. Interestingly, the activity was greater for smaller rather than larger shifts in pitch. The researchers suggest that responsiveness is enhanced during speech in order to monitor and correct any mispronunciations and that larger pitch shifts provoked smaller responses because they are not reflective of typical speech errors.

The results of these studies suggest that speaking-induced suppression and enhancement contribute to speech perception and that a reduced or delayed response in the auditory cortex may indicate a lack perception of self-produced speech. However, Sato (2022) observed that audiovisual feedback accelerated auditory responses in a group of 20 participants when compared to audio only feedback. Consequently, visual feedback may be able to compensate for reduced auditory responsiveness.

Experience: When a student is struggling to perceive a sound, I usually give them more audio-based perception exercises. **Reflection:** Students usually improve their perception after performing audio-based perception exercises. **Thoughts:** However, I realise now that they may progress more quickly with audiovisual-based perception exercises. **Action:** In view of this, I will encourage my students watch the jaw, mouth and lips during perception exercises. In this way they will benefit from accelerated auditory responses much in the same way as Sato (2022).

Feedback

Katz & Mehta (2015) demonstrated the benefits of visual feedback when they tested 5 participants' ability produce a foreign speech sound with and without visual feedback. The results demonstrated a significant improvement in accuracy with the assistance of visual feedback.

(Ballard et al., 2012) observed a similar benefit of visual feedback in 12 participants' ability to produce a foreign speech sound. However, the group of 6 participants which received constant feedback showed reduced retention when tested 1 week after training compared to the group of 6 participants that received limited feedback.

These studies suggest that, although visual feedback may facilitate the perception and production of speech, it may hinder speech motor learning in the long-term. Furthermore, both studies provided visual feedback via electropalatography, which is not readily available to most foreign language students. Despite this, students may obtain a similar benefit by focusing on articulatory gestures, such as lip shape and jaw movement (Navarra & Soto-Faraco, 2007).

Another way in which feedback may be used to improve perception is through recasts, which is when a teacher corrects a student's pronunciation mistake by modelling the correct form (Zhang & Liao, 2023). For example, Saito & Akiyama (2017) observed an improvement in the comprehensibility of 15 participants when error feedback was given in the form of recasts during conversation lessons.

Zhang & Liao (2023) observed a similar benefit in a group of 30 participants and noted a correlation between auditory processing aptitude and task performance – participants who demonstrated higher aptitude for auditory acuity performed better in perception tests following recast training whereas participants who demonstrated higher aptitude for audio-motor integration performed better in production tests. The researchers suggest that the benefits of recasts come from their unique ability to practice both perception and production skills by modelling the correct pronunciation and providing an opportunity for the student to reproduce it.

Recasts may also have contributed to the contradictory results of studies into perception and production-based training. For example, Lee et al. (2020, p. 5) gave corrective feedback “by way of repeating the targets with an overemphasis on the stress and syllabic breakdown or by demonstrating the proper clapping rhythm” and “these errors were discussed, with the instructor exaggerating the lip or tongue positions while producing the phonemes until the

students could recognise the difference between the phonemes". This suggests that the students practiced the perception of any mistakes and maybe even the production.

In contrast, in the Li (2024 p. 238–239) study "the correct answer was immediately provided" and "feedback on the responses was provided immediately after a response was made; a correct response triggered a ding sound, and an incorrect response triggered a buzz sound". This suggests that the students did not necessarily have the opportunity to perceive or produce any mistakes, only that their responses were marked as correct or incorrect.

Experience: I frequently use recasts and articulatory gestures to give feedback to my students. **Reflection:** Students usually improve after receiving feedback in the form of recasts and articulatory gestures. **Thoughts:** However, I realise now that visual feedback may be detrimental in the long-term. **Action:** In view of this I will provide visual feedback only where recasts fail.

Conclusion

Several factors influence a person's ability to perceive their pronunciation of a foreign language including education, experience, age, motivation and anxiety but, all else being equal, it is auditory processing aptitude which determines success (Doughty, 2019; Kachlicka et al., 2019; Saito, Cui, et al., 2022; Saito et al., 2020; Shao et al., 2023; Suzukida, 2021). This means that some people have a natural ability to distinguish foreign speech sounds and reproduce them, while others find it more challenging. Despite this, results from studies into auditory processing suggest that the following strategies may compensate for low auditory processing aptitude:

- Perception-based exercises, such as phoneme identification, may help students with higher auditory acuity aptitude (Lee et al., 2020; Sakai & Moorman, 2018; Shao et al., 2023).
- Production-based exercises, such as shadowing, may help students with higher audio-motor integration aptitude (Li, 2024; Shao et al., 2023).
- General auditory and musical training may transfer to the perception of foreign language speech sounds (Kempe et al., 2015; Saito, Petrova, et al., 2022; Suzukida, 2021).
- Targeted warm-up exercises, such as syllable pair repetition, may facilitate the perception of target speech sounds (Perron et al., 2024).
- Recasts are an effective way of providing pronunciation feedback (Lee et al., 2020; Saito & Akiyama, 2017; Zhang & Liao, 2023).

- Visual feedback may facilitate perception, but it should be used sparingly (Ballard et al., 2012; Katz & Mehta, 2015; Navarra & Soto-Faraco, 2007).
- Silent articulation may facilitate perception (Ito et al., 2009; Masapollo & Guenther, 2019; Sato et al., 2013).

Based on these results I intend to implement the following strategy into my lessons: I will be more responsive to my students' unique auditory processing profiles and adapt my methodology accordingly, focussing more on perception or production-based exercises where appropriate. I will also employ a wider range of exercises with students who demonstrate a lower auditory processing aptitude, including non-speech sound perception-based exercises and silent articulation. I will start each lesson with targeted warm-up exercises and provide feedback visually only where recasts fail.

Experience: I found reflective writing to be the most challenging part of this essay because I have never done it before. **Reflection:** I spent a significant amount of time trying to understand it on my own before asking for help from my tutor. **Thoughts:** I would have saved time if I had discussed it with my tutor earlier. **Action:** In view of this, I will arrange tutorials earlier if future modules include tasks which are new to me.

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Appendix

Personal Development Plan

Objective	Action	Resources	Timescale
Understand how foreign language learners can improve perception of their own pronunciation	Complete Module 1	UWTSD library	01/11/2024
Be more responsive to students' auditory processing profiles	Screen students and focus more on perception or production-based exercises where appropriate.	• https://sla-speech-tools.com/research • Target language • Audio files • Video files	Continuous
Facilitate the perception of target pronunciation features	• Allow more time for warm up exercises and tailor them to the students' specific needs. • Encourage students to silently imitate the audio during perception exercises. • Do more audiovisual-based perception exercises.	• Target language • Audio files • Video files	Continuous
Optimise the feedback of pronunciation mistakes	Provide visual feedback only where recasts fail.	• Target language • Articulatory gestures	Continuous
Improve general auditory processing	Incorporate non-speech sound perception exercises into lessons.	• Guitar • Slide	Continuous
Work more efficiently	Book tutorials and discuss concerns earlier.	Zoom	Continuous